ELECTRONICS WORLD

+ WIRELESS WORLD

JANUARY 1992 £1.95

Denmark DKr. 70.00
Germany DM 15.00
Greece Dra. 760
Holland Dfl. 14
Italy L 7300
IR £3.30
Spain Pts. 780
Singapore S$ 12.60
USA $6.70

HISTORY

Marconi's first experiments

SPOTLIGHT

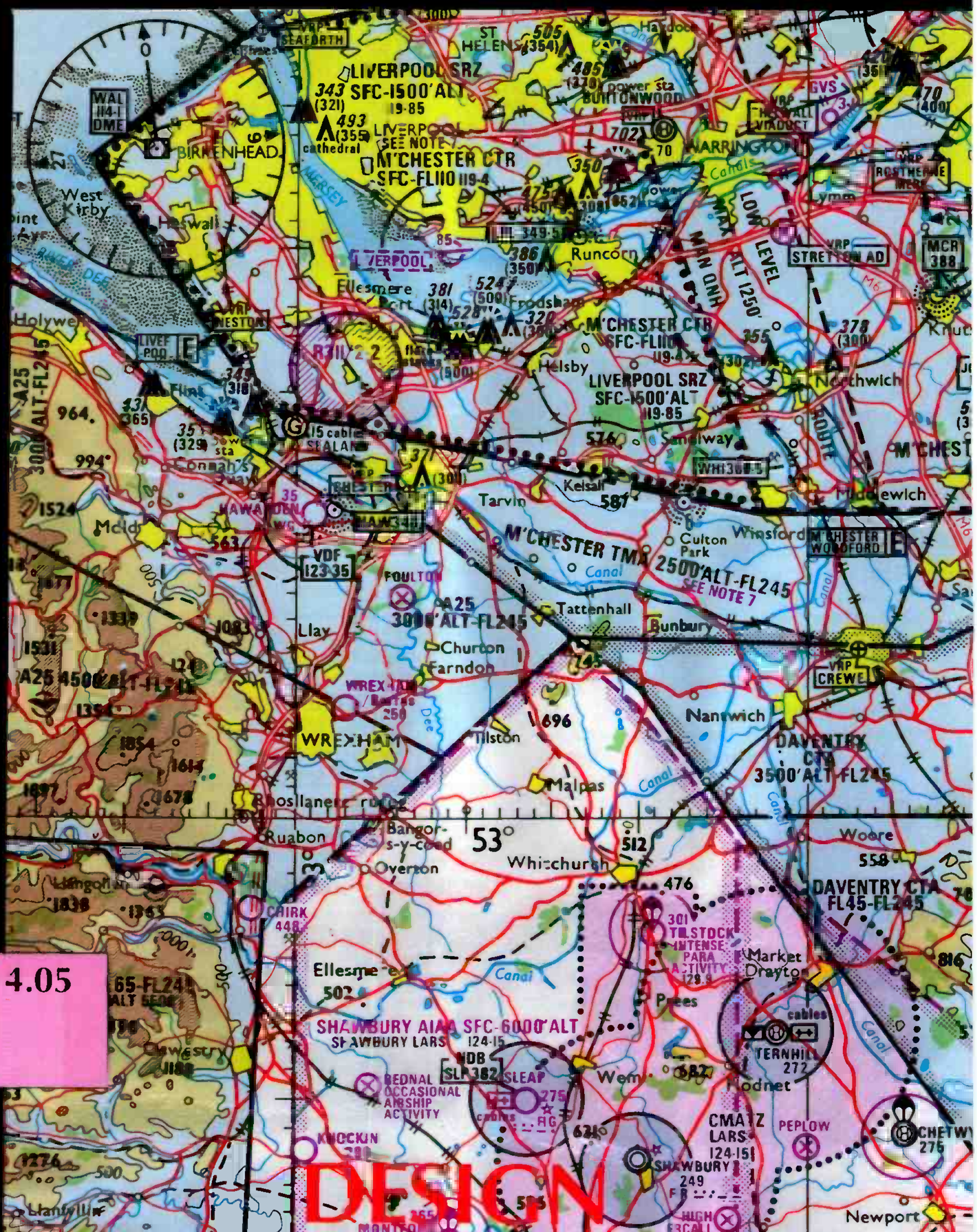
The perfect micropower op amp?

REVIEW

PC based speaker testing

SIMULATION

Working with PSpice



DESIGN

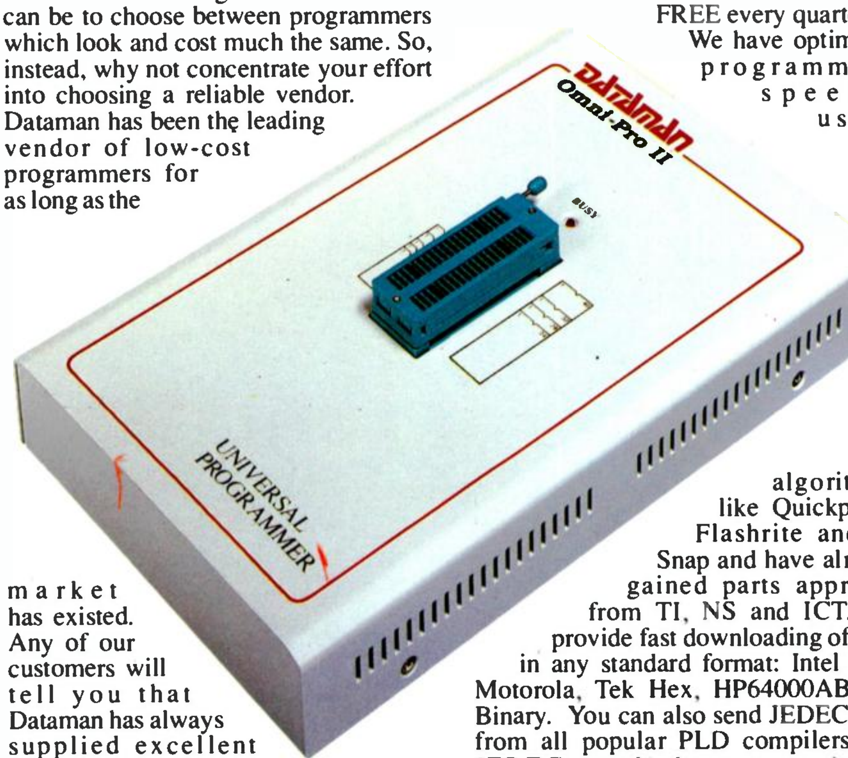
Electronic fluxgate compass

FREE SOFTWARE* PSpice 4.05
Zetex transistor models

*circulation only. See p6 for details.

Omni-Pro II - The Next Generation

When you get a new product, what are your main concerns? Freedom from frustration is certainly one important consideration, for your time is valuable. You will want a product which is reliable and sophisticated, yet simple to use, with clearly written documentation. You will be looking for a high standard of technical support and regular upgrades for the product.
We at Dataman recognise how difficult it can be to choose between programmers which look and cost much the same. So, instead, why not concentrate your effort into choosing a reliable vendor. Dataman has been the leading vendor of low-cost programmers for as long as the market has existed. Any of our customers will tell you that Dataman has always supplied excellent well-supported products. That's why we're still here! We take technical support seriously. We give you your money back, if you're not satisfied. These are important points to consider. But now let's take a look at some of the special benefits of owning Omni-Pro II.



What Benefits?

Well, for instance, the interface is not via the computer's parallel port, which is speed-limited, and probably connected to your printer. A dedicated plug-in half card performs fast data transfers.
The software is a professional package in full colour that will run in only 400K of RAM. What's more it will run on any PC/AT or compatible - even the latest 486 machines. That's because Omni-Pro II has its own independent clock - some programmers rely on the computer for timing, and won't work with faster machines.
Ground pins are connected by relays - not by logic outputs. Some vendors won't approve programmers which don't ground pins in this way.
The 40-pin Textool socket can be changed without even having to remove the cover. A complete range of PLCC adapters is available.

Truly Universal

Omni-Pro II has universal pin-drivers which will accommodate a very wide selection of parts. You can program BIPOLARS, PROMS, E/EEPROMS, PALS, GALS, FPLAS, PEELS, E/EEPLDS and MICRO-CONTROLLERS. The latest FLASH EPROMS are supported too. The list has 1250 devices already and substantial numbers of new devices will be added FREE every quarter.
We have optimised programming speeds, using algorithms like Quickpulse, Flashrite and TI Snap and have already gained parts approval from TI, NS and ICT. We provide fast downloading of files in any standard format: Intel Hex, Motorola, Tek Hex, HP64000ABS or Binary. You can also send JEDEC files from all popular PLD compilers and JEDEC standard vector testing is supported: a full array of test condition codes can be generated.

Remember - you get a 30 day money-back guarantee, FREE quarterly software updates and FREE technical support - as much as you need. Phone now for a free Demo Disk and up-to-date Device-List.

Omni-Pro II comes with a FREE copy of NS's superb Open Programmable Architecture Language - OPAL Junior.

Omni-Pro II - complete £495

Gang-of-eight Programmer.....£395

This production programmer from Dataman can handle all 25 and 27 pin EPROMs up to 512K bits. Programs eight copies from a master EPROM, or from an object file. The G8 offers fast programming methods and three, user-selectable programming voltages. G8 is clearly designed for the busy workshop being supplied, as standard, in a high quality steel case.

Software Development from £195

Dataman's Software Development Environment, **SDE**, comprises a two-window Editor, Macro Assembler, Linker, Librarian, Serial Comms and intelligent Make facility. The latter reassembles selectively just those files you have edited, links them and downloads the object-code to your Emulator or Programmer. It's quick and painless. If the assembler finds a mistake it puts you back in the Editor at the right place to fix it.
The Multi-Processor version supports all common micros - please ask for list. The Disassembler makes source files out of object code - from a ROM, for example. SDE is not copy-protected.

SDE Multi-processors & Disassemblers..........£695
SDE Multi-processors (includes 82 micros) ...£395
SDE Single-processor.....................................£195

OPAL from NS £297

Are you looking for a PLD design tool? Then OPAL could be just what you need. It supports state machine, truth table and Boolean equation entry, also optimisation, verification and implementation, for a great many PLDs.

Erase an EPROM in ten seconds!

Simply hold the gun right over the EPROM's window and squeeze the trigger. The strobe eraser puts out intense UV light at the right wavelength (253.7nm). Erase EPROMS on the bench, in the PCB or in the programmer.

Strobe Eraser...........................£175

UK customers please add VAT. Major credit cards accepted. UK delivery available next working day.

DATAMAN

Station Road, MAIDEN NEWTON, Dorset DT2 0AE, England
Phone 0300-20719
Fax..................................0300-21012
Telex 418442
Bulletin Board...............0300-21095
(300/1200/2400/9600 V. 32)

CIRCLE NO. 101 ON REPLY CARD

CONTENTS

FEATURES

REGULARS

In next months issue: Receiving teletext on the PC. Laurence Cook describes in detail the hardware/software mix to download teletext pages onto a PC. The age of the electronic newspaper has arrived.

FREE PSPICE V4.05 software + Zetex transistor models

See p6 for details...

CITIZEN

ALWAYS A GOOD IDEA

DOT MATRIX & NOTEBOOK PRINTERS

Silica presents some great offers on the award winning range of high quality matrix printers from Citizen. Each Citizen printer is built in the UK to exacting standards, ensuring superb reliability and output. Our confidence in Citizen's quality is such that we are pleased to include a 2 year guarantee with every printer. Plus, if you buy a Citizen printer from us, we will give you the Silica Systems Printer Starter Kit (worth £29.38), *FREE OF CHARGE!*

FREE DELIVERY
Next Day - Anywhere in the UK mainland

FREE STARTER KIT
Worth £29.38 - With every Citizen printer from Silica

2 YEAR WARRANTY
Silica offer a 2 year warranty (including the printer head) with every Citizen printer from Silica.

WINDOWS 3.0
Free Windows 3.0 driver. Included with the Silica Starter Kit.

FREE COLOUR KIT
With every Swift 9 and Swift 24e printer.

FREE HELPLINE
Technical support helpline open during office hours.

MADE IN THE UK
Citizen printers are manufactured to high standards.

9 PIN PRINTER

144 CPS — 80 COLUMN

- Citizen 120D+ - 9 pin - 80 column
- 144cps Draft, 30cps NLQ
- 4K Printer Buffer + 2 Fonts
- Parallel Interface as Standard
- Graphics Resolution: 240x240dpi
- Epson and IBM Emulation
- Pull tractor & bottom feed
- FREE Silica Printer Starter Kit

RRP: £199
STARTER KIT £25
TOTAL RRP: £224
SAVING £109
SILICA PRICE: £115

SERIAL INTERFACE OPTION
The 120D printer is available with a serial interface for £115+VAT. Ref: PRI 2125 - £135.13 inc VAT

£115
+VAT=£135.13 ref: PRI 2120

9 PIN PRINTERS

192 CPS — 80 COLUMN

- Citizen Swift 9 - 9 pin - 80 column
- 192cps Draft, 48cps NLQ
- 8K Printer Buffer + 3 Fonts
- Parallel Interface
- Graphics Resolution: 240x240dpi
- Epson and IBM Emulation
- FREE Colour Kit
- FREE Silica Printer Starter Kit

RRP: £239
COLOUR KIT £38
STARTER KIT £25
TOTAL RRP £302
SAVING £123
SILICA PRICE: £179

£179
+VAT=£222.06 ref PRI 2209

192 CPS — 136 COLUMN

- Citizen Swift 9x - 9 pin - 136 column
- 192cps Draft, 48cps NLQ
- 8K Printer Buffer + 3 Fonts
- Parallel Interface
- Graphics Resolution: 240x240dpi
- Epson and IBM Emulation
- A3 landscape printing
- FREE Silica Printer Starter Kit

RRP: £329
STARTER KIT £25
TOTAL RRP: £354
SAVING: £105
SILICA PRICE: £249

£249
+VAT=£292.58 ref: PRI 2309

24 PIN PRINTERS

216 CPS — 80 COLUMN

- Citizen Swift 24e - 24 pin - 80 column
- 216cps Draft, 72cps LQ
- 8K Printer Buffer + 6 Fonts
- Parallel Interface
- Graphics Resolution: 360x360dpi
- Epson, IBM & NEC P6+ Emulation
- FREE Colour Kit
- FREE Silica Printer Starter Kit

RRP: £365
COLOUR KIT £38
STARTER KIT £25
TOTAL RRP: £428
SAVING £169
SILICA PRICE: £259

£259
+VAT=£304.33 ref: PRI 2534

192 CPS — 80 COLUMN

- Citizen 224 - 24 pin - 80 column
- 192cps Draft, 64cps LQ
- 8K Printer Buffer + 2 Fonts
- Parallel Interface
- Graphics Resolution: 360x360dpi
- Epson and IBM Emulation
- Colour Option Available
- FREE Silica Printer Starter Kit

RRP: £269
STARTER KIT £25
TOTAL RRP: £294
SAVING: £95
SILICA PRICE: £199

£199
+VAT=£233.83 ref: PRI 2484

NOTEBOOK PRINTER

64 CPS — 80 COLUMN

- Citizen PN48 Notebook Printer
- Non-impact Printing On Plain Paper
- LASER QUALITY - 64cps
- 4K Printer Buffer + 2 Fonts
- Rear and Bottom Paper Loading
- Parallel Interface
- Graphics Resolution: 360x360dpi
- Epson, IBM, NEC P6 & Citizen Emulations
- Power: Mains, Battery or Car Adaptor
- FREE Silica Printer Starter Kit

RRP: £325
STARTER KIT £25
TOTAL RRP: £350
SAVING: £101
SILICA PRICE: £249

£249
+VAT=£292.58 ref PRI 2100

24 PIN PRINTER

192 CPS — 136 COLUMN

- Citizen Swift 24x - 24 pin - 136 column
- 192cps Draft, 64cps LQ
- 8K Printer Buffer + 4 Fonts
- Parallel Interface
- Graphics Resolution: 360x360dpi
- Epson, IBM and NEC P6 Emulation
- A3 landscape printing - FREE Colour Kit
- FREE Silica Printer Starter Kit

RRP: £489
STARTER KIT £25
TOTAL RRP: £514
SAVING £165
SILICA PRICE: £349

£349
+VAT=£410.08 ref: PRI 2574

24 PIN PRINTER

GOLD AWARD Best Budget Printer 1990 Micro Decision

144 CPS — 80 COLUMN

- Citizen 124D - 24 pin - 80 col
- 144cps Draft, 48cps LQ
- 8K Printer Buffer + 2 Fonts
- Parallel Interface
- Graphics Res: 360x360dpi
- Epson and IBM Emulation
- FREE Silica Printer Starter Kit

RRP: £249
STARTER KIT £25
TOTAL RRP: £274
SAVING: £105
SILICA PRICE: £169

£169
+VAT=£198.58 ref PRI 2534

ACCESSORIES

SHEET FEEDERS

PRA 1200	120D		£71.38
PRA 1215	124D/224 Sw9/24/24e		£88.70
PRA 1228	124D/224 Sw9/24/24e		£42.00

SERIAL INTERFACES

PRA 1189	120D+	£56.45
PRA 1209	124D/224 Swift 9	£32.25
PRA 1709	Swift 24/24e	£26.38

32K MEMORY EXPN

PRA 1753	124D/224 Swift 24/24e	£13.10

PRINTER STAND

PRA 1242	124D/224 Sw9/24/24e	£24.03
PRA 1274	Swift 9x/24x	£30.66

ORIGINAL RIBBONS

RIB 3520	120D/Swift 9 Black	£2.91
RIB 3949	Swift 9x Black	£7.15
RIB 3924	124D/224 Sw24/24e Black	£4.20
RIB 3936	Swift 9/24/24e Colour	£15.63
RIB 3248	PN48 Single Strike	£3.61
RIB 3348	PN48 Multi Strike	£3.61

COLOUR KITS

PRA 1236	Swift 9/24/24e	£35.25
PRA 1240	Swift 9x/24x	£35.25

PN48 ACCESSORIES

PRA 1148	PN48 Battery	£51.70
PRA 1155	PN48 Cable Extn	£ TBC
PRA 1162	PN48 Car Adaptor	£ TBC

All prices include VAT and Free delivery

STARTER KIT

FREE!

Worth: £25 +VAT=£29.38

To get you up and running with your new printer from Silica:

- 3½" Disk - Amiga & ST Drivers
- 3½" Disk - Drivers for Windows 3
- 2 Metre Parallel Printer Cable
- 200 Sheets of Continuous Paper
- 100 Continuous Address Labels
- 5 Continuous Envelopes

If you already own a printer, and would like to buy a kit, you may order one (ref: KIT 5500) for £24.95 - £5 off RRP!

SILICA SYSTEMS OFFER YOU

- **FREE OVERNIGHT DELIVERY:** On all hardware orders shipped in the UK mainland.
- **TECHNICAL SUPPORT HELPLINE:** Team of technical experts at your service.
- **PRICE MATCH:** We normally match competitors on a "Same product - Same price" basis.
- **ESTABLISHED 12 YEARS:** Proven track record in professional computer sales.
- **BUSINESS + EDUCATION + GOVERNMENT:** Volume discounts available for large orders.
- **SHOWROOMS:** Demonstration and training facilities at our London & Sidcup branches.
- **THE FULL STOCK RANGE:** All of your requirements from one supplier.
- **FREE CATALOGUES:** Will be mailed to you with offers and software/peripheral details.
- **PAYMENT:** By cash, cheque and all major credit cards.

Before you decide when to buy your new printer, we suggest you think very carefully about WHERE you buy it. Consider what it will be like a few months after you have made your purchase, when you may require additional peripherals or software, or help and advice. And, will the company you buy from contact you with details of new products? At Silica Systems, we ensure that you will have nothing to worry about. We have been established for over 12 years and, with our unrivalled experience and expertise, we can now claim to meet our customers requirements with an understanding which is second to none. But don't just take our word for it. Complete and return the coupon now for our latest Free literature and begin to experience the "Silica Systems Service".

MAIL ORDER HOTLINE **081-309 1111**

SILICA SYSTEMS

MAIL ORDER:	1-4 The Mews, Hatherley Rd, Sidcup, Kent, DA14 4DX	Tel: 081-309 1111
Order Lines Open: Mon-Sat 9.00am-6.00pm	No Late Night Opening	Fax No: 081-308 0608
LONDON SHOP:	52 Tottenham Court Road, London, W1P 0BA	Tel: 071-580 4000
Opening Hours: Mon-Sat 9.30am-6.00pm	No Late Night Opening	Fax No: 071-323 4737
LONDON SHOP:	Selfridges (1st Floor), Oxford Street, London, W1A 1AB	Tel: 071-629 1234
Opening Hours: Mon-Sat 9.30am-6.00pm	Late Night: Thursday until 8pm	Extension 3914
SIDCUP SHOP:	1-4 The Mews, Hatherley Rd, Sidcup, Kent, DA14 4DX	Tel: 081-302 8811
Opening Hours: Mon-Sat 9.00am-5.30pm	Late Night: Friday until 7pm	Fax No: 081-309 0017

To: Silica Systems, Dept EWWO-0192-55, 1–4 The Mews, Hatherley Rd, Sidcup, Kent, DA14 4DX

PLEASE SEND A CITIZEN COLOUR CATALOGUE

Mr/Mrs/Ms: .... Initials: .... Surname: ....

Address: ....

Postcode: ....

Tel (Home): .... Tel (Work): ....

Company Name (if applicable): ....

Which computer(s), if any, do you own? 55D

E&OE - Advertised prices and specifications may change - Please return the coupon for the latest information.

CIRCLE NO. 142 ON REPLY CARD

EDITOR
Frank Ogden
081-661 3128

DEPUTY EDITOR
Jonathan Campbell
081-661 8638

DESIGN & PRODUCTION
Alan Kerr

EDITORIAL ADMINISTRATION
081-661 3614

ADVERTISEMENT MANAGER
Jan Thorpe
081-661 3130

SALES MANAGER
Shona Finnie
081-661 8640

ADVERTISING ADMINISTRATION
Kathy Lambart
081-661 3139

ADVERTISING PRODUCTION
Neil Thompson
081-661 8675

CLASSIFIED SALES EXECUTIVE
Pat Bunce
081-661 8339

PUBLISHER
Rob Marcus
081-661 3930

FACSIMILE
081-661 8956

ARE WE HARD TO GET?

Just one phone call to our Circulation Actionline brings instant assistance.
Some readers have experienced problems in finding copies of *EW + WW* on newstrade shelves – so we've decided to do something about it. If you have any difficulty purchasing your copy, call our Circulation Actionline. We will follow up your complaint and, more importantly, make sure you can obtain your copy.
Call Olive Kahn on 081-661 8620 and let us tackle your supply problems.

REED BUSINESS PUBLISHING GROUP

Raising the national interest

As I sit here writing this the Maastricht summit approaches. By the time this gets read, the meeting of European heads of state will be largely forgotten. But there are some things which deeply affect industries dependent on long term investment, particularly electronics.

The Government tells us that we must not lose control of our currency, that economic and monetary union would place a straightjacket on the UK treasury, that we would no longer be in control of our own destiny. For instance, the Government expresses concern that subjugation to a European treasury would restrict its freedom to use interest rates as an instrument of economic control.

I submit that the Government has already relinquished control of UK monetary policies, a factual observation without any particular political bias. Mrs Thatcher came into office determined to free the UK from the strictures of a command economy, the notorious stop-go polices of previous conservative and labour chancellors alike. Her crystal clear view of the world determined that everything would find its own level and purpose if it could be freed from the dead hand of bureaucratic control.

She applied this to the economy with a vengeance. In 1981, the Treasury lifted all foreign exchange controls. International Money could come and go as it pleased. It could walk across national borders, it could dictate its own terms to the helpless local development authorities crying out for inwards investment, it could play whole countries off against each other for its favour.

Most countries responded with visible and invisible barriers. For instance the French telecommunications industry put together a careful procurement policy which effectively ruled out the purchase of anything which wasn't designed and built in France. The Japanese hid their industries behind impenetrable local standards for imported goods while at the same time orchestrating their outward investments to largely exclude leading technology transfer.

The freewheeling Reaganomics of the US in the eighties embodied much of Mrs Thatcher's vision of a totally free market. Its application very nearly killed the US semiconductor industry. It actually succeeded in the destruction of a US owned consumer manufacturing base.

The relaxation of credit controls has been equally damaging to the UK: when International Money packs its bags to live overseas, the Treasury can do no more than rack up the interest rates to entice it back. For instance, an engineering company needing cash for investment has to guarantee returns to International Money which match those on offer from the Treasury – why should Money spend its time on short term holiday in the electronics industry when it can get a better return from the banks? Although interest rates have come down some four points since their peak, they are still around eight points above the inflation rate, an historic high.

Mrs Thatcher's vision of a deregulated economy has placed our national industries in direct competition with the Treasury for investment funds, a truly extraordinary situation. After all, it would seem logical that our companies should compete against their foreign counterparts rather than the banks.

The loss of money controls with the exception of the interest rate is the same problem which has successively bedeviled chancellors Howe, Lawson, Major and Lamont. Going for a single euro-currency is simply recognition that a UK chancellor is now powerless.

Why not hand over the keys of office to Brussels? It currently stands more chance than we do of bringing International Money to heel. **Frank Ogden.**

Electronics World + Wireless World is published monthly By post, current issue £2.25, back issues (if available) £2.50.
Orders, payments and general correspondence to **L333, Electronics World + Wireless World, Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS.** Telex:892984 REED BP G Cheques should be made payable to Reed Business Publishing Group.
Newstrade: IPC Marketforce, 071 261-6745.
Subscriptions: Quadrant Subscription Services, Oakfield House, Perrymount Road, Haywards Heath, Sussex RH16 3DH. Telephone 0444 441212. Please notify a change of address. Subscription rates 1 year (normal rate) £30 UK and £35 outside UK.
USA: $116.00 airmail. Reed Business Publishing (USA), Subscriptions office, 205 E. 42nd Street, NY 10117.
Overseas advertising agents: France and Belgium: Pierre Mussard, 18-20 Place de la Madeleine,Paris 75008. United States of America: Ray Barnes, Reed Business Publishing Ltd, 205 E. 42nd Street, NY 10117.Telephone (212) 867-2080. Telex 23827.
USA mailing agents: Mercury Airfreight International Ltd Inc, 10(b) Englehard Ave, Avenel NJ 07001. 2nd class postage paid at Rahway NJ Postmaster. Send address changes to above.

©Reed Business Publishing Ltd 1992 ISSN 0266-3244

REGULARS

UPDATE

Spacecraft antenna put to the test

CATR control room at Queen Mary & Westfield College overlooking the range's test chamber.

Queen Mary & Westfield College, part of the University of London, has opened a millimetre-wave compact antenna test range (CATR) allowing radiation characteristics of spacecraft antennas to be measured at frequencies up to 200GHz in a clean room environment.

The facility will allow RF testing of AMSU-B (advanced microwave sounding unit), a satellite-borne microwave radiometer funded by the UK Meteorological Office. The instrument is being developed by British Aerospace to fly on future NOAA series weather satellites and the European and US Polar platforms.

Funding for the laboratory has been provided mainly by the UK Science & Engineering Research Council (Serc) under a rolling grant system.

The CATR consists of special reflector panels, a custom-built transparent tenting and air conditioning system, and a rail-mounted positioning system and turntable – all housed in an anechoic chamber.

Computer controlled test and measurement equipment includes an HP 9000 model 310 desk-top computer and a 375 Unix workstation connected to an Ethernet lan for pattern processing and file transfer.

PC on a chip

A single chip ms-dos computer is now a bit nearer with the release of a single device which integrates an 80C86 processor, systems logic, CGA graphics and a serial port.

Produced by US semiconductor company Chips and Technologies, the 8680 also features power management, memory controller and device emulation capabilities within a low cost 160 pin VLSI package.

The CPU has the complete instruction set of the 80C86 together with a few new ones to extend the operating environment. The fully static device runs up to 14MHz, realising three mips performance.

Eastern Europe open

The fall of the Berlin wall and the opening up of Eastern Europe to Western style capitalism is prompting a number of initiatives and potential big money contracts for western companies. But the unsteady political climate is still hitting military expenditure.

In Britain, the Royal Society is pushing for closer scientific relationships between the UK and the USSR and other Eastern Bloc countries by encouraging young postdoctoral scientists from those countries to make visits to the UK to acquire new scientific skills.

It has already signed agreements with Hungary, Poland and Czechoslovakia which will allow 12 postdoctoral fellowships from each country to be made available annually for visits to the UK.

Support for the Hungarian programme has been provided by the Foreign and Commonwealth Office (FCO) and the Soros Foundation and the first 12 fellows have come to the UK.

The Royal Society has also received a grant from the Wolfson Foundation plus extra support from the FCO to start the Polish and Czechoslovakian programmes.

A separate programme for the USSR has been developed with financial support from the FCO and the Society's Parliamentary Grant-in-aid.

In the US, the National Association of Broadcasters (NAB) is trying to establish sister station agreements between broadcast stations in the US and USSR. The initiative will involve the support of the US Information Agency which is responsible for the Voice of America.

Edward Fritts, NAB president, says the programme's objective will be to strengthen the cultural, educational, economic, and professional ties between participating US and USSR stations.

Cable & Wireless has signed its first joint venture agreement with Russian partner Comincom to establish and operate digital overlay networks in Nakhodka and Sakhalin in eastern Russia.

These will use international telephone, fax and data communications from C&W subsidiary Hong Kong Telecom. Each network will use 34Mbit/s microwave links interconnecting the earth stations and exchanges. Initially radio links will connect customers in Nakhodka and cable

UK particle detector for US

An advanced particle detector, designed and built at the Science and Engineering Research Council's Rutherford Appleton Laboratory is ready for shipment to the Stanford Linear Accelerator Centre. When installed in the accelerator it will detect and measure particles containing charm and beauty quarks from high energy reactions at the SLAC Linear Collider.

Quarks decay rapidly – lasting only about a million millionth of a second.To detect these particles and record their very short flight paths prior to decay, the design incorporates 480 charge coupled devices in a mosaic. Each CCD consists of a matrix of charge storage elements; in all there are 120million. This is the first time that so many CCDs have been used together in a single detector, giving a unique tracking precision of 0.005mm

Emergency call: Police forces have been turning to electronics to improve their response to emergencies. For example, a version of Walton Radar Systems' air traffic control digital voice recorder, Hindsight-DVR, can be used to allow 999 distress calls to be replayed rapidly allowing crash sites to be identified with pin-point accuracy within minutes of an incident. Avon & Somerset constabulary is having a Racal-Datacom data and voice communications network installed across 56 police stations in the area. Another division of the firm, Racal Recorders, is installing its Callmaster voice processing system at Hampshire Police headquarters in Winchester. The force is only the second customer for Callmaster; the first was Tomy Toys.

Betacam boost

There's still life in the old video dog. Broadcast Television Systems (BTS) is sticking with the Betacam format for professional post-production applications and is joining with Sony in developing digital Betacam, a 0.5in components digital video recorder suitable for the 625/50 market.

The recorder, planned for 1993, will be able to play analogue and digital Betacam SP recordings. BTS plan to push for this format to become a worldwide production standard.

Pieter van Dalen, BTS president, says that because Betacam has proven itself to be a durable tape standard over the last ten years, BTS believes it is the best solution for the multiple needs of this industry.

for business - sometimes

distribution links in Sakhalin.

Lord Young of Graffham, C&W's executive chair, says: "We have worked with Comincom and our other Russian partners throughout the recent developments in Russia. We are aware that these two joint ventures are just a start."

Comincom was established to build up and operate separate digital overlay networks in the USSR and its main activities are to provide commercial international telecommunications services and establish and operate international telecommunications centres and local networks to connect customers to them.

A Kozhanov, director general of Comincom, said he thought that such projects "will make our countries still more friendly and help Russia become closer to the world community."

Military upset

These closer links have, not surprisingly, hit into military budgets and have upset a number of western companies. The attitudes of these countries were summed up by a recent report from market watchers Frost & Sullivan.

The report commented: "Although democracy's return to fashion has turned the tide in terms of European security, it has prompted many politicians to make defence cuts instead of recognising that changes such as these require more defence rather than less."

This followed the research group's prediction that the European market for military electro-optic products is forecast to grow only marginally from US$1.17 billion in 1991 to US$1.35 billion by the end of 1996.

The report goes on to say that "military electro-optics are, for the most part, a highly defensive activity, and so Europe could spend a great deal more on electro-optic systems without breaking treaties or inviting aggression. It is self-justifying in that an electro-optic technique generally calls for development of a counter measure, and a counter measure requires development of a new electro-optic technique, and so on."

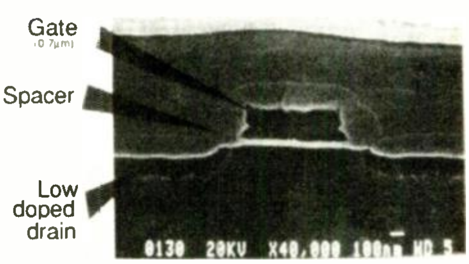
With attitudes such as these, it is clear to see why the military merry-go-round goes on, perhaps more slowly, but not as yet in reverse.

Joint venture for 0.7µm asic design

A 0.7µm cmos asic manufacturing process has been developed as part of the Jessi Logic and Esprit Acces projects. Several million ecu of investment have been committed for a new wafer stepper, metal sputters and etchers.

Until now 0.7µm has only been available internally in semiconductor companies where the production of a new standard part, such as a dram, will typically involve adjustments to the fabrication process and equipment to improve yields. This is not suitable for asic customers who need a stable process with short turnaround times.

The new process, called ECPD07, was jointly developed by ES2 and Philips and has already been installed by ES2 where, compared with the firm's existing 1µm process, it results in an area shrinkage to 64% from a previous size; speed improvement is 50%.



The ECPD07 0.7µm process resulted from a joint venture

Writing on the wall for domestic teletext?

The government's sale of teletext capacity on the commercial TV channels to big business is coming under heavy criticism for robbing the existing public service of 40% of its capacity.

The move has been made by the Home Office to increase the capacity available for commercial services sixfold. Capacity will now be sold off to the highest acceptable bidders, with the cash payable to the Treasury. Critics point out that money from the sale goes straight to the government, but the seven million people who have already bought teletext sets, and are buying at a rate of 0.1 million a month, will get a reduced service after the end of next year.

Behind the scenes the Independent Television Commission has fought hard to protect consumers who could have lost the entire service.

In fact the business capacity generated by the public cuts is so large that the ITC has had to split it into three packages for auction. National Transcommunications Ltd, recently sold by the Home Office to Mercury Asset Management, wins too, because NTL has a monopoly on carrying commercial services until 1996. The general public will have no access to these new services because they will be encrypted with decoders available only to closed user groups.

The ITC is also auctioning off the public service – to the highest bidder – with the Treasury getting the money. But the capacity for this service is so reduced that the ITC will offer only one franchise, with capacity spread over the two channels, ITV (soon to be called Channel 3) and Channel 4.

Although the consumer issues are clouded by a tangle of complicated technical facts and difficult comparisons, the 40% cut in public teletext capacity means a clear loss to the viewer. Viewers will either find fewer pages of text information from which to choose; or will have to switch channels to find them. Or it will take longer for selected pages to appear on screen. The only way viewers will be able to compensate for the capacity loss is to buy a new TV set which contains a large digital memory capable of storing pages in anticipation of use. These sets will be far more expensive than conventional sets.

The European teletext system slots digital data, running at a speed of around 7MHz, into the spare picture lines, or vertical blanking interval, which make up the black borders at the top and bottom of the screen.

Teletext TV sets decode and display this data as pages of information.

There are 25 VBI lines, but the maximum number available for teletext, without risk of interference to non-teletext TV sets, is 12. Currently Channel 4 uses all 12 whereas ITV sells off one line for commercial closed group business services.Two years ago the Home Office proposed that all the available lines should be auctioned off to the highest bidder, either private or commercial. The Independent Broadcasting Authority, now the ITC, feared that the highest bidders would be business users and there would be no public teletext on commercial TV. The IBA and ITC pushed the Home Office to a guarantee of 6 lines for public teletext and then 7.5 lines.

The ITC will now grant just one licence to run for ten years from January 1 1993. This will cover both ITV/Channel 3 and Channel 4. Although the single licence creates a pool of 15 lines, viewers will have to switch channels if the service operator puts different text information on each channel.

ITC describes this as a 30% reduction, but the figure is misleading because it is based on the situation in the spring, when broadcasters were using fewer lines. The real reduction, from 12 to 7.5, is nearly 40%.

Putting on a brave official face, the ITC reassures viewers that future technical developments will give the appearance of faster access from fewer lines – enabling technology is extra memory in the TV set.

Each page of text needs 1Kbyte. Most teletext sets have only a one page store. If extra kilobytes of memory are added, the receiver can store extra pages in anticipation of selection. But as the TV set has no way of knowing what pages the viewer will select, this is a hit and miss approach.

The ultimate solution – enough memory to store all pages – is prohibitively expensive. Manufacturers already add around £70 to the price of a TV set for a decoder and single page store which costs less than £5 to fit.

By restricting public teletext, the government has released three lines per channel for commercial services. Under the Broadcasting Act 1990, these can be used for closed user group business information, such as chain-store stock control and banking transactions. This gives a total of six lines, a six-fold increase on the current business capacity.

The ITC has split these into three franchises. One will get two lines on Channel 3, another will get two lines on Channel 4 and the third will get one line each on Channels 3 and 4. The auction has begun, without public consultation. Fourteen businesses have already expressed interest in bidding.

Barry Fox

FREE PSPICE OFFER TOKEN

GET YOUR FREE COPY of PSpice v4.05 evaluation package – with the compliments of ARS Microsystems and Electronics World.

Version 4.05 comes as a set of three 1.2MB 5.25in disks and requires a PC/AT fitted with a hard disk to run. Although limited in the number of nodes available, this version will run useful circuit models.

Semiconductor company Zetex is supplying a fourth disk with the set containing transistor models of its products for use with the package.

To get your three plus one disk set, cut out the software token from this page (photocopies are not acceptable) and return it together with your name and address (clearly written please) to:

Electronics World software offer
ARS Microsystems
Herriard Business Centre
Alton Road
Basingstoke
Hants RG25 2PN

This offer applies to UK readers only

RF MODULAR EQUIPMENT

LOW NOISE GASFET PREAMPLIFIERS

Two stage Gasfet preamplifiers High Q filters Masthead or local use

TYPE 9006 Tuned to your specified frequency in the range 5-250 MHz NF 0 6 dB Gain 10-40 dB variable 50 ohms — £94
TYPE 9006FM As Above Band II 88-108 MHz 75 ohms — £94
TYPE 9002 Tuned to your specified channels in bands IV or V NF 0 7 dB Gain 25 dB adjustable 75 ohms — £123
TYPE 9004 Aligned to your specified frequency in the range 250-1000 MHz NF 0 7 dB Gain 25 dB adjustable 50 ohns — £123
TYPE 9035 Mains power supply for above — £53
TYPE 9010 Masthead weatherproof unit for above amplifiers — £15

WIDEBAND AMPLIFIERS

Monolithic microwave integrated circuits in a fully packaged microstrip format Full-wave shottky diode protected inputs Temperature compensated bias circuitry Internal voltage regulation

TYPE 9301 100 KHz-500 MHz Nf 2 dB at 500 MHz Gain 30 dB Power output + 12 5 dBm, 18 mW — £165
TYPE 9302 10 MHz-1 GHz NF 2 dB at 500 MHz Gain 30 dB Power output + 12 5 dBm, 18 mW — £165
TYPE 9008 Gasfet 10 MHz-2 GHz NF 2 5 dB at 1 GHz Gain 10 dB Power output + 18 dBm, 65 mW — £165
TYPE 9009 Gasfet 10 MHz-2 GHz NF 3 8 dB at 1 GHz Gain 20 dB Power output +20 dBm, 100 mW — £165

PHASE LOCKED LOOP FREQUENCY CONVERTER

TYPE 9115 Converts your specified intput channels in the range 20-1000 MHz to your specified output channels in the range 20-1000 MHz Minimum input to output separation 10 channels 1mV input, 10 mW output (+10 dBm) Low noise Gasfet frone-end NF 0 7 dB AGC controlled Gain 60 dB adjustable-30 dB Will drive transmitting ampifiers directly — £495

PHASE LOCKED SIGNAL SOURCES

TYPE 8034 Frequency as specified in the range 20-250 MHz Output 10 mW — £154
TYPE 9036 Frequency as specified in the range 250-1500 MHz Output 10 mW — £291

FM/FSK EXCITERS

TYPE 9282 Frequency as specified in the range 20-1500 MHz Output 10 mW Deviation up to ±75 KHz — £348

PLEASE CONTACT US FOR FURTHER TECHNICAL INFORMATION COMPLETE SYSTEMS AVAILABLE. Prices exclude p&p and VAT

RF LINEAR POWER AMPLIFIERS

Tuned to your specified frequency in the range 20-250 MHz or your specified channel in bands I or III. 28V + DC supply

TYPE 9105 10 mW input, 3 watts output — £275
TYPE 9106 500 mW input, 10 watts output — £341
TYPE 9155 3 watts input, 30 watts output — £460
TYPE 9458 5 watts input, 50 watts output Integral forced air cooling and output transistor protection — £750

UHF LINEAR POWER AMPLIFIERS

Tuned to your specified frequency in the range 250-470 MHz 28V + DC supply

TYPE 9213 300 mW input, 3 watts output — £350
TYPE 9124 2-3 watts input, 25 watts output — £484

TELEVISION EXCITER

TYPE 9269 Phase locked loop vestigial sideband miniaturised television modulator with sound channel RF output 10 mW on your specified frequency in the range 40-1000 MHz or channel in bands I, III, IV or V — £299

TELEVISION LINEAR POWER AMPLIFIERS

Tuned to your specified channels in bands IV or V 28V + DC supply

TYPE 9252 10 mW input, 500 mW output — £308
TYPE 9259 500 mW input, 3 watts output — £352
TYPE 9262 500 mW input, 10 watts output — £638
TYPE 9263 2-3 watts input, 15 watts output — £484
TYPE 9266 10 watts input, 50 watts output Integral forced air cooling and output transistor protection — £1919

LINEAR POWER AMPLIFIERS 800-1000 MHz

Tuned to your specified frequency in the range 800-1000 MHz

TYPE 9265 500 mW input, 10 watts output — £484
TYPE 9264 2 watts input, 25 watts output — £840

WIDEBAND LINEAR POWER AMPLIFIERS

TYPE 9306 10 MHz-1 GHz Gain 15 dB Output + 30 dBm, 1 watt — £438
TYPE 9246 1 watt output 100 KHz-175 MHz 13 dB gain — £182
TYPE 9247 4 watts output 1-50 MHz 13 dB gain — £204
TYPE 9051 4 watts output 20-200 MHz 13 dB gain — £204
TYPE 9176 4 watts output 1-50 MHz 26 dB gain — £314
TYPE 9177 4 watts output 20-200 MHz 26 dB gain — £314
TYPE 9173 20 watts output 1-50 MHz 10 dB gain — £374
TYPE 9174 20 watts output 10-160 MHz 10 dB gain — £374
TYPE 9271 40 watts output 1-50 MHz 10 dB gain — £748
TYPE 9172 40 watts output 10-160 MHz 10 dB gain — £748

RESEARCH COMMUNICATIONS LTD
Unit 1, Aerodrome Industrial Complex, Aerodrome Road, Hawkinge, Folkestone, Kent CT18 7AG
Tel: 0303 893631 Fax: 0303 893838

CIRCLE NO. 113 ON REPLY CARD

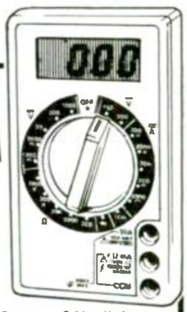
HENRYS

EXCITING **SPECIAL OFFERS!!**

BIG, BIG SAVINGS
HURRY LIMITED STOCKS

32 Range 3½ digit mm
12mm Display
FEATURES 5 Capacitance ranges 6 - resistance ranges to 20M ohm Diode and transistor test AC/DC volts ranges, 5 ranges AC/DC current to 10 amps Also continuity buzzer With leads, battery and instructions
£23.95 UK post etc £2 00 Post free when you Buy Two!

Instrument stockists for ■ Hameg Scopes ■ Black Star ■ Thurlby ■ Thandar ■ Test Lab
Always special offers for callers.



19 range 3 ½ digit mm
FEATURES Pocket Dmm with 12mm display AC/DC volts, 6 ranges DC current to 10 amps 5 resistance ranges Diode test With leads, battery and instructions
ONLY £10.95
UK post etc £2 00 Post free when you Buy Two!

Further Special Instruments Offers - while stocks last
ST300 AC Clamp meter with case 0/600v, 0/300A, 0 -1K ohm **£29.95** M265 Add on Clamp meter for Dmm's 0/1000A **£12.95** DW6060, True power digital watt meter, 0/6kw, 1000 VDC, 750 VAC **£35.95**

SPEAKERS FOR PA, DISCO AND HIGH POWER CAR SYSTEMS
All models available 4 ohms or 8 ohms Carr/pack/ins extra
10" 150watt H/D **Bass Speakers** 34Hz Res Ideal Bass or Subwoofer Huge magnet **£35.95**
8" 75 watt Bass/mid vented coil **£15.95**
12" 90/120 watt Bass/mid vented coil **£21.95**
15" 250 watt (400w max) H/D Bass Huge magnet 28Hz Res 102 dB **£81.95**
LARGE RANGE OF AMPLIFIERS, GRAPHICS, SPEAKERS AND SYSTEMS IN STOCK FOR PA - DISCO AND IN-CAR

OPEN 6 DAYS A WEEK FOR CALLERS OR TELEPHONE ORDERS

ALL PRICES INCLUDE UK VAT

Brand new ASTEC SW mode power supply

Three pin mains socket input on/off switch Output +5 volt 3 75 amp, +12 volt 1 5 amp, -12 volt 0 4 amp 115-230 V A/C Input Size 7 0 x 5 3 x 2 5 ins
ONLY £12.95 (UK Carr etc £2 05)

HENRY'S AUDIO ELECTRONICS
404 EDGWARE ROAD, LONDON W2 1ED
Tel: 071-724 3564/071-258 1831 Fax: 071-724 0322
DISCOUNTS FOR QUANTITY AND EDUCATIONAL

COLOUR CATALOGUE WITH SUPPLEMENTS SEND £4 FO/CHQ Callers £2 00 FREE to Trade/Education (Written Request)

CIRCLE NO. 114 ON REPLY CARD

HALCYON ELECTRONICS

Test equipment, video monitors, amateur radio gear, printers, power supplies, communications, disk drives, multimeters, oscilloscopes, scientific instruments, connectors, component bridges, frequency counters, signal generators, computers.

WAYNE KERR RA200+ADS1 DISP STORE	£2995	VACUUM PUMPS TYP 100MBAR (28L/MIN)	£95
HONEYWELL 612 HUMIDITY/TEMP RECORDERS	£95	ROHDE & SCHWARZ PZN PHASE METER	£125
TEK 5L4N 100KHz S/ANAL. 5110M/F, ETC	£1750	R&S SDR UHF SIG GEN 290-1020MHz	£175
SIEMENS XTC1012 2PEN CHART RECORDER	£395	R&S SCR UHF SIG GEN 950-1900MHz	£195
GOULD BRUSH 260 6CH CHART RECORDER	£395	R&S SMLM POWER SIG GEN 30-300MHz	£165
RUSH RT2 EN CU W/STRIPPER 28-45AWG	£245	R&S SMLR POWER SIG GEN .1-30MHz	£130
RUSH DCF4+VAR SPEED CONT 9-29AWG	£195	R&S ZBK ADMITTANCE BRIDGE 1 5-30MHz	£125
B&K 1013 BFO, 2305 LEVEL RECORDER	£195	R&S USVD UHF TEST RCVR 280-940MHz (4.6G)	£150
DATALAB DL912 TRANSIENT RECORDER	POA	COSSOR CRM533A VHF NAV/COM RF SIG GEN	POA
BBC-B & MASTER COMPUTERS	FROM £139	COSSOR CRM511 ILS/VOR AUDIO SIG GEN	POA
MARCONI TF2337A AUTO DIST'N METER	£495	7.5KVA ISOL 120/240 in 120/240 OUT	£249
MARCONI TF2331 DIST'N FACTOR METER	£175	MICROWAVE 1-20GHz ATTENUATORS, DIRECTIONAL	
LIGHT BOXES 230V 10×12" area	£49	DETECTORS/COUPLERS, NOISE SOURCE, SIGNAL	
DECADE R/C/V BOXES	FROM £15	GENERATORS, SWEEP OSCILLATORS, LP FILTERS,	
KAYE DEE PNEUMO UV EXP UNIT 390×260mm	£175	PIN MODULATORS, CARRIAGES, TERMINATIONS,	
KINGSHILL NS1540 15V 40A PSU CASED	£295	MOVING & ADJUSTABLE SHORTS, ETC	POA

Visit our bargain corner in shop.
Many valuable items at knock-down prices.

RECHARGEABLE SEALED LEAD ACID BATTS		HP 616B, 618C, 620B, 626A, 628A SIG GENS	£35 EA
6V 10AH LONG LIFE, EX NEW EQUIPT	£9.50	TEKTRONIX 7403N, DF1, 7D01 LOGIC ANAL	POA
HAMEG HM408 40MHz DIGITAL STORAGE SCOPE		OSCILLOSCOPES DUAL TRACE S/STATE	From £110
2 TRACE WITH HM8148-2 GRAPHIC PRINTER	£995	MARCONI TF2303 AM/FM MOD METER 520MHz	£245
EDDYSTONE RECEIVERS	From £49 to £125	ROBIN 4112 PHASE EARTH LOOP TESTER	£75
OTHER COMMS RECEIVERS	From £49 to £95	ROBIN 5402 DIGITAL RCCB (ELCB) TESTER	£75
FARNELL E350 PSU's 0-350V 6.3V's	£49	B&T LAB OVENS 12×13×14 INTERNAL 210°C	£195
MARCONI TF2300 FM/AM MODULATION METER	£195	TEKTRONIX 4662 PLOTTERS, GPIB & RS232	£179
TEK 545A, 545B, 585, 535A, 551, 535A	From £49	REDPOINT 6E-1 H/SINKS 1 5°C/W. QTY	POA
TEKTRONIX 834 PROG DATACOMMS TESTER	£395	STAG PP41 EPROM PROGRAMMER	£495
VARIABLE OUTPUT PSU's HV & LV	From £35	MARCONI TF2330 WAVE ANALYSER	£150
TEKTRONIX 520 521A PAL V/SCOPES	From £495	COHU 301 0-500V DC VOLTAGE STD INT REF	£125
WAYNE KERR CT492 UNIV LCR BRIDGES	£65	LEADER LBO-9C ALIGNMENT SCOPE	£249
RACAL DANA 9341 DIGITAL LCR BRIDGE	£295	SIGNAL GENERATORS AF TO 21GHz	From £15

LIST AVAILABLE, BUT 1000'S OF UNLISTED BARGAINS FOR CALLERS
QUALITY ELECTRONIC EQUIPMENT BOUGHT. ALL PRICE EXC. OF P&P AND VAT

423, KINGSTON ROAD, WIMBLEDON CHASE, LONDON SW20 8JR
SHOP HOURS 9-5.30 MON-SAT. TEL 081-542 6383.

CIRCLE NO. 115 ON REPLY CARD

REGULARS

RESEARCH NOTES

High power laser lenses – not just a mirage?

Why is the respected science magazine *Nature* (Vol 353, No 6344) carrying on its front cover a hazy picture of a water tower looking as though it were taken with either a pinhole camera or some battered old box brownie? The remarkable answer is that the 5km-distant tower was photographed through a lens consisting of nothing more than heated air!

Max Michaelis of the University of Natal in South Africa,who took the photograph, explains that the idea of exploiting the change of refractive index with temperature is far from new. Bell Labs experimented with gas lenses for focusing laser beams way back in the 1960s, but found difficulty in overcoming the effects of air turbulence on the image sharpness.

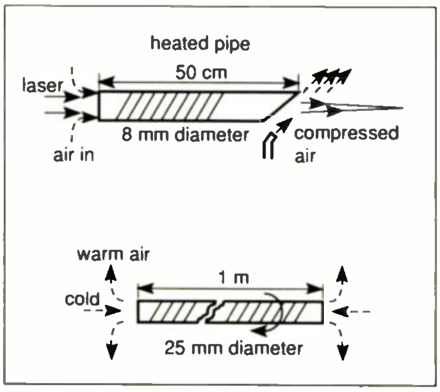
The basic gas lens consists of a heated pipe through which air is passed. The air nearest the pipe wall becomes hotter than that flowing down the middle and as a result has a lower refractive index. The whole aperture of the pipe thus behaves like a lens – or as Max Michaelis describes it – a "rolled up mirage".

What Michaelis and his colleagues (Drs Cunningham, Notcutt, Waltham and research workers Prause and Dempers) have now published are details of a relatively simple way of overcoming the problems of asymmetry caused by gravity and turbulence. The solution is to spin the tube at 30Hz, allowing creation of reasonably good lenses of up to 5cm diameter – much larger than the 8mm stationary gas lenses.

But why go to all this trouble when you can make a far more accurate lens from a few pence worth of glass or plastic? The answer is that gas lenses are virtually indestructible and can tolerate optical power levels that would vaporise a glass lens almost instantly.

Michaelis and his group have used gas lenses to focus carbon dioxide laser beams to drill holes in 1mm sheet steel.They also point to the prospects of using highly focused laser beams for

Continued over page



Top, Air passes through a heated pipe so that air nearest the pipe wall becomes hotter than that near the middle, has a lower refractive index and so produces a "rolled up mirage".

Bottom, Spinning the tube looks to overcome the problems of asymmetry caused by gravity and turbulence.

Shock, horror model probe

How shocking are you? Researchers at Sandia National Laboratories in Albuquerque, New Mexico, could give you the startling truth using a simulator they have developed to mimic the severe static electric discharge that can be triggered by a human body.

The severe human body electrostatic discharge tester (SSET), was designed to test devices and electronic systems which can malfunction or be destroyed if subjected to such a shock. Static electricity is an accumulation of charge on an insulated object and can be produced when a person walks across a carpeted floor, gets out of a car or even stands outdoors in the wind. When this accumulated charge is suddenly transferred to another object or person, either through direct contactor a spark, the electrostatic discharge (ESD) can be unpleasant, to say the least.

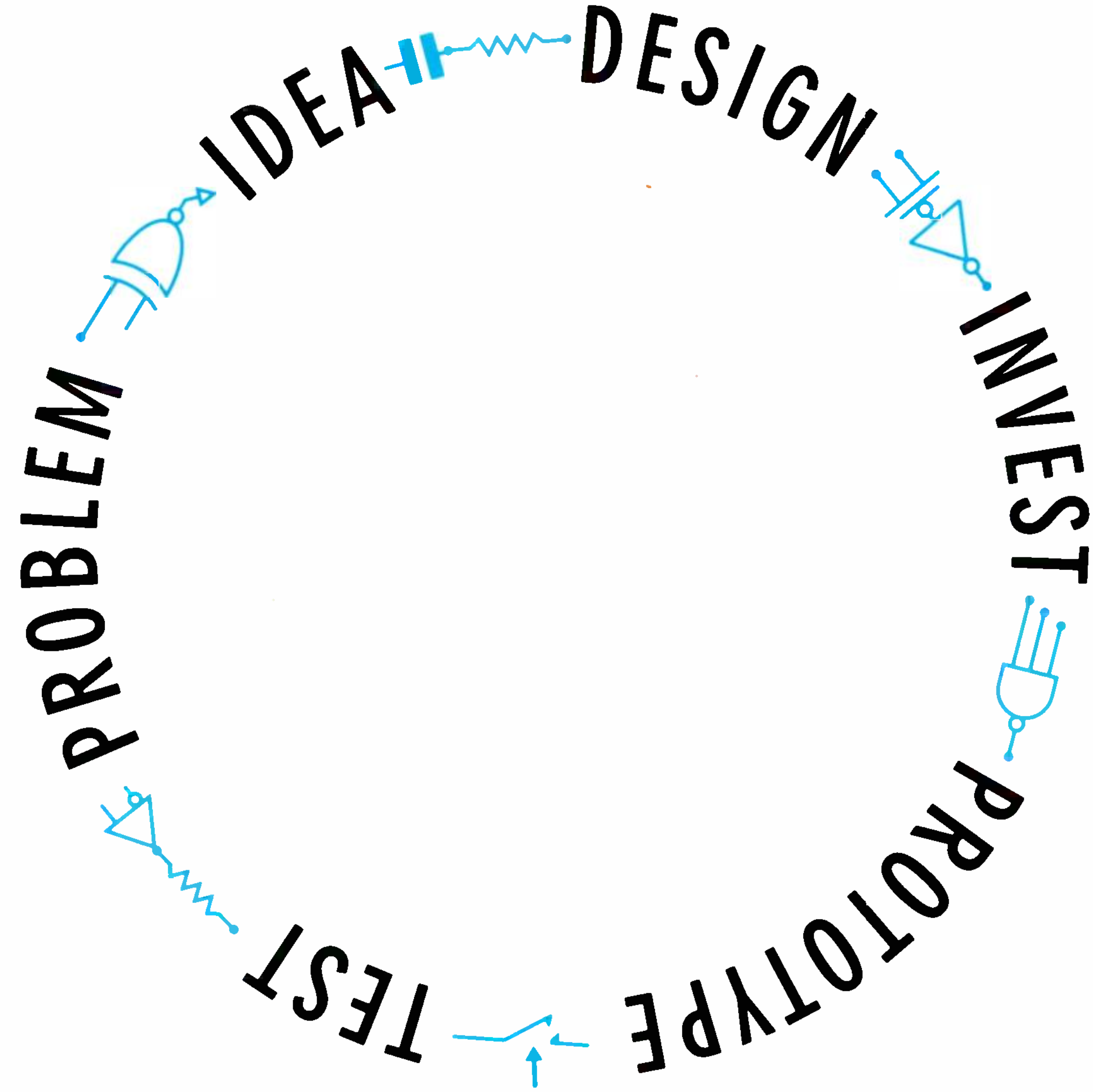
But more than just causing annoying electric shocks, ESD can result in significant losses in terms of life and property. In the US electronics industry, losses associated with ESD are estimated at between $0.5 and $5bn annually. Unintentional detonation of explosives (fireworks, industrial explosives, etc) is also an obvious danger.

When human beings acquire charge, the potential difference between the body and the ground will normally rise to between 6 and 12kV. But under dry conditions (10 to 20% relative humidity), a person can develop and sustain voltages of about 35kV. Normally it is difficult to sustain voltages of greater than 25kV due to the corona effect where some of the accumulated charge disperses.

Sandia researchers have investigated factors influencing ESD effects such as maximum sustainable voltages, humidity and individual height. A database assembled from scientific literature concerning measurements of human body electrical parameters (voltage, capacitance, resistance and inductance) has been developed into an electrical model of the human body.

The model uses extremes of documented data to define a severe human body ESD for use in qualification testing of systems with stringent safety or reliability requirements. It exhibits the distinctive characteristics of an actual human body ESD waveform, having an extremely fast rise time to peak current (approximately 1ns), and an initial voltage of 25kV. It also specifies that current be injected directly into a test object without a spark, replicating the most severe stress created by an ESD.

The model has been used to develop the SSET, a practical discharge tester which is constructed from off-the-shelf components costing approximately $750 excluding the power supply. Objects to be tested are attached directly to the coaxial output of the SSET.



Break the circuit

A product can always benefit from being smaller, faster, cheaper or simply more efficient.

But the route to these improvements is often through new technology.

What worries engineers is the fact that the route can easily turn into a vicious circle over which they feel they have no control.

That's why we developed the Falcon Programme which allows you to test before you invest.

This is how it works:

Firstly, we provide you with a software package. It allows you to design analog/digital arrays using 5 or 2 micron digital, or 3 micron mixed technologies, and, most important, verify the design/performance yourself.

Additionally, we can help you with a range of components for bread boarding critical analog functions.

As a result, you'll end up with a high degree of confidence that your design is going to work before you commit yourself to a prototype.

When you are satisfied and send us your prototyping brief, we again keep costs down by manufacturing in batches with many customers sharing the expense.

Your prototype is then returned to you within 28 days.

Finally, once the design is proven, we can provide you with production parts in any volume from very low to very high and to any screening level under BS9450 approval.

So if you want to get it right first time, make sure you talk to Mike Goodwin this time.

MCE
Micro Circuit Engineering

A Smiths Industries Company

Micro Circuit Engineering, Alexandra Way, Ashchurch, Tewkesbury, Glos GL20 8TB. Telephone: (0684) 297277 WWA

CIRCLE NO. 125 ON REPLY CARD

Gas telescope image of a water tower at a distance of5km..

satellite propulsion. Such beams could be used either to nudge satellites already in orbit or even to help place them in orbit. Suggestions have long been around for lifting a satellite to about l0km by balloon and then raising it further with a laser beam. No conventional lens or mirror could handle anything like the required power.

In their paper, Michaelis *et al* say the damage threshold intensity for short optical pulses through glass or germanium lenses is around $1GW/cm^2$ Gas lenses, by comparison, can handle intensities a hundred times greater.

For a more down-to-earth application of gas lenses, there is the prospect of laser-induced fusion power. Such lenses could focus the very powerful lasers needed to make atoms of hydrogen fuse together and release their energy. Michaelis says that the pulses required for the process are equivalent to about a tonne of TNT, adding with some mild understatement, that a tonne of TNT would do an awful lot of damage to glass components.

Beyond these rather awe-inspiring applications, there are also simpler gas lenses that can be made by exploiting the difference in refractive index between any gas and a vacuum. Quite recently it has been suggested that the problems of the ill-fated Hubble space telescope could be solved by using a transparent bag of helium as a sort of giant contact lens!

Max Michaelis is confident that, though few people take seriously the idea of all-gas telescopes in space, the whole subject is still very much in its infancy. Given more research, gas lenses could one day outperform solid lens or mirrors. They would have very low transmission losses and would not suffer from distortions arising from their mass. Perhaps one day we will see the all-inflatable space telescope ...propelled cheaply into orbit by gas-focused laser?

Sunk without a trace... of radioactivity

A few years before the birth of Christ, a not-very remarkable event took place. A Roman freighter of the class *navis oneraria* sank off the coast of Sardinia carrying a heavy cargo of lead. Around 1500 hall-marked ingots weighing a total of 50t were probably on their way to some ancient building site, to be made into water pipes or stone clamps. Since that rather unmemorable incident all the ingots have lain untouched in about 30m of water – until now when they have become the subject of excited interest to modern physicists.

The reason, or part of it, is that the cargo has been largely shielded from contamination. So this special ancient lead is extremely low in radioactivity. Modern lead, by contrast, is almost universally contaminated with minute traces of radioactive lead-210, bismuth-210 and polonium-210.

For most normal purposes such contamination is so insignificant that it can be ignored; but not when it comes to shielding detectors searching for the radioactive signatures of rare natural processes such as theinteractions of solar neutrinos.

Discovery of this cargo led to an interesting collaboration earlier this year between physicists at the Instituto Nazionale di Fisica Nucleare (INFN) and archaeologists representing the Italian authorities for artistic and historic heritage. According to a report (Cern Courier, Vol 31, No 7), this collaboration will give INFN access to a priceless material for use in the underground Gran Sasso Laboratory in exchange for support for the archaeologists in setting up a database of all the recovered artefacts.

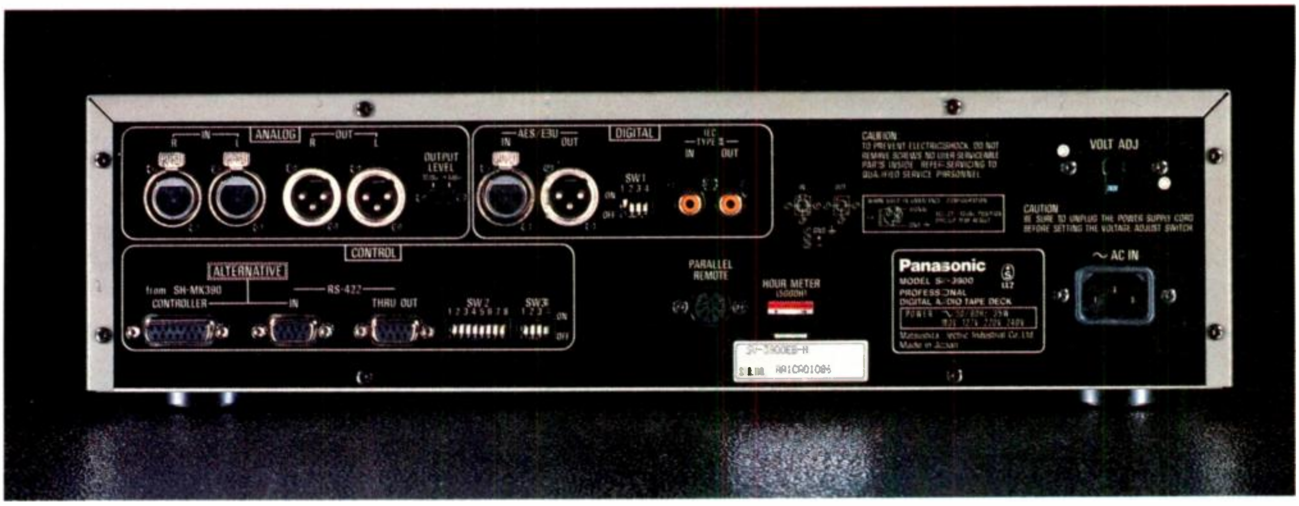
Photo: Cern Photo

One of the lead ingots found in a Roman ship sunk near Sardinia showing the manufacturer's mark.

Collaboration will also extend to use of trace element and isotope analysis to identify the precise origin of the lead ingots. It would be intriguing indeed if the same lead which has lain useless for 2000years could tell us about the history of the Roman Empire and also about the radioactive processes in the Sun which have played an even more fundamental role in our past.

Photo: Cern Photo

Protected from environmental radiation by some 30m of water, the lead will provide valuable low-background shielding for precision physics experiments.



THE NEW PANASONIC PROGRAMMABLE DAT. JUST LOOK WHAT YOU CAN GET OUT OF IT.

ES-Bus and P2 interface. 9 pin D-sub connectors. RS-422 interface, balanced AES/EBU. No it's not Mission Control, it's the back of Panasonic's new SV-3900 DAT machine. A remarkable new DAT recorder that boasts an unprecedented array of remote control possibilities plus superb sound quality.

ES-BUS AND SERIAL CONTROL PROTOCOLS.

Such is the versatility of the SV-3900, it can be used equally successfully to record music or as a scientific research tool. You can, for example, interface it with a wide variety of digital devices – CD players, workstations, recorders. Or, alternatively, it can be networked with up to 31 other SV-3900 DAT machines. (To achieve this you can use either the RS-422 industry standard computer interface, or the optional SH-MK390 remote controller.)

Communication on ES-bus and P2 interface is two-way. All tape and transport modes and functions can be controlled by computer, which in turn can receive and act upon technical and diagnostic information imparted by the SV-3900. Absolute/program times, counter number, error rates and the sampling frequency setting can all be read by the control computer.

With suitable software, the potential applications are almost limitless.

You could for example compile an overnight radio broadcast by using pre-recorded material from one machine, library selections from another and then patch into network news broadcasts at the appropriate times. (It goes without saying of course that traditional eight track cartridges are a thing of the past.)

Other less obvious applications include sophisticated telephone call management, data capture and satellite radio broadcasting. And because any sort of digital information presented in IEC II or AES/EBU format can be handled, the SV-3900 can even be used as a data recorder for remote applications such as monitoring oil flow in pipelines. (Information could be downloaded over the phone, or other network.)

Analogue data logging is of course possible using balanced inputs between –14dBu and +26dBu with >92dB dynamic range.

ONE-BIT ADCs.

Naturally the SV-3900 also offers stunning audio performance. One-bit ADCs linked to 64X oversampling anti-aliasing filters mean a complete absence of zero - cross distortion, and ensure total transparency and lucid detail at both high and low levels.

Similarly, the high resolution 4DAC system ensures low distortion and enhanced linearity at low levels on playback. Other useful touches include an error rate display (on-machine or output to the control computer) to keep you informed on the condition of tape and heads. A new tape transport system that allows access to any point on a two hour tape within 27 seconds. And, as you'd expect, sampling rates can be switched between 32, 44.1 and 48Khz.

The list of features packed into this machine is truly remarkable. But go down to your Panasonic dealer and you'll find the most impressive feature of all is tied on with a piece of string. A price tag of around £1300.

Panasonic

LONDON: RAPER & WAYMAN UNIT 3 CRUSADER ESTATE 167 HERMITAGE ROAD HARRINGEY LONDON N4 1LZ TEL 081 800 8288 HHB COMMUNICATIONS LTD 73 75 SCRUBS LANE LONDON NW10 6QU TEL 081 960 2144 BERKS: AUDIO SYSTEMS COMPONENTS LTD 1 COMET HOUSE CALLEAU PARK ALDERMASTON BERKS RG7 4QW TEL 0734 811000 CALIFORNIA: PANASONIC PRO SOUND DIVISION USA 6550 KATELLA AVENUE CYPRESS CALIFORNIA CA90630 TEL 714 373 7278

CIRCLE NO. 128 ON REPLY CARD

Solid state outshines gas lasers

Solid-state lasers have many advantages over older gas-laser tubes such as robustness, low voltage operation and potential for a very long life. They are also at least two orders of magnitude more compact. But there have been technical problems with generating high powers and/or shorter wavelengths of light in the solid state devices.

However in the last few months several papers have been published indicating these limitations may soon be overcome, enabling solid-state lasers to occupy an increasing slice of the territory formerly occupied by the gas laser.

A group from the University of Illinois at Urbana-Champaign and EG&G Optoelectronics in Vaudreuil, Quebec, have reported (*Electronics Letters*, Vol 27, No 21) development of a solid-state room-temperature infra-red laser capable of producing a 5W CW output at a wavelength of 1064nm. Such high power output from a single 100μm stripe represents an order of magnitude improvement on previous quantum well laser diodes operating at 1064nm.

The laser structure consists principally of a 70Å InGaAs quantum well surrounded by 1000Å GaAs barriers and optically confined in AlGaAs cladding layers. The whole assembly, together with facet coating, is mounted on a metallised diamond heat-sink for CW operation.

Room-temperature light vs current characteristic shows a rise to 5.25W at 9A before catastrophic facet damage occurs. Under pulsed conditions (200ns and 1kHz) 25W output can be achieved at a current of 40A.

The team are confident that where high coherence and high wavelength stability are not critical factors, solid-state devices could well replace Nd:yag lasers for many applications. Unlike the latter they would be cheap, small and easier to modulate.

8.5W visible from monolithic array

Producing shorter wavelength visible light is one further constraint on the designer of solid-state lasers. Without incorporation of quantum well active layers, designers would still be restricted to IR wavelengths and impossibly high lasing threshold currents.

In the same issue of *Electronics Letters*, a group from Spectra Diode Laboratories in San José, California, report development of a 680nm (red) laser diode that will generate 1W CW from a single 100μm-wide active layer based on a GaInP quantum well. As with the IR device above, it is bonded p-side down to its heat-sink. Minimum threshold current is 350A/cm^2 and efficiency is 38%.

The same team have taken this approach a stage further and fabricated sixteen 50μm emitters across an 8mm bar. This monolithic assembly, with emitters spaced every 500μm is capable of 8.5W output, limited principally by thermal considerations. The only other consequence of this multi-emitter approach is that the spectral band-width is broadened from the 2nm of a single emitter to around 4nm.

Into the blue

Applied Physics Letters, September 9, reports how Michael Haase and his colleagues at 3M in St Paul, Minneapolis have managed to create a solid-state laser capable of emitting light at 490nm. The blue-green emission is believed to be the shortest wavelength radiation ever generated by a solid-state laser.

The blue-green laser diode is based on zinc selenide which has the necessary band gap to generate light in the blue-green part of the spectrum. There have, however, been enormous practical difficulties in the making of a functioning laser, not least the problem of fabricating the now-inevitable quantum well. The figure shows the structure of the prototype, capable of producing pulsed emissions at 490nm when held at liquid nitrogen temperatures. At room temperature the colour of the light becomes a little greener at 500nm.

But a convenient, efficient, blue solid-state laser is still many years away. The 3M device has a high lasing threshold and, being relatively inefficient, generates large amounts of potentially self-destructive heat. Nevertheless, observing all the work currently going on – as well as the insatiable demand for high capacity transmission links and data storage – it seems we will not have to wait long before solid-state lasers replace low to medium power gas devices for virtually all industrial applications.

Research Notes is written by John Wilson of

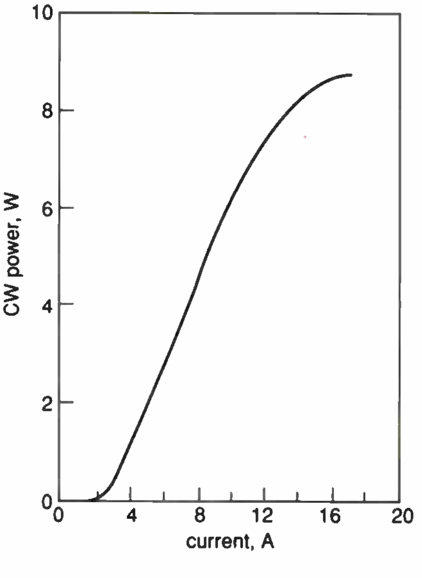
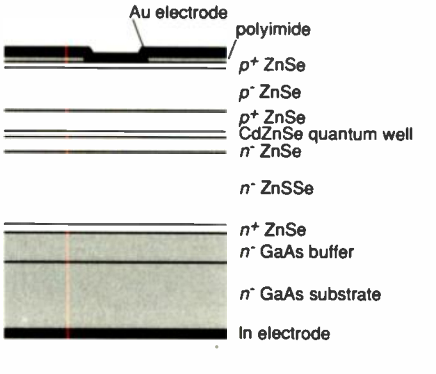


Fig. 1. Light output as a function of input current for 8mm monolithic array of 50μm emitters on 500μm centres.

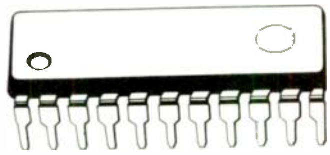
Fig. 2. Cross section of the blue-green laser diode.



HALF PRICE MEMORIES . . . GUARANTEED

. . . Recycled, quality i.c's for next day delivery

WHY PAY MORE?



ALL DEVICES SUPPLIED ARE

★ Ultrasonically cleaned
★ UV erased and tested
★ Handled in accordance with BS5783
★ Packed in antistatic tubes or boxes
★ Original OEM brands

Abracadabra – for an environmentally friendly service!

We are major suppliers to colleges, Universities, R&D Departments and OEMs who recognise our commitment to quality. Export orders welcome.
UK Orders please add £2 Carriage and VAT to total.

ABRACADABRA
ELECTRONICS

3 WAYS TO ORDER

1. By 'phone 0480 891119 (8am–7pm Mon–Fri) All major Credit Cards accepted
2. By Post – send cheque or Banker's Draft to: Abracadabra Electronics Ltd, 25 High Street, Ellington, HUNTINGDON, Cambs. PE18 0AB
3. By Fax: Official orders to 0480 890980 (24-Hour Service)

EXTENSIVE STOCKS

	1–25	25+	100+
***DRAMS**			
41256-10	£0.95	0.80	0.70
4164-15	£0.55	0.45	0.35
***SRAMS**			
62256LP-10	£1.90	1.70	1.50
6264LP-15	£0.79	0.69	0.59
6116LP-15	£0.55	0.45	0.39
***EPROMS**			
27C1000-15	£3.50	3.10	2.90
27C512-15	£2.20	1.99	1.80
27C256-25	£1.20	1.10	1.00
27128-25	£1.00	0.90	0.80
2764-25	£0.90	0.80	0.70
2732-25	£0.80	0.70	0.60
2532-5v	£2.50	2.40	2.30
2716-45	£0.80	0.70	0.60

Many other items in stock, for FREE List use reader enquiry service or 'phone now.

CIRCLE NO. 104 ON REPLY CARD

AOR **AOR (UK) Ltd.** Adam Bede High Tech Centre, Derby Road, Wirksworth, Derbys. DE4 4BG.
Tel: 0629 - 825926 Fax: 0629 - 825927

Radio Facsimile Terminal WX-2000

The WX-2000 is a stand alone radio facsimile terminal designed to produce hard copy images from various facsimile services including Weather charts, Maps, News media and even Satellite pictures from NOAA, GOES and METEOR etc. The WX-2000 simply requires an audio signal from a shortwave or satellite receiver capable of receiving facsimile signals.
The built-in high resolution (8 dots per mm) thermal line printer produces crisp images with high resolution. The WX-2000 is also capable of simulating grey scale which is ideal for Automatic Picture Transmission by weather satellites.
In addition to the basic functions, the WX-2000 provides full operational controls such as Auto Start, Sync, Adjustment, Position Alignment, Tuning LED etc to produce the highest quality images. The power requirement is 12 - 13.5V DC @ 3A, this makes the WX-2000 ideal for both on land and off shore applications.
Printing method: Thermal line printer 8 dots per mm
Printing scale: 2 (B/W) or 16, selectable
Paper width: A4 (210mm) x 30m
Audio input: FM 1900+/-400Hz 0.7V/600 OHM
AM 2400Hz 0-1V/600 OHM
Auto start: APSS type
Synchronisation: Independent type
Reception speed: 60, 90, 120 & 240 rpm, selectable
Collaboration factor: 576 or 288
Power requirements: 12 - 13.5V DC @ 3A
Size: 310mm (W) x 70mm (H) x 200mm (D)

Full details available upon request

CIRCLE NO. 105 ON REPLY CARD

CIRCLE NO. 106 ON REPLY CARD

ELECTRONIC fluxgate compass

The technology described here lends itself to nautical and aeronautical navigation either as a direct reading compass or the sensing heart of an autopilot. The system could equally well be adapted to providing directional information for deaf people.

By Richard Noble.

The fluxgate magnetic sensing head is an extremely sensitive detector of magnetic fields. These cover from tiny field probes, no larger than 0.03 inches in diameter, through current probes, impurity detectors, compasses, metal locators, prospecting equipment, even to submarine detectors. Granted, not many people will wish to detect submarines but how many underwater diving enthusiasts would love to have a "diveable" hand-held wreck-finder?

The compass designs presented here, though carried out in detail and mostly tested, are primarily intended as illustrations of the technique and suggestions for experimentation. Considerable scope exists for variation and final presentation or even use of the basic signals made available.

An earlier article (*EW & WW* September 91) entitled *A Simple Magnetometer* described the principle and use of a fluxgate sensor to produce an earth field measuring device sensitive enough to detect the influence of solar flares on the ionosphere.

It determined the magnitude of two horizontal field components at right angles to one another. Given that information, it is obvious that one can calculate the direction of the principal horizontal component, which is precisely what we ask a compass to tell us.

The magnetometer, however, needed to detect very small variations in the field to fulfil its proper function and consequently needed a high signal to noise ratio. A compass makes no such demands, happily coping with a much lower signal to noise ratio and allowing the circuitry to be even simpler than before. Three common integrated circuits suffice for the sensor conditioning and in the simplest case, the output indicator need be no more than a centre-zero meter.

The simplest systems could well be regarded as the poor man's autopilot since if the pilot is considered to be the device closing the feedback loop, that is exactly what it is. If you are steering a boat or flying an aeroplane, all you really need are steady-as-you-go turn left/turn right instructions to maintain a heading.

The technique has much to recommend it as the equipment is minimal and hopefully therefore more reliable and the steering arrangements if properly arranged are non-confusing, key elements in safe navigation.

Sensor circuits

The presence of an external magnetic field passing through a toroidal core produces an asymmetry in the magnetic induction waveform in the core. The previous design exploited the subtly changing widths of the less noisy pulses produced by induction in a sense winding over the two legs of the core. This design is less fussy and simply extracts the even harmonics produced by the asymmetry and, in particular, the second harmonic of the switching frequency. A rather crude resonance with the sense winding also enhances the size of the signal being sought.

The core, as before, is a tape wound toroid of HCR alloy, designed by Telcon Metals for magnetic control systems. This is wound with approximately 170 turns of 0.5mm enamelled wire to provide a switching primary winding. The drive circuit, shown in

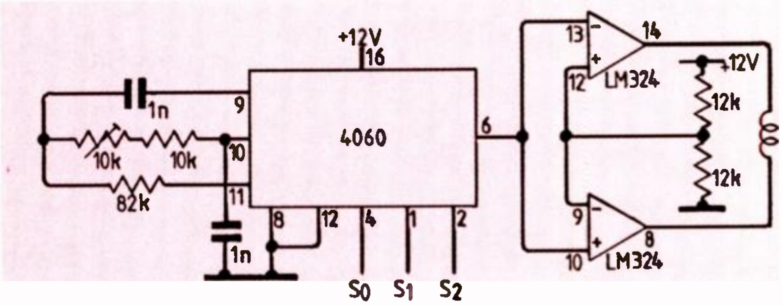


Fig. 1. The driver circuit used in all version

Fig.1, is provided by two of the operational amplifiers in an LM324 quad package working in a push-pull configuration. The input is a square-wave at the fundamental frequency of approximately 110Hz. This is provided by a 4060 cmos oscillator and divider chain which also supplies the second harmonic switching pulse for the phase detector from an appropriate tapping. This is needed because, although the second harmonic sensor signal varies as the external field, there is an abrupt change of 180° in the phase as the field reverses through zero, calling for a synchronous phase detector to preserve polarity correctly.

Returning to the drive system, the square-wave input does not produce a square-wave output voltage across the primary. Before the flux in the core reaches saturation, the primary core has inductance but at saturation the inductance collapses to zero and at this point the output voltage also disappears, producing an output waveform like that shown in **Fig 2a**. This does tend to warm the integrated circuit chip, but is within the short circuit protection capability of the device and makes the circuit delightfully simple. The frequency of the oscillator is adjusted to make the output waveform as symmetric as possible so as to avoid the transformer coupling even harmonics into the pickup winding. **Figure 3** shows the detector circuit.

The pickup winding is a single 500 turn winding of 0.2mm wire over the outside of the core, roughly resonated with the 10μF paper capacitor and fed to a unity gain amplifier which can have its phase reversed by 180°. The phase reversal is controlled by the analogue switch which either shorts the non-inverting input to ground or does nothing depending on its control voltage. When it is shorting to ground the circuit becomes a unity gain inverting amplifier. When it is open, the amplifier has a gain of -1 from the inverting input and +2 from the non-inverting input. The net result is a gain of +1.

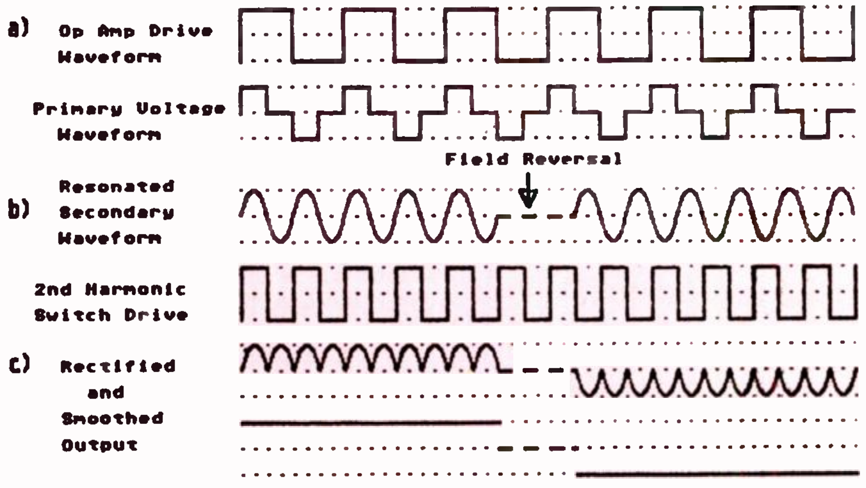
When the control is switched at the second harmonic frequency and in the appropriate phase, the amplifier neatly rectifies the signal and correctly converts the 180° phase change into a polarity change. In this way the DC output is a proper 4-quadrant vector component with a one-to-one correspondence to the equivalent earth field component. Two windings at right angles to each other will allow the reconstruction of an electric vector simulating the horizontal magnetic vector.

Idealised waveforms illustrating this process are shown in Fig. 2. All that remains is to amplify and smooth the rectified half sinusoids in an integrating circuit, the time constants chosen allowing some control over the damping of the instrument output. An oscilloscope will not show waveforms like the illustration because the signal is small and swamped by the interfering unbalanced signals. However if the external magnetic field is increased considerably then something much more like the idealised version can be seen. This is easy to do with a small bar magnet, held close to the sensor core, giving an increase in field strength of several orders of magnitude.

Fortunately the interfering signals which spoil an oscilloscope image have no effect on the final output and a large voltage swing is obtained for the tiny 0.18 gauss horizontal component of the earth's field.

The output from this single channel device is fed to a centre-zero meter. When the axis of the sense winding is at right angles to the earth's field the meter reading is zero. Any departure from this orientation will make the meter deflection positive or negative, providing a heading error indication. The sense of the correction can be chosen to provide a steer left/steer right type of display. By rotating the sensor to the desired angle relative to the vehicle, the instructions to steer, if followed, will eventually bring the vehicle on to the correct heading as the meter reading approaches zero. Maintaining the zero reading will maintain the vehicle heading.

Fig. 2. Idealised fluxgate waveforms



Heading-set mechanism

The following is a suggested design requiring no special tools and may obviously be improved upon by those with special facilities.

Fig. 4 (on p18) shows an exploded diagram of the parts and their method of assembly as made by the author.

Setting and calibration

The more observant reader may be wondering about what looks like an anomaly at the octant boundaries. The analogue x or y value barely changes as the octant code switches suggesting that the two different outputs correspond incorrectly to the same angle. However this is no different to what happens at any other threshold. In reality there are a number of lamps all spaced equally around a circle and only one is ever showing at any time; it is only necessary to point that one in the right direction. In fact the sensor can be placed in any orientation as long as the dial is fixed to the indicator in the right place.

This is most noticeable in the simple 8-point compass. No one really wants a compass that indicates NNE, ENE, ESE, SSE, etc. The sequence N, NE, E, SE, S, etc is much more acceptable and in boxing the compass the adjustor will naturally make this happen. What he actually does is offset the zero octant boundary by around 22° so as to make north appear in the middle of the lamp's "on" range. In the same way the 72-point compass will be offset by 2.5° and the 360-point version by 0.5°, though the latter is almost certainly masked by the precision limits of the system.

A reasonable target to aim for would be ±1° though this may not be achievable without considerable care. Certainly the second pickup winding on the sensor will have to be wound over a separate card or plastic sleeve to allow for some small adjustment during calibration. After the best position has been found it can be glued or varnished into place. The best position is that for which the zero-crossing points of the x and y signals are genuinely at right angles to one another.

Prior to checking this the amplifier zero offsets must have been set to ensure that the maximum excursions of the x and y signals are symmetrically disposed about zero volts. Some iteration of these adjustments may be necessary as they are interactive.

All of the above should be carried out while keeping the core in the horizontal plane though this need not be more complicated than temporarily securing it to a circle of card with blue-tack. If the card is first marked with a set of 15° protractor type markings and rotated over a cross marked on a flat surface the results can be reasonably accurate.

Subsequently the channel gains should be adjusted to match exactly the input span of the bar driver or A/D converter, whereupon the compass display should read correctly. Final tweaking may be beneficial while rotating the card over the cross to check the readings at 15° intervals. Once installed, careful checking in the usual manner is essential as navigation is sometimes a life-and-death matter and at this stage no effort is too great to ensure accuracy and reliability. Unless a good location can be found for the sensor the use of a deviation chart is recommended.

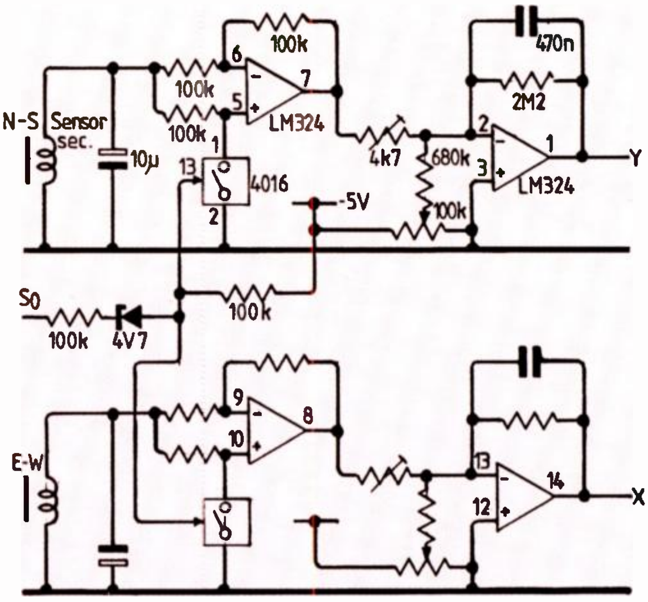


Fig. 5. Twin sensor circuit

The final fitting is left to the ingenuity of the installer, but should be such that the sensor is horizontal in the normal cruising attitude of the vehicle and reasonably removed from the influence of ferrous metal. In the case of a sailing boat, the first requirement means at least a fore and aft gimbal pivot to counter the vessel's heel. With an aeroplane, gimballing is pointless as apparent gravity can be markedly non-vertical in manoeuvres and a fixed mounting is all that is required. The usual "northerly turning error" will be present but, unlike a normal compass, no violent swinging results and the indicated reading becomes smoothly stable as levelling occurs.

Direct reading remote compass

At the cost of some additional circuitry, the sensor can be mounted remotely in an iron-free area and the display fitted in any convenient position. The sensor electronics need an extra LM324 operational amplifier chip to provide a second channel as shown in **Fig. 5**.

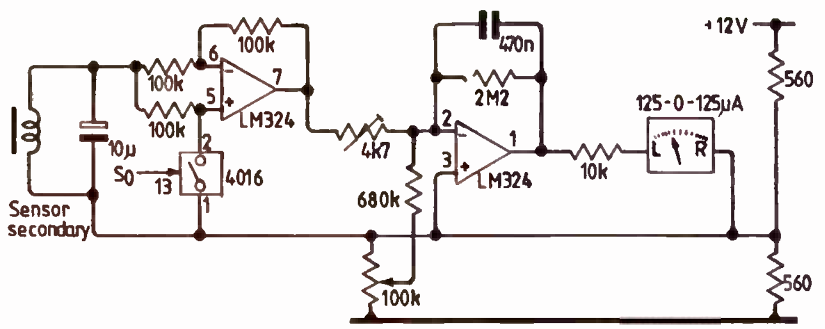
The sensor is wound, like the magnetometer version, with a second 500 turn pickup winding at right angles to the first. The electronics then provides two output signals, for convenience referred to as x and y, which represent the vector components of the horizontal magnetic field. From this point many different options are available to convert the signals into a display, with the usual tradeoff between precision, cost and complexity.

Before going into detail, however, it is instructive to examine the basic properties of the signal information the sensor system provides. The first obvious and familiar one is that the angle the magnetic vector makes to the axes is the arctangent of the ratio of x to y. One approach therefore would be to convert the analogue signals to digital and feed them to a single board computer. An eprom stored program written in assembler or a higher level language such as compiled Basic or Forth could solve for the arctangent and send the output to a port fitted with a three digit liquid crystal display. Using a chip such as the Motorola 68705R3 it could even be a single chip computer. To those with the ability to put together such a combination and program it, this is probably the most straightforward solution and can have additional options incorporated such as stored way-point lists for a flight plan or sailing pattern.

For a more subtle solution, a close look at the basic properties suggests some intriguing alternatives. At the very lowest levels, the signals range through both polarities and a glance at **Fig. 6a** reveals that the polarity combinations are a code for the quadrant the vector resides in, + + for 0 to 90°, + – for 90 to 180° and so on.

Another simple property is that the abso-

Fig. 3. Detector circuit for "steer-on-heading"



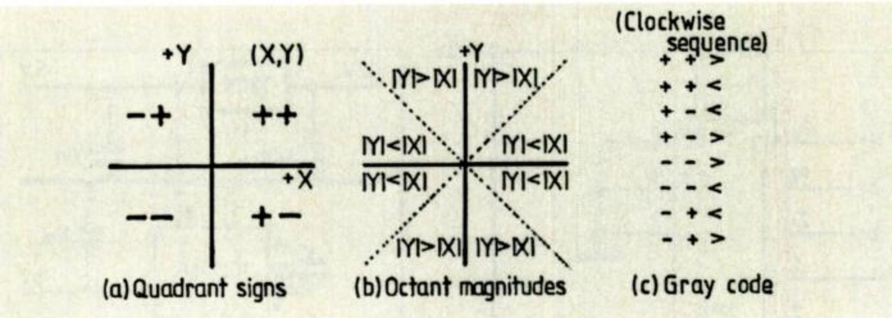


Fig. 6. Mapping out the octants with translation to Gray code equivalent

lute magnitude of x is either greater than that of y or vice versa, most of the time. **Fig 6b** reveals that this binary feature provides a third coded contribution increasing the resolution from quadrants to octants, x<y implying 0 to 45° for example in the first quadrant. All of which makes good sense as three bits exactly codes eight states.

Additionally it should also be noted that in one of those delightful accidents of nature the code developed this way falls into the class known as Gray codes, namely sequences in which the state transitions are marked by single bit changes. Our encoded output never gives false or ambiguous readings as the values change, simply because there is only ever a single bit changing at any time. All this, without any deliberate design effort!

The underlying idea is also very easy to implement electronically. Two more LM324 amplifiers will provide comparators delivering the first two sign dependent bits. The absolute magnitude circuits are just two more again, with a handful of identical resistors and some diodes. The outputs go to yet another comparator which outputs the third bit and the job is done. The greatest cost is probably the circuit board which the parts are soldered to.

Simple 8-point compass

At this point the first somewhat crude compass display is possible as in **Fig. 7.** The three coded bits are used as the address inputs to a 4051, 3-to-8 line analogue switch and the outputs are connected to eight leds arranged in a circle (in the straight numeric order to decode the Gray code, of course). The result gives a heading indication of eight directions with a precision of ±22.5°. This may not seem very good, but is entirely adequate for a road vehicle, to give one that comforting feeling of definitely heading in the right sort of direction when more or less lost. It should also be remembered that so far the analogue properties of the x and y signals have not even been considered. This gives a strong feeling that taking even a little notice of the analogue features should permit a major step forward.

One last convenient accident remains to be exploited. Between 0 and 45° the sine function is almost linear. A best fit line can be found for the ten points at 5° spacing by linear regression and this linear function used instead of the sine. The worst angular error is 1.3° at the 45° position and all the others are less than 1°, averaging about 0.6°.

Over this angular range the analogue x signal is theoretically a sine function of the angle being sought after, so a linear interpretation of its analogue value will give a low-error solution. Over the range 45 to 90°, the y signal is theoretically a cosine function of the angle, which is just the sine of 90° minus the angle and therefore has the same convenient linear properties. The electronic implementation is obviously to transform the x and y signals into the first quadrant and use an analogue-to-digital converter to create the increased resolution. The first part needs no components, because it already exists in the shape of the absolute magnitude circuits introduced earlier. Two alternatives exist for the second part, one for the analogue enthusiast, the other for those who like digital displays.

Analogue 72-point compass

The analogue version, **Fig. 8**, uses an LM3914 led bargraph driver in dot mode to drive nine led cathode lines, the anode lines being multiplexed as eight common anode lines, one for each octant. These octant switches are provided by a 4051 1-pole 8-way analogue switch decoding the 3-bit octant code derived earlier. The input to this A/D converter system needs to be switched between the x and y signals at the octant boundaries, but again no components are required because there is still one amplifier and two analogue switches left over in previously used chips and the driving signal is just the third bit of the already available octant code. This economically consumes all of the remaining spare parts.

The leds are arranged in a circle at 5° intervals and result in a display with ±2.5° precision and a worst error of about half that. Admittedly 72 leds are required, but bulk buying reduces the cost to no more than that of the digital version and some traditionalists just hate digital displays anyway.

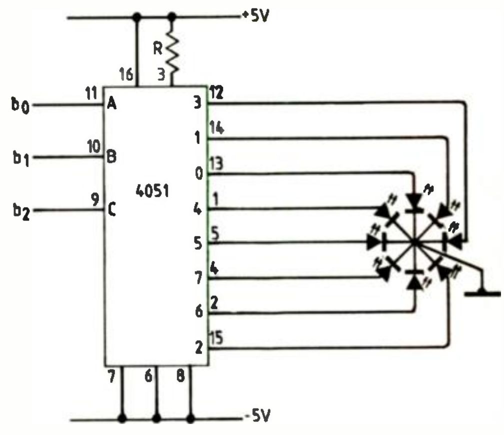
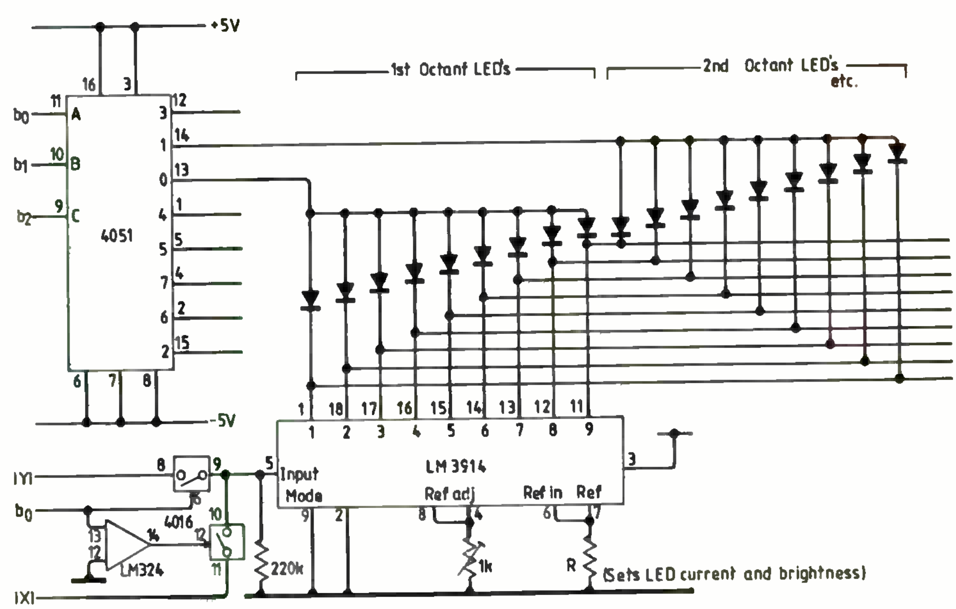


Fig. 7. A simple octant compass display

Digital 360-point compass

To make a digital version, the bar code driver is replaced with a CA3306 6-bit A/D flash converter, all earlier circuitry remaining the same. This divides the 45° octant into 64 levels providing the opportunity to correct for the slight non-linearity of the sine function, while providing even higher resolution. The technique is to use the six output bits as address bits for an eprom, together with the three octant bits, which are used to segment the EPROM into eight regions. In this way



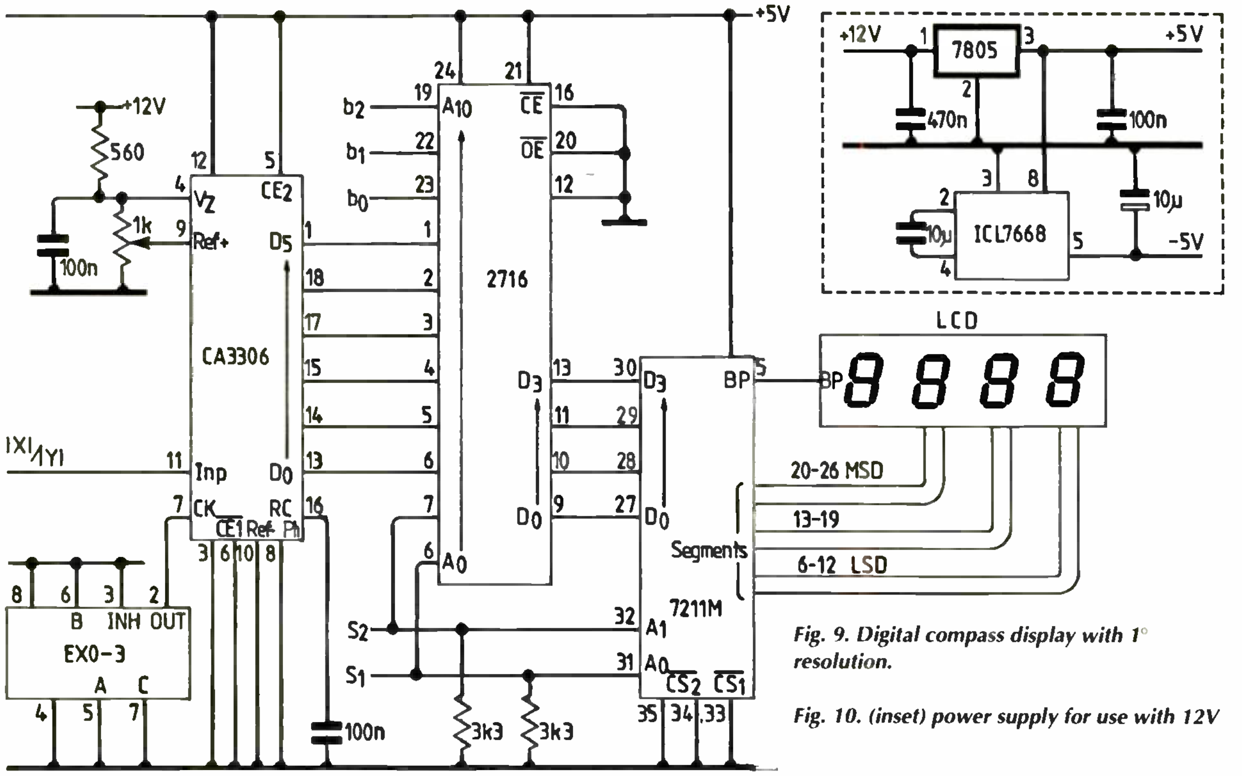


Fig. 9. Digital compass display with 1° resolution.

Fig. 10. (inset) power supply for use with 12V

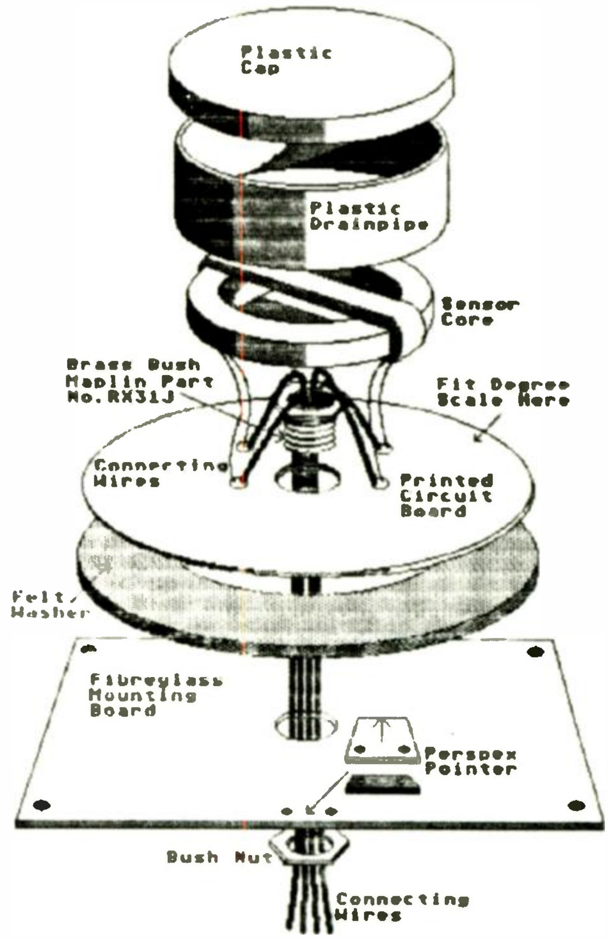
each combination of nine bits corresponds to a unique angle with a unique address, which can be programmed to output that angle to a display. Unfortunately the three digits needed for a compass display require twelve bits to code in BCD form and most eproms are only eight bits wide.

The solution is to give each digit an address of its own and multiplex them continuously to an appropriate display by providing two more address bits from a slowly cycling two bit counter. The same two bits are fed to the multiplexing address lines of the display driver to synchronise the eprom output to the digit position. A suitable display driver is the four-digit 7211M and the two bit counter needs no components as it already exists as the bottom end of the 4060 divider used in the sensor electronics. Bits 12 and 13 of this divider switch at approximately 7 and 3.5Hz respectively, giving a display update rate of about once per second.

Regrettably the serendipity of finding free parts just when they are needed does not extend to the 2MHz clock needed by the A/D converter. An EXO-3 crystal divider chip can be programmed to provide this.The 64 eprom locations in each octant are programmed to deliver the nearest integer degree value to the exact value predicted by the sine function. The nineteen duplicated values scattered through the 45° range automatically provide the linearisation to give a 1° resolution.

There is no reason why the digital display cannot be inserted into the centre of the analogue compass rose. ■

Fig. 4. Head/sensor assembly as made by the author.



The Telcon 7a cores mentioned in this article are available directly from the author price £10.50. PCBs for driver and sensor circuitry are also available price £12 for the pair. Contact R & W Noble, Penbidwal House, Pandy, Abergavenny, Gwent NP7 8EA. Phone 0878-890367.

B. BAMBER ELECTRONICS
Manufacturers Surplus Stocks

Farnell SSG520 synthesized Generator 520Mhz	**£650**
Telequipment Oscilloscope Type D83, 50Mhz Dual Trace	**£250**
Racal 9081 Synthesized Signal Generator 520Mhz	**£750**
Ando Spectrum Analyser Type AC8211, 2Ghz	**£1600**
Telequipment Curve Tracer Type CT71	**£200**
H.P. Storage Oscilloscope Type 1741A, 100 Mhz	**£400**
Sayrosa Automatic Mod. Meter Model 252, 2Ghz	**£120**
H.P. Spectrum Analyser Type 3582A, 0.02Hz–25.5Khz	**£1600**
H.P. Oscilloscope Model 1707B, Mains/Battery	**£200**
Tektronix Oscilloscope Model 5103N, 5A15N, 5A18, 5B10	**£400**
Avo Meters Model 8 with leads	**£65**
Marconi A.F. Power Meters Type TF893A	**£35**

ALL PRICES EXCLUDE V.A.T.
OPEN MON–FRI 9am–5pm

WANTED

Electronic Components, Test Gear, Factory Clearance
TOP PRICES PAID

5 STATION ROAD, LITTLEPORT, CAMBS CB6 1QE
PHONE: ELY (0353) 860185

CIRCLE NO. 132 ON REPLY CARD

ESYS

128 & 1024

ADVANCED ROM INTERFACE AND EMULATION SYSTEM

TOTAL ENVIRONMENT ASSEMBLERS AND EMULATORS TO SUIT ALL ROM'S AND MICROPROCESSORS

- ***Assemblers available for over 100 microprocessors***
- ***Integral Editor, Linker and intelligent MAKE facility***
- ***On-screen monitor, trace and source level debugging***
- ***ROM Emulator up to 128 Kbytes or 1024 Kbytes as standard***
- ***Add on Comms board***
- ***Fully portable battery backed units***
- ***Operating speed better than 100 ns***

SEND FOR FREE SOFTWARE EVALUATION PACK

21st Century Electronics
56b Milton Park, Abingdon
Oxon OX14 4RX
Telephone: 0235 832939
Fax: 0235 861039

CIRCLE NO. 133 ON REPLY CARD

Microprocessor Development Tools

EMULATORS - SIMULATORS - COMPILERS - ASSEMBLERS - PROGRAMMERS

77C82 8085 Z8 68000 8051 32010 68HC11 6301 6502 87C751 6805 Z80 6809 8096 740 Series 7720 MIPS R2000 etc . . .

UNIVERSAL PROGRAMMER

✓ Extensive device support
- PALs, GALs, PEELs, FPGAs etc...
- Serial PROMs, BPROMs, (E)EPROMs
- and microcontrollers

✓ DIL, QFP and PLCC packages
✓ TI and NatSemi approved
✓ Gang adapters available

NEW

SMAC UNIVERSAL ASSEMBLER

✓ Relocatable - fast assembly
✓ Caters for ALL Microprocessors and Controllers
✓ Instruction sets for many microprocessors included
- from Z80 to RISC 2000
- or add your own

✓ Iteritive macros, Intelligent jump facilities
✓ Linker and MAKE facility

ROM EMULATOR

from only £99

✓ Covers ROM sizes from 16 kbit to 8 Mbit
✓ Full screen editor
✓ Emulates all 24, 28, 32 & 40 pin devices
✓ Fast download - loads 1 Meg in under 5 seconds
✓ Split and shuffle capability

SIMULATORS

✓ Debug microprocessor and controller software on your pc
✓ Break points and trace
✓ Free run or single step

PROGRAMMERS

✓ Low cost
✓ Up to 8 Mbits
✓ 16 bit wide EPROMs
✓ Microcontrollers including 87C751
✓ PC based or stand-alone

2 Field End, Arkley, Barnet, Herts, EN5 3EZ **Telephone : 081-441 3890**

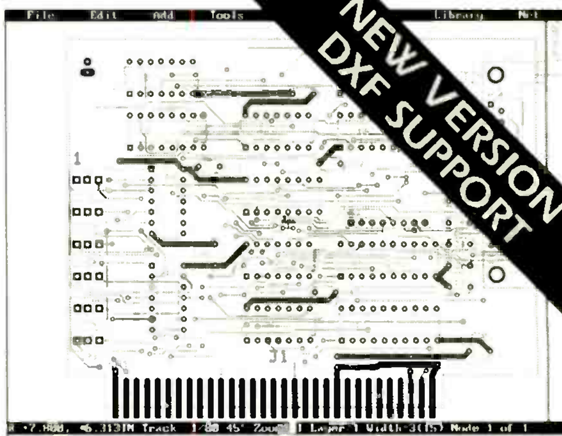
SMART COMMUNICATIONS

CIRCLE NO. 134 ON REPLY CARD

Take the Sensible Route!

BoardMaker is a powerful software tool which provides a convenient and fast method of designing printed circuit boards. Engineers worldwide have discovered that it provides an unparalleled price performance advantage over other PC-based and dedicated design systems by integrating sophisticated graphical editors and CAM outputs at an affordable price.

NEW VERSION
DXF SUPPORT

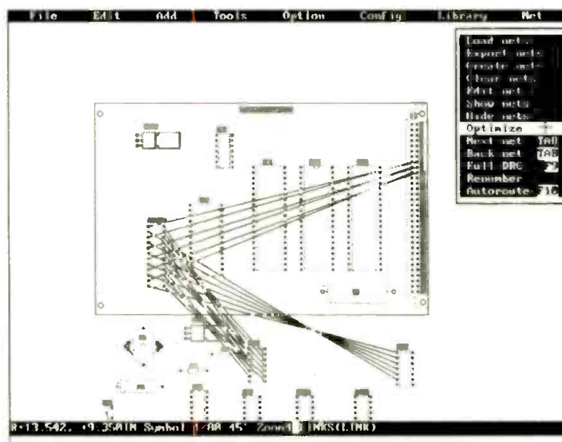


Full analogue, digital and SM support - ground and power planes - 45 degree, arced and any angle tracks with full net-based Design Rule Checking.

NEW VERSION

In the new version V2.40, full consideration has been given to allow designers to continue using their existing schematic capture package as a front end to BoardMaker. Even powerful facilities such as Top Down Modification, Component renumber and Back Annotation have been accomodated to provide overall design integrity between your schematic package and BoardMaker. Equally, powerful features are included to ensure that users who do not have schematic capture software can still take full advantage of BoardMaker's net capabilities.

BoardMaker V2.40 is a remarkable £295.00 (ex. carriage & VAT) and includes 3 months FREE software updates and full telephone technical support.



Optimized placement by displaying ratsnest per component. Lines indicate the unrouted nets.

AUTOROUTER

BoardRouter is a new integrated gridless autoroute module which overcomes the limitations normally associated with autorouting. **YOU** specify the track width, via size and design rules for individual nets, BoardRouter then routes the board based on these settings in the same way you would route it yourself manually.

This ability allows you to autoroute mixed technology designs (SMD, analogue, digital, power switching etc)in **ONE PASS** while respecting **ALL** design rules.

GRIDLESS ROUTING

No worrying about whether tracks will fit between pins. If the track widths and clearances allow, BoardRouter will automatically place 1, 2 or even 3 tracks between pins.

FULLY RE-ENTRANT

You can freely pre-route any tracks manually using BoardMaker prior to autorouting. Whilst autorouting you can pan and zoom to inspect the routes placed, interrupt it, manually modify the layout and resume autorouting.

BoardRouter is priced at £295.00, which includes 3 months FREE software updates and full telephone technical support. BoardMaker and BoardRouter can be bought together for only £495.00. (ex. carriage & VAT)

HIGHLIGHTS

- Net list import from OrCAD, Schema etc.
- Graphical and manual netlist entry
- Top down modification for ECOs
- Forward and back annotation
- Component renumber
- Effortless manual routing
- Fully re-entrant gridless autorouting
- Simultaneously routes up to eight layers
- Powerful component placement tools
- Copper fill
- Curved tracks
- Extensive Design Rule Checking
- Full complement of CAM outputs
- Support and update service
- Reports generator
- Gerber, PostScript & DXF output
- Full SMD support

tsien

Tsien (UK) Limited
Cambridge Research Laboratories
181A Huntingdon Road
Cambridge CB3 0DJ **UK**
Tel 0223 277777
Fax 0223 277747

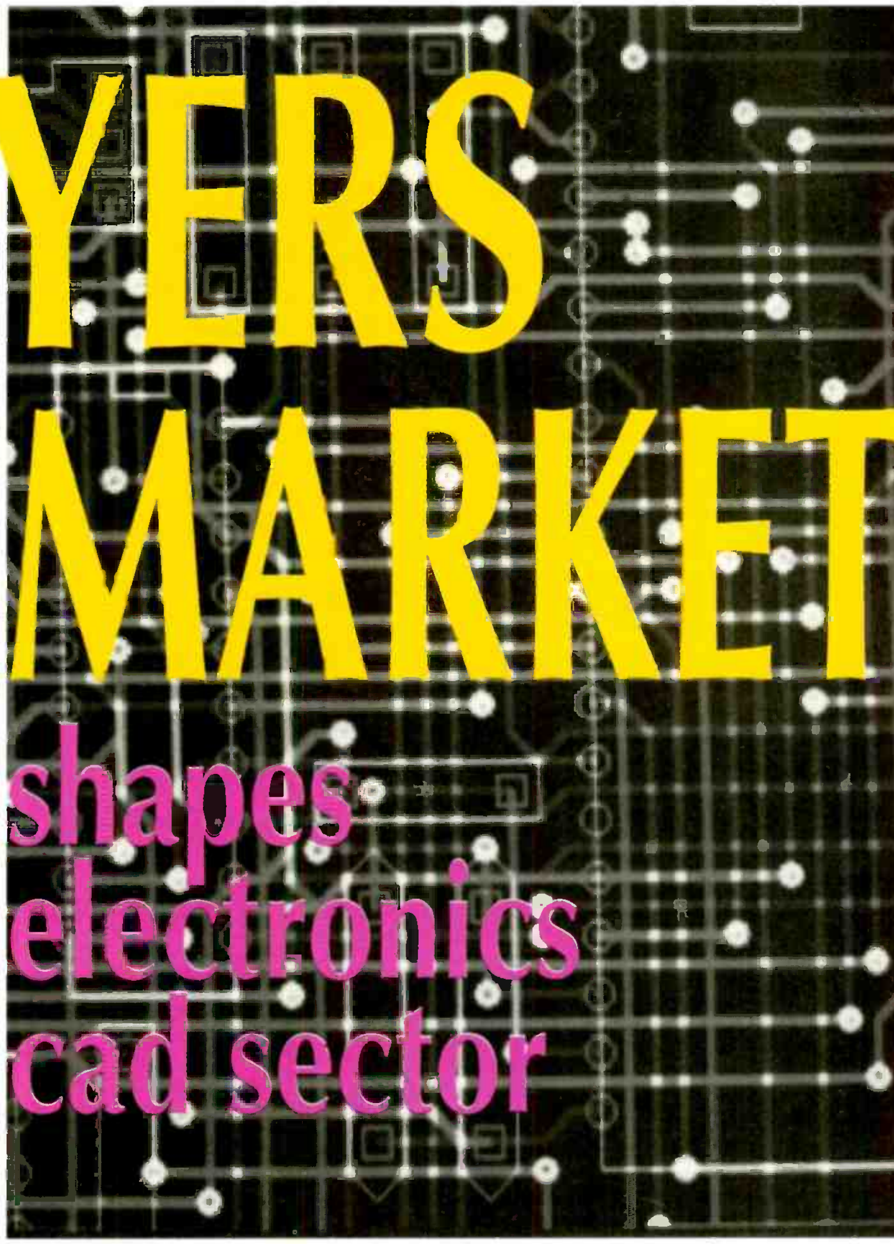
Don't just take our word for it. Call us today for a FREE Evaluation Pack and judge for yourself.

Access VISA

IMPORTS EASY PC FILES
UPGRADE DISCOUNTS
AVAILABLE

All trademarks acknowledged

BUYERS MARKET shapes electronics cad sector



Supplier companies pulling out of cad and suicidal price cutting point to a sector in crisis? Yet the choice of packages is still wide. Steve Rogerson explores.

In the teeth of a recession there can be few areas in electronics and computing that are feeling the pinch worse than computer aided design. What was once the glamour sector of the market is today marked skirmishes that are ripping the industry to shreds.

But the range of packages available is still very wide, even in this "sector within a sector" of cad for electronics (though including universal design packages such as Autocad).

The design process splits naturally into two main functional areas; the first consists of electronics designers looking to arrange the various components to perform the required functions for a particular circuit. Next the components must be arranged on a PCB in a logical and cost-effective way, usually aiming to take up as little space as possible.

Electronic simulation is a middle stage between these two, taking the original design and running it like a real package to see if it works. Simulation is something of a side issue, especially for low-end PCB design where it is often too expensive. But for large system design it is essential. Typical packages include Susie and PSpice.

At the bottom of the market, costing between £100 and £200, are the straightforward drawing packages with restricted intelligence. They do serve a function, but there is usually no upgrade path and they can only be treated as a short term solution.

To buy something of real use, with intelligence in the package, tends to cost £1000 to £3000. Products in this band take information in the circuit diagram and use it to help design the PCB.

Users can make certain that all the tracks are associated with the right connections.

At the moment most designers of PCBs will be satisfied with this level of package, typified by products such as Pads-PCB. There are, however, many packages available – all with their own quirks and benefits and users should shop around to find which are the best fits for their applications.

Upwards from here are the fully featured packages that can cost up to £10,000 or even more. In general, the more you pay the more facilities you get.

Peter Chidzey from Cad Services explains the developing cad market: "Traditionally you had the drawing office with professional PCB design engineers. These are being replaced with electronics engineers who design the circuit and use the expensive packages to design the PCB."

GoldStar

QUALITY, PROFESSIONAL PC's AT AFFORDABLE PRICES

EVERY PC COMES WITH:

1 YEAR ON-SITE WARRANTY
VGA GRAPHICS AS STANDARD
FREE UK DELIVERY

GoldStar is a key division of the Lucky GoldStar Group, one of the world's largest international corporations, employing over 100,000 people with a turnover approaching £14 billion. GoldStar, with their unrivalled resources and technical ability, have manufactured and labelled computers for many of the world's leading computer companies for over 30 years! In fact, other PCs you may have been considering, because they have a different brand "name" on the outside, may well be a GoldStar on the inside!

Silica Systems, an official GoldStar appointed dealer, are pleased to recommend this comprehensive range which combines the very latest technology with years of manufacturing experience. GoldStar's quality and reliability coupled with the Silica Systems service, provide you with the perfect PC solution for the home, business or education. From an entry level 286 desktop workstation to a powerful 486 EISA tower system, Silica and GoldStar have the answer, at an affordable price!

286 12MHz £399 + VAT

- *12.5MHz 286 (Landmark 17MHz)*
- *1Mb RAM (4Mb max on Motherboard)*
- *2Mb RAM on Plus Series*
- *EMS (LIM 4.0)*
- *42Mb, 130Mb or 210Mb IDE Hard Disk*
- *3½" or 5¼" Floppy Disk Drive*
- *3 Expansion Slots*
- *VGA (Paradise-1M) Graphics - 256K RAM*
- *Serial, Parallel & PS/2 Mouse Ports*
- *12 Months On-site Maintenance*
- *DOS 4.01, DOS Shell, GW BASIC, EMS 4.0, & Utility Software*
- *PLUS SERIES (from £599), Includes:*
  - *Dual Floppy Disk Drives*
  - *Mouse, Mouse Mat & Windows 3*
- *Price - £399+VAT without Hard Drive*

+£100 for VGA Mono Monitor
+£200 for VGA Colour Monitor

£499 GT212 WITH 42Mb HARD DRIVE

PLUS SERIES with GS1425 VGA Colour Monitor. Model Shown is GT212 286 12MHz

* All the GT212 PLUS SERIES models include 2Mb RAM as standard, so that they can run Windows 3.

Model	Processor	RAM Inc	Max RAM on Board	1 Year on Site	Expansion Slots	Landmark MHz	Co-Processor Socket	VGA Chips	VGA Video RAM	VGA 640×480	VGA 800×600	VGA 1024×768	No Hard Disk + Single Floppy 3½" or 5¼"	42Mb HD + Single Floppy 3½" or 5¼"	PLUS SERIES with Dual Floppy, Windows 3 & Mouse: 42Mb HD + Dual Floppies 3½" & 5¼"	130Mb HD + Dual Floppies 3½" & 5¼"	210Mb HD + Dual Floppies 3½" & 5¼"
GT 212	286 12MHz DESKTOP CASE	1 or 2 Mb	4 Mb	●	3 (2×16-bit 1×8-bit)	17 MHz	287-10	PARADISE	256K RAM	16 Colours	16 Colours	N/A	£399 +VAT= £468.83	£499 +VAT=£586.33	£599* +VAT=£703.83	£799* +VAT=£938.83	£1099* +VAT=£1291.33
GT 316	386SX 16MHz DESKTOP CASE	2 Mb	8 Mb	●	5 (4×16-bit 1×8-bit)	21 MHz	387SX-16	PARADISE	256K RAM	16 Colours	16 Colours	N/A	£599 +VAT=£703.83	£699 +VAT=£821.33	£799 +VAT=£938.83	£999 +VAT=£1173.83	£1299 +VAT=£1526.33
GS 318	386SX 20MHz DESKTOP CASE	2 Mb	8 Mb	●	5 (4×16-bit 1×8-bit)	25 MHz	387SX-20	PARADISE	512K RAM	256 Colours	256 Colours	16 Colours	£699 +VAT=£821.33	£799 +VAT=£938.83	£899 +VAT=£1056.33	£1099 +VAT=£1291.33	£1399 +VAT=£1643.83
GS 320	386DX 20MHz DESKTOP CASE - FULL SIZE	2 Mb	10 Mb	●	8 (5×16-bit 2×8, 1×32)	25 MHz	387DX-20	OAK	256K RAM	16 Colours	16 Colours	N/A	—	—	£899 +VAT=£1056.33	£1099 +VAT=£1291.33	£1399 +VAT=£1643.83
GS 347	386DX 25MHz DESKTOP CASE - 32K CACHE	4 Mb	8 Mb	●	5 (4×16-bit 1×8-bit)	40 MHz	386DX-25	PARADISE	256K RAM	16 Colours	16 Colours	N/A	—	—	£1399 +VAT=£1643.83	£1599 +VAT=£1878.83	£1899 +VAT=£2231.33
GS 335	386DX 33MHz TOWER SYSTEM - 64K CACHE	8 Mb	16 Mb	●	8 (6×16-bit 2×8-bit)	50 MHz	386DX-33	ATi Wonder +	512K RAM	256 Colours	256 Colours	16 Colours	—	—	—	£2099 +VAT=£2466.33	£2399 +VAT=£2818.83
GS 425	486DX 25MHz EISA TOWER SYSTEM - 8K CACHE	8 Mb	16 Mb	●	8 (8×EISA)	114 MHz	N/A	ATi Wonder +	512K RAM	256 Colours	256 Colours	16 Colours	—	—	—	£3499 +VAT=£4111.33	£3799 +VAT=£4463.83

14" VGA MONITORS

MODEL Nº	MONO/ COLOUR	DOT PITCH	VGA 31.5KHz	S-VGA 35.2KHz	E-VGA 35.5KHz	1 Yr On-Site	Tilt & Swivel	EXC VAT	INC VAT
GS 1405	MONO	N/A	640×480	800×600	–	●	●	£100	£117.50
GS 1425	COLOUR	.39mm	640×480	–	–	●	●	£200	£235.00
GS 1430	COLOUR	.31mm	640×480	–	–	●	●	£230	£270.25
GS 1460	COLOUR	.28mm	640×480	800×600	1024×768	●	●	£250	£293.75

OPTIONS

DESCRIPTION	EXC VAT	INC VAT
1Mb×9-bit SIMM Memory Board	£50	£58.75
287 -12MHz Maths Co-Processor - For GT 212	£100	£117.50
387sx-16MHz Maths Co-Processor - For GT 316	£85	£99.88
387sx-20MHz Maths Co-Processor - For GS 318	£100	£117.50

OPTIONS

DESCRIPTION	EXC VAT	INC VAT
387dx-20MHz Maths Co-Processor - For GS 320	£150	£176.25
387dx-25MHz Maths Co-Processor - For GS 347	£150	£176.25
387dx-33MHz Maths Co-Processor - For GS 335	£160	£188.00
337Mb SCSI Hard Disk Drive - 10.7ms Access	£999	£1173.83

SILICA SYSTEMS OFFER YOU

- ***FREE OVERNIGHT DELIVERY:*** On all hardware orders shipped in the UK mainland.
- ***TECHNICAL SUPPORT HELPLINE:*** Team of technical experts at your service.
- ***PRICE MATCH:*** We normally match competitors on a "Same product - Same price" basis.
- ***ESTABLISHED 12 YEARS:*** Proven track record in professional computer sales.
- ***BUSINESS + EDUCATION + GOVERNMENT:*** Volume discounts available for large orders.
- ***SHOWROOMS:*** Demonstration and training facilities at our London & Sidcup branches.
- ***THE FULL STOCK RANGE:*** All of your requirements from one supplier.
- ***FREE CATALOGUES:*** Will be mailed to you with offers and software/peripheral details.
- ***PAYMENT:*** By cash, cheque, all major credit cards, or extended payment plan.

Before you decide when to buy your new GoldStar PC, we suggest you think very carefully about WHERE you buy it. Consider what it will be like a few months after you have made your purchase, when you may require additional peripherals or software, or help and advice. And, will the company you buy from contact you with details of new products? At Silica Systems, we ensure that you will have nothing to worry about. We have been established for over 12 years and, with our unrivalled experience and expertise, we can now claim to meet our customers requirements with an understanding which is second to none. But don't just take our word for it. Complete and return the coupon now for our latest Free literature and begin to experience the "Silica Systems Service".

MAIL ORDER HOTLINE **081-309 1111**

SILICA SYSTEMS

MAIL ORDER: Order Lines Open: Mon-Sat 9.00am-6.00pm	1-4 The Mews, Hatherley Rd, Sidcup, Kent, DA14 4DX	No Late Night Opening	Tel: 081-309 1111 Fax No: 081-308 0608
LONDON SHOP: Opening Hours: Mon-Sat 9.30am-6.00pm	52 Tottenham Court Road, London, W1P 0BA	No Late Night Opening	Tel: 071-580 4000 Fax No: 071-323 4737
LONDON SHOP: Opening Hours: Mon-Sat 9.30am-6.00pm	Selfridges (1st Floor), Oxford Street, London, W1A 1AB	Late Night: Thursday until 8pm	Tel: 071-629 1234 Extension: 3914
SIDCUP SHOP: Opening Hours: Mon-Sat 9.00am-5.30pm	1-4 The Mews, Hatherley Rd, Sidcup, Kent, DA14 4DX	Late Night: Friday until 7pm	Tel: 081-302 8811 Fax No: 081-309 0017

To: Silica Systems, Dept EWWO-0192-66, 1-4 The Mews, Hatherley Rd, Sidcup, Kent, DA14 4DX

PLEASE SEND ME A GOLDSTAR CATALOGUE

Mr/Mrs/Ms: .... Initials: .... Surname: ....

Address: ....

....

.... Postcode: ....

Tel (Home): .... Tel (Work): ....

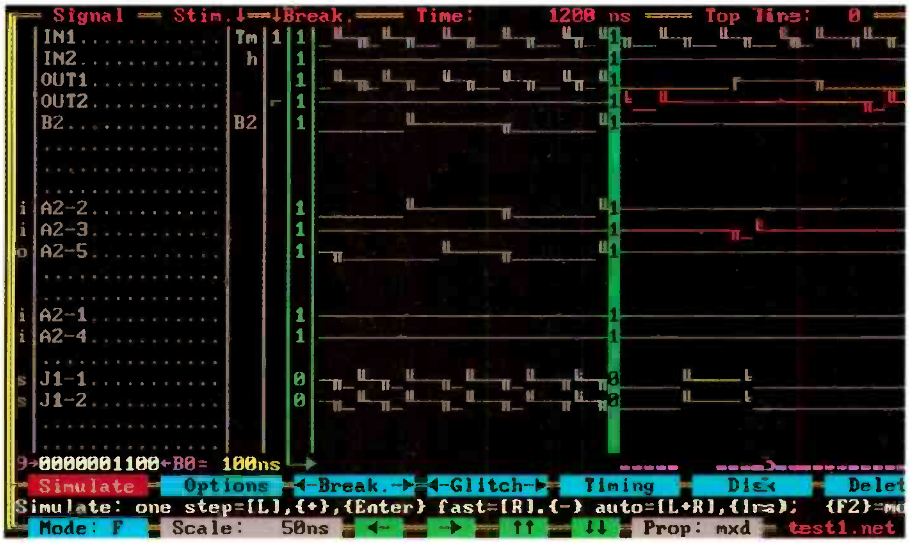
Company Name (if applicable): ....

Which computer(s), if any, do you own? 66B

E&OE - Advertised prices and specifications may change - Please return the coupon for the latest information.

CIRCLE NO. 143 ON REPLY CARD

Picture: Computer Solutions Ltd



Susie PC-based logic simulation program simplifies digital design.

Integration of the various stages in the process is also very much the trend.

"People are going for more integration of packages from silicon design right the way through", says Chris Stevens from Computer Solutions. "They want the best simulator right through to the best autorouter. But the wise person buys it all from the same manufacturer rather than trying to do it themselves."

Price war

The cad industry, as mentioned earlier, is in something of a crisis. It has been hit hard by the recession and individual dealers have launched a price war that is lowering profit margins and driving some firms to the wall.

Others, like Lloyd Doyle, have pulled out of the market to concentrate on other areas.

In March this year Lloyd Doyle described itself in the *Cadcam 1991* catalogue as "the UK's major distributor of the Pads suite of cad packages for PCB design."

Six months later and that segment of business has been confined to the "what we used to do" file.

There is a fear in parts of the industry that the cad business is not professionally handled, perhaps even being a little "cowboy-ish". Some believe that the way the business is organised from above encourages competitiveness among distributors, while there is not sufficient control over territories and price. A result is the worry that there is "too much" cut pricing going on.

Chidzey agrees: "At the moment the market is pretty flat. There are a lot of people chasing a small amount of business and most people are suffering. There are very few companies in the last year who have made money out of PC cad. It has become very cut throat."

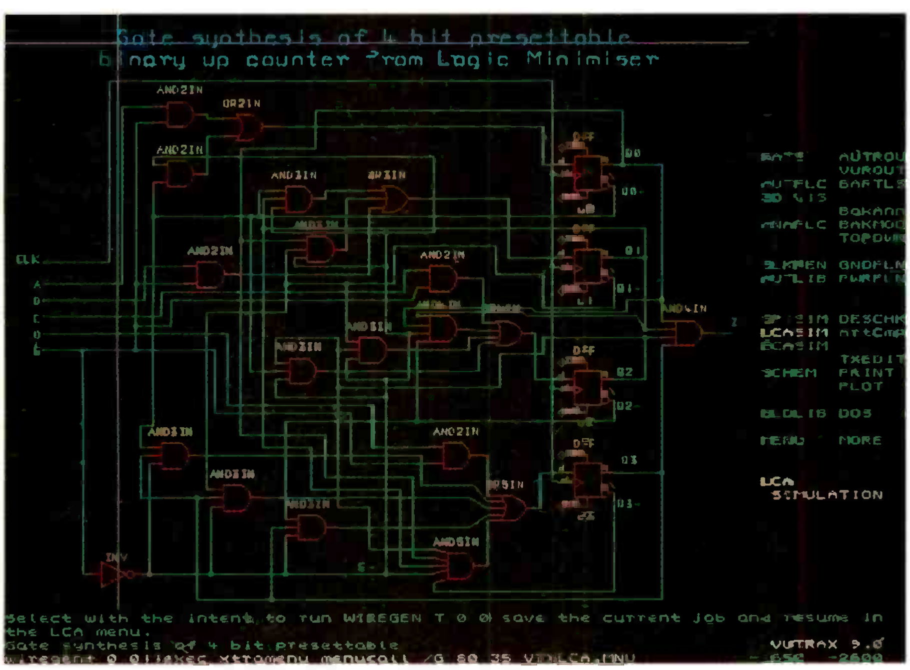
On one hand many potential buyers are probably rubbing their hands with glee. Everybody likes a bargain and if prices are low the cheque books should start coming out. But Chidzey believes this is a short-sighted attitude.

"There are firms who are cutting prices ridiculously just to stay in business," he says. "The customer suffers because the firms do not have the profit level to develop future systems."

Nevertheless there are still many packages around and a wide choice of sources. The following survey does not attempt to be comprehensive, but rather to give some idea of the types of packages around and some of the people who supply them.

Vutrax equivalent logic of boolean equation for 4 bit presetable binary up-counter.

Picture: Those Engineers



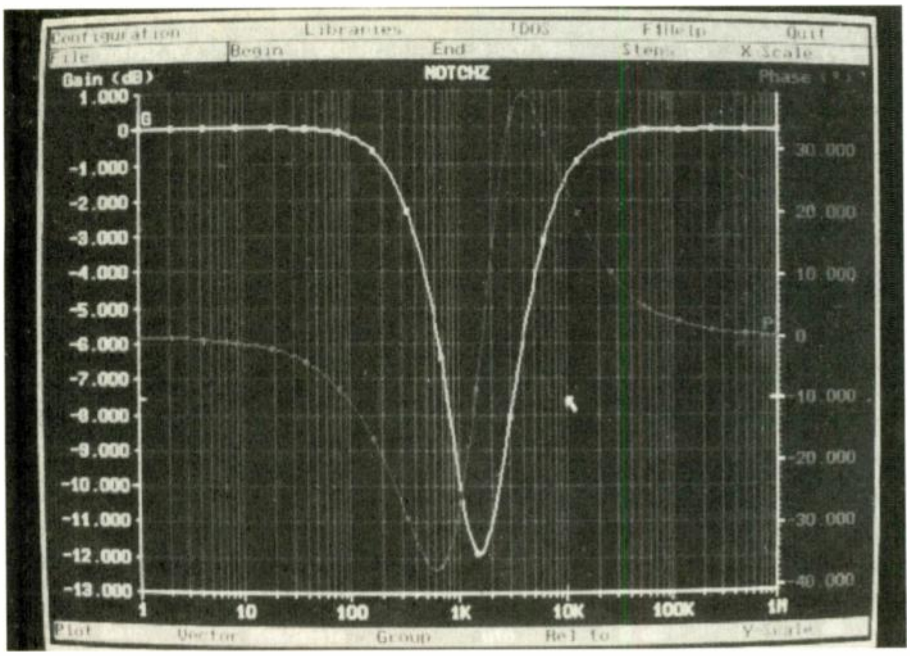
PRODUCT SUMMARY

ALS-View II
ALS-View II is a menu driven tool for eliminating PCB replots. It lets designers read in any Gerber file for viewing, editing and printing check plots on various printers including standard 300dot/in laser printers. It runs on 386 or compatible PCs.
Suppliers: ALS Design; ARS Microsystems.

Analyser III
Analyser III is a linear circuit analysis program that is suitable for analysing filters, amplifiers, crossover networks, wideband amplifiers, aerial matching networks, radio and TV IF amplifiers, chroma filters, and linear ICs. It runs on 386 and 486 PCs.
Suppliers: Number One Systems.

Ares
The Ares range of PCB design software comprises PCB II, Ares and Ares Autoroute all of which use a layout editor and the same graphical user interface as Isis.
Suppliers: Labcenter Electronics.

AutoCad
AutoCad is a 2D and 3D professional computer-aided drafting and design package. It is the most widely used cad system in the world with more than 400,000 installations. In the electronics field it can be used for designing enclosures and can run on PCs and workstations.
Suppliers: Data Technology; Hawke Systems; KGB Micros; Option Circuits; SSI Microcad.



Analyser III linear circuit analyser runs on 386 and 486 machines.

Autotrax
Working from a net list, Autotrax automatically places components and routes tracks in conformance with user-definable design rules. Board layout can also be manually edited. Blocks of components can be defined, moved, rotated, flipped or copied while connectivity is maintained.
Suppliers: JAV Electronics; Protel Technology.

Bitspice
Bitspice is a smaller version of the LCA1 logic simulator program. Schematic input is available as an optional extra.
Suppliers: Those Engineers.

BoardMaker
BoardMaker is a PCB cad system with mouse driven pop-up menus and windows to make it easier to use. Features include schematic capture, graphical and manual netlist entry, design on the fly, components placement, routing, design rule checking, top down modifications, and symbol libraries.
Suppliers: Tsien.

Cadstar
Cadstar is a suite of programs that includes schematic capture, PCB layout and routing, and advanced routing. The library has more than 5000 digital and discrete parts including ansi and IEEE standard schematic symbols. It works on PC based platforms.
Suppliers: Option Circuits; Racal-Redac.

Cam-Bridge
Cam-Bridge is PC-based cam software for linking PCB design and fabrication. It allows prototyping without replots, uncovers design and house-keeping errors, and ensures correct preparation of artwork.
Suppliers: ARS Microsystems; ALS Design.

Codas
Codas runs on a PC and is a tool for designing control systems. It is aimed at single-input and single-output systems; for example position controllers such as those used on large telescopes. Basically, it controls the use of servo motors.
Suppliers: Golten & Verwer.

Colorcam
Colorcam is a flexible PCB design package with a systems resolution of 0.001mm. It can accommodate any component – from SMD to conventional – with any pitch. There is no restriction on the number of components, pad shapes or track widths. It is supplied with a library and comes either as a manual design package or in modules including schematic capture and autorouting using the *T414* transputer.
Suppliers: LPKF; Tracks.

Dazix SDE
Dazix SDE is a synthesis design environment for the capture and synthesis of asics including PLDs, FPGAs, and ECLs. Designs can be described using any combination of entry methods including Boolean equations, truth tables, state machines, bubble diagrams, VHDL and schematics.
Suppliers: Dazix Intergraph.

Design Framework II
Design Framework II is a composition of a number of tools that provide complete design flows for IC, PCB and asic designers. Front end tools for design capture and simulation are the same for each technology, but physical layout programs are specific to the target technology.
Suppliers: Cadence Design Systems.

Easy PC
Easy PC, winner of a 1989 British Design award, is PCB design and schematic drafting cad software of which more than 7500 packages are in use around the world. Circuit diagrams and PCBs can be produced from the same package. It is aimed at 286 and 386 machines, but will also run on slower 8086 PCs.
Suppliers: Number One Systems.

Easytrax
Easytrax is a PCB design system that can run on PCs or Macs and includes pen plot, Gerber photoplot, N/C drill and PostScript capabilities. It is an entry level package.
Suppliers: JAV Electronics; Protel Technology.

ECA2
ECA2 is for analogue circuit analysis. It has a lot of power, but people who want the flexibility on smaller circuits may be better off with its little sister Spiceage. Both will handle digital circuits but not as quickly as LCA1 and Bitspice from the same family. Schematic input is available as an optional extra.
Suppliers: Those Engineers.

Ecad Plus
Ecad Plus is software for simplifying and speeding up the development of electrical, electrotechnical and electromechanical drawings and projects. Using the package, a user can develop on a PC a multi-sheet project including drawing phase and related literature.
Suppliers: ARS Microsystems; Microdata System.

EEDesigner
EEDesigner is an electronics design package that does schematics, simulation and PCB layout. It runs on the PC and is a fully integrated package for electronics, cad and cae. Powerful integration between the component parts is a feature of the package which works with the Maxroute autorouter package.
Suppliers: Betronex.

Elcad
Also known as RDS40, Elcad is a database oriented cad/cae system for the documentation of circuit and control diagrams. The database is automatically loaded with data from the electrics, electronics, hydraulics and pneumatic fields. Current path diagrams are drawn up graphically in interactive dialogue. It runs on 286 and 386 machines.
Suppliers: Rotring; SSI Microcad.

EPlan
EPlan is an electrical design package for the automotive industry and can be used for, say, running robots on a production line. It will run on Compaq computers.
Suppliers: Auto Metrix.

Flotherm
Flotherm is a thermal analysis cad package that uses computational fluid dynamics to predict the 3D air flow and heat transfer in an electronics system. It can simulate a complete set up from component to system level to help the designer work out the best ventilation methods.
Suppliers: Flomerics.

Fourier Perspective III
Fourier Perspective III is a complete digital signal processing environment with true menu selection. Applications include noise and vibration analysis, digital filter design, and financial analysis.
Suppliers: Laplace Instruments.

FutureNet-5
FutureNet-5 is a schematic designer for PC and Sun workstations. It includes a scripting language, layered database and help system. Other features include design rule checker, PCB translators, and back annotators.
Suppliers: Data I/O; Instrumatic; Option Circuits.

CONTINUED ON PAGE 43

SMALL SELECTION ONLY LISTED – EXPORT TRADE AND QUANTITY DISCOUNTS – RING US FOR YOUR REQUIREMENTS WHICH MAY BE IN STOCK

Tektronix 475 – 200Mc/s oscilloscopes – tested from £400 less attachments to £500 C/W manual probes.
Marconi TF2008 – AM-FM signal generator – Also sweeper – 10Kc/s – 510Mc/s – from £350 tested to £500 as new with manual – probe kit in wooden carrying box – £50.
HP DC Current source type 6177C – £200.
HP Frequency comb generator type 8406A – £400.
HP Sampling Voltmeter (Broadband) type 3406A – £200.
HP Vector Voltmeter type 8405A – £400 to £600.
HP Synthesiser/signal generator type 8672A – 2 to 18GHzS – £6000.
HP 8640A signal generator – OPT 001 – 002 – 5Mc/s –1024Mc/s – £1000.
HP Oscillographic recorder type 7404A – 4 track – £350.
HP Plotter type 9872B – 4 pen – £300.
HP Sweep Oscillators type 8690 A & B + plug-ins from 10Mc/s to 18GHz also 18-40GHz. P.O.R.
HP Signal Generators type 612 – 614 – 618 – 620 – 628 – frequency from 450Mc/s to 21GHz.
HP Network Analyser type 8407A + 8412A + 8601A – 100Kc/s – 110Mc/s – £1000.
HP 432A–435A or B Power Meters + Powerheads – 10Mc/s–40GHz – £200–£650.
HP Down Converter type 11710B – .01-11Mc/s – £450.
HP Pulse Modulator type 11720A – 2-18GHz – £1000.
HP Modulator type 8403A – £100-£200.
HP Pin Modulators for above-many different frequencies – £150.
HP Power Meter type 435A (no head) – £150.
HP Counter type 5342A – 18GHz – LED readout – £1500.
HP Signal Generator type 8640B – Opt001 + 003 – .5-512Mc/s AM/FM – £1200.
HP Spectrum Display type 3720A £200 – HP Correalator type 3721A £150.
HP 37555 + **3756A** – 90Mc/s Switch – £500.
HP Amplifier type 8447A – .1-400Mc/s £400 – HP8447F .1-1300Mc/s £800.
HP Frequency Counter type 5340A – 18GHz £1000 – rear output £800.
HP Programmable pulse generator type 8161A – £1500.
HP 8410 – A – B – C Network Analyser 110Mc/s to 12GHz or 18GHz – plus most other units and displays used in this set-up – 8411A – 8412 – 8413 – 8414 – 8418 – 8740 – 8741 – 8742 – 8743 – 8746 – 8650. P.O.R.
HP Signal Generator type 8660C – .1-2600Mc/s. AM/FM – £3000.
HP Signal Generator type 8656A – 0.1-990Mc/s. AM/FM – £2250.
HP 3730B Mainframe £200.
HP 8699B Sweep PI – 0.1-4GHz £750 – HP8690B Mainframe £250.
HP Digital Voltmeter type 3456A – £900.
Racal/Dana digital multimeter type 5001 – £250.
Racal/Dana Interface type 9932 – £150.
Racal/Dana GPIB Interface type 9934A – £100.
Racal/Dana Timer/counter type 9500 (9515 OPT42) – 1250Mc/s – £450.
Racal/Dana 9301A-9303 RF Millivoltmeter – 1.5-2GHz – £350-£750.
Racal/Dana Counters 9915M – 9916 – 9917 – 9921 – £150 to £450. Fitted FX standards.
Racal/Dana Modulation Meter type 9009 – 8Mc/s – 1.5GHz – £250.
Racal – SG Brown Comprehensive Headset Tester (with artificial head) Z1A200/1 – £450.
EIN 310L. RF Power Amp – 250KHz – 110Mc/s – 50Dbs – £250.
Marconi AF Power Meter type 893B – £300.
Marconi Bridge type TF2700 – £150.
Marconi/Saunders Signal Sources type – 6058B – 6070A – 6055B – 6059A – 400 to 18GHzS. P.O.R.
Marconi TF2015 Signal Generators – 10MHz – 520Mc/s – AM/FM – £250.
Marconi TF1245 Circuit magnification meter + 1246 & 1247 Oscillators – £100-£300.
Marconi microwave 6600A sweep osc., mainframe with 6650 PI – 18-26.5GHz or 6651 PI – 26.5-40GHz – £1000 or PI only £600.
Marconi distortion meter type TF2331 – £150, TF2331A – £200.
Marconi 6700B sweep mainframe – £200.
Thurlby convertor 19 – GP – IEEE – 488 – £150.
Philips logic multimeter type PM2544 – £100.
Microwave Systems MOS/3600 Microwave frequency stabilizer – 1 to 18GHzs & 18 to 40GHzs – £1000.
Bradley Oscilloscope calibrator type 156 – £150.
Bradley Oscilloscope calibrator type 192 – £500.
Tektronix Plug-ins 7A13 – 7A14 – 7A18 – 7A24 – 7A26 – 7A11 – 7M11 – 7S11 – 7D10 – 7S12 – S1 – S2 – S6 – S52 – PG506 – SC504 – SG502 – SG503 – SG504 – DC503 – DC508 – DD501 – WR501 – DM501A – FG501A – TG501 – PG502 – DC505A – FG504 – P.O.R.
Alltech Stoddart receiver type 17/27A – .01–32Mc/s – £5000.
Alltech Stoddart receiver type 37/57 – 30-1000Mc/s – £5000.
Alltech Stoddart receiver type NM65T – 1 to 10GHz – £3000.
Gould J3B Test oscillator + manual – £200.
Image Intensifiers – ex MOD – tripod fitting for long range night viewing – as new – £1500-£2000.
Don 10 Telephone Cable – ½ mile canvas containers or wooden drum – new – Mk2-3 or 4. P.O.R.
Infra-red Binoculars in fibre-glass carrying case – tested – £100ea. also Infra-red AFV sights – £100ea.
ACL Field intensity meter receiver type SR – 209 – 6. Plugs-ins from 5Mc/s to 4GHz – P.O.R.
Systron Donner Counter Model 6057 – 18Ghz – £800.
Clark Air Masts – Heavy Duty – Type Scam – 40ft or 70ft – £200-£600.
Tektronix 491 spectrum analyser – 1.5GHz-40GHz – as new – £1200 + manual.
Tektronix Mainframes – 7603 – 7623A – 7633 – 7704A – 7844 – 7904 – TM501 – TM503 – TM506.
Knott Polyskanner WM1001 + WM5001 + WM3002 + WM4001 – £1000.
Alltech 136 Precision test RX + 13505 head 2 – 4GHz – £350.
SE Lab Eight Four – FM 4 Channel recorder – £200.
Alltech 757 Spectrum Analyser – 001 22GHz – Digital Storage + Readout – £5000.
Dranetz 606 Power line disturbance analyser – £500.
Precision Aneroid barometers – 900-1050Mb – mechanical digit readout with electronic indicator – battery powered. Housed in polished wood carrying box – tested – £100-£200-£250. MK1, 2 or 3.
B & K Sound Level Meter type 2206 – small – lightweight – precision – ½" microphone – in foam protected filled brief type carrying case with windshield & battery + books + pistol grip handle – tested – £170. Carr: £8. – B & K 2206 Meter + Mike + Book – less carrying case etc. – £145. Carr: £8. **DISCOUNT ON QUANTITY**
HP 141T Spectrum Analysers. All new colours supplied with instruction manuals.
HP 141T-8552A or B – 8556A – 20Hz to 300kHz. £2000 A – £2200 B.
HP 141T-8552A or B – 8553B – 1kHz to 110Mc/s. £1800 A – £2000 B.
HP 141T-8552A or B – 8554B – 100kHz to 1250Mc/s. £2050 A – £2250 B.
HP 141T-8552A or B – 8555A – 10Mc/s to 18GHz. £3250 A – £3450 B.
HP 141T – old colour mainframe + 8552A; 8553B – 1kHz to 110Mc/s. Instruction manuals – £1500.
HP 3580A LF-spectrum analyser – 5kHz to 50kHz – LED readout – digital storage – £1600 with instruction manual or £1750 with internal rechargeable battery.
HP5352B – 40GHz counter – Liquid crystal readout with instruction manual – £5000.
Spectrascope 11 SD335 (S.A.) realtime LF analyser – 20Hz to 50kHz – LED readout with manual – £850.
Tektronix 7D20 plug-in 2-channel programmable digitizer – 70 Mc/s – for 7000 mainframes – £500 – manual – £50.
Datron 1065 Auto Cal digital multimeter with instruction manual – £750.
Racal MA 259 FX standard. Output 100kc/s–1Mc/s–5Mc/s – internal NiCad battery – with manual. £150.
Tektronix 2235 100Mc/s oscilloscope + two probes + manual. £800.
Tektronix 2465 300Mc/s oscilloscope + two probes + manual. £1600.
Tektronix 485 350Mc/s oscilloscope + two probes + manual £500.
Tektronix TR503 tracking generator – 10Mc/s to 1800Mc/s + manual – £1500.
Aerial array on metal plate 9" x 9" containing 4 aerials plus Narda detector – .100–11GHz. Using N type and SMA plugs & sockets – ex eqpt – £100.
EIP 451 microwave pulse counter 18GHz – £1500.
Marconi RF Power Amplifier TF2175 – 1.5Mc/s to 520Mc/s with book – £100.
HP 8614A Signal Generator 800Mc/s to 2.4GHz – old colour – £300. New colour – £600.
HP 8616A Signal Generator 1.8GHz to 4.5GHz – old colour – £200. New colour – £400.
HP 8620A or 8620C Sweep Generators – £400 or £900.
Marconi 6155A Signal Source – 1 to 2 GHz – LED readout – £600.
Schlumberger 2741 Programmable Microwave Counter – 10Hz to 7.1GHz – £750.
Schlumberger 2720 Programmable Universal Counter 0 to 1250Mc/s – £600.
HP 37203A HP-IB Extender – £150.
PPM 411F Current Reference – £150.
HP 5363B Time Interval Probes – £150.
Marconi 6057B Signal Source – 4.50 to 8.50 GHz – £300.
HP 8900B Peak Power Calibrator – £100.
HP 59313A A/D Convertor – £150.
HP 59306A Relay Actuator – £150.
HP 2225CR Thinkjet Printer – £150.
TEK 178 Linear IC Test Fixture – £150.
TEK 576 Calibration Fixture – 067-0597-99 – £250.
HP 4437A 600 Ohm Attenuator – £100.
Marconi Signal Source 6059A – 12-18 GHZ – £400.
HP 8006A Word Generator – £150.
HP 1645A Data Error Analyser – £150.
Texscan Rotary Attenuators – BNC/SMA 0-10-60-100DBS – £50-£150.
HP 809C Slotted Line Carriages – various frequencies to 18GHZ – £100 to £300.
HP 532-536-537 Frequency Meters – various frequencies – £150-£250.
HP 3200B VHF Oscillator – 10MC/S-500MC/S – £200.
VAL Radio Invertors – 200-watt 12V to 115/230V AC 50c/s. £100.
Barr & Stroud variable filter EF3 0.1Hz–100kc/s + high pass + low pass – mains – battery – £150.
Krohn-Hite Model 3343 filter – low pass, high pass. 0.1Hz–100kc/s – mains – battery.
Krohn-Hite 4100 oscillator.
Krohn-Hite 4141R oscillator – .1Hz-10,000kHz.
Krohn-Hite 6880 programmable distortion ANZ-IEEE-488.
Krohn-Hite 3750 filter, low pass, high pass – .02Hz–20kHz.
Parametron D150 variable active filter, low pass – high pass – 1.5Hz–10kHz. £100.
S.E. Lab SM215 Mk11 transfer standard voltmeter – 1000 volts.
Fluke 4210A programmable voltage source.
Alltech Stoddart P7 programmer – £200.
Fluke 8500A digital multimeter.
H.P. 3490A multimeter.
H.P. 6941B multiprogrammer extender. £100.
Fluke Y2000 RTD selector + Fluke 1120A IEEE-488-translator + Fluke 2180 RTD digital thermometer + 9 probes. £350 all three items.
H.P. 6181 DC current source. £150.
H.P. 59501A – HP-IB isolated D/A/power supply programmer.
H.P. 3438A digital multimeter.
H.P. 61775 DC current source.
H.P. 6207B DC power supply.
H.P. 741B AC/DC differential voltmeter standard (old colour) £100.
H.P. 6209B DC power unit.
Fluke 80 high voltage divider.
Fluke 887AB AC+DC differential voltmeter.
Fluke 431C high voltage DC supply.
H.P. 1104A trigger countdown unit.
Tektronix M2 gated delay calibration fixture. 067-0712-00.
Tektronix precision DC divider calibration fixture. 067-0503-00.
Tektronix overdrive recovery calibration fixture. 067-0608-00.
Schwarzbeck EMC H.F. Interference measuring RX's. FSME 1515 – 85kc/s–30Mc/s + **FSME 1514** – 85kc/s – 30Mc/s + **15141+15142** – loop aerials – £500. **Vume 1520A** VHF–UHF 25–1000Mc/s – £500.
Avo VC 163 valve tester+book £300.
Gould 60000 XYT recorder. £250.
H.P. 5011T logic trouble shooting kit. £150.
Marconi TF2163S attenuator – 1GHz. £200.
PPM 8000 programmable scanner.
H.P. 9133 disk drive + 7907A + 9121 twin disk.
Fluke 730A DC transfer standard.
B&K level recorder 2307 + 2010 heterodyne analyser – in rack – £1000.
B&K 2971 phase meter – £150.
B&K 2112 audio frequency spectrometer – £100.
B&K 4815 calibrator head.
B&K 4812 calibrator head.
B&K 4142 microphone calibrator – £100.
B&K 1022 band FX oscillator – £100.
B&K 1612 band pass filter set – £150.
B&K 2107 frequency analyser – £150.
B&K 1013 BFO – £100.
B&K 1014 BFO – £150.
B&K 4712 FX response tracer – £250.
B&K 2603 microphone amp – £150.
B&K 2604 microphone amp – £200.
B&K 2804 microphone power supply – £200.
B&K 2019 analyser – £350.
Farnell power unit H60/50 – £250.
H.P. FX doubler 938A, also 940A – £300.
Racal/Dana 9300 RMS voltmeter – £250.
A.B. noise figure meter 117B – £400.
Alltech 360D11+3601+3602 FX synthesizer 1Mc/s–2000Mc/s. £500.
H.P. sweeper plug-ins – 86240A – 2–8.4GHz – 86260A – 12.4–18GHz – 86260AH03 – 10–15GHz – 86290B – 2–18.6GHz.
Telequipment CT71 curve tracer – £200.
H.P. 461A amplifier – 1kc–150Mc/s – old colour – £150.
H.P. 8750A storage normalizer.
Tektronix oscilloscopes type 2215A – 60Mc/s – c/w book & probe – £400.
Tektronix monitor type 604 – £100.

SPECIAL END OF LINE OFFER

Marconi TF2008 Signal Generators 10KC/S to 510MC/S – AM-FM – off the pile – tested – working – £300. Not working or part-working – £200. Kit box of attachments – £25. All supplied with manual, quick test only given, working or non-working – fair looking condition – 300 only available. As new ones still available as normal, fully tested with box of attachments – £400-£500.
Clark Scam Heavy Duty 40' Telescopic Pneumatic Masts – retracted 7'8" – head load 40lbs – with or without supporting legs & erection kit – in bag + handbook – £200-£500.
Clark Scam Heavy Duty 70' Telescopic Pneumatic Masts – retracted 13'5" – head load 90lbs – with or without legs + erection kit + handbook – £500-£800.

ITEMS BOUGHT FROM HM GOVERNMENT BEING SURPLUS. PRICE IS EX WORKS. S.A.E. FOR ENQUIRIES. PHONE FOR APPOINTMENT OR FOR DEMONSTRATION OF ANY ITEMS. AVAILABILITY OR PRICE CHANGE. VAT AND CARR. EXTRA.

Johns Radio, Whitehall Works, 84 Whitehall Road East, Birkenshaw, Bradford BD11 2ER. Tel. No. (0274) 684007. Fax 651160.

CIRCLE NO. 127 ON REPLY CARD

MLSSA brings speaker design in from the cold

Dave Berriman reports on a PC card which may help acoustic engineers dispense with open air or anechoic chambers for those critical loudspeaker measurements.

SYSTEM REQUIREMENTS
PC/XT or AT with 8087, 80287 or 80387 co-processor
640K
Floppy disk (but hard disk recommended)
MS dos or PC dos 2.1 or higher
Expansion bus speed of 8MHz or less.

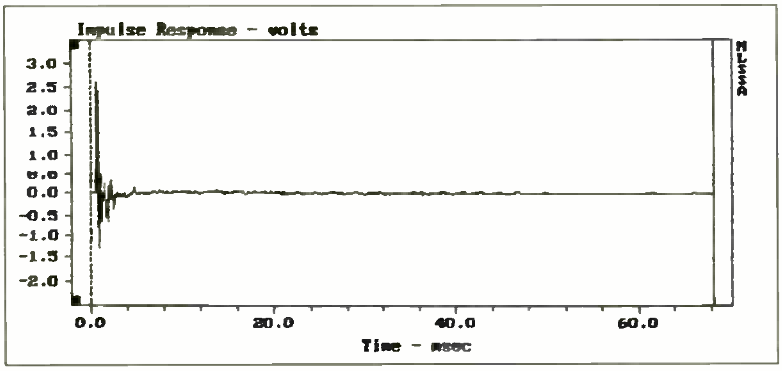
Traditionally, acoustics engineers – and in particular loudspeaker designers – have relied on anechoic rooms or the open air to eliminate sound reflections and achieve accurate sound pressure level measurements. But swept frequency response test equipment is expensive, and anechoic rooms are costly to hire and inaccurate at low frequencies (below about 150Hz, except for the very largest rooms).

However elimination of reflections can also be achieved using fast FFT, and DRA Laboratories' MLSSA (pronounced Melissa) plug-in audio FFT analyser card and associated software will enable that complex analysis to handled by the PC.

Reflections on measurements

Multiple reflections from room surfaces mean attempts to achieve accurate swept-frequency responses in ordinary rooms are fraught with danger. Bringing the microphone very close to the loudspeaker makes the direct sound dominant and allows quite accurate low-frequency tests to be made. But positioning the microphone at the traditional one metre measuring distance produces a response that can be all over the place.

Whole impulse time response, as shown at acquisition.



A frequency-modulated "warble tone" can prevent build up of some of the standing waves and can smooth-out the more obvious dips and peaks, but this is more of a cosmetic than a real cure. Bringing the microphone closer makes investigation of crossovers feasible. But in this kind of work, where phase relationships and relative driver-to-microphone time delays are critical, careful interpretation of results is required.

Elimination of reflections is the only real answer. Tone-burst gating systems, such as Bruel and Kjaer's, achieve this by gating a sine-wave signal on and off and cutting off the measurement before reflections are received. Fast fourier analysis techniques can achieve the same ends, either using noise or transient impulses, such as square, or raised sin or cosine waveforms.

The Fast FFT for audio design was pioneered by Kef in the 1970s, who did a lot of work on measuring loudspeakers with impulses. Computing the FFT of the impulse from the speaker, and comparing this with the FFT of the loudspeaker's input pulse, produces phase and frequency responses. By cutting off reflections, these can be eliminated.

Kef plotted a series of frequency responses against a third axis (time) to create a waterfall graph showing output decay over a range of frequencies.

Computers then were expensive and bulky. Now packages such as Melissa bring that power to the PC.

Quite a card

Melissa is a maximum length sequence system analyser card for PCs.

The card will operate with quite small PCs, but if lengthy computations and file management are to be avoided a 286, 386 or 486 machine with co-processor and a hard disk, are really essential. The more powerful machines also give other advantages, especially if applications include comparing memory-hungry, high-resolution, low-frequency responses or lengthy time/energy curves. For these tasks, the improved memory-management available with 386s and 486s is invaluable.

A-to-D converter, programmable filters, signal generator and any additional hardware required are included on the Melissa board. All that is needed for a complete measuring system is a microphone, microphone amplifier and power amplifier. One disadvantage is that this makes for a cumbersome set-up, particularly when compared with the compact self-contained Neutrik 3300 sine-wave plotter – my design mainstay up until now.

But Melissa is a much more capable unit in many other ways. Unlike a conventional FFT analyser using random noise or generating a series of identical impulses, Melissa generates a kind of pseudo-random noise signal called the maximum length sequence. It sounds a little like throbbing, filtered white noise but is cyclic, not random.

Designers DRA Laboratories claims that as long as the analyser samples the complete sequence, there will be no truncation error. This contrasts with conventional FFT analysers which introduce a truncation error when the measurement is cut off. As a result, DRA says Melissa can achieve 1Hz resolution with a 10kHz bandwidth; or 1kHz bandwidth with 0.125Hz resolution if the whole sample is used.

Using fewer samples (by setting the acquisition length, chosen when the measurement is made) simply reduces frequency resolution. After data has been captured, it is converted from its noise-like origins, to display a conventional impulse response, similar to an ordinary FFT.

For a loudspeaker being measured in a room, the screen will clearly show loudspeaker output and decay plus any reflections. All reflections occurring after a certain time can be cut out by reducing frequency resolution to 1/t, where t is the cut-of time. So the whole time-domain response can be subjected to FFT, giving the complete frequency and phase responses over the measured bandwidth, and resolution is limited only by the chosen acquisition length. Or an initial part of the time response can be selected, with a further reduction in resolution. Because the original MLS maximum length sequence is a "known" quantity, the analyser compares the MLS from the microphone to the original, and does not need to measure loudspeaker input. Thus, unlike a normal two-channel FFT analyser, Melissa requires only one measuring input.

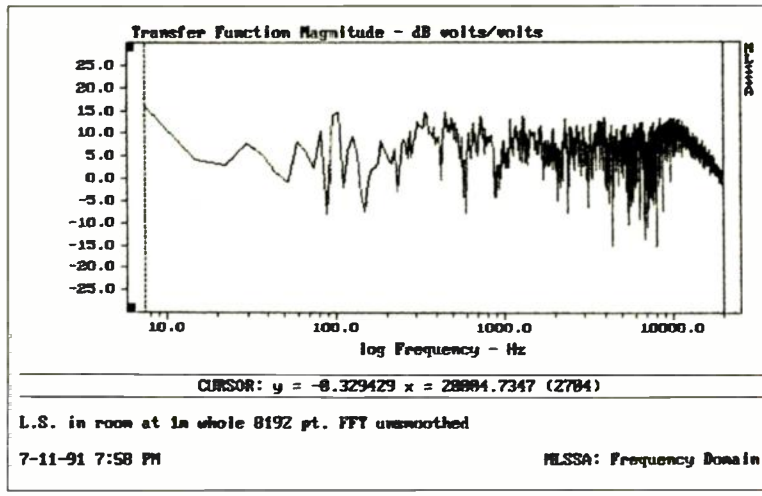
Acoustics speciality

Features have been designed with acoustics work firmly in mind. Of particular interest to acoustics engineers is the package's ability to cut short the analysed waveform, eliminating reflections from floors, ceiling and walls, creating a pseudo-anechoic response. The effect is achieved by moving the cursor and zooming in on the wanted section.

The result of executing the FFT on this time-slice is equal to a true anechoic measurement at high frequencies, but – as mentioned above – resolution will be reduced to 1/t, where t is the time duration of the sample taken. For example, a cut off at 5ms to eliminate a ceiling reflection would result in a resolution of 200Hz, giving points on the curve at 200Hz, 400Hz, 600Hz... and so on.

Below 200Hz there is nothing. Melissa displays a curve between the points, and also plots a spurious line below 200Hz – which should be ignored. This is not so much a limitation as something which must be acknowledged when interpreting measurements.

A full catalogue of the package's abilities and their use in practice would need a very lengthy article (see box). But the great thing about Melissa is that just one measurement, or "acquisition" is required. Everything else is post-processing and can be carried out later, at a different location and even on a different computer. So measurements could be made using a small monochrome machine, with processing carried out on a much more powerful colour computer for faster graph generation and a better display.



The whole 8192 point FFT of 8192 acquisition samples of a loudspeaker in an ordinary domestic living room. The curve is unsmoothed and clearly shows the effects of reflections which cause many peaks and dips. Resolution is 7.4Hz.

Melissa in practice

So much for the theory, what is Melissa like to set up and use?

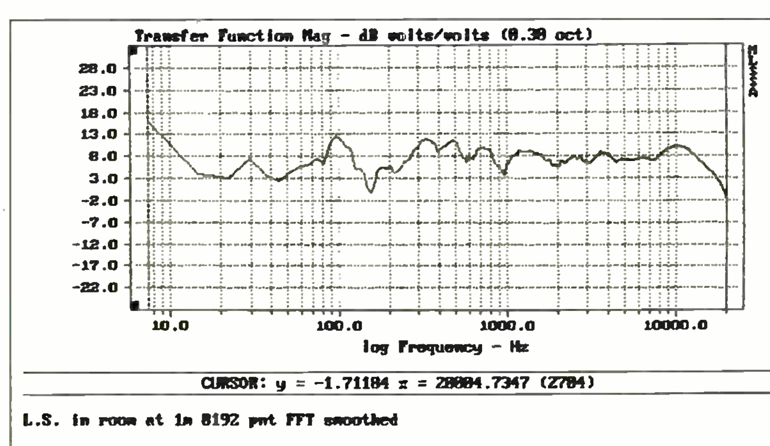
Munro Associates, who distribute the package, normally recommend one of the Toshiba laptop computers (with 286 or 386 processor and co-processor) for portable systems, because they take the full-length card. Many laptops only take a half-length card, or none at all.

But for me, Munro located a Samsung S5200 – which also takes a full-length card and was available at a somewhat lower price. Munro also installed the board and was extremely helpful with subsequent queries.

Once installed, Melissa works like a dream. Users must first find their way around the various menus and sort out the many functions. But that done the package really is easy to use, though you must read the manual before starting as the large choice of facilities and options available can cause confusion. However it is that range of facilities that gives Melissa such versatility.

For instance, after capturing the step-response "impulse", use cursors to decide which part is needed, zoom in then just press F followed by E (FFT EXECUTE). After a few seconds the FFT appears, viewed as it comes, or smoothed to whatever fraction of an octave is desired.

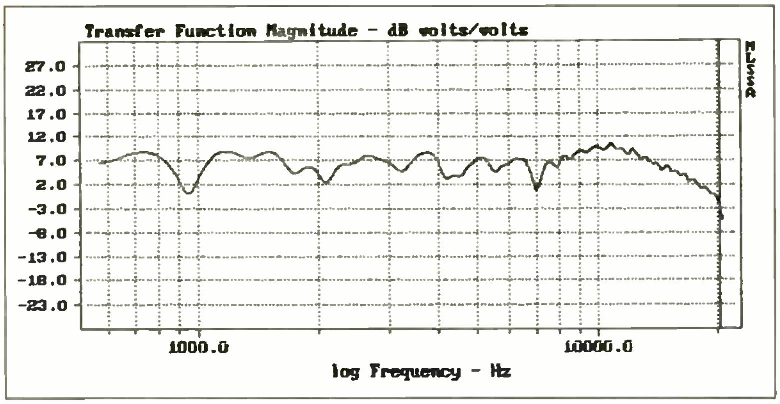
Press W and Melissa constructs a waterfall. On the



The whole 8192 point FFT of 8192 samples, but this time smoothed into 1/3 octave. Major dips and peaks are ironed out to show general response trend.

Samsung 286 machine a full-bandwidth waterfall takes fractionally over a minute due to the large number of computations required. But this can hardly be thought of as lengthy.

Time-domain responses and frequency-domain responses can both be stored. To avoid building up large lists of files I found it convenient to save just the whole time-domain response – from which all the other curves and measurements are derived – and perhaps one frequency-domain curve.



FFT of first of impulse with all room reflections removed. Frequency resolution is 330Hz, so low frequencies have been excluded from graph, printed as zoomed by cursors. This is the pseudo-anechoic response and is not smoothed in any way.

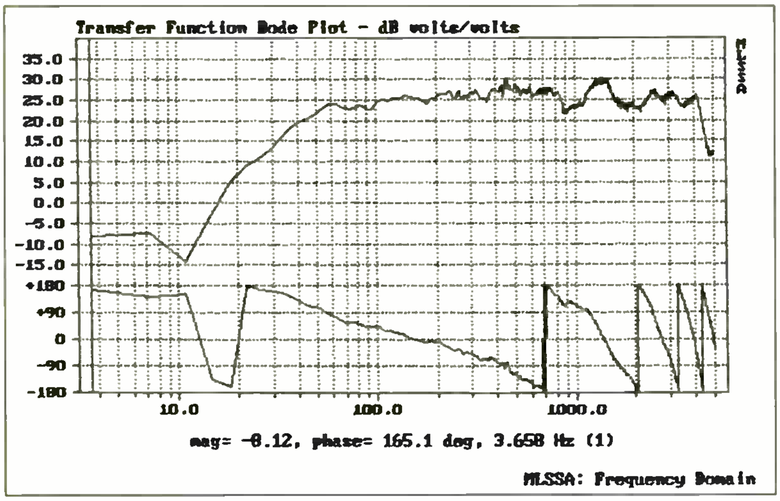
At a later date the time response can be recalled from memory and the various responses, phase plots, etc re-computed.

Macros allow measurements to be achieved automatically – particularly handy for repeated and tedious operations, such as polar response measurements, or perhaps measurements of vibration at different points on a loudspeaker panel.

For acousticians, Melissa's room measuring facilities will prove invaluable. By filtering Schroeder sound decay curves at various frequencies and selecting portions of the decay curves with the cursor, the RT 60 figures and early decay times can be presented. The only tedious aspect is the repetition, but it must still be quicker than any other way.

Even so if the effort proves too much, a macro can action the computations for different octave bands and print the results for you. Whichever way is chosen, just one acoustic measurement is required, with the rest of the work left to Melissa.

Bode plot of woofer unit showing amplitude and phase against frequency. Note the inaccuracy at low frequencies due to insufficient samples being taken at acquisition.



Keep an eye on printing

Once successfully up and running, I had no significant problems. First version of the software, 5.26, worked fine, though sometimes the display would "throw a wobbler", indicating unfamiliar numbers which would clear at the next command. Latest version 6 software, which includes useful features like sound pressure level measurements, was perfect from the outset and has caused no problems. The only minor niggle occurs when I occasionally try to print while the printer has run out of paper or is off line – the system locks up completely and refuses to respond to commands until the printer is brought on-line.

The reason is apparently because version 6 does not sense that the printer is not ready and just keeps on trying to print – a little foible which is to be cured in version 7, I am told (see box).

For printing I use the excellent little Kodak Diconix 150-plus portable ink-jet printer with the Samsung. It is light and compact and has a quite sharp print quality (curves in this feature have all been printed on ordinary paper on the 150-plus).

I have also used an HP Laserjet III without problems, apart from the time it takes to construct the image for the graphs; printing is much quicker on a dot-matrix or ink-jet printer.

Melissa is also compatible with the HPGL graphics interface.

Invaluable for loudspeaker design

I found Melissa to be a powerful tool for loudspeaker design work. It is especially useful for investigating hard-to-trace problems such as frequency response irregularities from tweeter horn resonances and tracking down effects due to grille frames and cabinet diffraction.

High-frequency mid-range-to-tweeter crossover work is also much easier without the clutter introduced by the room and this means that the microphone can be positioned at one metre, or further away, with Melissa still able to show how the loudspeaker is behaving.

The waterfalls are useful for indicating possible sources of audible coloration, though they need careful interpretation.

Where Melissa is not markedly better in an ordinary room than swept sine-wave techniques is at low frequencies. Here, because it is not possible to cut out reflections and have fine resolution, close microphone placement is still required to reduce the effect of the room (using Melissa in an anechoic room is a possible solution and I know of at least one manufacturer who does this).

A narrow acquisition bandwidth (say 5kHz) and a large FFT (4096 points) is required for an accurate low-frequency curve (3.66Hz resolution). Processing might be

Promise of Version 7

Version 7 is now on the way and is expected to include several refinements.

Of particular interest to loudspeaker designers is inclusion of Thiel Small parameter measurements using a complex curve fit algorithm. Because the algorithm does not rely on just three points on the impedance curve, it is claimed to be much more accurate than traditional techniques.

Version 7 should allow greater flexibility with overlays and provide an increased range of mathematical functions.

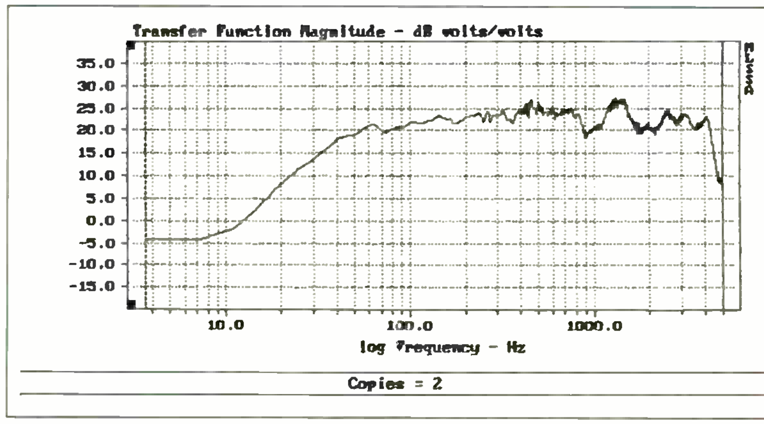
Double integration should allow acceleration, velocity and displacement to be viewed from an accelerometer input and there will also be enhancements to printer, file management and file exporting. To improve the available ram on 386 and 386SX computers, 386MAX will be bundled with version 7.

expected to take longer than the wide-bandwidth curves, but Melissa produces a frequency-response curve in just under a minute.

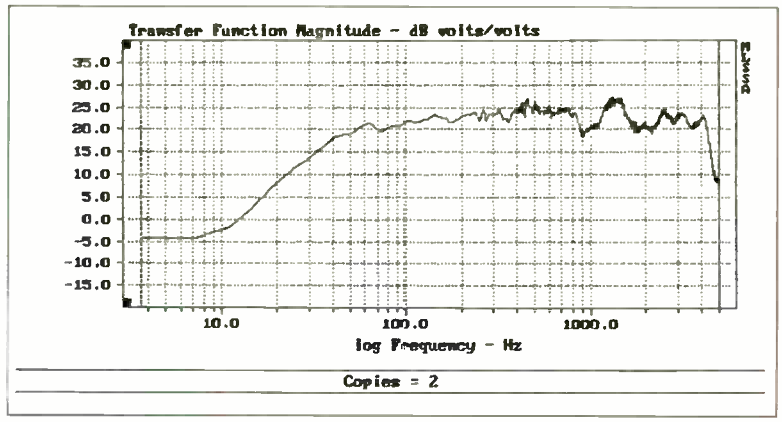
Pre-averaging can usefully be applied in these low frequency tests, helping the package to ignore any low-frequency background noise which can introduce inaccuracies. With pre-averaging and fine resolution, the Melissa curve is actually less cluttered by background noise than in-room sine-wave curves and in my view easier to interpret – provided the operator sets the acquisition length so as to achieve a narrow resolution.

With all measurements, the best approach is to set the acquisition to the same number of samples as the FFT. That way the set-up screen shows precisely the resolution that can be expected.

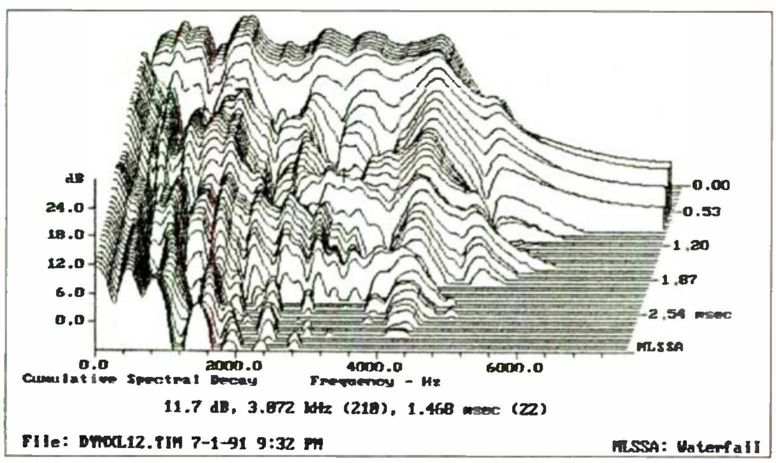
Version 6 has proved invaluable to me in loudspeaker design. But one more important feature is the upgradeability of new software. As a result I am now eagerly awaiting version 7 with a particular eye on its Thiel Small parameter measuring abilities. ■



Low-frequency resposne taken with 5kHz bandwidth and 4096 points acquisition, giving a resolution of 3.66Hz. This was taken with the microphone at 12cm from the woofer and shows the response clearly down to about 10Hz.



Group delay for woofer in room with microphone at 12cm.



Cumulative decay spectra of loudspeaker in sealed box, showing the decay in sound output after the "stimulus" has stopped. Plotted with a linear frequency axis.

Bibliography

1. D Rife and J Vanderkooy. "Transfer-Function Measurement with Maximum-Length Sequences" *JAES*, Vol. 37, No. 6, pp 419-443, 1989, June.
2. SP Lipshitz, TC Scott and J Vanderkooy. "Increasing the Audio Measurement Capability of FFT analysers by Microcomputer Post-Processing". *JAES*, Vol 33, pp. 626-648, 1985, September.
3. MR Schroeder. "New method on measuring reverberation time". *Journal of the Acoustical Society of America*, Vol. 38, pp. 329-361, 1965, and Vol. 40, pp. 549-551, 1966.
4. JM Berman and LR Fincham. "The application of Digital Techniques to the Measurement of Loudspeakers". *JAES*, Vol.25, pp. 370-382, 1977, June.
5. LR Fincham. "Refinements in the Impulse Testing of Loudspeakers". *JAES*, Vol. 33, No 3, pp. 133-140, 1985, March.
6. JD Bunton and RH Small. "Cumulative Spectra, Tone Bursts and Aperiodisation". *JAES*, Vol. 30, No 6, pp. 386-395, 1982, June.
7. CP Janse and AJM. Kaiser. "Time-Frequency Distributions of Loudspeakers: The Application of the Winger Distribution". *JAES*, Vol. 31, No 4, pp. 198-223, 1983, April.
8. T Houtgast and HJM. Steeneken. "Speech Intelligibility in Auditoria". *Acoustica*, Vol. 54, pp. 186-199, 1984.
9. JS Bradey and RE Haliwell, National Research Council of Canada. "Making Auditorium Acoustics More Quantitative". *Sound and Vibration*, February 1989.
10. H Moller and C Thompson. "Electroacoustic Free-Field Measurements in Ordinary Rooms, Using Gating Techniques". Bruel and Kjaer Application Notes, 15-107.

Melissa capabilities

Melissa can display the step response, frequency response, phase response, Bode and Nyquist plots, energy time curves, Schroeder reverberant decay curves and cumulative energy. It can measure impedance (both modulus and phase) and generate 3-D waterfalls, otherwise known as cumulative spectral decay graphs (there is also a variation on this known as the Wigner distribution). Early/late reflection ratios and reverb/direct ratio can be measured for acoustics work, and another function, known as coherence, allows errors introduced by the loudspeaker to be quantified. The function is a form of highly analytical distortion plot taken over a full bandwidth. But to make use of this facility the loudspeaker must be measured in an anechoic room – or well away from reflections which ruin the measurement.

Melissa can also measure accurate sound pressure level by referring to a library of microphone sensitivities, entered by the user.

A reference curve can be stored and compared to others, computing a difference curve, so that small changes introduced in, say, a crossover, can be accurately measured. It can also over-lay several curves on one screen for visual comparison. There are also numerous statistical computations which can be applied to the test results.

During system set-up, any inaccuracies introduced by the power amplifier etc, can be taken into account by storing the frequency and phase information about the amplifier link as a reference, which is subsequently automatically subtracted from the measurements. Also measurable are minimum and excess phase. The STI and RASTI speech intelligibility tests are also included. Programmable filters are included and these can be used to isolate reverberant decay within any octave or 1/3 octave band. Harmonic distortion can be measured

SUPPLIER DETAILS
MLSSA Distributors: Munro Associates, 13-16 Embankment Gardens, London SW3 4LW Tel: 071 352 8100 Fax: 071 351 0396
Price of plug-in card and software (inc one year guarantee on hardware) is £2490 + VAT.

Talent Computers

Custom Built Computers

High Quality Computers Built To Your Specification

Prices Start From

286	£500
386sx	£610
386dx	£730
486dx	£1100

All systems come with one-year warranty with the exception of hard disks which come with a minimum of 2 years warranty.

Tel 0533-376909

Fax 0533-376770

CIRCLE NO. 107 ON REPLY CARD

R.S.T. **LANGREX SUPPLIES LTD** R.S.T.

One of the largest stockists and distributors of electronic valves, tubes and semiconductors in this country.

Over 5 million items in stock covering more than 6,000 different types, including CRT's, camera tubes, diodes, ignitrons, image intensifiers, IC's, klystrons, magnetrons, microwave devices, opto electronics, photomultipliers, receiving tubes, rectifiers, tetrodes, thryatons, transistors, transmitting tubes, triodes, vidicons.

All from major UK & USA manufacturers.

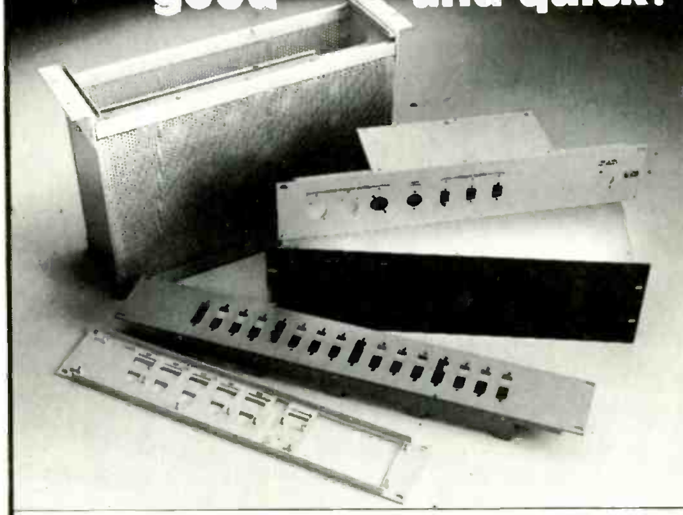
Where still available.

Obsolete items a speciality. Quotations by return. Telephone/telex or fax despatch within 24 hours on stock items. Accounts to approved customers. Mail order service available.

LANGREX SUPPLIES LTD
1 Mayo Road, Croydon, Surrey CR0 2QP.
Tel: 081-684 1166
Telex: 946708
Fax: 081-684 3056

CIRCLE NO. 108 ON REPLY CARD

Custom metalwork — good and quick!



Plus a wide range of stock products including:
- Nine sizes of standard 19" rack cases
- New "clam" case in any depth
- Eight-card 1U Eurocard case
- Audio, video and data patch panels
- Rack blanking and ventilation panels

All use the unique IPK extrusion, giving strength and rigidity with no visible fixing screws.
Rack mounting strips, cable trays etc. from stock.

ipk
IPK Broadcast Systems
3 Darwin Close Reading Berks RG2 0TB
Tel: (0734) 311030 Fax: (0734) 313836

CIRCLE NO. 109 ON REPLY CARD

THE CRUNCH FOR DSP CARDS ?

DSP power need no longer be limited to signal processing applications – if a new C compiler proves its worth. Allen Brown sums up XCX.

Principal platform for hosting digital signal processor chips is the PC expansion card. Originally the PC was seen as a low cost development system for DSP chips with software tools (C compiler, a cross assembler, linker and simulator) running under ms-dos.

Compiled code was down-loaded to the expansion card to run in real-time if necessary. So the role of the PC was limited to a development platform only, but represented an attractive entry-level alternative to chip-specific development systems.

Many manufacturers produce expansion cards hosting DSP chips, with applications largely confined (or limited) to signal processing needs – an annoying restriction considering the computational power of DSP chips.

But it was inevitable, recognising that DSP chips are potent number crunchers, that moves would be made to make expansion cards with DSP chips more accessible to non-signal processing requirements.

Now Rich Software (distributed in the UK by Bores Signal Processing) has issued XCX extended C compiler. The software package enables C source code with standard I/O and graphics instructions to be compiled and executed on expansion cards with an AT&T *DSP32(C)* chip.

By linking run-time libraries to the compiled C code, Rich has enabled the *DSP32(C)* to perform computational aspects of the code, with I/O data exchanged with the PC's CPU, accessing the PC's bios. Computational code written for Microsoft C, Quick C or Borland C compilers can be compiled for the *DSP32(C)* chip, targeting the *DSP32(C)* and not to the PC's CPU.

A marked upgrade in performance results. To demonstrate the improvement a short routine written in C for calculating a million square roots was compiled using XCX and down-loaded to a *DSP32C* on an LSI expansion card. It took seven seconds to complete.

The same piece of code, compiled with Microsoft Quick C, running on the PC's 20MHz 80386 with 80387 coprocessor, took 70s to complete – an order of magnitude slower.

The engineer or scientist who frequently refers to *C Numerical Recipes* (Cambridge University Press 1988) will find XCX a real joy as it also contains additional C instructions for manipulating matrices – an area where ansi C is particularly weak.

Manufacturers (**Table 1**) of expansion cards with the AT&T *DSP32(C)* may find a new customer base for their products providing they can produce cards with adequate memory and fast data transfer without the clutter of analogue I/O.

● Rich Software also produces a similar Pascal compiler, though effort may have been better spent if attention had been focused on C compilers for other floating point DSP chips such as the *TMS320C30*. ■

System Requirements
Expansion Card with either AT&T *DSP32* or *DSP32C* chip.
PC with expansion bus which matches card.
AT&T DSP32 C compiler, cross assembler and linker.

Availability
The XCX compiler (£300) and expansion cards listed in Table 1 are available from Bores Signal Processing, 39 Hawkswell Close, Woking, Surrey, GU21 3RS. Tel: 0483 740138.

Table 1. PC Expansion Card Hosting the AT&T DSP32(C).

Product code	Memory (bytes)	Analogue I/O	Price	Maker
ZPB32	64K (DSP32)	DSPlay serial i/f	£980	BB
XN1-AO	64K (DSP32	buffered serial i/f	£700	CAC
ZPB32-HS	64K (DSP32)	DSPlay serial i/f	£1470	BB
XN1-BO	64K (DSP32)	8 bit, 8kHz codec	£650	CAC
XC4-ax	64K-256K	buffered serial i/f	£800-1000	CAC
PC-32C	64K-256K zero w/s	DSPport interface	£1200-1500	ArieL
ZPB34	64K-576K two w/s	DSPLay serial i/f	£1960-4900	BB
AC5-ax	64K-256K zero w/s	CAC daughter boards	£1000-1200	CAC
PC/DSP32C 1.°2	two /s	DSPLink interface	£1400	LSI
V32C/256	128K-256K one w/s	DSPLink interface	£1400-1700	SMIS
PC-32M	256K-1.25M zero w/s	DSPport interface	£1800-3300	Ariel
AC5-ax-by 64K-1.25M	none one u/s	£1500-2200	CAC	
V32C/85	1.25M-8.25M seven w/s	DSPLink interface	£3200-4400	SMIS
DT2878	2-4M seven w/s	DT-Connect interface	£5000-6500	DT
ARIEL 32C 64K-256K	16 bit stereo 100kH zero w/s	£2700-3000	Ariel	
AC5-ax-J	64K-1.25M one w/s	16 bit stereo 50kHz	£1800-3500	CAC
PCS/DSP32C	192K two w/s	16 bit stereo 200kHz	£2000	LSI

SPICE• AGE

Non-Linear Analogue Circuit Simulator £245 complete

or £70 per Module

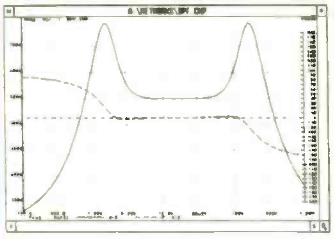
Those Engineers have a reputation for supplying the best value-for-money in microcomputer-based circuit simulation software. Just look at what the latest fully-integrated SPICE Advanced Graphics Environment (AGE) package offers in ease-of-use, performance, and facilities:

SPICE●AGE performs four types of analysis simply, speedily, and accurately.

- Module 1 – Frequency response
- Module 3 – Transient analysis
- Module 2 – DC quiescent analysis
- Module 4 – Fourier analysis

NEW VERSION 3.00 JUST RELEASED

FEATURES: New manual with introductory text on Fourier analysis, Fourier Zoom window. **UPGRADES £65.**



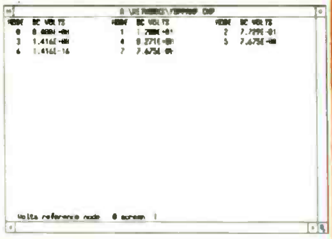
Impedance sweep

1 Frequency response

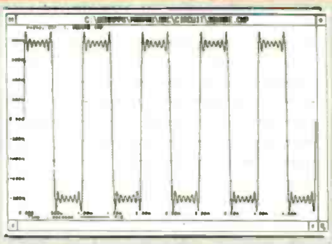
SPICE●AGE provides a clever hidden benefit. It first solves for circuit quiescence and only when the operating point is established does it release the correct small-signal results. This essential concept is featured in all Those Engineers' software. Numerical and graphical (log & lin) impedance, gain and phase results can be generated. A 'probe node' feature allows the output nodes to be changed. Output may be either dB or volts; the zero dB reference can be defined in six different ways.

2 DC Quiescent analysis

SPICE●AGE analyses DC voltages in any network and is useful, for example, for setting transistor bias. Non-linear components such as transistors and diodes are catered for. (The disk library of network models contains many commonly-used components – see below). This type of analysis is ideal for confirming bias conditions and establishing clipping margin prior to performing a transient analysis. Tabular results are given for each node: the reference node is user-selectable.



DC conditions within amplifier circuit



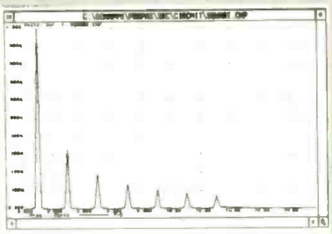
Square wave synthesis (transient analysis)

3 Transient analysis

The transient response arising from a wide range of inputs can be examined. 7 types of excitation are offered (impulse, sine wave, step, triangle, ramp, square, and pulse train); the parameters of each are user-definable. Reactive components may be pre-charged to steady-state condition. Up to 13 voltage generators and current generators may be connected. Sweep time is adjustable. Up to 4 probe nodes are allowed, and simultaneous plots permit easy comparison of results.

4 Fourier analyses now with Hanning window option

SPICE●AGE performs Fourier transforms on transient analysis data. This allows users to examine transient analysis waveforms for the most prevalent frequency components (amplitude is plotted against frequency). Functions as a simple spectrum analyser for snapshot of transients. Automatically interpolates from transient analysis data and handles up to 512 data values. Allows examination of waveform through different windows. Powerful analytical function is extremely easy to use.



Spectrum of synthesised square wave (Fourier analysis)

If your work involves designing, developing or verifying analogue or digital circuits, you will wonder how you ever managed without Those Engineers circuit Simulation Software.

A good range of properly supported and proven programs is available and our expert staff are at your service.

Telephone: Charles Clarke on 071-435 2771 for a demonstration disk.

Those Engineers LTD

WE HAVE MOVED TO

31 Birkbeck Rd · Mill Hill · London NW7 4BP
Tel: 081-906 0155 · Fax: 081-906 0969

CIRCLE NO. 110 ON REPLY CARD

KESTREL ELECTRONIC COMPONENTS LTD

☆ All items guaranteed to manufacturers' spec.
☆ Many other items available.

'Exclusive of V.A.T. and post and package'

	1+	100+		1+	100+
Z80A CPU	1.00	0.65	62256LP-100	3.40	2.32
Z80A CTC	0.60	0.30	6264LP-100	1.70	1.30
Z80A PIO	0.60	0.40	6264LP-120	1.50	1.10
Z80A SIO/O	1.20	0.90	6116LP-120	1.10	0.65
Z80A DMA	0.90	0.65	2764A-25	1.60	1.20
Z80A (CMOS) CPU	1.20	0.90	27C64-15	1.65	1.35
Z80B (CMOS) CTC	0.70	0.45	27C128-25	1.75	1.45
1488	0.14	0.12	27128A-20	1.65	1.30
1489	0.14	0.12	27256-25	1.80	1.40
ILQ-74	1.20	0.85	27C256-200	1.90	1.55
ULN2803A	0.50	0.35	27C512-150	2.50	2.00
6502AP	2.20	1.50	41256-100	1.30	0.95
6522AP	2.20	1.50	41C1000AP-80	4.10	3.25
6551	2.00	1.40	74LS04	0.10	0.07
65C21P2	2.80	2.40	74LS138	0.17	0.12
8031	1.90	1.40	74LS273	0.21	0.16
8251A	1.10	0.75	74LS368	0.14	0.10
8255-5	1.20	0.90	74LS373	0.20	0.14
8259AC	1.00	0.70	74LS374	0.20	0.14
D8742	10.50	9.40	74HC244	0.18	0.12
74LS00	0.10	0.07	74HC374	0.18	0.12
74LS02	0.10	0.07	74HCT373	0.18	0.12

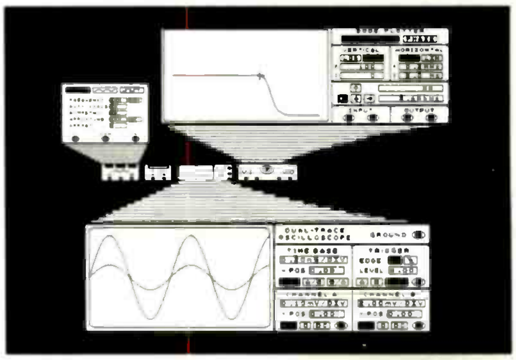
All memory prices are fluctuating daily, please phone to confirm prices

178 Brighton Road, Purley, Surrey CR8 4HA
Tel: 081-668 7522. Fax: 081-668 4190.

CIRCLE NO. 111 ON REPLY CARD

Electronics Workbench™

The electronics lab in a computer!



A simple, intuitive and very powerful teaching tool, Electronics Workbench™ lets students design and test both analog and digital electronic circuits, without the delays and expense of a laboratory.

Available in three packages:

Professional: **Full functionality, unlimited numbers of components in a circuit, with colour coding for circuit tracing EGA/VGA graphic support.**

Personal Plus: **Full functionality, unlimited number of components in a circuit, with monochrome graphics support.**

Personal: **Full functionality, 20 components or less in a circuit, with monochrome graphics support.**

EWB Professional single user
***£189.00** ex VAT.*
plus £5.00 post & packing.

Electronics Workbench™ is produced by Interactive Image Technologies Ltd.

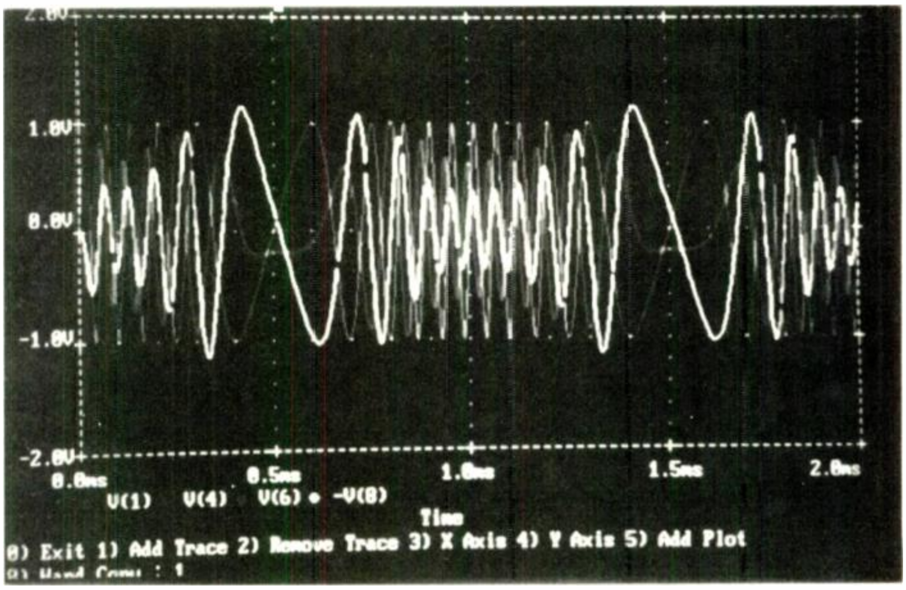
Electronics Workbench™ is available now through:

LJ Technical Systems Ltd.
Francis Way, Bowthorpe Industrial Estate, Norwich NR59JA.
Telephone: (0603) 748001.
Fax: (0603) 746340.

CIRCLE NO. 112 ON REPLY CARD

ADDING SPICE TO TECHNOLOGY

£30 and an IBM PC are enough to allow anyone to experiment with a wide range of electronic devices without having to connect even a single wire. Paul Stewart explains how to set about it.



Analogue simulation waveforms using the PSpice analogue simulator from ARS Microsystems.

A PC version of Spice (Microsim's simulation program with integrated circuit emphasis) now provides the user with a hands-off means of experimentation. Helped by a book called "Spice, a guide to circuit simulation & analysis using Pspice" by P.W.Tuinenga and published by Prentice Hall, he can gain access to a variety of electronic devices - from resistors and coils to transmission lines and quartz crystals - without so much as the need to connect a wire. The response of circuits to a variety of programmed stimuli can be monitored using a simulated oscilloscope.

This minimalist approach is aimed at the student; Microsim also offers evaluation and production versions. The evaluation package offers menu-driven software and comes with a complete 450 page document describing in much greater detail than Tuinenga's book all of the routines, parameters and options of the full Pspice package. Both this and the student version have a small library of device parameters or characteristics. The more expensive full production version has an extensive library of devices, including over 3000 analogue and 1200 digital devices.

Although only a rather small volume of device data is available in the student version, Tuinenga shows in his book how model parameters can be included for devices not covered by the library (see also the book by Antognietti and Massabrosi).

One important thing to remember with a software circuit simulator is that you cannot blow up a device: the computer will still give answers even if you try to drive a 100mA transistor with 10A. Make sure then that, before building your simulated circuit with real components, each of the various components is working within its power limit.

Pspice capabilities

Any competent engineer will be able to calculate mathematically the frequency at which an oscillator circuit will oscillate, provided that the amplitudes of the voltages of the waveforms generated are small in every part of the circuit. He may also be able to estimate the output voltages of such a circuit and even, with extreme difficulty, to assess the true frequency of oscillation, allowing for the existence of largeamplitude swings.

In a complex circuit, the mathematics

becomes too complicated; over the last thirty years engineers have therefore resorted to the use of the computer, even for circuits consisting entirely of passive components - for example, filters with twenty components. Although Pspice can cope with all this, it must be said that there can be no substitute for good design and flashes of inspiration!

The Pspice software simulator is controlled by a simple language with instructions in two broad categories: control statements and devices. Control statements instruct the computer to perform various types of analysis and produce output data in different formats: graphical and tabular. The devices section of the language is used to describe the types of device in a circuit and the connections made between them. The many control statements include instructions to calculate the DC voltages in a circuit, its frequency response and transient response to a variety of applied voltages such as sine, pulse and FM.

The following examples demonstrate some of the package's many facilities and give a better appreciation of the way in which the computer is instructed to perform various tasks.

Component types

Any electrical circuit may be described in terms of nodes or points of connection between the two different types of component from which it is made up. Passive devices such as resistors, capacitors and coils are components that passively transfer or dissipate energy without themselves being the source of it. Active devices such as diodes and transistors may have external bias energy applied. Part of this energy is used actively to increase the energy or modify the nature of a required signal.

In general, passive devices are rather easier to deal with because there is a simple one-to-one correspondence between the current flowing through them and the voltage developed across them. For example, the current through a resistor will double if the voltage applied to it is doubled, although this is not true for diodes and transistors, which are non-linear. This non-linear behaviour of active devices is what makes them so difficult to analyse and where a software package like Pspice comes into its own.

DC calculations

At the simplest level of any circuit calculation is the determination of the currents and voltages resulting from the application of steady DC voltages.

In a simple circuit consisting of two series resistors of 1 and 3Ω connected across a 1V DC supply, the following table shows the input file which describes the circuit in Pspice language.

```
potential divider circuit
V1 1 0 1V
R1 1 2 1Ω
R2 2 0 3Ω
.end
```

The first line of any Pspice program must be a string of symbols which serves to title the program; it has no significance as an instruction. The second line indicates that a steady voltage source of 1V is connected between points labelled *1* and *0* with node *1* at +1V, relative to node *0*. Every Pspice program must be terminated with an *.end*. Any line of a Pspice program that starts with an asterisk is ignored. It resembles an REM statement in Basic, and is used to insert remarks that make the program more readable.

If this program of instructions is held in a file called EXAMPLE.CIR, when the instruction pspice EXAMPLE.CIR is typed into the computer the program will be executed. After a short time another file, EXAMPLE.OUT, will be produced, part of which will look like this:

NODE	VOLTAGE	NODE	VOLTAGE
1)	1.0000	2)	.750

This table gives the voltages at various nodes relative to the *0* reference node; hence there is 1V between node *1* and *0* as one might expect since that is the voltage applied to the circuit. The other two figures indicate that between nodes *2* and *0* there is a voltage of 0.750V.

In fact this circuit is nothing more than a potential divider with 3/4 of the total series resistance between terminals *2* and *0*. This trivial example serves to show the basic structure of a program.

One point that should be noted is that computers fail if any attempt is made to divide a number by zero. This has certain implications for the execution of pspice in DC analysis of circuits with inductors and capacitors.

AC calculations

In circuit analysis, the frequency response of a circuit such as a filter or amplifier often needs to be determined. **Figure.1** shows a 50Ω 5-element low-pass filter with a design cut-off frequency of 1MHz. It consists of two inductors, l_1 and l_2 with values 10.73μH and connected between nodes *1* and *2* and *2*

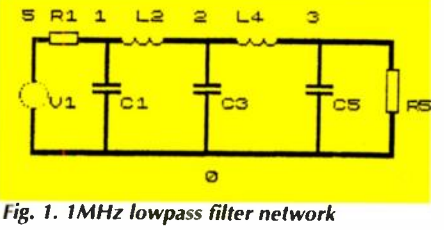
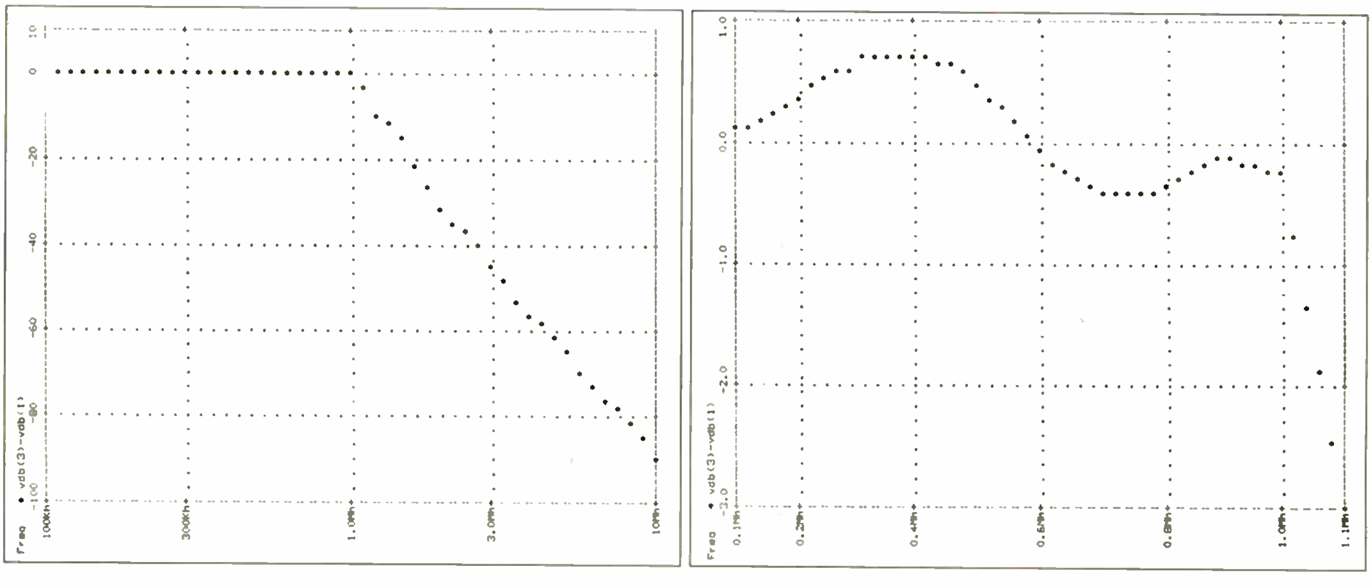


Fig. 1. 1MHz lowpass filter network



The left hand plot shows the frequency response of the filter network with the associated passband ripple indicated on the right

and *3*; the capacitors C_1, C_3 and C_5 are connected between ground, node *0*, and nodes *1*, *2* and *3*, respectively with C_1=C_5=3000pF and C_3=5600pF. The filter is terminated with its characteristic impedance of R_5=50Ω and fed by a signal generator V_1 with a source impedance that is also 50Ω. The corresponding Pspice program is shown below:

```
r.f low-pass filter
v1 5 0 ac 1
r1 5 1 50Ω
c1 1 0 3000pF
l2 1 2 10.73µH
c3 2 0 5600pF
l4 2 3 10.73µH
c5 3 0 3000pF
r5 3 0 50Ω
.ac dec 20 .1e6hz 100e6hz
.probe.end
```

Only three of these lines require explanation: line 2: v_1 *5 0 ac 1* indicates that an AC voltage of nominally 1V is applied between nodes *5* and *0*; line 10: *.ac dec 20 .1e6hz 100e6hz* indicates that the voltage source v_1 applied to the filter is to be swept through 20 different frequencies in decades from 0.1 to 100MHz; the symbol *e6* is used to indicate 10^6 as a multiplying factor (the symbol Meg may also be used); line 11: *.probe* instructs the computer to store all current and voltage values at and through each node in a file called PROBE.DAT.

When the program ends, you should type .PROBE into the computer. A menu will appear, offering you a variety of choices of graphical presentation of the computed data. As the name implies, the action of PROBE is to simulate an oscilloscope probe, providing a graphical view of the voltages and currents at any point in the circuit.

In Pspice talk, this *.ac* type of analysis gives what is called the small-signal steady-state response to the input; the number 1 at the end of line 2 does not mean 1V but is simply an arbitrary defining constant for V_1. The analysis assumes that the input signal is very small so that, if components such as transistors are included, they are not driven far from the DC bias conditions.

Of course, the filter circuit described above does not contain non-linear devices. Small-signal analysis is appropriate when the frequency response of an input RF receiver amplifier is being determined, but not for the response of an RF power amplifier of a transmitter where the input signal levels are very high; for example in class C mode.

Considerably higher volumes of data may be accessed through the use of PROBE than is discussed here, including the delay of a pulse of CW through the circuit and the phase of the output sine wave relative to that of the input.

Transient analysis

Transient analysis mode is particularly interesting. All electronic circuits are subject to transient behaviour, but whether this is important depends on the time the circuit takes to stabilise compared with the period over which it is handling a signal. For example, if a short burst of audio tone is passed through a high Q band-pass audio filter, the output of the filter may have an unacceptable ring which can be so long as to run into the next burst of tone; this is a well-known problem in CW filtering of high speed Morse signals.

The transient analysis mode in Pspice has another important feature: it allows the effects of large signals in a circuit containing non-linear elements like diodes and transistors to be determined. As we all know,over-driving an RF power amplifier produces harmonics. One simple example of transient analysis using Pspice (outlined below) forms the basis of Time Domain Reflectometry.

Figure.2a shows a transmission line of 50Ω impedance; to the input of the line is connected a 50Ω/1V pulse generator; the other end of the transmission line is shorted. If the pulse generator voltage "vpulse" rises from 0V to 1V at a time 10ns from the time origin 0 and is then held at that voltage indefinitely, what is the voltage at the input terminal to the transmission line at different times?

In fact what happens is that the pulse takes 10ns to travel down the line to the short, where it is inverted and reflected back

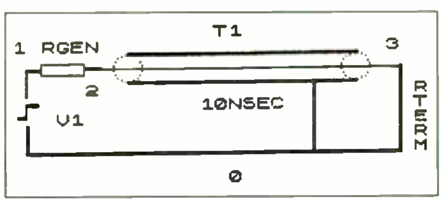


Fig. 2a. Short-circuited transmission line model

towards the pulse generator. This cancels the on-coming 1V from the generator, leaving 0V in its wake. 20ns after switch-on, the reflected signal cancels the on-coming wave completely at the input to the transmission line; from then on, there is no voltage across the line's input terminals although the 1V is sustained at the input to the 50Ω resistor.

This circuit is simulated using the Pspice program below:

```
pulsed transmission line
t1 2 0 3 0 Z0=50Ω td=10nsec
rgen 1 2 50Ω
rterm 3 0 .0001Ω
v1 1 0 pulse(0v 1v 5nsec 0nsec 0nsec 50nsec
500nsec)
.tran .05nsec 30nsec
.probe
.end
```

Four of these lines need some explanation: line 2: t_1 *2 0 3 0* Z_0*=50Ω td=10nsec*. Any *device* beginning with a *t* indicates a transmission line; the input is connected between nodes *2* and *0* and the output appears between nodes *3* and *0*; Z_0*=50Ω* refers to the line's characteristic impedance and *td=10nsec* is the delay length: 10 units of ns (1ns=10-9s).

Line 4: rterm 3 0 .0001Ω. The very low value of rterm (.0001Ω) has been given a value close to zero without actually making it zero since computers fail to compute with zeros; this simulates a short circuit at the output end of the line t_1.

Line 5: v_1 *1 0 pulse(0v 1v 5nsec 0nsec 0nsec 50nsec 500nsec)* This statement sets the voltage source v_1 to a pulse of 1V which switches from 0V at time=0 to 1V at time=5ns, with rise and fall times of 0s and has a 500ns period with the voltage being developed across nodes *1* and *0*;Line 6: *.tran .05nsec 30nsec*. This line instructs the computer to calculate the voltages and currents in the circuit over a 30ns period and to record them at .05ns intervals.

Addition of the .PROBE statement produces a file PROBE.DAT which, after the execution of the above program, can be accessed by typing probe as before.

Now consider two minor modifications to this circuit. Place a 5pF capacitor half way along the transmission line and across it and replace the short with a 50Ω resistor at the end of the line. This simulates the effect on a matched coaxial line which is fixed *too* hard into a wall with a U-shaped pin that compresses the cable, thereby increasing its capacitance locally. The circuit is shown in **Fig. 2b**.

If we apply the same pulse to the line and ask for the transient response, the Pspice program becomes:

```
defective transmission line pulsed
t1 2 0 3 0 Z0=50Ω td=5nsec
rgen 1 2 50Ω
cmid 3 0 5pF
t2 3 0 4 0 Z0=50Ω td=5nsec
rterm 4 0 50Ω
v1 1 0 pulse(0v 1v 5nsec 0nsec 0nsec 50nsec
500nsec)
.tran .05nsec 30nsec
.probe
.end
```

The PROBE facility can again be invoked to inspect the line voltages. With the line voltages displayed by PROBE in low time resolution (see **Fig.2c**), because the input voltage pulse V(1) takes 5ns to reach the capacitor, the effect of the capacitor is not felt until after that time.

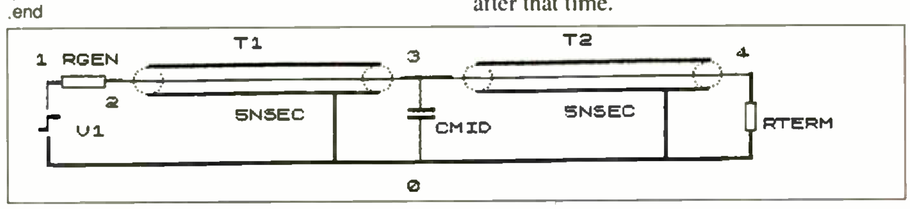


Fig. 2b. Transmission line model. The capacitance in the middle represents the effect of a drawing pin compressing the cable

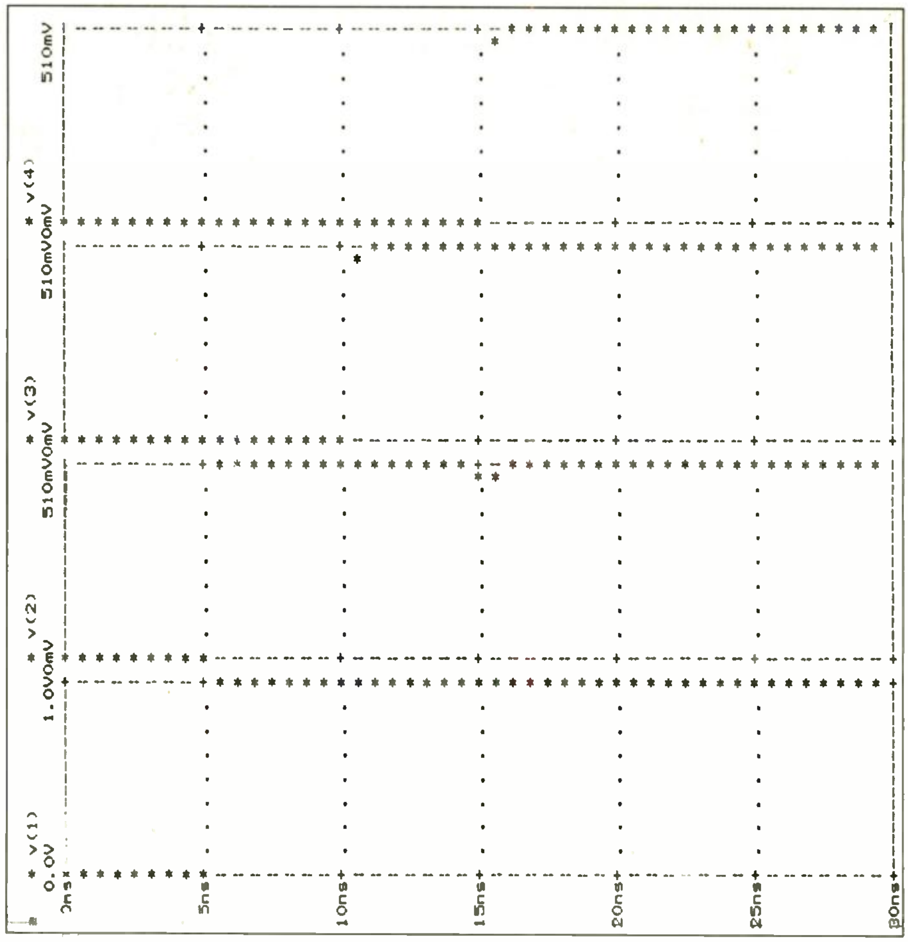


Fig. 2c. Transmission line voltages vs time (low resolution)

When the leading edge of the pulse strikes the capacitor, the sudden change in the capacitor potential makes the capacitor behave momentarily like a short circuit; the capacitor then proceeds to charge up to a steady voltage with a time constant of 0.125ns. This is half the time constant formed by 50Ω and a capacitor of 5pF. 10ns after the pulse has switched on at the input end, the information is received at the far end.

What of the signal reflected back to the generator? There are two possible reflections, one from the capacitor and the other from the termination at the end of the line t_2. The latter does not occur because, of course, the line is perfectly matched to the load.

The voltage that appears at the input end, node 2, is then the effect of the input voltage from the pulse generator and the signal reflectedfrom the capacitor. 10ns after the pulse is switched on, the signal which is reflected back from the capacitor has had time to make its effect felt on the input, node 2. In the first instance it produces an effective short similar to the previous example, so that the voltage drops to zero; this effect decays gradually to produce a steady distribution of voltages throughout the line with the input and output voltages both becoming 0.5V. **Figure.2d** shows the voltages at various points with a finer time resolution.

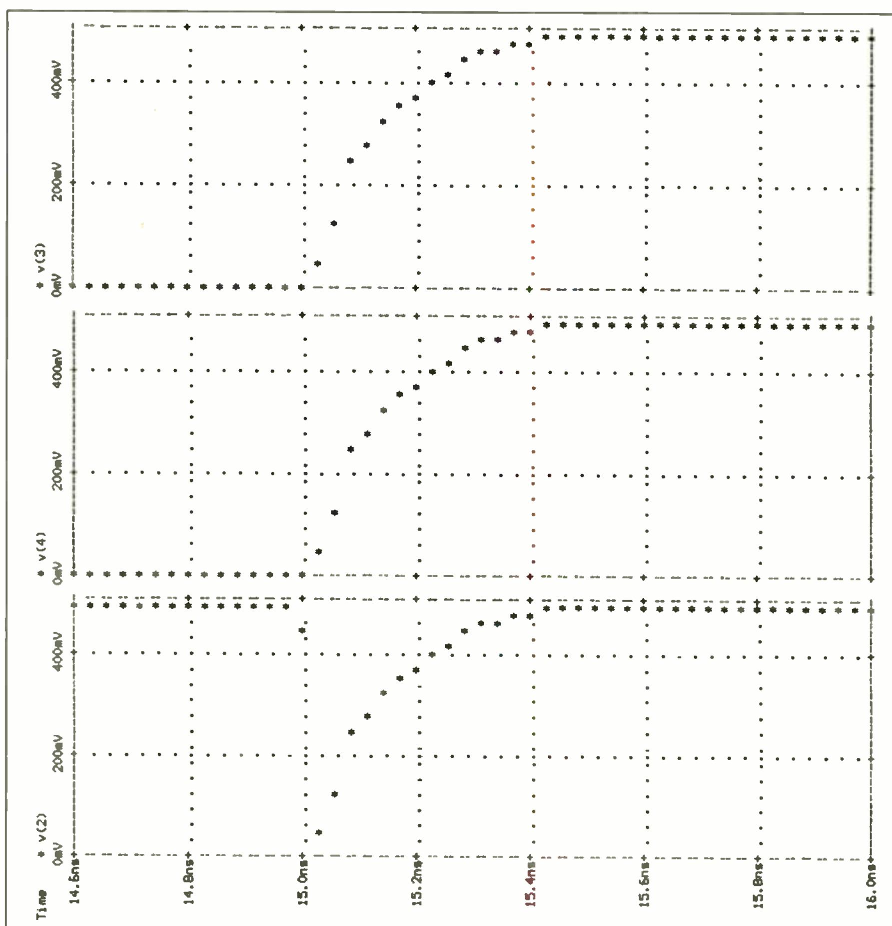


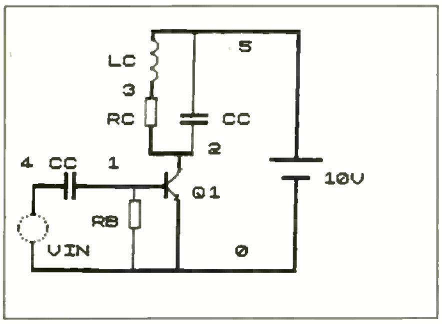
Fig. 2d. Transmission line voltages vs time (high resolution)

Other Pspice features

Since the 1987 student version was written, the codes of the evaluation and production versions have been updated. These two versions now include a powerful digital option that - amongst other features - enables TTL and discrete components to be interconnected. The PROBE may be invoked to give analogue voltages and a logic analyser display in terms of the 0s and 1s of various logic states as a function of time.

This facility necessitates the modelling of the I/O interfaces of TTL, cmos and ECL chips in analogue form as well as the various propagation delays from all of the internal components between the interfaces. Such models may be constructed either by the user or by invoking a digital library using a .LIB command, although this is not included in the student version.

Two other features available in evaluation and production versions are described under the heading Analogue Behavioural Modelling. It is possible, for example, to give the voltage current relation for a device in terms of a numerical table; such a facility is useful in modelling say a tunnel diode. Another aspect of this feature is its ability to write, in the form of a table, the frequency response of a filter which you wish to include in a larger circuit.



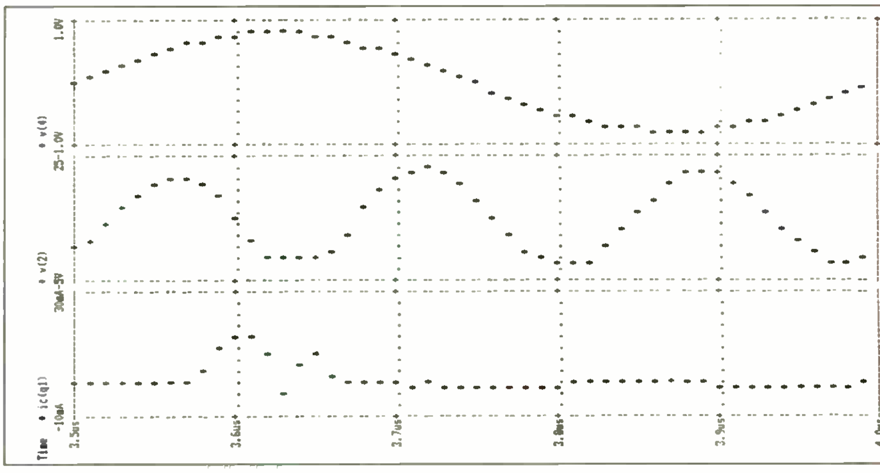


Fig. 3a (top) Transistor tripler model.

Fig. 3b (right) shows variations of the output voltage, v(2) the collector current ic(q1) together with that of the intput voltage v(4) for the last oscillation of the input voltage.

Fig. 3c displays the amplitudes of the various harmonics in the output voltage v(2) at the collector, the largest of which is the third as required

DC COMPONENT = 9.991873E+00

HARMONIC NO	FREQUENCY (HZ)	FOURIER COMPONENT	NORMALIZED COMPONENT	PHASE (DEG)	NORMALIZED PHASE (DEG)
1	2.000E+06	4.204E-01	1.000E+00	-8.411E+01	0.000E+00
2	4.000E+06	1.239E+00	2.948E+00	-1.604E+02	-7.624E+01
3	6.000E+06	1.086E+01	2.584E+01	-3.524E+01	4.887E+01
4	8.000E+06	8.374E-01	1.992E+00	-1.196E+02	-3.551E+01
5	1.000E+07	3.344E-01	7.956E-01	1.759E+02	2.600E+02
6	1.200E+07	2.037E-01	4.845E-01	1.381E+02	2.222E+02
7	1.400E+07	1.829E-01	4.350E-01	5.908E+01	1.432E+02
8	1.600E+07	1.695E-01	4.031E-01	-1.315E+01	7.096E+01
9	1.800E+07	1.750E-01	4.164E-01	-8.564E+01	-1.529E+00

TOTAL HARMONIC DISTORTION = 2.610554E+03 PERCENT

As a final example of Pspice, consider the tripler circuit of **Fig. 3**. We shall apply a 2MHz sine wave of amplitude 0.8V between the base and emitter of a 2N2222 transistor. A 10V supply feeds the transistor via a parallel coil and capacitor – the latter two components being chosen to resonate at the third harmonic of 2MHz. The program simulating the transient reponse follows.

```
transistor frequency tripler
.options itl5=0
.lib
q1 2 1 0 Q2N2222
vsupply 5 0 10v
rb 1 0 1kohms
1c 5 3 10e–6
rc 3 2 7.5ohms
cc 5 2 70pF
cb 4 1 1nF
vin 4 0 sin(0 .8v 2meg 0 sec 0)
.tran .1e–6 4e–6 0 .01e–6
.four 2e6v(2)
.probe
.end
```

The resistor rc is chosen to give the 10μH coil lc a realistic Q of 50 at 6MHz. The device q1 is a transistor with nodes 2, 1, and 0 as collector, base and emitter respectively. The model type "2N2222" has parameters held in the library and invoded by the .lib command on the second line.

In this program, the transient analysis proceeds for about four microseconds with data recorded every 0.1μs. The purpose of the instruction "four... " is to perform a harmonic analysis on the output voltage of the tripler during last 0.5μs (=1/2MHz) of the transient analysis when, hopefully, a steady state has been reached. **Fig. 3b** shows variations of the output voltage, v(2) the collector current ic(q1) together with that of the intput voltage v(4) for the last oscillation of the input voltage.

Fig. 3c displays the amplitudes of the various harmonics in the output voltage v(2) at the collector, the largest of which is the third as required.

Software

Evaluation and production versions are available from ARS Microsystems, Doman Road, Camberley, Surrey, GU15 3DF.

The evaluation version includes Tuinenga's book, a 450 page manual covering a complete list of routines plus two 1.2MB high density disks. The software for both the student and evaluation versions may be freely copied; this is encouraged by Microsim Corporation.

Computer system requirements

The student version of Pspice will run on an IBM compatible PC or PS/2 based on the 8088, 80286 and 80386 microprocessors; it will also run on a Macintosh, but you should specify which. Both monochrome and colour monitors are supported.

While the student and evaluation versions will work without a maths co-processor, both will run about ten times faster if one is installed; the full production version does, however, require a co-processor. Software is supplied on two 5 in double-density double-sided disks for the student version and two high density disks for the evaluation version.

Pspice runs under MS-DOS 2.0+ with at least 512kB of RAM. The production version will also run on a variety of workstations. Apart from the production version, the capacity is limited to about 10 transistors or 25 nodes; the full version however is limited by the available RAM and has a typical capacity of 1000 resistors or about 100 transistors per 500kB of memory.

Which version?

This article has concentrated on the student version of Spice prepared by Microsim for the obvious reason that it is cheap, supported by a reasonably priced book and usable on a cheap computer. Apart from the other more elaborate versions mentioned, there are a number of other versions of Spice. Among these are Spice-Plus by Analogue Tools, Dspice by Daisy Systems, AllSpice by Intusoft, Z-Spice by Z-Tech and Spice-Age by Those Engineers. ■

Acknowledgements

The author would like to thank Prentice-Hall and ARS Microsystems for providing access to their software products and for clarifying a number of details.

References

Semiconductor Device Modelling with SPICE, ed. P. Antognetti & G. Massobrio, pub. McGraw-Hill Book Co. (ISBN 0-07-002107-4), 1988.

See p6 for details on obtaining your free evaluation copy of Pspice...

AMSTRAD PORTABLE PC'S FROM £149 (PPC1512SD). £179 (PPC1512DD). £179 (PPC1640SD). £209 (PPC1640DD). MODEMS £30 EXTRA.NO MANUALS OR PSU.

HIGH POWER CAR SPEAKERS. Stereo pair output 100w each 4ohm impedance and consisting of 6 1/2" woofer 2" mid range and 1" tweeter. Ideal to work with the amplifier described above. Price per pair £30.00 Order ref 30P7R.
2KV 500 WATT TRANSFORMERS Suitable for high voltage experiments or as a spare for a microwave oven etc. 250v AC input. £10.00 ref 10P93R
MICROWAVE CONTROL PANEL Mains operated, with touch switches. Complete with 4 digit display, digital clock, and 2 relay outputs one for power and one for pulsed power (programmable). Ideal for all sorts of precision timer applications etc. £6.00 ref 6P18R
FIBRE OPTIC CABLE. Stranded optical fibres sheathed in black PVC. Five metre length £7.00 ref 7P29R
12V SOLAR CELL. 200mA output ideal for trickle charging etc. 300 mm square. Our price £15.00 ref 15P42R

PASSIVE INFRA-RED MOTION SENSOR. Complete with daylight sensor, adjustable lights on timer (8 secs -15 mins), 50' range with a 90 deg coverage. Manual overide facility. Complete with wall brackets, bulb holders etc. Brand new and guaranteed. £25.00 ref 25P24R.
Pack of two PAR38 bulbs for above unit £12.00 ref 12P43R

VIDEO SENDER UNIT Transmit both audio and video signals from either a video camera, video recorder or computer to any standard TV set within a 100' range! (tune TV to a spare channel). 12v DC op. £15.00 ref 15P39R Suitable mains adaptor £5.00 ref 5P191R
FM TRANSMITTER housed in a standard working 13A adapter (bug is mains driven). £26.00 ref 26P2R
MINATURE RADIO TRANSCEIVERS A pair of walkie talkies with a range of up to 2 kilometres. Units measure 22x52x155mm. Complete with cases. £30.00 ref 30P12R

FM CORDLESS MICROPHONE. Small hand held unit with a 500' range! 2 transmit power levels reqs PP3 battery. Tuneable to any FM receiver. Our price £15 ref 15P42AR
12 BAND COMMUNICATIONS RECEIVER. 9 short bands, FM, AM and LW DX/local switch, tuning 'eye' mains or battery. Complete with shoulder strap and mains lead. NOW ONLY £19.00!! REF 19P14R.

WHISPER 2000 LISTENING AID. Enables you to hear sounds that would otherwise be inaudible! Complete with headphones. Cased. £5.00 ref 5P179R
CAR STEREO AND FM RADIO Low cost stereo system giving 5 watts per channel. Signal to noise ratio better than 45db, wow and flutter less than .35%. Neg earth. £25.00 ref 25P21R.
LOW COST WALKIE TALKIES. Pair of battery operated units with a range of about 200'. Our price £8.00 a pair ref 8P50R

7 CHANNEL GRAPHIC EQUALIZER plus a 60 watt power amp! 20-21KHZ 4-8R 12-14v DC negative earth. Cased. £25 ref 25P14R.
NICAD BATTERIES. Brand new top quality. 4 x AA's £4.00 ref 4P44R. 2 x C's £4.00 ref 4P73R, 4 x D's £9.00 ref 9P12R, 1 x PP3 £6.00 ref 6P35R
TOWERS INTERNATIONAL TRANSISTOR SELECTOR GUIDE. The ultimate equivalents book. Latest edition £20.00 ref 20P32R
CABLE TIES. 142mm x 3.2mm white nylon pack of 100 £3.00 ref 3P104R. Bumper pack of 1,000 ties £14.00 ref 14P6R

1992 CATALOGUE AVAILABLE NOW
IF YOU DO NOT HAVE A COPY PLEASE REQUEST ONE WHEN ORDERING OR SEND US A 6"X9" SAE FOR A FREE COPY.

GEIGER COUNTER KIT. Complete with tube, PCB and all components to build a battery operated geiger counter. £39.00 ref 39P1R
FM BUG KIT. New design with PCB embedded coil. Transmits to any FM radio. 9v battery req'd. £5.00 ref 5P158R
FM BUG Built and tested superior 9v operation. £14.00 ref 14P3R
COMPOSITE VIDEO KITS. These convert composite video into separate H sync, V sync and video. 12v DC. £8.00 ref 8P39R.
SINCLAIR C5 MOTORS 12v 29A (full load) 3300 rpm 6"x4" 1/4" O/P shaft. New. £20.00 ref 20P22R.
As above but with fitted 4 to 1 inline reduction box (800rpm) and toothed nylon belt drive cog £40.00 ref 40P8R.
SINCLAIR C5 WHEELS 13" or 16" dia including treaded tyre and inner tube. Wheels are black, spoked one piece poly carbonate. 13" wheel £6.00 ref 6P20R, 16" wheel £6.00 ref 6P21R.
ELECTRONIC SPEED CONTROL KIT for c5 motor. PCB and all components to build a speed controller (0-95% of speed). Uses pulse width modulation. £17.00 ref 17P3R.
SOLAR POWERED NICAD CHARGER. Charges 4 AA nicads in 8 hours. Brand new and cased £6.00 ref 6P3R.

12 VOLT BRUSHLESS FAN 4 1/2" square brand new ideal for boat, car, caravan etc. £5.00 ref 5P206
ACORN DATA RECORDER ALF503 Made for BBC computer but suitable for others. Includes mains adapter, leads and book. £15.00 ref 15P43R
VIDEO TAPES. Three hour superior quality tapes made under licence from the famous JVC company. Pack of 10 tapes £20.00 ref 20P20R.
PHILIPS LASER. 2MW HELIUM NEON LASER TUBE. BRAND NEW FULL SPEC £40.00 REF 40P10R. MAINS POWER SUPPLY KIT £20.00 REF 20P33R READY BUILT AND TESTED LASER IN ONE CASE £75.00 REF 75P4R.
6V 10AH LEAD ACID sealed battery by yuasha ex equipment but in excellent condition now only 2 for £10.00 ref 10P95R.
12 TO 220V INVERTER KIT As supplied it will handle up to about 15 w at 220v but with a larger transformer it will handle 80 watts. Basic kit £12.00 ref 12P17R. Larger transformer £12.00 ref 12P41R.

VERO EASI WIRE PROTOTYPING SYSTEM Ideal for designing projects on etc. Complete with tools, wire and reusable board. Our price £6.00 ref 6P33R
MICROWAVE TURNTABLE MOTORS. Ideal for window displays etc. £5.00 ref 5P165R.
STC SWITCHED MODE POWER SUPPLY 220v or 110v input giving 5v at 2A, +24v at 0.25A, +12v at 0.15A and +90v at 0.4A £6.00 ref 6P59R
HIGH RESOLUTION 12" AMBER MONITOR 12v 1.5A Hercules compatible (TTL input) new and cased £22.00 ref 22P2R
VGA PAPER WHITE MONO monitors new and cased 240v AC. £59.00 ref 59P4R
25 WATT STEREO AMPLIFIER STK043. With the addition of a handful of components you can build a 25 watt amplifier. £4.00 ref 4P69R (Circuit dia included).
LINEAR POWER SUPPLY Brand new 220v input +5 at 3A, +12 at 1A, -12 at 1A. Short circuit protected. £12.00 ref 12P21R
MINI RADIO MODULE Only 2" square with ferrite aerial and tuner. Superhet. Req's PP3 battery. £1.00 ref BD716R
BARGAIN NICADS AAA SIZE 200MAH 1.2V PACK OF 10 £4.00 REF 4P92R, PACK OF 100 £30.00 REF 30P16R
FRESNEL MAGNIFYING LENS 83 x 52mm £1.00 ref BD827R.
ALARM TRANSMITTERS. No data avaliable but nicely made complex transmitters 9v operation. £4.00 each ref 4P81R.
UNIVERSAL BATTERY CHARGER. Takes AA's, C's, D's and PP3 nicads. Holds up to 5 batteries at once. New and cased, mains operated. £6.00 ref 6P36R.

COLOUR MONITORS
AMSTRAD CTM644
RGB INPUT
£75.00 REF A75P1

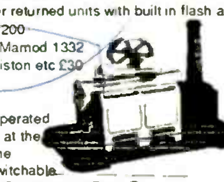
RESISTOR PACK. 10 x 50 values (500 resistors) all 1/4 watt 2% metal film. £5.00 ref 5P170R.
CAPACITOR PACK 1. 100 assorted non electrolytic capacitors £2.00 ref 2P286R
CAPACITOR PACK 2. 40 assorted electrolytic capacitors £2.00 ref 2P287R.
QUICK CUPPA? 12v immersion heater with lead and cigar lighter plug £3.00 ref 3P92R.
LED PACK. 50 red leds, 50 green leds and 50 yellow leds all 5mm £8.00 ref 8P52R
FERRARI TESTAROSSA. A true 2 channel radio controlled car with forward, reverse, 2 gears plus turbo. Working headlights. £22.00 ref 22P6R.

MIRACOM WS4000 MODEMS
V21/23
AT COMAND SET
AUTODIAL/AUTOANSWER
FULL SOFTWARE CONTROL
TONE AND PULSE DIALLING
£29

PIR LIGHT SWITCH Replaces a standard light switch in seconds light operates when anybody comes within detection range (4m) and stays on for an adjustable time (15 secs to 15 mins). Complete with daylight sensor. Unit also functions as a dimmer switch! 200 watt max. Not suitable for flourescents. £14.00 ref 14P10R
CUSTOMER RETURNED 2 channel full function radio controlled cars only £8.00 ref 8P200R
WINDUP SOLAR POWERED RADIO! FM/AM radio takes rechargeable batteries complete with hand charger and solar panel 14P200R
240 WATT RMS AMP KIT Stereo 30-0-30 psu required £40.00 ref 40P200R
300 WATT RMS MONO AMP KIT £55.00 Psu required ref 55P200
ALARM PIR SENSORS Standard 12v alarm type sensor will interface to most alarm panels. £16.00 ref 16P200
ALARM PANELS 2 zone cased keypad entry, entry exit time delay etc. £18.00 ref 18P200
MODEMS FOR THREE POUNDS!!
Fully cased UK modems designed for dial up system (PSTN) no data or info but only £3.00 ref 3P145R
TELEPHONE HANDSETS
Bargain pack of 10 brand new handsets with mic and speaker only £3.00 ref 3P146R
BARGAIN STRIPPERS
Computer keyboards. Loads of switches and components excellent value at £1.00 ref CD40R
PC POWER SUPPLIES
These units are new but need attention complete with case, fan IEC input plug disc drive and mother board fly leads. Our price is £5.00 (less than the fan alone would cost) ref 5P208R
HIGH VOLTAGE CAPACITORS
A pack of 20 500PF 10KV capacitors ideal for ionizers TV repairs and high voltage experiments etc. Price is £2.00 ref 2P378R
DATA RECORDERS
Customer returned mains battery units built in mic ideal for Computer or general purpose audio use. Price is £4.00 ref 4P100R
SPECTRUM JOYSTICK INTERFACE
Plugs into 48K Spectrum to provide a standard Atari type joystick port. Our price £4.00 ref 4P101R
ATARI JOYSTICKS
Ok for use with the above interface, our price £4.00 ref 4P102R
BENCH POWER SUPPLIES
Superbly made fully cased (metal) giving 12v at 2A plus a 6V supply. Fused and short circuit protected. For sale at less than the cost of the case! Our price is £4.00 ref 4P103R
SPEAKER WIRE
Brown twin core insulated cable 100 feet for £2.00 REF 2P79R
MAINS FANS
Brand new 5" x 3" complete with mounting plate quite powerfull and quite. Our price £1.00 ref CD41R
DISC DRIVES
Customer returned units mixed capacities (up to 1.44M) We have not sorted these so you just get the next one on the shelf. Price is only £7.00 ref 7P1R (worth it even as a stripper)
HEX KEYBOARDS
Brand new units approx 5" x 3" only £1.00 each ref CD42R
PROJECT BOX
51/2" x 31/2" x 1" black ABS with screw on lid. £1.00 ref CD43R
SCART TO SCART LEADS
Bargain price leads at 2 for £3.00 ref 3P147R
SCART TO D TYPE LEADS
Standard Scart on one end, Hi density D type on the other. Pack of ten leads only £7.00 ref 7P2R
OZONE FRIENDLY LATEX
250ml bottle of liquid rubber sets in 2 hours. Ideal for mounting PCB's fixing wires etc. £2.00 each ref 2P379R
QUICK SHOTS
Standard Atari compatible hand controller (same as joysticks) our price is 2 for £2.00 ref 2P380R
VIEWDATA SYSTEMS
Brand new units made by TANDATA complete with 1200/75 built in modem infra red remote controlled qwerty keyboard BT appproved Prestel compatible, Centronics printer port RGB colour and composite output (works with ordinary television) complete with power supply and fully cased. Our price is only £20.00 ref 20P1R
3 INCH DISCS
Ideal for Amstrad PCW and Spectrum +3 machines pack of 10 discs is £12.00 ref 12P1R
AC STEPDOWN CONVERTOR
Cased units that convert 240v to 110v 3" x 2" with mains input lead and 2 pin American output socket (suitable for resistive loads only) our price £2.00 ref 2P381R
SPECTRUM +3 LIGHT GUN PACK
complete with software and instructions £8.00 ref 8P58R
CURLY CABLE
Extends from 8" to 6 feet! D connector on one end, spade connectors on the other ideal for joysticks etc (6 core) £1.00 each ref CD44R
COMPUTER JOYSTICK BARGAIN
Pack of 2 joysticks only £2.00 ref 2P382R
MINI MONO AMPLIFIER PACK
4 amplifiers for £2.00! 3 watt units 9-12v operation ideal for experiments etc £2.00 ref 2P383R
BUGGING TAPE RECORDER
Small hand held cassette recorders that only operate when there is sound then turn off 6 seconds after so you could leave it in a room all day and just record any thing that was said. Price is £20.00 ref 20P3R
IEC MAINS LEADS
Complete with 13A plug our price is only £3.00 for TWO! ref 3P148R
COMPUTER SOFTWARE BARGAIN
10 cassettes with games for commodore 64, Spectrum etc. Our bargain price one pound! ref CD44R
NEW SOLAR ENERGY KIT
Contains 8 solar cells, motor, tools, fan etc plus educational booklet. Ideal for the budding enthusiast! Price is £12.00 ref 12P2R
FUSE PACK NO 1
Fifty fuses 1 1/4" long (glass) quick blow 10 popular values £2.00 ref 2P384R
FUSE PACK NO 2
Fifty fuses 20mm long (glass) quick blow 10 popular values £2.00 ref 2P385R
POTENTIOMETER PACK NO 1
30 pots for £3.00! ideal for projects etc. Ref CD45R

286 AT PC
286 MOTHER BOARD WITH 640K RAM FULL SIZE METAL CASE, TECHNICAL MANUAL, KEYBOARD AND POWER SUPPLY £139 REF 139P1 (no i/o cards or drives included)

35MM CAMERAS Customer returned units with built in flash and 28mm lens 2 for £8.00 ref 8P200
STEAM ENGINE Standard Mamod 1332 engine complete with boiler piston etc £30 ref 30P200



TALKING CLOCK
LCD display, alarm, battery operated. Clock will announce the time at the push of a button and when the alarm is due. The alarm is switchable from voice to a cock crowing! £14.00 ref 14P200.R
HANDHELD TONE DIALLERS
Small units that are designed to hold over the mouth piece of a telephone to send MF dialling tones. Ideal for the remote control of answer machines. £5.00 ref 5P209R
COMMODORE 64 MICRODRIVE SYSTEM
Complete cased brand new drives with disc and software 10 times faster than tape machines works with any Commodore 64 setup. The orginal price for these was £49.00 but we can offer them to you at only £25.00! Ref 25P1R
USED SCART PLUGS
Pack of 10 plugs suitable for making up leads only £5.00 ref 5P209R
C CELL SOLAR CHARGER
Same style as our 4 x AA charger but holds 2 C cells. Fully cased with flip top lid. Our price £6.00 Ref 6P79R

BULL ELECTRICAL
250 PORTLAND ROAD HOVE SUSSEX
BN3 5QT TELEPHONE 0273 203500
MAIL ORDER TERMS: CASH PO OR CHEQUE WITH ORDER PLUS £2.50 POST PLUS VAT.
PLEASE ALLOW 7 - 10 DAYS FOR DELIVERY
NEXT DAY DELIVERY £8.00
FAX 0273 23077

SOME OF OUR PRODUCTS MAY BE UNLICENSABLE IN THE UK

CIRCLE NO. 118 ON REPLY CARD

INTERFACING WITH C

by

HOWARD HUTCHINGS

Interfacing with C can be obtained from Lindsey Gardner, Room L333, Quadrant House, The Quadrant, Sutton, Surrey SM5 2AS. Please make cheques for £14.95 (which includes postage and packing) payable to Reed Business Publishing Group.

Alternatively, you can telephone your order, quoting a credit card number. Telephone 081-661 3614 (mornings only, please).

A disk containing all the example listings used in the book is available at £25.50 + VAT. Please specify size required.

C HERE!

If you have followed our series on the use of the C programming language, then you will recognise its value to the practising engineer.

But, rather than turning up old issues of the journal to check your design for a digital filter, why not have all the articles collected together in one book, Interfacing with C?

The book is a storehouse of information that will be of lasting value to anyone involved in the design of filters, A-to-D conversion, convolution, Fourier and many other applications, with not a soldering iron in sight.

To complement the published series, Howard Hutchings has written additional chapters on D-to-A and A-to-D conversion, waveform synthesis and audio special effects, including echo and reverberation. An appendix provides a "getting started" introduction to the running of the many programs scattered throughout the book.

This is a practical guide to real-time programming, the programs provided having been tested and proved. It is a distillation of the teaching of computer-assisted engineering at Humberside Polytechnic, at which Dr Hutchings is a senior lecturer.

Source code listings for the programs described in the book are available on disk.

INTEGRATED CREATIVITY

Ian Hickman experiments with the unusual *SMM-2044 audio IC*

Adding a component or two for which you have no immediate use to the end of your order is not as profligate as it might sound. Often the extra items can be used to avoid a "small order" surcharge, and so arrive, if not for free, then at least with a useful discount.

The resultant uncommitted stock items can come in very handy in an unforeseen application.

Sometimes an end-of-order component stays in stock for some time – until curiosity gets the better of me and I can't resist playing with it to find out what it can do. So it was with an *SMM-2044*, described by manufacturer PMI as a four-pole voltage-controlled filter/oscillator.

The device comes in a 16 pin plastic DIL package **(Fig. 1)**. Input is applied to an npn long-tailed pair (LTP) whose standing current is set by the frequency control input, V_{fc}, applied to pin 13. Output of the LTP is applied to a series of four single pole low-pass stages. Cut-off frequency of each is controlled by the current called up by the exponentially controlled tail-current generator (common to all four stages) and the capacitor that is associated with the particular stage; eg between pins 12 and 14.

Output from the fourth voltage-controlled filter stage (VCF) drives a current output stage – terminated to ground through (typically) a 3K3 resistor to give a voltage output or, if a larger low impedance output is desired, applied directly to the virtual earth of an inverting op-amp stage. Additionally, output from the fourth stage feeds another npn LTP whose standing current is also adjustable. A feedback loop is introduced by injecting a current into the Q control pin, pin 2, and has the effect of applying a replica of the output back to the input of the first LTP.

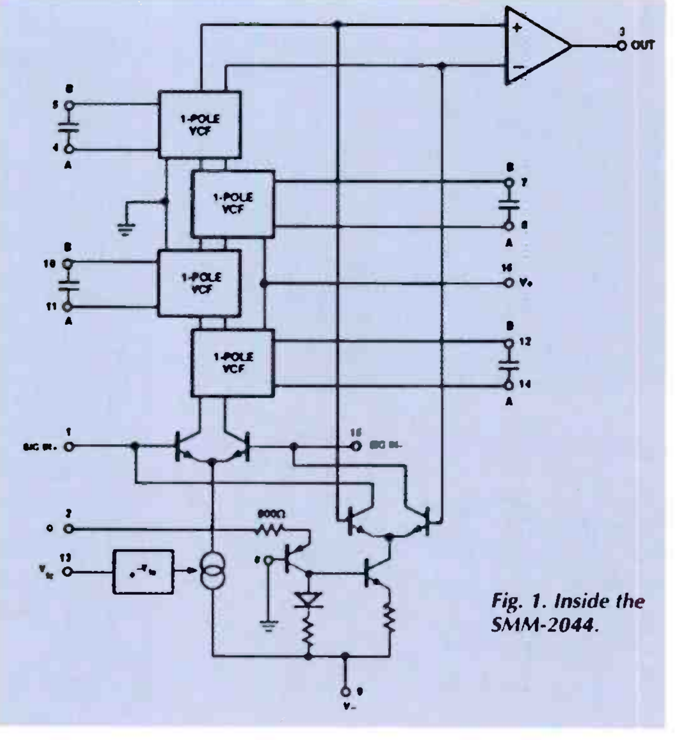


Fig. 1. Inside the SMM-2044.

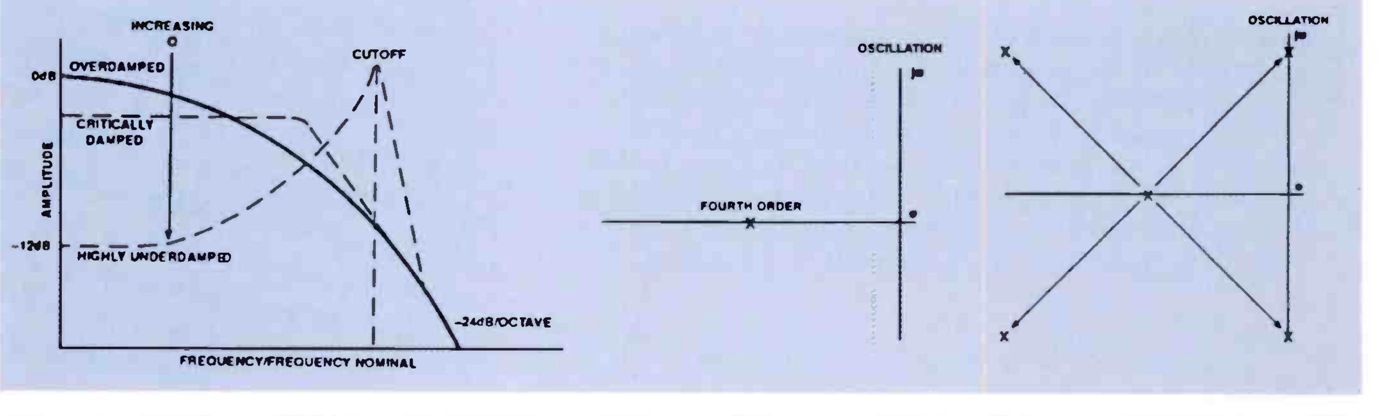
Clearly Fig. 1 is somewhat diagrammatic, since it appears that the feedback is positive at DC – at least if there is no net inversion through the four VCFs – whereas the second LTP applies DC negative feedback (NFB). But what happens when no current is injected into pin 2, so that the second LTP is effectively non-existent and there is no feedback? Assume for the moment that all four VCF capacitors have the same value, then at some frequency each VCF stage will contribute a 45° phase lag and an associated 3dB of attenuation. The result is a gradual transition from a flat frequency response at low frequencies; through –12dB at the cut-off frequency of this very non-optimum low-pass filter; to a stop-band attenuation increasing at 24dB per octave **(Fig 2a)**. As the second LTP is progressively powered up by Q control, the NFB reduces gain through the device at low frequencies.

But at the frequency where each VFC stage contributes a 45°

Fig. 2a (left). Gradual transition in frequency response at low frequencies, through –12dB at cut-off frequency, to a stop-band attenuation increasing at 24dB/octave.

Fig. 2b (centre). Pole diagram. Fourth-order transfer function Q=0V.

Fig. 2c (right). Transfer function as Q increases.



BRIEF

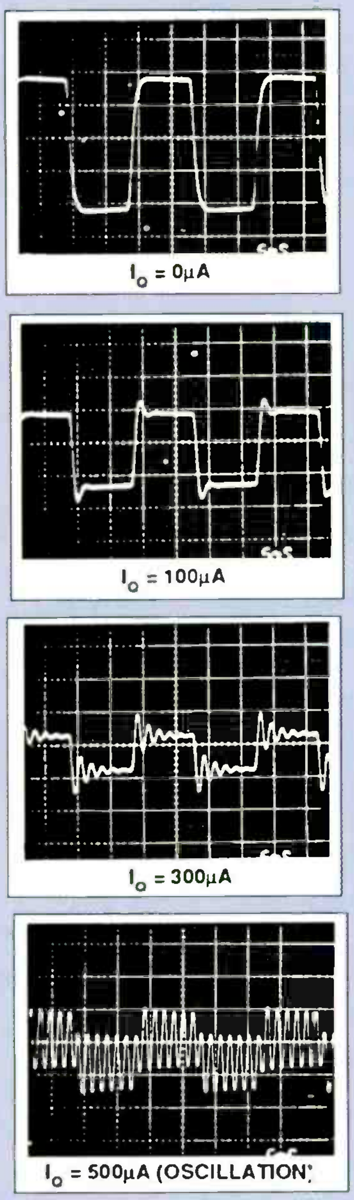


Fig. 3. Effect of applying a square wave to the circuit for different values of I_Q.

phase lag, total phase shift is 180°. The feedback has become positive and so the gain through the device will be enhanced. The four coincident poles (**Fig. 2b**) then migrate outwards (**Fig. 2c**).

If transconductance of the second LTP is increased then eventually the loop gain will exceed unity and oscillation will result, as two of the poles reach the jω axis. A square wave applied to the circuit for various values of I_Q shows a reduction in amplitude of the square wave as Q is increased (**Figs. 3a-d**), top to bottom.

An interesting – and as far as I was concerned totally unforeseen – result appears when the Q control is set just short of oscillation. When frequency of the square wave is such that one of its harmonics coincides with the resonant frequency of the circuit, **Fig. 3d** results. At other frequencies waveforms such as **Figs. 4a** and **4b** are seen; on one half cycle of the square wave, a harmonic is pretty well in phase with the natural frequency of the filter while on the other it is trying (and failing) to fit in an odd number of half cycles of the harmonic.

This explanation is rather simplistic but perhaps a knowledgeable reader will write in with a more exact description – preferably one not involving too much of the higher mathematics.

Possibly the effect is due to an unequal

Fig. 4. In one half-cycle of the square wave, harmonics are in phase with the natural frequency of the filter while on the other there is a failure to fit in an odd number of half cycles of the harmonic.

Uncommitted logic

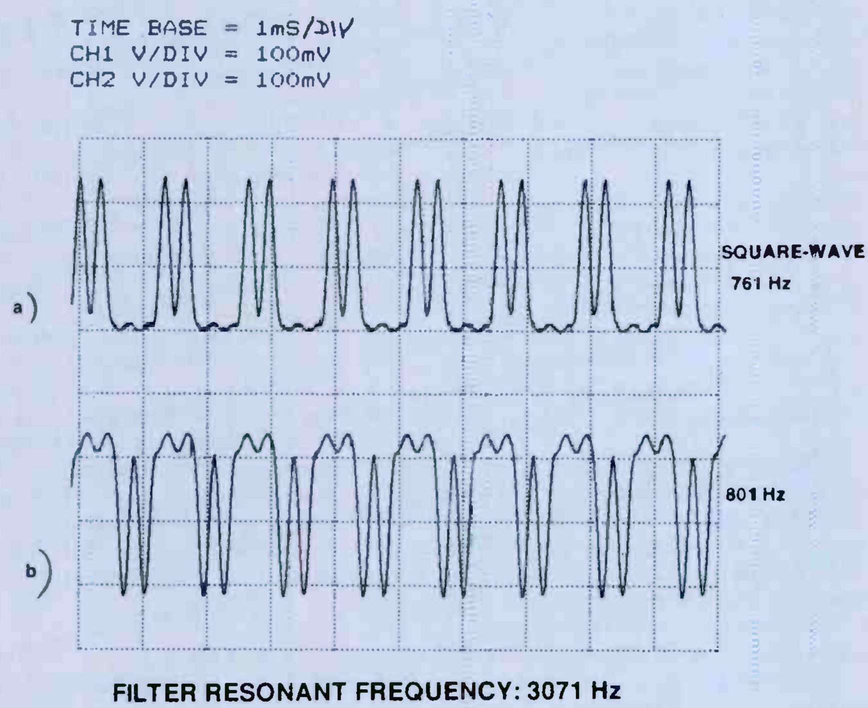
Creating a stock of uncommitted components through adding the odd item to component orders can give a definite flexibility to problem solving.

A typical example arose recently when I was developing a small 12/24VDC to 240VAC inverter. The devices driving the transformer were the familiar TIP121s, driven straight from the outputs of a 5V cmos source of 50Hz pulses derived from a 32768Hz crystal.

But they were groaning somewhat with the exertion, especially on a 12V supply where their saturation voltage was contributing embarrassingly to the circuit's poor regulation.

At that point I remembered I had bought in, on the end of an order, some BUZ10 mosfets. Their drain saturation resistance of only 0.08Ω cured the regulation problem at a stroke. They accepted the cmos drive directly, and even had a pin-out making them drop in replacements for the TIP121s! Problem solved – without any delay in procuring components.

IH.



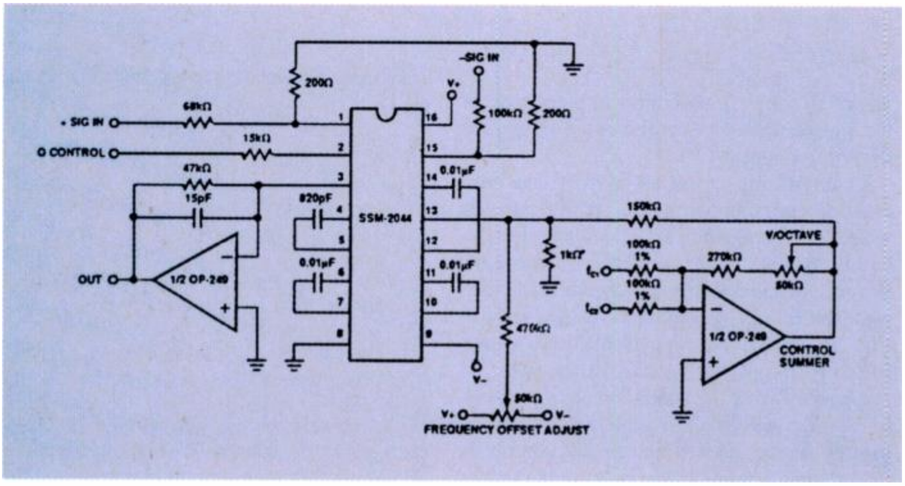


Fig. 5. Typical connection for breadboarding purposes, used as the basis for a programmable tone generator.

mark/space ratio of the square wave, though I measured this as being a very respectable 49.5/50.5 . The effect is still there even though the filter is not picking out a very high harmonic (Fig. 4).

Striking musical effects

Providing as it does independent control of Q and resonant frequency, the device can produce striking effects when applied to programme material such as music. A sample of the audio signal can be passed through the filter, modified, and then recombined with the original signal, either in phase or in antiphase.

Sweeping the resonant frequency of the filter up or down at different rates and Q settings can present novel effects, either manually or under program control from a computer, using D-to-A outputs from the latter to control both the centre frequency and Q.

A further possibility is to make filter parameters vary in sympathy with some aspect of the programme material itself, making envelope amplitude control the centre frequency or Q, for example.

But this versatile chip is not limited to filtering applications. By increasing Q up to the point of oscillation, it becomes a programmable tone generator.

Programmable tone generator

For application as a programmable tone generator, I used the recommended typical connection for breadboarding, **Fig. 5**. Note that one of the four capacitors is reduced to 820pF, leaving three coincident poles (**Fig. 2b**), but pushing the fourth one out by a factor of 12 along the $-\sigma$ axis. Oscillation sets in with around 500μA injected at pin 2, agreeing with the figure in the electrical characteristics Table of the data sheet, so I surmise that those figures apply to the circuit of **Fig. 5**, whereas **Figs. 2, 3** and **4** apply to the case of four equal capacitors.

With +13.5V applied to the 15K Q control resistor at pin 2, output from the op-amp is 8V pk-pk, varying by less than 1dB over a tuning range of 3Hz to 45kHz. At 1kHz total harmonic distortion (THD) is 0.75% – hardly suitable as a low distortion oscillator when making THD measurements on other equipment, but more than adequate as a general purpose programmable tone generator. Reducing current into pin 2 gives 6V pk-pk output and distortion falls to 0.3%. But output at 45kHz is 3dB down - you can't have everything at once.

Distortion looks distinctly second-ish, whereas the limiting mechanism is clipping in the balanced second long-tailed pair. This should be a symmetrical phenomenon and only produce odd-order distortion products.

The base terminals are internal to the circuit and so inaccessible, but not so the first LTP. Suspecting offsets in the long-tailed pairs, I added a 100k pot across the +15 and –15V supply rails with a 150K resistor from the wiper to pin 15.

Adjusting the pot, the distortion is reduced from 0.3% to 0.2%, nearly all third harmonic as expected. Reducing current into pin 2 further to give an output of 2V pk-pk produces a distortion at 1kHz of less than 0.08%. But at this low output level, the Q drive current needs readjusting at each frequency.

Idea waiting for a use

The *SMM-2044* is undoubtedly a versatile and interesting IC. I am sure that one day I shall find it just the solution for some job or other, along with some of its stable-mates from the PMI Audio Handbook Volume 1, – the *SSM-2120* dynamic range processor, the *SSM-2100* log/antilog amplifier, etc.

Just one point worth noting; I found it useful to add 10μF decoupling capacitors, not shown in the recommended circuit diagram, from the V+ and V- supply rails to ground. This cured a tendency for a low-level 6MHz oscillation to appear at high Q settings. ■

WITH C

IMPORTANT ANNOUNCEMENT.

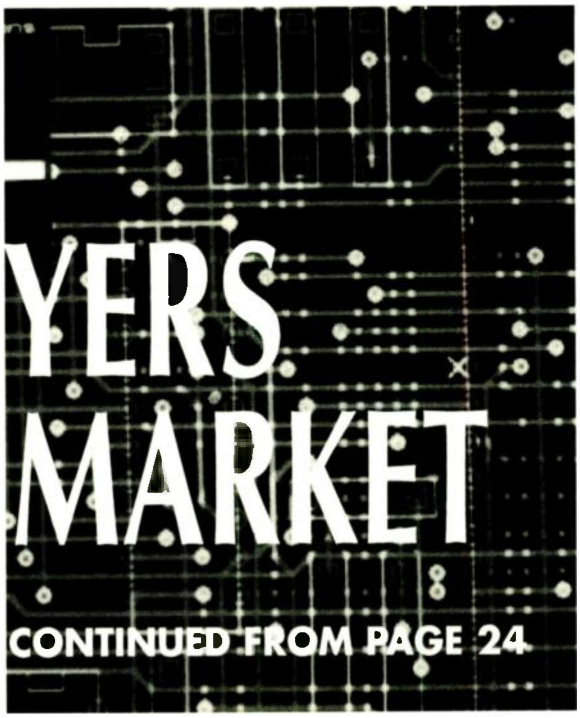
Many readers have been disappointed that Howard Hutchings' practical guide to real-time programming and use of the C programming language for electronics engineers sold out so quickly.

As a result of this popular demand, we are reprinting "Interfacing with C" and new copies will be available from the beginning of December.

To order, send a cheque for £14.95 to Lindsey Gardner, Room L333, Quadrant House, The Quadrant, Sutton, Surrey SM5 2AS. Make cheques payable to Reed Business Publishing Group or, for immediate response, you can telephone your order quoting your credit card number on 081 661 3614 (mornings only please).

The extensive source listings from the book are also available on disc at £25.50 + VAT from the above address.

BUYERS MARKET



CONTINUED FROM PAGE 24

Graftool
Graftool is a 3D graphics package with features including: linear and nonlinear curve fitting; unlimited zoom and rotation; multiple axes in linear, log or probability scales; more than 268 million data points; scientific spreadsheet that can directly read Lotus and ascii files; unrestricted placement of graphs and text; and compatibility with Microsoft Word and WordPerfect.
Suppliers: Adept Scientific.

HiWire II
HiWire II is schematic capture and PCB layout software package for use on IBM PCs and compatibles. It is based on a menu-driven interface which simplifies common operations such as extracting a net list, creating a bill of materials, producing check plots, and plotting final artwork.
Suppliers: Riva; Wintek.

Isis
The Isis range of schematic capture software has three products – Supersketch, Designer and Designer+. All have a graphical user interface and an intelligent diagram editor. They run on PC compatible hardware and can interface to other cad packages.
Suppliers: Labcenter Electronics.

LCA1
LCA1 is a logic simulator program for running on PCs and compatible computers. A less powerful version of the package is called Bitspice.
Suppliers: Those Engineers.

LM-2
LM-2 is a logic synthesis program that can create Boolean algebraic expressions from a truth table. It will also handle state logic so flip-flop devices can be incorporated. The package is particularly applicable to dealing with programmable logic devices. Results can be ported to LCA1 so that the timing can be checked before building the circuit.
Suppliers: Those Engineers.

Mathcad
Mathcad is a mathematics package. The user types equations and they are automatically formatted into mA notation. The screen can be used as a blank piece of paper to let the user lay out the equations along with pictures, plots and text. Mathcad is designed to run on PC, Macintosh and Unix systems.
Suppliers: Adept Scientific.

Maxi/PC
Maxi/PC is a PC-based PCB design tool with features such as schematic capture, component placement, automatic and interactive routing, and manufacturing outputs for complex PCB systems. It is compatible with Cadstar.
Suppliers: Option Circuits, Racal-Redac.

MaxRoute
MaxRoute is a PCB autorouting package that interfaces with most of the popular cad systems. It uses push and shove technology to emulate the way a manual designer works and also contains a complete suite of interactive design tools. Runs on a PC.
Suppliers: GDS PCB Design.

Micrologic 2
Micrologic 2 is for simulating logic gates and includes a library of components for Boolean functions etc.
Suppliers: Data Technology.

OrCad
There are more than 50,000 users of OrCad electronic design automation tools. In release IV the schematic parts library has been increased to more than 20,000 parts, the digital simulation process has been speeded up, the PCB layout package offers autoplacement and autorouting at no extra charge, and there is expanded memory support. It works on PCs or Sparc workstations.
Suppliers: ARS Microsystems; OrCad.

Pads-2000
Pads-2000 was the first cad system designed to run exclusively on 386 and 486 based PCs, and the first to run 32bit code with virtual memory. It provides all the tools needed to design a PCB including automatic component placement, 100% rip up and retry autorouting of traces, on-line DRC, and automatic engineering change verification.
Suppliers: Cad Services; Cad Software; Cavendish Automation.

Pads-PCB
Version 4.0 of Pads-PCB adds a complete new graphics and user interface to this popular PCB design package. Other extras include the use of pop-up menus, a user definable macro language, and support for high resolution VGA graphics cards. There are more than 500 Pads-PCB packages installed in Great Britain.
Suppliers: Cad Services; Cad Software; Cavendish Automation.

Pads-Logic
Version 2.0 of Pads-Logic shares the new graphics interface, plotter outputs and library capabilities of Pads-PCB 4.0. This schematic capture system was introduced in 1990 and more than 2000 systems are in use world wide.
Suppliers: Cad Services; Cad Software; Cavendish Automation.

P-Cad Master Designer
More than 18,000 PCB designers use P-Cad Master Designer. The suite of products include schematic capture, symbol library, digital and analogue simulation tools, placement tools, routers, and design rule checking.
Suppliers: Cadam, KGB Micros.

PCB II
PCB II is a PCB design package available either stand alone or as part of an Ares or Isis package. Features include GUI, topological route editor, 2D drawing capability, and package library.
Suppliers: Labcenter Electronics.

PCS
PCS stands for process control simulation. This package is a training tool to show how to tune three-term controllers used in the process industry. It runs on a PC.
Suppliers: Golten & Verwer.

PSpice
The PSpice family includes circuit analysis and circuit synthesis packages and can run analogue and digital packages concurrently under dos. It has virtual memory capacity, filter synthesis and an optimiser for arbitrary transfer functions.
Suppliers: ARS Microsystems; MicroSim; Riva; others

Pulsar
Pulsar is a digital logic circuit simulator program for testing designs rather than going through time consuming breadboarding. Simulation speed is more than 1000 gate state changes a second. It runs on 386 or 486 machines.
Suppliers: Number One Systems.

Quick Plot
Quick Plot is a memory resident program for producing a graphics screen dump from a 286 or 386 PC on to an HPGL or compatible pen plotter.
Suppliers: Number One Systems.

Satcam
Satcam is used for PCB design and runs on a PC. Facilities include schematic capture, PCB layout, design rule checking, and autorouting. It has a library of stored components with about 25,000 entries and can carry out functions like photoplotting. It can interface with AutoCad. Satchem schematic capture package is available separately.
Suppliers: Data Technology.

Schema
Schema is a schematic capture PCB package for use on IBM PC or compatible computers.
Suppliers: Auto Metrix.

Spiceage
Spiceage is a simulator for small analogue circuits. See ECA2 for more details.
Suppliers: Those Engineers.

Supermax
Supermax is an extension of IPL software and offers schematic circuit layout, circuit simulation, schematic capture, automatic placement, and thermal analysis. It can run under Unix or on 386 and 486 PCs.
Suppliers: Cadniques.

Susie
Susie is the world's best selling PC-based logic simulation program that simplifies digital design by getting rid of the breadboarding stage. It uses advanced logic simulation software to create a working model of hardware design.
Suppliers: Aldec; Computer Solutions; Option Circuits.

Tango PLD
The Tango PLD design language is a development tool for programmable logic devices. It allows data entry either as schematics or using a version of C. A schematic diagram input approach allows a logic diagram or net list to be used to describe the components required.
Suppliers: Accel Technologies; Computer Solutions.

Traxstar
Traxstar is a grid based costed maze autorouter with full rip up and reroute capability. It works on 386 machines and incorporates a user definable cost structure that allows separate cost structures for the route, rip-up and smoothing packages.
Suppliers: JAV Electronics; Protel Technology.

Traxview
Traxview is an RS274 Gerber format file viewer and editor. It lets users view files by zooming and panning. There are full editing facilities including placing, deleting, moving and editing of flashes and strokes. It also has block commands and a panelisation program that lets users place multiple Gerber files on the same film. Runs on 386 PCs.
Suppliers: JAV Electronics; Protel Technology.

VHDL 2000
The VHDL 2000 simulator is a full featured VHDL 1076 design analysis environment that supports comprehensive debugging facilities. It uses a simulation kernel optimised around the VHDL paradigm and is written in C++ with an object orientated database.
Suppliers: Racal-Redac.

Visula HPE
The Visula HPE suite of tools analyses the impact of physical layout on the integrity of the electronic design of systems on boards. It can directly control the physical layout process from design rules which govern factors such as path delays, reflection and crosstalk limits.
Suppliers: Racal-Redac.

V-System
V-Systen is a complete VHDL development environment including an IEEE1076 compliant compiler, simulator and debugger for either the Windows environment on a PC or on a Sun SparcStation.
Suppliers: Instrumatic.

Vutrax
The Vutrax schematic capture software is a stand alone hierarchical schematic drawing package with features for connection validation. Documentation can be produced including net lists, part lists, wiring schedules, engineering cross-reference tables, and check lists. It is for 286 and 386 PCs.
Suppliers: Computamation Systems; Those Engineers.

Z-Match II
Z-Match II is a software implementation of the Smith chart analysis tool for RF engineers. It keeps all the graphical advantages of the original chart but has features that eliminate repetitive calculations and make the chart more accessible to the occasional user.
Suppliers: Number One Systems. ■

DIRECTORY

Accel Technologies, 6825 Flanders Drive, San Diego, CA92121, USA.

Adept Scientific, 6 Business Centre West, Avenue One, Letchworth, Herts SG6 2HB. 0462 480055.

Aldec, 3525 Old Conejo Road, #111 Newbury Park, CA91320, USA. +1 805 499 6867.

ALS Design, 38 Rue Fessart, 92100 Boulonge, France. +33 1 46 04 30 47.

ARS Microsystems, Herriard Business Centre, Alton Road, Herriard, Basingstoke RG25 2PN. 0256 381400.

Auto Metrix, Fordbrook Business Centre, Marlborough Road, Pewsey, Wiltshire SN9 5NU. 0672 63650.

Betronex, Wells Yard, High Street, Ware, Herts SG12 9AS. 0920 469131.

Cad Services, Glanty House, The Causeway, Egham, Surrey TW20 9AH. 0784 434394.

Cad Software, 119 Russell Street, Littleton, Massachusetts 01460, USA. +1 508 486 8929.

Cadam, 2 Buckingham Place, Bellfield Road, High Wycombe, Buckinghamshire HP13 5HW. 0494 459500.

Cadence Design Systems, Foundation Park, Roxburgh Way, Maidenhead, Berkshire SL6 3WD. 0628 826821.

Cadniques, 3 Cutbush Court, Danehill, Lower Earley, Reading, Berkshire RG6 4UW. 0734 755007.

Cavendish Automation, Oak Park, Barford Road, St Neots, Cambs PE19 2SJ. 0480 219457.

Computamation Systems, 40 Lake Street, Leighton Buzzard, Bedfordshire LU7 8RX. 0525 378939.

Computer Solutions, Canada Road, Byfleet, Surrey KT14 7HQ. 0932 352744.

Data I/O, 10525 Willows Road NE, PO Box 97046, Richmond, WA9809746, USA. +1 206 881 6444.

Data Technology Datech, Sidcup Technology Centre, Maidstone Road, Sidcup, Kent DA14 5HU. 081-308 1800.

Dazix Intergraph, 2600 First Avenue, Newbury Business Park, Newbury, Berkshire RG13 2PZ. 0635 550455.

Flomerics, Kingsgate Business Centre, 12 Kingsgate Road, Kingston-upon-Thames, Surrey KT2 5AA. 081-547 3373.

GDS PCB Design, 131 Cardiff Road, Reading, Berkshire RG1 8ES. 0734 589898.

Golten & Verwer, 33 Mosely Road, Cheadle Hulme, Cheshire SK8 5HJ. 061-485 5435.

Hawke Systems, Newlands Drive, Poyle, Slough, Berkshire SL3 4DX. 0753 686676.

Instrumatic, First Avenue, Globe Park, Marlowe, Buckinghamshire SL7 1YA. 0628 476741.

JAV Electronics, Unit 12a, Heaton Street, Denton, Manchester M34 3RG. 061-320 7210.

KGB Micros, Lords Court, St Leonards Road, Windsor SL4 3DE. 0753 696069.

Labcenter Electronics, 14 Mariner's Drive, Bradford BD9 4JT. 0274 542868.

Laplace Instruments, Tudor House, Grammar School Road, North Walsham, Norfolk NR28 9JH. 0692 500777.

LPKF Cad/Cam Systeme, Scheffelstrabe 17, PO box 3829, D-3000 Hannover 1, Germany. +49 511 7 08 390.

Microdata System, Via Provinciale 45, 19030 Romito Magra-La Spezia, Italy. +39 187 988460.

MicroSim, 20 Fairbanks, Irvine, CA92718, USA. +1 714 770 3022.

Number One Systems, Harding Way, Somersham Road, St Ives, Huntingdon, Cambs PE17 4WR. 0480 61778.

Option Circuits, Carrs Industrial Estate, Haslingden, Lancashire BB4 5HR. 0706 218023.

OrCad, 3175 NW Aloclek Drive, Oregon 97124-7135, USA. +1 503 690 9881.

Protel Technology, GPO Box 204, Tochnopark, Dowsings Point, Hobart, Australia. +8102 73 010C.

Racal Redac, Redac House, 62 Sutton Park Avenue, Reading, Berkshire RG6 1AZ. 0734 782158.

Riva, 3 Bentley Industrial Estate, Bentley, Farnham GU10 5NJ. 0420 22666.

Rotring, Strathcona Road, Wembley, Middlesex HA9 8QP. 081-908 2577.

SSI Microcad, Fordbrook Business Centre, Marlborough Road, Pewsey, Wilts. 0672 630000.

Those Engineers, 106A Fortune Green Road, West Hampstead, London NW6 1DS. 071-435 2771.

Tracks, Meadows, Coppid Beach Lane, Wokingham, Berks RG11 5PJ. 0344 55046.

Tsjen, Cambridge Research Laboratories, Huntingdon Road, Cambridge CB3 0DJ. 0223 277777.

Wintek, 1801 South Street, Lafayette, Indiana 47904, USA. +1 317 448 1903.

TrimDAC – an electronic pot

Analog Devices's TrimDAC is a multi-channel D-to-A converter meant to eliminate mechanical potentiometers for circuit adjustment. Setting circuit parameters becomes a matter of software control and the benefits of hands-off control, accuracy and a high level of reliability not to mention the eight controls in one skinny-dip package, are offered. The main impetus for development of the device is cost reduction in manufacture, calibration and field adjustment.

An example is the factory adjustment of CRT displays, in which convergence and colour purity must be set. In a 1000-line display, up to eight pot settings have to be made – an expensive business in high-volume production, robot-controlled screwdrivers being the usual method of adjustment. This can take several minutes to complete, whereas the TrimDAC will do it in seconds.

First-generation TrimDACs, DAC-8800s, are cmos devices intended for DC control and contain eight unbuffered voltage-output D-to-A converters whose outputs are independently set. **Figure 1** shows the layout; eight DAC registers receive their contents from a TTL-compatible, three-wire serial interface, a CLR input allowing zero-setting for system power-up. An 11-bit word into the serial shift register is decoded and used to determine which DAC register is to receive the eight data bits, all eight being loaded in about 14μs. External voltage references determine the voltage output range, but DAC-8800 is primarily meant for fixed-reference DC voltage control.

Figure 2 is the block diagram of a second-generation TrimDAC, the DAC-8840, which extends the capability to the control of alternating voltages in, for example, audio volume control, video displays, modems, oscilloscopes and many other applications.

This device contains eight four-quadrant multiplying D-to-A converters. Each has a 1MHz bandwidth for ±3V input levels; THD is 0.01% and slewing rate is 2.5V/μs and, since the output amplifiers are of the differencing type, gain can be anything from full-scale positive to full-scale negative under the control of the input binary word.

A typical application of the 8840 is in the adjustment of video deflection waveforms, as shown in **Fig. 3**. The four-quadrant multipliers adjust the sawtooth waveforms, reference bias voltages and the parabolic waveforms, the three being summed to drive vertical and horizontal deflection coils.

There are two slight drawbacks to the use of TrimDACs in place of pots, both of which are reducible: one is the fact that a pot "remembers" its last setting, even without power, and the other is the presence of the "zipper" noise when an audio volume control is adjusted that results from the digital nature of the device. The first is avoidable by using system memory to reload set points at power-up and the second minimised by capacitive smoothing of the voltage-controlled amplifier controlled by the TrimDAC.

***Analog Devices Ltd**, Station Avenue, Walton-on-Thames, Surrey KT12 1PF. Telephone 0932 232222*

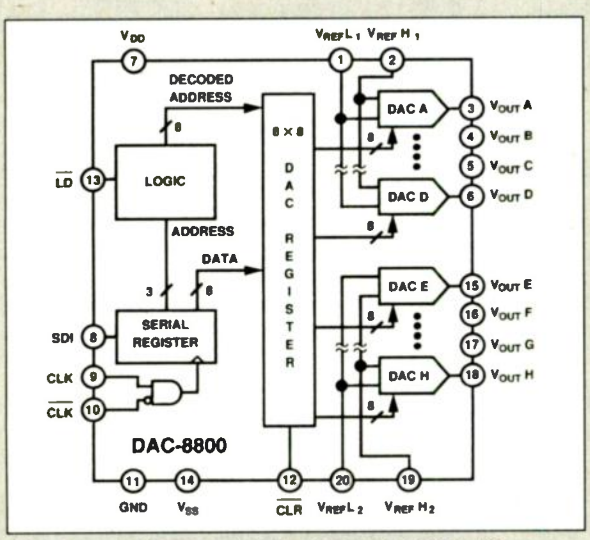


Fig. 1. Internal layout of Analog Devices's DAC-8800 TrimDAC for the replacement of mechanical potentiometers in the adjustment of direct voltages.

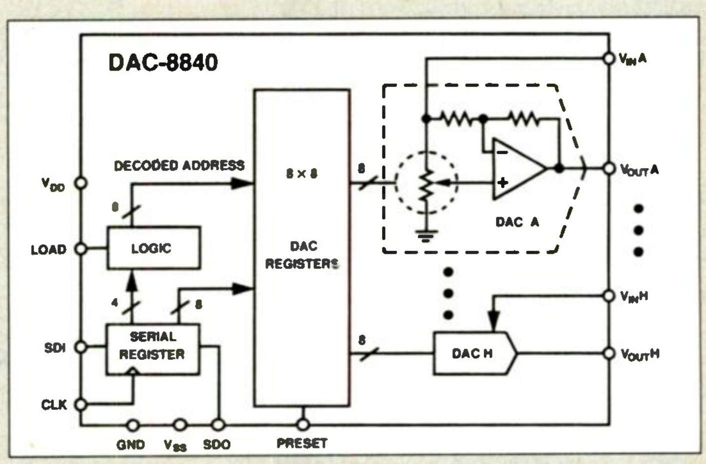


Fig. 2. DAC-8840 second-generation TrimDAC for AC control, which uses multiplying D-to-A converters for the combining of inputs.

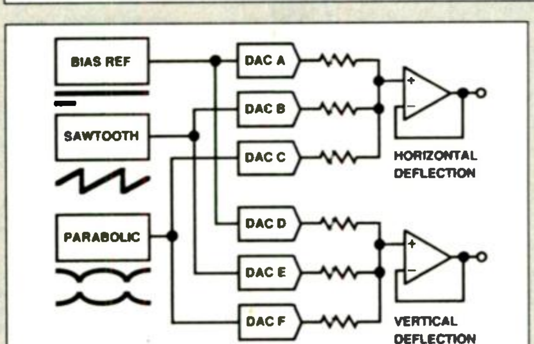


Fig. 3. One application of the 8840 is the combining of deflection-correction waveforms for CRT displays.

Versatile AM IF amp and detector

Plessey's SL6700 is an IF/det IC using single or double conversion, originally intended for use in low-power AM SSB receivers. It usually accepts an IF of 10.7MHz or 21.4MHz, the mixer converting to 455kHz; a detector is included, as are an AGC generator and monostable noise blanker. Both IF amplifiers will operate at 455kHz, which extends the use of the device to AM broadcast working. At 6V, the IC draws only 8mA.

Figure 1 is the block diagram of the SL6700. In its designed application, shown in **Fig. 2**, IF at 10.7MHz is amplified by both amplifiers and converted to 455kHz by the double balanced mixer, after which comes a ceramic filter and the full-wave detector. AGC is carrier-derived and has adjustable delay. Sensitivity is 5μV for 10dB s:n.

AM detection in the SL6700, seen in **Fig. 3**, takes input to one side of an emitter-coupled pair with common collectors, inverted input going to the other half. These two behave as a full-wave rectifier and provide output at the common emitter point, which also contains modulation, filtered externally. Detection is linear, an increase in AF output for an increase in modulation of 2.67 times (30-80%) being 8dB against a theoretical 8.52dB.

This linearity renders the device very suitable for use in AM broadcast reception, the low external component count giving minimum size and cost. Figure 3 shows an example of this application, in which the oscillator Tr_1 can be almost any of the small-signal n-p-n devices available. Inductor L_1 is the ferrite rod aerial and C_1L_1/C_2L_2 track, values being determined by reference to a book such as KR Sturley's *Radio Receiver Design*. If it is acceptable to reduce selectivity, filter F_2 can be replaced by a 100pF capacitor; AGC is left unused in this case.

Figure 4 is another "non-professional"

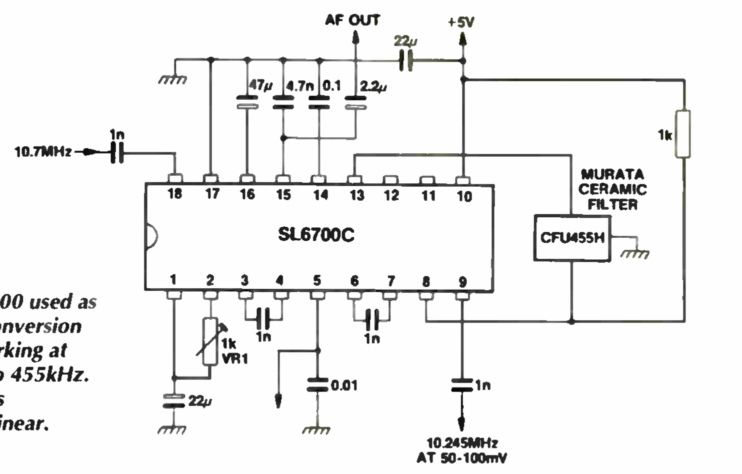


Fig. 2. SL6700 used as a double-conversion unit for working at 10.7MHz to 455kHz. Detection is extremely linear.

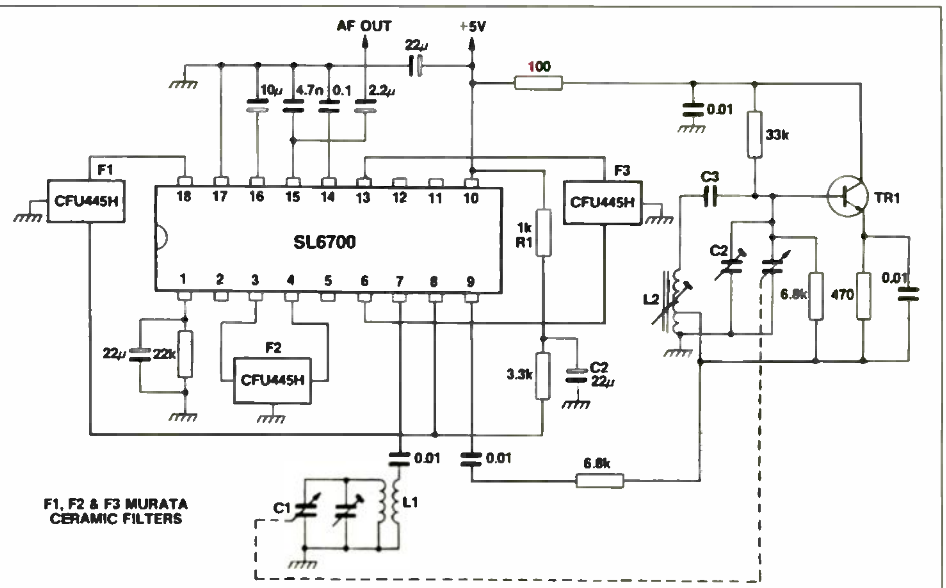


Fig. 3. Use of SL6700 in broadcast receiver takes advantage of detector linearity. Low supply needs are convenient in portables.

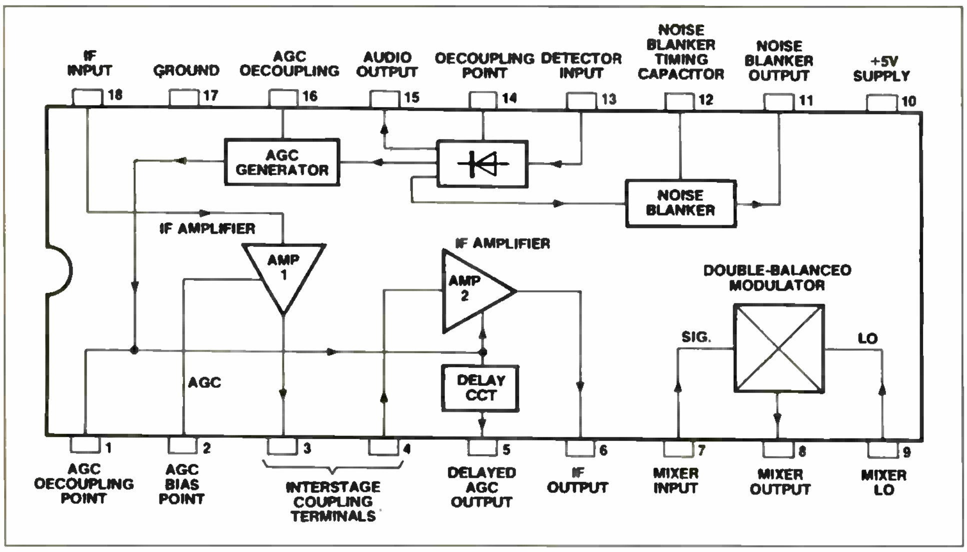
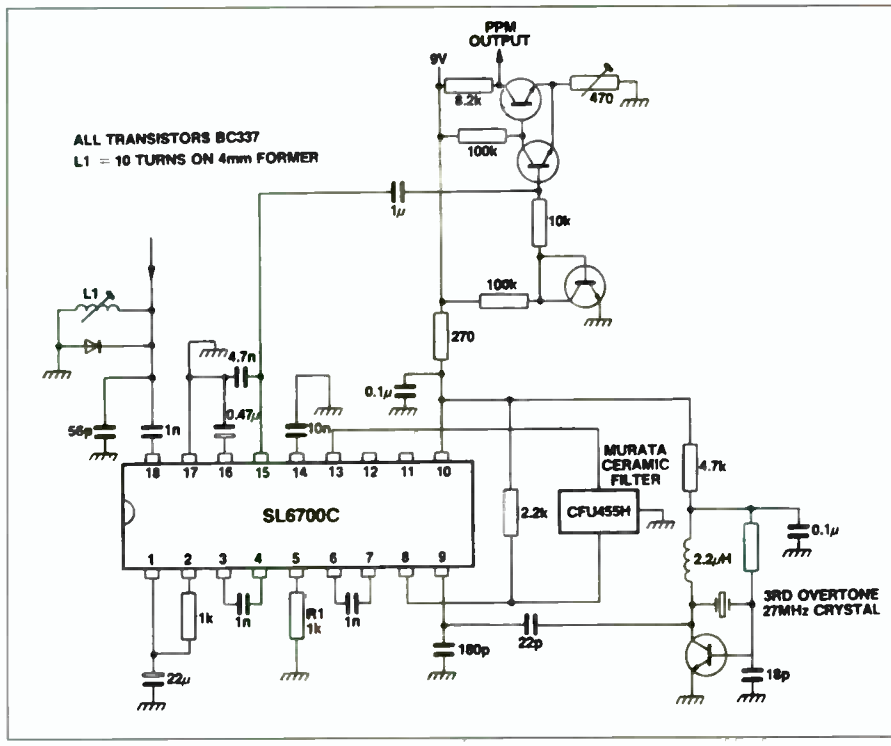


Fig. 1. Internal block diagram of Plessey's SL6700 AM radio IF and detector IC, intended for double-conversion SSB reception, but capable of filling a variety of roles.

Fig. 4. 27MHz model-control receiver, which will operate on 4.5V with quite small circuit changes.



application – a model-control receiver for 27MHz working. A supply of 9V is a little high, particularly for aircraft, but the SL6700 is flexible enough not to need extensive modification for lower supply voltages. In this instance, only the oscillator will need changing to work at, say, 4.5V. To reduce component count, omit R_1 and the network on pin 18, which can be replaced by a Murata SFE 27MA4 ceramic filter. This receiver takes 5mA at 4.5V.

The application note, taken from the 1991 Professional Products IC Handbook, goes on to describe an AM/SSB/CW IF strip and, using an SL6700 in conjunction with an SL6270, an SSB generator.

***GEC Plessey Semiconductors**, Cheney Manor, Swindon, Wiltshire SN2 2QW. 0793 518000.*

Protecting RF power transistors

Load mismatching can cause a high current in RF output transistors and increase power dissipation to the point of failure. Moreover, with temperature time constants in the region of 0.5 to 1ms, any attempt to counteract the effect does not have much time in which to operate.

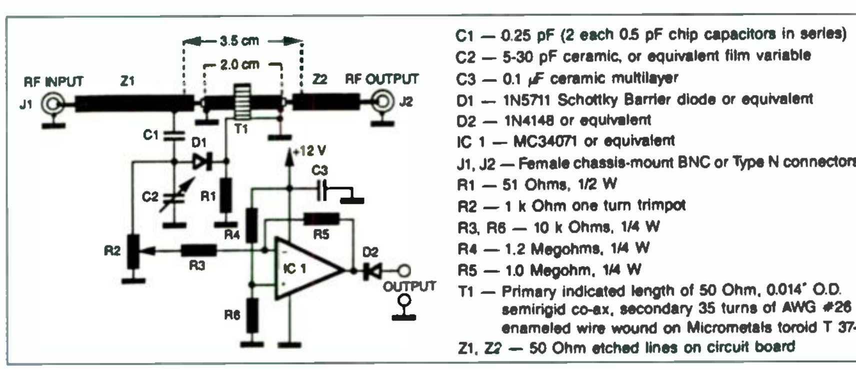
Commonly, a reflectometer VSWR sensor between output and load produces a voltage dependent on output mismatch, which is used in earlier stages to decrease power or shut down completely. Motorola's application note AR510/D describes such a method.

Figure 1 shows the principle, which is usable at VHF and UHF with lumped-constant design and up to the microwave region using stripline methods. In the former realisation, current in the amplifier output line is passed through a pickup coil, the two forming a tightly coupled transformer. The voltage from the pickup coil secondary is proportional to the output current and is compared with a voltage from the output line appearing at the junction of capacitive divider C_1C_2. When the load is matched, the two voltages are 180° out of phase, C_2 being adjusted until the potential divider voltage is zero.

Output from the MC34071 will operate as seen in **Fig. 2**, in which it turns off the bias voltage of a mosfet, either controlling the existing bias voltage or forming the bias source itself, as in the centre diagram. The only problem with this arrangement is that, while it is fine for a fast shutdown (2μs), linear operation is not possible, since a steady idle current is needed. For linear working, the layout in the right-hand diagram is used, in which sensor output is used to control a low-level PIN-diode attenuator. ■

***Motorola Ltd**, European Literature Centre, 88 Tanners Drive, Blakelands, Milton Keynes MK14 5BP. Telephone 0908 614614.*

Fig. 1. Protection circuit against load mismatching for RF power transistors. VSWR sensor goes between amplifier output and load, mismatch causing op-amp output to control or shut down RF output.



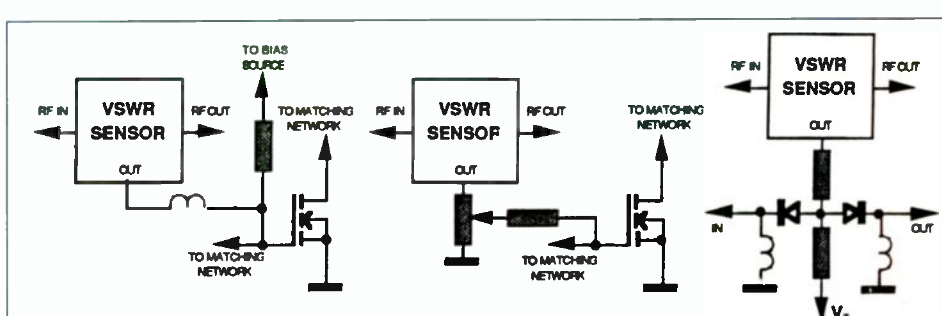


Fig. 2. Three possible methods of using VSWR sensor to control RF gain of amplifier. First two vary bias on mosfet and are useful for complete, fast shutdowns. Third method gives gain reduction for linear amplifier.

IT TAKES LESS THAN A WEEK TO FALL IN LOVE

Top quality test and instrumentation equipment is just a phone call away. Buy direct from ***Electronics World + Wireless World*** and we know that you won't be disappointed. And in the unlikely event that you are, simply return the goods and we will refund the purchase price.*

SC110A miniature portable oscilloscope

SC110A miniature portable oscilloscope

The SC110A from Thurlby-Thandar is a full feature, single trace analogue oscilloscope packaged into the size of a benchtop multimeter. Fitted with a 32mm x 26mm screen miniature CRT, the bright, sharp image provides resolution and detail associated with much larger instruments. UK designed and built, the internal switch mode power supply draws just 195mA from four C sized batteries (not supplied). The instrument will operate from 4 to 10V DC.

The specification includes a Y bandwidth of DC to 10MHz, 10mV/div sensitivity and an adjustable brightline trigger with AC/DC/TV coupling from both internal and external sources. The X timebase is adjustable from 500ms/div to 100ns/div in 24 steps. The case measures 25 x 5 x 15cm and the instrument weighs about 1kg. SC110A £249+VAT (£292.58).

1021 general purpose oscilloscope from Leader Electronics

1021 general purpose 20MHz oscilloscope

The Model 1021 general purpose oscilloscope from Japanese instrument maker Leader Electronics more than meets its published specification and is of exceptional build quality. Features include 20MHz dual channel operation, 8cm x 10cm display area, 5mV/div Y1/Y2 sensitivity at 20MHz, DC to 500kHz X-amplifier response, variable trigger response, multiple sync conditioning and an overall accuracy better than 3%. 1021 £299+VAT (£351.33)

These straightforward conditions apply:
The goods must be returned within seven days of receipt. The goods must be returned in their original packing.
The goods must not be tampered with in any way. The goods must be returned in the condition they were received.

PL320K laboratory triple power supply

TS3022S laboratory dual power supply

PL320K laboratory triple power supply

This power supply from Thurlby-Thandar combines three, totally independent power supplies within a single unit: 0–30V at 2A, 0–30V at 1A and 4–6V at 7A for logic supply. The 30V supplies will operate in a bipolar tracking mode for ±30V operation or in a series mode to provide 0 to 60V output. Both supplies incorporate independent remote sensing and independent precision voltage/over-voltage/current-limit preset. Three 3 3/4 digit led panel meters indicate current and voltage to an accuracy of 0.05% fsd. Output stability is typically 0.01% for 90% load change. PL320K £359+VAT (£421.83).

TS3022S laboratory dual power supply

This laboratory quality power supply from Thurlby-Thandar provides two fully floating 0–30V 2A outputs for parallel, series or independent operation. Each supply has its own metering of voltage and current by LCD display; with the output switch to off, the display can be used to preset the voltage and current limits prior to connection of the load. Coarse and fine controls permit output voltage adjustment to within 5mV of a predetermined value. The current limit control employs a log law for precise adjustment down to 1mA. Load regulation is typically within 0.01%. Both supplies incorporate remote sensing. TS3022S £299+VAT (£351.33).

TD201 digital storage adaptor

The TD201 digital storage adaptor from Thurlby-Thandar is a low power, single channel digital storage unit which adds digital storage capability to ordinary analogue oscilloscopes. The maximum sampling rate of 200kHz permits fast transients to be captured while the lowest rate can extend the sampling period to over an hour. The unit stores over a thousand points on the X axis with 256 levels in the Y axis. The internal batteries (not supplied) allow data retention for up to four years.Other features include an AC/DC sensitivity down to 5mV, selectable pre-trigger, roll and refresh modes and a plot mode. The case measures 25 x 5 x 15cm and the unit weighs about 1kg. The TD201 provides the ideal solution for those wanting a well specified and easy-to-use DSO at the lowest possible cost. TD201 £195+VAT (£229.13)

TD201 digital storage adaptor

How to order

To order equipment with your credit card, phone Lindsey Gardner on 081-661 3128. Alternatively, to order by post, fill in the coupon on the right.and send to, L333, Electronics World, Quadrant House,The Quadrant,Sutton, Surrey, SM2 5AS. All prices include postage, packing and delivery but exclude VAT. Inclusive price in brackets.

ORDER FORM

Please send model number(s)..

Total order price £.................... (please include VAT)

Debit my credit card

Expiry date VISA/MASTERCHARGE/AMEX/DINERS CLUB

or enclose cheque/PO made out for the total order price

Name (with initials)...

Address...

....

....

Signature

Contact phone number (if possible)...

Scratching the surface of electromagnetism

Part two of Scratching the surface postulates new theories for photons and protons

The analysis of electromagnetism presented last month does not take into account one of its most obvious characteristics: the enduring nature of permanent magnet fields.

It is hard to believe that permanent magnets are constantly emitting phaeons in the same kind of way as electrostatically charged objects. In contrast to the case of charged objects where the charge leaks away unless it is kept in a perfectly dry atmosphere and not heated or vibrated, permanent magnets can retain their magnetic fields for many years unless subjected to extreme stress, for example by being subjected to a larger opposing field from an electromagnet.

Another compelling feature of magnetic fields is their sense of being in some kind of continuous circulation. This can be illustrated by the importance of the vector curl function in magnetic fields, and in that the divergence vector of a magnetic field is always zero. Thus there is no source of a magnetic field in the sense of a charged object being a source for an electric field. Magnetic flux always forms a continuous loop.

We can expand the relativistic explanation of the origins of electromagnetism to account for these two properties (stability and circularity) of magnetic fields. However, it must be said that the analysis becomes extremely speculative at this point and leads to rather extraordinary conclusions.

From the discussion of the Lorentz transform given last month, we know that the linear separation of the atoms of the lattice of a wire appears to become smaller relative to the spacing of moving electrons when viewed from an electron in another conductor moving in the same direction as the electrons. We can define the direction that both sets of electrons are moving in as the positive z-axis. Think of the lattice of atoms of the metal as forming a series of x-y planes or plates across the wire. From the view of the electron in the second conductor, we can say that the trajectories of electrons in the first wire are compressed towards the x-y plane(s).

A fundamental part of the kinetic model is that an electron must rotate as it moves linearly through space. We can think of it in fact like a small gyroscope moving along the line of its spin axis. The relativistic compression of the electron trajectories towards the x-y plane can be thought of as a tilt in the electron trajectories towards this plane. We know that when we tilt a spinning gyroscope about its spin axis a new force is generated acting at right angles to both the axis of spin and the applied force. (A good example of this force in action is seen when a cyclist leans sideways at a corner; the tilt of the wheels generates a sideways force which helps him turn the corner.)

The relativistic tilt of the electron trajectory within the ball produces a similar turning force on the electron. This force will be perpendicular to the tilt direction and the initial trajectory of the electron. This force will tend to curve the trajectory of the electron about the z-axis, and while the z-axis motion is maintained, the trajectory will continue to be curved. (**Fig.10**).

Furthermore, since this turning force will be always proportional to the forward component of electron velocity in the x-y plane, we can predict that the projection of the new trajectory on to the x-y plane will be the arc of a circle. Also, regardless of the initial direction of the component of electron motion in the x-y plane, the turning force and hence direction of curvature will always be in the same direction about the z-axis for positive z-axis displacements.

We have already discussed the idea that when the electron is reflected from the inner surface of a surface the ricochet effect will twist the emitted phaeons and the reflected electron out of the plane formed by the line of incidence and the normal to the surface.

Now, just as the effects of relativistic changes will compress all initial electron trajectories towards the x-y plane, so the reflected trajectories will also be compressed into this plane. This compression tilts the trajectory of the electrons during the reflection process (tilts the ricochet) and we may conclude that an extra component of momentum needs to be lost (emitted) during the reflection process.

This extra momentum will be about the z-axis, and so the phaeon(s) emitted will have a component of rotation or spin about the z-axis. This raises a fundamental point: what is going to be the trajectory in space of a phaeon with angular momentum in two axes? Newton's Laws of motion tell us that a body must move in a straight line unless acted on by some external force. However the phaeon is like a gyroscope rotating in two axes at once, and therefore constantly tilting about the spin axis; and we know that a tilted gyroscope generates a reactive force at right angles to both the tilting force and the spin axis. We tentatively conclude that in this case Newton's Law does not hold, and that the trajectory of the phaeon as seen from the distant moving electron is, like the electron's, curved.

The curvature of the phaeon trajectories, however small, produces a fundamental change in the nature of the phaeon flux. We argue that the phaeons' trajectories are circular, and so the phaeons will eventually return to the wire from which they were emitted. Now, suppose we have a very large number of circular trajectories of differet radii. To simplify matters we can just consider trajectories in the x-y plane as in **Fig. 11a**.

We can see that no matter how large the radius of curvature of the trajectories, if we analyse the flux at any small region of space there will be as many phaeons returning towards the source as there are leaving it. Thus the net radial flux through an arbitrary region (eg that marked "alpha"in the figure) will be zero. The only non-zero component of momentum will be one tangential to circles around the emitting wire. This tangential momentum will have the same direction at all points around the wire. We can describe this effect as a circular "momentum flux" around the wire (**Fig. 11b**).

To sum up, we know from relativistic arguments that when electrons move through the lattice of a metallic conducting wire, there is a relativistic compression of the lattice as seen from electrons in another wire travelling in the same direction as the initial set. We have argued that because of the rotation of the electrons, this relativistic compression acts to produce a curvature in their trajectories as seen from the electrons in the other wire, and when the electrons reflect at the surface of the wire, there is also a curvature induced into the trajectory of the emitted phaeons (*assuming that such a particle exists – ed*). This curvature in the phaeon trajectory changes the net phaeon "momentum flux" from a radial to a circular form.

The interaction of the changed flux and the curvature of the electron trajectories produces an imbalance in the surface forces on the sides of the conductors and a net force between the wires. The force is attractive if the electron flow is in the same direction, repulsive if the flow is in opposite directions.

We can now thus explain why permanent magnets do not "run down". The phaeons are constantly circulating, exchanging momentum with the electrons in the magnet; indeed, in one sense, we can think of the phaeon trajectories as a kind of extension of electron orbitals; an electron may lose momentum at one point by reflection but regain it at another point by absorbtion of

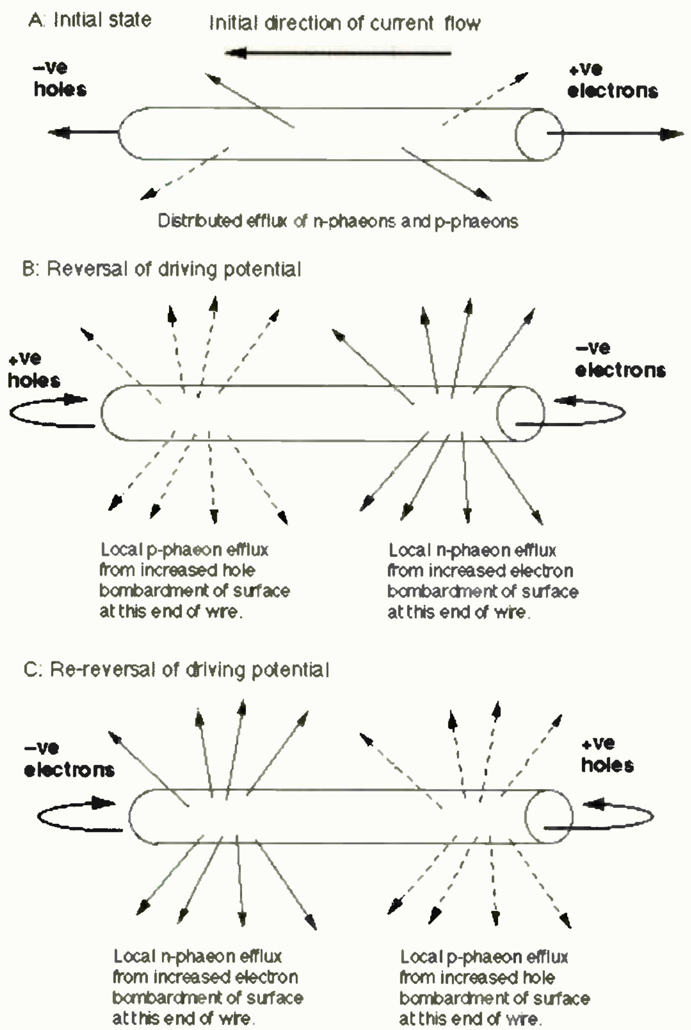


Fig. 12. Phaeon emission from an alternating current in a linear conductor.

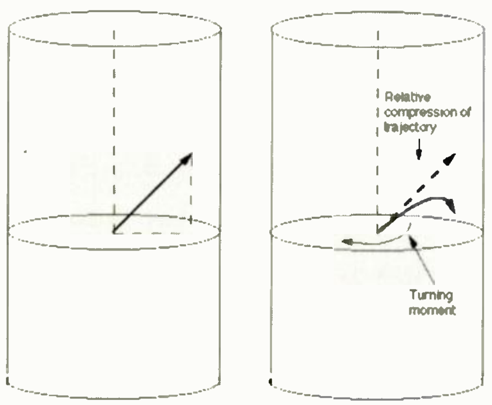


Fig. 10. Relativistic curvature of electron trajectories. Left: With no relativistic distortion the electrode trajectory is a straight line. The trajectory has a component in the z-axis and in the x-y plane. Right: The relativistic compression of the proton lattice as seen from another moving electron is equivalent to compression of the electron trajectory in the z axis. This compression generates a turning moment which curves the trajectory about the z axis.

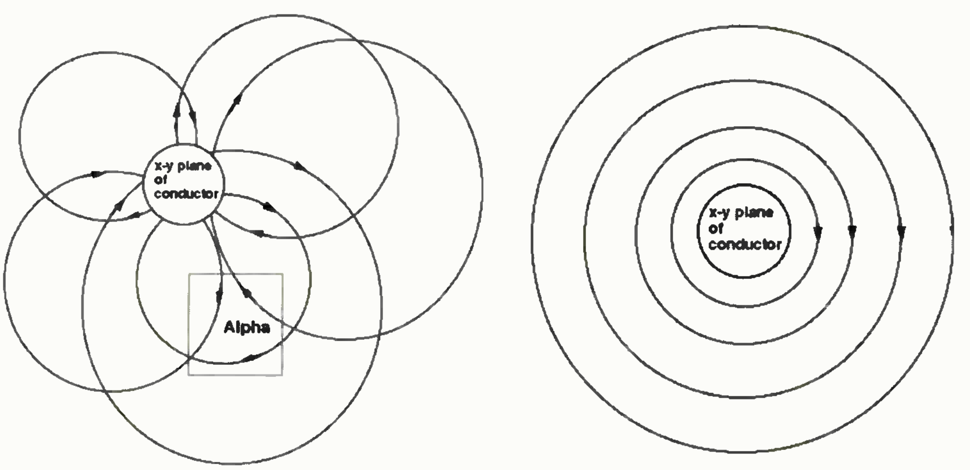


Fig. 11a. Relativistic curvature of phaeon trajectories. Because phaeons are emitted in all directions and thus return from all directions, the net radial flux through any arbitrary region of space such as that marked "Alpha" will be zero. The only non-zero component of momentum will be a component tangential to circles drawn around the conductor.
Fig. 11b. Net "Momentum Flux" around current-carrying conductor as seen from another moving electron.

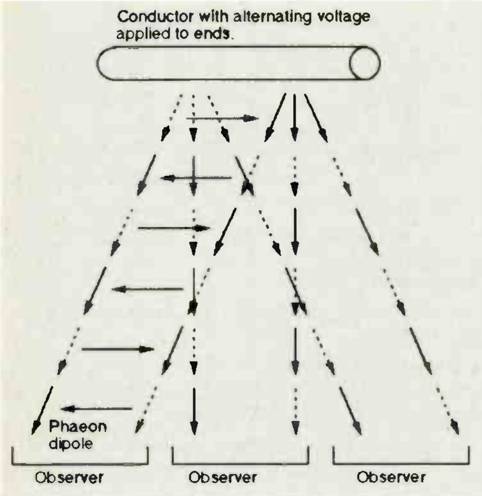


Fig. 13. Phaeon emissions from a conductor subject to an alternating voltage. Each observer sees a sequence of phaeon "dipoles" emitted from the conductor; with the polarity of the dipole reversing with each cycle of the applied voltage. (Dashed lines are p-phaeons, solid lines are n-phaeons.)

the same or a similar phaeon to that which it emitted.

Electromagnetic radiation

The reason electrons will move along a wire conductor will normally be the existence of an applied electric field. We can translate this into a "phaeon barrage". The electrons are "pushed" from one end by the impact of n-phaeons and "pulled" from the other end by the impact of p-phaeons. Under the influence of a steady potential, as we have seen in the previous section, electrons migrate one way through the conductor, and holes the other way, each colliding with the walls of the conductor as they move and emitting phaeons perpendicular to the current (**Fig. 12A.**)

Of course, in different conductors the proportion of the current carried by holes and electrons may vary enormously. In some semiconductors the current is carried almost exclusively by holes and in others almost exclusively by electrons.

Suppose that the direction of the steady applied field is then suddenly reversed (**Fig. 12B**). The electrons have finite inertia and so their direction of movement cannot be instantaneously reversed. Electrons will accumulate at the newly negative end of the wire - the electrons will effectively be transiently compressed in this region. Similarly holes will transiently accumulate at the newly positive end of the wire. We can visualise that the n-phaeon emission from the newly negative end of the wire where the electrons are compressed will be greatly increased, and similarly the p-phaeon emission from the newly positive end will be likewise increased. Thus the phaeon emission will become polarised; one end of the wire will emit excess n-phaeons and the other will emit excess p-phaeons.

Eventually of course equilibrium will be re-established and the normal electron and hole migration will be re-established in a reverse direction. If the potential is now re-reversed (**Fig. 12c**) the compression process occurs in reverse, with the region of the wire that first emitted n-phaeons now emitting p-phaeons, and vice-versa. We can see that the result of a relatively low frequency of an alternating field being applied to the wire is a sequence of simultaneous emissions of n and p phaeons from the two ends of the wire. If the applied frequency is high relative to the length of the wire, we might get harmonics formed, with several sites of emission of each type of phaeon from "nodes" where electrons or holes are momentarily compressed.

We assume that the phaeons travel at the speed of light. To an observer at some distance from the wire looking at it from the side, the emission of the bursts of n and p phaeons from the two ends of the wire will be detected simultaneously. We can think of a large number of n-p "phaeon dipoles" being emitted with each cycle of the applied field (**Fig. 13**).

The axes of these dipoles will be parallel to the wire and perpendicular to the axis of propagation of the phaeons. The dipoles will reverse direction each time the field applied to the wire reverses. What will happen when these phaeon dipoles meet electrons in recipient atoms or molecules? The linear momentum components of the n and p phaeons will cancel out, but the angular momentum components could act to give recipient electrons some kind of increase in vibrational or rotational energy.

The ability of an electron in an atomic or molecular orbital to absorb the phaeons might well depend on the frequency of reversal of the dipoles; there might need to be resonance between the vibrational frequency of the electron orbital and the dipole oscillation frequency. The dipoles can be considered as the origin of an electric field oriented perpendicular to the direction of propagation of the phaeons. This field will reverse with each reversal of the dipole. Note that the rotation of the n and p phaeons is complementary and so there will be a net angular momentum associated with the phaeon dipole (**Fig. 14**).

The direction of this angular momentum vector will be perpendicular to the electric field vector and to the direction of propagation; like the electric field vector, it will reverse direction with each reversal of the dipole. This resultant vector we can tentatively identify with a magnetic field vector as in **Fig 14B.**

Both electric and magnetic vectors will of course reverse with each reversal of the dipole. We can now see that the phaeon pairs have the characteristics of the photons that carry electromagnetic radiation. Furthermore we have an explanation for the fact that a particle, the photon, has a frequency associated with it. We argue that photons are in fact phaeon dipoles, oriented perpendicular to the direction of propagation of the electromagnetic energy, which reverse in orientation with each radiation cycle

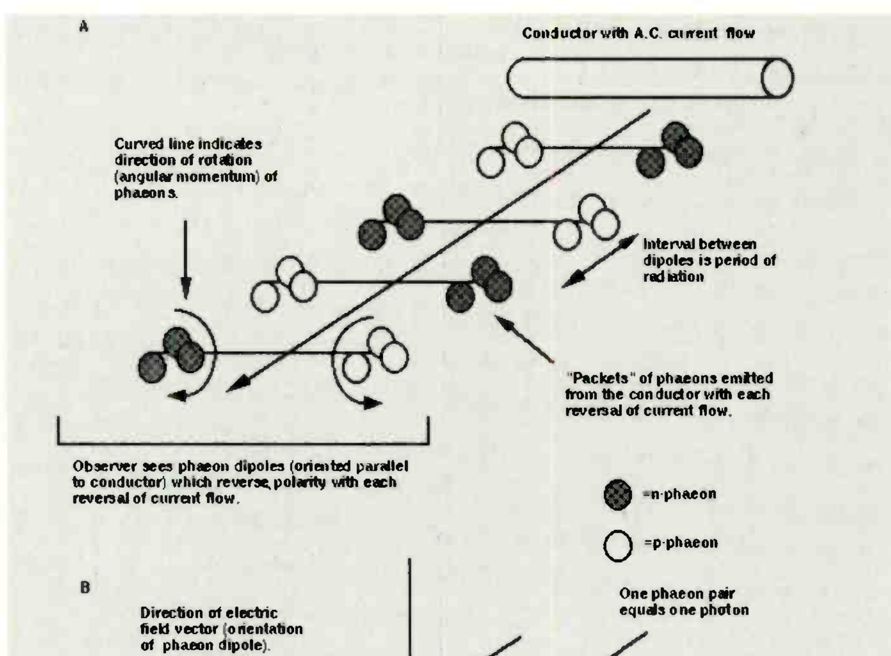


Fig. 14. Electric and magnetic fields associated with phaeon dipoles.

High energy photons are phaeon pairs which reverse at high frequencies, low frequency photons are phaeon pairs which reverse at low frequencies. When electromagnetic radiation is coherent, simultaneous emission of spatially separated n and p phaeons occurs. When spatially random simultaneous emission occurs, as from the conductor carrying a steady current, the phaeons can be detected in the form of heat energy.

In summary, we have generated a model of the photon which suggests that the photon is made up of two phaeons organised as a "phaeon dipole" which is perpendicular to the direction of propagation. The frequency of the photon is the frequency at which the dipole reverses its orientation.

The role of protons

According to the present model, all electrical and magnetic forces are due to the interactions of electrons and holes. Holes are virtual electrons, that is vacant orbitals around atoms that electrons could occupy but don't. The movement of holes can be thought of as a time-reversed movement of electrons. Thus ultimately all electromagnetic interactions are due to electrons, and the phaeons they emit when changing momentum.

The role of the proton can be seen as somehow deforming space so as to provide a set of "orbital spaces" at different energy levels around it. In one sense, a proton defines and creates a hole; but does not define the energy of the hole. According to this model a proton is not itself charged in the sense that it acts at a distance on other charged objects. However, if a proton does not have charge, we need to explain the observation that a free proton is acted on by electric and magnetic fields. This is because in a solid object, the protons are fixed in the lattice and the holes are formed by the loss of local electrons. However, if a proton is free to move in an electric or magnetic field it acts like a mobile hole in a lattice, with one important difference.

The "inertia" of a hole in a lattice is the same magnitude as the inertia of an electron, as migration of a hole is a time-reversal migration of an electron. The inertia of the hole around a free proton is in contrast much higher as it will be the inertia of the proton itself. Thus we can predict that a free proton will move in a complementary way to a free electron in a magnetic or electric field, but with different velocity because of its different inertia.

Conclusions

There is not room in this article to discuss all aspects of a "kinetic theory" of electromagnetism. If there are aspects of electromagnetism that the model is completely incompatible with, the model will have to be discarded. Even if it is wrong, the model leaves attractive images behind: the idea of a photon as an alternating "phaeon dipole" neatly explains how photons, which have neither charge nor magnetic dipole, do in fact combine both, but in a form which alternates at the frequency of the radiation. Conduction via holes is usually left in the hands of semiconductor engineers: the current model emphasises the essential symmetry between holes and electrons in the origins of charge and magnetism.

The puzzle of the identical magnitude of charge on protons and electrons is dealt with simply; positive charge is an expression of a lack of electrons, not some special property separate from the electron. The explanation of electrostatic forces emphasises the importance of surface forces and charge. Relativistic arguments are used to explain the link between charge and magnetism, but in an unusual way that also explains the importance of the curl of magnetic fields.

Perhaps the most radical aspect of the current model is the postulated role of the proton. If it does not indeed act at a distance as a source of positive charge but only acts locally to define a hole, much of our current analysis of intra-atomic forces may need revision.

My thanks go to T.G. Barnett who constantly urged me into print.

Dr Julian Millar is a medical physiologist at Queen Mary and Westfield College, University of London.

IN VIEW OF THE EXTREMELY RAPID CHANGE TAKING PLACE IN THE ELECTRONICS INDUSTRY, LARGE QUANTITIES OF COMPONENTS BECOME REDUNDANT. WE ARE CASH PURCHASERS OF SUCH MATERIALS AND WOULD APPRECIATE A TELEPHONE CALL OR A LIST IF AVAILABLE. WE PAY TOP PRICES AND COLLECT.

R. Henson Ltd.

21 Lodge Lane, N. Finchley, London, N12 8JG.
5 mins from Tally Ho Corner

Telephone:
081-445 2713/0749

CIRCLE NO. 117 ON REPLY CARD

TWIN TWIN PPM

Comprising two PPM9 boards, featuring inherent stability with law under micro-processor control, the unit gives simultaneous monitoring of A/B on red/green and M/S on white/yellow pointers. Together these provide complete information about stereo signals. Manufactured under licence from the BBC.

PPM10 In Vision PPM and Chart Recorder generates a high quality colour video display emulating the well known coaxial twin movements, long regarded as a most satisfactory way of monitoring stereo audio levels and mono compatibility. The eye can judge the level displayed, at a glance, from the angle of pointers, without needing to refer to scale markings.

Advanced Active Aerial 4kHz-30MHz *Stabilizers and Fixed Shift Circuit Boards for howl reduction *10 Outlet Distribution Amplifier 4 *Stereo Variable Emphasis Limiter 3 *Stereo Disc Amplifier *Peak Deviation Meter *PPM5 hybrid and PPM8 IEC/DIN −50/+6dB drives and movements *Broadcast Stereo Coders *Philips DC777 Short Wave Car Combination: discount £205 + VAT.

SURREY ELECTRONICS LTD
The Forge, Lucks Green, Cranleigh, Surrey GU6 7BG.
Telephone: 0483 275997. Fax: 276477.

REGULARS

LETTERS

Cause of illness

The article "Power lines, cancer and cyclotron resonance" by H Aspden (*EW + WW* September 1991) suggests that "a possible link between cancer and electromagnetic radiation from power lines... can be traced, experimentally, to a resonance effect known in physics as cyclotron resonance." The author goes on to suggest that the frequency of power generation and transmission should be changed from 50Hz to 100Hz to eliminate the supposed hazard.

We wish to state that there are no grounds whatsoever for believing that cyclotron resonance induced by the earth's magnetic field and a 50Hz electromagnetic field can exist in living organisms, or indeed in any electrolyte at normal densities.

It is not sufficient just to note, as Aspden has done, that the cyclotron frequency of the OH^- ion, or of other ions present in the body, is close to 50Hz in the geomagnetic field (about 50μT).

For a significant transfer of energy to occur even when the frequencies are exactly matched, the circular orbits of the ions must not be disrupted by collisions with other molecules or ions, so that they can be accelerated to large velocities. The average time between one collision and the next in an aqueous solution is about 10^{-11} seconds (this follows from simple estimates of the molecular density and thermal velocity).

Hence one orbit must be completed in rather less than this time to observe the resonance. In other words, the frequency must be above 100GHz. The frequency of power-line fields is too small by a factor of over a thousand million!

Since the proposed cyclotron resonance effect requires only the presence of ions in the body, any remaining doubts about its absence at 50Hz should be dispelled by looking at existing measurements of electromagnetic absorption in aqueous electrolytes at low frequencies.

However, measurements have also been carried out on bone and tissue, and they too show no sign of any resonant increase in absorption near 50Hz[1]. The AC conductivity, which can be extracted from the absorption data by an application of Maxwell's equations, typically shows no frequency dependence below100kHz, above which motion of polar molecules causes dispersion.

Incidentally, there is also no justification for a frequency-pulling effect even if cyclotron resonance were operative, since the ionic concentrations are low and the AC magnetic field is weak; magnetic fields generated by the resonating ions are negligible.

We do not wish to imply that, because cyclotron resonance absorption is not a player, that there are no adverse effects resulting from long-term exposure to low-frequency electromagnetic radiation, whether at 50 or 100Hz. The recent CRC handbook on the biological effects of EM fields[1] documents many such effects on particular tissues and cells as well as on whole animals.

A useful summary of possible mechanisms has been given by Straub[2]. An informed appreciation of current scientific knowledge in this area is an essential ingredient in the environmental debate concerning power lines, and this debate is ill-served by the article published in your magazine.

TC Choy, DR Hutton and DA Smith
Monash University
Clayton
Australia

1. Polk C and Postow E, "Handbook of biological effects of electromagnetic fields", CRC Press (1986)
2. Environmental Health Criteria v 16, "Radiofrequency and microwaves", World Health Organisation (1981)

BT parity line

Following the recent article and correspondence on the BT Phonebase service and its use of V23 data-rate, I should like to point out another problem that has so far been overlooked.

It should indeed be convenient for Phonebase to use the same V23 data-rate as provided by the mini-terminals universally used by European videotext services (Prestel, Télétel, Btx). But there is also the vital question of number of bits per word and parity bit protocol.

Prestel and Télétel use seven-bit/even parity, as did the original experimental Phonebase service.

That meant I could use Phonebase via a simple cheap interactive terminal connected to the phone which I also used to call Prestel and Télétel services.

But when Phonebase was relaunched, one of the giant intellects behind it decided that it would be a good idea to move further towards the ascii VT-terminal standard by changing to eight-bit, no parity – pity they didn't think to tell the writer of the Phonebase manuals – and bang goes my useful little terminal, which can't be changed from the seven-bit/even standard of V23 videotext.

In fact very few terminals (as opposed to PCs) on the market can operate V23 in eight-bit/odd mode; almost all offer V23 seven-bit/even and, sometimes, V21 eight-bit/odd (300 baud).

So here we have an excellent up-to-date computerised database, wanted by almost everyone, owned by the largest and wealthiest communications technology company in the country, but coupled to an unbelievably amateurish access system.

No one could describe it as a large or complicated task to set up reliable, multi-speed access to such a database. There are hundreds of part-time enthusiasts running free bulletin boards across the globe that achieve infinitely superior performance, flexibility and complexity of interface.

I would be most interested to see if those directly responsible for the service could be persuade to comment on this truly pathetic situation.

Alex Gray
BBC
Milton Keynes

Damming argument

A cyclotron uses a pumping system to produce a high vacuum in the space in which the ions are accelerated. This is because if an ion spiralling in a magnetic field is to pick up a significant amount of energy from an oscillating electric field it must be able to traverse several turns of its spiral path at resonance (usually one turn per cycle of the oscillating field) without being significantly deflected by collisions with other ions, atoms, or molecules. However Harold Aspden's hydroxyl and hydronium ions ("Power lines, cancer and cyclotron resonance", *EW + WW*, September, and November and December letters) are immersed in tissue or body fluids, so that they undergo many thousands of such collisions during each mains frequency cycle, and no cyclotron resonance can develop.

Shareholders in National Power and PowerGen may therefore breathe freely once again.

In November letters DT Moore extolled the green virtues of hydroelectric power, but this brings its own hazards. It is known that filling the deep reservoirs behind some high dams in mountainous country markedly increases the frequency of earth tremors, and in one case has triggered a landslide. The resulting water surge breached the dam. In seismically active regions dam structures – because of the large hydrostatic stresses imposed on them – are very vulnerable, and so are the people living downstream.

CF Coleman
Oxfordshire

Absorbing facts about ions

When Harold Aspden suggests cyclotron resonance as a means by which electromagnetic fields might produce biological effects (Power lines, cancer and cyclotron resonance, *EW + WW*, September, pp. 774-775); he overlooks a very important flaw in his argument.

During cyclotron resonance the ion's orbit is in phase with the electric field, such that it is only accelerated and never decelerated, over many orbits. So if the absorption of energy is to be any different from that of the simpler case of an oscillating ion in an AC electric field, it must complete at least one orbit before it is significantly scattered.

A sodium ion, with average thermal kinetic energy (3kT/2), will have a speed of 500m/s, and if it is to make 50 orbits/s then the circumference of the orbit will be 10m. In reality an ion will be scattered within nanometres. An alternative way of looking at this, is that the resonance has a Q of, of the order of, a trillionth.

Harold Aspden might take note of the corollary that when there is no scattering in a simple cyclotron; there is still a limit to the energy; which is predicted by, and only by, relativity.

Robert Woolley
Imperial College of Science and Technology
London

Active response

In his active filters article (*EW + WW*, October, pp. 812-818) John Linsley Hood correctly states that circuit details about active filter systems are not easily found, but then proceeds to introduce a curious hotch-potch of active and passive filter designs with, I feel, too little information to be useful, and at the same time containing a number of errors and misleading statements.

The circuit in Fig. 3 will not produce a flat or near-flat response with 1kHz cutoff; the LCR section as shown has a Q of 31.6 giving a 30dB response peak at 199Hz!

The terms Chebyshev, Butterworth and Bessel do not refer "broadly to filter types" as Mr Linsley Hood states. On the contrary, they precisely describe standard filter responses. The Bessel response gives maximally flat group delay (linear change of phase with frequency) but slow amplitude roll-off; the Butterworth response gives a maximally flat passband response, but with a peak in the group delay, and faster amplitude roll-off; the Chebyshev response gives still faster amplitude roll-off at the expense of ripples in the passband, and ripples and large peak in the group delay.

The pole positions for the low-pass versions of these, and other standard responses are quite often tabulated in filter design textbooks, typically for up to ten poles, though nowadays they are easy to calculate on a PC, or even a pocket calculator.

Turning now to the filter circuits, the article shows a tuneable notch filter requiring a pair of ganged capacitors for tuning. This seems a perverse choice given that there are at least two simple notch filter designs using single resistor frequency control, which have appeared in *EW + WW*.

Figure 13 is described as an "active integrator with overall loop negative feedback .... that gives a flat Butterworth-style response ..." This circuit is usually known as the single-amplifier multi-feedback filter, and the two-pole low-pass version shown in Figure 13 can give any two-pole low-pass response, including Chebyshev, Butterworth, Bessel etc. This emphasises the point that these are response shapes, not filter circuit types.

Next take Fig. 14, the bridged-T; this is correctly described as a third-order type (because it has three reactive elements) but then the article goes on to claim that the third CR circuit gives a further 6dB per octave roll-off. This is only partly true: the extra pole provided by the third CR circuit is actually needed to cancel the parasitic zero that the bridged-T introduces. The extra pole is typically made to coincide with and cancel the zero, so that an accurate two-pole response results. The pole can be moved down to a lower frequency if the Q is set >1 so that at low frequencies, a three-pole response is obtained. However, above the cut-off frequency, the zero still affects the response, and it becomes two-pole again.

This same problem afflicts the bootstrap circuit (Fig. 16) for the same reason; the circuit values shown for the low-pass circuit give a 1.5dB passband ripple three-pole Chebyshev response up to and beyond the –3dB cut-off frequency, but the parasitic zero has cut this to a two-pole 12dB per octave response by about 2.5 to 3 times the cut-off frequency. A true three-pole response would continue to attenuate at 18dB per octave above the cut-off frequency.

The Sallen and Key layout is described by Linsley Hood as "able to give high-pass and low-pass Butterworth filters". Again, this circuit gives a two-pole response, and can therefore provide any two-pole response characteristic. Besides low-pass and high-pass, it can also give a bandpass response as can, incidentally the multi-feedback and bridged-T layouts (but not the bootstrap).

The all-pass filter construction shown in Fig. 23 (labelled "The" all-pass filter) is not very useful since it has a fixed Q or zero (single-pole response). The function of the adjustable resistor is not clear, since the all-pass response is only available at the junction of the C and the end of the variable resistor. The all-pass response (but with adjustable Q) is the means by which a filter with the required amplitude response, but not phase response can be made to have the required phase response as well.

Lastly, Fig. 22 shows how a flat bandpass response can be obtained by cascaded HP and LP sections. While this will work, it will give poorer slopes near the pass-band edges for the same number of stages as the more conventional approach of using cascaded bandpass sections.

Brian J Pollard
Watford
Herts

Sporadic - E or spirit world?

I have recently come across a group of people who claim to have received images from beyond the grave on television sets. The phenomenon, known as TVEVP (television electronic voice phenomenon) is promoted by a group originating in Luxembourg, (CETL, BP 02/Hesperange, Luxembourg) who claim to have a "hot line" to a spirit guide known as "Technician".

They appear to be surprised that many of the images seen are of famous German people, including National Socialists. One viewer is known to have been shocked that such evil people have gone to heaven. Another image received was of Hannah Buschbeck a famous ESP (extra sensory perception) personality who died aged 84. However her image was when she was 30 "because she did not wish to project herself as an 84 year old". It is claimed that the image has been identified with photographs of her taken when she was 30.

The idea of intermittent long distance TV reception of films and documentaries does not seem to have occurred to the group, and they doggedly persist in sending out videos, newsletters and so on. One individual claims that there is a world-wide cover up, sponsored by governments and the churches who apparently don't want the populace to receive the "proof" that there is life after death and that contact can be made with the dead. The alleged motivation for this cover up is not known to me.

There is a story going round that in 1955 or 1956 a Mr H Reeves who lived on the south coast on a hill, appeared on British television, possibly on the evening news magazine *Highlight*. He related how he received a spirit message on his television from Technician and a group called Timestream. He was later confused with Mr Alec Reeves, the inventor of PCM who was also interested in ESP.

If any reader has a recollection of this broadcast about Mr H Reeves' activities, I would be grateful to have details, because as someone who knew Alec Reeves I am asked about this.

I would also be interested to hear from anyone who knows of a television play or film broadcast in the mid 1950s – snatches of which may have been received by Mr H Reeves by sporadic E or meteor scatter – that contained a character called Technician and a group called Timestream. It could have been an early regional ITV play.

Best of all, of course, is the possibility that Mr H Reeves is still alive and reads *EW + WW* and is willing to contact the group.

John de Rivaz
Porthtowan
Cornwall

Less loss

Mr Linsley Hood's article on active filters (*EW +WW*, October, pp. 812-818) was most interesting. Your readers should, however, be aware that the low-pass and high-pass second order responses given by the bridged-T feedback configuration and by its variant, the "bootstrap" circuit, have an ultimate attenuation band fall-off rate which is theoretically 20dB/decade less than that which would be obtained by designing the filters to make use of Sallen and Key (or equivalent) second order sections. In multi-pole filters, the loss in ultimate fall-off rate will approach 20dB/decade for each such section.

A Kraicer
Edgware
Middlesex

Dab hand

The entertainment industry is to be congratulated for pioneering FM, TV and now dab. FM is used for much more than broadcasting today; TV is used in medicine, teaching, astronomy, etc; and now dab will revolutionise mobile radio communications, fixed multiplex links, telecommunications in general and our lives in particular.

Your dab review article (All systems go for dab?, *EW + WW*, October, pp. 880-882) raises the following thoughts. If one block of 1.5MHz of radio spectrum can carry some 12 (six stereo) channels of 15kHz audio information this is the equivalent of 180kHz of analogue bandwidth with a dynamic range of more than 100db. That is roughly equivalent to 60 mobile radio channels using a 25kHz RF bandwidth.

Restricting the frequency response of each channel to the audio range of 300-3000Hz and the dynamic range to 60db the RF bandwidth requirement can surely be reduced to well below the 25kHz (FM) often in use today for mobiles. Using trunking techniques, Eureka style dab with its mutual interference cutting characteristics and low RF power requirements will allow implementation of mobile radio schemes with a lavishness that lack of RF spectrum has denied all these years.

After a decade of resistance on the part of the BBC to non-compatible FM stereo radio broadcasting it is good to see that at last the old lady has seen the light. A pity indeed that the price is that BBC researchers are so little involved, since dab is really what their business is all about.

Peter Hirschmann
Haifa Israel

Fluke details

The Fluke 80 series multimeters feature an ultrasonic data output facility for which, for some obscure reason, Philips is resolutely unwilling to provide details.

I would like to ask whether any *EW + WW* readers have successfully built an interface to the multimeter using this interface and have been able to decipher the data protocol. I would be very grateful for the advice and can be contacted on 0272 741918.

Paul Johnsonn
Clifton
Bristol

Criticism reviewed

It is apparent that the reviewer of my book *CTG Capacitance Theory of Gravity*, failed to grasp the concept of a voltage tcaygradient field in dimensions of volts per daraf through capacitance-dominated space, which is much like a volts per ohm field through resistance-dominated space. These fields were explained in pages 23-36 and in Appendix D. Volts/daraf equates in MKS(R) dimensions to coulombs, just as volts/ohm equates in MKS(R) dimensions to amperes. The dimensions remain balanced and true when converted and equated with MKS(NR), CGS, ESU, and EMU. The force, Q-times-the-volts-per-daraf, which is not in "newtons" (as explained on page 36 but misinterpreted by the reviewer), was therefore designated with new amplitude-equivalent-for-MKS called "gravits". Then 1 gravit = A newtons, where A is equal to one newton/gravit, or 1 daraf/m. When the F_g gravity force and A dimensions are both converted to other dimensional systems, no errors occur in either amplitude or dimensional balance.

In the CTG book, instead of A, amplitude-equivalence vertical brackets were used throughout the book to designate "gravit" force equivalence to "newton" force, as MKS units were used exclusively.

As far as demonstrating that electric field coulomb law forces disappear in the CTG theory, this was explained on pages 27 through 29. Electric fields from myriads of closely spaced plus and minus poles of dipoles with random orientation cancel at any point in space, hence no coulomb law forces.

I do hope that readers of *EW + WW* are not sufficiently persuaded by the negative review to make no judgement for themselves and will take a look at this new concept. Other reviews have been more comprehensive and more positive.

Morton F Spears
Spears Associates Inc
Norwood
Massachusetts
USA

Thanks... for the memories

A while ago I wrote asking for your help in looking up old issues of *Wireless World* to find data on the RAF receiver R1155. The response has been remarkable. Complete strangers have put themselves to all sorts of trouble on my behalf out of sheer good nature and, one can infer, some nostalgia. Your help has been invaluable. Thank you indeed.

But much wants more – my R1155 is my second priority request – my first is to obtain another ex-government receiver for long waves only. 15-200KC. Two receivers were made – one, code B28 (Marconi R100) was a general coverage one; the other, similar in appearance, code B29, covered the VLF spectrum. I have tried in vain in every way open to me to find one. True they are likely to be scarce, but they were on the disposals market in 1960 and there may be one tucked away somewhere. Can anyone help?

Douglas Barry
Ward of Turin
Rescobie
By Forfar
Angus

Vintage stuff

Can you help me to find a home for some 1940s equipment which I should like to donate to a good cause. The collection includes a TF144G, TF517F, Type 13 'scope, RA1B communications receiver and an ARR-3 sonobuoy receiver.

The items were on offer to the

ABC of amplifiers

The amplifier circuit suggested by WO Richards in Circuit Ideas, *EW + WW*, October 91 seems to be a neat up-date of the design approach described twenty years ago by Peter Blomley (New Approach to Class-B Amplifier Design, *WW*, Feb-Mar 1971). In that design, cross-over distortion was avoided completely by transferring the switching function from output to an earlier stage which divided the signal into "top" and "bottom" unidirectional halves. With the output stage biased just into conduction, the signal halves drove their respective output stage halves like class-B but without entering the cut-off area, and united in the load in the usual way. An amplifier using the system had a performance that may not be bettered today.

Why then, did it not sweep class-B off the market? One reason might be the patent application mentioned with the article. Blomley himself considered his design wasted on the transducers of the time. Many music-lovers are quite happy with their class-B equipment.Nevertheless, ears do twitch at cross-over distortion and the excellence of CD and (some) broadcasts bring a desire for amplifiers worthy of them. So anyone who tries the Blomley system simply for own interest may become quite pleased. (Yes, there are still plenty of audio hams – ask the firms who supply parts and kits). It would be helpful if Mr Richards would supply some performance details. Capacitive coupling may upset some purists. I am more concerned by the different total values in the two halves of the amplifier.

Finally, is it class-A or B? It operates in the class-A area but does not require a standing current large enough to meet the heaviest likely demand. Like class-B it draws current proportional to drive but operates clear of the cross-over area. Class-AB is what many circuits are already. What about class-BA?

W Groome
Wolverley
Worcestershire

Communications & Electronics Museum Trust at Bristol, but this now seems to have disappeared through a hole in the ground. I have tried to find other museums or collections of vintage electronic gear to which I could give these bits, but so far no one has been able to help. Of course I have heard of the Vintage Wireless Company, but that is a commercial operation, generally more concerned with the cosmetic details than with the gear per se.

Michael Hawkins
65 Osborne Road
Farnborough
Hants
GU14 6AP

RDS voids

With reference to Philip Darrington's "RDS on the road" (*EW + WW*, November, pp. 973-974), his statement that RDS data "is now carried on all FM Transmitters in the UK" is blatantly not true. Even if the statement referred to the BBC only, it would still be incorrect.

The BBC has many transmitters, mostly in Scotland which do not carry RDS data; eg some sites bordering the A9 from Perth to Inverness, sites in the Western Isle and also sites on the north west coast of Scotland carrying mono transmissions only. The BBC did admit to this, when pressed, at the Motorfair in London recently.

National Transcommunication Ltd (NTL) formerly the IBA have many local independent stations not carrying RDS data; eg Beacon Radio (Wolverhampton), Fox FM (Oxford) and Moray Firth Radio (Inverness) to name a few.

In addition, NTL have stations with dual sites and frequencies which do not carry AF listing, and so RDS radios will not retune as signal strengths vary; eg Radio 210 FM (Reading) has 102.9MHz from Hannington and 97.0MHz from Reading with neither carrying AF listing. As an extensive RDS user (both in UK and Europe) I find the UK well below average on operational techniques employed. My main frustration is the manual operation of the TA override command from studios. European Stations have automatic switching when the traffic announcement jingle tape is inserted and so drivers hear all the Traffic Announcement. UK stations employ manual switching and unless studio operators switch the TA on during the jingle tape, the start of the announcement will be lost.

I understand take up of RDS in the UK is very slow, but until the system is fully operational and studio operators are correctly trained, take up will continue to be well below our European partners.

Terry Parrott.
Hampshire

Tuner kit

The article "RDS on the road" (*EW + WW*, November 1991) prompts me to wonder whether any manufacturer produces a unit, or kit, which can be connected to a conventional FM tuner to give an RDS display. Can any reader or manufacturer help?

Allan C Jones
Newport Pagnell
Buckinghamshire

Relatively satisfactory

It is true that critics have perceived flaws in the theories of relativity, but it is still the case that relativity does provide a good explanation of observable phenomena. Ove Tedenstig states (Letters, November) that Einstein's theories should be relegated to the "lumber room of failed scientific ideas". But why, when no one has produced a better hypothesis?.

Critics of relativity must address themselves to some common observations that are not readily explained by Newtonian physics. For example the motion of Mercury, and the behaviour of high-speed electrons in discharge tubes. If relativity is not the (whole) answer then can we have another hypothesis?.

Some people have genuine and well-argued reasons to suspect that relativity is not the whole story, but I suspect that the majority of people who dismiss relativity just cannot cope with what, on the face of it, goes against everyday experience. I am reminded of the occasion where the church refused to believe in the moons of Jupiter.

The establishment may well be represented by some people with narrow-minded, blinkered views, but the tone of Tedenstig's letter suggests that there are such people in both camps.

David Gibson
Leed

Who has the problem?

It is with interest that I read your editorial "History is bunk?" (*EW + WW*, November). I note the change of title from Wireless World, but I also note the RF techniques are essential to accurate design of even humble circuits, and in particular the 32bit systems with which I am currently involved, are very sensitive to electromagnetic design – transmission line parameters, for example.

I would even assert that a humble bipolar transistor is a radiation-operated device when it has to be modelled to full accuracy, at least conceptually, as a quantum field device. This is essential for the proper understanding of p-type semiconductor material as containing not holes, but virtual positrons. I am not convinced that I have seen a fully satisfactory analysis of why base stopper resistors work - if anyone remembers the concepts of pre-integrated circuit days.

While I appreciate the preference of your magazine for practice and experiment over high-flown theory, I am not convinced by totalitarian relativism, and I suspect that it is a matter of time before Einstein's fundamentals go the way of Newton's principia, that is into history.

Allan Campbell

Travelling in the mind

Taking up the challenge thrown down by Alan Boswell (Letters, October), I would like to join the debate on time machines by asking a question:

Does the unfolding process of the material system depend on the mediation of some kind of agent corresponding to the notion of time as under relativity theory, or does this unfolding merely express the inherent dynamic characteristics of matter itself?

This question, raised over the nature of time as it may be inferred from relativity theory, stands in relation to the alternative hypothesis which posits time as an element of the mental domain, the indispensable concept for any mental comprehension of experience.

Should this hypothesis prevail, it follows from the exclusion of time from the physical domain, that timing operations would be admissible only as actions of the mind, when comparisons are made between stages of various physical processes.

Any process adopted as a standard for comparison derives its value from confidence in the qualities of the system undergoing it, to provide a repetition of stages which is regular.

The clock is such a system which the mind uses as a basis for recording the various series of events along an abstract dimension, but is merely represented as a spatial extension and has no location in the physical universe.

The timing standard has validity across the entire universe and cannot be affected by physical action such as mobility of objects. There are various practical problems in establishing simultaneity, including the finding of data-transmission delays between the site of an event and a timing-station registering it. These difficulties have no bearing on the concept of simultaneity, as Einstein asserted they did. What is measured with clocks is not time, but the synchronisation between processes.

The proposition I am putting is consistent with the Cartesian doctrine of duality: the physical and mental domains are recognised as having their autonomous existences, but their processes are mediated through the action of the neural complexes of living organisms. At this interface is defined the boundary between physics and metaphysics, the boundary which relativity theory vainly seeks to breach.

Am I a kill-joy for trying to undermine the basis for fun with time-machine fantasies and the like?

Possibly Mr Boswell would care to lend his incisiveness, or venture a little crankiness, in a "respectable" debate over the place of time in the universe.

C Francksen
Farnborough
Hants

Four channels on a single-channel oscilloscope

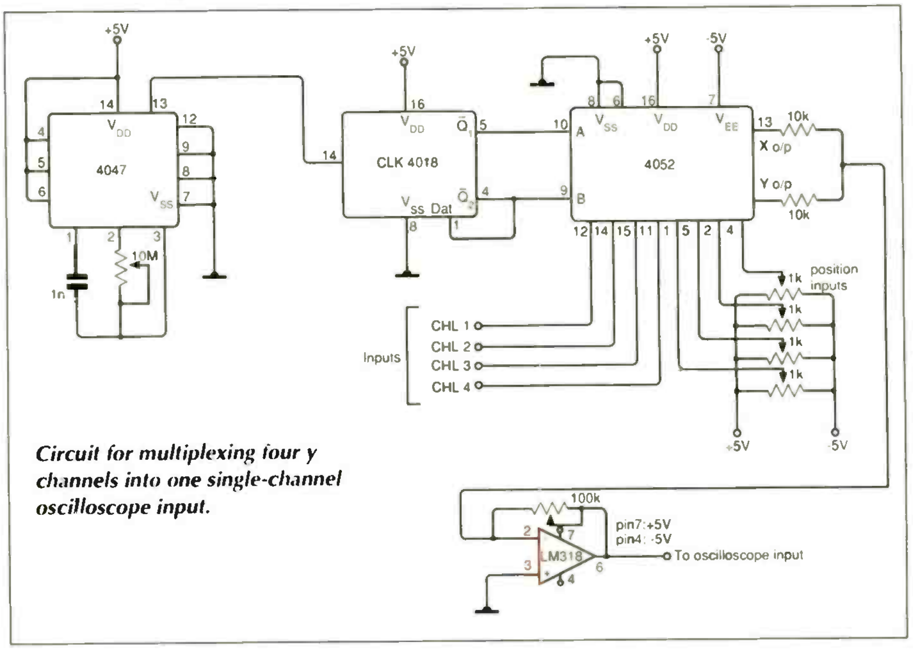
On a single-channel oscilloscope, this circuit, using only four ICs, multiplexes four signal channels for, effectively, simultaneous display.

The differential 4052 multiplexer works with two sets of four inputs: pins 11,12,14 and 15 carry the y signal, while pins 1, 2, 4 and 5 take DC potentials from the four potentiometers to determine the y position on the screen (a DC-coupled oscilloscope is assumed).

Clock pulses variable up to 2MHz are generated by the 4047 astable and drive the 2-bit Johnson counter, which produces A and B select waveforms for the multiplexer. High switching rates multiplex the y inputs at a higher rate than the oscilloscope sweep to give a virtually continuous display.

Output to the single input of the oscilloscope comes from an LM318 variable-gain op-amp.

V Lakshminarayanan
Centre for Development of Telematics
Bangalore, India



Circuit for multiplexing four y channels into one single-channel oscilloscope input.

Accurate astable multivibrator timing

In the free-running multivibrator of **Fig.1** the period is theoretically given by $T = 2CR_1 \ln(1+2R_2/R_3)$, positive and negative excursions being exactly equal.

Symmetry of the output waveform suffers in practice when the differential input voltage exceeds the specified value and, in some types of op-amp, causes an avalanche input current. This usually happens as a result of exceeding input threshold protection or when long-tailed pair base/emitter zener action occurs.

Figure 2 shows an improved circuit, in which the unity-gain buffer IC_2 isolates the timing circuit from the inverting input of IC_1, incidentally affording increased speed. Alternatively, the potential divider $R_{2,3}$ may be varied to give a lower differential input swing, but in this case the op-amp offset voltage cannot be neglected.

Dmitri Danyuk and George Pilko
Kiev, USSR

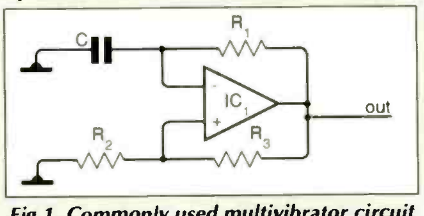


Fig.1. Commonly used multivibrator circuit may give asymmetrical output if inverting input avalanches.

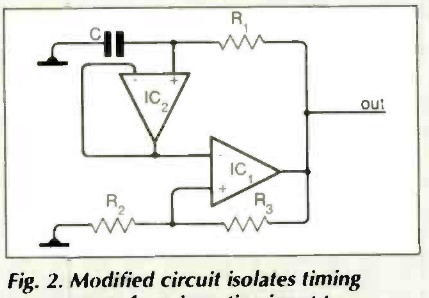


Fig. 2. Modified circuit isolates timing components from inverting input to preserve symmetry.

FRESH IDEAS

While we are not short of Circuit Ideas to publish, it would be agreeable to see some fresh input from the vast, untapped bank of talent that our thousands of readers represent. We pay a moderate fee for all ideas published. So send them to Circuit Ideas, *EW+WW*, Room L333, Quadrant House, The Quadrant, Sutton, Surrey, SM2 5AS.

We will be happy to consider them.

Millihertz multivibrator

When accurate and repeatable long-period timing is needed, a CD4053 analogue multiplexer and a CD4020 14-stage counter will form an astable multivibrator with independent setting of mark and space from seconds to minutes. No expensive large-value, low-leakage capacitors are needed and there is no initial pulse error, often present in analogue timing circuits.

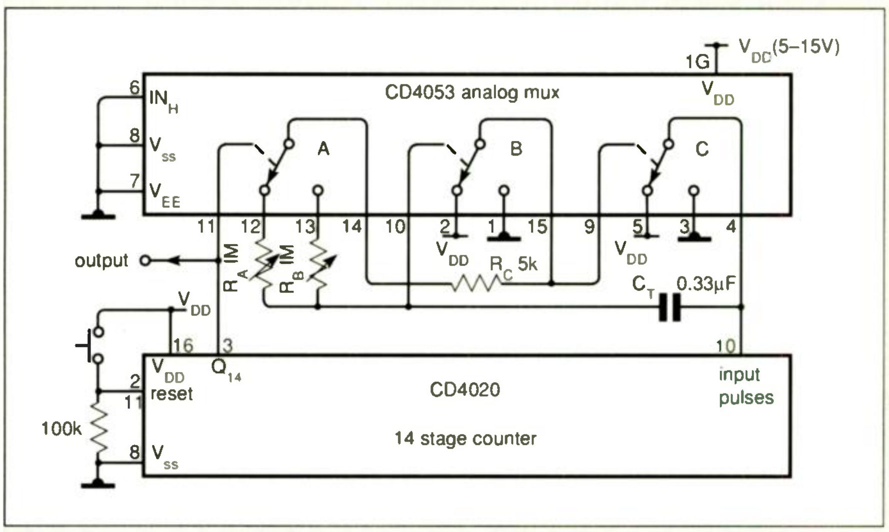
Analogue switches B and C of the 4053 are arranged as inverter gates, inputs and outputs therefore being complementary. Capacitor C_1 and resistors $R_{A,B,C}$ form an oscillator round the gates.

Pulses from the oscillator are counted by the 4020, its Q_{14} output changing state after every 8192 pulses at the input and controlling, by way of gate A, which of the two timing resistors R_A or R_B is in the oscillator circuit. The frequency of the oscillator is so decided by the value of R_A when Q_{14} is low and by R_B when it is high, Q_{14} being taken as the output.

With the component values shown in the diagram, on and off times are variable between 10s and 70min. Leakage in the off channel of gate A causes negligible change in the timing of each period when the timing resistor of the other period is varied.

If the preset feature of the 4020 is not needed, a 4045 21-stage counter can be used to give longer periods.

M S Nagaraj
ISRO Satellite Centre
Bangalore
India



Low-power counter and multiplexer give independent control of on and off periods of multivibrator from 10s to 70min, using no expensive capacitors. Timing is much more accurate and repeatable than in analogue timers.

Variable M:S op-amp oscillator

Needing a low-frequency oscillator to give a rough idea of the level of a control voltage, I considered the obvious 555 but, having a spare op-amp, developed this variation of a common design.

Op-amp oscillators commonly take the form shown in **Fig.1**, in which R_1 and R_2 provide positive feedback and the reference voltage. Capacitor C charges through R_3 to the reference level, whereupon the output goes low and C then discharges to the new level. When C reaches it, the output again goes high and the cycle repeats. With equal supplies, the mark:space ratio is 50:50.

In **Fig.2**, a single supply is used and the low impedance of the control voltage source enables it to be used to vary charge and discharge times by changing the switching point of the op-amp to alter the M:S ratio.

Values given provide a led flashing rate of 3Hz, assuming a low-leakage C, and M:S ratio is variable from 3:1 to 1:3 for a control voltage swing of +2V to +10V. I used a low-current led to 0V, but a higher-current device could be driven by a transistor.

Martin J Barratt
Reading, Berkshire

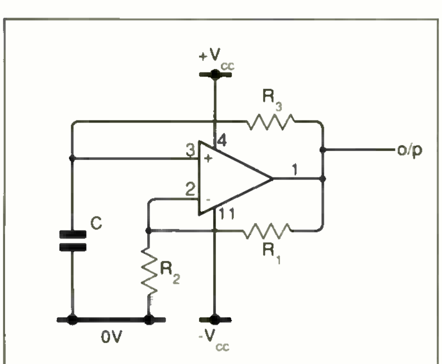
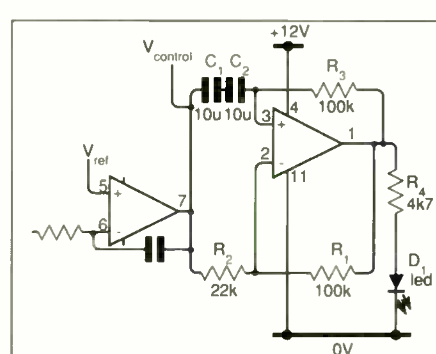


Fig. 1. Common form of op-amp oscillator, providing 50:50 mark:space ratio with equal supplies. Feedback resistors determine reference voltage.

Fig. 2. New circuit with single supply. Control voltage to be monitored varies mark:space ratio of waveform driving led indicator



Parallel-to-RS232-C conversion

The circuit shown in **Fig. 1** converts parallel 8-bit data at the inputs of the uart IC_2 (pins 26-33) to RS232-C serial data format for transmission at any of fourteen of the commonly used transmission rates as in **Table 1.** Data is entered either by means of switches DWS1-DWS8 or from an external source.

Transmission is initiated by applying a positive or negative edge to the trigger signal input of the multiple monostable IC_3, an HEF4528; selection of trigger polarity is by switches TS 1-4. Serial data from pin 25 of the IM6402 uart is inverted and converted to RS232-C levels by the Max232 driver, IC_4, appearing on pin 14. The uart inserts a start bit and either one or two stop bits and odd, even or no parity bits, selected by switches CW 1-5 as in **Table 2. Figure 2(a)** shows the data format and **Fig. 2(b)** the timing.

If data is to come from an external source (for example, from the motion detector published in *EW + WW*, July, pp. 571, Circuit Ideas), the switch/resistor network on pins 26-33 of the uart is omitted. In this case, valid data must be present at least 50ns before and 70ns after the trailing edge of the negative pulse at pin 23 of the uart.

K Kumaran
University of Keele

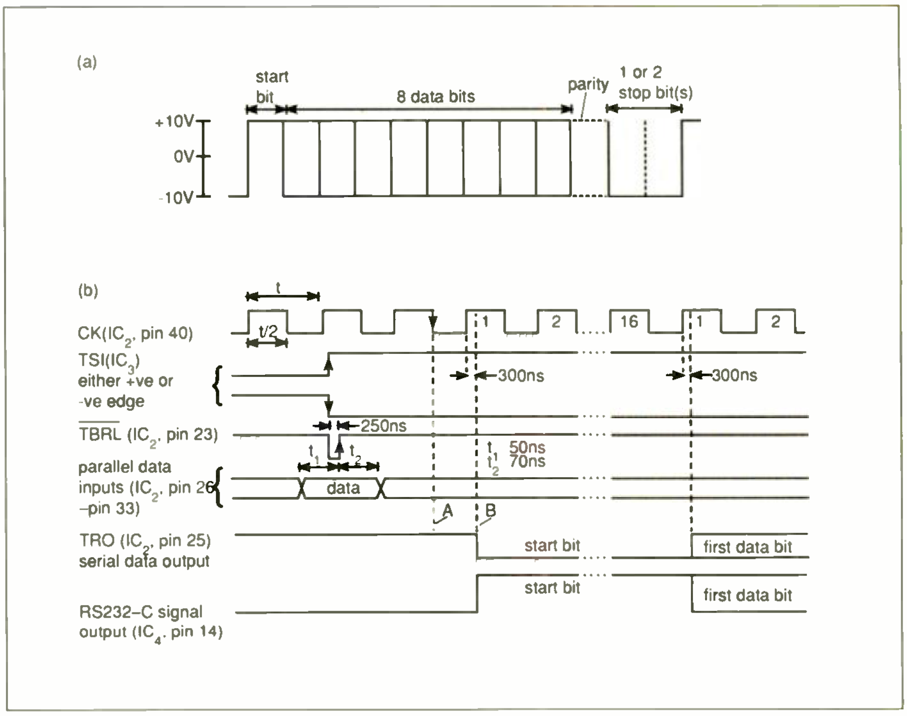


Fig. 2. Serial data format and levels at output of RS232-C driver (a). Number of stop bits is optional, as is inclusion of odd or even parity bit. Timing of circuit is at (b). Point A is first negative edge of clock, at least T/2+175ns after positive edge of $\overline{TBRL}$*; B is start bit time, T/2+300ns after A.*

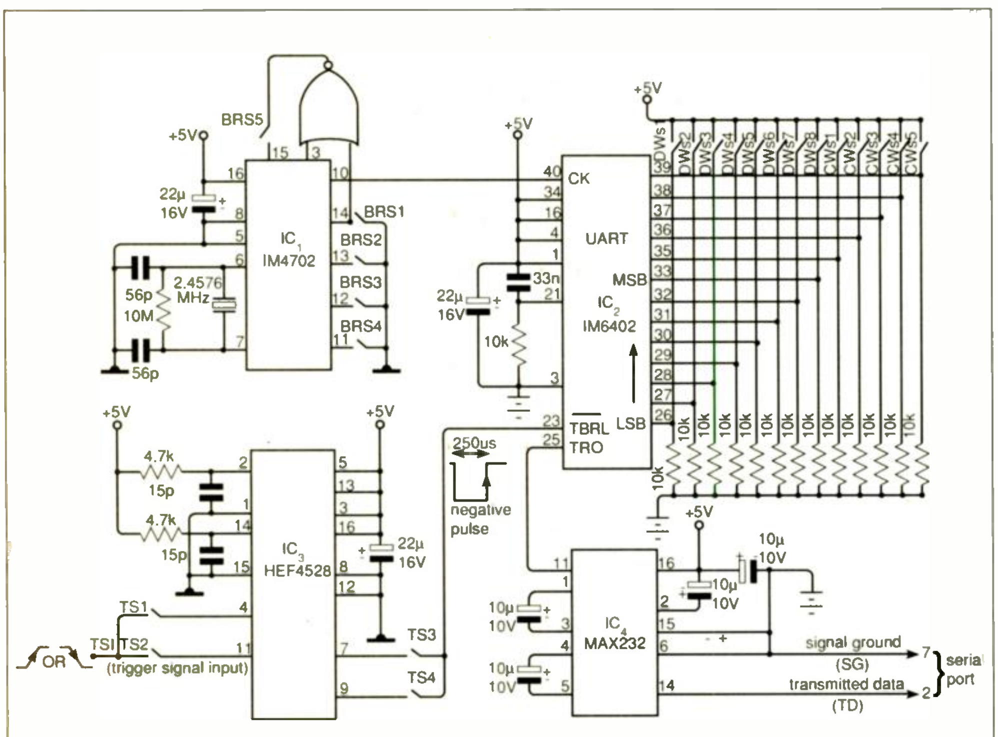


Fig. 1. Parallel-to-RS232-C converter for external data or for switched-input setting.

Table 1. Selecting data rate by setting of switches BRS 1-5.

Rate	BRSI	BRS2	BRS3	BRS4	BRS5
50	on	off	on	on	off
75	off	off	on	on	off
110	off	off	off	off	off
134.5	on	on	off	on	off
150	on	off	off	off	off
200	off	on	off	on	off
300	off	on	off	off	off
600	on	off	off	on	off
1200	off	off	on	off	off
1800	on	off	on	off	off
2400	on	on	off	off	off
4800	off	on	on	off	off
9600	on	on	on	off	off
19200	off	off	off	off	on

Table 2. Selection of start, stop and parity bits.

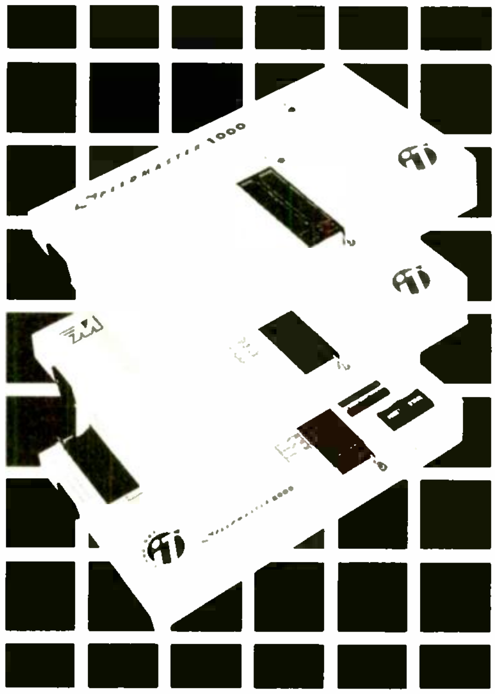
CWS 1	CWS 2	CWS 3	CWS 4	CWS 5	Parity	Stop bit(s)
on	off	on	on	x	none	1
on	on	on	on	x	none	2
off	off	on	on	off	odd	1
off	on	on	on	off	odd	2
off	off	on	on	on	even	1
off	on	on	on	on	even	2

x = don't care

PROGRAMMING FLEXIBILITY FOR PROFESSIONALS

HARDWARE FEATURES
- PC-BASED PROGRAMMERS
- UK DESIGN, MANUFACTURE AND *SUPPORT*
- NO MESSY INTERNAL CARD
- PLUGS DIRECTLY INTO PARALLEL PORT (LPT1-3)
- EASILY TRANSPORTABLE BETWEEN MACHINES
- WORKS WITH XT, AT, 386, & 486. EVEN LAPTOPS!
- INCREDIBLY FAST PROGRAMMING TIMES
- FLEXIBLE DESIGN MEANS NO ADAPTORS NEEDED FOR MOST DIP PACKAGES
- UPGRADES BY FLOPPY

SOFTWARE FEATURES
- MENU DRIVEN
- FLEXIBLE FILE LOADING (HEX, BINARY, JEDEC)
- READS, VERIFIES, BLANK CHECKS, BIT TESTS, OVER-PROGRAMMES AND AUTO-PROGRAMMES
- CAN MODIFY PARAMETERS OF EXISITING MEMORY DEVICES AND STORE IN USER DATABASE
- HANDLES SECURITY FEATURES OF ALL DEVICES
- AUTOMATIC PAL TO GAL CONVERSIONS
- FULL BUFFER EDITING CAPABILITIES
- TEST VECTOR SUPPORT



SPEEDMASTER 1000
- LOW COST, UNIVERSAL PROGRAMMER
- EPROMS, EEPROMS, FLASH EPROMS, NVRAMS, SERIAL EEPROMS, PALS, GALS, PEELS, EPLDS
- SUPER FAST PROGRAMMING e.g 27C256 (32kx8) IN 4.5 Seconds
- JEDEC TEST VECTOR SUPPORT FOR PALS
- INCLUDES PAL DEVELOPMENT SOFTWARE
- UP TO 40 PIN DIPS WITHOUT ADAPTORS

£395

MICROMASTER 1000
- ALL FUNCTIONS OF SPEEDMASTER 1000
- MICROCONTROLLERS FROM T.I (including TMS370 SERIES, TMS77C82), INTEL, ZILOG, MICROCHIP (PICS), MOTOROLA, PHILIPS AND OTHERS

£550

SPEEDMASTER 8000
- 8 WAY GANG/SET PROGRAMMER
- MASTER SOCKET
- EPROMS, EEPROMS, FLASH EPROMS
- UP TO 32 PIN
- PC OR STAND ALONE MODE
- SUPER FAST PROGRAMMING e.g. 8x27c256 (32Kx8) IN 6 Seconds

£595

Prices exclude VAT & delivery

ICE TECHNOLOGY

VISA

ICE TECHNOLOGY LTD UNIT 4, PENISTONE COURT, STATION BUILDINGS, PENISTONE, SOUTH YORKSHIRE S30 6HG

TEL (+44) 0226 767404 FAX (+44) 0226 370434

CIRCLE NO. 135 ON REPLY CARD

CRICKLEWOOD ELECTRONICS LTD

NEW 1992 CATALOGUE

SEND NOW FOR THE

CRICKLEWOOD ELECTRONICS LTD

COMPONENT CATALOGUE. ONE OF THE BEST RANGES AVAILABLE

NAME
ADDRESS

PLEASE SEND ______ COPIES OF CRICKLEWOOD ELECTRONICS CATALOGUE at £2.00 EACH. PLEASE MAKE CHEQUES OUT TO CRICKLEWOOD ELECTRONICS ETC

CRICKLEWOOD ELECTRONICS LTD, 40 CRICKLEWOOD BROADWAY LONDON NW2 3ET. TEL 081 450 0995, 081 452 0161 FAX 081 208 1441

CIRCLE NO. 122 ON REPLY CARD

COMMERCIAL QUALITY VHF/UHF RECEIVER

The IC-R7000, advanced technology, continuous coverage communications receiver has 99 programmable memories covering aircraft, marine, FM broadcast, Amateur radio, television and weather satellite bands. For simplified operation and quick tuning the IC-R7000 features direct keyboard entry. Precise frequencies can be selected by pushing the digit keys in sequence of the frequency or by tuning the main tuning knob FM wide/FM narrow/AM upper and lower SSB modes with 6 tuning speeds: 0.1, 1.0, 5, 10, 12.5 and 25kHz. A sophisticated scanning system provides instant access to the most used frequencies. By depressing the Auto-M switch the IC-R7000 automatically memorises frequencies in use whilst it is in the scan mode, this allows you to recall frequencies that were in use. Readout is clearly shown on a dual-colour fluorescent display. Options include the RC-12 infra-red remote controller, voice synthesizer and HP-2 headphones.

ICOM

Post to: Icom (UK) Ltd. Dept WW Sea Street Herne Bay Kent CT6 8LD Tel:0227 741741 (24hr). Fax: 0227 360155

10

Name/address/postcode ....

....

Call sign:.................. Tel: .... Dept: WW

CIRCLE NO. 123 ON REPLY CARD

Surplus always wanted for cash!

THE *ORIGINAL* SURPLUS WONDERLAND!

Surplus always wanted for cash!

BBC Model B APM Board

WIN £100 CASH!

£100 CASH FOR THE MOST NOVEL DEMONSTRATABLE APPLICATION!

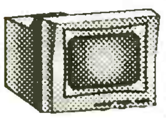
BBC Model B type computer on a board. A major purchase allows us to offer you the **PROFESSIONAL** version of the BBC computer at a parts only price. Used as a front end graphics system on large networked systems the architecture of the BBC board has so many similarities to the regular BBC model B that we are sure that with a bit of experimentation and ingenuity many useful applications will be found for this board!! It is supplied complete with a connector panel which brings all the I/O to 'D' and BNC type connectors - all you have to do is provide +5 and ± 12 v DC. The APM consists of a single PCB with most major ic's socketed. The ic's are too numerous to list but include a 6502, RAM and an SAA5050 teletext chip. Three 27128 EPROMS contain the custom operating system on which we have no data. On application of DC power the system boots and provides diagnostic information on the video output. On board DIP switches and jumpers select the ECONET address and enable the four extra EPROM sockets for user software. Appx. dims: main board 13" x 10". I/O board 14" x 3". Supplied tested with circuit diagram, data and competition entry form.

Only £29.95 or 2 for £53 (B)

MONITORS

MONOCHROME MONITORS

THIS MONTH'S SPECIAL!



There has never been a deal like this one! **Brand spanking new & boxed** monitors from NEC, normally selling at about £140! These are over-engineered for ultra reliability. 9" green screen composite input with etched non-glare screen plus switchable high/low impedance input and output for daisy-chaining. 3 front controls and 6 at rear. Standard BNC sockets. Beautiful high contrast screen and attractive case with carrying ledge. Perfect as a main or backup monitor and for quantity users! **£39.95 each** (D) **or 5 for £185**(G)

CALL FOR DISCOUNTS ON HIGHER QUANTITIES!

COLOUR MONITORS

Decca 16" 80 budget range colour monitor. Features a PIL tube, beautiful teak style case and guaranteed 80 column resolution, features usually seen only on colour monitors costing 3 times our price! Ready to connect to most computers or video outputs. 75Ω composite input with integral audio amp & speaker. Fully tested surplus, sold in little or hardly used condition with 90 day full RTB guarantee. Ideal for use with video recorder or our Telebox ST, and other audio visual uses. £99(E) 3/£275(G)

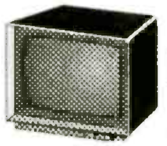
20", 22" and 26" AV SPECIALS

Superbly made UK manufacture. PIL all solid state colour monitors, complete with composite video & sound inputs. Attractive teak style case. Perfect for Schools, Shops, Disco, Clubs. In EXCELLENT little used condition with full 90 day guarantee.

20"....£135 22"....£155 26"....£185 (F)

CALL FOR PRICING ON NTSC VERSIONS!

HI-DEFINITION COLOUR MONITORS



Brand new 12" multiinput high definition colour monitors by Microvitek. Nice tight 0.31" dot pitch for superb clarity and modern metal black box styling. Operates from any 15.625 khz sync RGB video source, with either individual H & V syncs such as CGA IBM PC's or RGB analog with composite sync such as Atari, Commodore Amiga, Acorn Archimedes & BBC. Measures only 14" x 12" square. Free data sheet including connection information. Will also function as quality TV with our RGB Telebox.

Only **£145** (E)

Brand new Centronic 14" monitor for IBM PC and compatibles at a lower than ever price! Completely CGA equivalent. Hi-res Mitsubushi 0.42 dot pitch giving 669 x 507 pixels. Big 28 Mhz bandwidth. A super monitor in attractive style moulded case. Full 90 day guarantee. Only **£129** (E)

NEC CGA IBM-PC compatible. High quality ex-equipment fully tested with a 90 day guarantee. In an attractive two tone ribbed grey plastic case measuring 15"L x 13"W x 12"H. A terrific purchase enables us to pass these on at only.... **£79** (E)

V22 1200 BAUD MODEMS

Master Systems 2/12 microprocessor controlled V22 full duplex 1200 baud modem. Fully **BT approved** unit, provides standard V22 high speed data comm, which at 120 cps, can save your phone bill and connect time by a staggering 75%! Ultra slim 45 mm high. Full featured with LED status indicators and remote error diagnostics. Sync or Async use; speech or data switching; built in 240v mains supply and 2 wire connection to BT. Units are in used but good condition. Fully tested prior despatch, with data and a full 90 day guarantee. What more can you ask for - and at this price!! ONLY £69 (D)

IBM KEYBOARD DEALS

A replacement or backup keyboard, switchable for IBM PC, PC-XT or PC-AT. LED's for Caps, Scroll & Num Locks. Standard 84 keyboard layout. Made by NCR for the English & US markets. Absolutely standard. Brand new & boxed with manual and key template for user slogans on the function keys. Attractive beige, grey and cream finish, with the usual retractable legs underneath. A generous length of curly cord, terminating in the standard 5 pin DIN plug. A beautiful clean piece of manufacturers surplus. What a deal! £39 (B) 5/£175 (D)

Brand new and boxed 84 key PC/XT type keyboards in standard IBM grey with very attractive mottled finish and "clicky" solid feel keys. 10 function keys on side. English layout and £ sign. Green LEDs for Caps, Scroll & Num locks. £29.95 (B) 5/£135 (D)

CALL FOR DISCOUNTS ON HIGHER QUANTITIES!

FLOPPY DISK DRIVES BARGAINS GALORE !

NEW 5¼ inch from £29.95!

Massive purchases of standard 5¼" drives enables us to present prime product at industry beating low prices! All units (unless stated) are removed from often brand new equipment and are fully tested, aligned and shipped to you with a 90 day guarantee and operate from +5 & +12vdc, are of standard size and accept the standard 34 way connector.

TANDON TM100-2A IBM compatible DS £39.95(C)
CANON, TEC etc. DS half height. State 40 or 80T £79.00(C)
TEAC FD-55-F. 40-80 DS half height. BRAND NEW £79.00(C)

Specials!

TEAC FD-55 half height series in your choice of 40 track double sided 360k or 80 track double sided 720k. Ex-equipment fully tested in excellent condition with 90 day warranty. Order TE-36 for 360k £29.95(C) or TE-72 for 720k £39.95(C)

CHOOSE YOUR 8 INCH!

Shugart 800/801 SS refurbished & tested £150.00(E)
Shugart 851 double sided refurbished & tested £225.00(E)
Mitsubishi M2894-63 double sided switchable hard or soft sectors- BRAND NEW £250.00(E)

SPECIAL OFFERS!!

Dual 8" drives with 2 megabyte capacity housed in a smart case with built in power supply! Ideal as exterior drives! **Only £499.00** (F)

End of line purchase scoop! Brand new NEC D2246 8" 85 megabyte of hard disk storage! Full CPU control and industry standard SMD interface. Ultra hi speed transfer and access time leaves the good old ST506 interface standing. In mint condition and comes complete with manual. Only....£399(E)

AFFORDABLE 10 Mb WINCHESTERS

A fantastic deal - 10mb (formatted) Winchester for £39.95! **Tandon TM502** full height ST506 interface. Use it as a second hard drive on your present driver card or as a starter into Winchester land - see the driver card listed below. In excellent used condition, guaranteed for 90 days....£39.95(C)
Hard disk driver card, complete with cables ready to plug into your PC or compatible. Supports two Winchesters......£29.95(A)

No Break Uninterruptable PSU's

Brand new and boxed 230 volts uninterruptable power supplies from **Densei**. Model MUK 0565-AUAF is 0.5 kva and MUD 1085-AHBH is 1 kva. Both have sealed lead acid batteries. MUK are internal, MUD has them in a matching case. Times from interrupt are 5 and 15 minutes respectively. Complete with full operation manuals..........MUK.....£249 (F) MUD.....£525 (G)

RECHARGEABLE BATTERIES

LEAD ACID

Maintenance free sealed long life. Type A300.

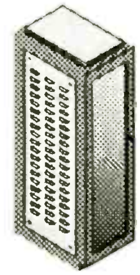
12 volts 12 volts 3 amp/hours £13.95(A)
6 volts 6 volts3 amp/hours £ 9.95(A)
12 volts Centre tapped 1.8 amp hours. RFE. £ 5.95(A)
12 volts 12 volts 38 amp hours.7-1/2"L x6"S.RFE £35.00(B)

EXTRA HI-CAPACITY NICKEL CADMIUM

Super high capacity **Chloride Alcad** 12 volts refillable type XL1.5. Electrolyte is readily available Potassium Hydroxide. In banks of 10 cells per 8"H x 24"L x 5.5"D wooden case. Each cell measures 8"H x 1.75"L x 4"D. Can be easily separated. Ideal for all standby power applications. Ex MoD, like new..£49.95 (E)

SPECIAL INTEREST

Newton Derby frequency changer 3 phase 50hz to 3 phase 400hz. 15 kva output. As new. £2900
Trio 0-18 vdc bench PSU. 30 amps. New £ 470
Fujitsu M3041 600 LPM band printer £2950
DEC LS/02 CPU board £ 150
Rhode & Schwarz SBUF TV test transmitter 25-1000mhz. Complete with SBTF2 Modulator £6500
Calcomp 1036 large drum 3 pen plotter £ 650
Thurlby LA 160B logic analyser £ 375
1.5kw 115v 60hz power source £ 950
Tektronix R140 NTSC TV test signal standard. £ 875
Sony KTX 1000 Videotex system - **brand new** £ 650
ADDS 2020 VDU terminals - **brand new** £ 225
Sekonic SD 150H 18 channel Hybrid recorder £2000
Trend 1-9-1 Data transmission test set £ 525
Kenwood DA-3501 CD tester, laser pickup simulator £ 350



Superb Quality 6 foot 40u

19" Rack Cabinets

Massive Reductions Virtually New, Ultra Smart! *Less Than Half Price!*

Top quality 19" rack cabinets made in UK by Optima Enclosures Ltd. Units feature designer, smoked acrylic lockable front door, full height lockable half louvered back door and removable side panels. Fully adjustable internal fixing struts, ready punched for any configuration of equipment mounting plus ready mounted integral 12 way 13 amp socket switched mains distribution strip make these racks some of the most versatile we have ever sold. Racks may be stacked side by side and therefore require only two side panels or stand singly. Overall dimensions are 77-1/2"H x 32-1/2"D x 22"W. Order as:

Rack 1 Complete with removable side panels......£275.00 (G)
Rack 2 Less side panels..........£145.00 (G)

POWER SUPPLIES

Power One SPL200-5200P 200 watt (250 w peak). Semi open frame giving +5v 35a, -5v 1.5a, +12v 4a (8a peak), -12v 1.5a, +24v 4a (6a peak). All outputs fully regulated with over voltage protection on the +5v output. AC input selectable for 110/240 vac. Dims 13" x 5" x 2.5". Fully guaranteed RFE. £85.00 (B)

Power One SPL130. 130 watts. Selectable for 12v (4A) or 24 v (2A). 5v @ 20A. ± 12v @ 1.5A. Switch mode. New. £59.95(B)

Astec AC-8151 40 watts. Switch mode. +5v @ 2.5a. +12v @ 2a. -12v @ 0.1a. 6-1/4" x 4" x 1-3/4". New £19.95(B)

Greendale 19AB0E 60 watts switch mode.+5v @ 6a,±12v @ 1a,+15v @ 1a. RFE and fully tested. 11 x 20 x 5.5cms. £24.95(C)

Conver AC130. 130 watt hi-grade VDE spec. Switch mode. +5v @ 15a, -5v @ 1a, ±12v @ 6a. 27 x 12.5 x 6.5cms. New. £49.95(C)

Boshert 13090. Switch mode. Ideal for drives & system. +5v @ 6a, +12v @ 2.5a, -12v @ 0.5a, -5v @ 0.5a. £29.95(B)

Farnell G6/40A. Switch mode. 5v @ 40a. Encased £95.00(C)

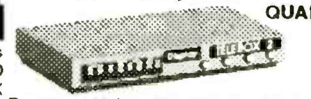
COOLING FANS

Please specify 110 or 240 volts for AC fans.

3 inch	AC. 1½" thick	£ 8.50(B)
3½ inch	AC ETRI slimline. Only 1" thick.	£ 9.95(B)
3 1/2 inch	AC 230 v 8 watts. Only 3/4" thick	£12.95(A)
4 inch	AC 110/240v 1½" thick.	£10.95(B)
10 inch	AC round. 3½ thick. Rotron 110v	£10.95(B)
10 inch	As above but 230 volts	£24.95(B)
60 mm	DC 1" thick. No.812 for 6/12v. 814 24v.	£15.95(A)
80 mm	DC 5 v. Papst 8105G 4w. 38mm. RFE.	£19.95(A)
92 mm	DC 12v. 18 mm thick.	£14.95(A)
4 inch	DC 12v. 12w 1½" thick	£12.50(B)
4 inch	DC 24v 8w. 1" thick.	£14.50(B)

THE *AMAZING* TELEBOX!

Converts your colour monitor into a QUALITY COLOUR TV!!



TV SOUND & VIDEO TUNER!

Brand new high quality, fully cased, 7 channel **UHF PAL TV** tuner system. Unit simply connects to your TV aerial socket and colour video monitor turning same into a fabulous colour TV. Dont worry if your monitor does'nt have sound, the TELEBOX even has an integral audio amp for driving a speaker plus an auxiliary output for Headphones or Hi Fi system etc. Many other features: LED Status indicator, Smart moulded case, Mains powered, Built to BS safety specs. Many other uses for TV sound or video etc. Supplied BRAND NEW with full 1 year guarantee.

Telebox ST for composite video input monitors........£32.95(B)
Telebox STL as ST but with integral speaker..........£36.50(B)
Telebox RGB for analogue RGB monitors...............£68.95(B)

RGB Telebox also suitable for IBM multisync monitors with RGB analog and composite sync. Overseas versions VHF & UHF call. SECAM / NTSC not available.

BRAND NEW PRINTERS

TEC Starwriter Model FP1500-25 daisywheel printer renowned for its reliability. Diablo type print mechanism gives superb registration and quality. On board microprocessor gives full Diablo/Oume command capability. Serial RS-232C with full handshake. Bidirectional 25 cps, switchable 10 or 12 pitch, 136 cpl in Pica, 163 in Elite. Friction or tractor feed. Full ASCII including £ sign. Font and ribbon Diablo compatible........£199(E)

DED DPG21 miniature ball point pen printer plotter mechanism with full 40 characters per line. Complete with data sheet which includes circuit diagrams for simple driver electronics......£49(B)

Centronics 150 series. Always known for their reliabilty in continuous use - real workhorses in any environment. Fast 150 cps with 4 fonts and choice of interfaces at a fantastic price!

150-4 Serial up to 9.5" paper, fan fold tractor..............£ 99.00(E)
150-4 Serial up to 9.5" paper, tractor, roll or s/sheet......£129.00(E)
152-2 parallel up to 14.5" paper, tractor or s/sheet.......£149.00(E)

CALL FOR THE MANY OTHERS IN STOCK.

VISIT OUR SHOP FOR BARGAINS

LARGE QUANTITIES OF OSCILLOSCOPES AND TEST GEAR ALWAYS AVAILABLE - CALL NOW!

DISPLAY -ELECTRONICS-

MAIL ORDER & OFFICES Open Mon-Fri 9.00-5.30 Dept WW, 32 Biggin Way, Upper Norwood, London SE19 3XF.

LONDON SHOP 100's of bargains! Open Mon-Sat 9-5.30 215 Whitehorse Lane, South Norwood, London, SE25 .

DISTEL © The Original Free dial-up database! 1000's of items+info On Line V21, V22 & V22 bis 081-679-1888

ALL ENQUIRIES 081-679-4414 Fax- 081-679-1927 Telex- 894502

All prices for UK Mainland. UK customers add 17.5% VAT to TOTAL order amount. Minimum order £10. PO orders from Government, Universities, Schools & Local Authorities welcome-minimum account order £25. Carriage charges (A)=£2.00. (B)=£5.50. (C)=£8.50. (D)=£11.50. (E)=£14.00 (F)=£18.00 (G)=Call . All goods supplied subject to our standard Conditions of Sale and unless otherwise stated guaranteed for 90 days. All guarantees on a return to base basis. We reserve the right to change prices & specifications without prior notice. Orders accepted subject to stock. Quotations willingly given for higher quantities than those stated. Bulk surplus always required for cash.

CIRCLE NO. 129 ON REPLY CARD

ACTIVE

Asic

Gate array asics. The CE31 series of gate-array asics has a complexity of up to 200,000 gates. They are cmos embedded gate arrays using a 0.8µm sea of gates array and 8µm standard cell series; both methods are used on the chip. Applications include system integration of microprocessors and peripherals in industrial environments, telecommunications products, and data processing. Compilable circuits can be configured and verified as hard macros using module compilers. Fujitsu Microelectronics, 0628 76100.

Triple-metal masters. Two triple-metal masters have been added to the TC160G series of gate arrays. These achieve maximum usable gate counts of 210,000 using 0.8µm hc^{2}mos technology. The usable gate figure is based on 70% gate utilisation compared with 40% for double-layer metal masters. The arrays are supported by a library of about 1000 macrocells as well as megacells for ram and rom. Toshiba Electronics, 0276 694600.

A-to-D & D-to-A converters

10bit. The SPT7820 and SPT7824 monolithic 10bit converters have sampling rates of 20 and 40Msample/s respectively. They are suited to medical and industrial imaging and have TTL compatible inputs and outputs. There is a fully integrated track and hold on the same monolithic die whereby input signals of up to 10MHz can be sampled. Ambar Cascom, 0296 434141.

12bit. The AD7233 and AD7243 12bit converters are for process control, calibration circuits, DSP based systems, and general I/O subsystems. With an internally connected 5V reference, twos-complement data format, and single output range of ±5V, the AD7233 is suitable for bipolar zero-centred process control applications. It can have internal or external reference connections, offset binary or twos-complement data format. Analog Devices, 0932 232222.

8bit. The DAC8840 and DAC8841 TrimDacs are 8bit octal multiplying D-to-A converters for replacing mechanical potentiometers for automatic microprocessor adjustments of AC and DC voltage gain. Eight independent channels of digitally programmable signal-level attenuation provides 256 values of unipolar or bipolar gain (two or four quadrant multiplications) for DC to 1MHz analogue signal inputs. Each buffered channel can provide a minimum 5mA of output drive current. Analog Devices, 0932 232222.

12bit. The HI5800 is a 3Msample/s 330ns 3MHz monolithic 12bit A-to-D converter. The 10,000-transistor chip has an on-chip voltage reference and sample and hold that samples below 1µs and converts above 1MHz. Distortion is 72dB. It contains a buffered sample and hold amplifier, precision temperature and curvature corrected bandgap voltage reference (2.5V ratio metric), two-step subranging A-to-D with 7bit flash and 7bit D-to-A with digital error correction, control logic, and timing generator. It can also be driven by a 2.5V external reference. Harris Semiconductor, 0276 686886.

Linear integrated circuits

Battery back-up. Battery back-up IC S8420 has been added to the Seiko range of low power linear ICs. It is for switching circuits of main and back-up power supplies in hand-held or battery powered equipment, and consists of a voltage regulator, three voltage detectors, a power alteration switch, and a control circuit. Amega Electronics, 0256 843166.

Audio preamp. SSM2017 integrated microphone preamplifier replaces discrete solutions made from up to 20 passive components, four transistors and an op amp. It is housed in an 8-pin minidip and needs a resistor for setting gains between unity and 1000. Input noise is specified at 950pV√Hz at 1kHz. Total harmonic distortion is typically 0.01% from 20Hz to 20kHz at 100 gain. Output signals of 100V RMS can be driven into low load impedance without significant degradation of performance. Analog Devices, 0932 232222.

Bipolar op amps. OPA177 and OPA77 precision bipolar op amps have laser trimmed offset, drift and input bias current. Input offset voltage is 4µV typical, 10µV maximum, at 25°C, with minimum drift specified at 0.1µV/°C across the -40 to +85°C range. Typical unloaded power consumption is 40mW and typical input bias current 0.3nA. Open loop gain is 134dB minimum and common mode rejection ratio is at least 130dB. Noise voltage is 85nV RMS referred to the input, and closed loop unity-gain bandwidth is typically 600kHz. The inputs are protected against up to ±30V differential inputs by 500Ω series input resistors and diode clamps. Burr-Brown International, 0923 33837.

Feedback amp. A precision voltage feedback amplifier, the EL2075, has a 2GHz gain-bandwidth product, settling time of 13ns to 0.1%, and a minimum of 50mA output drive current over temperature. It is gain-of-ten stable with a -3dB bandwidth of 400MHz at an Av of +10.Input offset voltage is 200µV and input bias current 2µA. It is available in 8-pin dip, eight-lead SO, and 8-pin military cerdip. Elantec, 071-482 4596.

Monolithic amp. EL2044 is a monolithic amplifier, operating from a single 2.5V supply. It is designed to drive low impedance loads where it can drive a 6V peak-to-peak signal into a 150Ω load. It can also drive unlimited load capacitances and, because of its conventional voltage feedback topology, can be used with reactive or nonlinear elements in its feedback network. It is unity gain stable and has a 325V/µs slew rate and 60MHz gain-bandwidth product. Elantec, 071-482 4596.

Supervisory circuit. A microprocessor supervisory circuit includes a conditional battery back-up feature for ram data and has a guaranteed reset assertion down to 1V, preventing microprocessor malfunction at low supply voltages. Chip enable gating on the LTC1235 is 35ns maximum and supply current is 1.5mA maximum. It is supplied in a 16-pin SO or dil package. Linear Technology, 0932 765688.

Battery-charger IC. U2400B offers three programmable charging times of 30min, 1h or 12h with subsequent automatic trickle charging. It also provides an automatic predischarge facility for NiCd cells to ensure complete discharge before recharging. Two independent charging interrupts protect batteries from damage due to overvoltage and over-temperature conditions. An integral PWM comparator ensures batteries of different capacities can be accommodated. Telefunken Electronic, 0635 30905.

Memory chips

2Mbit sram. 8F8259C 2Mbit cmos sram is organised as 256K by 8bit. It is based on two 256K by 4bit srams mounted on a multi-layered epoxy laminate FR4 substrate and has access times from 20 to 55ns. The 32-pin 0.6in DIP pinout adheres to the Jedec standard. All inputs and outputs are TTL compatible and operate from a single 5V supply. Electronic Designs, 0276 72637.

In the hand: Harris' laser diode and photodiode.

32Kbit fifo. PDSP16540 fifo, configured as 1K by 32bit, is designed to extend capabilities of the PDSP16510 FFT. It can be used as a flexible data reservoir in any DSP system. Up to 40MHz data read and 16MHz data write rates can be sustained. Words, read as a complete block, can be programmed in multiples of 32 up to a maximum of 1024. GEC Plessey Semiconductors, 0793 518000.

128bit eeprom. X24C00 is a 128bit cmos serial eeprom organised as 16 by 8bit and made by Xicor using textured poly floating gate technology. It has a serial interface and software protocol allowing operation on a two-wire bus at a 1MHz clock rate. Available in an eight-pin minidip or SOIC package at commercial and industrial temperature ranges. Micro Call, 0844 261939.

1Mbit dram. The MT4C4256H is a 3.3V low-power extended refresh dram in a 256K by 4bit configuration. It is aimed at the 3.3V flat-panel controllers used in low-voltage laptop and notebook computers. Typical standby current is 0.1mW and typical active current is 100mW. Refresh rate specification is extended from 8 to 64ms. Low battery back-up current has a maximum specification of 90µA. Micron Technology, 0344 360055.

16Kbit fram. Ramtron FM1408 ferroelectric ram, organised as 2K by 8bit, gives equal read and write cycle times with 150ns maximum read access. From a single 5V supply it consumes 44mW operating and 55µW standby. All input and output pins are cmos/TTL compatible. Standard 28-pin package. Pin one switches between dynamic and nonvolatile modes. Mogul Electronics, 0732 741841.

1Mbit sram. Three families of 1Mbit srams including versions with 12ns access times are based on 0.7µm microlithographic technology and have a bicmos structure. They are available in single-outline J-lead and DIP packages. TC55B4257 is a 32-pin 256K by 4bit unit; TC55B4256 is a 28-pin 256K by 4bit unit, and the TC55B812 is a 32-pin 128K by 8bit unit. Toshiba Electronics, 0276 694600.

Microprocessors and controllers

Z80 Microcontroller. FEM180 microcontroller, incorporating the Z80180 CPU, offers an interface providing 48 digital I/O lines and three serial ports, 32K sram and 32K eprom. It comes with a firmware monitor for program development using a PC or dumb terminal. FES180 support card has PSU, 24 8mA drivers, six 5mA drivers, DPCC relay, and space for two extra cards. RS232, RS485 and 20mA current loop interface circuits provide communications. Fernwood Electronics, 04917 8898.

8bit microcontroller. OLMS65K single-chip 8bit microcontroller has internal rom capacities from 4 to 64Kbyte and external memory capability of 64Kbyte. Instruction cycles are 400ns with 10MHz clocks and current consumption is typically less than 25mA. Most devices in the family have 16bit capture and compare registers for high precision timer measurements and one device has an 8bit eight-channel A-to-D converter. Highland Electronics, 0444 236000.

Optical devices

Laser and photo diodes. HL1325CF laser diode and HR1105CR photodiode operating temperature range is -20 to +70°C. The laser diode consists of a 1.3µm Fabry-Perot diode in a miniature coaxial package with a single-mode fibre pigtail. It gives a kink free optical output of 0.3mW at ambient 70°C. Photodiode is an InGaAs pin unit in a miniature coaxial package with a multimode fibre pigtail. Photosensitive aperture is 80µm. Optical sensitivity is 0.78A/W at 1.3µm. Hitachi Europe, 0628 585000.

SM led. A high brightness surface-mount led, called Topled, based on the Tantal-B capacitor package, incorporates an internal reflector to increase the on-axis brightness to a level comparable with standard leaded leds. Colours are standard red, orange, yellow, green and hyper red. Versions are also produced using single and double heterojunction GaAlAs die giving high brightness red leds with typical on-axis intensity of 20mcd at 10mA, emission half angle of ±60°. Siemens, 0932 752323.

In the rocks: OLMS65K 8bit microcontroller from Highland Technology.

Laser diode. SLD1301XT visible laser diode has an optical output of 100mW and a nominal wavelength of 670nm. It comes with a thermoelectric cooler and thermistor housed in a 20 by 33mm flat package. 2.5V drawing 600mA under typical operating conditions. Typical threshold current is 450mA. Temperature range from -10 to +30°C. Sony Components & Computer, 0784 466660.

Programmable logic arrays

PLA pair. Two programmable logic array devices are claimed to match the speed of the fastest PAL chips without the architectural limitations of current PAL parts. With propagation delays of 10ns, the Plus153-10 and 173-10 are for high speed I/O and memory address decode functions in PCs and workstations as well as memory and address mapping applications, specialised arithmetic functions, code conversions, and data manipulation. Signetics, 0101 408 991 2000.

Power semiconductors

SCSI regulator. LT1117-2.85 is a 2.85V low drop out regulator for use in active terminations for the SCSI standard. It provides a regulated output of 2.85V ±1% from the SCSI termpower supply. Output current is 800mA. It comes in a SOT223 package and operates down to 1V drop out voltage. Quiescent current is 10mA maximum. It handles fault conditions with short-circuit current limiting, thermal shutdown, and on-chip ESD protection. Linear Technology, 0932 765688.

Quad drivers. Two quad RS485 drivers have maximum supply currents 300 times lower than earlier RS485 drivers. The LTC486 is a pin-compatible replacement for the SN75172, DS96172 and 96F172. And the LTC487 replaces the SN75174, DS9G174 and DS96F174. They draw a maximum 200µA of supply current and support data transmission rates up to 10Mbaud. They operate from a single 5V supply and can handle -7 to +12V common mode range on the bus. Linear Technology, 0932 765688.

Power IC. The TPIC2801 is a monolithic intelligent power IC with eight 1A/30V outputs each configured as a low side switch. The eight switches are controlled from a single input by an 8bit serial word. Each of the eight drivers in the 30V device has a 40mJ rating and can drive up to a 30V 1A load. The presence of a 35V collector base clamp on each switch eliminates the need for external clamp diodes when switching inductive loads. Texas Instruments, 0234 223252.

Quad driver. The TPIC2404 is a monolithic quad 1A low side driver for switching peripheral loads such as relays, motors, solenoids, and other loads requiring up to 45V supply voltage. Each of its four 1A power outputs has overvoltage, over-temperature, and current limiting protection. It comes in a 15-pin 25W sip and is specified for the -40 to +125°C range. Texas Instruments, 0234 223252.

Quad mosfet. The TPIC2406 quadruple mosfet latch is for high power load applications and contains four self-protecting low-side switches with output clamp diodes for inductive transient protection. Each open drain output can drive a continuous output current of 700mA while operating from voltages as high as 60V. Pulsed current outputs up to 3A per channel are possible because of the 0.5Ω driver output resistance. It can also be cascaded to deliver a peak output current of 12A. Texas Instruments, 0234 223252.

PASSIVE

Passive components

Ceramic caps. The Capax parallel plate ceramic microwave capacitors are designed for minimum insertion loss at frequencies up to 40GHz. They range in size from 0.01 by 0.01in to 0.1 by 0.1in with a thickness of 0.005in for 50V and 0.007in for 100V DC specification. There are 14standard dielectrics available and capacitances range from 0.05 to 1500pF. They work from -55 to +125°C. Anglia Microwaves, 0277 630000.

Voltage suppressors. Ten passive devices, with maximum continuous voltage ratings from 3.5 to 69V DC, have been added to the ML multilayer series of surface mount transient voltage suppressors. Applications include logic protection (3.5 to 5.5V), automotive (14 to 18V), computer communications such as RS232 (26V), and telecom line cards using high voltage DC analogue (33 to 68V). As well as being fully bidirectional, they are up to six times smaller than Zeners and need no derating for operation at 125°C. Harris Semiconductor, 0276 686886.

Electrolytic caps. For use in switching power supplies, the PQ series of electrolytic capacitors has a load life of 160,000h at 55°C. Impedance is 0.16Ω minimum and temperature range is from -55 to +105°C. Working voltage range is 6.3 to 50V DC and capacitance range from 0.47 to 390µF, ±20% tolerance. Allowable ripple is 460mA maximum and leakage current 4µA. The radial lead units range in size from 5 by 1mm to 8 by 11.5mm. Nichicon, 0276 685393.

Electrolytic caps. For Hi-Rel and high ripple current (2.1 to 30.5A) applications, the NR series of electrolytic capacitors has a load life of 40,000h at 55°C. The screw terminal units have can sizes from 35 by 80mm to 90 by 190mm, operating temperatures from -40 to +85°C (16 to 100V) and -25 to +85°C (160 to 450V), capacitances from 470 to 470,000µF, tolerance 20%, and leakage current 5mA. Nichicon, 0276 685393.

Current limiters. Added to the NTC surge protector range are 13mm diameter metal oxide in-rush current limiters. They are available with cold resistances of 5 to 16Ω and with steady state currents of 3 to 5A. Applications include halogen lamps and transformers. Power Development, 0823 335200.

Connectors and cabling

IDC connectors. The UL approved Harting SEK18 series of IDC flat cable connectors have from 6 to 64 contacts. The male headers have angle and straight pins in lengths of 2.9, 4.5 and 15mm. Grid pattern for the male connector is 2.54mm and for the female 1.27mm. Current rating is 1A, contact resistance 20mΩ, and operating temperature -55 to 125°C. Gothic Crellon, 0734 788878.

Zif connector. A compact zero insertion force connector is totally self contained with no manual actuation mechanism. Called DL Drawer, it uses the movement of the drawer or subassembly to mate and unmate the connector halves. It has been tested to withstand 100,000 mating cycles and comes with crimp contacts, wire wrap or solder tails. It can be used for PCB, cable or flat-flex terminations and uses gold over nickel plated copper alloy contacts. ITT Cannon, 0256 473171.

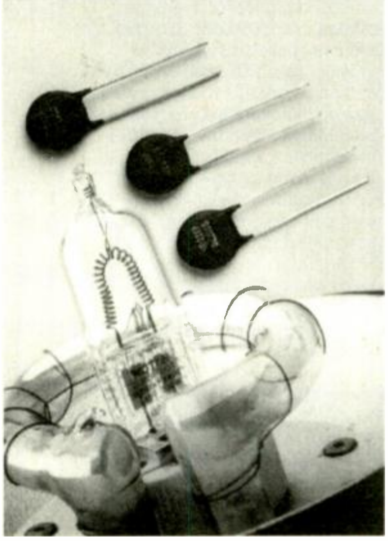
Displays

Plasma display. The FPF8050HRUC-001 is a 10in AC gas discharge plasma display with a 640 by 400pixel resolution matrix with dots of 0.33mm pitch. Typical brightness is 150cd/m^2, contrast ratio exceeds 20:1, and viewing angle is 160°. Service life without reduction in brightness is 50,000h. It can be used as a flat-screen CRT replacement or in infra-red touch sensitive screen overlay systems. Fujitsu Microelectronics, 0628 76100.

Hardware

PC chassis. The Armagard Pro-chassis lets custom computer systems be built using IBM PC compatible motherboards and backplanes. It comprises an outer enclosure, front and rear card supports, shock-proof card clamps, and ventilated disc drive housings for 3.5 and 5.25in drives. Minor panel work will allow ticket printers, keypads and screens to be incorporated. It can be desk or 19in rack mounted. Intek Electronics, 0352 85603.

In the rush: NTC inrush current limiters from Power Development.



Fan. The Shicoh 0410N-12 40 by 40 fan is 10mm deep and delivers 4.24cfm at a noise level of 26dB. It has UL approval for flame resistance and class E insulation. The DC brushless axial fan also has full protection against burn-out and short-term polarity reversal. It works from a 12V DC supply, consumes 1.08W, and has a 30,000h life span. Key Electronic Components, 0734 351546.

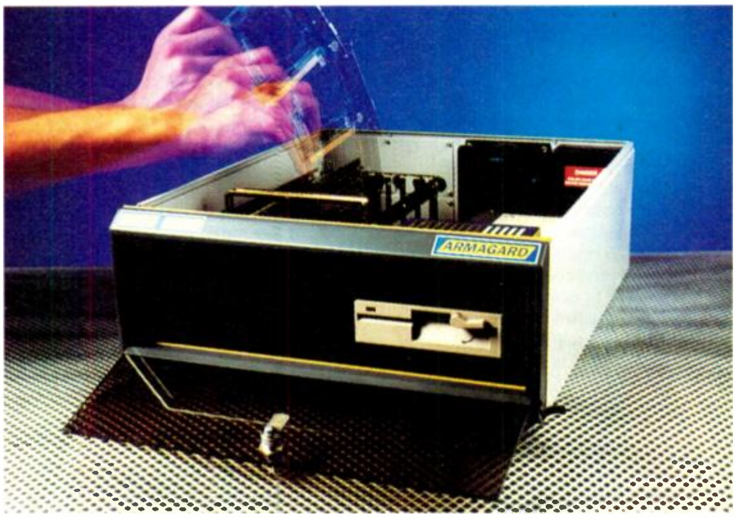
Instrumentation

Analogue multimeter. The Circuitmate AM12 analogue multimeter uses fet technology to prevent loading the circuit under test thus giving error free readings. It incorporates a 115mm mirror scale for parallax-free readings and RMS, peak-to-peak and dB scales are provided for AC voltages. A centre-zero scale and adjustment is provided for AC and DC voltage measurements. AC and DC current and voltage measurements are to 12A and 1.2kV. Beckman Industrial, 0384 442394.

RF wattmeters. The Thruline range of 2 to 1000MHz 250W to 250kW ±5% wattmeters are rectangular 4 by 4.5in multiscale glass plate meters with 50Ω line section and 10ft of shielded interconnect cable. The carrying case provides storage sockets for extra plug-in items. They are also available as panel meters for 19in rack mounting. Bird Electronic, 0101 216 248 1200.

50MHz scope. The 50MHz V525 and VC6024 are combined real-time and digital storage oscilloscopes. The portable V525 is mains operated with DC offset and alternative magnifier functions. Stable triggering is possible on both channels even if the channel frequencies differ. The VC6024 has a repetitive signal sampling rate of 20Msample/s, two channel alternate, or 100Ksample/s, two channel chopping. Memory capacity is 2Kword on both channels at 50µs/div to 50s/div and 1Kword at 50ns/div to 2µs/div. Hitachi Denshi, 081-202 4311.

200MHz scope. The 200MHz 100Msample/s (four channels simultaneously, memory capacity 8kW/channel) VC9140 digital storage oscilloscope incorporates a PC which is FDD compatible with PC-Dos. The 9in gas plasma flat display has PC equivalent menus and submenus that are displayed at all times. Up to 17 waveform parameters can be observed with plus, minus and multiplication operation between waveforms, waveform inversion and absolute value operations. Special trigger facilities are provided. Hitachi Denshi, 081-202 4311.



In the slot: Armagard Pro-chassis from Intek.

RMS/peak voltmeter. The URE3 RMS/peak voltmeter is designed for taking measurements in environments that are subject to severe interference and high electromagnetic fields. It is also suitable for use in EMC laboratories and for materials testing. It has passed IEC and VDE tests with only minimal problems and all the disturbances visible during operation disappeared as soon as the source of the interference was removed. Neither the instrument set-ups nor the readouts underwent lasting change. Rohde & Schwarz, 0252 811377.

GPIB scope. The 3100D digital storage oscilloscope from Leader is controllable via a GPIB interface. It can sample at 40Msample/s with storage of waveforms up to 100MHz. Vertical resolution is 8bit, 256 points, and horizontal 11bit, 2048 points. Each channel has a separate reference memory allowing the storage of up to four waveforms. A summation facility allows 256 acquisitions to be averaged. Thurlby-Thandar, 0480 412451.

Literature IC selector guide. Motorola has revised its linear and interface ICs selector guide and cross reference - SG96/D revision 4. The 112-page guide includes switching regulator control circuits, RF communication circuits and surface mount devices as well as a variety of the previous standard devices. Motorola, 0908 614614.

Production equipment

Soldering irons. A range of antistatic soldering irons has been designed for hand soldering static sensitive devices without damaging the components. Any charge built up on the tip is earthed through the handle and lead. The lead is made of a carbon loaded silicone rubber compound and the handle a carbon fibre-reinforced thermoplastic material. The 240V AC model has a tip temperature of 410°C and comes with 2m cable and standard 4.8mm diameter chisel bit and hook. The 24V AC model can have tip temperatures from 350 to 500°C and comes with 1.25m cable and 2.4mm iron-plated bit. RS Components, 0536 201234.

Power supplies

1kW switcher. The 9C series of 1kW switching power supplies has 5, 12, 15, 24, 28 and 48V single outputs and is approved to IEC950, UL1950 and CSA22.2 requirements. Built-in features include an EMI filter to FCE/VDE level A, soft start inrush current limiting, single-wire parallel current sharing, input power fail and output good signals, remote adjustment and margining, and overvoltage and thermal shutdown protection. It measures 5 by 5 by 10in. Astec Standard Power, 0246 455946.

1kW supply. With universal 90 to 264V AC input range, 0.99 active power factor correction to meet IEC555-2, and better than 75% efficiency, the BVM10000 1kW power supply has four output configurations in a 305 by 203 by 86mm ventilated case. Power density is more than 3W/cu in. Outputs of 5V/150A, +12V/20A and -12V/10A are common to all models. The fourth output can be 3.3V/10A, 5V/10A, 12V/10A or 24V/5A. Input surge current is limited to 30A. Operating range is 0 to 70°C with full power derating linearly to 50% from 50°C. BICC-Vero Electronics, 0489 780078.

DC-DC converters. A series of PCB mounting low-profile DC-DC converters comprises isolated modules for use in decentralised power systems. Called PKE, these units are rated from 25 to 30W and are aimed at the telecomms and data communications industries. They can operate continually with natural convection cooling and run directly from 48 or 60V battery systems. There are five models in single, dual and triple output versions, and all have a 10.7mm profile and a 3 by 3in footprint. Ericsson Components, 0203 553647.

Uninterruptible supply. The Accupower Gold UPS from Emerson complies with IEE555-2 and is aimed at PC lans, multi-user systems, printers, phone systems, laboratory equipment, epos, and process control. Two ratings are available - 1kVA (AU1000) and 1.5kVA (AU1500). Gardners Transformers, 0202 482284.

Triple supply. The Model 1300 bench power supply has triple floating outputs and short circuit protection. The first output is 5V variable from 0 to 1A with current limiting and displayed on an analogue meter with a ±5% accuracy. Regulation on line is 0.2%, load 1% and maximum ripple 10mV. The second and third outputs are variable from 0 to 20V with a maximum current of 0.25A. Regulation is 0.05% for line and 0.1% for load. Ripple is again 10mV

In the light: 386SX processor board from Arcom.

maximum. Global Specialties, 0978 853920.

Uninterruptible power. The Delta series of uninterruptible power supplies are rated from 3 to 17.5kVA and are fitted with an interface that can automatically initiate an orderly shutdown of a computer system before the UPS batteries are exhausted during a mains failure. They are compatible with IBM AS/400 and several other mini and mainframe computers as well as major network systems. They support crest factors of 5:1 without derating and offer back-up times from 30min. Victron, 0455 618666.

DC-DC converter. The NFC20 from Computer Products is a 20W output DC-DC converter housed in a 2 by 1.6 by 0.4in package. It has input voltage ranges of 18 to 36V and 36 to 72V, five output voltage variations, and an MTBF of one million hours. With no heatsink required and no derating up to 60°C, it uses a switching frequency of 200kHz and offers a 2:1 input voltage range, remote on/off control, and overvoltage protection. XP, 0734 845515.

Radio communications products

Spectrum analysers. Two microwave analysers for digital mobile radio are designed to handle the fast rise time characteristics associated with GSM and PCN. Made by Advantest, the R3265 and R3271 respectively cover the ranges 100Hz to 8GHz and 100Hz to 26.5GHz. Frequency span covers 200Hz to full span with an accuracy of ±3% for spans greater than 25MHz. In zero span, sweep times range from 50µs to 1000s. Plug-in data memory cards are standard on each unit. Chase Electronics, 081 878 7747.

Data receiver. The SL6649-1 is a compact direct conversion FSK data receiver for the radio paging market and contains a low noise RF amplifier for signals up to 200MHz. The signal is split into I and Q channels, following a direct conversion architecture, then into mixers, such that with an external LO they can be mixed down to baseband for on-chip processing. It contains on-chip capacitors for channel filtering and requires the minimum amount of external components to become a single chip receiver, handling RF at one end and providing data at its output up to the maximum paging rate of 1200baud. GEC Plessey Semiconductors, 0793 518000.

Switches and relays

Pushbuttons. A range of PCB or panel-mount alternate-action maintained lighted miniature pushbutton switches is called the LVP/LHP series. Rather than being just back-lit, the whole actuator lights up. They use silver plated contacts rated at 24V DC, 50mA, and tin/lead plated terminals. Life expectancy is one million cycles at rated load. Solder heat resistance is 260°C/5s. Six versions are available including front-panel mounted, vertical PCB (round and square), and horizontal PCB in normally open or closed options. Augat, 0952 670281.

Encoder switches. Grayhill has introduced a range of optically encoded rotary encoder switches for the audio-visual, aerospace and medical markets. As well as the rotary function, there is a pushbutton element activated via the switch shaft to let a digital code be set and entered. They meet MIL202 for vibration, shock and humidity. All provide quadrature 2bit code output and devices are available with 16 and 32 detent positions. Highland Electronics, 0444 236000.

PCB switches. A family of pushbutton and toggle switches, the Elma Type 09, are for PCB mounting and through panel applications. Either latching or momentary options can be selected for the pushbutton options each offering two n/o contacts switching up to 42V DC and 200mA, 2.5VA switching capacity. The toggle switches can be two or three position. The standard 2.54mm PCB pinout conforms to DIN41494. Radiatron Components, 081-891 1221.

Television components

AV switch. The TA8628N is a monolithic AV switch with electronic volume control. Housed in a 24-pin shrink dip, it can be used in various tv applications such as Scart switches and switching between, say, tv and video recorder. The video section has two inputs and produces monitor and tv outputs. The parallel sound section has left and right sound inputs for the tv and external signals, producing separate tv and audio left and right outputs. Also included are a mute function and sound volume controls for left and right channels. It runs from a 12V DC supply and works from -20 to +70°C. Toshiba Electronics, 0276 694600.

Transducers and sensors

Load indicators. A collection of load indicator and controller systems comprises load cells or load washers and various 3.5 and 4.5 digit LED indicator controllers. Load cells range from 30g to 200tonne. They can be supplied scaled in any variety of engineering units including tonnes, kN and volume capacity. Accuracy varies from 0.1 to 0.5%. Control Transducers, 0234 217704.

Infra-red sensors. Pyroelectric infra-red sensor modules from Seikosha have a low current drain design which includes an amplifier, comparator and timer on a single circuit board. They are for surface mounting. A light-dependent resistor is incorporated to prevent daylight operation. Minimum operating current is 1mA (3mA maximum) and operating voltage is 5.5V DC. Masking time is 1.2s, circuit stabilising time is 12s typical, sensor rise time is 10s, and operating temperature range is -10 to +50°C. Without a lens, the detection range is 1.5 to 2m. ESD Mercator, 0493 844911.

Pressure transducer. The Autotran-700 transducer has its lowest range at 25Pa (0.25mbar) and can tolerate 100kPa over-pressure. Models from 25Pa to 1.25kPa come as standard. Double ranges are available, for example ±250Pa. Compensated for temperature variations from 5 to 60°C and 1% repeatability standard, the long term drift is not more than 1% a year. EuroSensor, 071 405 6060.

COMPUTER

Computer board level products

Notebook subsystem. OakNote is a notebook PC subsystem with operating system independent power management control that lets makers of notebook and hand-held PCs design a full 25MHz 286/386SX PC motherboard using only three chips. Using OakNote, a 386SX motherboard needs only 34sq in. The three chip subsystem comprises the OTI041 system controller, the OTI042 peripheral controller and the OTI043 flat panel VGA controller. Ambar Components, 0844 261144.

386SX board. The PC386SX is an AT compatible 16 or 20MHz 386SX bus-based processor board for embedded applications. It is aimed at engineers building systems for industrial use. The ScatSX chipset is used and there are 16 memory sites allowing the board to be supplied with up to 8Mbyte of dram expandable to 16Mbyte via a local expansion bus port accepting a plug-on module. Further hardware includes three Flash compatible eprom sockets, 128Kbyte sram, maths coprocessor socket, SVGA controller with 0.5Mbyte of video ram, and a feature control facility for the display of video pictures. Arcom Control Systems, 0223 411200.

Data Acquisition. The PC74 data acquisition board from UEI is for use with PC/XT/AT and PS/2 models 20 and 30. There are 16 analogue inputs accurate to 12bit and a built-in programmable gain amplifier with differential inputs. Either a low or high gain set of programming gains is available so the user can mix high and low level signals without external signal conditioning. Citadel Products, 081-951 1848.

ADC card. The DB140A is a 12bit 10MHz A-to-D card for use with VME DSP boards based on Motorola and Texas Instruments processors. It integrates all of the components necessary to form a complete data acquisition system on a single 3U VME card. It uses the dBex mezzanine bus for transfers of acquired data, and includes sample rate generation via an on-board 20MHz clock and a fifo up to 4Kword deep for output data storage. Inputs can be from 108mV to 1.024V. Data Beta, 0734 303631.

Single board computer. A 386-based single board computer for PCbus systems from I-Bus uses the 40MHz Am386DX 32bit processor with 128Kbyte of on-board cache. Called I386/40, it is configured as a standard format 16bit AT/ISA card and can support up to 32Mbyte of on-board dram. It is supplied with an IDE hard disc interface and floppy disc controller. Two serial ports and one parallel port are provided as well as a socket for a 40MHz Cyrix CX83D87-40 maths coprocessor. Dean Microsystems, 0734 845155.

Test instruments. A Blue Chip Technology plug-in PCB board offers the facilities of four test instruments - pulse generator, customised waveform generator, universal counter/timer, and function generator - together with IEEE interfaces. The VIP-Gen occupies a single slot of any IBM compatible PC making the PC screen emulate a typical instrument front-panel layout. Test parameters and waveforms can be saved to disc. ESD Instrument Services, 0279 641641.

A-to-D card. By using the 33Mbyte/s DMA transfer rate of EISA computers, AD-Series A-to-D converter cards from Adtek achieve sustained sampling rates of 10Msample/s at 12bit resolution. Cards in the range go from a single channel 10MHz 12bit resolution to eight channel 200kHz 18bit which is expandable to 32 channels. All have separate converters for each channel, simultaneous sampling of inputs, triggering from a software programmable threshold detector or an external trigger, and an on-board fifo buffer that provides pre and post triggering facilities. Laplace Instruments, 0692 500777.

Computer systems

Notebook computer. The B330SX is a 386SX-based notebook computer using the AMD Am386SXL 25MHz microprocessor. It has a 2.5in 60Mbyte hard disc, 2Mbyte ram expandable to 5Mbyte, triple supertwist VGA screen with 64 grey shades, 3.5in 1.44Mbyte floppy drive, 80387SX maths coprocessor socket, and optional internal 2400bps modem. Bondwell, 081-365 1993.

Programming hardware

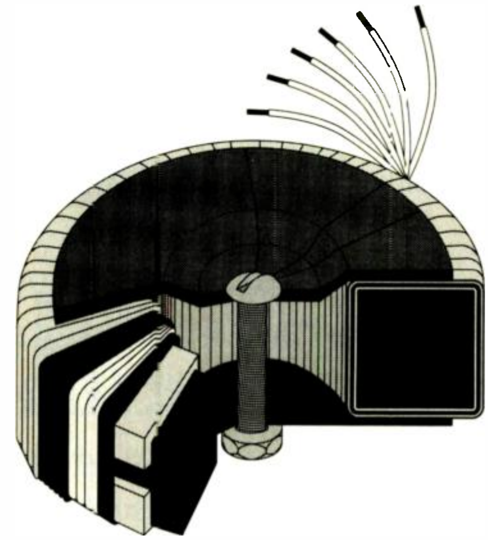
Device programmer. The Tribal Microsystems TUP300 universal device programmer can program pals, gals, peels, FPGAs, serial proms, bipolar proms, e(e)proms, and microcontrollers. The device list supports thousands of devices including the AMD Mach, Altera Max and Signetics 42VA12 series. A facility is also included to test and identify TTL74 and 4000 series logic. Optional gang adapters let it be used as a production tool. Smart Communications, 081-441 3890.

Software

Bus analysis. A software package has been developed to let the Model 4811 bus analyser be remotely controlled from a Macintosh or PC. The analyser performs the functions of a bus monitor, device simulator, bus controller, pattern generator, and bus signal waveform recorder. The use of a computer allows expanded data analysis on a larger screen and the reconstruction of the bus signal waveform. The control panel is displayed on the computer monitor and a mouse can be used to activate the command functions. Amplicon Liveline, 0273 608331.

Asic for risc. Solo 1400 version 3.1.5 is a fully integrated asic design package for Sun SparcStations and Sun 4 workstations. It provides a user-friendly schematic capture program, HDL, multi-level analogue and digital simulator, and automatic place and route program.The Synthesise logic synthesis tool is incorporated to let complex logic functions be designed at a high level. ES2, 0344 525252.

Serial communications. The Comio V1.0 serial communications software, supplied as a C and 8086 source function library, is for simplifying the development of C programs to provide interrupt driven data communications with the IBM PC com port. There are read/write functions for single-byte, string and blocked data transfers. All I/O functions operate in no-wait mode. The interrupt driver and I/O buffers are only resident during program execution. Micro SciTech, 0252 625439. ■



TRANSFORMERS

- Comprehensive standard range of high quality toroidal transformers. Competitive price and ex–stock delivery.
- In–house core manufacture allows fast and competitive custom design service for non–standard requirements —up to 3kVA.
- Low noise designs available for the most demanding audio applications.
- Triple insulation to IEC 742 on all standard transformers and where specified on custom designs.
- All types of toroid power transformers supplied —low profile, potted centres, cased, auto transformers, control gear, lighting and others.

UK and overseas distributorships are available

Telephone or fax for details

ΩLF® ELECTRONICS LTD.

COTTON ROAD · WINCHEAP

CANTERBURY · KENT CT1 3RB

Telephone: (0227) 454778

Facsimile: (0227) 450507

CIRCLE NO. 126 ON REPLY CARD

LOW COST RANGER1 PCB DESIGN FROM SEETRAX

- Circuit Schematic
- Circuit Capture
- PCB Design
- Host Of Outputs

REDUCED PRICE!

All-In-One Design System

£100

Fully Integrated Auto Router

£50

Ask Us About Trade-In Deals

Call Now For Demo Disk on 0705 591037

Seetrax CAE • Hinton Daubnay House
Broadway Lane • Lovedean • Hants • PO8 0SG
Tel: 0705 591037 • Fax: 0705 599036

What The Press Said About RANGER1

For most small users, Seetrax Ranger1 provides a sophisticated system at an affordable price. It is better than EasyPC or Tsien's Boardmaker since it provides a lot more automation and takes the design all the way from schematic to PCB - other packages separate designs for both, that is, no schematic capture. It is more expensive but the ability to draw in the circuit diagram and quickly turn it into a board design easily makes up for this.

Source JUNE 1991 Practical Electronics

Pay by Visa or Access

CIRCLE NO. 139 ON REPLY CARD

MQP ELECTRONICS SYSTEM 200

UNIVERSAL DEVICE PROGRAMMING SYSTEM

- **Fast and reliable programming**
- **Low cost**
- **Expandable system – buy only what you need**
- **Virtually all programmable devices covered**
- **Easy to upgrade**
- **Manufacturer approved algorithms**
- **Efficient and attractive software interface**
- **Special batch mode for production**

System 200 is one of the most versatile programming systems available. At the heart of the system is the award-winning Model 200A programmer. Designed to quickly connect to the serial or parallel port of any PC compatible, the Model 200A is controlled by PROMDRIVER, widely acclaimed as the best driver software available for any programmer.

- EPROMs, EEPROMs and FLASH memories up to 4Mbit and beyond
- Microcontrollers from most manufacturers including
  - 8748 Family
  - 8751 Family (including 87C751/2 and 87C552)
  - Z8 Family
  - PIC16C5X Family
- Emulators
- 8-pin Serial EEPROMs
- PALs, GALs, EPLDs etc
- Bipolar PROMs

Write or phone today for Free Information Pack:
Phone: (0666) 825146 Fax: (0666) 825141

MQP ELECTRONICS LTD,
PARK ROAD CENTRE,
MALMESBURY,
WILTSHIRE SN16 0BX UK

European Distributors: Digitron, Norway Tel 071-17 890; Synatron, Germany Tel 089/4602071; Logtek, Sweden Tel 08 770 1470 Italy, Elexind Tel 02 92 10 35 54

CIRCLE NO. 119 ON REPLY CARD

Micro AMPS

ICE 751	An emulator/programmer for the Philips 24-pin skinny DIP 8051; the 87C751. The ICE751 provides the cheapest way to emulate and program these devices.
ICE51™	A low-cost emulator for the industry standard 8051. This product is also available in kit form.
PEB552	The official Philips 80C552 evaluation board for this highly integrated 8051 variant. Optional debug monitor and 87C552 programming adapter are available.
BASIC COMPILER	A PC-based cross-compiler that enables code written for the 8052AH-BASIC processor to be compiled for the standard 8051 or 8052. Interpreted Basic is also available on the ICE51.
8051 BOOK	8051 Architecture, Programming and Applications. A recommended book for readers who require a text on the 8051 and interfacing techniques. This book is supplied with a PC-based cross-assembler and simulator for personal or educational use only.
OTHER	Contact us for information on these and many other related products such as 'C' compilers, I²C tools and drivers.

ICE51 is a trademark of Intel.

Micro AMPS Ltd
66 Smithbrook Kilns, Cranleigh,
Surrey, GU6 8JJ
Tel: +44(0)483-268999 Fax: +44(0)483-268397

CIRCLE NO. 120 ON REPLY CARD

Circuits, Systems & Standards

First published in the US magazine EDN and edited here by Ian Hickman.

Micropower op amp offers simplicity and versatility

A little nearer the ideal op amp

As every analogue engineer knows, the ideal op amp would have zero input offset voltage and tempco, zero bias current, rail-to-rail input common mode range, infinite CMRR and PSRR, zero open loop output impedance with rail-to-rail swing and wide bandwidth with high slew rate: they also know that it will not be available in their lifetime, if ever. However, the common mode input range of a few op amps includes the positive rail and in many more (with the popularity of single rail applications) the negative rail. Here is an op amp which includes both and offers a rail-to-rail output swing to boot. IH

Linear circuits intended to meet the stringent demands of medical and industrial instrumentation, remote data acquisition, and portable equipment must deliver precision at low voltages. A low-power, battery-operated op amp, for instance, requires precision DC characteristics to process low-level signals from high source impedances, low supply current to conserve power, and wide bandwidth to process audio-frequency signals. Because low-voltage applications produce low signal levels, the op amp should have a wide dynamic range at the input and output. Moreover, both it and its external circuit should function properly at the end-of-life battery voltage.

The *NE5230* op amp is suited to such requirements. It operates from a supply voltage of 1.8 to 15V and performs well in systems powered by single 5V supplies. The op amp not only offers precision DC characteristics: its common-mode voltage can swing within 100mV of either supply rail – a characteristic matched by few other commercially available op amps.

Table 1. Salient specs for the NE5230 (V^+=1.8V; V-=gnd).

	Bias current	T_A=25°C	0°C<T_A<70°C
Single/dual supply voltage	-1.	8 to 15V or ±0.9 to ±7.5V	
Supply current	low	110µA	250µA max
	high	600µA	800µA max
Output swing	any	1.6V	1.4V min
V_{OS}	any	0.4mV	4mV max
I_B	low	20nA	150nA max
	high	40nA	200nA max
A_{VO}	low	150V/mV	50V/mV min
	high	200V/mV	100V/mV min
CMRR	any	95dB	80dB min
Output source current	high	5mA	4mA (typ) at low bias
Output sink current	high	11mA	5mA (typ) at low bias
Slew rate	low	90V/ms	90V/ms
	high	250V/ms	250Vms
bandwidth	low	250kHz	-
	high	600kHz	

*Note. THE NE5230 operates at low bias current if the bias adjust pin (pin 5) is left open. Shorting the NE5230's pin 5 to V^- provides maximum bias current. Connecting a variable resistor between pin 5 and V^- lets you adjust the amplifier's bias current and high-frequency characteristics.

Furthermore, the bias-adjust terminal lets you adjust the op amp's slew rate from 90 to 250V/ms by varying the op amp's internal bias currents. The device also offers decent performance in two other parameters of concern in low-power applications – noise and output-current drive. The *NE5230*'s input voltage noise is 22nV/√Hz at 1kHz, and it can source and sink 5 and 11mA, respectively, when operating from a 1.8V supply at 25°C.

Other key specifications are listed in **Table 1**. These attributes allow you to use the op amp in battery-powered applications such as half-wave and full-wave rectifiers, window detectors with rail-to-rail input ranges, temperature-limit alarms, sound-activated intrusion detectors, and supply-voltage splitters. An equally important application involves signal-conditioning circuits for bridge transducers – circuits that require no reference voltage or instrumentation amplifier.

Rectify signals without diodes

To keep costs low, battery-operated circuits for consumer applications should have a minimum component count. Fewer components also bestow the bonus of higher reliability. These considerations lead to the half-wave-rectifier circuits of Fig 1.

Neither circuit uses diodes. Because the op amp's input common-mode range extends beyond the supply rails, you can simply ground the non-inverting terminal and thereby configure the amplifier as an inverter. You should also short the bias-adjust terminal (pin 5) to V^- to

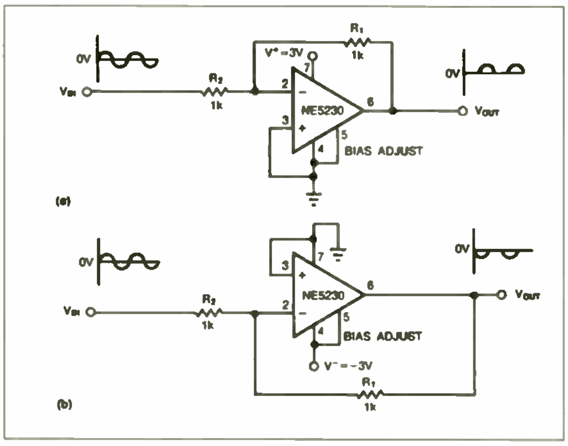


Fig. 1. These positive (a) and negative (b) half-wave-rectifier circuits accomplish their job without the use of diodes. The resistors give you the option of gains other than unity.

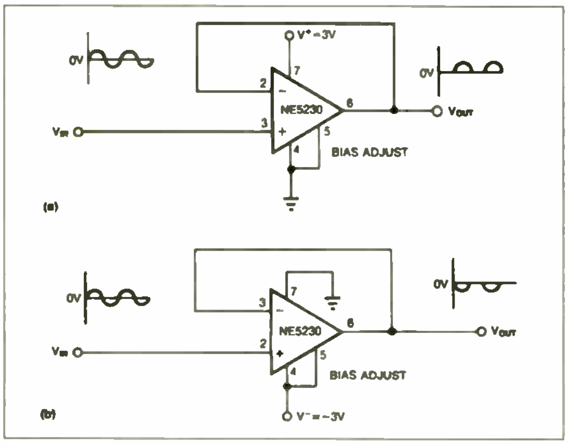


Fig. 2. Requiring no external components, these op amp circuits perform (a) positive and (b) negative half-wave rectification for ground referenced AC signals.

provide a maximum slew rate.

The amplifier behaves as a unity-gain inverter for negative inputs; positive inputs drive the output into saturation (**Fig. 1a**). But the *NE5230*'s internal detectors prohibit the hard saturation that would occur in most op amps. Recovery from saturation is relatively fast. Operating from a 3V supply, the circuit can rectify signal amplitudes as high as ±2.85V at frequencies well above 10kHz. If the input signal has a reference level between 0V and V+, you can simply reference the amplifier's non-inverting input to the same level. If required, resistors R_1 and R_2 can provide a gain other than unity.

To obtain a negative-polarity half-wave-rectified signal using a conventional op amp, you have to provide dual (bipolar) power supplies. The *NE5230*'s rail-to-rail input range and near rail-to-rail output range, however, let you achieve this function using a single supply. Simply connect the supply's positive terminal and the amplifier's V^+ terminal to ground, and connect the supply's negative terminal to the amplifier's V^- terminal (**Fig. 1b**).

The amplifier's common-mode range lets you reference the input signal to the positive rail (ground) by tying the non-inverting and V^+ terminals together. (You cannot do this with most op amps, and most op amps' output voltage must remain at least one V_{BE} voltage below the positive rail). In short, you can use the amplifier with a single negative supply to condition the signal output from a variety of ground-referenced sensors. Again, if the input-signal reference is a voltage between 0V and V^- instead of ground, you should connect the amplifier's non-inverting input to the same potential.

Overdriving most op amps (beyond the supply rail, for instance) saturates the input stage, causing a phase reversal within the amplifier that can reverse the feedback signal's polarity. Circuitry within the NE5230 prevents phase reversal for inputs as large as 2V beyond the supply rail. This feature allows the amplifiers of Fig. 2 to produce half-wave rectification without external components for input signals referenced to 0V.

In **Fig. 2a**, the amplifier output follows the input signal above 0V and goes into negative saturation for inputs below 0V, the output clamps near 0V for negative inputs. The circuit as shown can rectify signals of ±2V at frequencies above 10 kHz. Inputs below –2V will cause internal phase reversal, however, allowing the output voltage to rise. You can prevent this situation by adding a large resistor in series with the amplifier's input. To obtain a negative-polarity half-wave rectifier, simply reverse Fig 2a's supply-voltage connections (**Fig. 2b**). Again, this circuit can rectify 0V-referenced signal amplitudes to ±2V at frequencies above 10kHz.

Figure 3's circuit performs full-wave rectification using a single positive power supply. When a negative input voltage causes IC_1 to clamp IC_2's non-inverting input to 0V, IC_1 delivers current through D_1 and R_3 to the signal source. IC_2 acts as an inverting amplifier for negative input signals.

Positive input signals produce a differential voltage between the IC_1 inputs and create reverse-bias across D_1 placing IC_1's output in negative saturation. This condition removes the 0V clamp at IC_2's inverting input by breaking IC_1's feedback loop. Consequently, IC_2 behaves as a follower during positive excursions of the input voltage.

Although D_1 is reverse-biased, clamp diodes at IC_1's inverting input turn on and draw current through R_3. Accordingly, R_3's value should be 500Ω or less to avoid a significant offset due to this parasitic current flow. (R_1 and R_2 can be large-valued resistors). **Figure 3b** shows the circuit operating with a 5.7V pk-pk signal at 400Hz.

Similar to the way it rectified the half-wave circuits, the *NE5230* performs negative full-wave rectification in **Fig. 4** using a single negative power supply. The same precautions apply as for Fig. 3.

You can also use the *NE5230* to monitor a signal and to detect fault conditions in which the signal is shorted to either supply voltage. The window-detector circuit of **Fig.**

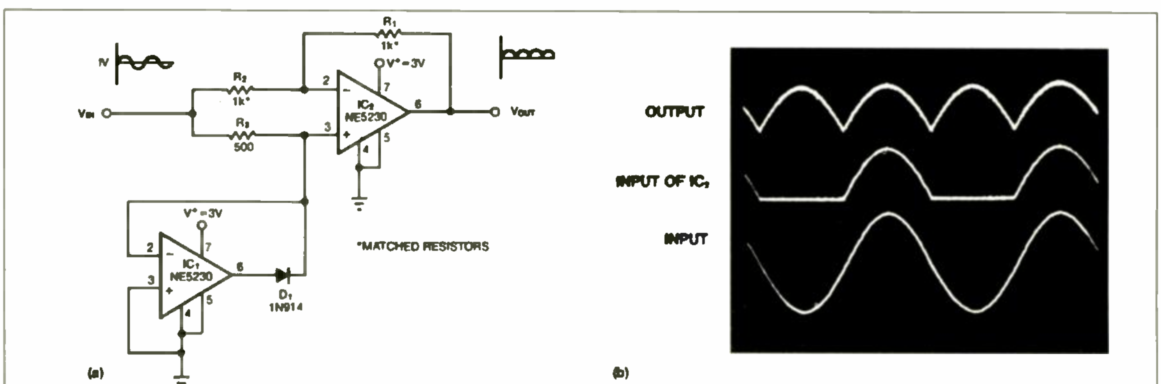


Fig. 3. This absolute-value circuit (a) achieves full-wave rectification by clamping IC_2's non-inverting input to 0V when V_{IN} is negative, and removing the clamp when V_{IN} is positive. Thus IC_2 alternates between an inverter and a follower every half cycle. Photo (b) shows circuit performance at 400Hz for a 5.7V pk-pk input signal. The vertical scale is 2V/div, and the horizontal scale is 0.5ms/div.

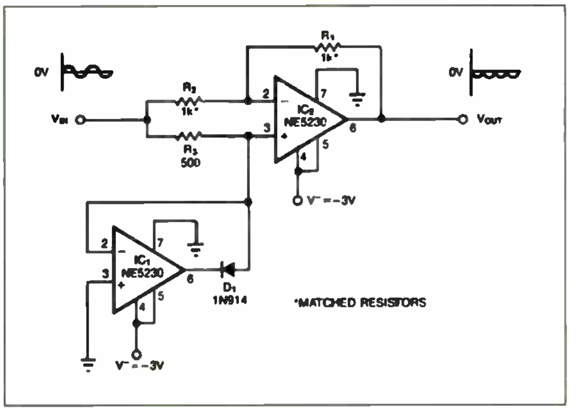


Fig. 4. This circuit (obtained by reversing the power supply connections in Fig. 3) performs negative full-wave rectification using a single supply voltage.

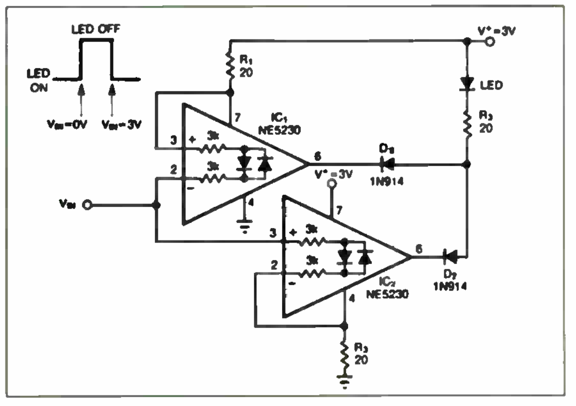


Fig. 5. This window detector's rail-to-rail input range allows the circuit to detect faults in which the input signal becomes shorted to either rail.

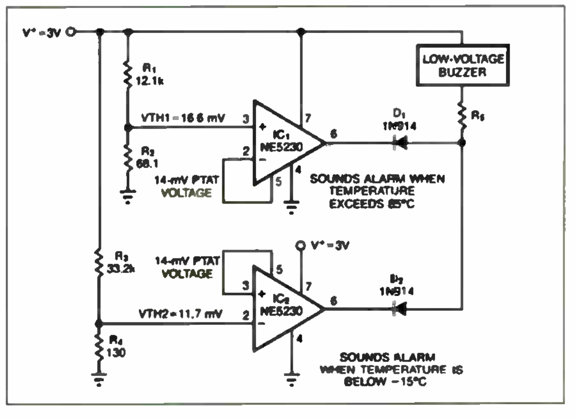


Fig. 6. The op amp's bias-adjust pin (pin 5) is the PTAT (proportional to absolute temperature) voltage, which lets you use the amplifier as a temperature sensor. This circuit activates the buzzer when the temperature exceeds a user-specified limit.

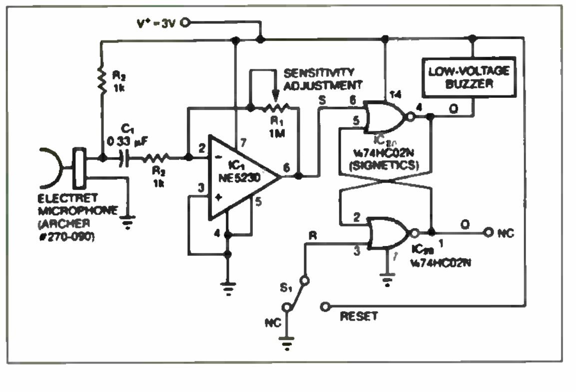


Fig. 7. Ambient sound above a user-determined threshold activates this intrusion detector. Once triggered, the alarm will sound until you momentarily press the switch (S_1).

5 must have the same supply voltage as that of the remote signal source. Power supply currents through R_1 and R_2 create small offsets essential to the circuit's operation.

Both op amp outputs remain in positive saturation for V_{IN} values between approximately 0 and 3V, which keeps the led off. If V_{IN} shorts to V⁺, however, IC_1 saturates negatively (at 0V), turning on the led.

Similarly, IC_2 turns on the led by saturating negatively when V_{IN} shorts to ground. As you can see, the op amp inputs' series resistors and clamp diodes limit the current drawn from the V_{IN} source.Normally, building a two-limit temperature alarm requires a temperature sensor and two op amps. The *NE5230* itself becomes a temperature sensor, however, if you make use of the PTAT (proportional to absolute temperature) voltage at pin 5. This voltage is independent of the supply voltage and measures 14mV at 27°C. What is more, it changes predictably at a rate of 46.667μV/°C. For instance, at +85 and −15°C, the pin 5 PTAT voltage is 16.7 and 12.04mV, respectively.

The alarm circuit (**Fig. 6**) uses these trip points to activate a buzzer when the ambient temperature moves outside the −15 to +85°C window. The R_1/R_2-divider voltage sets the upper temperature limit and the R_3/R_4-divider voltage sets the lower one. When the ambient temperature exceeds 85°C, IC_1's inverting-input voltage is more positive than that at the non-inverting input, and the resulting saturated output (0V) causes the buzzer to sound. Conversely, IC_2's output sounds the buzzer when the ambient temperature drops below -15°C, again by going into negative saturation.

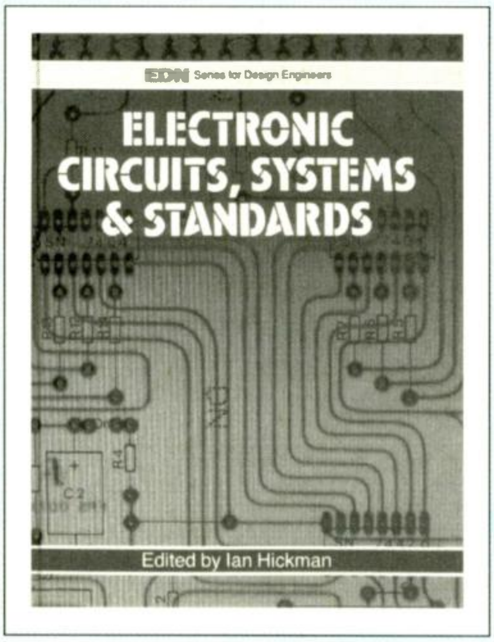
The resistors that you use in the voltage dividers should have similar temperature coefficients to prevent a shift in threshold voltage as the temperature changes. On the other hand, the op amp's input-offset voltage (V_{OS}) has a greater effect on the circuit's accuracy. Because V_{OS} is a significant percentage of the small PTAT voltage, you must set the temperature limits far apart to reduce error. The typical 400μV V_{OS} and 5μV/°C V_{OS} drift can introduce an uncertainty of ±15°C or more. Although Fig. 6 isn't intended for precision applications, you can improve its accuracy by selecting *NE5230*s with low V_{OS}.

The battery-operated intrusion detector of **Fig. 7** illustrates another type of alarm circuit possible with the *NE5230* op amp. Using an electret-microphone sensor, the circuit activates a buzzer when the ambient sound exceeds a user-specified threshold. Resistor R_3 biases the microphone and capacitor C_1 blocks the microphone's DC signal component. IC_1 is connected as an inverting amplifier with adjustable gain. The amplifier cannot respond to positive inputs because the V⁻ terminal is grounded, and without sound the amplifier's input and output are near 0V. The output drives an RS (reset-set) flip-flop formed by the cross-coupled cmos Nor gates. Therefore, in the absence of sound the flip-flop's Q\ output is high, and the buzzer is off. IC_2's negligible standby current and the low quiescent current of the microphone and op amp ensure long battery life.

Sound detector has adjustable threshold

Sound causes the microphone to produce an AC signal whose reference is ground on the other side of C_1. (The capacitor you choose should have low leakage current). This signal's negative excursions produce positive excursions at the flip-flop's *S* input. If the amplifier's gain (set by R_1) is sufficient, the signal at *S* will cross the gate's switching threshold and latch the /Q output low, activating the buzzer. The buzzer will remain on until you reset the latch by momentarily pressing S_1. Remember that high closed-loop gain settings will reduce the circuit's sensitivity to high-pitched sound by lowering the amplifier's -3dB bandwidth. If you need more sensitivity, you can cascade two op amps and split the required gain between them.

Circuits that process ground-referenced signals often require dual power supplies, but dual-voltage battery supplies can increase a system's size and cost. You can avoid this extra hardware in some cases by converting a single 3V lithium-battery output into a ±1.5V output (**Fig.**



Electronic Circuits, Systems & Standards

Edited by Ian Hickman, published by Butterworth Heinemann Newnes. ISBN 0 7506 0068 3. price £20.

Since its appearance in 1956 the US-based EDN has established itself as a leader in controlled circulation electronics magazines. Now this "best" of EDN – with useful information on components, equipment, circuits, systems and standards is available in a 216 page hardback publication

Available from bookshops, or direct by postal application to EW +WW, Quadrant House, The Quadrant, Sutton Surrey SM2 5AS. Cost £20 plus £1.50 post and packing. Cheques payable to Reed Business Publishing Group.

8a). The R_1/R_2 divider splits the 3V supply, and the op amp's 40nA input-bias current offers a minimal load to the divider. The amplifier's output becomes the common terminal for all ground-referenced loads and signals.

The *NE5230*'s low output impedance minimises any offset voltage created by the connection of loads between the amplifier's output and V^- or V^+. Moreover, the dual voltages track in magnitude as the battery cell discharges – a feature useful in applications that must maintain a precise voltage null despite fluctuations in the supply voltages. Figure 8a circuit sources and sinks 15 and 24mA, respectively.

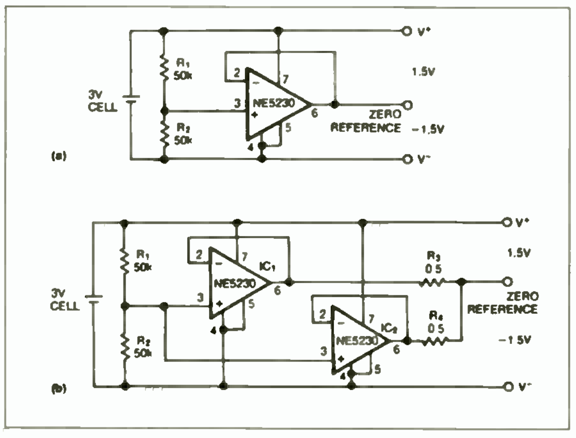


Fig. 8. The circuit in (a) converts a 3V cell into a ±1.5V dual tracking supply. By connecting two amplifiers in parallel (b), you can nearly double the circuit's load-carrying capability.

To obtain higher load currents, you can connect two *NE5230*s in parallel (**Fig. 8b**). The difference in offset voltages (ΔV_{OS}) appears across R_3 and R_4. The standby current in one op amp increases by $\Delta V_{OS}(R_3+R_4)$ but current in the other op amp decreases by the same amount, so the sum of the supply current through the two op amps remains constant.

Large load currents divide equally between the two op amps, and you would expect this circuit to provide twice the output current of Fig. 8a, but the load-current capability is generally less because of mismatch in the op amp's output resistances and mismatch between R_3 and R_4. The Fig. 8b circuit sources and sinks 24 and 35mA, respectively, when operating from a 3V supply.

Bridge transducers for precision applications usually require an accurate low-drift voltage reference and a precision instrumentation amplifier (see box "What you

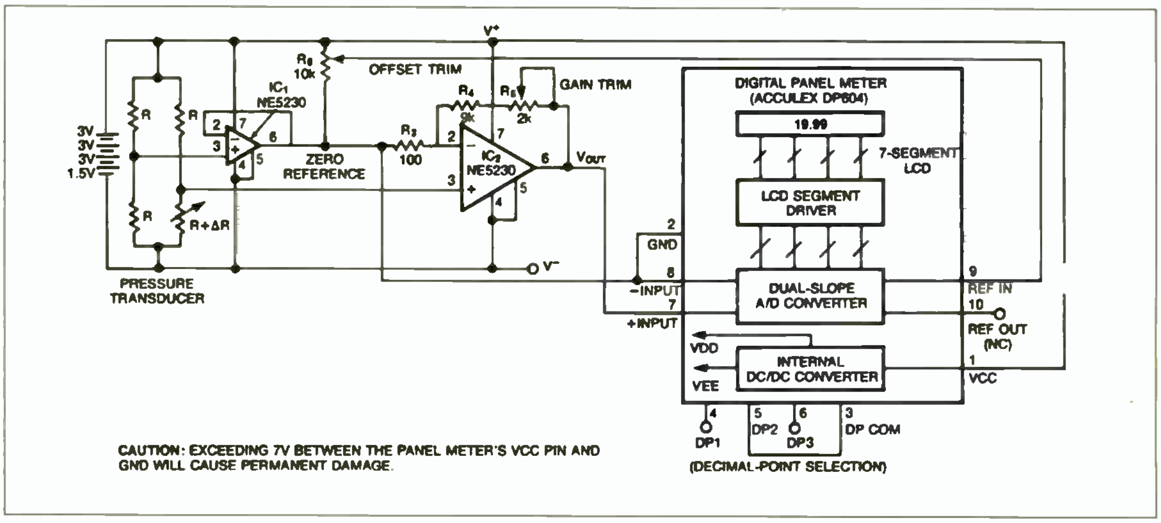


Fig. 9. This bridge transducer interface circuit conditions the bridge's output signal for ratiometric operation and eliminates the need for a reference voltage and an instrumentation amplifier.

should know about bridge circuits"). The **Fig. 9** circuit, however, acquires and displays the bridge transducer's output without using a voltage reference or an instrumentation amplifier.

Op amp IC_1 buffers the fixed arm of the bridge and provides a reference potential for all ground-referred loads. Choosing this node as the reference potential converts the bridge's differential output signal to asingle-ended signal referred to ground. This reference remains halfway between V^+ and V^- even if the battery discharges. The reference potential is thus a floating ground, often called an active guard.

Converting the bridge's differential signal to a ground-referred signal eliminates the bridge output's common-mode voltage, which also eliminates the need for common-mode rejection, usually obtained by adding an instrumentation amplifier. IC_2 amplifies the bridge's output signal, and R_5 lets you adjust the circuit's full scale output level.

The IC_2 output V_{OUT} will change as the batteries discharge, but the V_{OUT}/V^+ ratio will remain fixed. This relationship lets you remove the effect of battery discharge by operating the panel meter's A-to-D converter in the ratiometric mode. Connect the wiper of R_6 to the converter's reference input to ensure that the signal and reference remain in proportion as the supply voltage changes. Finally, note that IC_2 amplifies its own input-offset voltage. You should null this effect by first balancing the bridge, and then adjusting R_6 for an all-zeros output at the panel meter.

***Zahid Rahim**, Signetics Corp*

References

1. Huijsing, Johan H, and Linebarger, Daniel. "Low-voltage operational amplifier with rail-to-rail input and output ranges", *IEEE Journal of Solid-State Circuits*, Vol SC-20, December 1985, pp. 1144-1150.
2. Huijsing, Johan H. "Multistage amplifier with capacitive nesting for frequency compensation", US Patent Application Serial No 602.234, filed April 19,1984
3. Blauschild, Robert. "Differential amplifier with rail-to-rail capability", US Patent Application Serial No 525.181, filed August 23,1983.

What you should know about bridge circuits

A bridge circuit, often known as a Wheatstone bridge, consists of a pair of series-connected resistors connected in parallel with a similar pair of resistors (**Fig. A**). Bridge circuits are widely found in precision-null applications because the differential voltage (V_1-V_2) across the bridge is 0V when the bridge is balanced.

What's more, this balanced condition is unaffected by voltage drops across line resistances or shifts in the reference voltage V_R. You can use such a balanced bridge to measure capacitance, inductance, or its own frequency of excitation (when applied in place of V_R).

A more common application for a bridge circuit is as a bridge transducer for converting physical parameters such as temperature or pressure into electrical signals. Normally, the resistance in one arm of the bridge varies with the measured parameter as resistances in the other three arms remain constant. This type of application usually includes a differential amplifier to amplify the bridge's differential output voltage.

The amplifier's output indicates any change in the measured parameter with respect to a reference level corresponding to the condition of a balanced bridge. You do need a fixed reference voltage; shifts in V_R will change the amplifier's output voltage unless the bridge happens to be balanced. The bridge's output signal usually consists of several millivolts riding on a much larger common-mode signal.

Accordingly, you should choose a bridge amplifier that minimises inaccuracies through high common-mode rejection (CMR), low input-offset voltage (V_{OS}) and low V_{OS} drift with temperature. The amplifier should have high open loop gain to ensure a linear transfer function and low input-bias current to avoid loading the bridge. An instrumentation amplifier meets all these requirements and is designed specifically for conditioning the output of bridge transducers.

Note that even an ideal bridge amplifier will have a non-linear response because the bridge itself is inherently non-linear. The following derivation shows why:

$$V_0 = A_{CL}(V_1 - V_2)$$
$$= A_{CL}\left[\frac{V_R}{2} - \frac{V_R(R+\Delta R)}{R+R+\Delta R}\right]$$
$$= -\frac{A_{CL}V_R}{4}\left(\frac{\Delta R/R}{1+\Delta R/2R}\right)$$

A_{CL} is the amplifier's closed-loop gain. The bridge's output signal is non-linear because both the numerator and the denominator contain the transducer-deviation term ΔV. The signal is approximately linear over a small range of amplitudes, however. Such signals are held to low amplitude for that reason.

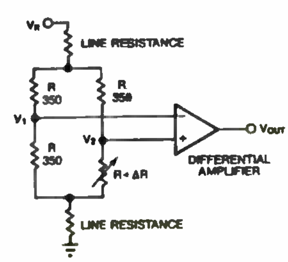


***Fig. A.** In a conventional transducer bridge, the parameter of interest causes a variation (ΔV) in the bridge's output. The amplifier senses the resulting small differential signal and also rejects the bridge's relatively large common-mode voltage.*

MARCONI BEGINNINGS

Marconi in 1896 with some of his apparatus: the spark-generator is on the left, and a morse key to the right.

The first aerial (facing page, top left) was an elevated iron plate attached to the spark gap. Another plate had to be buried in the ground, the lead for which can be seen tied to the left-hand table leg. This 1895 apparatus achieved a tenfold increase in transmission distance – from 100m to 1km

Progress leading up to Marconi's 1901 bridging of the Atlantic with wireless signals (*EW + WW*, December) had seen a development, in only eight years, from primitive table-top apparatus to the massive, high-powered (20kW equivalent input) installation at Poldhu.

Marconi's early experiments with radio transmission had begun in 1894, when he was 20. In 1895, while using slabs of sheet-iron to increase the transmitter spark's wavelength, he placed one on the ground, and held the other in the air. This, in effect the first aerial, produced a large increase in the signal strength, and in the range – from about 100m to 1km.

Marconi's transmitter consisted of a spark-gap between two metal spheres, attached to metal plates - one elevated, one buried in the ground.

The receiver used an identical aerial arrangement, attached to a coherer - an evacuated glass tube containing fine metal filings and closed by an electrode at each end. When a signal was received, the filings "cohered", their resistance dropped and a relay circuit was completed, enabling operation of a tapper and a morse inker.

Marconi took out his first wireless patent in 1896. In September that year he conducted a demonstration on Salisbury Plain, for the benefit of the War Office and the Post Office, at which a range of 1.75miles was recorded.

Next year saw the bridging of the Bristol Channel, a distance of more than eight miles, and communication between the Royal Needles Hotel at Alum Bay on the Isle of Wight and a house in Bournemouth, which was almost twice as far.

In 1898, Lord Kelvin used the Alum Bay transmitter to send the first wireless-transmitted paid telegram. It read: "Tell Blyth this is transmitted commercially through ether from Alum Bay to Bournemouth and by postal telegraph thence to Glasgow".

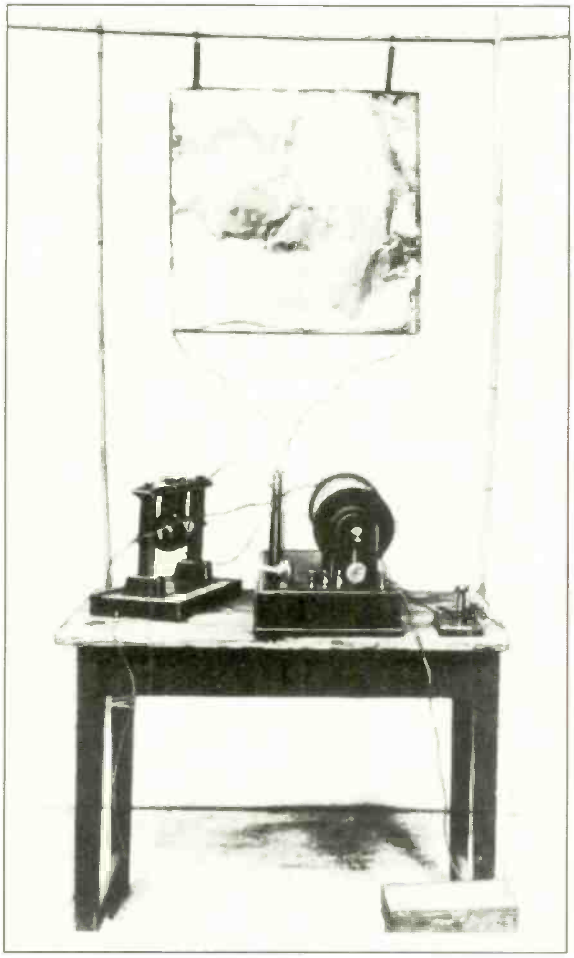
Kelvin's insistence on paying Marconi to send the message, and referring to it in the text, was intended as a challenge to the Post Office's monopoly on paid messages – a challenge it chose at the time to ignore.

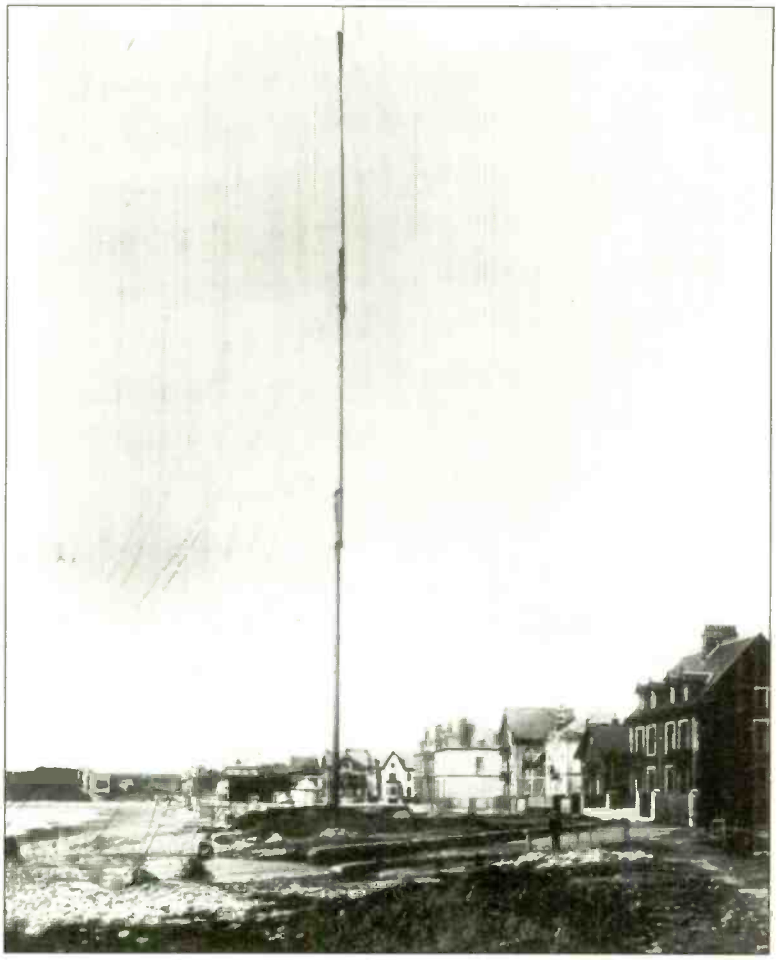
Wireless distress

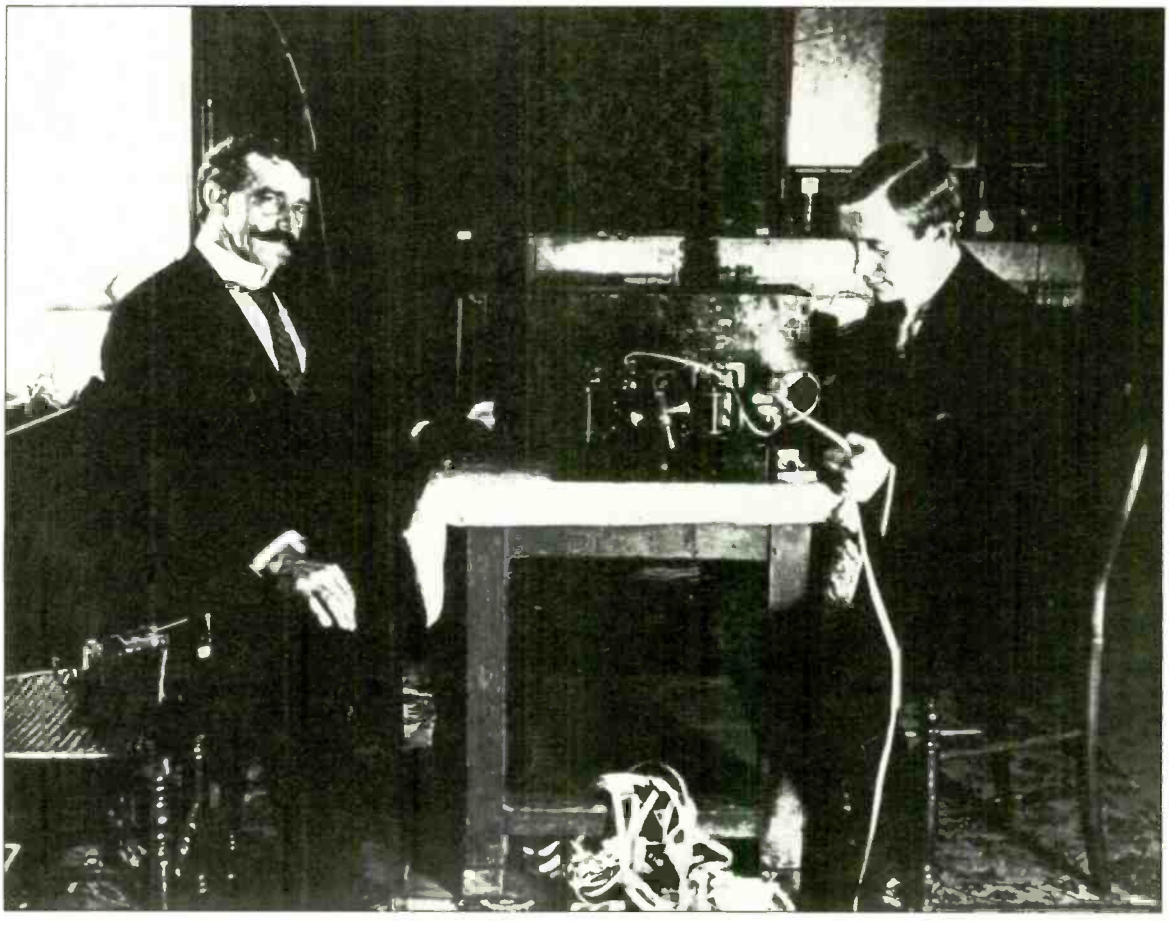
The Kelvin telegram was something of a stunt, but the first genuine use, as distinct from demonstration, of wireless telegraphy was not long in coming.

In 1899, the East Goodwin lightship, which had been rigged as a demonstration station, suffered storm damage and used its transmitter to send out distress signals.

Later the same year, it was struck by a ship and again used the transmitter, this time triggering the first sea

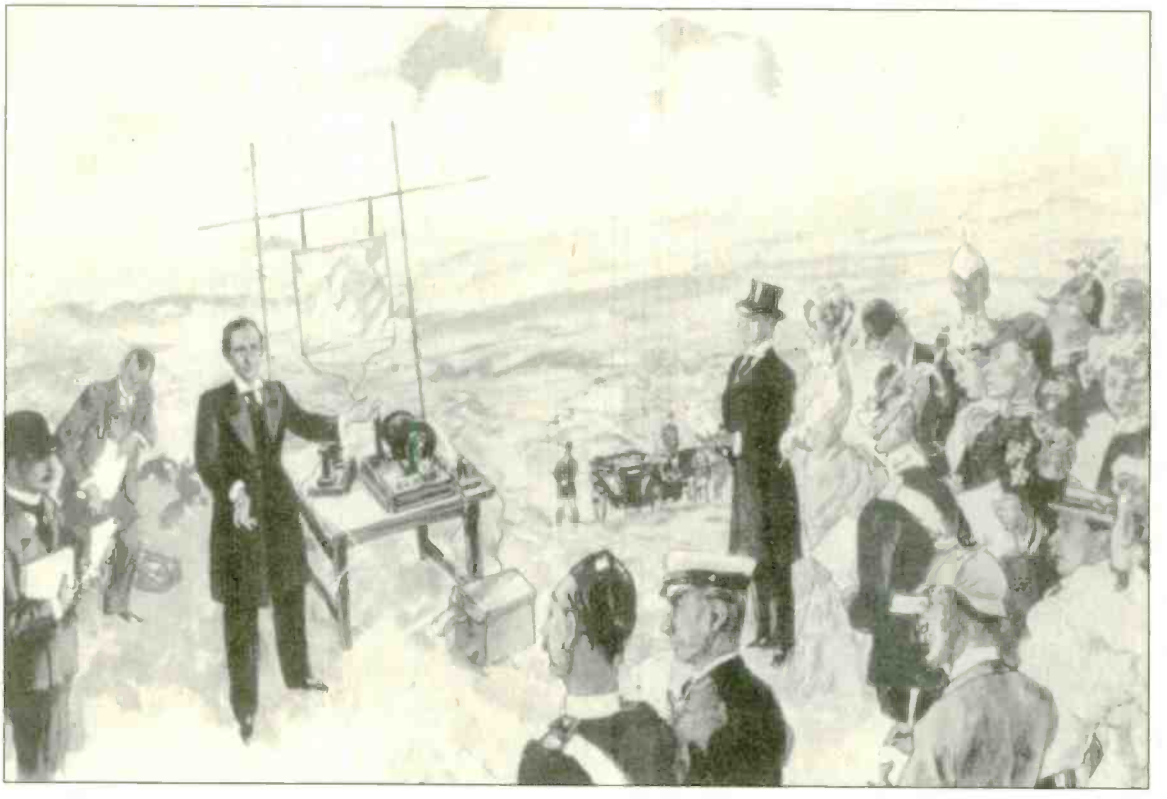






By 1899, signal range had increased sufficiently to cross the English Channel, between Wimereux, near Boulogne (above), and the South Foreland. The photo left shows a message being received at Wimereux. On the left is George Kemp, Marconi's personal assistant for over 30 years.

Marconi's 1986 Salisbury Plain demonstration, at which a range of 1.75miles was recorded, was commemorated in a contemporary etching. It was probably drawn after the event since, although it identifies some of the War Office and Post Office officials present, it is not thought to be accurate in terms of the equipment used. Far larger aerials, probably suspended on balloons, would have been employed.



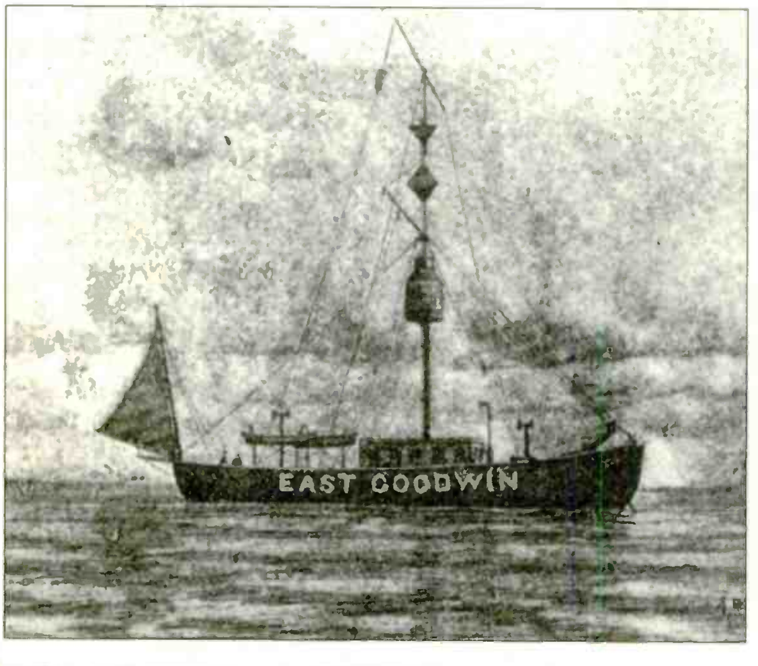
rescue in response to a wireless distress signal.

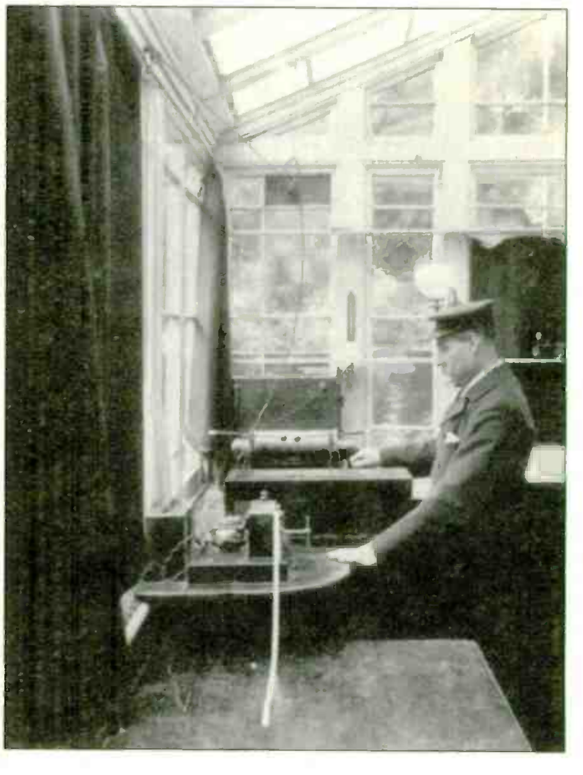
By 1899, transmission range had increased sufficiently to cross the English Channel, between Wimereux, near Boulogne, and the South Foreland. The signal proved strong enough to be picked up at Marconi's HQ in Chelmsford, 130km away.

By the turn of the century wireless was beginning to establish itself as a tool of communication, and in 1900 the Marconi International Marine Communication Company was set up. ■

Wireless was already being put to use in a variety of ways by 1900. Picture below shows the Mitcham Lane Fire Station, London, around 1900, with Station Inspector Preston despatching a message. The spark-generator near his right hand and the Morse printer in the foreground can both be clearly seen.

The East Goodwin lightship, rigged for demonstrations, sent the first wireless distress signals in 1899.





£1 BARGAIN PACKS

In fact, cheaper than £1 because if you buy 10 you can choose one other and receive it free.

5 13A spurs provide a fused outlet to a ring main where devices such as a clock must not be switched off. Order Ref 2

4 In flex switches with neon on/off lights, saves leaving things switched on Order Ref. 7

2 6V 1A mains transformers upright mounting with fixing clamps. Order Ref. 9

1 6½in speaker cabinet ideal for extensions, takes our 6½in speaker. Order Ref. 11.

12 30 watt reed switches, it's surprising what you can make with these – burglar alarms, secret switches, relay, etc. Order Ref. 13.

2 25 watt loudspeakers two unit crossovers. Order Ref. 22.

2 Nicad constant current chargers adapt to charge almost any nicad battery. Order Ref. 30.

2 Humidity switches, as the air becomes damper the membrane stretches and operates a microswitch. Order Ref. 32

5 13A rocker switch three tags so on/off, or change over with centre off. Order Ref. 42.

1 24hr time switch, ex-Electricity Board, automatically adjust for lengthening and shortening day. Original cost £40 each. Order Ref. 45.

1 Mini uniselector, one use is for an electric jigsaw puzzle, we give circuit diagram for this. One pulse into motor moves switch through one pole. Order Ref. 56.

2 Flat solenoids – you could make your multi-tester read AC amps with this. Order Ref. 79.

1 Suck or blow operated pressure switch, or it can be operated by any low pressure variation such as water level in water tanks. Order Ref. 67.

1 Mains operated motors with gearbox. Final speed 16 rpm, 2 watt rated Order Ref. 91.

1 6V 750mA power supply, nicely cased with mains input and 6V output leads. Order Ref. 103A.

2 Stripper boards, each contains a 400V 2A bridge rectifier and 14 other diodes and rectifiers as well as dozens of condensers, etc. Order Ref. 120.

10m Twin screened flex with white pvc cover. Order Ref. 122

12 Very fine drills for pcb boards etc. Normal cost about 80p each. Order Ref. 128

2 Plastic boxes approx 3in cube with square hole through top so ideal for interrupted beam switch etc. Order Ref. 132.

5 Motors for model aeroplanes, spin to start so needs no switch. Order Ref. 134.

6 Microphone inserts – magnetic 400 ohm also act as speakers. Order Ref. 139.

4 Reed relay kits, you get 16 reed switches and 4 coil sets with notes on making c/o relays and other gadgets. Order Ref. 148.

6 Safety cover for 13A sockets – prevent those inquisitive little fingers from getting nasty shocks. Order Ref. 149

6 Neon indicators in panel mounting holders with lens. Order Ref. 180.

1 in flex simmerstat – keeps your soldering iron etc. always at the ready. Order Ref. 196.

1 Mains solenoid, very powerful as ½in pull or could push if modified. Order Ref. 199.

10 Keyboard switches – made for computers but have many other applications. Order Ref. 201

1 Electric clock, mains operated, put this in a box and you need never be late. Order Ref. 211

4 12V alarms, make a noise about as loud as a car horn. All brand new. Order Ref 221.

2 6in x 4in speakers, 4 ohm made from Radiomobile so very good quality. Order Ref 242.

2 6in x 4in speakers, 16 ohm 5 watts so can be joined in parallel to make a high wattage column Order Ref. 243

1 Panostat, controls output of boiling ring from simmer up to boil. Order Ref. 252.

50 Leads with push-on ¼in tags – a must for hook ups – mains connections etc Order Ref 259.

2 Oblong push switches for bell or chimes, these can switch mains up to 5 amps so could be foot switch if fitted into pattress. Order Ref. 263

1 Mini 1 watt amp for record player attached to unit that will also change speed of record player motor. Order Ref. 268

3 Mild steel boxes approx 3in x 3in x 1in deep – standard electrical. Order Ref. 283.

50 Mixed silicon diodes. Order Ref. 293.

1 6 digit mains operated counter, standard size but counts in even numbers. Order Ref. 28

1 In-flight stereo unit. Has 2 most useful mini moving coil speakers. Ex BOAC. Order Ref. 29.

2 6V operated reed relays, one normally on, other normally closed. Order Ref. 48

2 Plug in relays with 3 changeover contacts. Coil operated by 12V DC or 24V AC Order Ref. 50.

1 12V pcb mounting relay. 2 changeover. Order Ref ??

1 Cabinet lock with 2 keys. Order Ref. 55.

4 Dolls house switches or use them for any other low voltage application. Order Ref 57.

1 Magnetic brake for stopping a motor or rotating tool. Order Ref. 66.

1 Time reminder. Set it for anything up to 60 minutes. Order Ref. 77

1 Shaded pole mains motor. ¾in stack so quite powerful Order Ref. 85

2 5in aluminium fan blades Could be fitted to the above motor Order Ref ??

— BARGAINS GALORE —

RESISTORS TEN A PENNY and they are top class 5% carbon foil types either ½ or ⅓watt rating You can buy at this silly price on condition that you take a full reel, which is 3000 on a bandolier You specify the value you want but please say if you can accept a near value as, although we have a very wide range, we do not have every value Over a million in stock and if you will buy 50 reels or more you can have them at £2 a bandolier but please come to our store, pick them out yourself

LITHIUM BATTERIES 3.5v penlight size, 2 mounted on p c.b with diodes, other bits Lithium batteries as you may know are virtually everlasting (until they are put in circuit of course) so they are idea for alarms and similar devices that do not draw current but do rely on it always being available 4 panels that is 8 batteries altogether £2, order ref 2P258B

POWER SUPPLY WITH EXTRAS output 12v 1amp, mains input is fused and filtered and 12v output is voltage regulated, very well made on p c b, and also mounted on the board but easily removed are two 12v relays and a Piezosounder Made for expensive equipment but never installed, price £3 order ref 3P80B.

12 VOLT 1.9 AMP-HOUR rechargeable battery by Jap YUASHA brand new, charged ready for use £6.50 each Solar charger to house this and keep it ready £29 50

100 WATT MAINS TRANSFORMERS all normal primaries 20-0-20 volt 2½A 30volt 3½A, 40volt 2½A and 50volt 2A all upright mounting, all £4 each, good quantities in stock

COLOUR MONITORS 12" high resolution in black metal case with mains p s.u built in, unused, but line rejects so will require servicing, hence offered at the very low price of £49 00 plus £5 delivery

PHILIPS 9" HIGH RESOLUTION MONITOR black and white in metal frame for easy mounting, brand new still in makers packing, offered at less than price of tube alone, only £15 plus £5 delivery — good discount for quantities

16 CHARACTER 2 LINE DISPLAY screen size 85mm × 36mm, Alpha-numeric LCD dot matrix module with integral micro processor made by Epson their ref 16027AR brand £8 each, 10 for £70, 100 for £500

INSULATION TESTER WITH MULTIMETER internally generates voltages which enable you to read insulation directly in megohms The multimeter has four ranges, AC/DC volts, 3 ranges DC milliamps, 3 ranges resistance and 5 amp range These instruments are EX British Telecom, but in very good condition, tested and gntd OK, probably cost at least £50 each, yours for only £7 50 with leads, carrying case £2 00 extra

BRUSHLESS D.C. 12V FAN tiny, only 60mm square, good air mover but causes no interference £8 00

2MW LASER Helium Neon by PHILIPS, full spec. £30, power supply for this in kit form with case is £15.00, or in larger case to house tube as well £17 00 The larger unit, made up, tested and ready to use, complete with laser tube £69 00 plus £5 insured delivery.

MAINS 230V FAN best make "PAPST" 4½" square, metal blades £8 00

SOLAR CHARGER holds 4 AA nicads and recharges these in 8 hrs., in very neat plastic case £6.00.

SOLAR CELLS with terminals for joining in series for higher volts or parallel for extra current. 100mA £1, 400mA £2, 700mA £2 75, 1A £3 50.

SOLAR MOTORS 1½-9V precision made to operate from low current off solar cells £1 50, solar generator to drive this £7 00, has provision for battery back up when sun is not shining!

AIR SPACED TRIMMER CAPS 2–20 pf ideal for precision tuning uhf circuits 25p each, 10 for £2, 100 for £15

1Khz. TONE GENERATOR this is PP3 battery operated and has a 1Khz output that can be continuous or interrupted at a rate variable by a panel mounted control Constructed on a pcb and front panel size approx 105×50mm ex equipment but in as new condition £2 each.

MAINS ISOLATION TRANSFORMER stops you getting "to earth" shocks 230V in and 230V out 150 watt upright mounting £7 50

MINI MONO AMP on pcb size 4" × 2" with front panel holding volume control and with spare hole for switch or tone control, output is 4 watt into 4 ohm speaker using 12V or 1 watt into 8 ohm using 9V Brand new and perfect only £1 each or 12 for £10

5 RPM 60W MAINS DRIVEN MOTOR AND GEARBOX this has a 3in square mounting plate and is 4in deep It is a shaded pole motor Price £5

POWER SUPPLY UNITS mains in, dc out, based 4.5v 100mA regulated £1, 6v 200mA regulated £1, 6v 700mA £1, 9v 500mA £2, 12v 500mA £2, 12v 2A£5, 24v 200mA £2

TORROIDAL MAINS TRANSFORMER with twin outputs, 6.3v 2 amps and 12v 1 amp, one use would be power supply, price £5

AMSTRAD POWER UNIT 13 5v at 1 9A encased and with leads and output plug, normal mains input £5 each, 10 for £45.

AMSTRAD 3.5 FLOPPY DRIVE Reference FD9 brand new and perfect, £35.

ATARI 64XE COMPUTER at 65K this is quite powerful so suitable for home or business, unused and in perfect order but less PSU, only £19 50, Handbook £5 extra

9" CATHODE RAY TUBE Philips M24/306W, which is not only high resolution but is also X Ray and implosion protected, regular price over £30, you can have them at £12 each Tubes are guaranteed unused

80 Watt MAINS TRANSFORMERS two available in good quality, both with normal primaries and upright mounting, one is 20V 4A the other 40V 2A only £3 each or 10 for £27 carriage paid

PROJECT BOX size approx 8" × 4" × 4½" metal, sprayed grey, louvred ends for ventilation otherwise undrilled made for GPO so best quality, only £3 each or £10 for £27

12V SOLENOID has good ½" pull or could push if modified, size approx 1½" long by 1" square, £1 each or 10 for £9.

WATER VALVE 230V operated with hose connections, ideal for auto plant spray or would control air or gas into tanks etc, £1 each or 10 for £9

HANG UP PHONE won't clutter up your desk or workbench, current model, has push button dialling, last number recall, internal alarm etc., Ex B T in good condition and fully working ready to plug in £5

HIGH VOLTAGE CAPS if you use these ask for our 1-20 Kv Capacitor list, we have over ¼ million in stock and might save you a lot of money

ELECTRONIC BUMP & GO SPACESHIP sound and impact controlled responds to claps and shouts and reverses or diverts should it hit anything! Kit with really detailed instructions, will make ideal present for budding young electrician. Should be able to assemble but you may have to help with the soldering of the components on the PCB. Complete kit £8 95

500V BRIDGE MEGGER developed for G P O technicians the Ohmeter 18B is the modern equivalent of the bridge meggar 9V battery operated it incorporates a 500V generation for insulation testing and a null balance bridge for very accurate resistance measurement. Ex B.T. in quite good condition with data & tested Yours for a fraction of original cost £45 + £5 insured delivery

EXPERIMENTING WITH VALVES don't spend a fortune on a mains transformer we can supply one with standard mains input and secs of 250-0-250V at 75 mA and 6 3V at 3 A, price £5

15Watt 8ohm 8" SPEAKER & 3" TWEETER made for a discontinued high quality music centre, give real hi fi and for only £4 pair

ULTRASONIC TRANSMITTER/RECEIVER with Piezo alarm, built into preformed case, is triggered by movement disturbing reflected signal, intended for burglar alarm, car alarm etc. has many extras, time delay, auto reset, secret off device etc. A £40 instrument yours for £10.

MOVEMENT ALARM goes off with slightest touch, ideal to protect car, cycle, doorway, window, stairway, etc etc. Complete with piezo shrieker ready to use Only £2 (PP3 battery not supplied)

STEREO HEADPHONE extra lightweight with plug £2 each or 10 pairs for £18

B.T. TELEPHONE LEAD 3m long and with B T flat plug ideal to make extension for phone, Fax, etc 50p each, £40 per 100, £300 per 1000.

WATER PUMP very powerful and with twin outlets, mains operated, £10 00.

STUDIO 100 by Amstrad, the ultimate disco control panel, has four separately controlled and metered channels, twin cassettes, AM/FM radio, stereo audio amplifier, phono & C D. inputs, etc, etc, etc, regular price over £400 we have a few still in maker's packing, brand new and guaranteed, yours for £99

ROTARY POSITION CONTROLLER for aerials, ventilators, dampers, rheostats, dampers or applications requiring 180 degrees clockwise and anti-clockwise movement We have the Sauter MVE4 154 servo motor drive ref AR30W3S regular price over £70 brand new, £15 each

12 VOLT 8 AMP MAINS TRANSFORMER £4, waterproof metal box for same, £4.

110 WATT SWITCHMODE POWER SUPPLY 230v mains operated, outputs of 38v 2½A and 5v 3A, we have a lot of these and need the space so you can have these at a fraction of their cost if you order before Dec 31 price is £6.

10 VA MAINS TRANSFORMERS all p c b mounting, all £1 each, 10 for £9, 100 for £75 for output 12-0-12v order ref WA1, 20/0/20v order ref WA3, 18-0-18v not p.c b mounting but fully shrouded same price order ref WA4

0-1 mA FULL VISION PANEL METER 2¾" square, scaled 0-100 but scale easily removed for re-writing £1 each, 10 for £9, 100 for £75

PANEL AMP-METERS 80 × 70mm beautiful instruments £5 each, 10 amp order ref WA6, 5 amp order ref WA7

Vu METER illuminate this from behind becomes on/off indicator as well, 1½" square 75p each, 10 for £6, 100 for £50

EDGE-WISE PANEL METER ideal when short of panel space only 40 × 14mm, also have built-in led, 500 uA f sdd, scaled 0-5, £1 each, 10 for £9, 100 for £75

VIBRATING REED FREQUENCY PANEL METER 4" square, 55-65 Hz only £9 each.

P.C.B. DRILLS 12 assorted sizes between 75 and 1 5mm £1 the lot

LOW PRICED FIELD TELEPHONES. Ex-GPO models, not quite so nice-looking but quite efficient, and have the big advantage that the ringing is done by means of a hand operated internal generator This saves a lot of batteries. These 'phones have the normal type of rotary dial built in and can still be connected into a normal B T system. Tested, guartanteed in good order, price only £9 50 each Order Ref 9P5.

HAND GENERATORS as fitted in the above held telephones, this hand generator is a permanent magnet type and has an AC output of approximately 50v depending on how quickly you wind it If you want a higher voltage then simply connect the output to a transformer We have lit a 60 watt bulb quite successfully. The hand generator, complete with handle, £4 00 Order Ref 4P51

AMSTRAD 3" FLOPPY DRIVE cased and with built-in power supply so a self contained extra drive for you if you use 3" discs real bargain **£35.00**. Order Ref 35P2B

DRY BATTERIES CAN BE RECHARGED but not with a normal dc charger, it must be a periodic current reversal type. We can supply the kit, with data, £6 50 Order Ref 6P9B

THE COMPUTER GRADE CAPACITOR ideal for low volt, high current experiments, 75p each or 10 for £6 00 Two types available, 15000µf 10V or 10000µf 15V.

HELP YOUR BOYS INTO ELECTRONICS let them learn by experiments with our simple kits See our latest newsletter which will be sent to you with any order or ask us for a copy

SUPER MULTI-METER Ex British Telecom, this is a 19-range 20K o p v. top grade instrument, covers AC & DC voltages, current and resistance, very good condition, fully working and complete with leads £9 50, leather carrying case £2 extra (batteries not included but readily available)

SOLAR ENERGY EDUCATIONAL KIT – an ideal present for electronics students it shows how to make solar circuits and electrical circuits, how to increase the voltage or current, how to use solar power to work a radio, calculator, cassette player and to charge nicad batteries The kit comprises 8 solar cells, one solar motor, fan blades to fit motor and metal frame to hold it to complete a free-standing electric fan A really well written instruction manual makes this a lovely little present Price **£8.00**. Order Ref 8P42B

WANT TO KNOW HOW FAST IT'S TURNING? Made by the famous Muirhead Company, we have DC tachometer generators which have an output voltage depending upon its speed At 1000rpm for instance, the output voltage is 3. Ex-equipment, price only 2 for £1.00 Order Ref 246

BSR RECORD PLAYERS – Although records are fast being superseded by compact discs, you or yours may still have a collection of records that you wish to play from time to time and it would, therefore, be a good idea to buy a spare record player before they disappear from the market We have some that were originally intended for quite expensive midi systems, have never been used, are complete with diamond styli, price only **£6.00** each. Order Ref 6P5B

BLOW HEATERS Winter is coming on so it is a good idea to check your heaters to make sure they are all up to scratch We can still supply tangential units. 2.5kw, which is approx. 9" long plus the motor This can be operated at full heat, half heat or cold blow. Price of unit is **£6.00**, and we include a control switch and wiring diagram. Order Ref 6P12. We also have 1kw blow heater, only 6" wide, so ideal where space is limited – under a desk or similar – or can be made into a portable heater for defrosting pipes, etc Complete little unit, although motorised, is virtually silent in operation A shaded pole motor drives air from tangential fan through 1kw spiral element. There is also a cut-out to switch heat off should anything stop the fan from blowing. Regular price of this unit is around £20.00, yours for **£5.00** or 5 for **£20.00**. Order Ref 5P23

Prices include V.A T. Send cheque/postal order or ring and quote credit card number Add £3 post and packing Orders over £25 post free, unless postage quoted separately

M&B ELECTRICAL SUPPLIES LTD

12 Boundary Road, Hove, Sussex BN3 4EH

Telephone (0273) 430380 Fax (0273) 410142

CIRCLE NO. 136 ON REPLY CARD

IMPROVED HF RECEIVING LOOP

Small loops are easy to tune but relatively insensitive. Large loops deliver more signal but at the expense of tuning range and omnidirectional lobe shape. Ronald Salter suggests that aerial loops based on parallel clover leaves overcome these limitations.

When selecting an aerial, the serious short wave listener is not well served since the repertoire consists of long wires, dipoles, whips, small tuned loops, and little else. More elaborate aerials don't always improve the signal to noise ratio. Rising interference levels, however, require new solutions.

At the writer's location, there is high voltage reticulation and an arterial road, while six nearby AM broadcast transmitters produce cross-modulation across most of the HF spectrum. Tests have shown that a small resonant aerial gives the best signal to noise ratio under these conditions. The aerial described here is three metres square and can be mounted on a pole or above a ceiling.

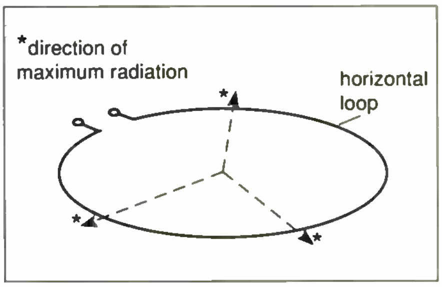
The noise reducing properties of small vertical loops are well known. Low radiation resistance, and a figure-of-8 field pattern combine to give good signal/noise ratios. However, size limitations restricts sensitivity; a single-turn HF loop must be no more than 0.1λ in circumference, or the loop current becomes non-uniform and the field pattern breaks into lobes.

Typically, a 10MHz loop will have a diameter of less than 0.5m, and an area of about 0.2m. A 10MHz dipole has a conservatively estimated aperture area of 60m^2. Signal strength is, among other things, proportional to aperture area, so the difference is obvious. Loop gains reported in the literature are from −14dB, to −17dB w.r.t. a dipole. A loop larger than 0.1λ may also have too much inductance to be tuned with a practical value of capacitor, especially if it is shielded.

In addition, the need to tune and rotate the loop means that it must be near the operator, unless a remote control system is used. Much can be done however, to remedy the situation.

Firstly, mounting the loop horizontally gives an omnidirectional field pattern (**Fig. 1**). Low mounting height will raise the radiation angle, so the loop should ideally be at a height of λ/2, which is 25m at 6MHz; the prototype is giving good results at a height of about 6m.

Fig. 1. Radiation pattern from a simple loop.



Secondly, the aperture area can be enlarged while keeping the inductance low by putting multiple turns in parallel. These cannot be placed side by side as in a normal LF loop; doing so gives the effect of a single turn with a larger cross-sectional area and roughly the same inductance. However, if the turns are separated to minimize the magnetic coupling between them, the inductance looking into the network terminals (**Fig. 2**) is given by:

$$L_n = L_a/N \qquad (1)$$

where L_n is the inductance of the network, L_a is the inductance of one loop, and N is the number of loops.

It follows from (1) that the individual loops in an N loop array can each be larger than a single loop having the same inductance as the array, and can cover the same frequency range using the same tuning capacitor. The prototype consists of four loops mounted horizontally in a clover leaf pattern.

Although the individual loop currents are non-uniform at C/λ>0.1, the geometric symmetry of the array keeps the overall field pattern reasonably uniform.

Thirdly, varicap diodes at the aerial can provide remote tuning, balancing, and impedance matching; DC control voltages are conveyed by a multi-core cable strapped to the feed-line.

Fig. 3a shows a small loop with tuning capacitor C and load resistance R_L; **3b** the equivalent circuit. V_{oc} is the open-circuit induced signal voltage, $+j\omega L_a$ is the inductive reactance, R_r the radiation resistance, R_i the RF resistance, and $-j/\omega C$ the reactance of the capacitor. Let R_a be the total in-phase component of the loop impedance

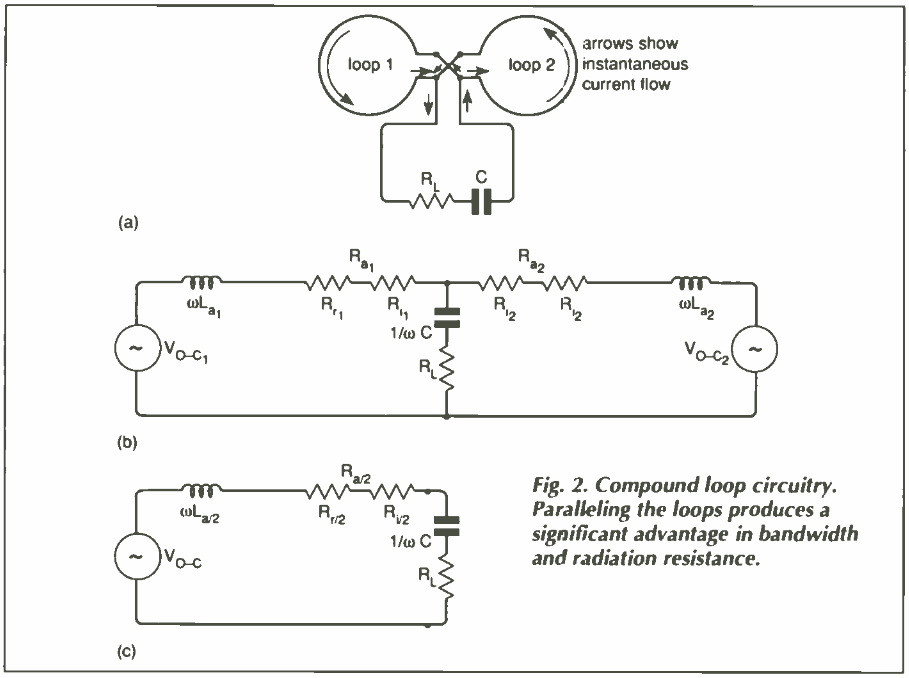


Fig. 2. Compound loop circuitry. Paralleling the loops produces a significant advantage in bandwidth and radiation resistance.

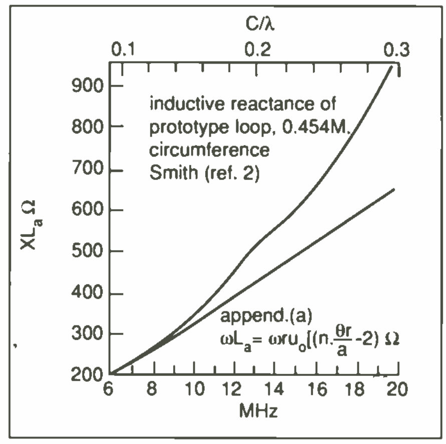


Fig. 4. Inductive reactance of prototype 0.454m loop

(R_a=R_r+R_l). Then at resonance, +jωL= –jωC, and the voltage across R_L is given by:

$$V_{RL} = \frac{V_{oc} \times R_L}{R_a + R_L} \qquad (2)$$

Figure 2a shows two identical loops mounted in the same plane, and connected so that their currents sum at the junction; **2b** is the equivalent circuit. It can be shown that Fig. 3b can be replaced by the circuit of 2c. When +jωL_a/2 = –j/ωC:

$$V_{RL} = \frac{V_{oc} \times R_L}{\frac{R_a}{2} + R_L} \qquad (3)$$

It can be similarly shown that for N identical loops:

$$V_{RL} = \frac{V_{oc} \times R_L}{\frac{R_a}{N} + R_L} \qquad (4)$$

when $+\omega L_a/N = -j/\omega C$ (5)

We can now find the gain of an N loop array compared to a single loop having the same inductance. Maximum power transfer occurs when $R_L = R_a/N$; power developed in R_L is:

$$P_{RL} = \frac{V_{oc}^2}{4 \times \frac{R_a}{N}} \qquad (6)$$

From (6) and appendix b, we can develop an expression:

$$10\log\frac{C_2^4 \times R_{a1} \times N_2}{C_1^4 \times R_{a2} \times N_1} \qquad (7)$$

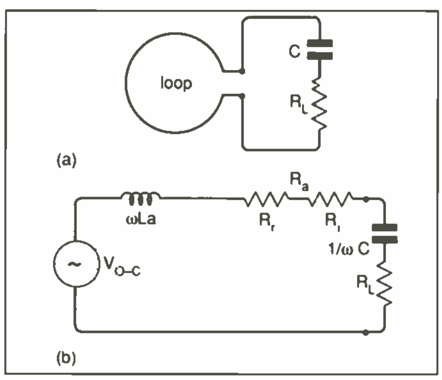


Fig. 3. Electrical circuit of a single tuned loop with resonating components.

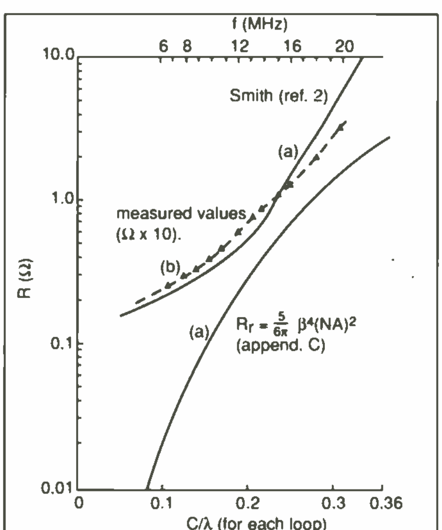


Fig. 5. Comparisons between expected and measured radiation resistance.

where C_l is the circumference of the single loop, C_2 is the circumference of one loop of the array, R_{al} is the resistance of the single loop, R_{a2} is the resistance of the array, N_l = 1 (for a single loop), and N_2 is the number of loops in the array.

There are no simple impedance relationships for larger loops; when C/λ> 0.1, both X_{La} and R_a rise faster than predicted (**Fig. 4**).

Masses of gain

Further, radiation coupling between close-spaced loops causes R_a to rise to much higher values than for one loop in free space. The writer measured R_a directly by two different methods; these were in substantial agreement (**Fig. 5**).

The prototype has four loops, each of 4.54m circumference, made from 5mm thick coaxial cable. At 10MHz the C/λ ratio = 0.15, XL_a = 87.5Ω and Ra = 3.6Ω. By extrapolation from the calculated performance of a 0.15m single loop aerial, the effective performance for the 4.54m four loop system is some 12dB better. This gives a gain of -2 dB to -5 dB w.r.t. a dipole - a good performance for a small antenna. Furthermore, this gain is available over 360°.

Equation 7 assumes circular loops, but no more than two such loops can be mounted side-by-side without overlapping. For N>2, a shape other than a circle must be used; measurements on the prototype show this is not a major factor provided the departure from the circular form is not too great.

Realising this gain requires a match between the array R_a values, ranging from 2.4Ω at 6.5MHz, to 30Ω at 20MHz, and the load impedance – normally 50 to 70Ω. A shunt capacitor matching network was used in the prototype in conjunction with a balancing/matching transformer.

Inserting the R_a values in the appropriate

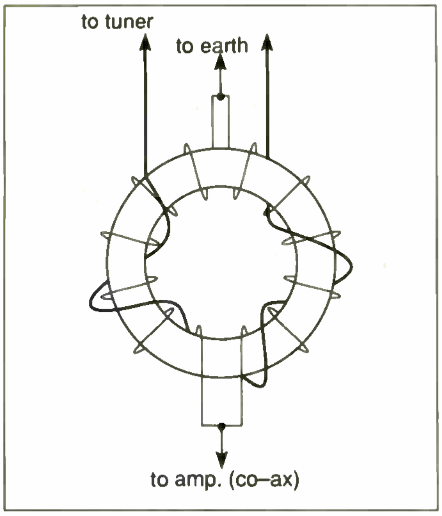
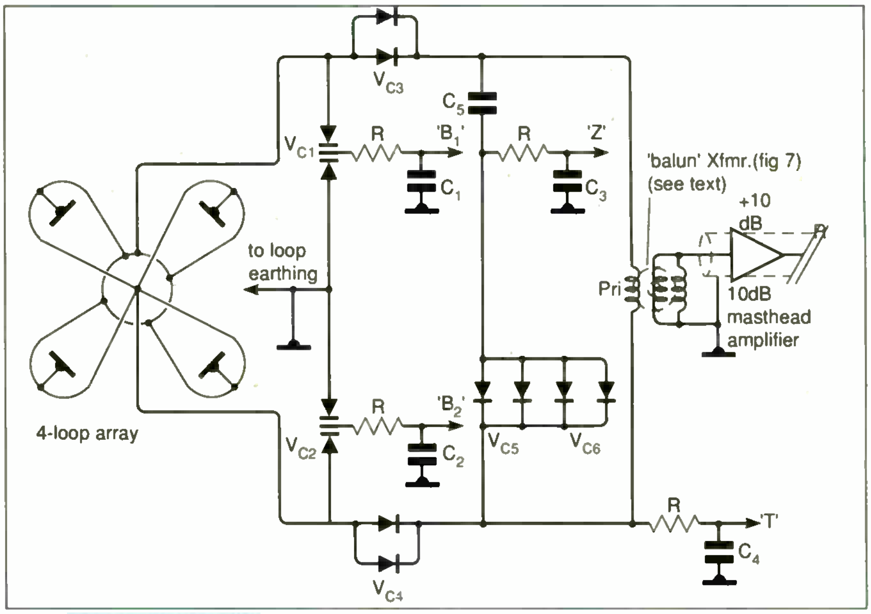


Fig. 6. Balancing/matching transformer.



equation gives a shunt capacitor vs frequency curve similar in shape to the tuning curve; the varicap voltages can then be arranged so that the shunt capacitance tracks the tuning capacitance across the frequency range and allows close to optimum matching. Although this is not of great importance in a receiving application, tests show it works quite well.

Constructional points

The transformer is wound on a toroid, and has two secondary windings of six turns each, wound in opposite directions, connected in parallel, and each spaced over half the core length. The four turn primary is wound over the secondaries and occupies the full core length (**Fig. 6**). This arrangement attempts to balance inter-winding capacitance while retaining full core usage. Tests with a source and load show high transmission efficiency and an essentially flat frequency response (1dB).

RF balancing is by varicaps to earth from each side of the array. Their control voltages mimic the action of a differential capacitor - as one voltage rises, the other falls. Thus the effect of the balancing circuit on the tuning calibration is minimised, while still allowing a large change in the balance point.

The prototype array is shown in **Fig. 7**. Needing to suspend it between masts, the writer produced an assembly of spars, spreaders, wire and rope worthy of the Wright brothers. Each loop is earthed at its mid-point to minimise broadcast crossmodulation; the earth conductors are two metal spars, and two lengths of coax strapped to the support rope. All four join at the centre.

Loop phasing is important. Each loop exits, curves clockwise (looking from above) and enters below. The four starts are joined inside a top cap; the four ends are joined in the tee body. Flexible leads and screw connectors connect these joins to the tuner.

Figures 8(a) and **8(b)** show the masthead tuner and control circuitry. The emitter follower allows the tuning, matching, and balance voltages to follow the setting of the tuning potentiometer. It has been found convenient to allow the balancing voltage to follow the tuning also; this allows roughly constant adjustment of the balance pot at different frequencies. Occasionally, a better s/n ratio is obtained by reducing the balance voltage below the maximum, but this happens so rarely that the balance voltage pot may be eliminated if desired, the supply for the balance network being taken direct from the emitter of the transistor.

The tuner exhibits an apparent double-humped tuning characteristic, due to the array coming to balance at resonance. To tune, set the balance pot central, adjust tuning to mid way between noise peaks, then reset balance pot. If a noise null cannot be found (a rare occurrence) slight adjustment of the Z-match will often help. While the exact reason for this latter phenomenon is not apparent, it may be that adjusting *V* changes the phase relationship between the signal current and components flowing in the array earth network.

The modest gain (+10dB) line amplifier was an after thought, and is useful particularly at the lower frequencies. At the top of the spectrum, a little white noise is apparent, which may be reduced by lowering the amplifier supply voltage to about half the normal value.

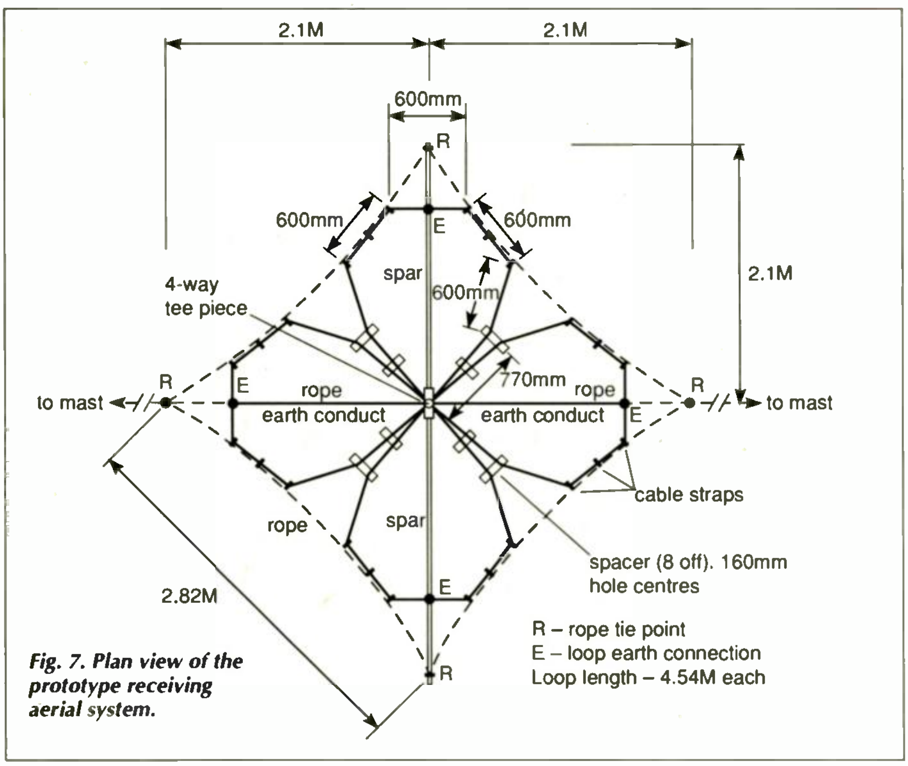


Fig. 7. Plan view of the prototype receiving aerial system.

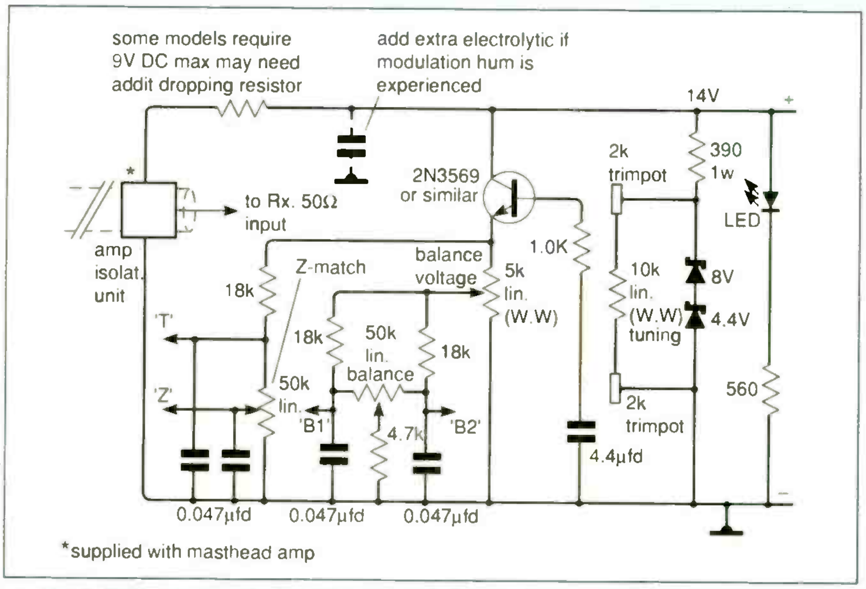


Fig. 8. Tuning and control circuitry. 8(a) (left) masthead tuner; 8(b) above) control box.

Table 1. Summary w.r.t the dipole set.

Frequency	Long wire	Loop array	Whip
7MHz	−2dB	+3dB	−3dB
11MHz	−3dB	+8dB	0dB
17MHz	−0.5dB	+10dB	−1dB

Performance

The writer has compared the loop array performance, over several years, against three other aerials: a 2m long tuned whip, a 35m wire, and an array of three dipoles cut log-periodic fashion across the frequency range. Accurate measurements are difficult – but an idea of performance has been gained.

The calculated figure of +12dB w.r.t. a loop, and −3dB w.r.t. a dipole, at 10MHz, has been confirmed. No attempt has been made to measure the field pattern, but where the dipoles and long wire are clearly directional, no such property has been observed.

As expected, broadcast cross-modulation is severe with both the long wire and dipoles, but is scarcely observable with both the whip and the loop array.

The most important property, the signal/noise ratio, depends on the frequency and the conditions – i.e. the current level of electro-magnetic noise.

Table 1 gives a summary at three frequencies w.r.t the dipole set. These figures, based mainly on receiver AGC measurements, do not accurately reflect the ability of the loops to reject impulse noise, especially at the lower frequencies. Tape recordings have been made of signals which are clear and legible on the loop array, but unreadable on all other aerials. The performance of the loops is such that the whip and dipoles have been discarded, the long wire being retained only for demonstration purposes. ■

Bibliography

Mukherjee, S. *Indoor Loop Aerial for Short Waves. Electronics and Wireless World*, April 1985, p. 39.

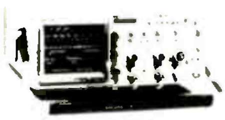
Smith, G.S. *Loop antennas*, Chapter 5. *Antenna Engineering Handbook*, by Johnson and Jasik, Mcgraw-Hill.

Patterson, R.H. *Down-to-Earth Army antennas*, Electronics (Amer.) August 1967, p. 111.

Network Transformers, R.S.G.B. *Communications Handbook*, Radio Society of Great Britain

Alford, A. and . A. Kandoian, *Loop Antennas*, Trans. A.I.E.E. Supplement, vol. 59, p. 843, 1940.

SPECTRUM ANALYSERS



HP182C/8558B 0.1–1500MHz £2250
HP182T/8559A 21GHz system £5000
HP8590A 1500MHz GPIB £3600
MARCONI TF2370 110MHz analyser £2750
MARCONI TF2371 200MHz analyser £3250
HP141T/8552B/8554B 1250MHz system £2000
HP140 1250MHz system with 'A' units £1100
ANRITSU MS62B 1700MHz analyser £2250
MARCONI 2382/2380 400MHz system £9000

MARCONI INSTRUMENTS

2019A synthesized signal generator 10kHz–1040MHz £ SOLD
2091C/2092C white noise receiver/transmitter, pair £1750
2015 signal generator AM/FM 10–520MHz £200
2015/2171 above but with synchronizer £400
2177 RF amplifier 3W 40dB gain to 1GHz £950
2356/2357 level oscillator/level meter £1000
2380/82 400MHz spectrum analyser £9000
2430A 80MHz frequency counter £95
2431A 200MHz frequency counter £110
2501 RF power meter 0.3W DC–1GHz £150
2503 RF power meter to 100W DC–1GHz £200
2828A/2829 digital simulator/analyser £1500
2833 digital in-line monitor £250
2870 data communications tester £1000
6460 microwave power meter with head 6421 £300
6700B sweep oscillator 8–12.4GHz £1000
OA2805A PCM regenerator test set £750
TF1245A Q-Meter with 1246 and 47 oscillators £500
TF2006 FM signal generator 10–1000MHz £350
TF2011 FM signal generator 130–180MHz £50
TF2013 FM signal generator 800–960MHz £150
TF2162 audio frequency attenuator £100
TF2163S DC–1GHz attenuator £350
TF2370 110MHz spectrum analyser £2750
TF2371 200MHz spectrum analyser £3250
TF2500 audio frequency power meter £75
TF2600B video voltmeter 1mV–300V fsd £125
TF2908 blanking & sync mixer £150
TF893A audio power meter £50
TM4520 inductor set £250

URGENTLY REQUIRED — 'HIGH-END' test Equipment by brand names. TOP prices paid for HP, TEK, MARCONI etc. PLEASE CALL.

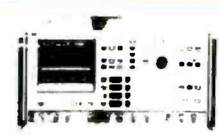
RALFE · ELECTRONICS
36 EASTCOTE LANE, S. HARROW, MIDDLESEX HA2 8DB
TEL: 081-422 3593. FAX: 081-423 4009

EST 35 YEARS

TEST EQUIPMENT

AIM 501 low distortion oscillator GPIB/RS232 £550
ANRITSU MW98A/MH925A optical TDR £2500
ANRITSU MS62B 1700MHz spectrum analyser £2250
AVO CB154/5 electrolytic & tant' cap' bridge £750
AVO RM160/3 megohmmeter £175
AVO RM215L-2 ac/dc breakdown tester to 12kV £695
BRANDENBURG Alpha II 507R 0–5kV £300
BRUEL & KJAER 4416 response test unit £550
BOONTON 102B AM/FM signal generator £1000
FARNELL PSG520 signal generator AM/FM 10–520MHz £1000
GIGATRONICS GU1240A signal source 0.01–4GHz £1250
NATIONAL VP-7750A wow & flutter meter £225
PHILIPS PM5190 synthesized function generator £950
PHILIPS PM5534 standard pattern generator NTSC £2500
PHILIPS PM5545 colour encoder PAL £1000
PHILIPS PM5597 VHF modulators £250, PM5598 UHF £500
PHILIPS PM5580 I.F. modulator £1500
PHILIPS PM6652 1.5GHz timer/counter GPIB £850
PHILIPS PM8202 recorder with 9874/01 temp' unit £450
RACAL 9081 signal generator 5–520MHz synthesized £850
RACAL 9082 signal generator 1.5–520MHz synthesized £950
RACAL 9105 RF micro-wattmeter 0.02μW–200mW £250
RACAL 9300 RMS voltmeter −80dB to +50 £325
RACAL Store 4 4-channel tape recorder £1000
RACAL 9341 LCR databridge component tester £350
SCHAFFNER NSG200C/NSG223A interference generator £1100
SCHLUMBERGER 4021 mobile radio test set £1500
SHIBASOKU 217A/33 SECAM colour bar generator £325
SYSTEM VIDEO TV vectorscope/waveform monitor £600
TEKTRONIX J16 digital photometer £275
TEKTRONIX 1485R full spec' TV waveform monitor £2000
TEKTRONIX 1503B/03/04 TDR cable tester £3000
TEKTRONIX 475A 250MHz oscilloscope £500
TEKTRONIX 2335 ruggedized 100MHz oscilloscope £950
TEKTRONIX SG503/PG506/TG501 calibration system £2250
TEKTRONIX 7623A 100MHz scope 7B53A 7A18s £1250
TEKTRONIX 7613/7A19/7B10 storage scope system £750
TEKTRONIX 7A13, 7A26, 7B53A, 7A18, 7B85, 7B87, 7CT1 NPOA
TEKTRONIX FG504 function generator £550
TEXSCAN VS60C 1000MHz sweep generator £1100
TEXSCAN VS90 5MHz–2400MHz sweep generator £850
TOA PM 30R RF volt-meter 1mV–10V fsd £250
WAYNE KERR 3245 precision inductance analyser GPIB £3750
YOKOGAWA 3655 analysing recorder £950
YOKOGAWA 3061-21 6-channel chart recorder £350

HEWLETT PACKARD



11602B transistor fixture for S-parameter test £350
11710 frequency down-converter for 8640B £650
141T/8552B/8554B 1250MHz spectrum analyser system £2250
1741A 100MHz storage (analogue) oscilloscope £450
334A distortion meter **SOLD** £450
3580A audio spectrum analyser 15Hz–50kHz **SOLD** £1750
400FL mV-Meter 100μV–300V fs. 20Hz–4MHz £325
4274A multi-frequency LCR meter HPIB **SOLD** £3500
435A/3484A microwave power meter £700
4342A Q-meter 22kHz–70MHz. Q-range 5–1000 **SOLD** £1000
5005B signature multi-meter, programmable £1750
5300A/5302A 50MHz counter-timer £95
5328A 100MHz frequency counter/DVM option £500
5363B time-interval probes £250
6516A power supply 0–3kV @ 6mA £250
70300A tracking generator plug-in unit £3000
70907A external mixer £2750
7015B analogue X-Y recorder with timebase £650
8405A vector voltmeter, voltage & phase to 1000MHz £1250
8406A comb generator £1000
8503A S-parameter test set £1500
8505A network analyser £5000
8553B 110MHz spectrum analyser plug-in £750
8556A 141T-system based spectrum analyser plug-in £750
8558B/182C 1500MHz spectrum analyser system £2250
8559A/182T 21GHz spectrum analyser system £5000
8566A spectrum analyser £15000
8566B spectrum analyser £29000
8569A 22GHz spectrum analyser £6500
8590A 1500MHz spectrum analyser GPIB option £3500
8600A digital marker generator for 8601A £325
8614A signal generator 800MHz–2.4GHz £1250
8620A sweeper main frame & 8621B plug-in units £1500
86222A sweep generator plug-in 10MHz–2.4GHz £1750
8640A signal generator 5–520MHz AM/FM £850
8640B signal generator options 1, 2 and 3 **SOLD** £1750
8750A storage normaliser £750
8954A transceiver interface £750

PLEASE NOTE: ALL OUR EQUIPMENT IS NOW CHECKED TO MANUFACTURERS' SPECIFICATIONS BY INDEPENDENT LABORATORY TO BS5750. Certificates of calibration to this standard can be supplied at very reasonable cost. All items guaranteed for 3 months (90 days) and 7-days 'return for full refund' warranty. URGENTLY REQUIRED FOR STOCK – 'high end' test equipment, cash waiting for first quality second-user instruments. **ALL PRICES SUBJECT TO ADDITIONAL VAT.**

CIRCLE NO. 137 ON REPLY CARD

Looking into a crystal memory

Results from a project at the Clarendon Laboratory shows the production of memory systems made out of stacks of atoms may at last be possible. Shaz Horner reports.

Massive but miniaturised storage capacity has been the computer industry's ultimate goal for over a decade. When magnetic bubble memories came about in the late 1970s they were highly regarded as a major leap forward. But now, following from observations made by a team of physicists during the course of a research project, there may be a new way of developing high capacity storage systems.

The research project is taking place at Oxford University's Physics Department (the Clarendon Laboratory), and the aim is to study the magnetic properties of crystals containing rare earth ions.

As part of the project the team is developing rare earth multilayers and superlattice structures by using an ultra high vacuum deposition plant.

Layers of magnetic and non-magnetic atoms are deposited in succession to form a multiple sandwich repeated about 100 times in coherent epitaxy. The atomic layers are deposited in a regular coherent array – more akin to materials engineering, putting rafts of atoms on top of each other. The layers, each of which can be about two atomic layers thick, are deposited by using molecular beam epitaxy (MBE) - this is where the project gets its name; LaMBE. La comes from the lanthanide series of rare earths. MBE has been in use for sometime for semiconductor deposition and for the development of high temperature superconductors.

The resulting sandwich is thin at about 50 Angstrom or less.

Alternating layers are deposited on a sapphire substrate coated with a niobium buffer layer. The substrate/buffer system provides the atomically smooth and regular surface on which the rare earths can be deposited in any desired sequence or thickness, and built up atomic layer by atomic layer.

It is when the designed crystal structures are placed in a magnetic field that they show "interesting properties". According to the team: "New and unexpected magnetic phenomena have been observed in these designer materials which suggest tantalising possibilities for device application".

One example is that in a multilayer structure where the "particular"rare earth metals and the thicknesses of the layers are optimised, "metastable magnetic states" are observed.

In these states the magnetisation vector for neighbouring rare earth ions along a specified direction, form a left handed or right handed helix depending on magnetic and thermal history. In addition the magnetic behaviour is translated through the layers - one layer talks to another layer magnetically even if there is a non-magnetic layer in between. Therefore by assigning zero or one to each of the states respectively an n-digit binary number could be stored vertically through the n-layer sample.

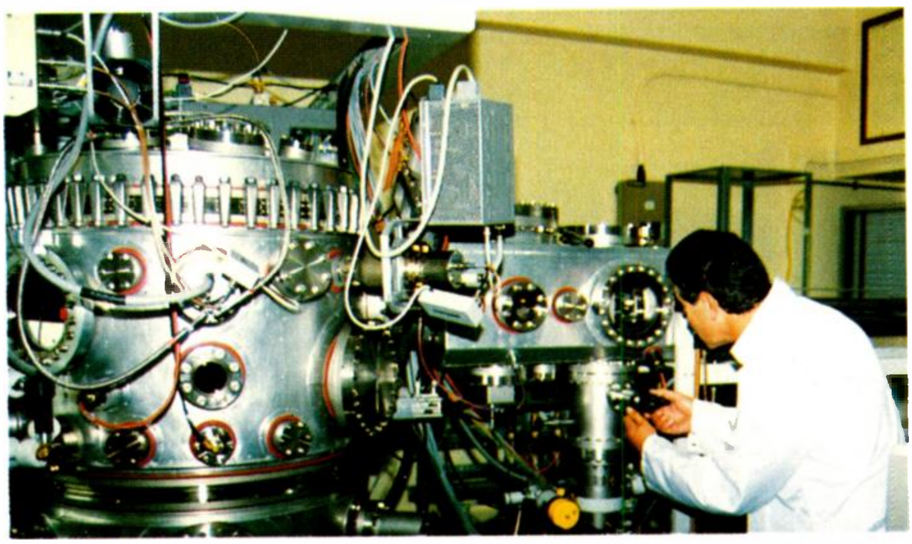
If the results obtained from this research project can be harnessed for developing high density storage devices the consequences for the computer industry would be far reaching. The project could enable development of magnetic storage chips made of artificial crystals containing rare earth materials. It may prove to be the basis of devices with increased storage capacity and greater miniaturisation.

But one major hurdle still to be tackled would be finding a way to write and read data to and from such memories. A possible solution could be the use of variable intensity, focused laser radiation which uses the skin-depth effect, according to the LaMBE team

Nonetheless, the project's aim at present is to grow and understand the physical properties of the crystals. Finding a way to read or write the information, would be a problem for engineers to solve.

As to why rare earth metals are used for the research project, the team say that rare earth ions have smaller inter-atomic interactions which make them more "amenable" to investigations The magnetic behaviour of a rare earth ion arises from its incomplete shell of electrons. This shell is shielded by conduction electrons and therefore the effects observed are easier to piece together than would be the case with transition metals such as iron and cobalt.

Shaz Horner



Looking for "New and unexpected magnetic phenomena": Mike Wells of the Oxford team examines the loaded cassettes in the UMS 630 at the Clarendon Laboratory

Deposition process

The laboratory uses a Serc funded Blazers UMS 630 customised to meet the project's specific requirements. The plant provides a vacuum of 10^{-11}mbar as well as computerised control of the evaporation process. Up to six substrates may be loaded onto a cassette system and are transferred one at a time, from the load-lock chamber into the main growth chamber. The growth chamber has been fitted with a specially developed cryogenic shield for protection against contamination during deposition. Currently the plant has two electron beam guns and one effusion cell but there is capacity for expansion. These provide the sources of rare earth metal vapour and niobium.

According to the LaMBE team a particular advantage of the plant is the provision of a quadrupole mass spectrometer to monitor the evaporant beams from the electron-gun-heated hearths. The measured flux is compared with a reference value and the difference is fed back to the electron gun controller. Slow control in the range of seconds is affected by altering the filament current of the electron source. Fast control in the range of ten milliseconds is produced by changing the voltage on the Wehnelt shield surrounding the source of electrons thereby altering the number which arrive at the hearth.

COMPUTER ICS

2817A-20 used £2
80C88A-2 used £1.25
27C64-25 used/wiped .... £1.50 100+ £1
27S191 PROM £2
IMS1400P-45 .... £2
80C31 MICRO £2
P8749H MICRO £5
D8751H £10
NEW 4164-15 .... £1
USED 41256-15 .... £1
USED 4164-15 .... 60p
BBC VIDEO ULA £10
VIDEO ULA 201647 .... £10 ea. 10+ £8
6845 CRT £5
6522 PIA £3
DM88LS120 .... £4.50
AY3-1015D UART £2.50
9 × 41256-15 SIMM £10
8 × 4164 SIP MODULE NEW £8
HD 146818 CLOCK IC £2
2864 EPROM £3
27128A 250ns EPROM USED .... £2 NEW £2.30
27C1001-20Z NEW 1M EPROM £6
FLOPPY DISC CONTROLLER CHIPS 1771 .... £10
FLOPPY DISC CONTROLLER CHIPS 1772 .... £17.50
68000-8 PROCESSOR NEW £6
HD6384-8 .... £5
ALL USED EPROMS ERASED AND BLANK CHECKED CAN BE PROGRAMMED IF DESIRED
2716-45 USED £2 100 £1
2732-45 USED £2 100 £1
2764-30 USED £2 100 £1.60
27C256-30 USED £2
27C512 USED £3.50
1702 EPROM EX EQPT £5
2114 EX EQPT 50p 4116 EX EQPT 70p
6264-15 8k STATIC RAM £2
SN76489AN £3
GR281 NON VOLATILE RAM EQUIV 6116 .... £5
Z80A SIO-O £1.25
TMS27PC256-25 ONE SHOT 27C256 .... £1 ea 100 £70
8085 PROCESSOR £2 MC6802 PROCESSOR £2

REGULATORS

78M05 5V 0.5A 7 £1
LM317H T05 CAN £1
LM317T PLASTIC TO220 variable £1
LM317 METAL £2.20
7812 METAL 12V 1A £1
7805/12 15/24V plastic .... 25p 100+ 20p 1000+ 15p
7905/12 15/24 plastic .... 25p 100+ 20p 1000+ 15p
CA3085 TO99 variable reg 2 £1
LM338 5A VARIABLE £8
L387 5v ½A WITH RESET OUTPUT £1ea £50 100

CRYSTAL OSCILLATORS

1M000 1M8432 1M000 4M000 16M000 20M500 32M0000 56M6092 .... £1.50 each

CRYSTALS

1M0 2M77 4M000 4M9152 5M0688 6M0000 8M0000 12M000 14M31818 15M000 16M000 16M5888 17M000 20M000 21M855 22M1184 49M50 .... £1 each

TRANSISTORS

BC107 BCY70 PREFORMED LEADS full spec £1 £4 100 £30 1000
BC557, BC546B, BC238C, BC308B £1 30 £3.50 100

POWER TRANSISTORS

P POWER FET IRF9531 8A 60V 3 £1
N POWER FET IRF531 8A 60V 2 £1
2SC1520 sim BF259 .... 3 £1 100 £22
TIP 141 2 £1 ea TIP 112 125 42B 2 £1
TIP35B/TIP35C £1.50
SE9301 100V 1DA DARL SIM TIP121 .... 2 £1
PLASTIC 3055 OR 2955 equiv 50p 100 £35
2N3773 NPN 25A 160V £1.60 .... 10 £14
2N3055H .... 4 for £2

TEXTOOL ZIF SOCKETS

28 WAY ZIF EX NEW EQUIPMENT £2.50
40 WAY NEW £5
SINGLE IN LINE 32 WAY CAN BE GANGED FOR USE WITH ANY DUAL IN LINE DEVICES . . . COUPLING SUPPLIED 2 £1.50

CAPACITORS COMPUTER GRADE

TOROID 350VA 35+35V AND 15V+15V 24VA £12 (£4)
2200µF 160V SIC SAFCO FELSIC CO38 .... £4 (£1.20)
24,000µF 50V £3 (£1.30)
10,000µF 100V SPRAGUE 36D £6

QUARTZ HALOGEN LAMPS

12V 50watt LAMP TYPE M312 .... £1 ea HOLDERS 60p ea
24V 150 WATTS LAMP TYPE A1/215 .... £2.50 each

MISCELLANEOUS

HITACHI LM018L LCD MODULE 40×2 CHARACTERS 182×35×13mm £10
HITACHI LM016L LCD MODULE 16×2 CHARACTERS 84×44×12mm £5
6-32 UNC 5/16 POZI PAN SCREWS £1 100
NUTS £1.25 100
PUSH SWITCH CHANGEOVER 2 £1
RS232 SERIAL CABLE D25 WAY MALE CONNECTORS .... £5.90 ea (£1.30)
25 FEET LONG, 15 PINS WIRED BRAID + FOIL SCREENS .... INMAC LIST PRICE £30

STICK ON CABINET FEET RS NO 543-327 .... 30 £1
LEMAG EARTH LEAKAGE TRIP 35A 35mA TRIP £9
FANS 240V 120MM £6 (£1.50)
(OTHER VOLTAGES SIZES USUALLY AVAILABLE)
AMERICAN 2 3 P N CHASSIS SOCKET 2 £1
HUMIDITY SWITCH ADJUSTABLE £2
WIRE ENDED FUSES 0.25A 30 £1
NEW ULTRASONIC TRANSDUCERS 32kHz .... £2 pr
12-CORE CABLE 7 0.2mm OVERALL SCREEN .... 70p metre
POWERFUL SMALL CYLINDRICAL MAGNETS 3 £1
BNC 50OHM SCREENED CHASSIS SOCKET 2 £1
SMALL MICROWAVE DIODES AE1 OC1026A 2 £1
D.I.L. SWITCHES 10-WAY £1 8-WAY 80p 4 5 6-WAY 80p
180VOLT 1WATT ZENERS also 12V & 75V 20 £1
PLASTIC EQUIPMENT CASE 9×6×1.25 WITH FRONT AND REAR PANELS CONTAINING PCB WITH EPROM 2764-30 AND ICS 7417 LS30 LS32 LS367 7805 REG. 9-WAY D PLUG. PUSH BUTTON SWITCH. DIN SOCKET £1.90
VN 10LM 60V ½A 5 Ohm TO-92 mosfet 4 £1 100 £20
MIN GLASS NEONS 10 £1
RELAY 5V 2-pole changeover looks like RS 355-741 marked STC 47WBost .... £1 ea
MINIATURE CO-AX FREE PLUG RS 456-071 .... 2 £1
MINIATURE CO-AX FREE SKT RS 456-273 .... 2 £1.50
DIL REED RELAY 2 POLE n o CONTACTS .... ££
PCB WITH 2N2646 UNIJUNCTION WITH 12V 4-POLE RELAY £1
400m 0.5W thick film resistors (yes four hundred megohms) 4 £1
STRAIN GAUGES 40 ohm Foil type polyester backed balco grid alloy .... £1.50 ea 10+ £1
ELECTRET MICROPHONE INSERT £0.90
Linear Hall effect IC Micro Switch no 613 SS4 sim RS 304-267 .... £2.50 100+ £1.50
HALL EFFECT IC UGS3040 + magnet £1
OSCILLOSCOPE PROBE SWITCHED ×1 ×10 .... £12
CHEAP PHONO PLUGS 50 £2 1000 £10
1 pole 12-way rotary switch 4 £1
AUDIO ICS LM380 LM386 TDA 2003 .... £1 ea
555 TIMERS £1 741 OP AMP 6 £1
ZN414 AM RAIDO CHIP 80p
COAX PLUGS nice ones 4 £1
COAX BACK TO BACK JOINERS 3 £1
4×4 MEMBRANE KEYBOARD £1.50
INDUCTOR 20µH 1.5A 5 £1
1.25" PANEL FUSEHOLDERS 3 £1
CHROMED STEEL HINGES 14.5×1" OPEN .... £1 each
12V 1.2W small wire ended lamps fit Audi VW Saab Volvo 10 £1
STEREO CASSETTE HEAD £2
MONO CASS. HEAD £1 ERASE HEAD 50p
THERMAL CUT OUTS 50 77 85 120 C .... £1 ea
THERMAL FUSES 220 C 121 C 240V 15A 5 £1
TRANSISTOR MOUNTING PADS TO-5 TO-18 .... £3 1000
TO-3 TRANSISTOR COVERS 10 £1
PCB PINS FIT 0.1" VERO 200 £1
TO-220 micas + bushes .... 10/50p 100/£2
TO-3 micas + bushes 15 £1
PTFE min screened cable 10m £1
Large heat shrink sleeving pack £2
CERAMIC FILTERS 6M 9M 10.7M 60p 100 £20
IEC chassis plug filter 10A £3
Potentiometers short spindles values 2k5 10k 25k 1m 2m5 lin 4 £1
500k lin 500k log 4 £1
40kHz ULTRASONIC TRANSDUCERS EX-EQPT NO DATA .... £1 pr
LM335Z TEMP SENSOR 10 C PER MV £1
LM234Z CONST. CURRENT I.C. £1
PAPST 18-24V FAN 120MM WORKS OK ON 12V £5
BNC TO 4MM BINDING POST SIM RS 455-961 .... £1
BUTTON CELLS/WATCH BATTERIES SIM AG10/AG12 .... 4 £1
MIN PCB POWER RELAY 12V COIL 6V CONTACTS 2 P C/O £1.25
AVEL LINDBERD MOULDED TRANSFORMER TYPE 0B10 15+15V 10VA QTY. AVAILABLE .... £2 ea
BANDOLIERED COMPONENTS ASSORTED Rs, Cs, ZENERS £5 1000

DIODES AND RECTIFIERS

A115M 3A 600V FAST RECOVERY DIODE 4 £1
1N5407 3A 1000V 8 £1
1N4148 .... 100 £1.50
1N4004 SD4 1A 300V 100 £3
1N5401 3A 100V 10 £1
BA158 1A 400V fast recovery 100 £3
BY127 1200V 1.2A 10 £1
BY254 800V 3A 8 £1
BY255 1300V 3A 6 £1
6A 100V SIMILAR MR751 .... 4 £1
1A 600V BRIDGE RECTIFIER 4 £1
4A 100V BRIDGE 3 £1
6A 100V BRIDGE 2 £1
8A 200V BRIDGE 2 £1.35
10A 200V BRIDGE £1.50
25A 200V BRIDGE £2 .... 10 £18
25A 400V BRIDGE £2.50 .... 10 £22

SCRS

PULSE TRANSFORMERS 1:1+1 .... £1.25
2P4M EQUIV C106D 3 £1

TICV106D 800mA 400C SCR 3 £1 .... 100 £15
MEU21 PROG. UNIJUNCTION 3 £1

TRIACS .... DIACS 4/£1

NEC TRIAC ACO8F 8A 600V TO220 .... 5 £2 100 £30
TXAL225 8A 500V 5mA GATE 2 £1 100 £35
BTA 08-400 ISO TAB 400V 5mA GATE 90p
TRAL2230D 30A 400V ISOLATED STUD .... £5 ea

CONNECTORS

D25 IDC SOCKET FUJITSU £2
34-way card edge IDCCONNECTOR (disk drive type) £1.25
CENTRONICS 36 WAY IDC PLUG £2.50
CENTRONICS 36 WAY IDC SKT £4.00
BBC TO CENTRONICS PRINTER LEAD 1.5M £3
CENTRONICS 36 WAY PLUG SOLDER TYPE £4
USED CENTRONICS 36W PLUG+SKT £3

USED D CONNECTORS price per pair

D9 60p, D15 £1.50, D25 £2, D37 £2, D50 £3.50, covers 50p ea

WIRE WOUND RESISTORS

W21 or sim 2.5W 10 of one value £1
R10 0R15 0R21 2R0 4R7 5R0 5R6 8R2 10R 12R 15R 18R 20R 22R 27R 33R 47R 56R 62R 91R 120R 180R 390R 430R 470R 680R 820R 910R 1K15 1K2 1K5 1K8 2K4 2K7 3K3 3K0 5K0
R05 (50 milli-ohm) 1% 3W .... 4 for £1
W22 or sim 6W 7 OF ONE VALUE £1

PHOTO DEVICES

HI BRIGHTNESS LEDS CQX24 RED 5 £1
SLOTTED OPTO-SWITCH OPCOA OPB815 .... £1.30
2N5777 .... 50p
TIL81 PHOTO TRANSISTOR £1
TIL38 INFRA RED LED 5 £1
4N25, OP12252 OPTO ISOLATOR 50p
PHOTO DIODE 50P .... 6/£2
MEL12 (PHOTO DARLINGTON BASE n c) 50p
LED's RED 3 or 5mm 12 £1 .... 100 £6
LED's GREEN OR YELLOW 10 £1 .... 100 £6
FLASHING RED OR GREEN LED 5mm 50p 100 £40
HIGH SPEED MEDIUM AREA PHOTODIODE RS651-995 .... £10 ea

STC NTC BEAD THERMISTORS

G22 220R, G13 1K, G23 2K, G24 20K, G54 50K, G25 200K, RES 20 C DIRECTLY HEATED TYPE .... £1 ea
FS22BW NTC BEAD INSIDE END OF 1" GLASS PROBE RES 20 C 200R .... £1 ea
A13 DIRECTLY HEATED BEAD THERMISTOR 1k res. ideal for audio Wien Bridge Oscillator .... £2 ea

CERMET MULTI TURN PRESETS ¾"

10R 20R 100R 200R 250R 500R 2K 2K2 2K5 5K 10K 47K 50K 100K 200K 500K 2M .... 50p ea

IC SOCKETS

32-WAY TURNED PIN SOCKETS 7K AVAILABLE 3 £1
6 pin 15 £1 8 pin 12 £1 14/16 pin 10 £1 18 20 pin 7 £1 22 24 28 pin 4 £1 40 30p
SIMM SOCKET TAKES 2X30 WAY SIMMS £1

SOLID STATE RELAYS

40A 250V AC SOLID STATE RELAYS £10

POLYESTER/POLYCARB CAPS

100n, 220n 63V 5mm 20 £1 100 £3
1n 3n3 5n6 8n2 10n 1% 63V 10mm 100 £5
10n 15n 22n 33n 47n 66n 10mm rad 100 £3.50
100n 250V radial 10mm .... 100/£3
100n 600V Sprague axial 10 £1 .... 100/£6 (£1)
2µ2 160V rad 22mm, 2µ2 100V rad 15mm 100 £10
10n 33n 47n 250V AC x rated 15mm 10 £1
1µ 600V MIXED DIELECTRIC .... 50p ea
1µ0 100V rad 15mm, 1µ0 22mm rad 100 £6

RF BITS

CONHEX 50ohm PCB RIGHT ANGLE PLUG ITT/SEALECTRO 051 053 9029 22-0 4K AVAILABLE 2 £1
TRW 50watt 50ohm DUMMY LOADS £50
TRIMMER CAPS .... ALL 4 50p
SMALL 5pF 2 pin mounting 5mm centres
SMALL MULLARD 2 to 22pF 4/50p
Larger type grey 2 to 25pF black 15 to 20pF
TRANSISTORS 2N4427 .... 70p
FEED THRU CERAMIC CAPS 1000pF .... 10/£1

MINIATURE RELAYS Suitable for RF

5 volt coil 1 pole changeover £1
5 volt coil 2 pole changeover £1
12 volt coil 1 pole changeover £1

MONOLITHIC CERAMIC CAPACITORS

10n 50V 2.5mm 100 £4.50
100n 50V 2.5mm or 5mm .... 100/£6
100n ax short leads 100 £3
100n ax long leads 100 £5
100n 50V dil package 0.3" rad 100 £8
1µF 50v 5mm £6/100

STEPPER MOTORS

2 CENTRE-TAPPED 9 VOLT WINDINGS 7.5 STEPS £4

SEND £1 STAMPS FOR CURRENT IC + SEMI STOCK LIST – ALSO AVAILABLE ON 3½" FLOPPY DISK

MAIL ORDER ONLY

MIN. CASH ORDER £3.00. OFFICIAL ORDERS WELCOME
UNIVERSITIES COLLEGES SCHOOLS GOVT. DEPARTMENTS
MIN. ACCOUNT ORDER £10.00
P&P AS SHOWN IN BRACKETS (HEAVY) ITEMS
65p OTHERWISE (LIGHT) ITEMS

ADD 17½% VAT TO TOTAL

ELECTRONIC COMPONENTS BOUGHT FOR CASH

KEYTRONICS

TEL. 0279-505543
FAX. 0279-757656
P O BOX 634
BISHOPS STORTFORD
HERTFORDSHIRE CM23 2RX

CIRCLE NO. 140 ON REPLY CARD

Low-cost synchronous detection

Direct-conversion receivers have a number of fundamental advantages over competitive techniques. But up to now nobody has yet marketed a direct-conversion receiver with synchronous demodulation for broadcast signals at a competitive price. However a recent patent application for design of a synchronised double-sideband AM broadcast receiver with no IF stages could change all that.

One of the important advantages of direct-conversion receivers is virtual elimination of spurious responses, in particular image-response. Benefits also include the opportunity to utilise the linear demodulated signal for effective post-detector filtering (including digital signal processing). This is preferable to IF filtering based on crystal filters of limited dynamic range which exhibit non-reciprocal characteristics.

Considerable use has been made of direct conversion, particularly for simple low-cost SSB/CW receivers built by amateurs without fully synchronous I, Q demodulators. But the technique is suitable for simple applications such as paging receivers where it is possible to integrate the entire receiver on a chip. Direct conversion is also seen as one way of implementing digital HF receivers, although in this case there is usually a preliminary mixer and broadband IF.

Over the years there have been a few designs for synchronous detection receivers for the reception of MF/HF AM broadcast stations, but only those based on superhet-type front-ends seem to have reached the market-place.

Some years ago Phase Track of Reading introduced a portable superhet receiver, crystalled for a limited number of HF broadcast channels (eg BBC World Service) that featured synchronous AM detection to counter distortion due to selective fading. Later, for general coverage, a model with a frequency synthesizer was marketed.

More recently, Sony has marketed an "enthusiast's receiver" with synchronous detection and provision for reception of AM/SSB/NBFM/RTTY/FAX mode plus VHF/FM, including a massive bank of channel memories and also a built-in spectrum analyser to provide panoramic reception facilities for around £3000.

But, to the best of my knowledge, nobody has yet marketed a direct-conversion receiver with synchronous demodulation for broadcast signals at a competitive price.

Patent advance

This could soon change. In July, Edward Forster of Phase Track filed a patent application for design of a synchronised double-sideband AM broadcast receiver with no IF stages, aimed at low-cost receivers for the long, medium and short-wave bands (**Fig. 1**).

Elimination of the IF stages simplifies design of a receiver and should improve performance.

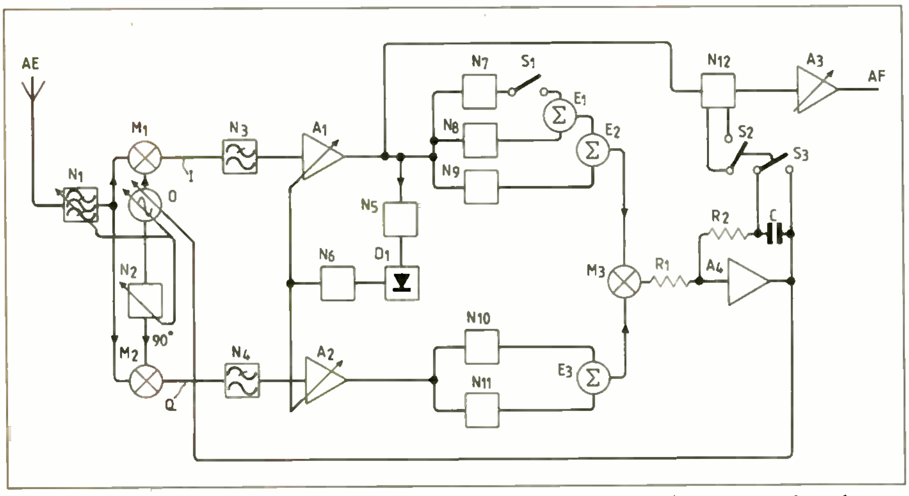
The receiver has no unwanted image responses and the bandwidth can be more accurately and cheaply set than with conventional IF filters. The only real spurious response, to the third harmonic, is easily filtered by a tracking pre-selector which may also usefully tune a small rod

Early developments

Almost 20 years ago, I wrote a two-part article for *Wireless World* on synchronous detection in radio reception (September and November, 1972) which drew attention to the attractions of the form of phase-locked-loop synchronous detector described by J P Costas of General Electric (US) as the basis of a high-performance direct-conversion HF communications receiver.

Costas was a powerful advocate of synchronous systems and direct-conversion (zero-IF) receivers in the 1950s. In the December 1956 issue of *Proc IRE*, an issue devoted almost entirely to advocacy of HF SSB with fully suppressed carriers, he struck an "odd-man-out" attitude in showing that the main arguments in favour of SSB were based on use of conventional envelope detection of AM, and would not apply if receivers fully utilised synchronous demodulation, permitting the use of double-sideband, suppressed-carrier transmissions as well as reception of conventional AM signals.

He outlined, as Professor DG Tucker had done previously, the practical advantages of direct-conversion rather than superhet principles and provided some detail of an experimental high-performance direct-conversion receiver with one of the then very complex frequency synthesizers – the AN/FRR-48 (XW-1) prototype with two-phase synchronous demodulation (using what has become known as the Costas loop), phase-locking the local oscillator by the use of an AM phase discriminator.



EC Forster's direct-conversion synchronous receiver for AM or reduced-carrier SSB broadcast transmissions.

antenna giving better performance than untuned active antenna counterparts. Being synchronous, very little non-linear distortion is experienced compared with that found in conventional (AM) receivers using envelope detectors.

Forster believes that with direct-conversion, two-phase (I,Q) receivers, the key to making the synchronisation satisfactory is to ensure that it holds during modulation pauses. In his original (Phase Track) superhet design synchronisation is to the carrier alone, but since this is subject to severe fading on HF, characteristics of the loop had to be carefully adjusted so as to hold synchronisation during these fades and also maintain high spectral purity. The approach has now been applied to the direct-conversion receiver. However, there are many other interactions in such a receiver between the AGC, the high level carrier and the modulation which has to be adjusted for correct operation.

Initially it proved difficult to overcome such drawbacks. But now Edward Forster is convinced he has solved these problems. His aim is to develop a design that could make possible LW/MW/SW receivers at a cost comparable to the bottom-line superhet models with envelope detection now on the market. But these would be capable of outperforming superhet-type receivers, particularly on HF.

Looking for exploitation

Forster is currently trying to interest consumer-receiver manufacturers in his design. The demonstration prototype receiver uses a few standard IC devices but there is considerable scope to reduce the component-count with greater integration. The basic RF input sections are similar to those of superhet receivers but are simpler to implement since all sections track the same signal frequency.

The patent application acknowledges that the concept is based on the techniques described by Costas in 1956, by D Richman in "Colour carrier reference phase synchronisation accuracy in NTSC colour television", (*Proc IRE*, January 1954 and in British Patent GB 2 077 533). In the figure, *N1* to *N12* are passive networks (*N5* to *N11* simple resistor-capacitor networks); *A1* to *A4* are amplifiers; *M1* to *M3* mixers (preferably doubly-balanced mixers); *E1* to *E3* summing circuits.

In practice *N1*, *N2* and *O* are gang tuned, *N1* preferably being double-tuned with *N2* constructed using a low Q series inductor tuned by a shunt capacitor, one of the ganged section.

Since no frequency-synthesizer is used, the spectral purity of the oscillator is very good and power consumption much lower than for synthesised receivers.

The patent application explains: "The output of amplifier *A4* frequency modulates oscillator *O* by a small amount which is nearly constant throughout the receiver's frequency range so that loop gain remains substantially constant. This kind of feedback loop is known as a type II system where this refers to the number of integrators in the loop. The circuit *R1*, *C* and *A4* provide a virtually perfect integrator if adjusted correctly. Since the error output of *M3* is driven to zero by the loop action, momentary lapses of modulation can be accommodated since the loop control voltage is held by the voltage across *C*.

"Thus the circuit remains substantially synchronised at all times.

However, to help initial synchronisation and maintain synchronisation during path disturbances on short wave, some extra acquisition system is required. This is obtained by a frequency discriminator characteristic set about the carrier (zero baseband frequency) and operating below modulation frequencies so that it is not normally operative.

"This discriminator action is provided by the additional networks *N8* and *N10* which provide a high frequency gain and phase balance but a low frequency gain slope and phase unbalance. The gain of the discriminator thus formed has to be adjusted to match the loop operation normally set for modulation control. As an aid to acquisition during tuning, network *N7* provides wider discriminator action operated by momentary switch *S1*.

"Summing circuits *E1*, *E2* and *E3* feed the resultant *I* and *Q* components to mixer *M3*. During tuning, it is desirable to short-circuit integrating capacitor *C* with switch *S3* and at the same time reduce the output volume by bringing into operation attenuator *N12* by closing switch *S2*. Finally the audio output *AF* is fed from the manually variable gain amplifier, *A3*."

The result appears to be an effective and simple-to-operate receiver of improved performance.

Whether Edward Forster will be able to convince the traditionally-conservative consumer industry to market receivers based on his patent-application remains to be seen; one can hope only that somebody will be prepared to give this promising development a whirl.

Pat Hawker

Phasing-type SSB generation

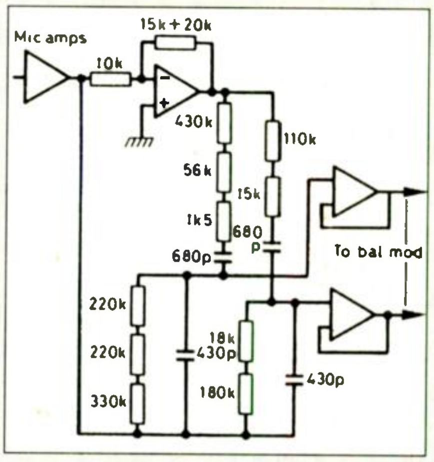
Much of early amateur-radio equipment in the then absence of effective SSB crystal and mechanical filters at HF, was based on phasing-type generators and occasionally phasing-type demodulators (with some later use of the Weaver "Third Method" and the Gingell "Polyphase" networks).

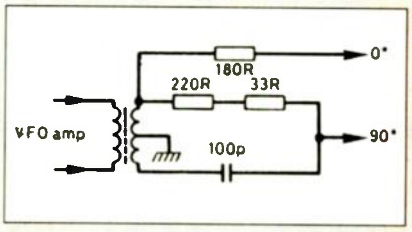
But in practice for many years virtually all commercially manufactured, and most home-built, SSB transceivers have used filter-type systems.

These are based on lattice-type HF crystal filter or crystal ladder filters, the latter type, where all crystals can be on the same frequency, can be based on low-cost colour-TV or "clock" crystals.

Phasing-type SSB generation tended to fall into disfavour largely because of the critical, non-standard component values required for 90° (±45°) wideband (300-4000Hz) audio phasing networks and the difficulty in maintaining accurate phasing over an appreciable temperature range.

Recently, however, John R Hey, G3TDZ has been endeavouring to re-popularise classic phasing-type SSB generation as part of a "White Rose" club project designed to show that amateur SSB HF equipment need not involve factory-built £1000-plus transceivers. The White Rose project includes a 3.5MHz SSB exciter that takes advantage of the improved stability of modern components such as metal film resistors, multi-turn cermet trimmers and polystyrene capacitors and use of combinations of standard 1% tolerance values to form audio and RF phase-shift networks that give excellent results between about 150Hz and 4kHz and between 3600 and 3800kHz (the SSB segment of the 3.5MHz amateur band.





The RF phase-shift network (above) used for the White Rose constructional project. *(Radio Communication, June 1991)*

Practical realisation of the audio phase-shift network (left) using standard value components (1%) found to give excellent results between 150Hz and 4kHz. *(Radio Communication, June 1991)*

APPOINTMENTS

BROADCAST ENGINEERS

Ref: 25/91

We are currently looking for Broadcast Engineers to work in our Broadcast Engineering Department.

The ideal candidates will be aged 23–35, educated to HND standard in electronic engineering and have work experience in broadcast or related industries.

The work, in this country and overseas, includes the operation, maintenance and installation of the full range of professional radio and television studio equipment and, in some areas, medium wave and VHF transmitters.

We give 22 days annual leave and benefits include: subsidised BUPA, contributory pension scheme, free lunch in the staff restaurant and free car parking.

For an application form please contact the Assistant Personnel Manager on 02407 4461 ext: 407.

SSVC

The Services Sound and Vision Corporation
Chalfont Grove, Narcot Lane, Chalfont St Peter, Gerrards Cross, Bucks SL9 8TN

UNIVERSITY OF READING
Computer Services Centre

Technician (Grade D)

The Computer Services Centre is responsible for providing support for computing and network facilities throughout the University. Applications are invited for a post in the Technicians team who are responsible for the installation, maintenance and repair of a wide range of microcomputing and network equipment. Candidates should possess a BTEC HNC in Electronics and Communications or equivalent. Previous experience in the support of PCs or networking is desirable. Salary in range £10,385–£12,400 p.a. Apply for application forms and further particulars to the Personnel Officer, University of Reading, WHITEKNIGHTS, P.O. Box 217, READING, RG6 2AH. Telephone (0734) 875123 x 7142. Please quote Ref: T9129.

TO ADVERTISE IN THIS SECTION PLEASE CALL PAT BUNCE ON 081 661 8339

WE HAVE THE WIDEST CHOICE OF USED OSCILLOSCOPES IN THE COUNTRY

TEKTRONIX 2445B Four Channel 150MHz	£2000
TEKTRONIX 2445A Four Channel 150MHz	£1500
TEKTRONIX 2246 Four Channel 150MHz	£1000
TEKTRONIX 485 Dual Trace 350MHz Delay Sweep	£800
TEKTRONIX 475 Dual Trace 200MHz Delay Sweep	£550
SCHLUMBERGER 5218 Three Trace 200MHz Delay Sweep with Trigger view	£550
HITACHI V650F Dual Trace 60MHz Delay Sweep	£450
TEKTRONIX 2215 Dual Trace 60MHz Delay Sweep	£450
TEKTRONIX 2225 Dual Trace 50MHz Delay Sweep	£500
TEKTRONIX 465 Dual Trace 100MHz Delay Sweep	£450
PHILIPS RM3217 Dual Trace 50MHz Delay Sweep	£400
TELEQUIPMENT 083 Dual Trace 50MHz Delay Sweep (with V4 &S2A)	£250
TELEQUIPMENT V3 Differential Amplifier for above	£40
HAMEG 605 Dual Trace 60MHz Delay Sweep	£400
HAMEG 705 Dual Trace 70MHz Delay Sweep	£300
GOULD OS300 Dual Trace 20MHz Unused with 2 probes	£250
GOULD OS300 Dual Trace 20MHz	£200
HITACHI V212 Dual Trace 20MHz	£250
TRIO CS1022 Dual Trace 20MHz	£225
H.P. 1980B Measuring System 100MHz	£750

THIS IS JUST A SAMPLE – MANY OTHERS AVAILABLE

RACAL/DANA Wideband Level Meter 5002	£1000
H.P. 8620C with 86290C Sweep Generator 2–18.6GHz	£3000
TEKTRONIX 577 Curve Tracer with 177 fixture	£2250
WAYNE KERR LCR 4250 with Binning option	£1250
RACAL/DANA (AIM) LCR Databridge 9341	£350
WAYNE KERR LCR Meter 4210	£600
WAYNE KERR Automatic Component Bridge 8605	£450
WAYNE KERR Universal RF Bridge 8602	£150
FARNELL Synthesized Oscillator DSG1 – 0.0001Hz – 99.99kHz	£275
MARCONI TF2008 AM/FM 10kHz–510MHz Sig Gen	£300
MARCONI TF2015 AM/FM 10–520MHz Sig Gen with TF2171	£400
MARCONI TF2015 without Synchroniser TF2171	£250
MARCONI TF2016 AM/FM 10kHz–120MHz with TF2173	£350
MARCONI TF2016 without Synchroniser TF2173	£175
MARCONI TF2356/2357 Level Osc Meter 20MHz	the pair £950
AMBER Model 4400 Multipurpose Audio Test Set	£750
MARCONI SANDERS Sig Sources	
Various models from £300 covering 400MHz–8.5GHz	
RACAL 9009 Mod Meter 10MHz–1.5GHz	£350
TEKTRONIX Waveformer Monitor type 528	£300
RACAL Instrumentation Recorders Store 4D and Store 7D	from £500
KEITHLEY 224 Programmable Current Source	£1000
FERROGRAPH RTS2 Recorder Test Set	from £150

SPECTRUM ANALYSERS

TEKTRONIX 491 1.5–12.4GHz	£750
H.P. 141T with 8555A & IF Plug-in 10MHz–18GHz	£3000
H.P. 140 Series with 8554 & IF Plug-in 500kHz–1250MHz	£1500
H.P. 140 Series with 8553 & IF Plug-in 1kHz–110MHz	£800
H.P. 180 Series with 8558B 0.1–1500MHz	from £2000
POLARAD type 641/1 10MHz–18GHz	£3000

PHILIPS PM2525 multi-function DMM $4\frac{1}{2}$–$5\frac{1}{2}$ digit with GPIB/IEEE-488	only £300
THURLBY PL320T-GP Bench PSU, 0–30V 2amp twice with GPIB	only £350
HANDHELD MULTIMETERS – $3\frac{1}{2}$ digit DM105 – 14 ranges DC–2amp	only £18
M2355 – 32 ranges AC/DC, 10 amps, Diode/Transistor Tester, Freq Counter etc	only £32.50

MARCONI 2440 20GHz Microwave Counter	£1500
MARCONI TF2610 True RMS Voltmeter	£800
FARNELL SSG1000 Sig Gen 10Hz–1GHz, Synthesised	£1750
RACAL 1998 1.3GHz Freq Counter with IEEE	£700
SOLARTRON/SCH 7151 Computing Multimeter	£750
PHILIPS PM5131 Function Gen 0.1Hz–2MHz	from £200
FARNELL PSU L30-5, 30V 5Amp	£150
DERRITRON TA120 with VP3 Vibrator	£1300
Uninterruptable PSU – Unused	from £150
AVO RM215-L/2 AC/DC Breakdown Tester	£600

BRUEL & KJAER

Sound Level Meter 2206 – ½" mic. With carrying case	£160
Sound Level Meter 2203 with 1" Mic	from £225

Mics available – 1" 4117 & 4132, ½" 4134.
Pre Amps 2613, 2615, & 2630
OTHER B & K EQUIPMENT AVAILABLE

THORN PSU 0–40V, 0–50Amps Metered	£300
FARNELL PSU H30/100 30V 100Amps	£750
FARNELL PSU H60/25 60V 25A	£400
TELEQUIPMENT CT71 Curve Tracer	£250
MARCONI TF2700 Universal LCR Bridge, Battery	from £125
MARCONI TF2337A Auto Distort Meter 400Hz 1kHz 0.01%	£175
RACAL 9915 Freq Counter 10Hz–520MHz (Crystal Oven)	£150
MANNESMAN TALLY Pixy 3 XY Plotter RS232	£100

AVO MULTIMETERS

Model 8 or 9 (what's available)	£40 each
Test Set No 1, 8X, 95X	from £65
8 Mk5 with Carrying Case	£90
8 Mk6 with Carrying Case	£120

All Meters supplied with Batteries & Leads

NEW EQUIPMENT

HAMEG OSCILLOSCOPE HM1005 Triple Trace 100MHz Delay Timebase	£792
HAMEG OSCILLOSCOPE HM604 Dual Trace 60MHz Delay Sweep	£610
HAMEG OSCILLOSCOPE HM203.7 Duel Trace 20MHz Component Tester	£338
HAMEG OSCILLOSCOPE HM205.3 Duel Trace 20MHz Digital Storage	£610

All other models available – all oscilloscopes supplied with 2 probes

BLACK STAR EQUIPMENT (P&P all units £5)	
APOLLO 10 100MHz Ratio Period Time interval etc	£222
APOLLO 100 100MHz (As above with more functions)	£295
METEOR 100 FREQUENCY COUNTER 100MHz	£109
METEOR 600 FREQUENCY COUNTER 600MHz	£135
METEOR 1000 FREQUENCY COUNTER 1GHz	£178
JUPITOR 500 FUNCTION GEN 0.1Hz–500kHz Sine Sq Tri	£110
ORION COLOUR BAR GENERATOR Pal TV Video	£209
All other Black Star Equipment available	
OSCILLOSCOPE PROBES Switched X1X10 (P&P £3)	£11

Used Equipment · With 30 days guarantee · Manuals supplied if possible.
This is a VERY SMALL SAMPLE OF STOCK. SAE or Telephone for lists. Please check availability before ordering. CARRIAGE: all units £16. VAT to be added to Total of Goods and Carriage.

STEWART OF READING
110 WYKEHAM ROAD, READING, BERKS RG6 1PL
Tel: 0734 268041 Fax: 0734 351696
Callers welcome 9am to 5.30pm Mon–Fri (until 8pm Thurs)

CIRCLE NO. 141 ON REPLY CARD

Field Electric Ltd. Tel: 081-953 6009. 3 Shenley Road, Borehamwood, Herts. WD6 1AA. Fax: 081-207 6375, 0836 640328

HT12 fully 286 compatible; half size mother board; Intel 286 CPU; running at 12/16/20MHz; zero wait state; 1Mb RAM supplied; up to 4Mb. AMI BIOS; set-up disk. New & boxed. **£115+VAT** c/p £6.00.
386sx half size mother board same as above but expandable to 8Mb. New & boxed.
Sola mini UPS. 500watt + line conditioner & inverter. **£95 inc VAT** c/p please ring.
Chloride Powersafe batteries. 12V DC 24Ah sealed lead acid. **£19.95** c/p £9.00. New, marked cases.
3.5" floppy disk drive Chinon BBC compatible, new **£35** c/p £4.00.
Astrolux Mono Headset New **£15.95 c/p £3.50**
Astrolux Headset with boom mic **£19.95 c/p £3.50**
Tektronix 7403N Mainframe only **£80**
3.5" floppy disk drive NEC IBM compatible. Full height unit. **£39.95** new & boxed, 1.6Mb. c/p £3.00.
Switch mode power supplies 240V AC input 5V DC 40amp **£29**; 12V DC 10amp **£46**; 5V DC 40amp – 12V DC 4amp + 15V DC 11amp **£48**.
NEC 9" mono monitor composite video input, switchable high-low impedance input & output for daisy-chaining. BNC sockets. Built-in carry handle. **£29.95** c/p £7.50.
H.P. 4328A milliohmmeter **£450** c/p £11.00.
H.P. 3400A RMS voltmeter **£225** c/p £11.00.
H.P. 3330B auto synthesizer **£550** c/p please ring.
Tektronix 191 constant amplitude sig.gen. **£175** c/p £12.00.
Tektronix 178 linear IC test fixture **£125**.
Tektronix 067-502 standard amplitude calibrator **£120** c/p £12.00.
Leader LBO-5810A dual trace programmable 25MHz o'scope **£200** c/p £18.00.

Apple II Europlus **£75**
Apple II E **£125** Disk drive extra
Hewlett Packard 618B SHF signal generator **£75.00**.
Hewlett Packard 606B signal generator **£75.00**.
Hewlett Packard 612A UHF signal generator **£75.00**.
Hewlett Packard 86A personal computer new **£95.00**.
Hewlett Packard 5000A logic state analyser **£60.00**.
Hewlett Packard 3450B multi-function meter **£65.00**.
Hewlett Packard 693D sweep oscillator **£175.00**.
Hewlett Packard 651B test oscillator **£75.00**.
Hewlett Packard 9868 I/O expander **£55.00**.
Iswatsu SS5705 40 MHz O'scope **£295**
Kikusui COS 5040 40MHz O'Scope Calto 1-92 **£350**
Hitachi V212 20MHz O'scope **£230**
Hitachi V202F 20MHz O'scope Calto 1-92 **£230**
Tektronix 455 O'scope **£350**
Leader Programable 20 MHz O'scope £95
Tektronix 7B70 time base plug-in **£100.00**.
Tektronix 7D01 logic analyser plug-in **£100.00**.
Singer spectrum analyser 20Hz to 35kHz **£275.00**.
Singer Alfred o'scope c/with sweep network analyser 7051 **£175.00**.
Datron 1030A RMS voltmeter **£65.00**.
Datron 1030 RMS voltmeter **£65.00**.
Wavetek voltage controlled generator Model III **£60.00**.
Paratronics Model 532 logic state analyser 32chn **£165.00**.
All above prices +17½% VAT. Please ring for c/p rates.

VISA

We would like the opportunity to tender for surplus equipment
Official orders credit card telephone orders accepted with Access, Amex, Diners, Visa cards. Overseas enquiries welcome c/p rates U.K. mainland only.
Please ring for c/p rates not shown.
All prices inc. V.A.T. unless stated. Stock list available.

CIRCLE NO. 131 ON REPLY CARD

081 661 8469 CLASSIFIED 081 661 8640

TO MANUFACTURERS, WHOLESALERS, BULK BUYERS, ETC.

LARGE QUANTITIES OF RADIO, TV AND ELECTRONIC COMPONENTS FOR DISPOSAL

SEMICONDUCTORS, all types, INTEGRATED CIRCUITS, TRANSISTORS, DIODES, RECTIFIERS, THYRISTORS, etc. RESISTORS, C/F, M/F, W/W, etc. CAPACITORS, SILVER MICA, POLYSTYRENE, C280, C296, DISC CERAMICS, PLATE CERAMICS, etc. ELECTROLYTIC CONDENSERS, SPEAKERS, CONNECTING WIRE, CABLES SCREENED WIRE, SCREWS, NUTS, CHOKES, TRANSFORMERS, ETC. **ALL AT KNOCKOUT PRICES** – Come and pay us a visit ALADDIN'S CAVE

TELEPHONE 081 445 0749/445 2713

R. HENSON LTD

21 Lodge Lane, North Finchley, London N12 8JG.

(5 minutes from Tally Ho Corner)

VISA

COOKE INTERNATIONAL

TELEQUIPMENT D83 Oscilloscopes DC-50 MHz Dual Trace with Delay	from £195
TELEQUIPMENT DM63 Oscilloscopes DC-15 MHz Dual Beam with Analogue Storage	£250
TEXTRONIX 654B Storage Oscilloscopes DC-10 MHz with Plug Ins	£95
MARCONI 2210 Oscilloscopes DC-100 MHz Dual Trace Dual Time Base	£275
H.P. 180A Oscilloscopes DC-50 MHz Dual Trace with Plug Ins	£100
SOLARTRON 4601 Programmable Synth. Signal Generators A.M. F.M.	£350

MUCH MORE AVAILABLE, VISIT, PHONE OR S.A.E. FOR LISTS

COOKE INTERNATIONAL

Unit 4 Fordingbridge Site, Main Road, Barnham, Bognor Regis, West Sussex PO22 0EB.

TEL. 0243 545111 **FAX 0243 542457**

We are always looking to purchase good S/H stock

FREE ... 7000-item Semiconductor Price List – 50% Off Many Items. **DIAL ELECTRONICS LTD, BURNHOPE RD., WASHINGTON, TYNE & WEAR NE38 8HZ. Tel: 091-417 7003. Fax: 091-417 7053.**

VALVES AND C.R.T.s

(also Magnetrons, Klystrons, 4CX250/350)

Minimum order charge of £50 + VAT

One million valves in stock. Obsolete types a speciality! Fax or phone for quote.
Special prices for wholesale quantities.
Orders from government departments, overseas etc. most welcome.
Many other types in stock. Please enquire re any type not listed.

CATHODE RAY TUBES 400 different types in stock.
Please enquire if your requirements are not listed below.

						M28.13LG	£45.00
3JP1	POA	D10.230GM	£45.00	E723 (EEV)	POA	M31 182GV	£45.00
12CSP4	£35.00	D13.611GH	£59.00	F28-130LDS	POA	M31 184W	£55.00
1074H	£45.00	D13.630GH	£59.00	F31 12LD	£75.00	M31.190GR	£45.00
1396P	POA	D14.200GM	£75.00	LD708	£75.00	M31 191W	£55.00
8931 (W H)	POA	D16.100GH97	£65.00	M7 120W	£19.50	M31.325GH	£35.00
CME822W	£7.00	DG7-5	£45.00	M14 100GM	£35.00	M38 100W	POA
CME1523W	£9.50	DG7-6	£45.00	M17 151GVR	£175.00	M40 120W	£59.00
CRE1400	£29.50	DG7-32	£55.00	M23 112GV	£45.00	MV6-5 (Mul)	£50.00
D9.110GH	£45.00	DG7-36	£55.00	M24 121GH	£55.00	SE5FP31	£45.00
CME1431W	POA	DH3-91	£50.00	M24 122WA	£55.00	VLS429AG	POA

VALVES Prices on application. Please enquire re any type not listed below.

A2426	ECC804 Maz	M8136 Mul	VL5631	6BJ6
A2521	ECC81	M8162 Mul	Z759	6BM6
C1149-1	ECC81 Spec Q	M5138	Z803U	6CH6
C1166	ECC82	Magnetrons	Y644	6CJ6
CCS1	ECC82 Spec Q	PC900	1B35A	6F33
CV TYPES. Many	ECC83	PCC89	2K25	6L6GC
in stock. Not all	ECC83 Spec Q	PD500	3B28	6SL7GT
listed below	ECC88	PL509	3C/800E	6SN7GT
Please	ECC88 Spec Q	QQV03-10	3J-160E	12BH7
inquire.	ECC804	QQV03-10 Mul	4-65A	12E1
CV488	EF39	QQV03-20A	4-125A Eimac	13E1
CV1881	EF73	QQV03-20A EEV	4-400A	19AQ5
CV2355	EF91	QQV06-40A	4C28	211
CV4014	EF92	QQV06-40A Mul	4CX250B	805
CV4024	EF86 Siemens	QY3-125	4CX250BC	807
CV6087	EF93	QY4-250	4CX350A	811A
CV7180	EF95	QV04-7	4CX1000A	813
CX1140	EL34	R10	4CX5000A	4635
DA42	EL38	SU2150	5B-254M	5763
DET22	EL81	TT21	5B-255M	6336A
DET23	EL81 Mul	S11E12	5B-257M	6973
DF91	EL84	TD03-10E	5B-258M	8056
E80L	EL5070	TY4-400A	5U4G	8122
E83F	GY501	U19	5V4G	*Sockets:*
E88CC	Klystrons	UBC41	6AK5W	B9A PCB
E180F	KT61	UCL82	6A56	B9A chassis
E810F	KT81	UL41	6B4G	Octal chassis
EC158	KT88/6550	UY85	6BH6	Many others
ECC35 Mul		VA222A		

Testing to special quality – Military/CV, low microphony etc available on request

BILLINGTON EXPORT

Unit F2, Oakendene Industrial Estate, Near Horsham, Sussex RH13 8AZ.
Callers by appointment only.
Telephone: 0403 865105 Fax: 0403 865106
Min. UK order £50 + VAT. Min. Export order £50 + Carriage.

PRODUCTION/A.T.E.
SECOND USER EQUIPMENT
HUGE SAVINGS ON NEW PRICES

ATE/TEST

GENRAD 2272 – 1024 Test Points – **£69,000**

MARCONI 80X – 1024 Test Points. Vacuum Pump. – **£26,500**

MARCONI MIDATA – 540 and 530 ATE Systems. Less than 2 years old, call for details – **£21,000**

ZEHNTEL 3200 – Performance/Functional Tester. New 1987. – **£36,950**

FACTRON 7760S – Board Tester. Call for configuration. – **£9,750**

VANWELL 3260 – IC Test System. Call for details. – **£call**

CLEANING EQUIPMENT

KERRY 300/2HPF – 35 litre 2 Stage Ultrasonic Cleaning Plant. Tank size 250 x 350 x 250mm 240V 1 Phase – **£2,975**

KERRY CRD 1500/4HP – 4 Stage Ultrasonic Cleaning, Rinsing, Drying System incorporating Thermal Recovery Unit and Microprocessor Controlled Work Transporter. – **POA**

SEMICONDUCTOR

EDWARDS E12E3 – 12 inch Coater. For general, optical and electrical coating. Stainless steel pumping group with vapour trap. – **£3,950**

MRC SEM-8620 – RF Sputtering system. With S-3013 1kW RF Power Generator. Capable of performing Sputter, Etch and Bias sputtering functions. Rebuilt and Tested. – **£9,500**

K&S 1419-3 – Series B Automatic Wire Bonder. Generator and Closed Circuit TV System From – **£9,900**

ENVIRONMENTAL TEST

ACE FS360 – 360 litre Temp. Chamber. −20°C to + 150°C. Programmable. Over/Under Temp Protection. – **£3,000**

MONTFORD TSP-X2-E-LN2 – Fast Cycling, Thermal Shock Stress Screening Chamber. −70°C to + 200°C. Liquid N_2 cooling. Internal dimensions: 18x18x18". X2 Profile Controller. Temperature speeds in excess of 60°C per minute. – **£5,950**

ACE – 360 litre Temperature/Vibration Test Chamber. −55°C to + 100°C @ 5°C per minute. Fitted with Flat Bed Vibration Table 800x400mm. Peak g value adjustable up to 5.0g over 20-60Hz – **£5,790**

RINGWAY – Hot/Humid and cold test chambers. 25"x15"x15". Temp from 40°C : 100°C. RH to 90%. Timer. Chart recorder. Prices from – **£2,500**

SAPRATIN – Altitude Test Chamber. 3.5m³ Volume. Pressure: Atmospheric to 100mm Hg −60°C to + 100°C. 20% RH to Saturation. – **£call**

MISCELLANEOUS

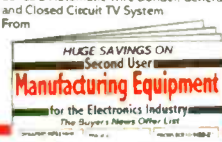
KOMAX 30 – Automatic Cut and Strip. – **£3,795**

SHIN MEIWA AWS4 – Automatic Wire Cut and Strip. Offers Invited. – **£call**

BLUNDELL – Cropmatic & Vacuclamp. Accommodates Boards up to 18x12 inches. Recent overhaul with new blades. – **£5,950**

FLOW SOLDER MACHINES – Benchtop and Free standing. Many Makes/Models with and without solder. Prices from – **£1,900**

See latest issue of Buyers News for full listing and Terms & Conditions. Prices exclude VAT. Buyers Premium not included



BUYERS NEWS Tel: 071-284 4074 (UK)
Fax: 071-267 7363 (UK)
146 Camden Street, London NW1 9PF

CIRCLE NO. 130 ON REPLY CARD

Technical & Scientific Supplies

Data Analyser/programmer, Ferret/A for RS232, parallel, current loop, EPROM etc data transfer and monitoring, with user's reference and training manuals	£195
Bench lights, adjustable heavy duty, unused	£12
UV Exposure unit, RS 556-238, little used, tested	£85
Computers Hewlett Packard 2100A, A600 etc	from £290
PCM Decommutator Decom 7103, general-purpose	£1900
Mains disturbance analyser, Dranetz series 626	£2,100
SHF Signal Generator HP618B 3.8 to 7.6GHz	£550
Fitted container. Air conditioning, power distribution, rack, bench, cupboards. Secure storage and/or workshop	£900
Pulse/Function Gen. Thandar TG503. New, boxed.	£395
B & K eighth inch mike 4138 with adaptor. Unused	£500

Some furniture still available All prices exclude carriage and VAT
Please enquire – write/fax/phone (any time)

Technical & Scientific Supplies, PO Box 19, Hythe, Southampton, Hampshire SO4 6XQ.
Tel: (0703) 848 666 Fax: (0703) 897 079

GOLLEDGE
ELECTRONICS

CRYSTALS OSCILLATORS FILTERS

Comprehensive stocks of standard items. Over 650 stock lines. Specials made to order. OEM support: design advice, prototype quantities, production schedules.

Personal and export orders welcome.
SAE for our latest product information sheets.

GOLLEDGE ELECTRONICS LTD **Tel: 0460 73718**
Merriott, Somerset, TA16 5NS **Fax: 0460 76340**

ARTICLES WANTED

WANTED

Test equipment, receivers, valves, transmitters, components, cable and electronic scrap and quantity. Prompt service and cash.

M & B RADIO
86 Bishopgate Street, Leeds LS1 4BB.
Tel: 0532 435649
Fax: 0532 426881

9956

WANTED: VALVES, TRANSISTORS, I.Cs (especially types KT66, KT88, PX4, PX25). Also capacitors, antique radios, shop clearance considered. If possible, send written list for offer by return. Billington Valves, phone 0403 865105. Fax: 0403 865106. See adjoining advert.

STEWART OF READING
110 WYKEHAM ROAD,
READING, RG6 1PL.
TEL: 0734 68041
FAX: 0734 351696

TOP PRICES PAID FOR ALL TYPES OF SURPLUS TEST EQUIPMENT, COMPUTER EQUIPMENT, COMPONENTS etc. ANY QUANTITY.

103

WANTED

Receivers, Transmitters, Test Equipment, Components, Cable and Electronic, Scrap, Boxes, PCB's, Plugs and Sockets, Computers, Edge Connectors.

TOP PRICES PAID FOR ALL TYPES OF ELECTRONICS EQUIPMENT

A.R. Sinclair, Electronics, Stockholders, 2 Normans Lane, Rabley Heath, Welwyn, Herts AL6 9TQ. Telephone: 0438 812 193. Mobile: 0860 214302. Fax: 0438 812 387

780

matmos

TATUNG TCS8000 386 COMPUTER SYSTEM at £359

Full 386DX system complete with 102 keyboard and manual. Includes 210 watt PSU, I/O card, hard and floppy controller (please state MFM, RLL, IDE or SCSI), 1 2 or 1 4 Mbyte floppy drive, 1 Mbyte RAM upgradable to 16 Mbyte on the motherboard, eight expansion slots, C and T "CHIPS" chipset co-proc socket, MS-DOS 3 3, GW BASIC and manuals 16 MHz clock £359, with 2 Mbytes RAM £379
20 MHz version of above with 2 Mbytes RAM £459

MATMOS HIGH PERFORMANCE 286 SYSTEM at £299

A quality 286 system running at a Landmark speed of 16 MHz, clock speed 12 MHz. 1 Mbyte RAM expandable to 4 Mbytes Serial and parallel ports, 101 keyboard, mono card, 1 44 Mbyte 3 5-inch drive, IDE hard drive controller (add £20 for MFM or RLL unless purchased with Matmos hard drive), eight slots. AMI bios with setup and diagnostics, well-made stylish case, full manuals included £299 Fitted with 62 Mbyte hard drive £399

TOP SPEC. 386 AND 486 SYSTEMS

25 MHz 386 system, 1 Mbyte RAM, 1 44 Mbyte floppy drive, HDD controller, i/o card etc £549
40 MHz 386 system, 64K Cache RAM, 1 Mbyte RAM, 1 44 Mbyte floppy drive, i/o card etc £799.
33 MHz 486 system, 64K cache RAM, with 2 Mbytes RAM £949
Phone for details. carriage on systems £15 See below for add-ons and other stock items.

486 CAD/DTP SYSTEM WITH 1280 × 1024 MONITOR

486 33 MHz cache system with 91 Mbyte Seagate hard drive, 3 5-inch 1 44 floppy, 4 megs RAM (upgradeable to 32 Megs), tower case, 102 keyboard, 2 serial, 1 parallel ports, OPTI chipset, AMI bios, Microfield Graphics TB colour graphics controller with 2 Mbytes video RAM and 8 MIPS processor, Hitachi 15-inch ultra high resolution monitor to display 1280 × 1024 non interlaced Will drive Windows 3, ACAD etc Cancelled defence order limited stocks £1995.
386-20 CAD system, with 2 Mbytes RAM, 1024 × 768 colour monitor, 62 Mbytes hard drive, co-processor, will drive Windows 3, ACAD etc £999 phone for details.

FLOPPY DISK DRIVES

360K 5 25-inch IBM standard half height drive £29 95 (carr £3.50)
720K 3.5-inch Citizen OSD third-height drive for XT (NOT Amstrad 1512/1640) £27 50 (carr £3)
720K 3.5-inch Citizen DSDA45 third height drive for AT/286/386 cream bezel £19 95 (carr £3)
1.44 Mbyte 3.5-inch Citizen OSDA39C third height drive for ATs, grey bezel £45.95 (carr £3)
Fitting kit for 5 25-inch space suitable for all Citizen 3 5-inch drives inc cable adaptors £8 49 (carr free with drives)
IBM standard floppy disk drive cable £4
External 720K cased 3 5 inch in smart case (suitable for ATs only) £29 50 (carr £3.50) Cable adaptor kit for AT £12 50

HARD DISK DRIVES

10 Mbyte NEC 5 25-inch MFM £39 95 (carr £4)
20 Mbyte NEC 5 25-inch MFM £89 95 (carr £4)
20 Mbyte Miniscribe 8225 3 5 inch in 5.25 inch chassis, 24 msec IDE with controller and all cabling – AT only – £69.95 (carr £5)
30 Mbyte NEC 5.25-inch RLL £109 (carr £5)
40 Mbyte Quantum 40S Pro 3 5-inch, 18 msec SCSI £149 (carr £4)
65 Mbyte NEC 5.25-inch RLL £159 (carr £4)
62 Mbyte Micropolis 1324A 5.25-inch, 28 msec MFM, full height £139 – £125 in systems – (carr £5)
94 Mbyte Seagate/Imprimus ST2106E 5.25-inch, 16.5 msec ESDI drive with 16-bit high speed controller card and cables £239 (carr £5).
Hard card – 40 Mbyte Quantum very high speed internal cache SCSI XT or AT £179 (carr £6)
ALL DRIVES HALF HEIGHT UNLESS STATED. HDD cable set £5.

DISK DRIVE CONTROLLER CARDS (carr £2.50)

XT MFM £37 50, XT RLL £37 50, XT SCSI £29 50, AT RLL £37 50, AT MFM £39 95, AT IDE £12 95, AT SCSI £37 50

HITACHI CD ROM DRIVE (ex dem.)

External cased AT bus CDR1502S, half height, 5 25 inch with card and cable £179 (carr £5).

IBM COMPATIBLE AT MOTHERBOARDS, CARDS etc.

33 MHz 486 Very latest 80486 baby size motherboard with extra 64K cache Floating point co-processor built into CPU Eight expansion slots £649 (carr £5)
25 MHz 386 motherboard, 80386 cpu, Landmark speed 33 MHz, accepts up to 8 Mbytes SIPPS RAM £299 (carr £3 50)
20 MHz 386 motherboard, accepts up to 8 Mbytes SIMMS RAM £199 (carr £3 50)
1 Mbyte RAM for 386/486 £40
12 MHz 286 motherboard, 8 slots, AMI BIOS, 80287 socket, Landmark 16 MHz, up to 4 Mbyte of SIPPS RAM on board £79 (carr £3 50)
16 MHz 286 version of above £89 (carr £3 50) 20 MHz £125
AT multi I/O board with 1 parallel, 2 serial, 1 game, 2 floppy, IDE hard drive £25 95
AT I/O card, parallel, 2 serial, game £14 95
AT/XT floppy disk controller £9 95
Mono graphics card £12 95 (all carr £2)
Ethernet card Novell NE-2000 compatible 16-bit £89 (carr £2)
Mouse Microsoft compatible, serial with software inc full paint box £19 95 (carr £4)
Keyboard 102 key UK, top quality click action £29 95 (carr £4)

AT/XT CASES WITH PSU

Desktop with 3 × 5 25 inch and 1 × 3 5-inch bays, latest styling £34 95 With 200W psu £69 (carr £6 50)
Luxury desktop As above, with psu, but to accept full size motherboard, small footprint £89 (carr £6.50)
Full size tower with 6 × 5 25-inch bays, 230W psu, digital speed display, suits all motherboards inc 486 £139 (carr £10).

INTEL 386 PROCESSOR AND 287 AND 387 CO-PROCESSORS

80287 maths co processor £69
(386 and 387 processors extracted from new systems and guaranteed 1 year)
20 MHz 386-20 DX cpu £89.
25 MHz 386-25 DX cpu £109
20 MHz 387-20 co-processor £79
25 MHz 387-25 co processor £99.

MONITORS

MONO HERCULES: 12 inch Philips green screen, high res display, £59 95 (carr £6 50)
MONO VGA 12 inch paper white high resolution £79 95 (carr £6 50)
COLOUR SUPER VGA 14 inch Tystar 1024 by 768 multisync, 0 28 dot pitch, high-quality 1024 × 768 display £239 (carr £10)

CAD COLOUR

20-inch multisync Hitachi CM2085M from VGA up to 64kHz at 1280 by 1024 (ex dem) £899
20-inch fixed frequency monitors (1024 by 768 and 1280 by 1024) – phone for current stocks
15-inch fixed frequency 64kHz Hitachi HM4115 with Microfield Graphics T8 driver card for Autocad and Windows 3 at 1280 by 1024 (new) £559 – £459 in systems
14-inch fixed frequency 48kHz Seiko 1024 by 768 non interlaced, very high res top-quality monitor, requires mod to run from VGA card Brand new but sold without technical support or guarantee £89
(p o a for carriage for above)

VGA CARDS

16-bit VGA card, 256K, all emulations, up to 800 × 600, with software to run all major packages Oak chip set Switchable for use in XT's £49
16-bit 1024 × 768 super VGA card. Very high resolution with 512K and drivers for Windows 3, Acad, VP etc Full manuals and disks. Trident chip set £85; 1 Mbyte version £99 (carr on cards £2 00)

FAX CARD

Plug into PC expansion slot Giving powerful fax features, ATS Cipher BT approved Group III intelligent receive/transmit, with multiple output and call scheduling With disks, cables and full user manual £119 (carr £5)

POWER SUPPLIES

Astec BM140 IBM XT/AT compatible 150W, +5V at 15A, +12V at 5A, −5V at 0 3A, −12V at 0 5A, fan cooled, rear panel switch, good value at £19.50 (carr £4)
Digitisers and video printers sometimes in stock – availability and prices on request

NB ★ VAT and carriage must be added to all items (quotes for carriage overseas)
★ Everything new, and guaranteed one year unless stated, ex-dem. products guaranteed 6 months
★ Access and Visa telephone service

MATMOS LTD., UNIT 11, THE ENTERPRISE PARK, LEWES ROAD, LINDFIELD, WEST SUSSEX RH16 2LX.
0444 482091 and 0444 483830 (Fax: 0444 484258).

Matmos Ltd has been trading successfully since 1976

CIRCLE NO. 138 ON REPLY CARD

INDEX TO ADVERTISERS

OVERSEAS ADVERTISEMENT AGENTS

France and Belgium: Pierre Mussard, 18–20 Place de la Madeleine, Paris 75008.
United States of America: Jay Fenman, Reed Business Ltd., 205 East 42nd Street, New York, NY 10017 – Telephone (212) 867 2080 – Telex 23827.

Printed in Great Britain by Riverside Press, Gillingham, Kent, and typeset by Marlin Graphics, Sidcup, Kent DA14 5DT, for the proprietors, Reed Business Publishing Ltd, Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS. © Reed Publishing Ltd 1991. *Electronics and Wireless World* can be obtained from the following: AUSTRALIA and NEW ZEALAND: Gordon & Gotch Ltd, INDIA: A.H. Wheeler & Co, CANADA: The Wm Dawson Subscription Service Ltd.; Gordon & Gotch Ltd., SOUTH AFRICA: Central News Agency Ltd.; William Dawson & Sons (S.A.) Ltd.; UNITED STATES: Worldwide Media Services Inc., 115 East 23rd Street, NEW YORK, N.Y. 10010. USA. *Electronics & Wireless World* $5.95 (74513).

COLOURJET 132

COLOUR INK JET PRINTER

Compatible with:–
IBM pc
Archimedes
Nimbus
BBC Micro
Amiga
Apple Mac
(serial version)

LOW COST
LIST PRICE
from £579 + VAT

Low Operating Cost

Windows 3 Driver Available

EMULATES OTHER COLOUR PRINTERS EG IBM 3852, Canon PJ1080A, Quadjet
PRINTS OVERHEAD TRANSPARENCIES

EDUCATIONAL DISCOUNTS AVALIABLE

INTEGREX LTD., CHURCH GRESLEY, SWADLINCOTE
DERBYS DE11 9PT
Tel (0283) 551551
Fax (0283) 550325
T/x 341727 INTEGX

CIRCLE NO. 102 ON REPLY CARD

IC PROGRAMMING TESTING & ERASING SOLUTIONS

PC82 UNIVERSAL PROGRAMMER & TESTER £395

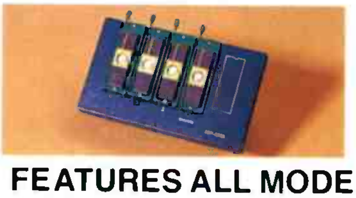
Universal programmer. The complete designer's kit. This will program EPROMS, EEROMS, BPROMS, PALS, GALS, EPLD's, Z8 and 87XX microprocessors. A unique feature is the testing of logic parts such as 74LS393 etc. Software is supplied to write vectors for most unique chips. One of the most popular programmers in the USA.

TTL, CMOS, DRAM & SRAM TESTING

PC82 can test and verify any TTL/CMOS logic chip, DRAM & SRAM. The software will also identify a TTL chip. Do you have a few TTL chips aside not knowing whether they are working?

DEVICE GUIDE

Over 1500 types are now covered, with many more to be added shortly. Some require an adapter.
EPROM – Full range of 8/16 bit wide types from 16k to 16mBit. 2716 to THA 16PO100.
FLASH EPROM – Full range of AMD & Intel types. 28FXX ranges.
EPROM – 17 manufacturers full range of types from AMD to Xicor. 2816 etc
SERIAL EEPROM – 12 manufacturers full range of types. 9306/46 etc
BPROM 32×8 to 4096×8, incl. 63S080,7C28X,29X etc
PAL – 18 manufacturers including Altera, Amd, AMI, Atmel, etc.
GAL 16V8,18P8,20V8,20RA10,22V10,26V12,26CV12,6001
EPLD 20G10,22V10, EP310/320/600/610/900/910/5C031/32/60/90
CMOS EPAL C16L8,R8,R6,R4,C18V8,C20G10,L8,R8,R6,R4, C22V10
MPU Z8,8741,41,44,49,50,51,95,96,97,98,C51,C52,54,58,75,196,252,451,521,528,552, 528,652654, 751,752,63705,68701,705,68HC705,711,4074008 series 77P008,25,108, 116,PSD301, PIC16C54,55,56,57



ADAPTERS FOR PC82 FROM £95

A wide range of plug-in adapters to expand the capability of the PC82. Various PLCC convertors & 4 gang 28/32/40 pin Eprom, Gal & Pal. Popular CPU types include PIC 16C54/5/6/7, 8796/7, 68705, 87C751/2, & TMS320E25.

FEATURES ALL MODELS

For the IBM PC, install the interface card and programming socket, load the menu-driven software and you have a complete design system at your fingertips.

EASY TO INSTALL

The programmer comes with an interface card that plugs into any free slot of your PC. There is no DMA channel to worry about and it occupies limited I/O space. The programmer socket box is connected via a ribbon cable to the back of the interface card so that the socket box is external. After the interface card is installed the PC never need be opened again.

SUITS ALL PC's

The programmers will run on any compatible IBM machines such as XT's, AT's, '386 and '486. Whether it be AMSTRAD or COMPAQ the programmers will work. The software is text only monographic so is compatible with any machine.

SOFTWARE DRIVEN

All software for the programmers is supplied on 5¼" low-density disks. The software can be copied onto hard disk using the DOS copy command. Programs are supplied for the various features and are menu-driven. All programming is done from the menu, no hardware switches are needed. Just select the type and manufacturer and the programming is done automatically. Free software updates for new types which are continually being added.
The menu-driven software is a full editing, filing and compiling package as well as a programming package. Save to disk and load from disk allows full filing of patterns on disk, to be saved and recalled instantaneously. Device blank check, checksum, program, verify, read and modify are all standard features. Hex to bin file conversions included for popular file formats including Intel Motorola etc. 2 ways/4 ways bin file splitter for 16/32 bit file data. Selection of speed algorithm for FAST, INTELLIGENT, INTEL, etc.

PC86 HANDY POCKET TESTER £99

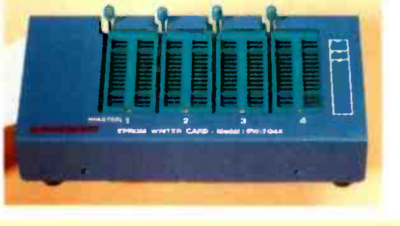
Tests all popular TTL 74/54, CMOS 40/45 & DRAM types, can search and display type number of unknown/house marked types. Simple operation. 9 volt battery operated with LCD display.

M1 FAST ERASER £99

NO MORE WAITING FOR EPROMs TO ERASE. New advanced UV source gives under 2 minute erasure time on most types of modern EPROM. Digital down counter & display plus added features for simple operation in use. Large capacity e.g. 13×28 pin devices. Small footprint. Designed for heavy industrial/workshop use. UK design & manufacture.

PC84 EPROM PROGRAMMERS 1-GANG £139, 4-GANG £199 & 8-GANG £299

PC84 -1, -4, -8 Eprom programmers only. The variant is only gang size. The - 4 and -8 gang will program multiple EPROMs simultaneously. Device are from 2716 to 271000 both C and NMOS & EEPROM from 2816 to 2864. ZIF (zero insertion force) sockets are used on all models



ORDER INFORMATION

Please Include £7 for carriage by courier, plus VAT on all UK orders. (£20 for exports.) All pricing for programmers includes software, interface card, socket box and full Instructions. (Prices do not Include VAT or carriage). ACCESS, VISA or CWO. Official orders welcome from Government bodies & local authorities.

BARCLAYCARD VISA CP Citadel

CITADEL PRODUCTS LTD
Dept. WW, 50 High St, Edgware, Middx. HA8 7EP
Tel: 081-951 1848