

Proteus professional CAD – save 10%

ELECTRONICS WORLD

Austria Asch. 68.00
Denmark DKr. 69.00
Germany DM 18.00
Greece Dra. 1300.00
Holland Dfl. 12.50
Italy L. 9000.00
Malta Lm. 1.65
IR £3.30
Singapore S\$7.50
Spain Pts. 900
USA \$6.50

INCORPORATING WIRELESS WORLD

MAY 1998 £2.45

**The route to
pcb CAD**

**Enhanced
radiation
detector**

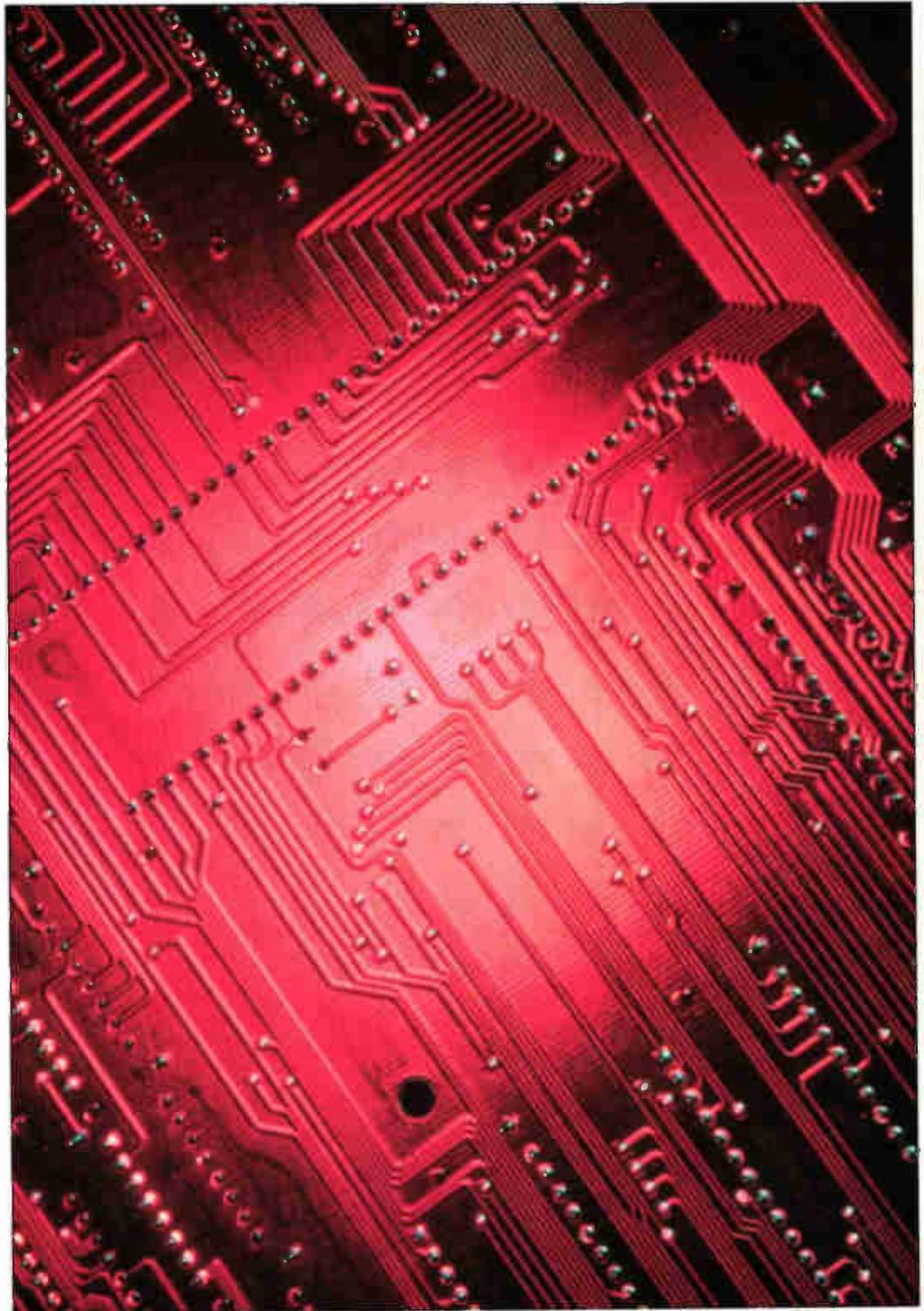
**In-system
programming**

**56k modems
exposed**

**Sweeping: past
and present**

**Designing with
low-voltage
op-amps**

Film capacitors



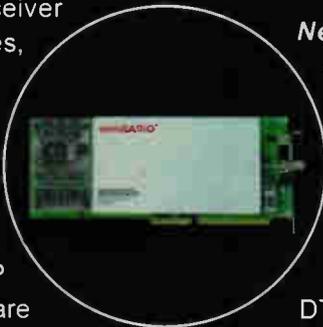
9 770959 833042

A REED BUSINESS PUBLICATION
SOR DISTRIBUTION

Is this the end of wireless as we know it..

Couple all the power of the latest Windows PCs (not just the fraction that you can squeeze down an RS232 connection) to the latest synthesised receiver design techniques, and you'll get the ultimate in wide range, all mode programmable radio reception.

The WR3000iDSP include AD hardware signal processing for total signal processing.

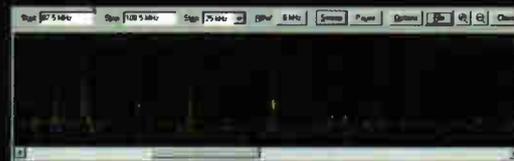


WiNRADiO™ provides a complete communications system on a full-length ISA PC Card, with software for Windows 3, NT or 95.

New optional Digital Suite software includes facilities for recording, audio spectrum, packet radio, oscilloscope display, HF fax, Squelch-controlled Audio Recorder and Playback, Signal Classifier, DTMF, ACARS, CTSS - use with SoundBlaster™ compatible audio cards.



Your choice of virtual front panel



VisiTune™ spectrum tuning display

Use WiNRADiO™ scanning PC communications receiver systems for...

Broadcast • Media monitoring • Professional and amateur radio communications • Scanning
Spot frequency and whole spectrum monitoring • Surveillance (and recording) • Instrumentation

Model No	WR-1000i	WR-3000i-DSP
Construction	Full length ISA card	Full length ISA card
Frequency range	0.5-1300 MHz	0.15-1500 MHz
Modes	AM,SSB/CW,FM-N,FM-W	AM,LSB,USB,CW,FM-N,FM-W
Tuning step size	100 Hz (5 Hz BFO)	100 Hz (10 Hz for SSB and CW)
IF bandwidths	6 kHz (AM/SSB), 17 kHz (FM-N) 270 kHz (FM-W)	2.5 kHz (SSB/CW), 9 kHz (AM) 17 kHz (FM-N) 270 kHz (FM-W)
Receiver type	PLL-based triple-convt. superhet	
Scanning speed	10 ch/sec (AM), 50 ch/sec (FM)	
Audio output on card	200mW	200mW
Max on one motherboard	8 cards	8 cards
Dynamic range	85 dB	85 dB
IF shift (passband tuning)	no	±2 kHz
DSP in hardware	no	yes
IRQ required	no	yes
Spectrum Scope	yes	yes
VisiTune	yes	yes
Published software API	yes	yes
Task Manager/scheduler	no	yes
Audio Recording/Playback	no	yes
Signal Strength Recorder	no	yes
Logger	no	yes
Price (ex VAT)	£275	£995
Digital Suite Software	£69	£69



The DSP applet provided with the WR3000i allows continuous control of audio bandwidth and other signal conditioning functions.

New! Digital Suite Software option- only £69+vat (requires a SoundBlaster 16 compatible sound card), and currently features facilities for:

- WEFAX / HF Fax
- Packet Radio for HF and VHF
- Aircraft Addressing and Reporting System (ACARS)
- Audio Oscilloscope, real time Spectrum Analyzer with calibration cursors
- Squelch-controlled AF Recorder and Playback
- DTMF, CTSS decode and analyse

For a free information pack and software emulation demo disk

contact Broadcasting Communication Systems

<http://www.broadercasting.com>

email: info@broadercasting.co.uk

FREEPHONE: 0800 0746 263

fax: 01245 287057

Widford Old Rectory, London Road, Chelmsford, Essex CM2 8TE



WiNRADiO and VisiTune are trademarks of WiNRADiO Communications Pty.

Contents

363 COMMENT

Love story or shotgun wedding?

364 NEWS

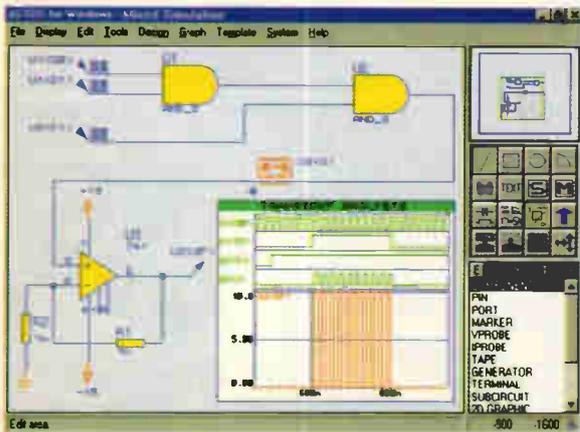
Mobile phones: new health risk? Robot the size of an Oxo cube, University for all, Euro brain drain threat.

370 THE ROUTE TO PCB CAD

First article in a new series of pcb CAD reviews by Rod Cooper features an explanation of what to watch out for, and looks in detail at the new *Proteus IV*.

376 CIRCUIT IDEAS

- PT100 lineariser
- Call-sign generator
- Low-ripple dc supply
- Dumping stored high voltages
- Timebase event positioner
- Cheap time-delay relay



384 READER OFFER

10% reader discount on any of the Proteus series CAD packages – see page 384.

385 SWEEPING BACK

Ian Hickman looks at some ingenious methods for generating linear timebase sawteeth, both ancient and modern.

391 UNDERSTANDING CAPACITORS

Plastic film capacitors – second in popularity only to ceramic types – are examined in detail by Cyril Bateman.

397 SPEAKERS CORNER

John Watkinson looks at an often overlooked loudspeaker design aspect – diffraction.

402 VERSATILE RADIATION METER

Disappointed with current Geiger-tube circuits, Darren Heywood set about designing a more versatile meter with voltage, 4-20mA and audio outputs.



408 HANDS-ON INTERNET

Want a browser that fits on a floppy? Interested in circuit simulation CAD? See Cyril Bateman's monthly report.

413 SINGLE-SUPPLY OP-AMPS

Knowing the trade-offs involved when manufacturers make single-supply op-amps helps you design better circuits.

418 DISK CAMERA UPDATE

Leslie Warwick reports on new broadcast video cameras using disk storage, and their emerging domestic counterparts.

421 56K MODEMS EXPOSED

Will your 56k modem ever run at 56k? Steve Bush investigates.

424 BOOKS TO BUY

A new selection of electronics and computing titles from Wiley.

427 AIR WAVES

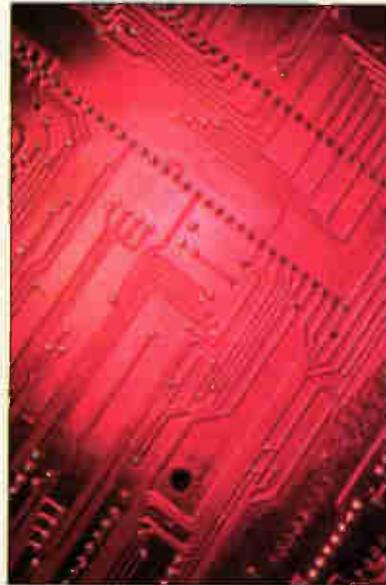
New European mobile phone standard.

431 NEW PRODUCTS

Four pages of densely packed product information, selected by Phil Darrington.

436 IN-SYSTEM PROGRAMMABLE LOGIC

Having a logic device that can be altered without removing it from the board makes designing a lot easier, quicker and cheaper. Geoff Newton looks at what's available.



Photography Philippe Sion



This self-powered cubic inch robot has a PIC microcontroller on board. See page 364.



In theory, your 56kbit/s modem will run at 56kbit/s. But will it ever reach that speed in practice? Read Steve Bush's report on page 421.

**JUNE ISSUE
ON SALE 30 APRIL**

OLSON®

For all your Power Distribution
Olson offer a varied choice

OLSON Distribution Units

OLSON ELECTRONICS LIMITED

OLSON DISTRIBUTION PANELS
FUSED, WITH R.F. FILTER
AND R.C.D. PROTECTION

OLSON ELECTRONICS LIMITED

OLSON FUSED WITH R.F. FILTER
PROJECTOR

OLSON ELECTRONICS LIMITED

OLSON The Rack Range
mains distribution panels
for 19" rack mounting

OLSON ELECTRONICS LIMITED

OLSON Office Furniture
Cable Management
Manufactured to BS 6396

OLSON ELECTRONICS LIMITED

OLSON Mains Distribution
Panels with
Non Standard Sockets

OLSON ELECTRONICS LIMITED

OLSON FUSED SUPER SLIM
WITH R.F. FILTER
AND R.C.D. PROTECTION

OLSON ELECTRONICS LIMITED

OLSON Earth Leakage
Distribution
Units

PORTABLE UNIT
Type PHS 1

BENCH MOUNTED UNIT
Type PHS 2

OLSON ELECTRONICS LIMITED

OLSON Distribution
Units

OLSON ELECTRONICS LIMITED

OLSON PANELS with 10AMP
CEE2/IEC
SHUTTERED SOCKETS
FUSED, DOUBLE FUSED WITH R.F. FILTER
AND R.C.D. PROTECTION

OLSON ELECTRONICS LIMITED

OLSON The Rack Range
WITH AMERICAN
AND METRIC SOCKETS

OLSON ELECTRONICS LIMITED

OLSON Mains Distribution
Panels
INTERNATIONAL RANGE

OLSON ELECTRONICS LIMITED

OLSON FUSED SUPER SLIM
WITH R.F. FILTER
AND R.C.D. PROTECTION

OLSON ELECTRONICS LIMITED

OLSON DATA PROTECTOR
16 AMP 110V AND 240V
TO BS 4343/IEC 309

OLSON ELECTRONICS LIMITED

OLSON INDUSTRIAL RANGE
16 AMP 110V AND 240V
TO BS 4343/IEC 309

OLSON ELECTRONICS LIMITED

Industrious study of existing conditions is essential for accurate and meaningful data. All units featured in this advertisement are based on the following information:
Standard: 16 amp (20A) Single phase supply
The sockets are for use in conjunction with all manufacturers' plugs designed to BS 4343/IEC 309
All units featured meet 16 amp

OLSON Distribution
Units

OLSON ELECTRONICS LIMITED

OLSON 19" FAN TRAYS

OLSON ELECTRONICS LIMITED

OLSON The Rack Range
WITH AMERICAN
AND METRIC SOCKETS

OLSON ELECTRONICS LIMITED

OLSON SERVICE PILLAR FOR
THE OPEN-PLAN OFFICE

OLSON ELECTRONICS LIMITED

OLSON Distribution
Units

OLSON ELECTRONICS LIMITED

Love story or shotgun wedding?

EDITOR

Martin Eccles
0181 652 3128

CONSULTANTS

Ian Hickman
Philip Darrington
Frank Ogden

EDITORIAL ADMINISTRATION

Jackie Lowe
0181-652 3614

E-MAIL ORDERS

jackie.lowe@rbi.co.uk

ADVERTISEMENT MANAGER

Richard Napier
0181-652 3620

DISPLAY SALES EXECUTIVE

Joannah Cox
0181-652 3620

ADVERTISING PRODUCTION

0181-652 3620

PUBLISHER

Mick Elliott

EDITORIAL FAX

0181-652 8111

CLASSIFIED FAX

0181-652 8938

NEWSTRADE ENQUIRIES

0171 261 7704

ISSN 0959-8332

SUBSCRIPTION HOTLINE

01622 778000

SUBSCRIPTION QUERIES

rpb.subscriptions@rbi.co.uk
Tel 01444 445566
Fax 01444 445447

For a full listing of
RBI magazines:
<http://www.reedbusiness.com>



When Reeves invented pcm, it became possible to represent any analogue waveform by a bit stream. From that point on convergence of video, audio, computers and communications became inevitable. The timing has been controlled by the technology – primarily the economics of LSI number crunching and the cost-per-bit of data recording.

When the cost of implementing real time Reed-Solomon error correction fell to consumer levels, the compact disc arrived overnight and eclipsed the vinyl disc. Audio had become economic data rather than laboratory data. When the blossoming pc market caused the price of hard drives to plummet, the digital audio workstation arrived and – with the help of the DAT format – eclipsed the analogue stereo tape recorder.

Now LSI technology has advanced to the point where real time discrete cosine transforms are possible at consumer prices and suddenly MPEG video compression arrives. Video becomes economic data, and analogue television broadcasting will be eclipsed by it. In comparison with MPEG, analogue video compression techniques such as interlace and composite video are simply less efficient and use up too much radio spectrum.

Governments the world over want to make broadcast television digital not to improve our lives – but simply so that the existing analogue television channel bandwidth can be sold. This has a ring of inevitability about it.

Another inevitability is that now broadcast video is economic data, the computer companies with their mastery of storage and processing naturally want a piece of the action and are in the process of taking it.

When a television set contains an MPEG decoder, it has become digital to the extent that there isn't much difference between a television and a pc. Both require a cabinet, crt, power supply and scan systems and some logic.

The pc industry wants to combine the features of a computer and a television by using communications to make television viewing interactive. While only an example, a hybrid television could have a split screen where one half is video of a sports event and the other half is data about the competitors sourced via Internet. Links in the system would allow the viewer to jump immediately to web pages related to the event such as sporting goods suppliers or the products of the sponsors. The hard drive could be set to loop record the last few minutes of action so that instant replay is under control of the viewer.

While not everyone would want this degree of interactivity, the same system could download the program guide to save having to buy a paper one. When not in use as a television, the system becomes a general purpose pc and for many households a single unit would represent a significant saving in space, cost and power consumption.

The only thorn in the side of this concept is that traditional broadcast television signals uses interlace, where odd and even screen lines are sent in alternate

fields. Computer graphics uses progressive scan where all of the lines are sent in every frame.

Advanced televisions use up-conversion to put more lines on the screen than are in the video standard. This makes the raster structure invisible. Progressive scan video contains all of the data about a picture in each frame and up-conversion and resizing for split screen is easy. In interlaced video the vertical resolution is shared between two fields which were captured at different times. When there is motion the two fields cannot be de-interlaced to a frame and up-conversion and re-sizing becomes much harder.

In short, a computer/television becomes simpler and cheaper and gives better pictures if the broadcast television signals are progressive scan. Interlaced broadcast signals would require the use of an additional de-interlacing stage.

However, the broadcasters have a huge infrastructure of interlaced production equipment and they naturally want to keep interlace. Consequently war has broken out to the extent that the ATSC – the advanced television systems

Governments the world over want to make broadcast television digital not to improve our lives, but simply so that the existing analogue television channel bandwidth can be sold.

committee – in the USA was unable to recommend a single standard. As this is why it was formed, the result is called failure.

In the mean time it is becoming clear that MPEG compression gives better pictures for the same bit rate, or lower bit rate for the same quality if progressive scan is used. I predicted it theoretically, and tests by Panasonic and Microsoft have confirmed the results practically.

It transpires that what the broadcasters are saying is that they want to use a higher data rate than necessary to send pictures to televisions which cost more than necessary. This doesn't make sense.

Surely the broadcasters can continue to produce in interlaced formats if they wish, but the conversion to progressive scan should be done leaving the studio prior to MPEG encoding.

Interlace was the best that could be done with vacuum tubes fifty years ago and it's become a tradition. Tradition means not questioning what you do.

John Watkinson

John is a Chartered Information Systems Practitioner and Fellow of the Audio Engineering Society. He is also an international consultant and director of Celtic Audio Ltd. www.culinaire.se/JWA.

Electronics World is published monthly. By post, current issue £2.45, back issues (if available) £3.00. Orders, payments and general correspondence to **L333, Electronics World, Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS**. Tlx:892984 REED BP G. Cheques should be made payable to Reed Business Information Ltd

Newstrade: Distributed by Marketforce (UK) Ltd, 247 Tottenham Court Road London W1P 0AU 0171 261-5108.

Subscriptions: Quadrant Subscription Services, Oakfield House Perryman Road, Haywards Heath, Sussex RH16 3DH. Telephone 01444 445566. Please notify change of address.

Subscription rates: 1 year UK £34.00 2 years £54.00 3 years £68.00. Europe/Eu 1 year £49.00 2 years £78.00 3 years £98.00 ROW 1 year £59.00 2 years £94.00 3 years £119

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, 475 Park Avenue South, 2nd Fl New York, NY 10016 Tel; (212) 679 8888 Fax; (212) 679 9455

USA mailing agents: Mercury Airfreight International Ltd Inc, 10(b) Englehard Ave, Avenel NJ 07001. Periodicals Postage Paid at Rahway NJ Postmaster. Send address changes to above.

Printed by BPCC Magazines (Carlisle) Ltd, Newtown Trading Estate Carlisle, Cumbria, CA2 7NR

Typeset by Marlin Imaging 2-4 Powerscroft Road, Sidcup, Kent DA1 4SDT

© Reed Business Information Ltd 1997 ISSN 0959 8332

Mobile phones: new health risk fears

The effects of mobile phones on human memory and learning capacity have now been added to the list of potential health risks – notably cancer – under investigation.

The Department of Health is spending more than £100 000 on two investigations. The larger project, costing £100 000, is being undertaken by the government's Porton Down research establishment in Wiltshire. This is into learning deficiencies in rats caused by the radiation. Rats have been chosen as a suitable lower mammal with similarities to humans for early research.

The second study, costing £3 000, is being conducted at Bristol University into the effect of microwaves on human memory and

reaction times.

To date, mobile phone safety research has included an Australian study on the risk of cancer while the EU is undertaking a study on the neurophysiological effects and damage to the immune system.

Both of the UK investigations are expected to take a year to complete and the results will be reported to Health Secretary Frank Dobson.

A government spokeswoman said the investigations had been launched following concerns expressed by medical experts, but would not detail their fears.

"As part of its radiations protection research programme, the Department supports a number of projects investigating the possible health effects of electromagnetic fields,"

said the spokeswoman. "It has recently commissioned a short study of the effects of microwave radiation on memory and reaction times in humans."

It is also currently funding a study into electromagnetic field risk perception. This follows on from a study by Australian doctor Andrew Davidson which showed a rise of more than 50 per cent in brain tumour cases in Western Australia between 1982 and 1992.

He believes this may have been caused by the growth of analogue mobile phone usage in that period.

The EC is looking to set up a research programme into possible dangers while the World Health Organisation is also considering a "major epidemiological study".

A machine the size of an Oxo cube

How small can a robot be? A man who set himself, and his students, the task of finding out is Professor Jean-Daniel Nicoud. And the answer

is 1cm³, or one inch cubed (16cm³) if it has to be autonomous.

Nicoud works in the Laboratoire de Microinformatique (Lami) at the

Swiss Federal Institute of technology. He said: "Realistically, 1cm³ is the smallest size that motors can be fitted into. If the robot needs to carry its

Minibot racing

Jemmy, the 1cm³ robot, won the 1 cm³ category at the 1997 International Microrobot Maze Contest in Nagoya Japan.

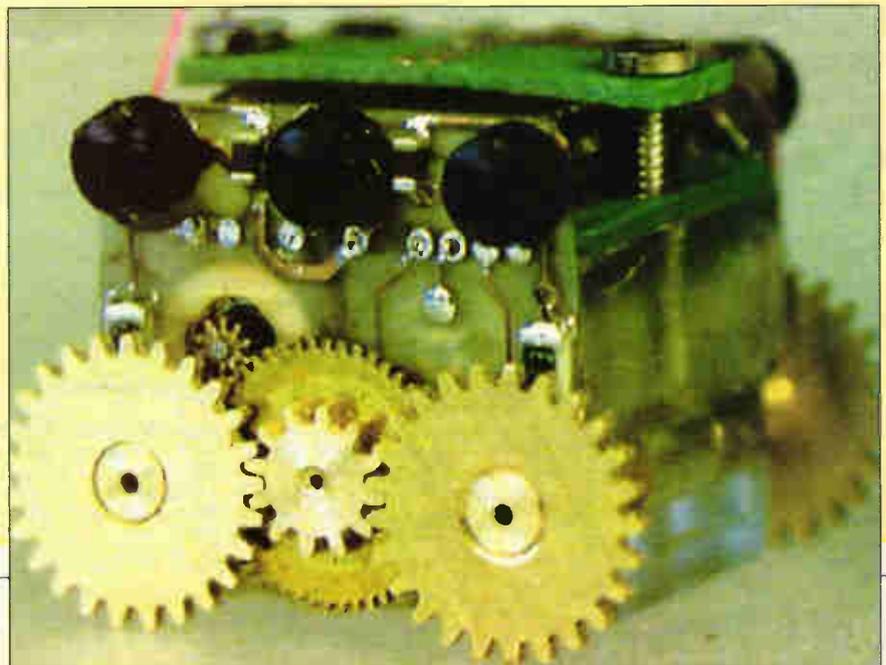
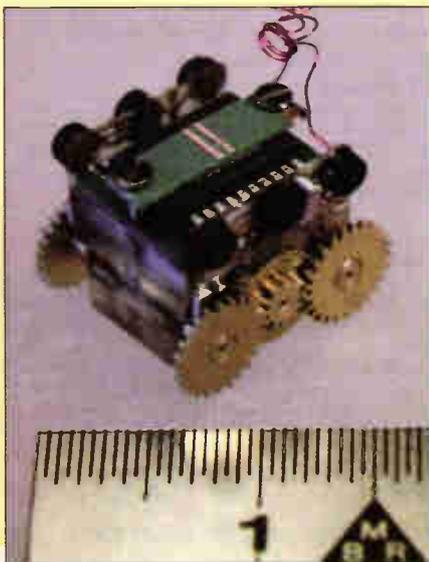
In the competition, robots have to negotiate a simple 3 by 3 maze, under the

control of an operator if necessary. The biggest challenges are slopes between some of the boxes which prevent underpowered robots from moving about.

The 1 inch robot, Inchy, also competed at Nagoya in its size category. Unfortunately its infra-red sensors, which

operated well in the lab, were swamped by the bright arena lighting.

Nicoud's team has competed for several years with several different designs, but fears lack of time may prevent Lami from sending another robot. "Universities must concentrate on doing new research rather



PLUG IN AND MEASURE

8-12 bit
200kHz-50MHz
100mVolt-1200Volt

STORAGE OSCILLOSCOPE
SPECTRUM ANALYZER
VOLTMETER
TRANSIENT RECORDER



TiePie introduces the HANDYSCOPE 2 A powerful 12 bit virtual measuring instrument for the PC

The HANDYSCOPE 2, connected to the parallel printer port of the PC and controlled by very user friendly software under Windows or DOS, gives everybody the possibility to measure within a few minutes. The philosophy of the HANDYSCOPE 2 is:

"PLUG IN AND MEASURE".

Because of the good hardware specs (two channels, 12 bit, 200 kHz sampling on both channels simultaneously, 32 KWord memory, 0.1 to 80 volt full scale, 0.2% absolute accuracy, software controlled AC/DC switch) and the very complete software (oscilloscope, voltmeter, transient recorder and spectrum analyzer) the HANDYSCOPE 2 is the best PC controlled measuring instrument in its category.

The four integrated virtual instruments give lots of possibilities for performing good measurements and making clear documentation. The software for the HANDYSCOPE 2 is suitable for Windows 3.1 and Windows 95. There is also software available for DOS 3.1 and higher.

A key point of the Windows software is the quick and easy control of the instruments. This is done by using:

- the speed button bar. Gives direct access to most settings.
- the mouse. Place the cursor on an object and press the right mouse button for the corresponding settings menu.

- menus. All settings can be changed using the menus.

Some quick examples:

The voltage axis can be set using a drag and drop principle. Both the gain and the position can be changed in an easy way. The time axis is controlled using a scalable scroll bar. With this scroll bar the measured signal (10 to 32k samples) can be zoomed live in and out.

The pre and post trigger moment is displayed graphically and can be adjusted by means of the mouse. For triggering a graphical WYSIWYG trigger symbol is available. This symbol indicates the trigger mode, slope and level. These can be adjusted with the mouse.

The oscilloscope has an AUTO DISK function with which unexpected disturbances can be captured. When the instrument is set up for the disturbance, the AUTO DISK function can be started. Each time the disturbance occurs, it is measured and the measured data is stored on disk. When pre samples are selected, both samples before and after the moment of disturbance are stored.

The spectrum analyzer is capable to calculate an 8K spectrum and disposes of 6 window functions. Because of this higher harmonics can be measured well (e.g. for power line analysis and audio analysis).

The voltmeter has 6 fully configurable displays. 11 different values can be measured and these values can be displayed in 16 different ways. This results in an easy way of reading the requested values. Besides this, for each display a bar graph is available.

When slowly changing events (like temperature or pressure) have to be measured, the transient recorder is the solution. The time between two samples can be set from 0.01 sec to 500 sec, so it is easy to measure events that last up to almost 200 days.

The extensive possibilities of the cursors in the oscilloscope, the transient recorder and the spectrum analyzer can be used to analyze the measured signal. Besides the standard measurements, also True RMS, Peak-Peak, Mean, Max and Min values of the measured signal are available.

To document the measured signal three features is provided for. For common documentation three lines of text are available. These lines are printed on every print out. They can be used e.g. for the company name and address. For measurement specific documentation 240 characters text can be added to the measurement. Also "text balloons" are available, which can be placed within the measurement. These balloons can be configured to your own demands.

For printing both black and white printers and color printers are supported. Exporting data can be done in ASCII (SCV) so the data can be read in a

spreadsheet program. All instrument settings are stored in a SET file. By reading a SET file, the instrument is configured completely and measuring can start at once. Each data file is accompanied by a settings file. The data file contains the measured values (ASCII or binary) and the settings file contains the settings of the instrument. The settings file is in ASCII and can be read easily by other programs.

Other TiePie measuring instruments are: HS508 (50MHz-8bit), TP112 (1MHz-12bit), TP208 (20MHz-8bit) and TP508 (50MHz-8bit).

Convince yourself and download the demo software from our web page: <http://www.tiepie.nl>. When you have questions and / or remarks, contact us via e-mail: support@tiepie.nl

Total Package:
The HANDYSCOPE 2 is delivered with two 1:1/1:10 switchable oscilloscope probe's, a user manual, Windows and DOS software. The price of the HANDYSCOPE 2 is £299.00 excl. VAT.

TiePie engineering (UK), 28 Stephenson Road, Industrial Estate, St. Ives, Cambridgeshire, PE17 4WJ, UK
Tel: 01480-460028; Fax: 01480-460340

TiePie engineering (NL)
Koperslagersstraat 37
8601 WL SNEEK
The Netherlands
Tel: +31 515 415416
Fax +31 515 418819

own batteries rather than be powered over wire links, the size has to increase."

To prove the point, ex-watchmaker André Guignard has built robots to Nicoud's designs. Each has multiple infra-red distance sensors on-board as well as a PIC 16C54 microcontroller to link the sensors to the motors and provide intelligence. "The PIC is the smallest microcontroller available," said Nicoud.

One cubic inch has given Nicoud "plenty of room" in which to fit a battery, but finding a suitable one has been difficult. "Most small high power density batteries are made to

supply a low current for a long period of time, powering a clock for instance," he said, "these have too much internal resistance to supply motors, which need 20 to 50mA." Salvation came in the form of an experimental battery from a Swiss cell-maker.

"Leclanché made ten small experimental NiMH batteries for a medical application. I was offered one of those."

There were only just enough made to supply Leclanché's own needs and someone at the company started to get cold feet. "I drove over here myself and picked one up before they

changed their minds," said Nicoud.

The battery enables the bigger robot to run for half an hour, and achieve the creditable speed of 30cm/s.

But these automatons have not just been made for fun. "We are investigating the limits of cost-effectively making small machines by conventional [watchmaking] and semiconductor fabrication techniques. There is still a gap, where micromachining is too small and watchmaking too coarse. This limit of cost-effective microsystems is slowly moving down, let us say with a factor of two every ten years."

Steve Bush, *Electronics Weekly*

New brain-drain threat for Europe

A battle is brewing in the US whose outcome could threaten Europe and the Far East with a brain drain.

Large US electronics firms have been telling a US Senate hearing that the current limit on immigration visas is hurting their businesses. Critics, meanwhile, counter the claims saying that the companies' goal is to undermine salaries with cheap labour.

Senior executives from Texas Instruments, Sun Microsystems, Cypress Semiconductor and Microsoft spoke in front of a special Senate Judiciary Committee claiming that US immigration restrictions are harming their competitiveness.

"The high technology industry added some 290000 new jobs to the US economy in the 1990's.

Unfortunately, the future growth of our industry is being threatened by a limited supply of skilled workers," testified Stephen Leven, TI's director of worldwide human resources.

US electronics companies want the current 65000 visa limit on foreign professionals to be increased or scrapped, allowing them to recruit tens of thousands of high-tech staff from anywhere in the world.

But the US Institute of Electrical and Electronics Engineers (IEEE-USA), representing more than 220000 electronics engineers and IT professionals, says that the worker shortage is a myth. The IEEE points out that if there were a major shortage, engineering salaries would have increased tremendously, yet there has

been little or no increase in engineering salaries over recent years.

Dr John Reinert, president of the IEEE-USA, told the committee that if there is a worker shortage, the focus should be on retraining workers and attracting more women and other minorities. "By raising the visa limits, the government would provide a powerful incentive to squander these important national resources and cause an increasing erosion of our domestic technical infrastructure," Reinert testified.

He pointed out that more than 80 per cent of IT workers have degrees in different fields, and the solution is to train domestic workers and recruit older engineers who have been forced out due to early retirement or layoffs.

Internet telephony imminent

UK-based start-up Vega-Stream says it will have two Internet telephony products available by June.

The company, set up this month with £1.2m raised by the founder and former CEO of Tricom Communications, Mike Hafferty, is employing seven people to develop the products.

"We have four development engineers who are creating the two main products: an Internet telephony gateway and an audio conferencing bridge," said Hafferty.

The gateway will allow people to

Hafferty... "With Internet telephony standards available, like H.323, quality is well established."

phone their local Internet service provider and route an international call for the price of a local telephone call. The conferencing bridge, costing less than £4000, will work with Microsoft's *NetMeeting* software, enabling up to 30 people to converse while viewing the same screen of data.

Hafferty scoffed at the suggestion that lost packets and the slowness of the Internet would disrupt calls. "That position is changing almost week by week," he said. "With Internet telephony standards available, like H.323, quality is well established. I don't think that anyone - including the big phone companies - can dispute that."

Free E-mail addresses

BT is to bring electronic communications to the masses with the launch of a free E-mail address service. Called Mill-e-Mail, the initiative is part of the Millennium project. It will provide users with an E-mail address and directory which can be accessed from anywhere in the world. The scheme will be open to nine-year-olds and above and will be aimed particularly at the education sector. "We want to raise the agenda for E-mail and Internet use," said a BT spokesman.



CROWNHILL ASSOCIATES LIMITED

The Old Bakery, New Barns Road, Ely, Cambs. CB4 7PW

Tel: +44 (0) 1353 666709 Fax: +44 (0) 1353 666710

<http://www.towitoko.co.uk>

<http://www.crownhill.co.uk>

CHIP DRIVE - PROFESSIONAL

Smart Card Programming System

Intelligent programmer for Smart Cards using the International Standard T=0 or T=1 protocols also Memory and Secure Memory using 1²C, 2-wire & 3-wire interfaces

Supplied with software to read and write to most popular secure smart cards, Inc GSM, PAY PHONE and ACCESS CONTROL cards.

T=0 or T=1 @ 3.579MHZ
RS232 @ 9600 - 11500 bps
Internal Supply / Ni-MH
Size: 100x70x80 mm
Weight 660 Gram

Supplied with CardServer API for easy development of SmartCard Applications using Visual Basic, Delphi or C++

Supplied with Sample Memory cards & Secure Smart cards

CE Compliant



£79.95

NEW CHIPDRIVE - micro

Fully Compatible with TOOLBOX for application Development



TOOLBOX

Driver and application software is available for the CHIPDRIVE family of terminals including the command set DLL for Windows 3.11/95NT, easy to use 16 and 32 Bit DLLs with just one function call to the CardServer, a powerful Background task with relieves the application programmer from device and card administration. Featuring automatic protocol and card type detection controlling access of several application to one terminal dependent on the inserted card



SMARTCARDS

Available from Stock:

GemPlus, Atmel, Xicor, Siemens, SGS Crownhill and more.....

SLE4442, 4432, 4418, 4428, 4404

AT88SCxx, AT24c01-16

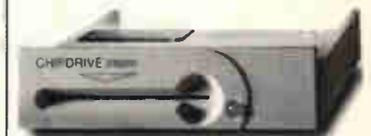
GPM103, GFM1K, 2K, 4K, GPM416

Phone Cards, Loyalty Cards

Cards specified, engineered and produced to your specification.

Chip Drive Internal

3.5" floppy bay version of the CHIPDRIVE



Applications are available to provide SmartCard controlled access of data on Hard drives or "PC-LOCK", to control access to the whole PC Fully Compatible with TOOLBOX for systems development.

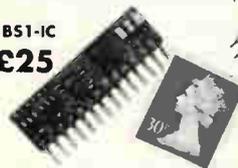
CIRCLE NO. 108 ON REPLY CARD

Control Essentials from Milford Instruments

BASIC Stamps - low cost alternative to PLCs

BASIC Stamps are small, low cost re-programmable controllers running easy-to-programme BASIC. They can source/sink up to 20mA and support buttons/keypads/LCDs/LEDs/Comms/Serial Driver Chips etc. Once programmed from the PC, Stamps are fully autonomous and will find many uses in ATE equipment, one-offs and as an alternative to expensive PLCs.

BS1-IC
£25



BS2-IC
£39



BS1-IC
8 I/O lines
Up to 80 programme lines
2,000 lines/sec
Comms to 2,400 baud

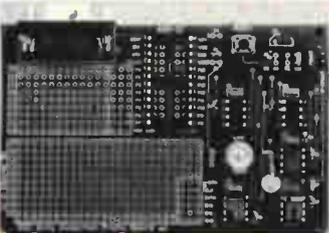
BS2-IC
16 I/O lines
Up to 500 programme lines
SPI, DTMF etc
Comms to 19,200 baud

Development kits from £79 which include application notes, software, cable and Stamp.

Data Logging

BS2-IC based Data collection board with real-time clock/calendar, up to 32kBytes EEPROM, dual 12-bit ADC and user development area. Kit complete with extensive manual and ready-to-go software routines that may be user customised.

£65



Serial Maths Processors

Number crunching? Let our serial maths processors take the strain

- 32-bit floating point
- SPI (3-wire) interface
- Multiply, divide, add, subtract, sine, log, square-root, ● 32-programmable counter,
- 4-channel ADCs

£20

All prices exclude shipping and VAT

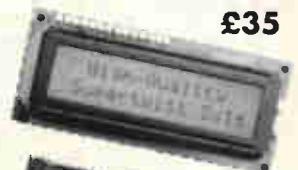
Serial LCD Modules

- banish lcd hassle

Three quality, backlit LCD modules each fitted with an easy-to-use serial driver board. Simple 3-wire interface to PC, micro or Stamp (+5vdc, Gnd and signal). Enhanced driver board supports full-screen height numerals, standard characters and software switchable backlight. RS232 interface at 2,400 or 9,600 baud.

Standard driver boards (without lcd) and bulk driver chips for OEM use also available.

£85



£125

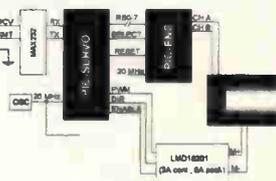


DC Servo Control

DC Motor control chipset for use with incremental encoders.

RS232/RS485 interface capability, Positional control, Velocity control and Trapezoidal profiling, Programmable P.I.D filter 32-bit position, velocity and acceleration

£29



www.milinst.demon.co.uk

To order or request further information, please call Milford Instruments at 01977 683665, fax 681465

CIRCLE NO. 109 ON REPLY CARD

Battle over BDB set-top box plans

British Sky Broadcasting (BSkyB) will sue British Digital Broadcasting (BDB) if it does not change its digital set-top box plans. BSkyB's chief executive has warned.

The Murdoch-backed pay television company is furious with the digital terrestrial group's decision to use the SECA conditional access system – used for access control – within its set-top boxes because it believes SECA boxes will be incompatible with its own.

BSkyB chief executive Mark Booth pointed out that the decision is bad for consumers. "We are committed to

interoperability and what matters here is that consumers are not disadvantaged by being faced with set-top boxes that are not compatible," he said.

But according to a BDB spokesman, interoperability has nothing to do with the choice of conditional access system. He explained that BDB, with the help of BSkyB, will need to design a "sidecar" device that will plug into the set-top to allow consumers to access BSkyB's services. "Interoperability is a two-way street," he said. "We are perfectly happy to co-operate. The

door is open and we'd like them to come and sit at the table with us."

According to BDB, the decision to use SECA – already used in over 1.5 million set-tops across Europe – means the company will remain on schedule for the launch of its terrestrial service in the last quarter of the year.

Pace Micro Technology, the Yorkshire-based set-top box manufacturer, believes the BDB decision increases its chances of winning a contract from BDB. The company uses the SECA system in the set-tops it is shipping to French broadcaster Canal Plus.

'University for everyone' outlined

The government has given more details of its University for Industry (UFI) which will enable people to keep up with developments in technology from their workplaces or homes. Computers and the Internet will be central to bringing about the learning scheme.

The UFI will publish its pathfinder prospectus in March and will begin next year. While one target group will

be adults who missed out on their school education, retraining staff in new skills will be a key role for the scheme.

Whitehall sources said that the electronics industry – where the pace of technological change was extremely rapid – was one of the sectors of the economy where the UFI could be of most use.

People wishing to make use of the

UFI will start individual learning accounts into which they, their employer and the government may invest.

The proposals are outlined in a Green Paper 'The Learning Age' published last week which stressed that high-tech information now kept only in universities and colleges will become available to all workers wanting to retrain through the UFI.

IN BRIEF

8-bit micro for less than 50 cents

The first 8-bit microcontroller to be launched at under 50 cents is the claim made for Motorola's 68HC705KJ1 which puts together a 68HC05, 8kbits of EPROM, 512bits of SRAM, memory mapped i/o registers, and ten bi-directional i/o pins. It draws 10mA and comes in 16-pin SOIC and DIP packaging. Windowed packages for uv erase and reprogramming are available.

Ferroelectric lcd research tie-up

Ferroelectric lcds, the understudy to today's TFT and STN displays, should be boosted from a tie-up between research organisations in the UK and Japan. "We will be pooling our knowledge to get a more rounded attack on the problems," said Peter Raynes, director of research at Sharp's UK research labs. Other members of the group are Sharp's Functional Device Laboratory in Japan and the UK's Defence Evaluation Research Agency (DERA). Apart from a Canon display, direct view ferroelectric displays have yet to make it into the commercial arena.

Will SCSI give way to fibre?

External storage systems will be forced to move from SCSI to Fibre Channel, says interface company Adaptec.

"As storage disk farms grow, the only way they can communicate is by SCSI. You're going to need to go to fibre," said Ray Castle, Adaptec's sales director in Northern Europe.

SCSI is limited to 15 devices, while Fibre Channel can handle up to 126 devices such as external disks.

A degree more relevant

Today's engineering degrees may lose their relevance within four years, according to David Jefferies the new president of the IEE, who calls for an approach of life-long learning amongst engineering employers. "Engineering knowledge is expanding so rapidly that a good engineering degree has a 'half life' of only four years," said Jefferies.

FUSE programme extended

Bolton Institute Microelectronics Centre, agent for the European Commission's FUSE programme in the North of England, is extending its remit to cover Scotland and Northern Ireland.

FUSE – First User Action initiative – gives financial assistance to firms moving into microelectronics for the first time or

into new areas. Typical projects are developing Asics, multichip modules, FPGAs and microcontroller systems.

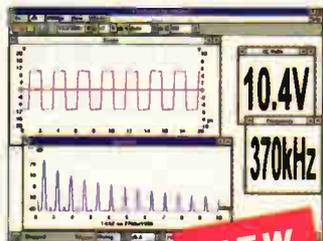
"It shows that our success in spreading the FUSE message in our own area has been recognised by the controllers of the project in Brussels," said Richard Fairbank, director of the Bolton Centre. In the initiative's first two years, the Bolton Centre has helped in 26 company projects. "Forty per cent of those are with companies that have never used electronics before," said Fairbank. Contracts for the second phase of FUSE have now been signed. E-mail ttn@bolton.ac.uk

Survey highlights increasing skills shortage

Skills shortages in sectors such as electronics are worsening if the findings of a survey carried out by venture capitalist firm 3i are a good indication. The survey, dubbed the *Enterprise Barometer*, said that 60 per cent of medium-sized businesses questioned believed a lack of skilled staff was restricting growth. Almost a quarter of firms identified the skills issue as their single most important problem. Engineering sectors like electronics and computing, where the skills shortages are particularly acute, could see pressure on rising salary levels.

**'Pico's Virtual Instrument is
the most powerful, flexible
test equipment in my lab.'**

Pico's virtual instruments emulate the functions of traditional instruments such as **Oscilloscopes, Spectrum Analysers and Multimeters**. Controlled using the standard Windows interface, the software is easy to use with full on line help.



**NEW
100 MS/s**

ADC-200

Dual Channel High Speed

- ▼ 100, 50 or 20 MS/s sampling.
- ▼ 50, 25 or 10 MHz spectrum analysis.
- ▼ Advanced trigger modes - capture intermittent one-off events.
- ▼ Less than half the cost of a comparable benchtop scope.

ADC 200-100 £549.00

ADC 200-50 £499.00

ADC 200-20 £359.00

Supplied with cables and power supply.



ADC-100

Dual Channel 12 bit resolution

The ADC-100 offers both a high sampling rate 100kS/s and a high resolution. Flexible input ranges ($\pm 50\text{mV}$ to $\pm 20\text{V}$) make the unit ideal for audio, automotive and education use.

ADC-100 with PicoScope software £199.00

with PicoScope & PicoLog software £219.00

ADC-40/42

Single Channel - low cost

- ▼ 20 kS/s sampling.
- ▼ 10 kHz spectrum analysis.
- ▼ $\pm 5\text{V}$ input range.

ADC-40 8 bit resolution £59.00

ADC-42 12 bit resolution £85.00



**Call for free demo disk
or download our web site:
<http://www.picotech.com>**

All prices exclusive of VAT.

Broadway House, 149-151 St Neots Rd,
Hardwick, Cambridge. CB3 7QJ UK
Tel: (0)1954 211716 Fax: (0)1954 211880
E-mail: post@picotech.co.uk

SOFT
BY DESIGN
HARD
ON RFI



FABTRACK®

Fabtrack is the latest development from Warth's Fabshield family of EMC gaskets utilising conductive fabric as a shielding medium. It outperforms all similar flame retardant environmental sealing gaskets by the use of multiple shielding planes which provide maximum shielding performance. Manufactured in the UK by Warth to ISO9002, Fabtrack is qualified to UL and IP65 standards

Warth Commitment to innovation makes the difference

warth

Warth International Ltd

Birches Industrial Estate, East Grinstead, West Sussex RH19 1XH
tel 01342 315044, fax 01342 312969, <http://www.warth.co.uk>

CIRCLE NO. 111 ON REPLY CARD

CIRCLE NO. 110 ON REPLY CARD

May 1998 ELECTRONICS WORLD



Rod Cooper's series of software reviews is designed to help you choose the best low-cost cad package for your needs. This first installment tells you what to watch out for, and looks in detail at the pcb design side of the new *Proteus IV*.

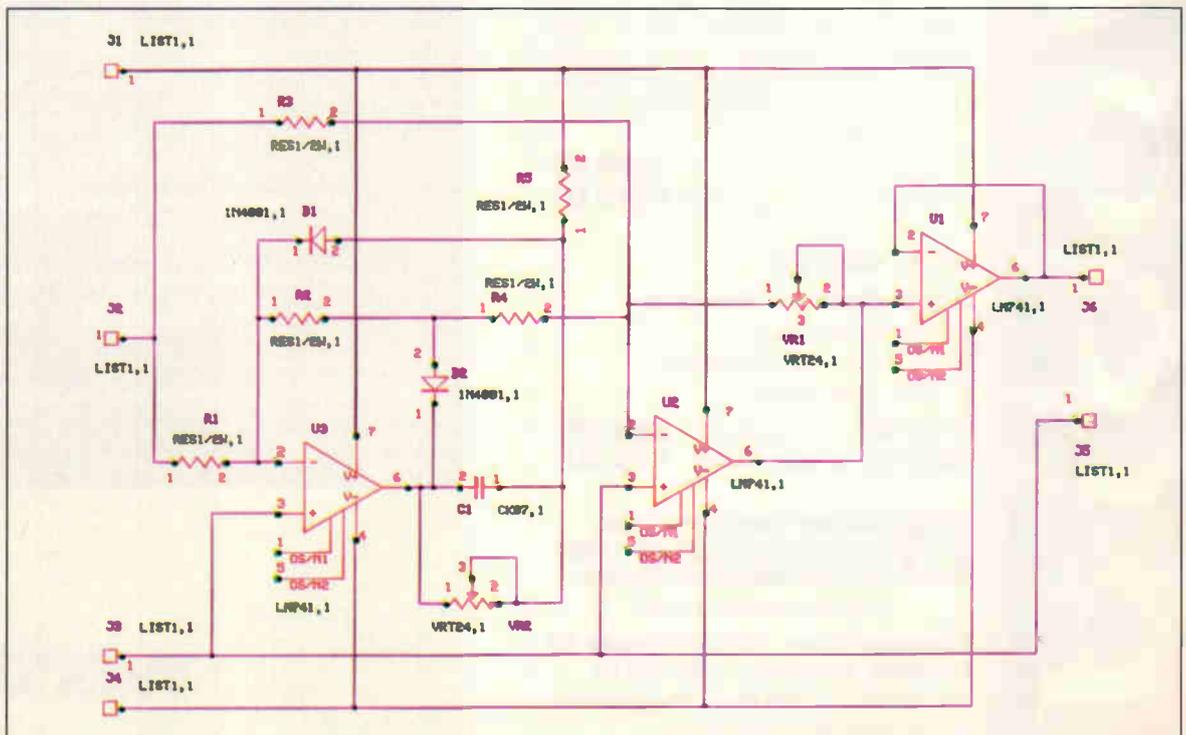
The route to pcb cad

First, a word about the programs I have selected for this set of reviews. Although the wisest first step in the route to pcb-cad probably means buying a simple product to see what is involved, eventually most small firms and designers will want something more sophisticated. All the products reviewed in this series are therefore integrated schematic-capture and autorouter programs. Some have auto-placement and a few other nice features.

As a prospective buyer, don't be put off by the apparent complexity of the programs mentioned in the forthcoming series of reviews. They can all be mastered by being broken down into smaller, more manageable sections. But if you do want to make multi-layer pcbs, you will find even relatively simple programs like *Traxmaker* can support them.

With the almost universal adoption of Windows and the advent of Windows 95, most producers have updated their

Although not sufficiently good for pcb layouts, one thing a Windows plotter driver can do is produce multi-colour circuit diagrams like this one from EDwin. Most plotters can handle page sizes up to A3.



products to suit. New Windows versions of *Ranger2*, *Proteus*, *EasyPC* and *TraxMaker* are therefore reviewed. Two more programs of the schematic capture/autorouter type, *EDWin* and *Ultimate*, have been added.

Just because its expensive...

This set of reviews covers the range £100 to £800. This excludes many over-priced programs that would otherwise have been of interest. It may be tempting to splash out and buy one of these high-priced products from the so-called top end of the market in the mistaken belief that leap-frogging to the top will bring some imagined benefit and be a better investment of money.

But if you do, you could be in for an unpleasant surprise. These products may have more features and options, but you will find the penalty for complexity is a very steep learning curve. Some lack the intuitive interface that nearly all the middle-market products have discovered is vital to their success. There is nothing worse than struggling for hours to get something to work that you know should be easy, but isn't.

As a rule-of-thumb, if you are familiar with Windows, it should take you no longer than about sixty minutes to grasp the basics of drawing a simple schematic. By drawing a simple schematic I mean extracting a handful of symbols from the library, placing them and then wiring them up exactly as you want them – as opposed to how the program wants them – with correct connectivity. If it starts to take you much longer than an hour then the package concerned is probably wrong for you.

Dry manuals

Some of the manuals for these up-market products are written in a mixture of dry prose and product-specific jargon, which does not make easy reading. Often, the manuals assume that you already have complete command of the program's own jargon, and this can be very irritating for a designer whose knowledge of the subject may not yet be complete. One manual I checked did not even have such a basic feature as an index.

Also, you may well find a particular feature, such as the excellent schematic autowirer systems found in *Proteus* and *Circuitmaker*, and which you expected to find as a matter of course in a more expensive program, is in fact absent.

The law of diminishing returns applies to pcb-cad programs as much as any other field, and I have concluded that, as with so many other products, the best cost-benefit ratio is to be found in the middle-price part of the market, where the competition is fiercest.

If you are starting out in pcb-cad, it is probably more important to have a program that concentrates on the intuitive aspect. It should provide just the main options, but perform them really well. The point to bear in mind is that a simple program and a complex program both end up producing a pcb. It is not necessarily the complex program that will give the best result, because so much depends on how well the operator interacts with the program.

Autorouters

While autorouters can do a lot to relieve the difficulty of routing traces, it will have become clear to you if you read my earlier set of reviews that many programs simply transfer the burden of manually finding pcb routes, into one of manually compiling rat's nests to suit the autorouter. Only one program – *TraxMaker* – made any attempt to use the available computing power for logical compilation of the rat's nest.

In this new set of reviews there are two more programs that offer this autoplacement facility – *EDWin* and *Proteus IV*. In addition, these two offer another aid to rat's nesting in the form of 'vector forces'. These are indicators or flags on each component pointing the way that a component should be

Review subjects

In addition to *Proteus*, which is reviewed here, the following packages are to be reviewed in the coming months.

- *TraxMaker*
- *EDWin NC*
- *Ranger 2 for Windows*
- *Ultimate Challenger*
- *EasyPC for Windows*

moved for shortening the ratline.

Of course, other factors such as thermal considerations and accessibility will often mean that you cannot move them as indicated, but this feature is a step in the right direction. Unfortunately, if you blindly follow the pointer of the force vector, you will often decrease the routability of the board by increasing the number of crossed rat lines. This means that vector on its own has limited use.

It should be possible to use the considerable computing power now available to increase the scope of the autoplacer by automatically rotating parts and moving component positions around so that rat lines are minimised in length and the number of crossovers reduced until an optimum is reached.

No doubt autopacers will become much more aggressive in the future to improve routability, using methods akin to the rip-up-and-retry and push-and-shove systems currently used in the better autorouters.

Track spreading for excellence

On the subject of autorouters, it is worth mentioning a strategy called track-spreading. This is used by some autorouters for improving spacing between tracks on the routed pcb design, after route-finding has been completed.

Track-spreading works by moving the tracks further apart slightly, within the physical confines of the pcb outline. This makes the most of the available space, and has four main benefits, as follows.

First, track-spreading can reduce the cross-talk between long lengths of closely-spaced track. Secondly, it dramatically reduces the chances of a filament of copper remaining across adjacent closely-spaced tracks after etching, improving the yield in manufacture. Sometimes these filaments are so tiny they are invisible to the naked eye. Thirdly, during solder-bath operations, the chances of a solder bridge are much reduced.

But the fourth benefit will be of considerable interest to anyone who has tried plotting the pcb artwork direct onto copper laminate with a flat-bed plotter and etch-resistant ink. This method was described in the July 1997 issue. The spread-track feature improves the success rate considerably.

Of the packages reviewed, only the *Specctra* autorouter has track spreading. However, I did not find the implementation in *Specctra* very user friendly. But track spreading is so useful that if your autorouter does not have it, you should be really asking your supplier why not.

The trend towards Windows

From the pcb-cad user's point of view, Windows offers both advantages and drawbacks. Most important of the advantages is the ability to use larger monitors in Windows, without the hassle of setting-up that plagues dos programs. Monitors of 17in and above are so much more pleasant to work with – assuming you can afford one.

With Dos-based cad packages, getting the right combination of driver, resolution and video card for anything other than the 14in standard 640 by 480 pixel screen can be problematical. This is due to the lack of standardisation and compatibility that still afflicts the pc industry.

Windows has its own set of drivers applicable to every program – regardless of its origin. However, the generic graphics drivers provided in Windows may not get the best out of any particular card. As cad is an area where good graphics performance is vital, it is always worthwhile taking the trouble to install the card maker's specific driver for Windows 3.x or 95.

Screen redraws are slower in Windows, but this problem has lessened due to the overall speed increase – even in current low-cost entry-level pcs. If you still have a slower 386, it may well be a problem.

Remember that for the real task of pcb-cad – i.e. that of drawing schematics and artwork – the screen area available in a Windows program is invariably less than that of a Dos program. This is especially significant if you have a 14 or 15in monitor

Now for the plot

Generally, printers are well catered for in Windows, but pen plotters continue to present a few difficulties – even though the drivers in Windows 95 are much improved over those in its predecessor. The drivers provided in Windows are not really suitable for the demanding work of pcb artwork, although they will of course produce an image.

Typically, when driven by a driver from Windows, the pen will execute a rapid see-saw action when called on to produce thick tracks. A specialised pcb-cad driver on the other hand will execute a series of straight overlapping lines, providing much better results. With a see-saw action, if there is any play whatsoever in the plotter mechanism, or if a resonant mode is struck, a roughly-drawn outline will result. There are a few other oddities like this, as the designer who persists in using the Windows driver will find out.

The choice of pen width ceases at 0.3mm, whereas pen widths of 0.2mm and less are used frequently in pcb-cad. There is no incremental adjustment of pen width, although this is often essential in pcb-cad to achieve the fine clearances that are necessary.

But you will get results of a sort with Windows – especially if you stick to thin lines and small pads and don't attempt anything too ambitious. Because plotters can generate such excellent artwork with the right driver, a specialised driver provided by the pcb-cad program makers should be a standard item in every Windows pcb-CAD product. This is not always the case.

On reflection

Some programs cannot mirror the artwork for plotting or printing. For example, this used to be true on *Ranger2*, although you could always get round this by using the Gerber import/export utility. The new Windows version of *Ranger2* has this feature built-in.

You should check that mirror-imaging actually works on the pcb-CAD program of your choice, with your particular printer or plotter. Sooner or later you will want to mirror the artwork, even if you don't plot direct to copper.

One disadvantage of Windows programs is their higher cost. Because individual Windows programs are not encumbered any more with numerous drivers for printers, video etc. and because the development tools are more advanced, Windows packages should be cheaper than their Dos counterparts. Usually, though the opposite is true. There seems no justification for this.

Recently two different program makers commented to me, without prompting, that sometimes a Dos-based program can be easier to operate – a sentiment that I can sympathise with. Over-reliance on the mouse, and over-use of icons in Windows programs could be to blame.

Identifying icons

Although it is easy to memorise icons that have become universally recognisable, like the + and – magnifying glass for zoom in/out, it is well-nigh impossible to identify the 50 icons or so that some programs display.

In an attempt to get round this difficulty, pop-up text, sometimes called 'tooltips', is now widely used to identify each icon – but this rather defeats the object of having an icon in the first place. In my view, it would be easier to have the text permanently displayed with, or actually on, the icon. There is usually a delay before the text appears to give you time to remember the icon, and this is adjustable on some programs. However, such a device is an unsatisfactory compromise solution to over-use of icons, so beware of programs with too many of them.

My advice is to look closely at the icons of any program you are interested in buying as they are very much a personal like/dislike subject. Are there too many for you? Are they distinctive? Are they appropriate to the job? And most importantly, are they memorable?

In Windows programs, there is probably a happy medium between menus and icons, but not many programs manage to achieve it. At one end of the spectrum there is *Ranger2* with just a handful of icons and more menus, and at the other end is *EDWin*, with dozens of icons.

PROTEUS IV

Reviewed in the January 1997 issue, the dos version of *Proteus* emerged as one of the recommended systems. All its original features have been retained in the newer Windows version, – the subject of this review. Much of what was said in the first review still applies. But this version, in addition to running under Windows instead of Dos, has had several significant new features.

Being 32-bit throughout, *Proteus IV* needs the WIN32S driver to be installed before it can be used with Windows 3.1. The two components of *Proteus IV*, namely *Isis* and *Ares IV*, occupy 9.5Mbyte of disk space. The system is supplied on four

floppy disks, and this version, at £550, is limited to 1000 pins. Other versions with different pin limits are available. Security is by registering name and number.

The manual is a single large volume, well written and concise. Labcenter has its own terminology for many items, but explanations are given. References to the dos version have now been removed, making the manual easier to read. It is split into three sections covering the schematic, layout, and simulator program – supplied as an extra – and each section has its own comprehensive index.

Schematic section

Consistent with Labcenter's product description policy, *Proteus*'s schematic section is called *Isis IV*.

This sub-package has taken on board much of the character of *Propak*'s *Isis* *Illustrator*. Readers will remember that *Propak* was singled out for its good

graphics presentation in Part 1 of the review, so this is an interesting development by Labcenter.

A typical schematic screen is shown in Fig. 1. Compared to the other programs in this set of reviews, Labcenter's package seems to have a reasonable balance between icons and menus.

Note that the non-standard Windows format has been retained, with the original 'map' area, icon area and parts bin, and the absence of scroll-bars. Previous users of Labcenter's products will therefore be able to transfer readily to *Proteus IV* without much re-learning.

Relative to its earlier Dos version, *Isis IV*'s icons are easier to use as pop-up help has been added. This help appears whenever the mouse pointer is over an icon. As usual with this type of system, there is a short delay before the help appears, so experienced users working at speed will not be distracted.

The area with the icons, map etc

Proteus IV

Cost; £550
 Maker; Labcenter
 Supplier; Labcenter Electronics
 53-55 Main Street
 Grassington
 North Yorks BD23 5AA
 Tel. 01756 753440

System requirements

WIN 3.1 with 8Mbyte ram,
 WIN95 or NT with 16Mbyte ram.

takes up a fixed amount of screen space so the drawing area is only fair, at 7.5in by 5.5in on a 14in monitor. Not having any scroll-bars provides a bit more room.

It would be nice to be able to turn off the parts bin and map area, as can be done in *EDWin* for example. However, on larger monitors, 17in and above, this is less of an issue.

Selecting and placing

The process of selecting and placing components is done exactly as before. If you are interested in this aspect, consult my earlier review for an insight.

Notably, the libraries have been expanded, particularly with 4000 series devices. The library components carry simulator data for Labcenter's integrated *Lisa* circuit simulator. Access to the libraries is good, and you automatically get a graphical representation before selection.

There is only one generic symbol provided for resistors, capacitors and the like. The pcb footprint is entered on editing each symbol. But this system is rapid because what the footprint code signifies is readily apparent on editing, for example RES40 is a resistor on a 0.4in pitch.

If you need extra footprints, it is relatively easy in *Proteus* to edit the existing library items in order to provide them. If you generate your own devices like this, they should be kept apart in their own library volume – and backed up so they are never lost.

Placing and moving symbols is easy, and unlike some programs, symbol-text stays upright and readable when symbols are rotated. It is easy to edit text to produce a neat diagram.

The choice of manually drawing the connections or using the excellent wiring autorouter remains. Both are well-designed systems, easy to use and effective. Unlike *Propak's Isis*, in *Isis IV* drawing lines in space is not inhibited. The hierarchical multi-sheet system is still present.

Getting in closer

Zooming is done by selecting one of seven fixed levels. There is a big jump in the sequence from 100% to 200%, which is rather coarse. An incremental zoom feature like the one in *EDWin* would be more useful. However there is a second zoom feature in *Proteus IV* called shift-zoom which gives more control.

Shift-zoom is activated by pressing the shift key and drawing a window round the area of interest with the mouse. Besides giving more zoom levels and detailed close-up views, the advantage is a lot more control over the area in view after zooming.

There is a zoom-all feature which fits the schematic to the drawing area. Panning is done by holding down the right mouse button and bumping the edge of the screen while pressing the shift key.

Generally, *Proteus* makes good use of the right mouse button to perform other functions like edit and select, for symbols and wires. At first the interaction between left and right mouse buttons may take some getting used to, but my advice to newcomers to this method is to persevere. Using both mouse buttons in this way can significantly increase your drawing speed because it avoids you constantly having to refer to menu/tool bars or the keyboard for the most common operations.

Two heavyweight tools are available in *Proteus*. Firstly, there is *PAT*, short for property assignment tool. With this, you can label such things as a set of bus taps, a set of components of the same type, or a common device package size can be fixed for a string of components.

This is very useful on a large board with many components of the same type.

Secondly, there is *ADI*, standing for Ascii data import. This was mentioned in my first set of reviews. It allows the operator to specify data for component types in a simple text file, which you can readily generate with *Windows*'s Notepad. This can then be imported into any design with a single command. You could, for example, fix the value, tolerance and cost for 0.125W resistors throughout a design. Like *PAT*, *ADI* is a feature most useful for big-board use, or for company use, where data such as cost, stock numbers etc. is more significant.

It takes some effort to learn how to use *PAT* and *ADI*, but if you are working regularly on large pcb designs they become very useful. The package does not oblige you to use them and you can get along very well without them. In this respect, *Isis* can be operated on two levels; simple but flexible, which would

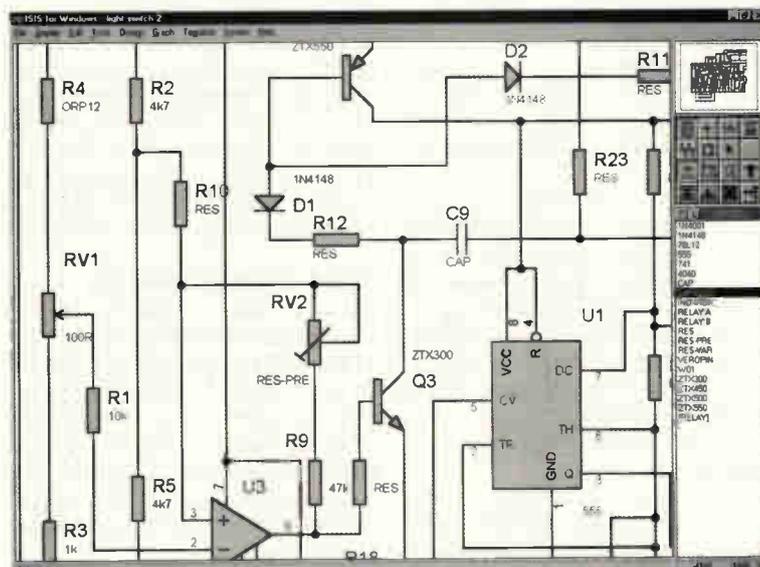


Fig. 1. Typical schematic screen from *ISIS IV*. Compare these graphics with those in *Propak*, reviewed in the December 1996 issue.

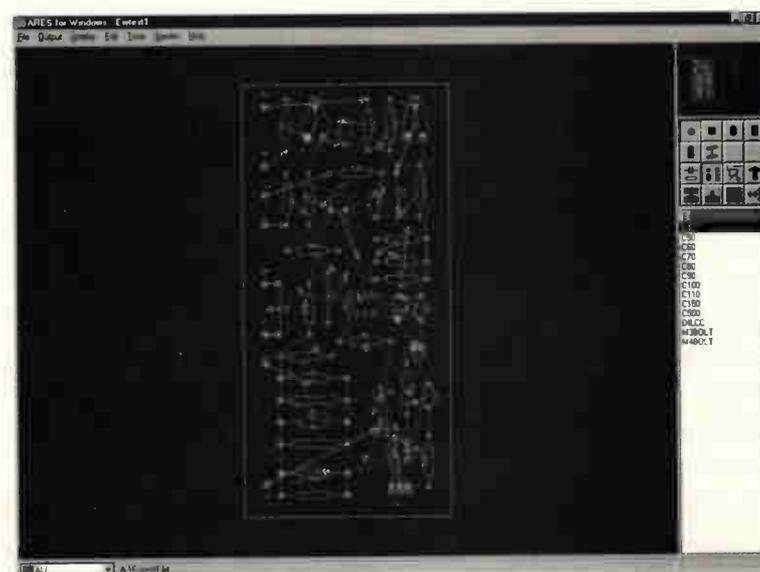
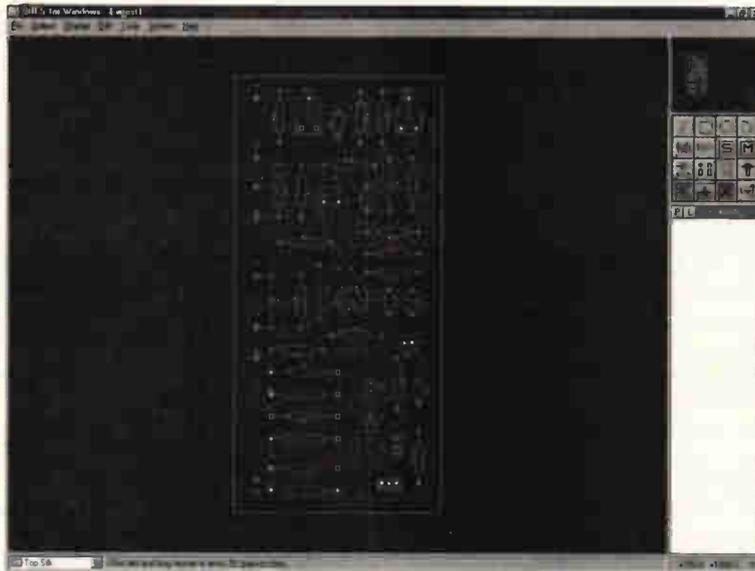


Fig. 2. Rat's nest of one of the test circuits used in the review. Note yellow vector arrows to assist placement.

Fig. 3. The autorouter routed the above rat's nest single-sided in just 14 seconds using a 133MHz Pentium with 16Mb ram.



suit the prototype designer, or alternatively with the greater automation of PAT and ADI, which would benefit the production company.

Laying out pcbs

The layout package, *Ares IV*, is an area where the most significant changes have been made to Proteus. One such change is the adoption of a component autoplacer.

Previously, to make a rat's nest, components from *Ares'* schematic capture were automatically transferred to a parts bin – called the “object selector” in Labcenter parlance – and then dragged-and-dropped onto the board manually. This was a very good system and much faster than having the components dumped in a overlapping heap or in a linear array – which is not unusual in other systems.

A component autoplacer is even quicker, particularly on the larger boards. Even so, I would still recommend you to use the manual technique to place a few major components that have a large influence on the pcb design, like edge connectors, heat-evolving power devices and cpus, and then to let the auto-placer do the rest.

The auto-placer can be configured before use in much the same way as an autorouter. It is very flexible, but it can only tackle the top side of the board at present. Boards with components on both sides will no doubt be catered for in due course.

In addition, the concept of force vectors has been adopted. As shown in Fig. 2, a yellow arrow on each of the components in the rat's nest suggests the direction in which it might be moved to get a shorter rat-line. This may not be what you want for any particular component of course, but it is a big help in the complex task of sorting out a viable rat's nest. This feature can be turned off

if you wish to rely solely on your own intuition.

The interactive layout tool is basically unchanged, but a number of features have been added to the *Ares* autorouter. These include pin and gate swapping, and a tidy pass. The latter seems to be a very useful instrument. The original autorouter gave good results, but did leave the occasional kink or detour. In the main, these were not intrusive and could be easily edited out if you wished to improve the appearance of the board.

Towards better routing

However, the new tidy-pass strategy does much more than just remove these kinks; it rips up the track and relays it. In the process of moving the track, a new and superior route may be found for adjoining tracks, so the strategy then iterates until no more can be done. Such a system could be used to free a design that had become stuck, permitting further routing.

Although intended to clean up the results of the autorouter, the tidy pass can be used on manually-routed boards. This opens up new possibilities for manual routing and means that a rapid rough-draft approach could be used for sketching out the manual routes, leaving the tidy pass to produce an acceptable design automatically.

The tidy pass takes time to execute – typically as long or longer than it takes to autoroute a design. It is, in effect rerouting the layout several times to get optimum results. Despite the time taken, I think most designers will find this additional feature well worthwhile. The results are good. Typically, I was able to achieve a track length reduction of 5 to 10% on 50-component boards.

Some autorouters grind on for a while if they reach a stalemate condition, at a point where ripping up and retrying does not achieve any further real

progress, leaving the operator to realise when this has occurred. In *Ares IV* a new check on stalemate has been introduced. I tried this out on some rat's nests that had been made deliberately impossible, and indeed the autorouter seemed much more ready to declare when stalemate had been reached. This is re-assuring, because you can be confident that the autorouter isn't going round in circles.

The excellent system for manually placing any tracks left undone by the autorouter has been retained. This was described in the first review. If you dislike rubber-banding, this is the system for you. It also makes re-entrant use of the autorouter particularly attractive, especially for single-sided boards that nearly always need some editing to finish off or to put in jumpers.

The only feature that the autorouter lacks is the track-spreading feature which was mentioned earlier in the introduction.

Unlike some of its competitors, Labcenter still provides a separate pen-plotter driver and does not rely entirely on the Windows drivers. The manual says that the Windows driver is only partly used and the *Ares IV* driver does the rest.

The plots I tried were all consistently good. There is plenty of control over such items as pen speed and width, and a mirror function is included. This will be of particular interest to those who want to prototype pcbs by plotting direct to copper with etch-resistant ink. If you want to pen-plot artwork, *Proteus* is a very suitable program.

In summary

Proteus IV can be endorsed as a superior product. The learning curve can be moderate or steep, depending on your approach, as mentioned earlier.

The revamped schematic drawing section is quick, versatile, and gives good graphics quality – recommended if your schematics are to be plotted/printed out for professional use. The autoplacer is a significant advance and works well.

With its new tidy pass, the rip-up-and-retry autorouter is one of the best of the packages reviewed; for re-entrant use it gets full marks. Besides making good double-sided and multilayer boards, the autoneck and manual track edit systems give the autorouter the edge over its competitors for making single-sided boards.

Finally, although not reviewed here, the availability of an integrated simulator using the same terminology and style makes the overall package even more attractive. This simulator, Lisa, will be discussed in a separate comparative review of simulators. ■

new

excel 100



The new off the shelf
power supply from Weir Lambda

- 4 Safety Extra Low Voltage (SELV) outputs
- 100 watt convection-cooled rating
- Fits 1U rack
- Input and Output connectors for rapid installation
- Harmonic correction to EN61000-3-2
- EMC performance to EN55022
- Auto-ranging input for worldwide operation
- Standard output voltage variants available from stock
- Non-PFC version available for cost sensitive applications
- Customised versions available for volume OEM users

**WEIR
LAMBDA** 

Weir Lambda, Durban Road, Bognor Regis, West Sussex PO22 9RW

Tel 01243 865991 Fax 01243 841628 <http://www.weirlambda.com>

Contact us now on 01243 865991

CIRCLE NO. 112 ON REPLY CARD

CIRCUIT IDEAS

Over £600 for a circuit idea?

New awards scheme for circuit ideas

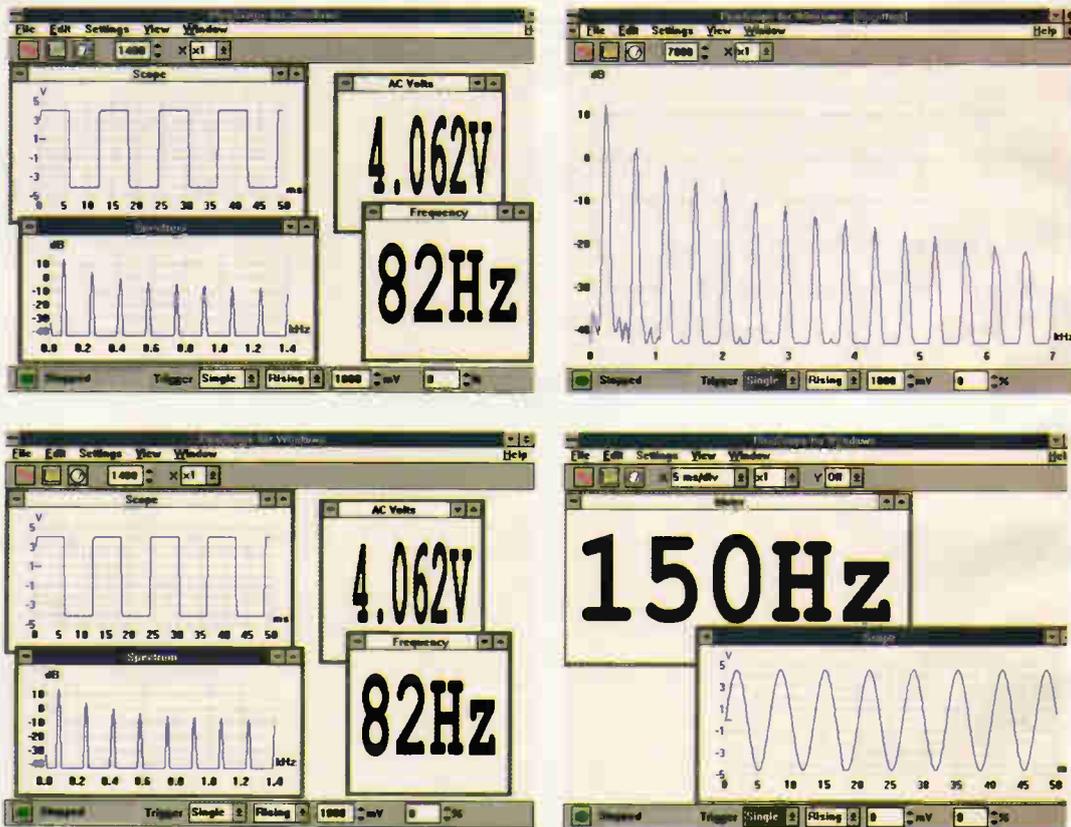
- Every circuit idea published in *Electronics World* receives £35.
- The pick of the month circuit idea receives a Pico Technology ADC42 – worth over £90 – in addition to £35.
- Once every six months, Pico Technology and *Electronics World* will select the best circuit idea published during the period and award the winner a Pico Technology ADC200-50 – worth £586.

How to submit your ideas

The best ideas are the ones that save readers time or money, or that solve a problem in a better or more elegant way than existing circuits. We will also consider the odd solution looking for a problem – if it has a degree of ingenuity.

Your submission will be judged on its originality. This means that the idea should certainly not have been published before. Useful modifications to existing circuits will be considered though – provided that they are original.

Don't forget to say why you think your idea is worthy. We can accept anything from clear hand writing and hand-drawn circuits on the back of an envelope. Type written text is better. But it helps us if the idea is on disk in a popular pc or Mac format. Include an ascii file and hard-copy drawing as a safety net and please label the disk with as much information as you can.



Turn your PC into a high-performance virtual instrument in return for a circuit idea.

The ADC200-50 is a dual-channel 50MHz digital storage oscilloscope, a 25MHz spectrum analyser and a multimeter. Interfacing to a pc via its parallel port, ADC200-50 also offers non-volatile storage and hard-copy facilities. Windows and DOS virtual instrument software is included.

ADC42 is a low-cost, high-resolution a-to-d converter sampling to 12 bits at 20ksample/s. This single-channel converter benefits from all the instrumentation features of the ADC200-50.

ADC-42 WINNER

Conditioning temperature sensor output

A recent task was to design a temperature monitoring system using some 400 sensors and this required a rethinking of the basic sensor conditioning amplifier.

This circuit uses a single op-amp to perform all the functions, usually implemented in a four op-amp configuration, needed by a Pt100 temperature-sensor conditioning amplifier: sensor wire resistance compensation, current-source sensor drive, a three-wire sensing scheme, 10mV/K sensitivity, the Celsius scale offset and induced-noise filtering.

Resistance of the Pt100 platinum sensor relates to the temperature as :

$$R_T = R_0(1 + a(T - T_0))$$

where $R_0 = 100\Omega$ at $T_0 = 273K$ and a is the temperature coefficient of 3850ppm/K, giving 61.5 Ω and 138.5 Ω at $-100^\circ C$ and $+100^\circ C$. With such low resistance, wire resistance compensation is necessary and separate current supply and voltage sensing wires are normally used. Differential circuit configuration allows the use of only three wires, instead of four.

Also, a high-impedance current source must supply the sensor to preserve linearity. In this amplifier, the current source impedance is limited only by the op-amp open-loop d.c. gain and resistor tolerances.

In the circuit shown, R_T is the sensing element; R_{wi} are the wire resistances; $R_{1,2,3,4}$ around the op-amp form a conventional bipolar current source; and R_x and R_o subtract the wire resistance error and set the output voltage to zero for $0^\circ C$. Resistor R_b compensates for the op-amp input offset current and $C_{1,2,3}$ provide input filtering of any noise picked up by the long sensing wires.

If a reference current of 2.597mA is used (the inverse of the temperature coefficient value), the basic sensitivity of 1mV/K is achieved. A further 10 times gain is needed by the circuit to get the 10mV/K, which can be fed directly to a digital volt-meter with a 2V full-scale range. This gain of ten is set by making $R_4 = 9R_3$. Then, the current source configuration requests the same nine times ratio for R_2 and R_1 .

If R_x is chosen to be the parallel combination of R_3 and R_4 ,

$$V_{out} = I_{ref} (R_T - R_o)(1 + R_4/R_3)$$

and, to ensure that the reference current is fairly independent of either R_w or R_T ,

$$I_{ref} = V_{ref} / (R_1 + AR_o + BR_T + CR_w),$$

where,

$$A = 1 + R_1/R_2 + R_1/R_x + (R_1/R_2)(1 + R_4/R_3)$$

$$B = 1 - (R_1/R_2)(R_4/R_3)$$

$$C = 2(1 + R_1/R_2) + R_1/R_x$$

Since R_o is constant, A can be of any value. The B factor is cancelled by the current-source configuration requirement: $R_1 = kR_3$ and $R_2 = kR_4$. Substituting R_x , R_1 and R_2 in C , it also becomes evident that C can be minimised by making k small, say 0.1, so $C = 2.31$, much less than the system gain. With the same substitution, A is

equal to C , so the equation for reference current becomes,

$$I_{ref} = V_{ref} / (R_1 + 2.31R_o + 2.31R_w)$$

With 10m of 0.2mm diameter wire, R_w is 4.6 Ω . If R_1 is 3k Ω , I_{ref} will be in error by less than $\pm 0.33\%$ for values of R_w of up to 5 Ω .

Figure 2 shows that this means some 0.3 $^\circ C$. error for each 100 $^\circ C$, but this error is constant for a given wire resistance and can be corrected by readjusting V_{ref} . To minimise the errors, use 0.1% resistors and pay attention to op-amp input offset voltage, since it is amplified by the system gain and a 0.1mV offset becomes a 0.1K reading error; use an OP-07, which has an input voltage offset below 50 μV .

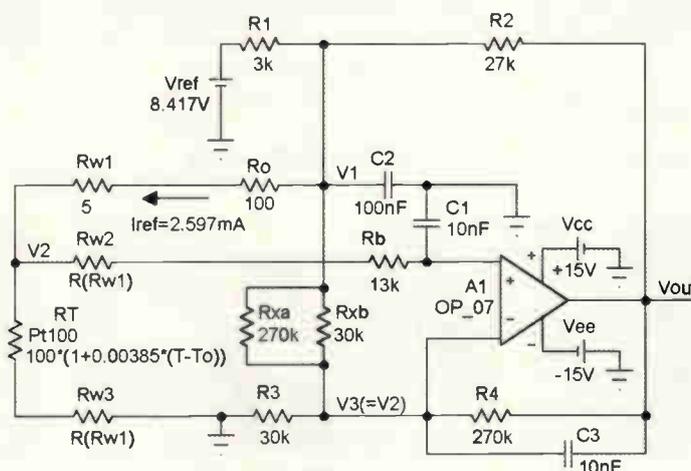


Fig. 1. In spite of the use of only one op-amp instead of the usual four, this conditioning amplifier for resistance temperature sensors still provides all the requirements for a Pt100 sensor, including three-wire sensing and 10mV/K sensitivity.

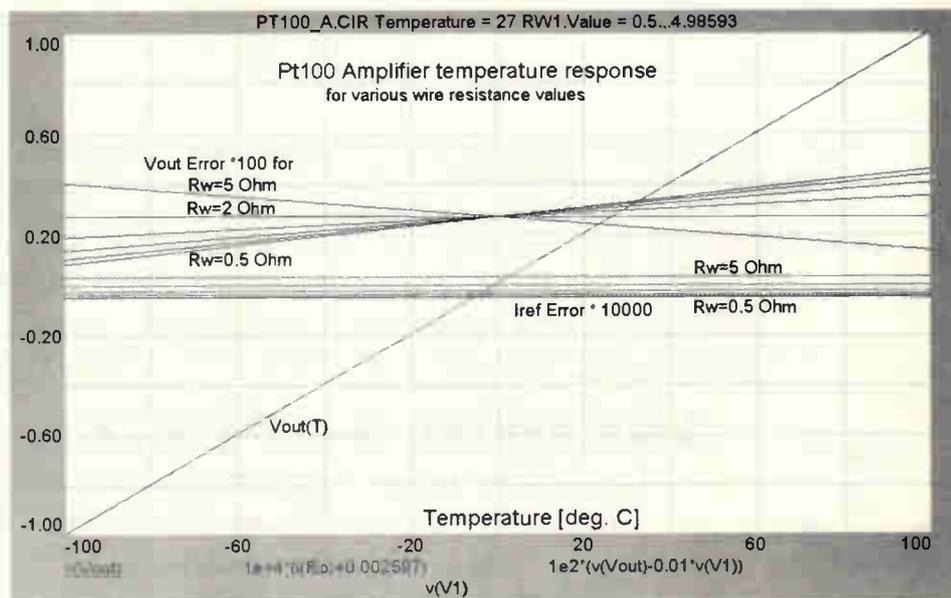


Fig. 2. Temperature response of the amplifier when using wires of different resistances.

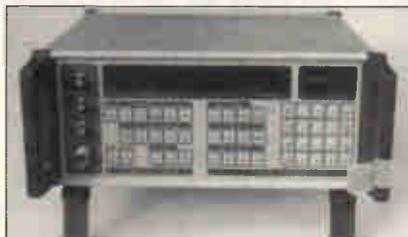
NEW Unused Test Equipment

from one of the UK's Leading Manufacturers



Automatic Modulation Meter
Model AMM255. 1.5MHz - 2Ghz
Fitted IEEE488. LCD Display

ONLY £495 + vat **



Automatic Modulation Meter
Model AMM2000. 10Hz - 2.4Ghz
32 chr alphanumeric display
Fitted GPIB and RS232

ONLY £995 + vat **



Synthesised Clock Generator
Model SCG50 15MHz - 50MHz
LED Display

ONLY £125 + vat **



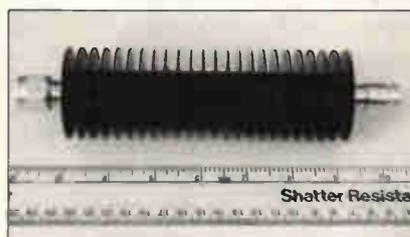
Transmitter Test Set
Model TTS520. RF power, mod,
AF upto 520MHz 100W. 50ohm

ONLY £750 + vat



RF Power Meter
Model 2081. to 500MHz.
100W. 50ohms. 7 ranges

ONLY £125 + vat **



RF Attenuators
to 520 MHz. 50ohm. N type.
75W in for 1W out

ONLY £20 + vat



Portable Appliance Tester
Model PAT1000.
LCD Display

ONLY £350 + vat**



*****SPECIAL*****
Oscilloscope Probes.
x1 x10 switchable. 100MHz

ONLY £9.95 + vat



Portable Appliance Tester
Model PAT2000.
LCD Display.

Detachable Keyboard
ONLY £550 + vat**

Programmable Signal Generator Model PSG1000. 10Hz-1Ghz fitted GPIB. **ONLY £995+vatt****

Spectrum Analyser Model 352C.300kHz-1Ghz. Small and Compact. **ONLY £1500+vatt**

Black Star Meteor 100 Frequency Counters with TXO option. To 100MHz. **ONLY £75+vatt****

Black Star Meteor 1000 Frequency Counters with TXO option. To 1000MHz. **ONLY £150+vatt****

NOTE: All items marked ** are supplied Complete WITH MANUALS

SPECIAL OFFER.. "PROBE-ABLY the Best Offer you will see this YEAR"

Brand New x1 x10 Switchable Oscilloscope Probes.. OK to 100MHz.. Supplied with adaptors etc
Quality German made.. NOT Rubbish. Blister Packed: (see picture above) **ONLY £9.95 + vat**



ANCHOR SUPPLIES LTD

The Cattle Market, Nottingham NG2 3GY. UK

Tel: (0115) 986 4902 Fax: (0115) 986 4667

Mail Order Most Welcome

Open 6 Days a week (Closed Sunday)

WEB Site: <http://www.anchor-supplies.ltd.uk> e-mail: hitek@anchor-supplies.ltd.uk

All Prices are plus VAT. Courier Delivery to UK mainland addresses £7.95 + vat



Be aware that sensors can have different self-heating coefficients, due to different case thermal resistance. With 0.67mW of dissipation due to I_{ref} , choosing a sensor with 0.2K/mW will not pose a problem.

Calibration is simple. Trim V_{ref} (about 8.4V) until the voltage across R_o is 259.7mV. Replace the sensor by

a 100Ω resistor and verify that the output offset is close enough to 0V. Finally, reconnect the sensor and verify the gain by putting the sensor in boiling water and checking that V_{out} is 1V.

Pt100 nonlinearity over a larger temperature range can be corrected by adding a resistance of several

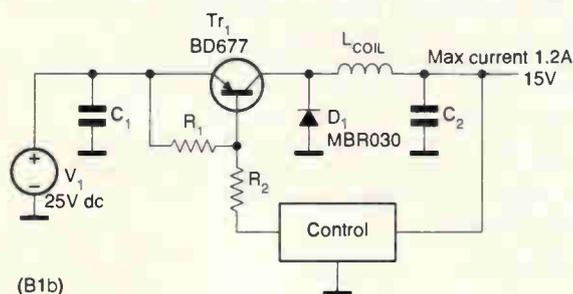
megaohms in parallel with R_o . If only temperatures above 10°C are to be monitored, a single positive power supply can be used.

Erik Margan
Ljubljana
Slovenia
(A109)

Low-ripple dc supply for 50°C working

Several methods exist of making a 12V, 1A power supply, having very low ripple and capable of working at fairly high temperatures. Most, however, dissipate too much power. A linear regulator needs a largish heat sink and releases too much heat and the most promising approach appears to be a switching regulator before the linear type. Many have been published, but most of them still generate too much heat. This circuit gives 2mV ripple and only a 10mV output variation at $I_{out}=0.1-0.9A$, without too much power loss in the circuit components.

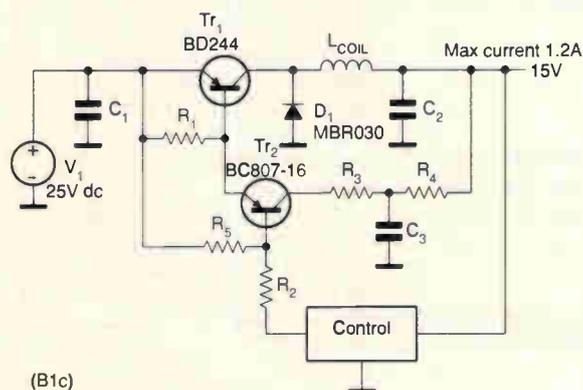
My approach to the final design was as follows. Figure 1 shows a switched-mode circuit preceding the linear regulator, a bipolar transistor being used as a switch, with



(B1b)

Fig. 1. One method of reducing losses is to insert this type of switched-mode regulator before a linear type, but there is still loss in the transistor base resistor, even when a Darlington is used.

consequent low loss. The loss here is 1.5W in the base resistor R_2 , assuming 50% duty cycle and current gain of 20 for a peak collector current of 2.5A. In Fig. 2, the use of a Darlington transistor in the same type of circuit presents the same problem: a V_{CE} drop of about 1.5V causes a 1W loss and the device still needs a heat sink. This is also true if an ic such as the MAX724/726, which contains the

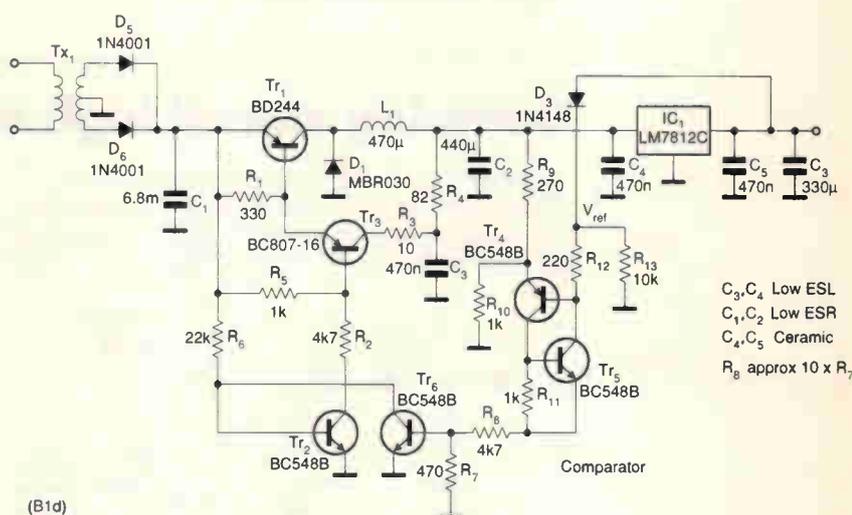


(B1c)

Fig. 2. This method combines the low drive current of a Darlington with the saturation voltage drop of a single transistor.

control and power transistors, is used.

Figure 2 shows the basics of my circuit, which combines the advantages of the previous ones with much lower losses. In this, drive current is the same as that in the Darlington circuit and saturation voltage drop equals that



(B1d)

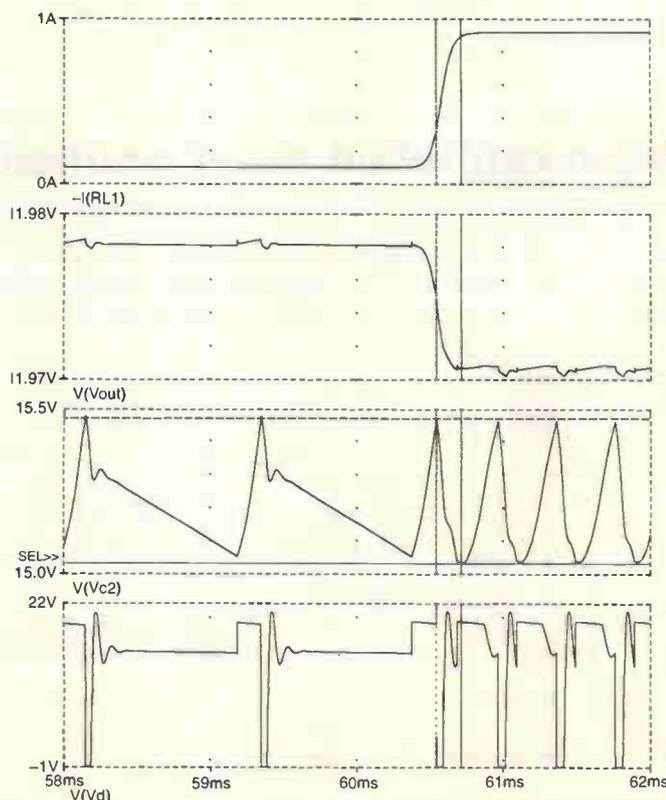


Fig. 3. Final circuit of the Fig. 2 arrangement, complete with linear regulator to give low ripple. Feedback ensures that the voltage across the regulator is constant. Use of an available coil of 470µH gives a low switching frequency, which may be increased by reducing its value and that of C_2 .

of Fig. 1, loss being only 0.25W; no heat sink is needed. Voltage spikes caused by the use of an electrolytic, with its higher equivalent series inductance, at C_2 are reduced by the 1-p filter in the drive transistor collector.

The final circuit is that of Fig. 3, in which the input voltage to the regulator is 25V on C_1 at 0.1A load and 20V at 1.2A. I wanted to make the voltage drop across the LM7812 linear regulator 3V, regardless of the $\pm 5\%$ output tolerance, so used V_{out} as reference; at worst, a fixed reference can give an additional power loss of 1.2W at 1A. The diode is for safety and is biased by R_{13} .

Maximum voltage at the input of the LM7812 is determined by $R_{9,10}$ and is.

$$V_{in} = ((V_{out}/R_{10}) + (0.68/R_{11}))R_9 + V_{out}$$

The minimum depends on $R_{8,12}$ and, slightly, R_{11} :

$$V'_{out} = \frac{0.68 \times \left(1 + R_8 \times \left(\frac{1}{R_{11}} - \frac{1}{R_{12}} \right) \right) + V_{out} \times \frac{R_8}{R_{12}}}{1 + \frac{R_8}{R_{12}}}$$

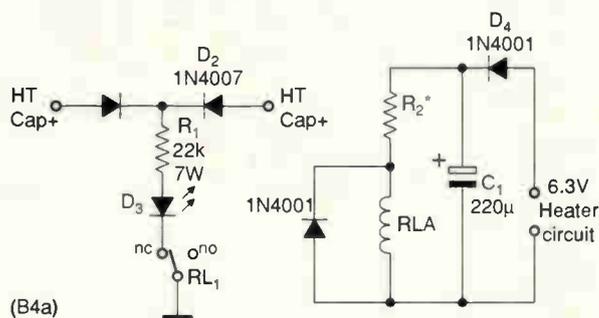
Since, when power is first applied, there is no reference voltage, make $R_{7,8}$ such that $V_{out}R_7/(R_7+R_8)=1V$. To ensure that $T_{r4,5}$ define the switching, make R_{11} greater than 2.7 Ω .

E. Vanderfeesten

Genk
Belgium
(B1)

Dumping stored high voltages

Anyone working with valve equipment will know, probably from hard-won experience, that high-value, high-voltage capacitors will store a charge for many hours and still provide entertainment for colleagues, if not worse.



(B4a)

This little circuit prevents all that.

When power goes off, the normally open relay closes and the ht capacitors discharge to earth through R_1, D_3 indicating the current flow. In principle, you can connect any number of capacitors, wire-Ored via diodes, which isolate capacitors from each other.

The relay may be any 6V type with a changeover contact rated at the relevant voltage and about 1A. Choose R_2 to drop any excess voltage from the heater line.

Jeff Macaulay

Chichester
West Sussex
(B4a)

Discharger for lingering dangerous voltages on capacitors in valve equipment; only two dischargers are shown, but more may be connected.

Timebase-controlled event positioner

If an oscilloscope's timebase waveform is brought out to the front panel, this circuit allows the viewing of an event at any point on the sweep, rather in the manner of a delaying sweep.

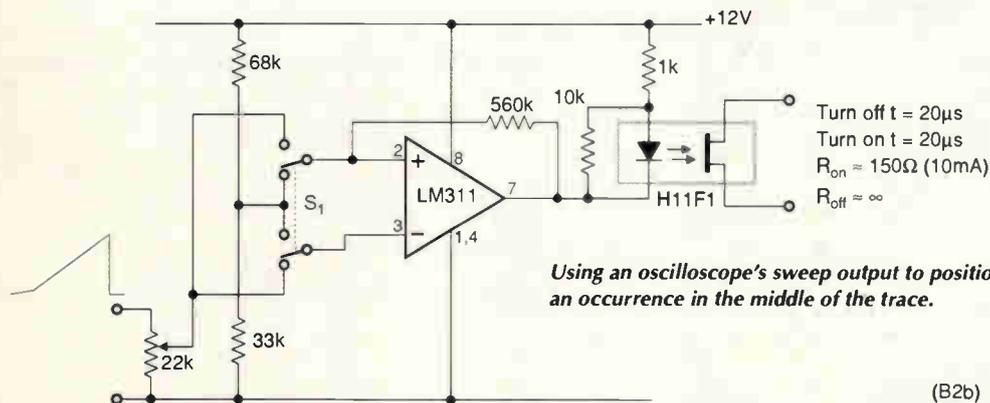
An LM311 comparator switches the optoisolator at a time after the start of a sweep determined by the setting of the potentiometer, the output terminals being taken to the circuit providing the "event" to

be examined. At any timebase speed, the event is always at the same point on the screen.

Several types of optoisolator can be used: the H11F1, which turns on and off in 20 μ s, is used for audio; for fast logic, the H11L1; when looking at mains frequency, the H11C6 scr output or the S21ME3 triac device are useful; and for analogue switching, the TLP59G may be used.

I used the circuit to examine the operation of an agc circuit, a step level change being placed in the centre of the screen.

Peter Kenyon
Almancil
Portugal
(B2)



Using an oscilloscope's sweep output to position an occurrence in the middle of the trace.

(B2b)

Money-Back
30 day Trial

If you do not agree that these truly are the most powerful portable programmers you can buy, simply return your Dataman product within 30 days for a full refund

Surely not. Surely someone somewhere has developed a portable programmer that has even more features, even greater flexibility and is even better value for money.

Actually, no. But don't take our word for it. Use the feature summary below to see how other manufacturers' products compare.

Dataman-48LV

- Plugs straight into parallel port of PC or laptop
- Programs and verifies at 2, 2.7, 3.3 and 5V
- True no-adaptor programming up to 48 pin DIL devices
- Free universal 44 pin PLCC adaptor
- Built-in world standard PSU - for go-anywhere programming
- Package adaptors available for TSOP, PSOP, QFP, SOIC and PLCC
- Optional EPROM emulator



Enq no 179

FREE 30 DAY TRIAL still the world's most powerful, portable programmers

free software

upgrades +

technical support

for life

3 year GUARANTEE

Support

- 3 year parts and labour guarantee
- Windows/DOS software included
- Free technical support for life
- Next day delivery - always in stock
- Dedicated UK supplier, established 1978

DATAMAN

Dataman Programmers Ltd, Station Road, Maiden Newton, Dorchester, Dorset, DT2 0AE, UK

Telephone +44/0 1300 320719

Fax +44/0 1300 321012

BBS +44/0 1300 321095 (24hr)

Modem V.34/V.FCV.32bis

Home page: <http://www.dataman.com>

FTP: <ftp://ftp.dataman.com>

Email: sales@dataman.com

CE



Dataman S4

- Programs 8 and 16 bit EPROMs, EEPROMs, PEROMs, 5 and 12V FLASH, Boot-Block FLASH, PICs, 8751 microcontrollers and more
- EPROM emulation as standard
- Rechargeable battery power for total portability
- All-in-one price includes emulation leads, AC charger, PC software, spare library ROM, user-friendly manual
- Supplied fully charged and ready to use

S4 GAL module

- Programs wide range of 20 and 24 pin logic devices from the major GAL vendors
- Supports JEDEC files from all popular compilers

Still as unbeatable as ever!

Beware of cheap imitations. Beware of false promises. Beware of hidden extras.

If you want the best, there's still only one choice - Dataman.

Order via credit card hotline - phone today, use tomorrow.

Alternatively, request more detailed information on these and other market-leading programming solutions.

hotline
01300 320719



Orders received by 4pm will normally be despatched same day.

Order today, get it tomorrow!

Inexpensive time-delay relay

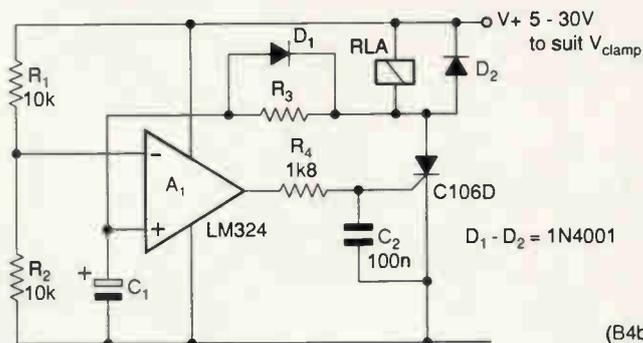
Commercial time-delay relays, though easily obtainable, are expensive. This one is not and has the advantage that it can be immediately recycled. It was used to delay the application of ht to a valve amplifier until the heaters have warmed up, so avoiding valve cathode stripping.

At switch-on, C_1 charges through R_3 and R_{Lc} until the voltage on the non-inverting op-amp input reaches that on the other input, at which point the op-amp output goes high, the thyristor fires and C_1 quickly discharges through D_1 and the thyristor, resetting the circuit.

A 324 op-amp output includes 0V, it is cheap and operates from 5-30V supplies. Time delay is $0.7C_1R_3$ seconds and may be up to two minutes.

Jeff Macaulay

Chichester
West Sussex



(B4b)

Object code for the callsign generator. The callsign used is G8DQQ and the NGR is SJ 703 107. To locate these in order to modify them, print out the listing as Ascii. Alternatively, send a £12 cheque payable to B. Olliver at 12 Fountain Drive, St Georges, Telford, Shropshire TF2 9DP for a preprogrammed PIC. Don't forget to add an SAE and your details.

```

:0A00000088008800FF00280064005B
:1000000002280228000000308B0083160F30810088
:10001000831281010030660086011F306500850172
:10002000023098000000851C16281F2806140000C6
:10003000000006124E20051C8615372812280000E5
:100040000616000006150000061000000008611CC
:100050007E209F2099202D2012286400FF309800D8
:100060004E20851C1228980B30281F280800640099
:10007000EF3098004E20051886110000000051C86
:1000800086150000000051806150000051C061165
:10009000000085181228980B3A281F28A10000009C
:1000A0000000430A700A600043099006400A60BED
:1000B0005728051886146400A60B5C286400A60B5C
:1000C0005F28051886106400A60B64286400A60B40
:1000D0006728051886146400A70B57286400861F3C
:1000E0007328861B75288617762886130000051846
:1000F0008610990B56286400A10808000000C03043
:10010000920003309300C820E03092000530930045
:10011000C8208030920003309300C820D030920075
:1001200004309300C820D030920004309300C820DF
:100130000800A030920003309300C820080000306F
:10014000920003309300C820703092000430930076
:10015000C820C030920005309300C820F8309200CB
:1001600005309300C8201830920005309300C82055
:100170007830920005309300C820F83092000530A6
:100180009300C820C030920005309300C8200800BA
:1001900000000310920D0318CF28D820D228D820B1
:1001A000D820D820E720930BC928E720E7200800B3
:1001B0006430940086148C309500950BDD288610F1
:1001C0008C309500950BE228940BDA280800640027
:1001D00080309600FF3097006400970BED28960B57
:0401E000EA28080001
:00000001FF
    
```

PIC microcontroller replaces small-scale logic in an amateur television repeater controller, which is due to go into service in Shropshire.

Control and callsign generator for amateur television

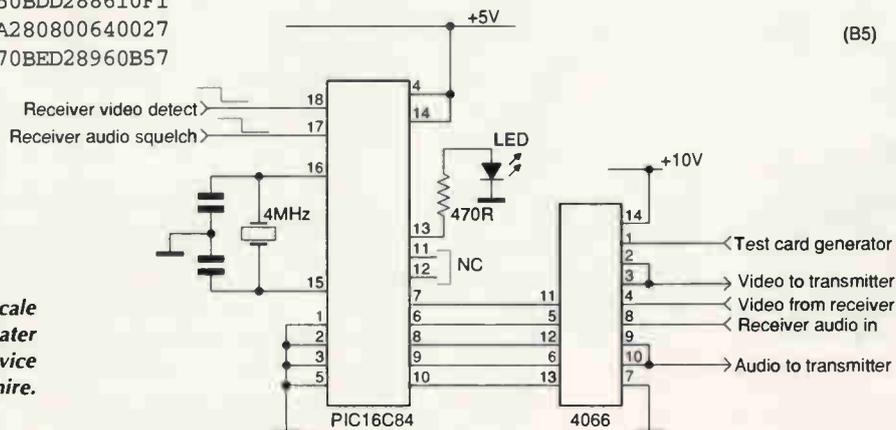
Instead of a collection of logic chips and diodes, I have used a PIC16C84 to monitor incoming signal status and control the operation of a repeater station, including the requirements of the Radio Communications Agency to send a timed callsign in morse regardless of conditions. The device will control the audio channel independently of video; should the audio fall below an acceptable level, it blocks it and switches to a tone between callsigns. When a suitable signal is received, the microcontroller and 4066 switch deselects the test card, connects the received video and reinstates audio.

I have programmed a morse code library into the PIC, so that any alphanumeric combination may be sent; in this system, the callsign, followed by the NGR and a "k" to indicate the end of text are sent, the maximum 15 minute gap being used with a led to indicate counts during the 15 minutes.

The internal watchdog timer reboots the program 2.5s after any glitch causing a lock-up and continuous input monitoring allows a 4s response to any change of input status. A 10V supply to the 4066 provides the best switching performance, although it might be useful to use one of the newer types of switch. Similarly, I used the PIC16C84 because I am used to it; a one-time-programmable type would be cheaper.

Brian Oliver

Telford
Shropshire
(B5)



(B5)



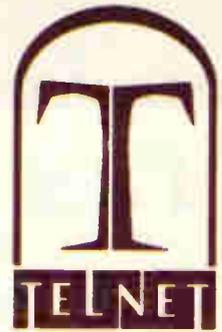
**Marconi 2955 Radio
Communications Test Set**
£2250

Marconi 2955A
£2500

Marconi 2958 (TACS)
£2750

Marconi 2960 (TACS + Band III)
£2750

Marconi 2960A (TACS)
£2950



For Quality Test
and Measurement
Second-User Equipment

HEWLETT PACKARD 8920A -
R/F Communications.....Test Set
(Fitted with Various Options).....£4995
HEWLETT PACKARD 8922 -
BGH G.S.M. Test Set.....£P.O.A.

SCHLUMBERGER - STABILOCK 4031 -
Radio Communication Test Set
(0.4 to 10.00MHz).....£4995
SCHLUMBERGER - STABILOCK 4040 -
'High Accuracy' Radio Communication Test Set..£3500

WANDEL & GOLTERMANN PFJ-8 -
Error & Jitter.....Test Set
(All Options Fitted)£12500
WANDEL & GOLTERMANN PCM 4 -
PCM Channel Measuring Set£P.O.A.

HEWLETT PACKARD 3585A -
Spectrum Analyser (20Hz - 40MHz) £5000
HEWLETT PACKARD 3582A -
Spectrum Analyser (Dual Chann 25.5KHz) £2000

HEWLETT PACKARD 436A -
Power Meter + Lead + Sensor
(Various Available) from £995
435A + 435B Power Meters Also Available

HEWLETT PACKARD 8656B -
Synthesised Signal Generator
(100KHz - 990MHz).....£2950
HEWLETT PACKARD 4338A -
Milliohmeter (As New)£2000

HEWLETT PACKARD 4275A - LCR Meter -
Multi-Frequency (10KHz-10MHz)£3000
HEWLETT PACKARD 3562'A' -
Dual Channel Dynamic Signal Analyser
(64MHz - 100KHz).....£6250

HEWLETT PACKARD 3748A -
Digital Transmission Analyser.....£4995
HEWLETT PACKARD 8757A -
Scalar Network Analyser.....£2250

ROHDE & SCHWARZ CM5 54 -
Radio Communication Service Monitor
(0.4 to 1000MHz).....£6250
ROHDE & SCHWARZ CMTA 94 -
GSM Radio Comms Analyser.....£7500

MARCONI 2305 -
Modulation Meter£1995
MARCONI 2041 -
(10KHz - 2.7GHz)
Low Noise Signal Generator.....£7500

ANRITSU MS3401A & MS3401B -
Network Analysers (10Hz - 30MHz)
A = £3995 B = £4995
ANRITSU MS 610 B SPECTRUM -
Analyser (10KHz - 2GHz).....£4750

ADVANTEST 4133B -
Spectrum Analyser (10KHz - 20GHz) ..£7250
ADVANTEST 4131B -
Spectrum Analyser (10KHz - 3.5 GHz)...£4750

HEWLETT PACKARD 4278A -
1KHz/1MHz Capacitance Meter.....£3500
HEWLETT PACKARD 4278A -
1MHz C-V Meter£4500

LEADER 3216 SIGNAL GENERATOR
100KHz to 140MHz - AM/FM/CW with built-in FM
Stereo Modulator (as new)a snip at £995
PHILIPS PM5193
Synthesised Function Generator£1500

HEWLETT PACKARD 8350B -
Sweep Oscillator Mainframe (various
plug-in options available).....£2500
HEWLETT PACKARD 3325A -
Synthesiser/Function Generator£1500

RACAL 6111/6151 -
GSM Test Sets.....£P.O.A.
TEKTRONIX 495P -
Spectrum Analyser
(Programmable - 1.8GHz)£5000

All equipment is used - with 30 days guarantee. Carriage & VAT to be added to all goods.

Please telephone for further details on:

01203 650702 Fax: 01203 650773 Mobile: 0860 400683

Telnet, 8 Cavans Way, Binley Industrial Estate, Coventry CV3 2SF

PROTEUS

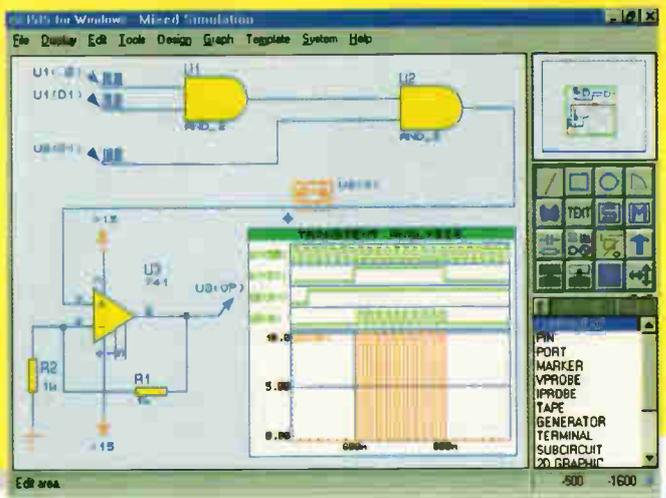
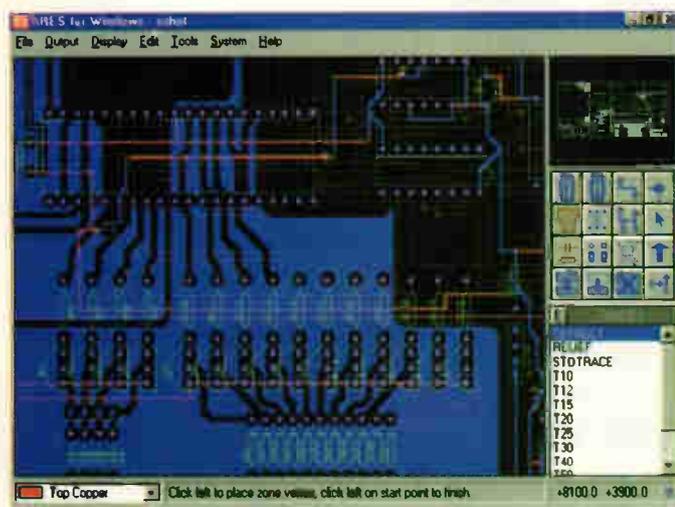
The IVth Generation

Labcenter Electronics is pleased to include the PROTEUS IV demonstration CD with this month's UK edition of *Electronics World*. PROTEUS is a complete electronics design system comprising modules for Schematic Capture, Analogue and Digital Simulation, PCB design and autorouting. A full independent review of the product appears elsewhere in this issue.

To install the software on Windows 95 or NT, just insert the CD and the main menu program should appear automatically. For Windows 3.1 – or if you have disabled the autorun feature – run the program D:\SETUP where D: is the letter of your CD ROM drive. Once you have the main menu on screen, just click the appropriate buttons to install the programs you want to try.

The CD includes both the demonstration version of PROTEUS IV, and our shareware products ISIS Lite and ARES Lite. In addition there are electronic copies of the product literature, price lists and user manuals. For more information, click the "About the CD" button on the CD menu program.

EWW readers receive a 10% discount on orders placed before 30 June 1998.



PROTEUS is available in five levels – Levels 1 and 2 impose some feature restrictions and pin-count limits while Level 3 is entirely unlimited. For further information see the product literature on the CD.

Prices – and special reader discount prices – for the most popular options are shown below. Note that these prices include UK postage but *not* VAT.

Product	Ex VAT price	Discount price
Level 1 Schematic/PCB	£300	£270
Level 1 Complete	£400	£360
Level 1+ Schematic/PCB	£400	£360
Level 1+ Complete	£500	£450
Level 2 Schematic/PCB	£555	£499.5
Level 2 Complete	£755	£679.5
Level 2+ Schematic/PCB	£855	£769.5
Level 2+ Complete	£1000	£900
Level 3 Schematic/PCB	£1230	£1107
Level 3 Complete	£1630	£1467

Educational pricing and ordering details for overseas customers are included in the literature on the CD. Please add £5 for EC delivery or £10 row. Discount prices valid until 30 June 1998.

Order coupon

Level required.....PRICE £

Your name.....

Company (if applicable)

Address

.....Post code.....

Phone number.....Fax.....

Cheque payable to Labcenter Electronics Yes

Or, please debit my Master, Visa

Card No..... Expiry date

Fax this coupon to 01756 752857 or post it to 53-55 Main St, Grassington. BD23 5AA. Please allow 7 days for UK delivery.

labcenter
E l e c t r o n i c s

Tel: 01756 753440. Fax: 01756 752857.
53-55 Main St, Grassington. BD23 5AA.

EMAIL: info@labcenter.co.uk
WWW: http://www.labcenter.co.uk

Ian Hickman looks at some ingenious methods for generating linear timebase sawteeth, both ancient and modern.

Sweeping back

The modern circuit designer is spoilt for choice when it comes to producing this or that repetitive waveform. Numerous waveform generator chips are to be found in the catalogues, some needing no external components at all, others just a few to tailor the odd parameter of the output waveform.

There are even arbitrary wavefunction generators, letting you program whatever fancy waveshape meets your needs or desires. But it was not always so. One application in particular exercised the minds of circuit designers over a period of many decades – and still does.

This is the generation of a linear sawtooth waveform to drive the X amplifier and horizontal deflection plates in an oscilloscope, known in earlier times as a cro or cathode-ray oscilloscope. The requirements are not trivial. The rising voltage – the scan or sweep – must be very linear, Fig. 1a). If not the display will be spread out at one side and become progressively more cramped across to the other – a form of picture distortion evident on many a television set.

Linearity of the falling voltage is not nearly so important, but this part of the waveform, the retrace or flyback, should be a good deal faster than the sweep.

In addition, there should be some means of synchronising the sweep repetition frequency with that of the waveform being displayed, to obtain a steady picture rather than a jumble. Ideally – and always in practice in modern oscilloscopes – this synchronisation should affect neither the speed of the ramp, nor its amplitude. But again, this was not always so.

Early timebase circuits

The earliest timebase circuits used the rising voltage across a charging capacitor as the sweep, with flyback due to the turn-on of a triode valve, Fig. 1b). The dot within the device indicates that it is a 'soft' triode, known as a 'gas relay'. It contains a little gas at low pressure, and – given a high enough anode voltage – the gas ionises or 'breaks down' as soon as the anode current starts to flow. This provides a near short circuit, which only opens when the anode voltage falls below the de-ionisation potential, a constant which is a parameter of the particular tube type.

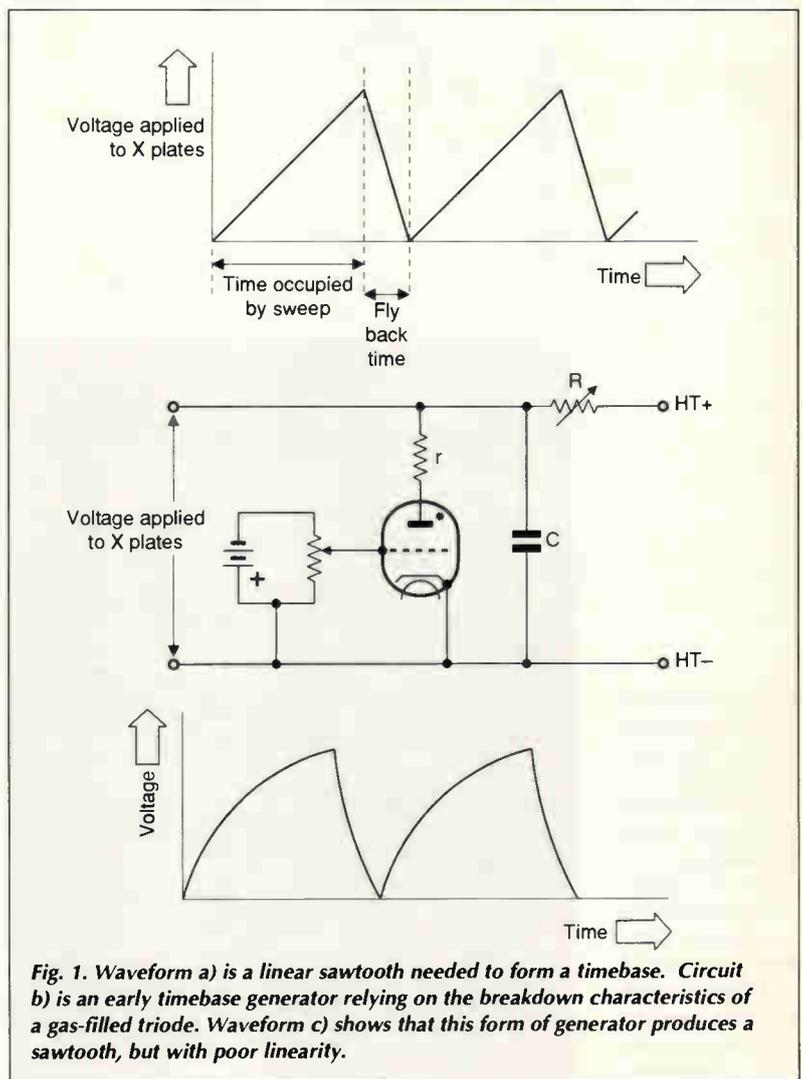
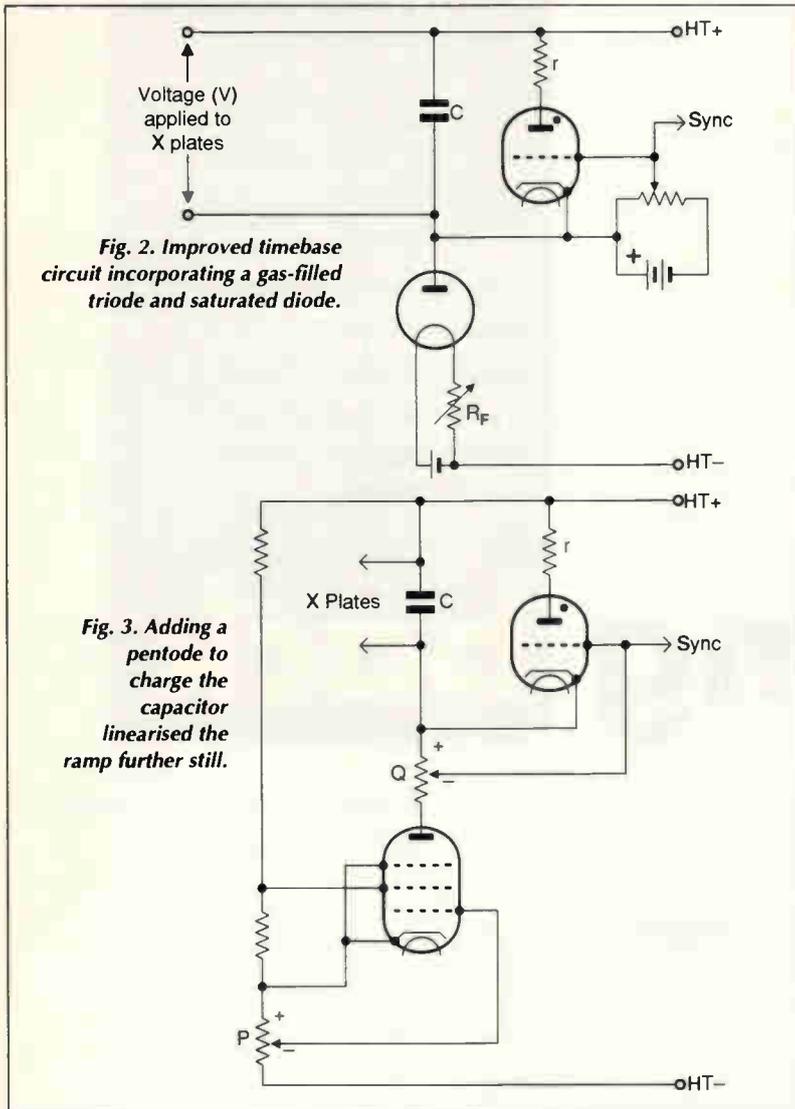


Fig. 1. Waveform a) is a linear sawtooth needed to form a timebase. Circuit b) is an early timebase generator relying on the breakdown characteristics of a gas-filled triode. Waveform c) shows that this form of generator produces a sawtooth, but with poor linearity.



The rate of voltage rise of the sweep is determined by the time constant CR , C being switchable in steps to provide different timebase ranges. Fine control is carried out by varying R . Anode resistor r limits the discharge current to a safe value when the valve 'strikes'.

The voltage applied to the grid determines the voltage at which the tube strikes, thus acting as the amplitude control. It also has an unintended but marginal effect on the frequency of this free running circuit, the frequency being mainly determined by C and R .

As Fig. 1c) shows, both the flyback and the sweep are non linear, though the linearity can be improved by making the HT supply voltage much larger than the tube's anode striking voltage. Unfortunately, for this ruse to be effective, the HT has to be very much larger. Initially the current through the resistor is simply V/R , where V is the HT voltage. This decays exponentially towards zero – but never reaching it – as the flyback starts a new sweep.

If the voltage across the capacitor at any instant is e , then during the sweep $e = V(1 - e^{-t/CR})$. If the original rate of rise of voltage were maintained, and the triode did not strike, the voltage e would reach V in a time equal to CR seconds. In practice, in CR seconds, it would reach $V(1 - e^{-1})$, or only 63% of V . In a time $0.1CR$ seconds, it would ideally reach $V/10$, but in practice only $0.095 \times V$. Thus there is already a shortfall of 5% with the HT ten times the valve's anode striking voltage. So designers sought ways of producing a constant charging current.

Figure 2 shows one early way of achieving this, using a directly heated diode with an under-run filament. Operating like this, all of the electrons emitted by the filament are attracted immediately to the anode; there is no cloud of 'space-charge' electrons surrounding the filament. Thus the current is inherently limited and independent of the anode voltage.

However, the requirement for a special filament supply for one valve was inconvenient, so the circuit of Fig. 3 was developed. This uses the high anode incremental or 'slope' resistance of a pentode valve as the constant current source. As in Fig. 2, a gas filled triode was used to terminate the sweep and initiate the flyback.

To be useful, the sweep, besides being linear, must be synchronised with the waveform being examined in order to produce a steady, stationary trace. In Figures 2 and 3, this is achieved by applying a portion of the waveform to be displayed to the grid of the gas relay. This influences the breakdown voltage of the tube. It causes the tube to strike earlier than would otherwise be the case, on a positive excursion of the synchronising waveform at the tube's grid. Thus the sweep terminates short of the right hand side of the graticule, the sweep repetition frequency being raised somewhat to make it a subharmonic of the frequency of the signal being displayed.

Faster and faster...

The maximum repetition frequency of timebases using a gas filled triode is limited to about 10kHz, permitting the examination of waveforms up to about 100kHz. With advances in electronics, there was a need to examine higher frequency signals. This required the use of timebase circuits free of the soft triode gas relay, i.e. 'hard-valve' circuits.

One of the first and best known of these was due to O. S. Puckle. It appeared in early Cossor oscilloscopes, marketed as long ago as before the Second World War. Figure 4 shows an example from this illustrious line of oscilloscopes. O. S. Puckle's famous timebase circuit is shown in Fig. 5.

Initially, with C uncharged, V_1 's cathode is at HT+, while its grid is at some lower potential due to V_2 's anode current

Fig. 4. An advanced oscilloscope of the forties. The Cossor 1035 Mk IIA was a true dual-beam oscilloscope with a maximum bandwidth of 7MHz (Y1 amplifier), 100kHz (Y2 amplifier) and a fastest sweep rate of 15us/scan, with repetitive, triggered and single-stroke operation.



flowing in the amplitude control resistor *A*. Capacitor *C* charges negatively via sweep rate control resistor *R*, until V_1 starts to conduct.

The consequent fall in V_1 's anode voltage is coupled via a capacitor to the suppressor grid, grid 3, of V_1 . This cuts off the latter's anode current, all of the cathode current then flowing instead to the screen, grid 2. Valve V_2 's anode rises to HT+, turning V_1 on hard, as the two valves form a positive feedback loop. As the lower plate of *C* discharges via V_1 towards HT+, V_1 's anode voltage rises, eventually turning on V_2 's anode current again.

The drop across resistor *A* cuts off V_1 again, and the cycle repeats. Synchronisation is achieved by modulating the cathode current of V_2 , by applying a portion of the signal under examination to the signal grid, grid 1.

As with the circuit of Fig. 1, the sweep is actually a portion of an exponential, rather than a true linear ramp. But by use of a high value of HT+ and a comparatively small amplitude of the sawtooth across *C*, acceptable linearity was achieved, and of course much higher sweep speeds were possible than with soft valve timebases.

Both fast and linear

A very linear sweep was provided by the circuit of Fig. 6, the 'Miller transitron' timebase. I used this in my first home made oscilloscope, converted from a government surplus Indicator Unit 182A – part of an airborne radar – with its 6.5in VCR517C cathode ray tube.

A positive voltage is applied via a high source resistance to grid 1 of a pentode. The grid voltage is actually held somewhat negative, as the increasing anode current causes a falling voltage which is fed back to grid 1 via C_1 . In fact, the valve forms an integrator using the Miller effect, and the anode voltage falls linearly, the voltage at grid 1 rising but slightly the while, due to the stage's large voltage gain.

Eventually, the anode voltage bottoms, the grid 1 voltage rises rapidly, so does the cathode current and the grid 2 voltage consequently falls. This is coupled via C_2 back to grid 3, cutting off the anode current completely. Capacitor C_1 is rapidly recharged via R_2 and grid current, grid 1 becoming positive and acting as a diode.

The time constant of C_2 , R_4 is chosen just long enough for the recharging of C_1 to complete, before the negative voltage at grid 3 leaks away enough for the anode current to turn on again. This robs current from the screen grid, so grid 2 voltage now rises, coupled via C_2 back to the suppressor grid. A small negative step of anode voltage results, sufficient to drive grid 1 negative again, and the Miller run down at the anode recommences.

This 'Miller step' was a minor disadvantage of the circuit of Fig. 6, and many later variants of the circuit were developed. These were used not only in oscilloscopes but also in radar displays and in navigation equipments such as the airborne Gee Mk III system, which, like the much earlier oscilloscope of Figure 4, was produced by Cossor.

Some of these later circuit variants had curious but descriptive names. The 'Sanatron' produced a very clean waveform, while the performance of the 'Phanatron' was presumably phantastic. Unfortunately I no longer have a record of these circuits, but if any reader out there has, I would be grateful for the information.

Don't just synchronise – trigger

By the fifties, oscilloscopes were becoming more sophisticated, and in addition to synchronised operation, a trigger function was also available. Thus the oscilloscope could be used in single shot mode, although cathode ray storage tubes did not appear for another decade.

Single shot mode was ideal for capturing transients, rather than viewing repetitive waveforms. Along with oscilloscopes

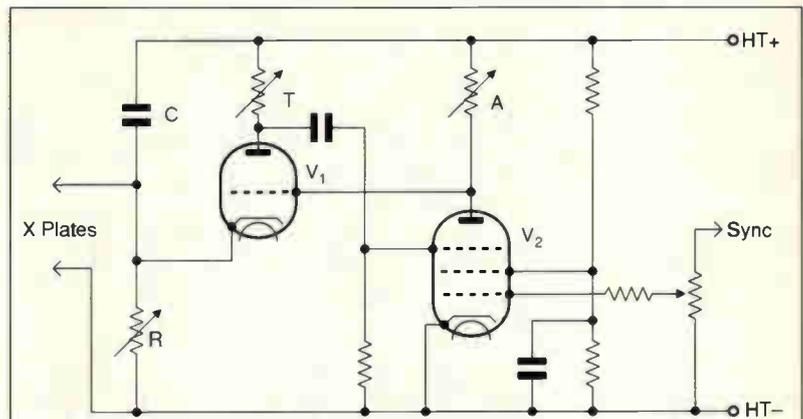


Fig. 5. Puckle's time-base generator was a breakthrough in that it no longer relied on breakdown of a gas-filled device.

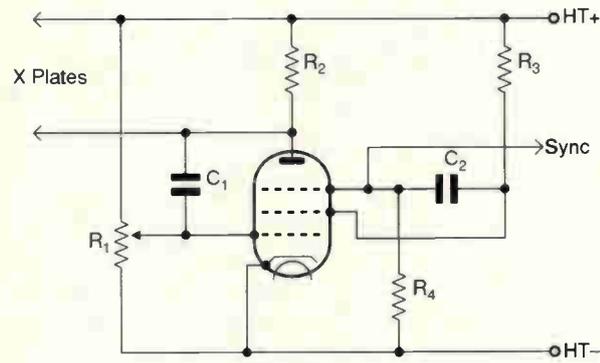


Fig. 6. Miller transitron sawtooth generator combined good linearity and improved speed relative to its predecessors.

specially designed for high writing speeds, oscilloscope cameras with very fast films used in conjunction with the technique of 'fogging', enabled an event to be captured and recorded. This was the case even if the event was invisible to the naked eye. And even without a camera, oscilloscopes with a long persistence phosphor permitted the visual observation, and a quick sketch, of one-off events.

By the early sixties, writing speed had reached the point where a 1 μ s pulse occurring once a second was clearly visible on a Tektronix oscilloscope of the time. This was with its standard P31 medium-short green phosphor, with the aid of its snug fitting viewing hood. You had to wait for your eyes to become adapted to the dark first though.

Advanced oscilloscopes of the period – and that meant in practice models from Tektronix – by now offered triggered rather than synchronised operation as standard. This meant that the timebase was not free running, the spot remaining stationary at the left hand edge of the graticule until the input waveform crossed the selected trigger level and polarity.

A consequence of this was that, to prevent spot-burn on the phosphor, dc-coupled sweep-time bright-up was used, instead of the simpler flyback blanking which sufficed with a continuous free-running timebase.

But synchronisation of a free-running timebase had not disappeared completely, for the trigger circuitry was not fast enough to cope with the highest frequencies the instrument could display. So instruments were provided with a front panel 'Stability' control, used in conjunction with the 'HF Sync' position of the trigger selector.

With the control set counterclockwise, the timebase was

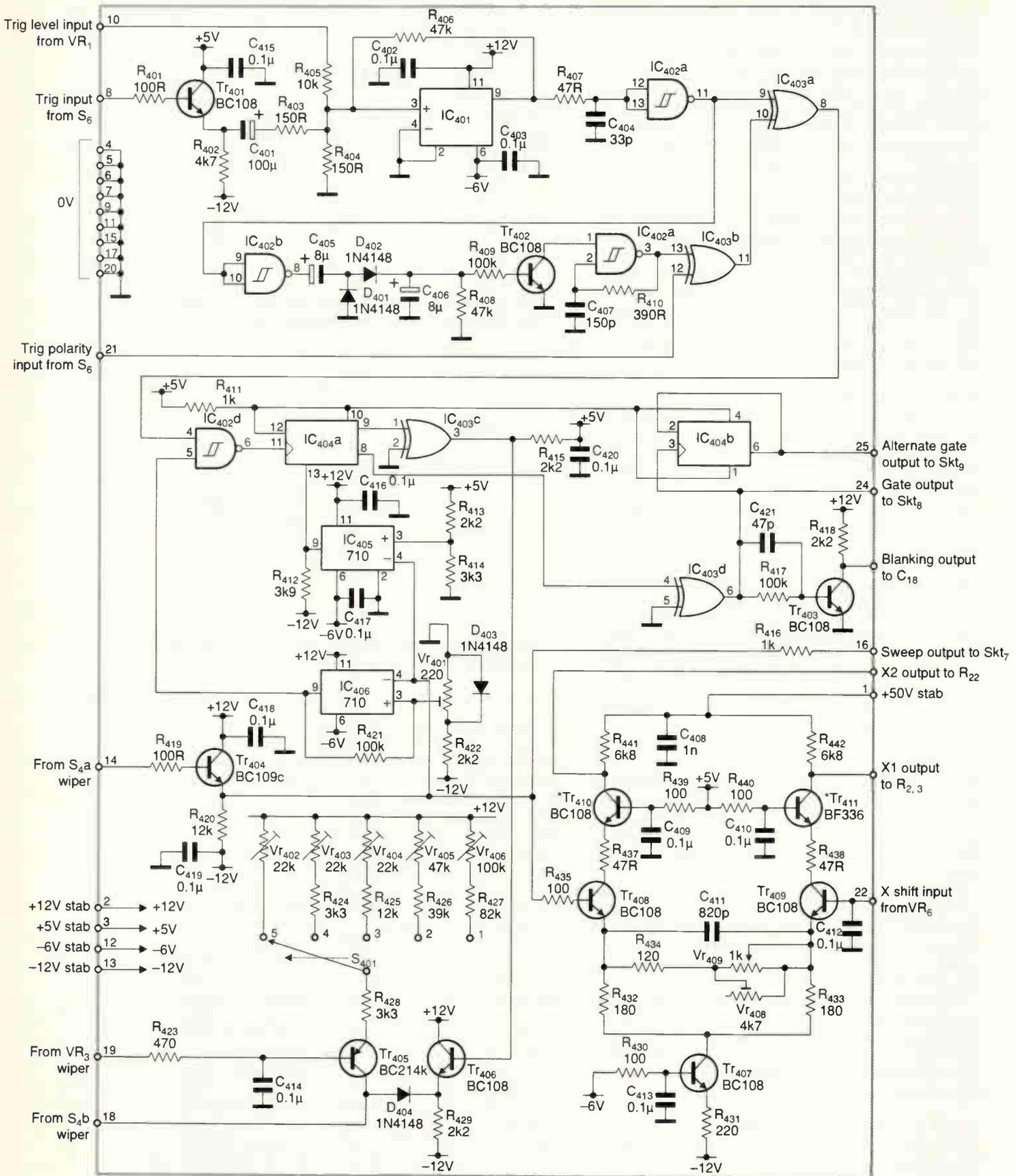


Fig. 7. The X timebase department of the 'Purbeck' oscilloscope.

monostable, and operated only when triggered. With it set clockwise, the timebase was astable or free-running. The control could then be carefully wound back until the timebase just stopped free running. It would then, with luck, be synchronised, since in HF Sync mode, a small sample of the Y input signal was routed to the grid of a valve in the timebase control monostable.

In the next generation of oscilloscopes, free running timebases were out, along with HF Sync and Stability controls. Now, timebase operation was always triggered, but to keep the trace visible in the absence of a Y input signal, an auto-trigger facility caused repeated triggering in the absence of a Y input, to provide a bright line.

Enter the transistorised oscilloscope

By the mid sixties, I had completed the design and construction of an all transistorised oscilloscope. It used 2G106, 2S131 and similar transistors, there being few if any integrated circuits at the time – and certainly not analogue ICs.

Commercially, my design came to nothing as it was beaten to market by the first all solid state oscilloscope introduced in the UK by EMI. But it did incorporate many of the advanced features found in oscilloscopes of the period, particularly in the trigger department.

Trigger lock-out – not to be confused with trigger hold-off – prevented the output of the trigger slicer reaching the timebase circuitry from the moment a sweep was triggered, until the completion of the retrace or fly-back. This kept both the sweep speed and the sweep amplitude totally unaffected by whatever the input signal was doing.

The circuit of this oscilloscope is no longer extant, having met its end at a periodic clear-out. Figure 7 shows the circuit of the X department of a development of the circuit dating from about a decade later.¹ This is from one installment of a series of articles which appeared in a popular electronics magazine, describing the 'Purbeck' oscilloscope.

The sweep appeared across one of a number of sweep range capacitors connected to pin 18 of the board, which also connected to emitter follower Tr₄₀₄ – except in the external X input function. The capacitor was charged via constant current generator Tr₄₀₅.

Comparator IC₄₀₁, an SN72710, is the trigger slicer, its output setting sweep control D-type bistable IC₄₀₅ via gates IC_{402a}, IC_{403a} and IC_{402d}. The bistable's Q output raises the base of Tr₄₀₆ to +5V, cutting off D₄₀₄ and initiating the sweep.

Comparator IC₄₀₅ detects the end of sweep, at +3V, and resets IC_{404a}. This cuts off Tr₄₀₆ and current via D₄₀₄ discharges the sweep capacitor to provide the retrace. The trigger lock-out comparator is IC₄₀₆; by blocking IC_{404d} it prevents further trigger pulses reaching IC_{404a} during the sweep and until the retrace is complete.

In the absence of a Y input, and hence in the absence of trigger pulses from IC₄₀₁, IC_{402c} free runs to provide a bright-line trace. It is inhibited by Tr₄₀₂ if a Y input is detected by D_{401,402}.

Even nowadays, it is common enough to find oscilloscopes specifying a trigger sensitivity so poor as to need at least one half of a graticule division vertical deflection to ensure triggering. By contrast, the circuit of Fig. 7 provided a solid lock even if the vertical deflection was barely discernable – less even than the trace width. This is very useful when trying to identify a small signal, at or beyond the instrument's bandwidth. If you can lock the trace, you can at least count the cycles across the screen and determine the signal's frequency, if nothing else.

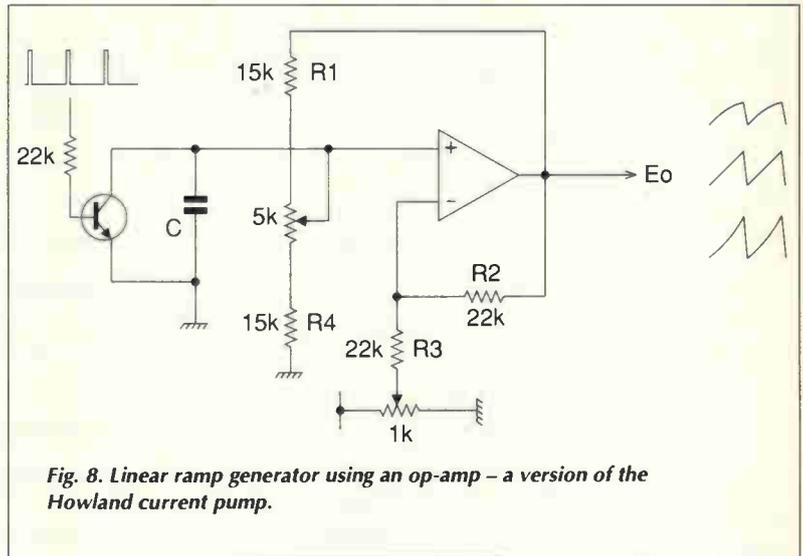


Fig. 8. Linear ramp generator using an op-amp – a version of the Howland current pump.

Sawtooth generator varieties

Sawtooth generators can be implemented in all sorts of ways, op-amps coming in very handy for the purpose.

Figure 8 shows a circuit that appeared in 1970.² The sweep speed is set by the voltage applied from the potentiometer, and the sweeps can be very linear, as in the centre waveform. This is because, properly adjusted, the circuit supplies the capacitor with a constant current. In other words, looking into the op-amp's non-inverting input, the capacitor sees an infinite source resistance.

If not properly adjusted, the source resistance charging the capacitor may be less than infinity, giving the usual expo-

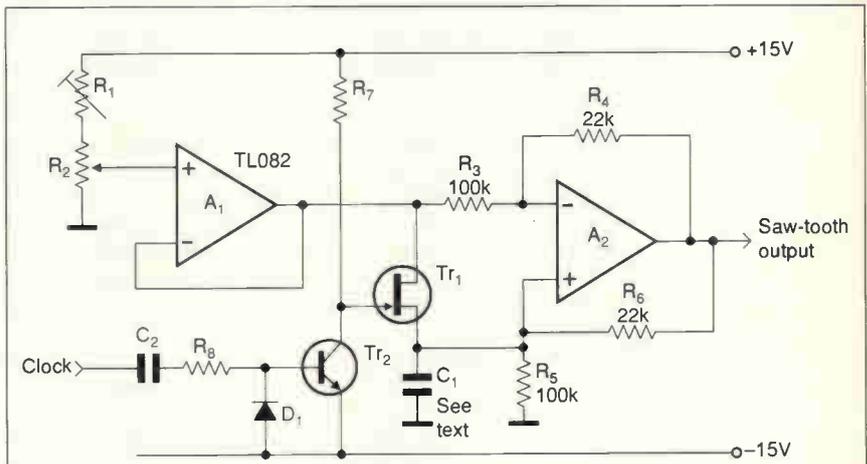
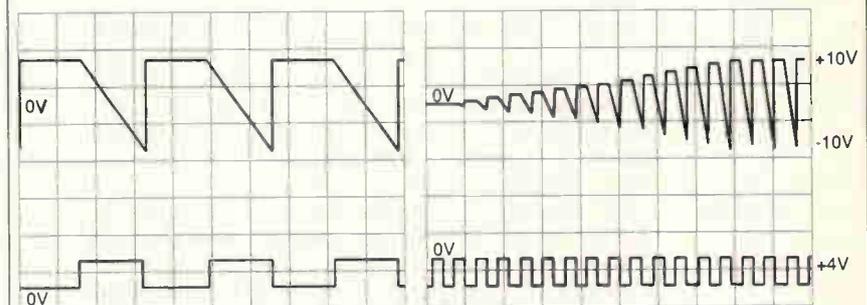


Fig. 9a). Basic circuit of a tuning sweep generator, employing a Howland current pump.



b) Output waveform shown in relation to the controlling clock waveform (left); advancing R₂ from ground to maximum increases the sweep width while remaining ground centred (right).

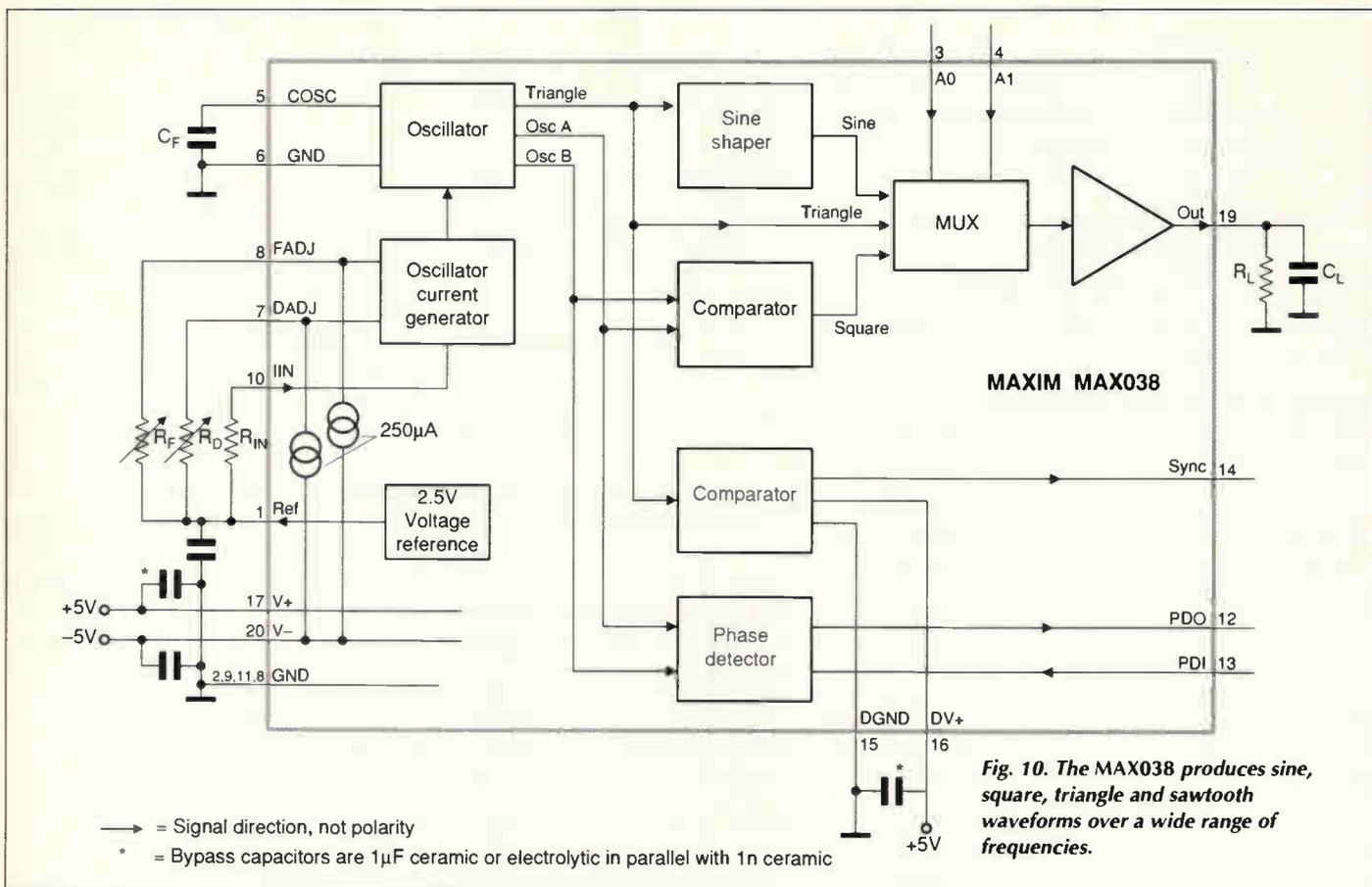


Fig. 10. The MAX038 produces sine, square, triangle and sawtooth waveforms over a wide range of frequencies.

ponential charging shape shown in the upper waveform. As the potentiometer is adjusted, the source resistance rises to infinity, making the time constant not seconds, days or years, but for ever.

Tweaking the potentiometer further causes the source resistance seen by the capacitor to return, from minus infinity, to a finite negative value, resulting in the lower of the three waveforms shown. The linear waveform results when the resistance to ground from the op-amp's non-inverting input equals the resistance back to the op-amp's output, to match the two resistors at the inverting input: this assumes that the potentiometer resistance is negligible by comparison.

The famous current pump

I later found that the circuit of Fig. 8 is just a version of the Howland current pump.³ I subsequently used it in a spectrum monitor, designed for use with an oscilloscope as its display. The complete design, which appeared in these pages,⁴ used the linear ramp not as the timebase for the oscilloscope, but as the tuning voltage for the monitor's front end – an all-band tv tuner.

Figure 9 shows the ramp generator, simplified for purposes of explanation. In view of the intended application, it presents two special features. Firstly, the amplitude of the ramp can be adjusted over a wide range, right down to zero, while keeping it centre-grounded. Secondly, the speed of the ramp is directly proportional to its amplitude, so that the sweep time is independent of the amplitude.

The ramp was used as the frequency sweep control, being added to an adjustable voltage setting the centre frequency. Thus the 'span' covered by the display could be set to cover the whole band. Alternatively, by reducing the sweep amplitude, the display could zoom in to cover as small a section of the band as desired, centred on the frequency set by the adjustable voltage.

Note that for a linear sweep, the resistors connected to the

inverting input – and also the non-inverting input – do not need to be equal. It is only necessary that they are in the same ratio at the two inputs. Ironically, although the circuit produces a beautifully linear ramp, this was subsequently modified to a non-linear shape. This was so as to produce a linear frequency sweep, taking into account the varactor law at the tuner's tuning-voltage input pin.

Today, linear ramps are easily produced. The ubiquitous NE555 can do the job. Other ICs can do this and provide other waveforms. The ICL8038 is a function generator capable of producing triangular waves, square waves and – by shaping the triangle – a close approximation to a sine wave.

In addition, the positive and negative-going flanks of the triangular wave may be set to different rates up to 10%/90% or vice versa, giving sawtooth or reverse sawtooth waveforms.

The device is second sourced by various other manufacturers. A good example is the MAX038 – an improved version from Maxim, Fig. 10. This produces low distortion sinewaves, and in triangular and squarewave mode, the frequency is very nearly constant as the symmetry is varied from 10%/90% through 50%/50% to 90%/10%.

This is just one example of the numerous waveform generator available nowadays to the circuit designer. ■

References

1. Hickman, I, 'The "Purbeck" Oscilloscope,' *Practical Wireless*, April - September 1978.
2. 'Improved Sawtooth Generator has Grounded Reference Point,' *Electronic Design*, Feb. 15 1970, Vol. 4 No. 18 page 80.
3. Pease, R A, 'Improve Circuit Performance with a 1-op-amp Current Pump,' *EDN*, Jan. 20 1983 pp. 85-90.
4. Hickman, I, 'Add on a spectrum analyser,' *Wireless World*, December 1993 pp. 982 - 989.

Acknowledgments

Figures 1- 3, 4 and 6 are reproduced with permission from The Handbook of Line Communication, Her Majesty's Stationery Office, London 1947. Figure 9 is reproduced from Oscilloscopes by Ian Hickman, Pub. Butterworth-Heinemann 4th Ed. 1995, being the frontispiece.

Cyril Bateman looks at the second most widely used capacitor technology – namely plastic film – and reveals the features of all the different types in common use.

Understanding capacitors

The modern plastic film capacitor offers a unique balance between pulse current handling, size and cost. Historically, ceramic capacitor development was driven by American technology. The plastic film capacitor on the other hand was a European, mostly German driven, development.

Today, ceramic and film capacitors are manufactured throughout the world, but evidence of these past differences remain. Being influenced by Europe and the USA, UK component makers became strong in both technologies.

Plastic film capacitors fall into two main application categories – those with metallised electrodes for conventional decoupling tasks and those with foil electrodes for improved pulse-current handling. All are manufactured using commercially available, flexible plastic dielectric films. These films need only the base metal electrodes to be added.

Film capacitors can be automatically wound and economically assembled. Choice of the film material and electrode type determines the capacitor's finished size and performance relative to temperature and frequency.

Plastic film background

The original plastic dielectric could not be produced as a thin self-supporting film. One method used in early plastic-film capacitors was described in British patent 587935 of 1944. This involved soft metal-foil electrodes, onto which the plastic dielectric film was applied. Known as lacquered film capacitors, these types are now obsolete. The technique permitted polymer dielectric as thin as 1.5 microns to be cast directly onto foil electrodes.

Plastic material for use in modern capacitors must have the right electrical properties. It is essential that the material can be produced with sufficient strength and flexibility to withstand element winding at speed, and with a thickness providing the desired size and capacitance.

Development of plastic materials¹ escalated rapidly in the fifties, resulting in today's three most popular plastic capacitor dielectric materials – polyethylene-terephthalate, polycarbonate and polypropylene. Polystyrene is also used. Plastic film capacitors are now the second most widely used capacitor family, accounting for more than one quarter of all capacitor sales.

Note that polyethylene terephthalate is known by several names including Mylar PET, Melinex, Polyester and

Hostaphan. For convenience I will use the term PET, except when referring to material produced by Du Pont de Nemours.

In 1951, Du Pont's Luxembourg plant developed a thin, bi-axially stretched, self supporting Mylar film for use in capacitors. By 1959 the Westermann Company of Mannheim in Germany, maker of Wima capacitors, had developed suitable electrode metallisation methods for 6 micron film. The first viable, mass produced, general purpose metallised film capacitor had arrived.²

Modern plastic-film capacitors

To improve resistance to soldering heat and cleaning solvents, the long established polystyrene dielectric is slowly being replaced by polypropylene – especially for small, very close tolerance, axial and radial leaded parts.

Recent developments using polyethylene-naphthalate and polyphenylene-sulphide have provided a surface mounting, uncased yet moisture-resistant chip film capacitor. Polyphenylene-sulphide chip capacitors can withstand flow soldering.

This article covers the main film-capacitor products in use today. Other types not mentioned here have been popular in the past but are now redundant and are therefore omitted.

Making film dielectric

All polymers have a very high molecular weight. They have extremely long, and frequently multi-branched, molecular chains made up mainly of hydrocarbons. These repeating molecular chains have a natural inclination to merge into a dense tangle of twisted and intertwined chains.¹

Thin films of these plastics are made using one of two main methods – spreading from a molten state and casting from solution using a solvent.

Although inherently brittle when cold, polystyrene can be heated and extruded as a tube. The diameter can be mechanically expanded while the polymer is hot. Additionally, longitudinal stretching can be applied as the film cools.

Stretching is important not only in reducing film thickness. Due to the partial alignment of the molecular chains that occurs, brittleness is reduced, and the film is made stronger. At the final stage, the stretched tube is flattened by passing between rollers. By 1960, a consistent film thickness of 10 microns was achievable using these techniques.³

Polyolefine films – such as low and high-density polythene and polypropylene – can be produced in a similar way. Usually though, the initial diameter stretching is done by blowing air through the centre of the extrusion die into the still hot tube.

Using extrusion and stretching techniques Mylar capacitor film of 1.5 microns thickness – some 15-20 times thinner than human hair – was first introduced in 1978. This film had a tensile strength of 1000kg/cm² and a 500V dielectric breakdown strength. This exceedingly thin film was used in the production of Wima capacitors² in 1980.

In contrast, a 2 micron thick polycarbonate film was available in the late sixties. It was used by the A H Hunt Company in the production of their Metalac metallised polycarbonate capacitors. These had values up to 10µF at 100V in a tubular case measuring 14 by 33mm.

The polycarbonate film was produced by casting from

solution in a suitable solvent. Solvent casting is expensive but can produce a more uniform thin film than extrusion and blowing. This cast film is stretched or drawn down to final thickness.

Adding electrodes

As with paper capacitors, discussed in the February issue, either soft metal electrode foils or metallisation of the dielectric film's surface can be used.

Metallised-film electrodes, usually of aluminium evaporated under vacuum at high temperature, are extremely thin and optically transparent. Metallised film gives the best possible capacitance/voltage ratio for a given case size. But such thin electrodes are resistive, degrading power factor at high frequency and restricting capacitor current handling, Fig. 1.

The major benefit from using metallised electrodes is their ability to self heal, allowing much thinner dielectric films to be used relative to foil electrodes. When subjected to an excess voltage, during manufacture or service, this thin resistive metallised electrode easily evaporates away from any weak areas of dielectric. This evaporation isolates the weak areas and restores the capacitor's insulation resistance, Fig. 2. The same weak dielectric in a foil electrode capacitor becomes permanently short circuited and the capacitor fails.

The metallised film needs to have a non-metallised edge to insulate it from one or other of the two termination electrodes. The virgin polymer film is often masked down one edge during the metallising process. Alternatively, spark erosion can be used to produce an insulated edge on the film after the metallisation process.

Extended foil construction

Unlike paper capacitors, foil-with-film capacitor windings are almost invariably of 'extended-foil' construction. Inserted tab connections are sometimes used with buried foil electrodes in polystyrene capacitors, allowing heat sealing of the winding.

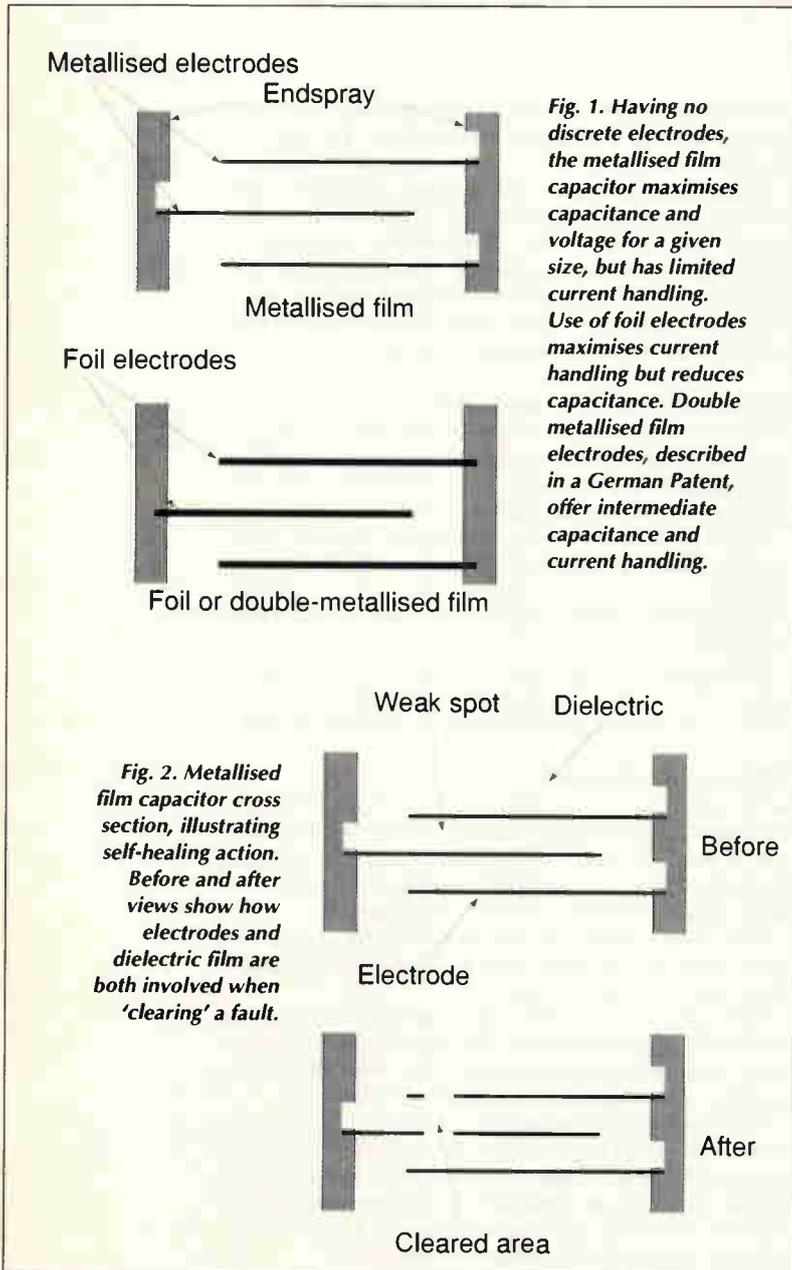
Due to their low resistance, metal-foil electrodes give better power factor and current handling. Their 5 to 6 micron foil thickness increases the capacitor's physical size though. Not being a self-healing construction, these metal-foil types need to have either a thicker dielectric or a reduced working voltage, compared to a capacitor with metallised electrodes, Fig. 1.

A good compromise

An alternative thinner electrode system has been developed which helps keep the size increase down. Its current handling is much better than metallised film, and it features self healing. Electrode resistance is intermediate between foil and conventional metallised dielectric. In this construction, electrodes of very thin film metallised on both sides, are used with non-metallised dielectric film.

These electrodes are made using PET or polycarbonate. Both materials are easy to metallise and are available as very thin films. Being used only as electrodes and not as part of the capacitor's dielectric, they can be more heavily metallised. The resulting electrodes are much thinner and softer than conventional metal foil electrodes and have a lower resistance than is possible with metallised dielectric film.

Being self-healing, these doubly metallised film electrodes can be used with very thin, un-metallised dielectric films. This results in a small capacitor with excellent current pulse



capabilities. This construction was described⁴ in German patent G.P.2151438.

Polypropylene film is difficult to metallise – even after corona surface treatment to improve adhesion. Resulting electrode resistance is generally 3 to 5Ω per square.

This doubly metallised film electrode system, used with untreated Polypropylene dielectric, optimises ac and pulse current performance. It provides a polypropylene capacitor that is physically small, self healing and has good pulse handling capability.

Putting it together

Having chosen the electrode and dielectric film system, how are film capacitors assembled? Two methods prevail – winding and stacking. Larger capacitors are invariably wound, but for common printed board sizes, Siemens favours the stacked-film approach. Westermann by contrast winds everything.

Strictly speaking, both types are wound. Westermann winds to the finished size whereas Siemens winds many metallised-film capacitors in one master capacitor on core wheels up to 60cm diameter. These capacitors⁵ are metal sprayed at the ends, heat treated as needed, then diced to produce the finished capacitor elements, Fig. 3. A similar approach is used to make Panasonic's surface mounted chips, introduced in 1992.

Having used both stacked and wound miniature film capacitors interchangeably for many years, I find both styles satisfactory. If you are interested in exploring the wound versus stacked discussions, take a look at an article in *Elektronik*⁵ and page 202 of the Siemens Film Capacitor Databook on cd rom.

Capacitor elements are usually wound in clean-room conditions using high speed, split mandrel, fully automatic winders. The split mandrels are part of the winding machine. They are arranged to withdraw from either side of the capacitor, releasing the completed winding. Increased diameter mandrels are used to facilitate capacitor flattening, Fig. 4.

Large tubular capacitor windings may use the so-called lost core or lost mandrel approach. Here, the winding mandrel is not part of the winding machine, but usually an injection moulded hollow spindle. The mandrel becomes part of the finished capacitor, ensuring mechanical stability during subsequent heat treatment and in service.

Various arrangements of foil or metallised electrodes can be provided – including extended foil and two-in-series constructions.⁶

All windings, whether round, stacked or flattened, are stabilised by heat treatment. This treatment allows the film's natural shrinkage to consolidate the winding and relieve stresses in the dielectric.

Terminations

Termination wires for extended-foil-electrode capacitors can be soldered or electrical resistance welded directly to the foil electrodes. With both foil and metallised electrodes though, metal-sprayed end connection are more common.⁶ The metal spraying technique used is known as 'Schoop' end spraying.

Due to its low melting temperature, polystyrene dielectric is not end sprayed. Often, the foil is extended slightly to allow the lead wires to be connected directly. Alternatively, tabs connected to the lead wires are inserted into the foil electrodes.

Where metal spraying is concerned, after the initial spray,

Fig. 3. Stacked film production technology. Large rings of metallised film, of width equal to the final capacitor body length, are wound on 'core' wheels. These rings are metal end sprayed, then sliced to make individual capacitors.

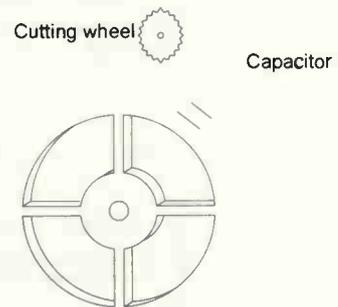
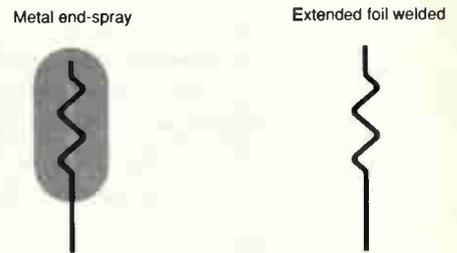


Fig. 4. Winding on a larger diameter mandrel allows the roll to be flattened to form the capacitor element. Both metallised and extended-foil electrode capacitors can take advantage of sprayed-metal end connections. Foil electrodes that extend beyond the dielectric roll allow resistance welded, directly attached lead wires. In the centre is the wound capacitor before compression.



the end contact can be consolidated by spraying other metals and/or solder coating. Final lead-wire connection is made either by soldering or resistance welding.

Dielectric characteristics

All capacitor dielectrics described as polar or non-polar, depending on the symmetry of their molecular structure. Symmetrical, non-polar materials have electrical characteristics effectively constant with changing frequency. They also exhibit minimal dielectric absorption effects.

If the molecular structure is not symmetrical, it has a dipole moment resulting in increased dielectric constant, and is designated as polar. Electrical characteristics are strongly frequency dependent. As frequency rises, the capacitance decreases while $\tan\delta$ losses increase. In addition, there are notable dielectric absorption effects.

These polar and non-polar terms are a function of the basic material used and should not be confused with the constructional terms polarised and non-polarised, as applied to electrolytic capacitors.⁷

Generally, the non-polar dielectric PTFE provides the best performance – especially at very high frequencies and temperatures. But PTFE capacitors are expensive and rare.

The polystyrene alternative

Polystyrene is a low-cost non-polar dielectric that is freely available. At low frequencies, it has better capacitance stability and lower losses than PTFE. It offers the best characteristics of any commercial film dielectric and exhibits a slightly negative temperature coefficient of -150ppm .

This material provides stable capacitance and extremely low $\tan\delta$ losses with frequency. In addition it has very low dielectric absorption, negligible voltage coefficient, good long-term capacitance stability and a 'Q' approaching 1000 at 1MHz for small values.

For many years polystyrene remained the preferred dielectric for precision capacitors, but its low softening temperature required careful soldering. Polystyrene cannot be metallised and is attacked by board-washing solvents in

unprotected. For these reasons it is slowly being replaced by polypropylene.

PET dielectric is strongly polar, with a dielectric absorption figure of around 0.25%. It has a 'K' value of 3.3 and a typical temperature coefficient of +400ppm. PET's capacitance and $\tan\delta$ characteristics are both frequency and temperature dependent.

Despite these poorer electrical characteristics though, PET metallised film provides significant size and cost reduction benefits. As a result, PET components are used in almost all general-purpose film-capacitor applications.

Polycarbonate and polypropylene

Polycarbonate is also polar, but less so than PET. Its dielectric absorption is around 0.2%. It has a 'K' value of 2.8 that remains nearly constant with temperature, but it is more expensive. Its use now is generally restricted to the higher temperature rated, or flatter temperature coefficient circuit needs.

Polypropylene is a non-polar dielectric, with a 'K' value of 2.2 and less than 0.1% dielectric absorption. It offers similar but slightly poorer electrical characteristics than polystyrene. It has a high softening temperature and is relatively inert to solvents. As a result, it is tending to replace small precision polystyrene and foil capacitors.

With a slightly negative temperature coefficient of -150ppm, polypropylene provides stable capacitance and extremely low $\tan\delta$ losses with increasing frequency. It has a negligible voltage coefficient, a capacitance stable over time and a 'Q' approaching 1000 at 1MHz for small capacitance values. It has the highest voltage breakdown strength of these films, but cannot be used thinner than 4 microns to make capacitors.

When introduced as a capacitor dielectric in the early seventies, usable polypropylene film could not be produced any thinner than 9 microns. But its excellent ac characteristics, combined with the pressing market need for a good 250V ac mains capacitor, led to its first commercial introduction.

The Erie 54000 polypropylene film capacitor was wound on a lost core for long term mechanical stability.⁸ It used two metallised-film windings in series to avoid internal ionisation. This technique is still used in modern designs.

High working stresses

A pressing design problem was presented by the introduction of the first generation all solid state 110° colour televisions. The high voltage transistorised line deflection systems required two extremely highly stressed capacitors.

The capacitor used to resonate the line output transformer to the fifth harmonic of the line scan frequency was subject to 1.5kV pulses. The 'S' or scan correction capacitor was required to pass 6A at line scan frequency. Initially, these tasks were carried out by using custom designed tubular windings of metallised polypropylene. A four-in-series winding was used for the 'Line-tuning' and a 'two-in-series' for the 'S' correction capacitors.⁸

Subsequently, Westermann introduced the first very high voltage and pulse capable capacitor ranges. Their MKP10 and FKP1 self healing, flattened designs also used polypropylene dielectric. The original FKP1 samples that I have were resin cast, but current production components⁴ use a moulded 'E' case with resin filling, Fig. 5.

At that time in the early 70's, many capacitor designers^{9,10} including me expected that polypropylene would become a near universal film capacitor dielectric for both ac and dc

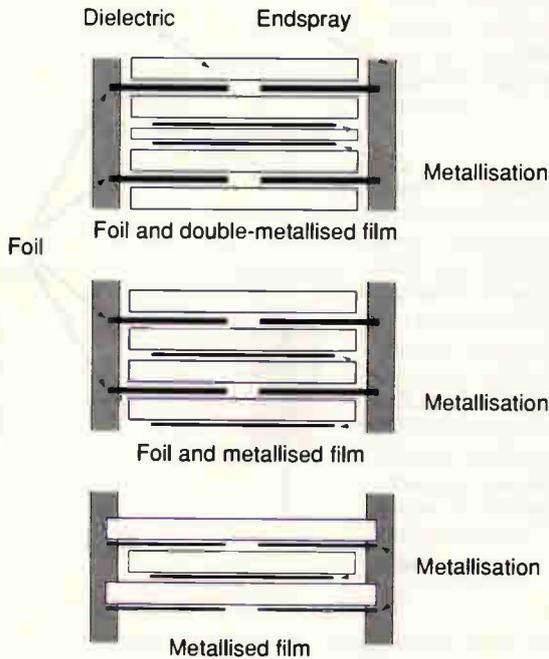


Fig. 5. Low-current, high-voltage, pulse capacitors are made using only metallised film electrodes. Increased current handling is provided by use of foil electrodes with a conventional series metallised film dielectric, or the doubly metallised non-dielectric film electrode, as used in the original Wima FKP1 samples. This represents a trade-off between capacitor size and current handling.

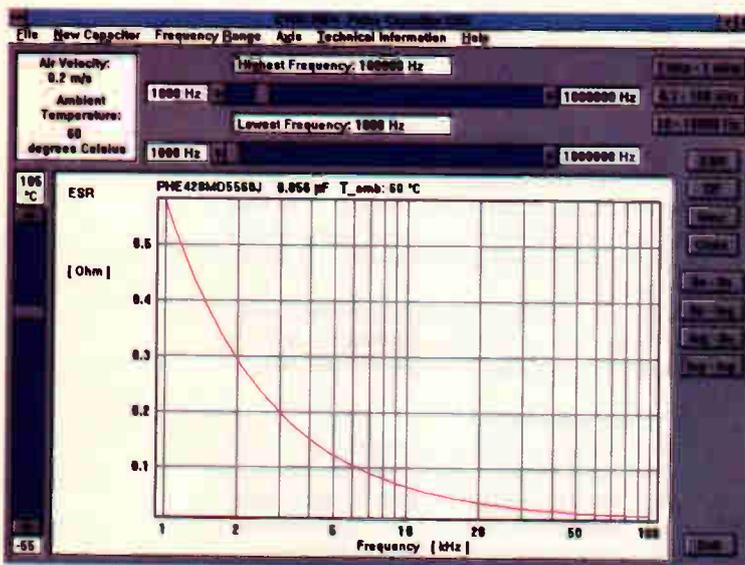


Fig. 6. The Evox-Rifa pulse capacitor on-screen catalogue, used to ascertain capacitor esr by frequency, at 60° ambient. Alternatively it can provide plots of $\tan\delta$ by frequency, and rms current and voltage limits versus frequency and temperature.

applications. But two inhibiting factors emerged. Polypropylene has an extremely smooth surface finish that has to be corona treated to make the metallised electrode adhere properly. PET suppliers rapidly developed much thinner, more easily metallised and stronger capacitor films.

Consequently, polypropylene is currently replacing polystyrene in low value precision foil and film designs. It remains the benchmark dielectric for ac tasks and applications where high pulses are expected. These capacitors are made with foil and metallised film carrier electrodes and non metallised polypropylene dielectric films.

Recent developments

The drive to provide small low-cost surface mounted bare chip capacitors to compete with ceramic chip capacitors has resulted in the introduction of two new film dielectrics.

The general-purpose polyethylene-naphthalate, or PEN, has a +200ppm temperature coefficient and characteristics similar to PET. It is strongly polar. At 1.2%, it has the highest dielectric absorption of any capacitor film.

Low-loss polyphenylene-sulphide, or PPS, is a non-polar dielectric with a 'K' of 3. Its capacitance value and $\tan\delta$ losses are stable over temperature. Its small negative temperature coefficient and other characteristics are similar to polypropylene, but it is available in thicknesses down to 2 microns. PPS has a much higher softening temperature and in sections thicker than 25 microns, it is recognised as a V-0 (UL94) flame retardant material.

Many older plastic dielectric films resulted from developments by UK or German engineers. But this bi-axially stretched PPS film was developed jointly by the Phillips Petroleum Company and Toray Industries of Japan. The basic PPS polymer may be familiar to many as the high temperature moulding compound Ryton.¹¹

PPS has a melting point of 285° celsius a $\tan\delta$ and dielectric absorption second only to polystyrene and polypropylene. With a dielectric constant of 3, a 2 micron minimum thickness and a very high tensile strength similar to PET, you can expect to see PPS film finding use in many ac and pulsed-current applications in the future.

While more than ten different plastic-film dielectrics are currently used in capacitor manufacture, those mentioned above represent the most widely used.

Pulse and ac applications

Properly constructed plastic-film pulse capacitors provide a long service life while subjected to extremely severe conditions of voltage or current pulse and temperature. Presented with a pulse or ac application, how can a designer determine which capacitor can handle the task without overspecifying?

Figure 5 shows alternative constructions for high-voltage pulse-handling capacitors. With sinusoidal applications, determining the circuit voltage and current requirements is simple. Given the capacitor's $\tan\delta$ or equivalent series resistance at the relevant frequency, capacitor power dissipated is easily calculated, either manually or using Spice simulations.

With non-sinusoidal waveforms this is no longer the case since the equivalent series resistance for all capacitors varies with frequency. Using transient or time domain simulations, Spice can calculate capacitor currents over time. But it cannot then use the frequency-dependent resistance value needed to calculate the capacitor's actual power dissipation. Rules of thumb have been invented but they tend to be hit and miss.

For a low-loss component, capacitor current at any given harmonic relates to the harmonic's voltage multiplied by the

harmonic number. Assume a simple square wave application at 10kHz repetition with the 0.056 μ F capacitor shown in Fig. 6. Equivalent series resistance, or esr, at the fundamental frequency is 0.0593 Ω . For such a low loss, near ideal capacitor, the current at the fundamental and each harmonic will be almost equal. Since this capacitor's esr continues to reduce with frequency, then some 80% of its total RMS power is dissipated at the 10kHz fundamental.

At a certain frequency, a capacitor's esr reaches a minimum. Generally, this frequency is lower for larger capacitors. As frequency rises beyond this point, esr increases again, contradicting assumptions made in the last paragraph and much increasing power dissipation at harmonic frequencies.

Of course the square wave is only one possible waveform. With pulse waveforms, as duty cycle changes, the voltages for higher harmonics quickly increase compared to those of a square wave. Harmonic power then considerably exceeds that dissipated at the fundamental frequency, dominating the power dissipated by the capacitor.¹²

Dissipation with complex waveforms

The only useful way of determining power dissipation under these conditions requires a number of procedures. First, FFT conversion of the observed voltage waveform across the capacitor into the frequency domain is used to identify the voltages and relative phases of each harmonic component.

Calculation of capacitor current then needs to be carried out at each harmonic frequency. Identification of the capacitor's esr at each relevant harmonic frequency comes next. Finally, calculation of the total power dissipated by these harmonics in the capacitor can be determined.

Designers interested in a step-by-step method of calculating capacitor power dissipation due to pulse waveforms will find details in my April 1995 capacitor article.¹²

Every manufacturer of pulse capacitors provides guidance on how best to perform these calculations in their catalogues and application notes. They frequently use simplifications and approximations. Many offer to perform the above recommended FFT routines and more for you, on receipt of accurate voltage and current oscillograms.

Evov Rifa provides two additional aids. One is a booklet called *Pulse capacitors basic information*, written by Professor Bengt Alvsten of the University of Aalborg, Denmark. The other is a software package dedicated to calculations for their pulse capacitors, called *PCCAD*. This software can be downloaded from the company's web page or requested on floppy disk.¹³

The *PCCAD* software package includes an on disk catalogue of pulse capacitors together with a form of FFT program that allows a pulse waveform to be analysed. The catalogue can be accessed graphically to extract any needed capacitor parameter – esr, $\tan\delta$ or maximum permissible current or voltage – all versus frequency and ambient temperature. The slider bars and simple menu approach used are clearly visible in Fig. 6.

Capacitor self inductance

With the exception of the bare surface mount capacitor chip, all film capacitors use wire connecting leads between the external circuit board and the capacitor winding.

A long established rule of thumb assumes the self inductance of a wound, extended foil or Schoop end-sprayed capacitor element is similar to, or maybe slightly less than, its body length of lead wire. This low self inductance value results from each wound turn being effectively short circuited

to every other turn, in effect a single turn winding.

Depending on wire gauge used, typical capacitor wire leads display some 7 to 8nH of self inductance per cm length. Printed circuit board tracks 0.5mm wide display some 8 to 9nH of self inductance per cm length, according to copper laminate thickness used.¹⁴

A small 7.5mm lead spacing boxed radial capacitor, pcb mounted, will thus exhibit some 5nH of self inductance due to its element winding length and a further 5nH due to its mounting lead wires – 10nH in total.

So the capacitor element has similar or less inductance than its body length of printed circuit track. When inserting or removing a leaded capacitor in an existing track length, only the capacitor lead wires affect the net inductance. The capacitor element's self inductance is pretty much offset in each case by change in the printed circuit track length used, hence track inductance.

Inserting a non-leaded chip capacitor with a body width similar to or wider than the track can be expected to slightly reduce a printed board track's net inductance.

In practice most pcb-mounted, leaded film capacitors of 1nF or above exhibit series resonance well below 100MHz. With many applications this is unimportant, but with faster logic and micro-processors, lead-wire contribution is unacceptable. Such applications force use of non-leaded, physically short, uncased capacitor elements.

To aid the designer's choice, most capacitor makers supply tables or graphs of self resonant frequencies. ■

References

1. McMillan, Frank. 'The Chain Straighteners,' Pub. Macmillan Press.
2. Müller, Friederike. 'Small but Vital,' *Du Pont Magazin*, No 3, 1984.
3. Charlton and Shen. 'Plastic Film Dielectric Capacitors,' *Proc IEE*, 1961 p. 476.
4. Westermann, Wolfgang. 'Reliable Plastic Film Capacitors for Pulse Application,' *Elektronik*, No 18, 1982.
5. Westermann, Wolfgang. 'Wound or Stacked: that is the question?' *Elektronik*, Nos 5 & 6, 1988.
6. Bateman, C. 'Understanding capacitors,' *Electronics World*, Feb. 1998.
7. Bateman, C. 'Understanding capacitors,' *Electronics World*, Dec. 1997.
8. Metallised Film Capacitors. Polypropylene, Erie Electronics.
9. Harrop, P.J. 'The use of polypropylene in capacitors,' *Electronic Components*, Jan. 15, 1974.
10. Taylor, P. 'Polypropylene – the extraordinary dielectric,' *Capacitors*, Apr. 1980.
11. Capacitor and Resistor Technology Symposium. CARTS '87, p. 41.
12. Bateman, C. 'Power dissipation in capacitors,' *Electronics World*, Apr. 1995.
13. Pulse Capacitor CAD (PCCCAD), Evox Rifa AB, Kalmar, Sweden.
14. Applications Reference Manual, Analog Devices Inc., Norwood MA.

NOW AVAILABLE

RANGER 2

for Windows 95™

Demo Software - available from our Web Address

The Complete, Integrated Schematic & PCB Layout Package

Windows Ranger 2

For Windows 95 & NT

- New Hierarchical Circuit
- Split Devices • Gate & Pin Swap
- New Edit Devices in Circuit
- Copper Fill • Power Planes
- Autorouter • Back Annotation

£250

Ranger 2 Outputs:

Full Windows Outputs
Plus - HP-GL
Gerber
NC Drill
AutoCad DXF

Windows Ranger 2 with Spectra SP2

Ranger & Spectra Autorouter provide the most cost effective PCB Design system available. A powerful, intuitive system at an outstanding price!

£600

Windows Ranger 2 Upgrade

Upgrade your existing PCB Package to Windows Ranger 2.

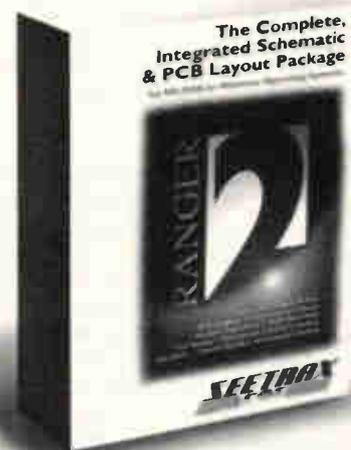
£150

SPECIAL OFFER Ranger 2 Lite £35 (Prices exc VAT/P&P)

Demo Software -download from <http://biz.ukonline.co.uk/seetrax>

Call 01730 260062

Fax 01730 267273 Old Buriton Limeworks, Kiln Lane,
Buriton, Petersfield, Hants. GU31 5SJ



SEETRAX
Advanced Systems & Technology for PCB Manufacture

CIRCLE NO. 115 ON REPLY CARD

SPEAKERS'

AUDIO DESIGN

CORNER

John Watkinson looks at the often overlooked loudspeaker design topic – diffraction.

Diffraction is the means by which all wave-based forms of energy propagate. This includes light, radio waves and sound. Diffraction is not the simplest subject, but an understanding of it is important in many disciplines.

In certain types of optical systems a simplification can be made which uses the concept of rays, but there are many phenomena which ray theory cannot explain. The traditional loudspeaker designer deals with the complexities of diffraction by completely ignoring it, but progress beyond modest quality limits then becomes impossible.

Diffraction correctly predicts the result when distributed or multiple sources radiate in three dimensions. In this case the result at any point is the vector sum of all contributions from wherever. The vector sum requires that phase be taken into account. The interaction of wave energy in this way is called interference.

Interference

In an interference system, the results depend heavily on wavelength. The parameter used to describe this change of behaviour with wavelength is known as the wave number k and is defined as $k=2\pi f/c=2\pi/\lambda$ where f is the frequency, c the speed of sound and λ the wavelength.

In practice the size of any object or distance a in metres is multiplied by k . A good rule of thumb is that when ka is less than 1, sound tends to be omnidirectional whereas when ka is greater than 1, sound tends to be directional.

At low audio frequencies the wavelength is so long that all points near a woofer are in the same phase. The radiation is omnidirectional. However, as wavelength falls, this is no longer true. Consider an ideal rigid piston vibrating such that ka is much greater than 1. The diaphragm can be considered to be an infinity of point sources that interfere with one another.

Because the summation considers phase, and this is a function of distance, a point one wavelength from the diaphragm will receive radiation at a multitude of different phases from the infinity of points on the diaphragm. The random phase results in cancellation, except in the forward direction, where a wavefront can be formed.

Effectively, energy can only leave in one direction. In a loudspeaker this is the undesirable phenomenon of beaming. In light this would be a ray.

Rigid pistons – good or not?

The rigid piston is an undesirable item at high frequencies as it becomes too directional. In practical loudspeakers, things have to be arranged so that the radiating area falls with rising frequency.

Simply crossing over to smaller and smaller drive units doesn't actually achieve the ideal. Figure 1a) shows the

on-axis frequency response of a three-way speaker. However, if the off-axis response is considered, at the top of the band of each driver the directivity will have narrowed, whereas at the bottom of the band of the next driver it will have widened again. Figure 1b) shows that the off-axis response is highly irregular, causing a coloured reverberant field.

One simple rule about diffraction is that it always occurs. At high frequencies, the entire loudspeaker cabinet is a diffraction surface and the shape of the cabinet has a dramatic effect on the high-frequency radiation.

Sound leaving a tweeter propagates in all directions – including transversely across the baffle board. At the edge of the baffle, in a conventional box-shaped speakers, the sound finds a sudden impedance change. Figure 2 shows that prior to the edge, the sound is radiating into an acoustic half space, whereas at the edge it is radiating into three-quarter space. The impedance mismatch causes a reflection. Sound is re-radiated from the edge and interferes with the direct sound.

At the listening point the result will depend on the wavelength. At some frequencies the diffracted sound will have travelled an extra distance which is a whole number of wavelengths and the interference will be constructive. At intermediate frequencies the extra distance will be an odd number of half wavelengths and the inter-

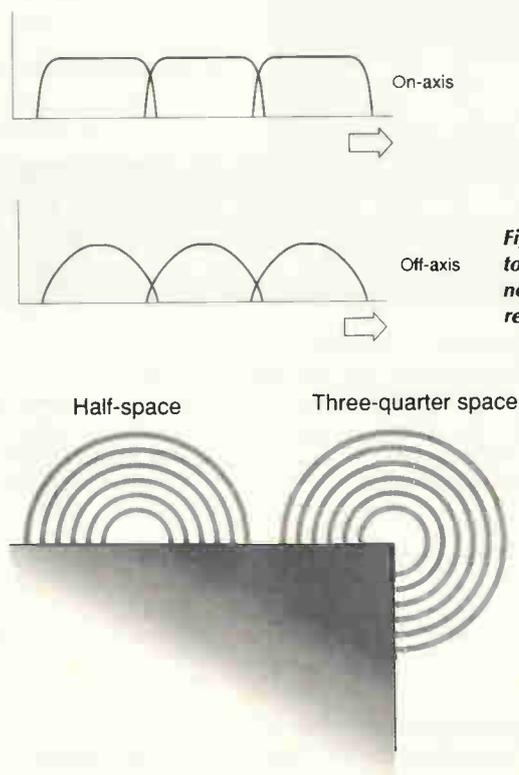
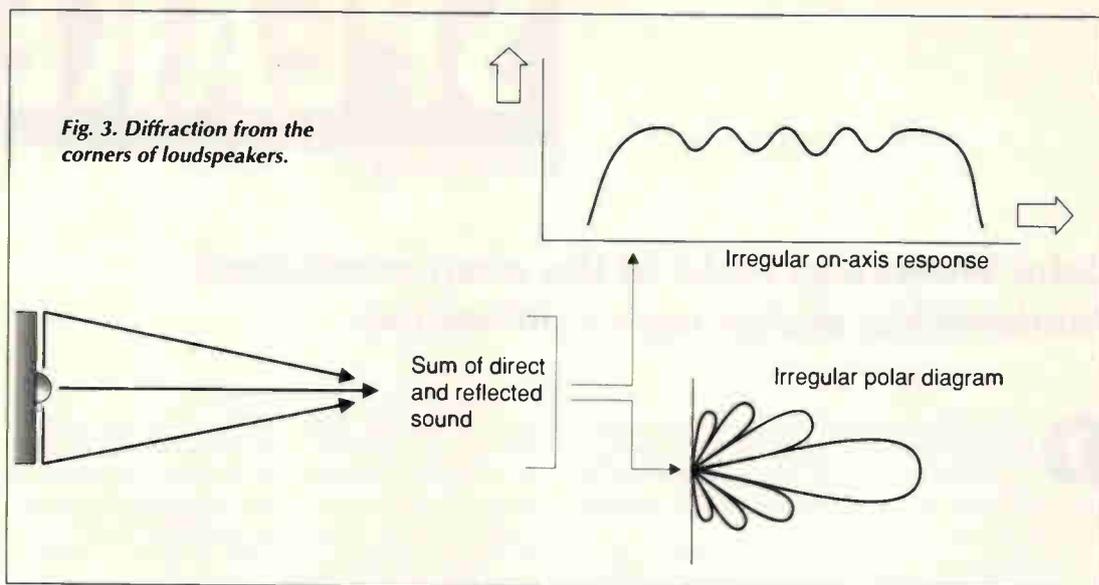


Fig. 1. Simply crossing over to smaller drive units does not solve the off-axis requirement.

Fig. 2. Acoustic impedance change at cabinet edge causes a reflection.



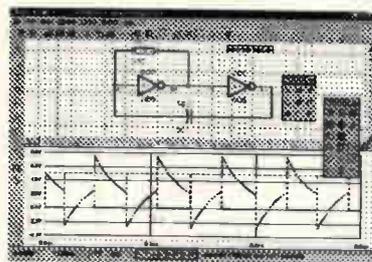
ference will be destructive. The result is periodic ripples in the frequency response which cause colouration.

Enclosure edge problem

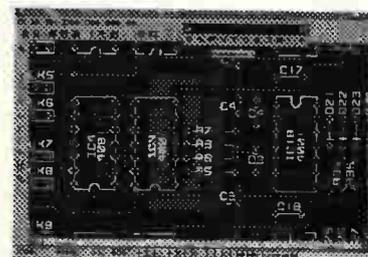
The radiation from the edge of the enclosure effectively increases *ka* so that the speaker becomes more directional. Figure 3 shows that for a fixed frequency the interference can be constructive or destructive according

to the angle. Such a directivity pattern is not desirable in a stereo system as it impairs imaging accuracy.

Loudspeaker enclosures should be shaped to minimise diffraction, and those which *are* simply sound better. Nothing in this is new. In fact an exhaustive study was published by Olson nearly thirty years ago. Like so much of reality, the traditional loudspeaker designer has simply ignored Olson's findings. ■



Schematic Capture with a FREE mixed mode simulator.



Integrated PCB Design with autorouter & CAD/CAM support.

Looks like Quickroute 4.0 has Got It All!

FREEphone 0800 731 2824
FAX 0161 476 0505
 FREE Demo on www.quickroute.co.uk
 Ref 401

The new Quickroute 4.0 is here and with it a revolution in our price/performance structure. We've kept the features the same at all levels of Quickroute and just varied the number of pins you can use in a design. So now you can get started FAST with Quickroute 4.0 for just £79 (300 pins), £149 (800 pins) or £249 (full access). Prices exclude P+P and VAT.

All versions of Quickroute 4.0 now include:
 *New user interface with dockable tool bars *Multi-sheet schematic capture *Power rail & data bus support *1-8 layer autorouter *For a limited period a FREE Integrated 32 bit mixed mode simulator *Copper Fill *Engineering Change *Gerber Import and export *Export NC-Drill, WMF, DXF and SPICE files *Netlist Import and export *Over 1000 library parts

Send me a FREE DEMO. My name, address & phone number are:



Send To: Quickroute Systems Ltd, FREEPOST 13136, Stockport, SK4 1BS
 Outside the U.K please fax this coupon. (c) 1997. All rights reserved. Ref 401.

CIRCLE NO. 116 ON REPLY CARD

The Low Cost Controller That's Easy to Use

Features

The K-307 Module provides the features required for most embedded applications

- Analogue** • 4 Channels in 1 Channel out
- Digital** • 36 Digital in or out & Timers
- Serial** • RS-232 or RS-485 plus I2C
- Display** • LCD both text and graphics
- Keyboard** • Upto 8 x 8 matrix keyboard
- Memory** • > 2Mbytes available on board
- Low Power** • Many modes to choose from

Development

The PC Starter Pack provides the quickest method to get your application up & running

- Operating System** • Real Time Multi Tasking
- Languages** • 'C', Modula-2 and Assembler
- Expansion** • Easy to expand to a wide range of peripheral cards

Other Features

Real Time Calendar Clock, Battery Back Up, Watch Dog, Power Fail Detect, STE I/O Bus, 8051 interface, 68000 and PC Interface

Cambridge Microprocessor Systems Limited



Units 17 - 18 Zone 'D'
Chelmsford Road Ind Est
Great Dunmow Essex CM6 1XG
E-mail cms@dial.pipex.com

Phone 01 371 875 644



SEE OUR WEBSITE
<http://www.cms.uk.com>

CIRCLE NO. 117 ON REPLY CARD



- 100% Transparent Cable Replacement !
- No Special Software Drivers Required !
- Typically Only 10ms System Latency !
- Handles Single Bytes or Complete Files !
- Dual RS232 + RS422/RS485 Interfaces !

RTcom-Global RF Modem:
2400bps to 9600bps ASCII Data Rate
Between 200m to 1 km Range
UK, I-ETS-300-220, FCC Part 90,
RSA and Australian 472MHz Versions
Dual RS232 + RS422/RS485 Interface
Wall Mount or IP67 Die Cast Box
On-Air Code Balancing & Encryption



RTcom-Universal RF Modem:
2400bps to 19200bps ASCII Data Rate
Between 100m to 300m Range
UK and I-ETS-300-220 Versions
Dual RS232 + RS422/RS485 Interface
Wall Mount or IP67 Die Cast Box
On-Air Code Balancing & Encryption



New from Radio-Tech the RTcom Radio Modems offer industry a competitive alternative to cables. Fully customised versions are available to suit customer needs at little or no additional costs.

A MEMBER OF



LOW POWER RADIO ASSOCIATION

Radio - Tech Limited, Overbridge House, Weald Hall Lane
Thornwood Common, Epping, Essex CM16 6NB.
Sales +44 (0) 1992 57 6107 (4-lines) Fax +44 (0) 1992 56 1994
e-mail sales@radtec.demon.co.uk
<http://www.radio-tech.co.uk>

ADVANCED ACTIVE AERIAL



The aerial consists of an outdoor head unit with a control and power unit and offers exceptional intermodulation performance: SOIP +90dBm, TOIP +55dBm. For the first time this permits full use of an active system around the lf and mf broadcast bands where products found are only those radiated from transmitter sites.

- General purpose professional reception 4kHz-30MHz.
- -10dB gain, field strength in volts/metre to 50 Ohms.
- Preselector and attenuators allow full dynamic range to be realised on practical receivers and spectrum analysers.
- Noise - 150dBm in 1Hz. Clipping 16 volts/metre. Also 50 volts/metre version.

- ★ Broadcast Monitor Receiver 150kHz-30MHz.
- ★ Stabilizer and Frequency Shifters for Howl Reduction
- ★ Stereo Variable Emphasis Limiter 3
- ★ 10-Outlet Distribution Amplifier 4
- ★ PPM10 In-vision PPM and chart recorder
- ★ Twin PPM Rack and Box Units.
- ★ PPM5 hybrid, PPM9 microprocessor and PPM8 IEC/DIN -50/+6dB drives and meter movements
- ★ Broadcast Stereo Coders
- ★

SURREY ELECTRONICS LTD
The Forge, Lucks Green, Cranleigh, Surrey GU6 7BG.
Telephone: 01483 275997. Fax: 276477.

CIRCLE NO. 118 ON REPLY CARD

Visit the UK's first ever Fair on CD Rom and real £2000



Forget Novotel Hammersmith, forget Birmingham's NEC, because from April 15th you will be able to communicate with some of the World's leading electronics companies directly from the comfort of your PC.

Electronics Weekly's Virtual Recruitment Fair is the first ever Recruitment Fair on CD Rom. Distributed free of charge to readers of *Electronics Weekly*, The Virtual Recruitment Fair uses fantastic 3D graphics and sophisticated animation techniques to bring a whole new dimension to job seeking for the electronics professional.

Once inside the prestigious life-like venue, you can complete your CV at registration, pick up a virtual carrier bag then visit the impressive array of interactive company stands in the Main Hall.

electronicsWEEKLY



Just some of the companies you'll find at The Virtual Recruitment Fair:
Siemens ♦ Motorola ♦ Lucent ♦ Symbionics ♦ Crescere ♦ Cadence ♦ Visteon ♦ Oxford Semiconductor ♦ 3 Com ♦ Melville Craig ♦ Lateral Connections ♦ Quest

Virtual Recruitment you could pick up a very cash prize.

Take a seat in the big screen cinema or enjoy a moment of tranquillity in the reading room whilst you read back issues of *Electronics Weekly* from the archives.

From the exhibition stands themselves, you can: view (and respond with CV) well over a thousand live vacancies; connect to advertiser websites; view and print company brochures; launch slide presentations and watch video footage to find out exactly what it's like to work for a prospective electronics employer.

And as if all that wasn't enough, count up the exact number of jobs on offer at The Virtual Recruitment Fair and you could win a £2000 cash prize...it's a virtual give away!

Watch out for your free copy with *Electronics Weekly* April 15th issue.



electronicsWEEKLY





Versatile radiation meter

Disappointed with current Geiger-tube circuits, Darren Heywood set about designing a more versatile meter with voltage, 4-20mA and audio outputs.

Designs for geiger counters that I have seen published tend to be crude. For example, the HT power supply powering the geiger tube is not regulated and of extremely high impedance. Moreover, the output is usually just a simple series of audio clicks. Assuming that a geiger tube costs £30 or more, providing it with such a basic output method is a waste.

The reason for my interest in Geiger counters was to find out if a high voltage flash over produced gamma radiation. This idea seemed plausible since a spark gap radiates electromagnetic radiation in the hf band, light and ultra violet rays, and perhaps X rays. Gamma radiation is just above

ultra violet and X-rays in the electro magnetic spectrum.

Features of my finished design are given in the panel.

Geiger tube selection

I spent a while looking for a suitable tube. Langrex Electronics was helpful in supplying data on the *MX* series. From that data, it seemed obvious that the most sensitive tube would have the following properties:

- Highest counts/min for 1mrad/h (good resolution)
- Lowest background counts (low noise)
- Lowest dead time

The *MX178* seemed to be the most suitable candidate, but I was quoted £350 for it. Out of the suppliers I contacted, Colomar Electronics gave the best deal, offering an *MX120/01* for £35 inclusive. This tube is robust and measures around 20mm diameter by 160mm long.

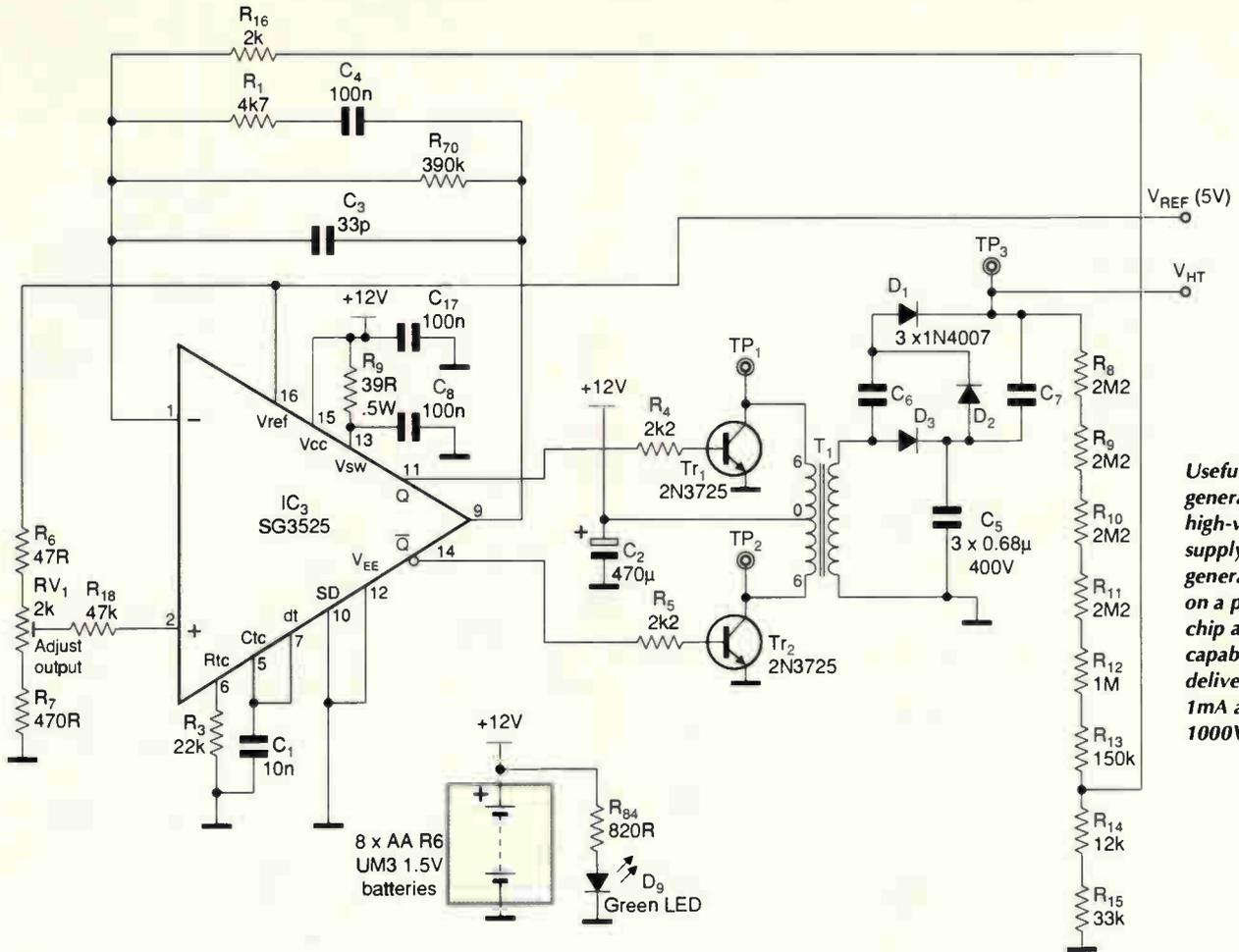
For the price, the gain of this particular tube is good. At 1millirad/hour, it outputs 113.3Hz. Maximum background count averages around 1.5Hz, so resolution is 1.5/113.3, which equates to 13.24µrad/hour. This means that if the tube was exposed to 13.24µrad/h, it would be unlikely that any pickup would be detected. In other words, you would not be able to tell difference between background radiation and this dose level.

Gain of the *MX120/01* is simply 113.3Hz/mrad/h. In contrast, the *MX178* has a gain of 146.7Hz/mrad/hour with a resolution of 1/146.7, which is 6.82µrad/hour. Clearly this is a better choice if you can afford it.

Dead time for the *120/01* is approximately 250µs measured on a *TEK475* oscilloscope. This is the time span that the tube is ionised or active. Once the tube has been activated by ionising radiation, it will take it about 250µs to return to its normal state.

Features of the radiation meter

- HT continuously variable between 0-1100V
- HT can source 1mA continuously at 1000V
- The instrument is portable, powered by 12V batteries
- Five calibrated outputs, namely:
 - 0-5V output
 - 4-20mA output for chart recorders, etc, calibrated for 0-1mrad/h
 - Direct frequency output
 - 0-1mA moving coil meter output, calibrated in two ranges
 - 0.5W variable audio output
- Can accept a variety of different tubes
- Excellent accuracy
- Low battery indicator
- Simple to calibrate if tube data is available
- Two meter ranges
- All parts easily obtainable and cheap



Useful also as a general-purpose high-voltage supply, this HT generator is based on a pwm driver chip and is capable of delivering up to 1mA at 0 to 1000V.

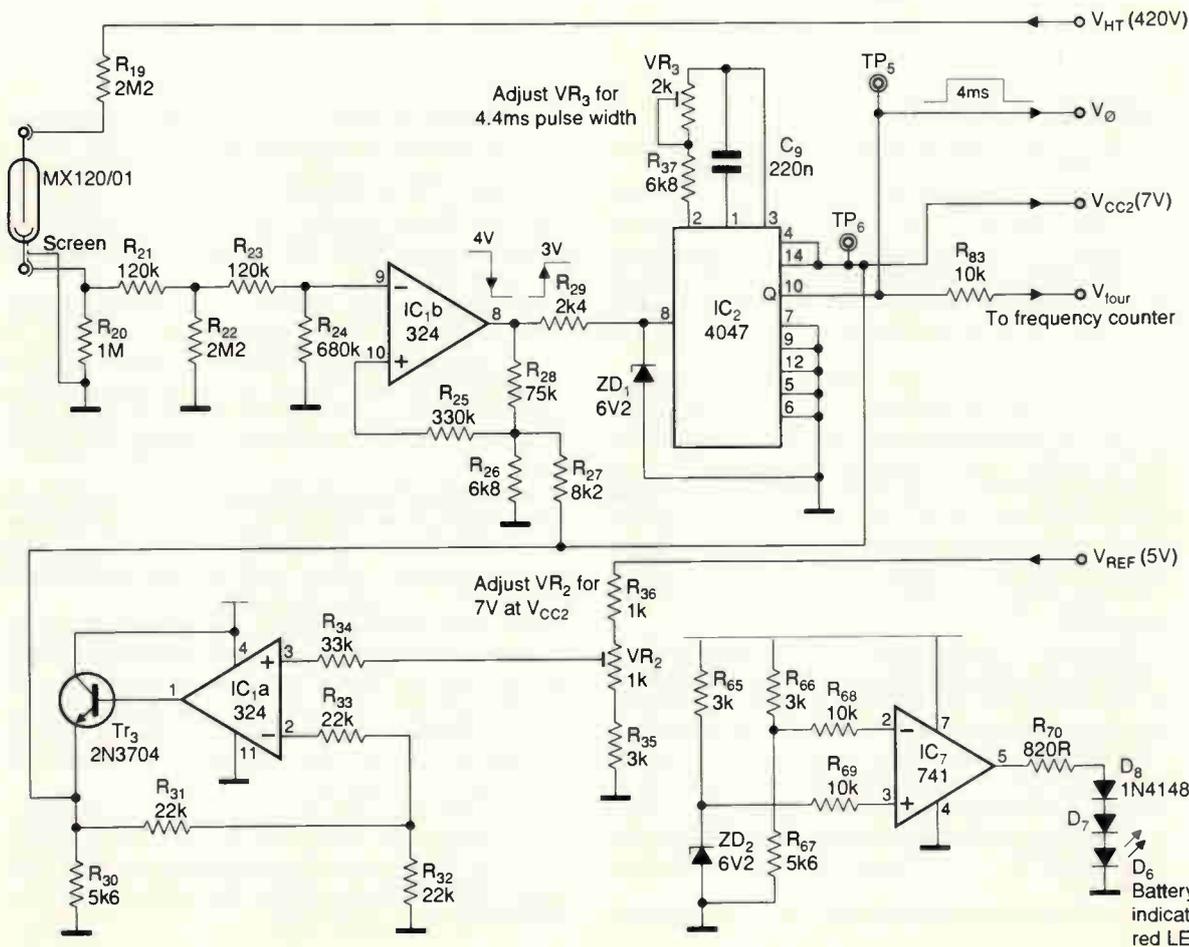
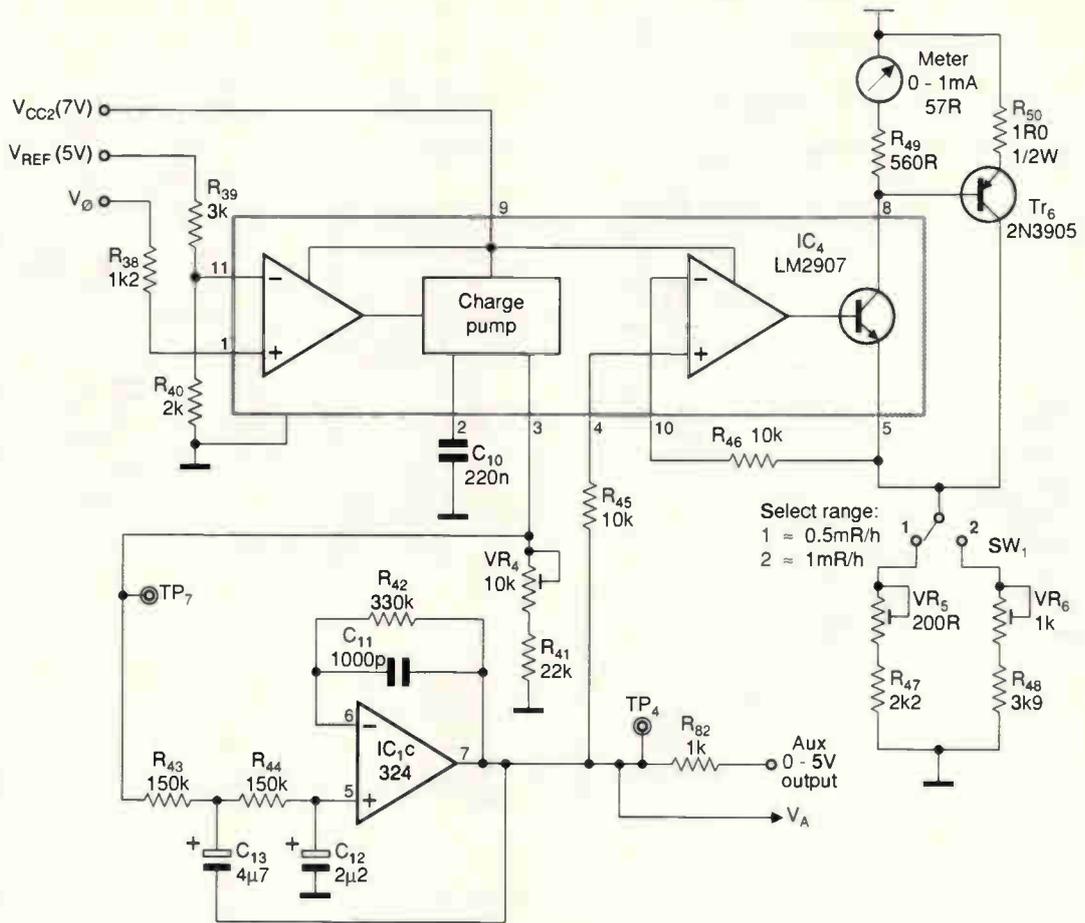


Fig. 2. Input conditioning circuits. Positive pulses from the tube feed a schmitt trigger to insure integrity. Bottom left is the 7V V_{cc2} regulator.

Heart of the radiation detector is this frequency-to-voltage converter. In addition to providing meter drive, this circuit also has a 0 to 5V auxiliary output.



Generating 1kV at 1mA

One of the most efficient methods of transferring energy across a transformer is via pulse width modulation.

As you can see from Fig. 1, I have exploited the SG3525 pwm chip. Potentiometer R_{V1} allows the output voltage to be adjusted anywhere between 0 and 1100V, the output having very little ripple. At 1000V, the output, is capable of sourcing 1mA continuously and hence a power of 1W is delivered. This figure may be increased by reducing resistor values R_4 and R_5 .

The manufacturer guarantees 400mA sourcing/sinking at output pins 11 and 14. I tried this on breadboard, only to find that the chip became excessively hot. For this reason, two 2N3725 moderate power switches were added. These are superior to the more common 2N2219As and faster. While on, these transistors conduct approximately 250 to 300mA.

In conjunction with R_3 , pins 6, 5 and 7 and C_1 set the free running oscillator to 3.570kHz. Pin 7 is the dead time pin but is not used in this application since turn on/off times of $T_{1,2}$ are very fast.

Transformer T_1 is a standard 6VA 240V primary with 6-0-6 secondary type for pcb mounting. Mine came from Rapid Electronics, part No 88-0150. Components $D_{1,3}$ and $C_{5,7}$ form the voltage tripling and smoothing of the output.

You will notice that $R_{14}+R_{15}+R_{16}$ is equal to R_{18} so the two op-amp input currents are about balanced. This helps reduce offset and drift inherent in the op-amp. It is good design practice to balance the differential inputs no matter what the circuit application is. I have endeavoured to do this throughout this design.

It is common knowledge that the first stage op-amp on the

front end of any pwm chip provides the majority of the open-loop or system gain. Consider the output divider $R_{8,15}$ which attenuates the output by as much as 46.2dB. This means the closed-loop gain will be around 46dB or approximately 200.

Since the closed-loop gain requirement is so high and the loop gain is only 80dB or 10000, I was slightly worried about the overall accuracy.

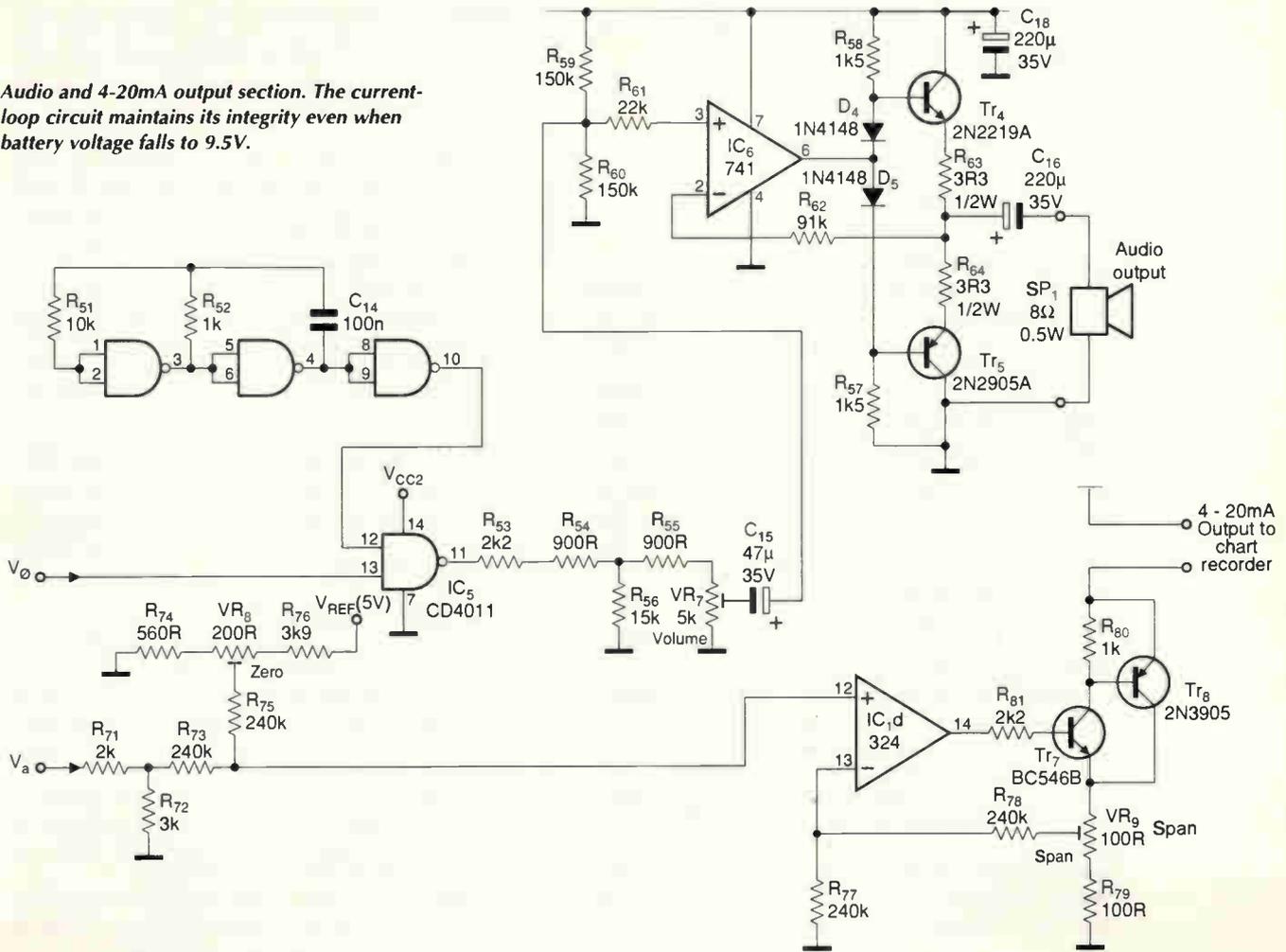
For example, the error between the two differential inputs will be about 10mV. This disregards offsets and drift etc. As a result, it would be desirable to have an open-loop gain of say 100dB. This would reduce the closed-loop error by a factor of 10. Now, an error of 1mV would exist between the differential inputs. This is of course without R_{17} being in circuit.

Loop tuning components consisted of C_3, R_1 . Capacitor C_4 and R_7 were included at a later stage. To check the loop performance, I injected a variable frequency signal on pin 2 and noticed the natural frequency of the loop was in the order of 25Hz – and it was almost oscillating.

At this point, I had two choices. I could either increase C_4 , thus increasing the phase margin, or I could reduce the overall gain. I was reluctant to do the former since this would slow the loop response down. Consequently I strapped a resistance decade box across pins 1 and 9 and adjusted the box until good stability was achieved at 25Hz. This is the main reason for including R_{17} .

Overall, the stability is excellent, the loop being reasonably fast. The output stays within 1V anywhere in range 0 to 1100V. Pin 16 outputs a stable 5.1V reference voltage capable of supplying 20mA or more. This reference voltage is used throughout the instrument.

Audio and 4-20mA output section. The current-loop circuit maintains its integrity even when battery voltage falls to 9.5V.



Geiger input action

As you can see from Fig. 2, the tube is fed from the HT via a 2.2MΩ resistor. The cathode end of the tube connects to a 1MΩ resistor to ground. This ensures that positive only pulses are dropped across R₂₀ and are approximately 12V in amplitude.

From here the signal passes through a -3dB attenuator and on to schmitt trigger, IC_{1b}. The output switches low at about 4V and returns when the input pulse is around 3V.

Output of IC_{1b} feeds a monostable pulse stretcher in non-retriggerable mode, via R₂₉/ZD₁, which limits the pulse output presented to IC₂ to 6-2V. This is done because IC₂'s supply line is fed from V_{cc2}, which is 7V. Pulse width from IC₂ may be advanced or retarded. I recommend that you set this pulse at around 4ms, which corresponds to a little over 113.3Hz - full span for the MX120/01.

Note that IC_{1a} is designed to generate a stable 7V supply, V_{cc2}, for powering IC_{2,4,5}. The reasoning behind this was that the LM2907 frequency-to-voltage converter includes V_{cc2} in its transfer equation. This makes it essential that V_{cc2} be kept constant at all times.

Another benefit of this scheme is that since the instrument is powered by batteries, the effect on accuracy of the gradually falling supply voltage is minimised.

Supply V_{cc2} is capable of sourcing more than 50mA and its output impedance is quite low. However the circuit draws nowhere near this amount of current under normal conditions. Stability of V_{cc2} depends on V_{ref} output of the SG3525 pwm chip, so its drift is very low.

I included a low-voltage indicator in the form of a 5mm red

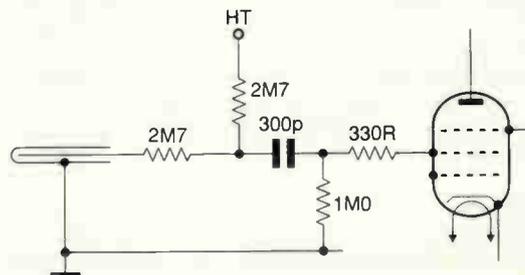
led. This led is designed to switch when the battery discharges to around 9.5V. Once this led comes on, the 4-20mA accuracy begins to be affected. Diodes D_{7,8} were included because IC₇ does not swing all the way to ground. Without these diodes, the led will not turn off properly.

Frequency to voltage conversion

The LM2907 is the heart of the instrument. It converts the varying frequency from the tube converted to a varying dc level.

National Semiconductor guarantees a basic linear transfer of ±0.3%, which is a very good figure. In fact, on calibrating the instrument, non-linearity is not noticeable. The chip is versatile and easy to use. Its transfer equation is simply,

$$\frac{dV_{out}}{df_{in}} = V_{cc2} \times C_{10} \times R$$



Recommended connections from the MX120/01 tube data sheet. This halogen-quenched Geiger-Müller tube has a working voltage of 420V, threshold voltage of 375V and a 200µs dead time. Its maximum background figure is 90 counts a minute.

where $R=RV_4+R_{41}$. Voltage V_{cc2} is fixed at 7V but may be varied to accommodate other configurations. For the *MX120/01* tube,

$$\Delta V_{out} = 0 \text{ to } 5V$$

$$\Delta f_{in} = 0 \text{ to } 113.3\text{Hz}$$

$$\frac{\Delta V_{out}}{\Delta f_{in}} = 0.044 \text{ V/Hz}$$

Capacitor C_{10} is 220nF and, $0.044=7 \times 220 \times 10^{-9} \times R$. As a result, R is 28647.8 Ω . Hence potentiometer RV_4 is used to trim the output on pin 7 of IC_1 to 5V at 113.3Hz. The only component that you may have to change to accommodate a different tube is R_{41} .

For an in depth discussion on exactly how the *LM2907* charge pump operates, refer to National's Linear Applications Handbook 1994, Application Note AN162, p. 345.

Output of the charge pump is injected into a Butterworth type second-order low-pass filter which has a break frequency of about 0.33Hz. Its output will be around 40dB down at 3.3Hz. The output of the filter feeds the 0-1mA meter drive circuitry within the *LM2907* converter.

There are two ranges to choose from. The first is 0-500 μ rad/h and the second 0-1000 μ rad/h.

Transistor Tr_6 was included simply to redirect meter current should it exceed about 1.2mA, thus meter protection is incorporated in the design. Should a 0-5V output be required for external purposes, R_{82} provides suitable output.

Voltage V_{ref} , from the pwm chip supplies R_{39} and R_{40} . The hysteresis span on the input amplifier is about 0.6V.

I thoroughly recommend the use of an analogue meter as opposed to a digital type. The output of the tube is a continuously varying frequency being largely dependent on the nature of radiation. Although the low-pass filter does a good job at averaging or integrating, the output still varies according to the intermittent bombardment of the tube.

4-20mA output

Here, output from IC_1 is fed directly to R_{71}/R_{72} which drops it from 0-5 to 0-3V full scale. This allows a greater voltage drop to occur in the 4-20mA output loop. Again, V_{ref} from the *SG3525* is used, affording a stable low drift zero setting via RV_8 . This potentiometer is used in conjunction with RV_9 , which sets the span.

Transistors $Tr_{7,8}$ form a compound or current feedback structure. The inclusion of Tr_8 greatly increases the input impedance of Tr_7 , allowing IC_{1d} to exercise its maximum gain. This increases overall accuracy.

The 4-20mA output easily drives a standard 250 Ω , 0.1 % resistor – even with the battery supply as low as 9.5V.

Unfortunately, I do not, have access to a chart recorder, but I thoroughly recommend this output since the peaks and troughs would be exposed for further analysis.

Audio output

The audio section of the instrument is straight forward. Running at 5kHz, oscillator IC_5 is gated with the output of the 4047 monostable (pin 10).

Maximum output at RV_7 is about 3V pk-pk of 5kHz 'packets'. Potentiometer RV_7 may be adjusted for a comfortable audio output.

In conjunction with $Tr_{4,5}$, IC_6 makes up a low impedance buffer amplifier. It is capable of outputting around half a watt into an 8 Ω speaker. The audio output is a convincing series of 5kHz clicks.

Setting up

Set a frequency generator on square wave and adjust this signal for 0-12V peak. Set the frequency generator for 113.3Hz

– assuming you are using the *MX120/01* – and inject this signal between ground and negative terminal of the tube connection on the pcb. The tube is obviously removed at this stage. Adjust RV_7 for comfortable audio output. Connect a volt meter between ground and TP_6 and adjust VR_2 for V_{cc2} of 7V exactly.

Next, with the aid of an oscilloscope, connect the probe between ground and TP_5 and adjust the pulse width for 4ms. With the function generator precisely set to 113Hz, adjust RV_4 for 5V exactly at TP_4 . With S_1 on range 2, adjust RV_6 for 1mA reading on the moving coil meter.

With a current meter connected between the 4-20mA terminals, adjust the span potentiometer RV_9 for 20mA, then switch off the function generator (0Hz) and adjust RV_8 zero for 4mA. Switch the generator back on and re-adjust the span pot RV_9 for 20mA. Repeat this procedure until you get satisfactory results.

Once the above has been completed, set the frequency generator for $113/2=56.5\text{Hz}$, switch S_1 to range 1 and adjust RV_5 for full span on the moving coil meter, i.e. 1mA. Connect a volt meter across ground and HT and adjust RV_1 for 420V, again assuming you are using the *MX120/01*. Your instrument is now ready for use.

How do I know if it works?

Elsewhere in the article, I mentioned that HT flash over perhaps radiates gamma radiation. Sadly this is not the case. Further to this, I picked up no appreciable radiation reading from house bricks, luminous watches, uv lamps or television screens. In fact, television screens probably emit low level X-rays instead of gamma radiation.

What I found to worked extremely well was the mantle as used in Calor gas lamps. This is that little piece of material that covers the flame and glows, emitting light. These are available in abundance at the local ironmonger.

With three of these mantles wrapped around the *MX120/01* tube, it is possible to obtain a reading of between 250 μ rad/h and 300 μ rad/h rising to sometimes to 400 μ rad/h. I have no idea what the safe permitted dose actually is.

Other thoughts

With regards to the various op-amps used in the instrument, only one exhibited hf on its output, namely IC_{1c} . This is why C_{11} is strapped across its input/output terminals. I suspect the reason for this is the high source/feedback resistance used. I expected hf on the 4-20mA amplifier, IC_{1d} , but it was stable. This leads me to think that the *LM324* quad op-amps are well compensated internally.

The *LM324* quad op-amp will swing all the way to ground and its common mode input range includes ground. I recommend that the tube connection be of twin screened audio cable, the screen being connected to ground.

The *MX* series of tubes are old Mullard types. I believe that tube performance has changed little over the years. Also, the new unit for radiation is the gray, I have used millirads per hour to quantify absorbed dose throughout this article but, 1mrad/h is simply 0.01mGy/h. ■

Technical support

Linear Applications Specific ICs databook 1993, National Semiconductor.

Linear Applications Handbook AN-162, p. 345, 1994, National Semiconductor.

1990 Linear Databook, Linear Technology Corp. Page 5-97, (*SG3525* data sheet).

Langrex, 0181 684 1166, fax 0181 684 3056.

Colomor, 0181 743 0899, fax. 0181 749 3934.

electronicsWEEKLY

HyperACTIVE

CONNECT WITH THE UK'S

NO. 1 READ FOR ELECTRONICS
PROFESSIONALS ON THE
INTERNET

Electronics Weekly HyperActive is more than just a magazine on the Web. Check out the site and you'll see why thousands of electronics professionals around the world regularly log onto www.electronicweekly.co.uk/

For **News** HyperActive's Daily News Service brings you the latest news in the industry - as it breaks. For **Jobs** HyperActive has the largest and most varied collection of jobs available in the electronics market. Now we bring you the improved **Jobs and Careers** service with a whole range of new and exciting features.

All this plus, the **latest technology**, market information, toolkit's, a searchable archive, and loads more....

Don't miss out.

Point your browser at <http://www.electronicweekly.co.uk/>
register now (it's free)

SPONSORED BY



TOSHIBA

SIEMENS



ADVERTISER INFORMATION: 0181 652 3639 OR E-MAIL: richardnapier@rbi.co.uk

Explorer and Navigator aren't the only options. **Cyril Bateman** has found a well-received browser that fits on a floppy. He also has information on filter design and circuit simulation, together with a sighting of a useful club for wireless engineers. And there's news of the imminent 450MHz Pentium.

Hands-on Internet

Following the release in January of its latest 'Slot 1' processor, the *Deschutes* 333MHz fabricated in 0.25µm technology. Intel announced its processor plans for the remainder of 1998. According to News.Com¹, Intel is to make 16 different *Pentium II* models. This quantity seems certain to confuse potential purchasers.

The 'Slot 2' processors, due by midyear, are targeted at the high end computer market, mostly servers and workstations. Initially they will run at 400MHz, have 512Kbyte of high-speed cache. In addition, they will operate with a faster 100MHz mother board bus. They will be followed not long after by 1Mbyte and 2Mbyte cache versions. Towards the year end, expect processor speed to reach 450MHz, with similar high speed cache memory options.

These Slot 2 processors will have a larger core, similar in

size to that of the *Pentium Pro*, and will be capable of multiprocessing, with up to eight processors. The slot and packaging, being longer, will not be interchangeable with Slot 1 systems.

And for Slot 1?

During this year, Slot 1 processor speeds will increase to 400MHz, reaching 450MHz by the year end. The fastest speed version has already been demonstrated by screening the film 'The Terminator' from a digital video disk drive, and with power to spare.

Various Slot 1 processor options are planned, covering both low and high cost desktop and mid-range servers. There will be three Slot 1 versions for low end desktop computers and three for sub-\$1000 computers.

Similar processor speed enhancements and cache combinations are scheduled for portable systems, which later this year will also provide for a 100MHz system bus.

Despite this emphasis on the two slot-styles, production of the older 'socket 7' Pentium processors with MMX is to extend at least throughout 1998.

National enters low-cost pc race

Following its acquisitions last year of Cyrix and Mediamatics, National Semiconductor now "has all the pieces" to make a single-chip pc.² Its Tel Aviv design studio is planning to develop a single-chip personal computer chip, having full multimedia, graphics, audio and DVD capability and costing \$100. The company plans to invest between \$100 and \$150 million over 18 months in this project, and hopes to make commercial products available in June 1999.

Compaq and Digital merger

The planned merger between Compaq and Digital³ – the largest in computing history – has resulted in Compaq's firm commitment to 64bit technology Alpha processors, Digital UNIX and Open VMS. An article in *PC Week* expressed

Fig. 1. Microsoft has been released from the threatened \$1 million daily fine, having agreed to supply oems with a non-Internet Explorer and working version of Windows 95.



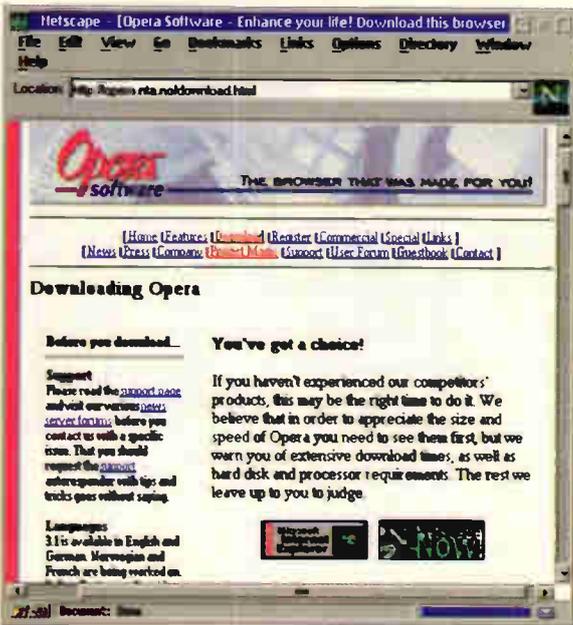


Fig. 2. Web Review described the tiny browser Opera as "Breathhtakingly fast, flexible and fun".

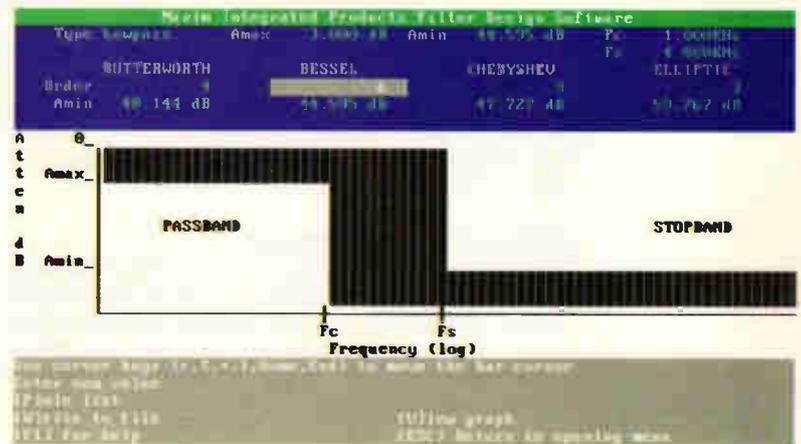


Fig. 4. A virtual community and meeting place for wireless design professionals.

Fig. 5. Maxim's freeware filter design software, optimised for use with the company's 'time continuous' integrated filter chips.



Fig. 3. Microsoft's latest Internet search engine/front door, with up to date news feeds, organised in conjunction with NBC News and Bloomberg Television.



resolved. Not least of these is the release of *Windows '98*. Microsoft however continues to work to a June 1998 target date.

According to News.Com,⁶ the rush to market in 1997 both of *Explorer 4* and *Netscape Communicator* resulted in both Netscape and Microsoft giving priority to shipment timing at the expense of product quality. This News.Com article accused both products of being "rife with bugs", at least in their initial releases.

In part this rush resulted from the introduction of the 'push' technology, used to custom-deliver Web pages, software and data to a user.

With *Internet Explorer's* enforced shipping with *Windows '95* on new computers, Microsoft's share of the browser market rose while Netscape's fell. Netscape reported large losses,⁷ leading to rumours that it could be taken over. In the event an 11% staff cut and a return to supplying its browser free of charge is seen to be the solution. In the meantime Netscape shares have fallen to 25% of their peak value.

A browser that fits on one floppy?

Many other companies are busy writing Net-based software. Compared with *IE4* at 13Mbyte download size and *Communicator* at 8Mbyte, a new super-slim browser from Norway⁶ is rapidly gaining popularity. At only 1Mbyte, it is rapidly downloaded.

Called *Opera*, this \$35 shareware program⁸ can be evaluated for 30 days free of charge. Version 3.1 is available now

concern about the future of Digital's pc products. More specific plans will be released following clearance of this merger by the regulators.

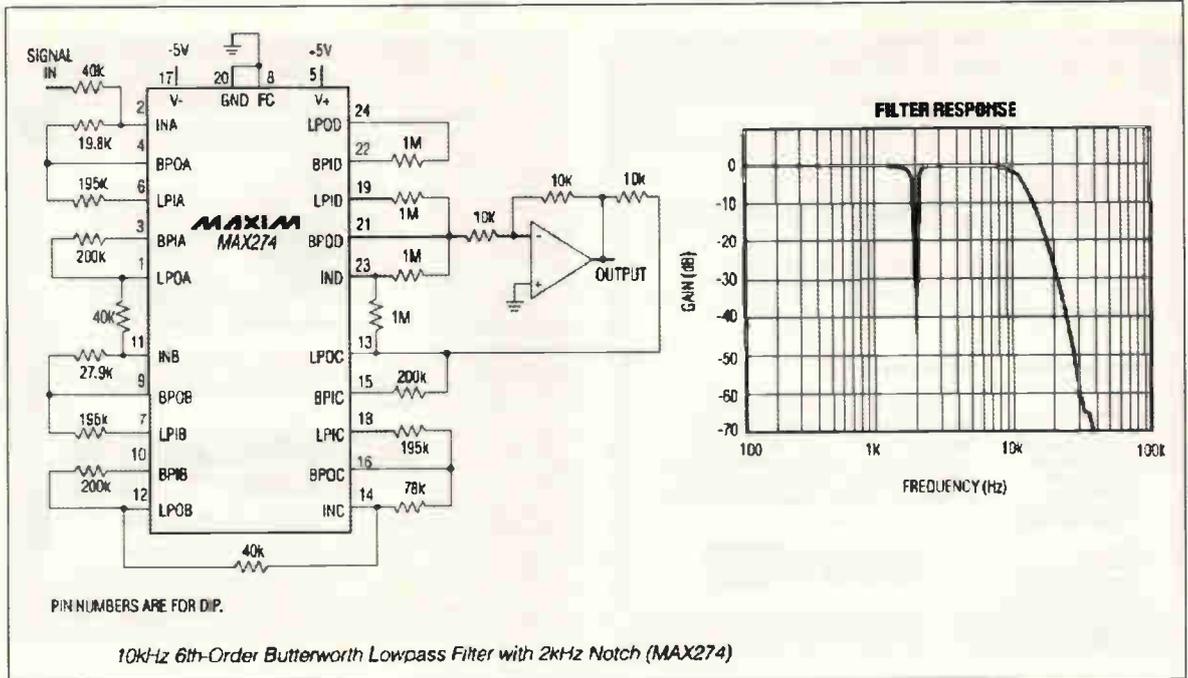
Microsoft still under pressure

An out-of-court settlement between Microsoft and the Department of Justice removed the threat of a \$1 million a day fine against Microsoft. It is seen by many as a win for the DOJ and consumers.⁴

Computer makers can now ship a properly functioning Windows 95 system, without Internet Explorer being a compulsory part of the installation, Fig. 1.

But settlement of this case does not end the Microsoft v Government battles. Bill Gates is to appear before an anti-trust Senate hearing⁵ and many other matters have still to be

Fig. 6. Having two fourth-order filters in one package allows band-pass and low-pass functions to be implemented using just one filter chip and an output buffer.



in English and German. Norwegian and French versions are being worked on, to be followed shortly by Italian, Portuguese, Spanish, Afrikaans and Russian Fig. 2.

Described as 'breathtakingly fast, flexible and fun' by Web Review, Opera has established a loyal following of users. I have already downloaded my copy for evaluation and I'll let you know what I think.

Fed up of browser banners?

While searching Internet, the so-called 'banner' advertisements that fund the search engine's costs significantly slow down your search engine access. Internet Fast Forward⁹ was a software package designed to 'filter out' such adverts. Pressurised by advertisers though, the writer of this filter sold

it to PrivNet, which in turn discontinued it following the pressures it too experienced.

Solid-Oak Software,¹⁰ supplier of the filtering software 'Cybersitter', has recently added tools to filter out banner advertisements. Many of the 1.2 million existing Cybersitter users, having older computers with slow Internet connections, apparently requested the upgrade.

As a simpler alternative, I search with both graphics download and Java disabled when making lengthy searches. These can be quickly re-enabled once you have found the page you need.

It may be that the much faster downloads promised when you upgraded to a 56kbit/s modem are about to arrive. One delaying factor was the existence of two competing and incompatible standards. On 6 February, the International Telecommunications Union¹¹ accepted a 'determined' or preliminary, V.90 standard. Compatible modems could be available by the time you read this article. Final ratification of the standard is expected by September.

Microsoft recently established a new search-engine/home page, called 'Microsoft Start'.¹² Regular users can customise much of this start-up page to suit their needs and interests. A choice from seven news sources, eight sports and five search engines can be selected.

As a casual visitor wanting only to try out this search engine's access facilities, I found it slow to download and much too time consuming. It needs strict customisation if you are to use it regularly. In the past, Microsoft has tried out many re-thinks of its Web presence. This version however could prove popular with Explorer users, Fig. 3.

Now, over to circuit design

RF and wireless designers searching for specialised design software will find *Wireless-design-online* a good starting point.¹³ It comprises search facilities, a product showcase and discussion forums, together with a download page for specialised software, Fig. 4.

Continuing last month's theme, namely

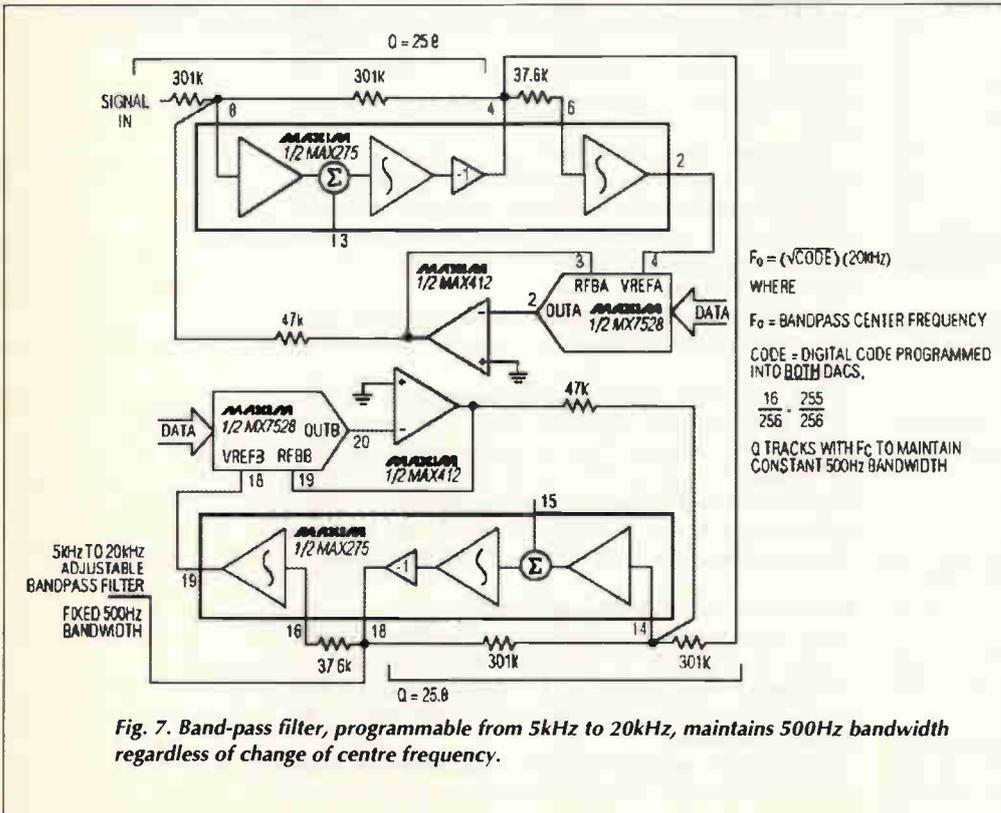


Fig. 7. Band-pass filter, programmable from 5kHz to 20kHz, maintains 500Hz bandwidth regardless of centre frequency.

designing time-continuous active filters using dedicated software and integrated circuits, the *MAX275* from Maxim comprises two second-order filters with a distortion figure typically better than -86dB .¹⁴

A variation, the *MAX274*, provides two 275s on one chip – giving a total of four second-order filters. It has a 3dB better distortion figure but a lower frequency capability than the 275. Similar in concept to the *UAF42* described last month, these chips also include precision capacitors having a nominal value of 80pF.

Maxim provides the design software needed to allow easy what if design evaluations free of charge¹⁴. The company can also supply time saving, ready assembled evaluation kits to facilitate design and testing prototype filters, Fig. 5.

Need exotic filters?

Four filter stages in one package allows more exotic combination filters to be made with relative ease. Two applications caught my attention. The first intended for fixed frequency measurements was a simple notch filter and sixth-order low-pass combination, needing little board space. It is easily designed for other frequencies, using the supplied software, Fig. 6.

The second was rather more complex. It provided a bandpass filter with a centre frequency programmable from 5kHz to 20kHz. It had a constant 500Hz bandwidth – regardless of the bandpass centre frequency. This circuit used dual d-to-a converters with two buffers to control its centre frequency, Fig. 7.

Simulation

If you are a regular reader of this column, you will have noticed that I find finite-element simulation program useful in my work.

Over the years I have found a small, easy to use program, sufficient for my needs. It is written by a team of software engineers in St Petersburg Russia, specialising in electronic, magnetic and thermal applications.¹⁵

Called *Quickfield*, it has recently been upgraded and now supports Window95/NT.¹⁶ A student's shareware version can be freely downloaded, either from the Tor or Tera-analysis sites, and a one months trial of the full package can also be arranged, Fig. 8.

While circuit simulation programs are invaluable for sav-

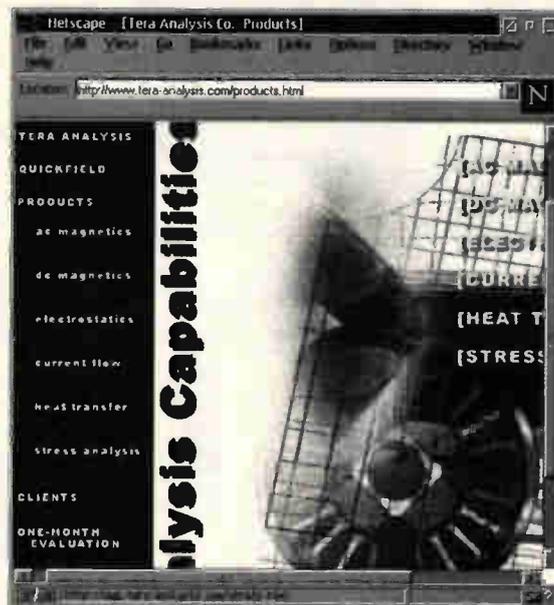


Fig. 8. 'Quickfield' is a small, easy to use, finite element software from a Russian software co-operative. It is specially optimised for electronic design needs and has been recently updated for Windows95/NT. Try out the shareware student's version or have a one month free trial.

ing design calculation time, each software package requires an initial learning curve. The larger more competent packages naturally take longer to learn. This can be discouraging.

PC-ECAP is a very simple low cost and easy to learn time and frequency domain analysis program for DOS or Windows.¹⁷ Being rapidly downloaded and small, it is very popular with radio hams for quick 'what-if' calculations. More importantly, it has been designed to facilitate calculations of group delay, vswr and return loss.

All calculations are made in the frequency domain, ensuring exceptionally quick simulation results, free from convergence problems. The software includes a transparent, easy to use FFT conversion routine, to translate its frequency-domain results into time domain, in order to display transient simulations.

Most useful of all for inexperienced users, *PC-ECAP*'s net-lists bear a close similarity to those needed for popular Spice simulators. It allows both user and net-list conversion for use on other larger simulators. ■

Where to surf

- | | | |
|---|---|--------------------|
| 1. Intel to make 16 kinds of Pentium II | http://www.news.com/News/Item/ | 0,25,18912,00.html |
| 2. \$100 single-chip PC on the way | http://www.news.com/News/Item/ | 0,4,18805,00.html |
| 3. Future of Digital's PCs in question | http://www8.zdnet.com/pcweek/news/ | 0202/06edigi.html |
| 4. Government, Microsoft settlement | http://www.news.com/SpecialFeatures/ | 0,5,18396,00.html |
| 5. Gates to testify | http://www.news.com | |
| 6. The year in browsers | http://www.news.com/News/Item/ | 0,4,17765,00.html |
| 7. No, Netscape isn't throwing in the towel | http://www.businessweek.com/premium/ | 08/b3566076.htm |
| 8. The browser that was made for you | http://opera.nta.no | |
| 9. Ad filtering catching on? | http://www.news.com/News/Item/ | 0,25,19156,00.html |
| 10. Solid Oak Software Inc. | http://www.cybersitter.com | |
| 11. 56-kbps standard here | http://www.news.com/News/Item/ | 0,4,18896,00.html |
| 12. Microsoft Start. | http://home.microsoft.com/default.asp | |
| 13. Wireless design online | http://www.wirelessdesignonline.com | |
| 14. Maxim Integrated Products | http://www.maxim-ic.com | |
| 15. TOR Cooperative Enterprise | http://www.tor.ru | |
| 16. Quickfield | http://www.tera-analysis.com | |
| 17. Circuit Systems | http://www.ourworld.compuserve.com/homepages/circuitsys/PCECAP.HTM | |



PHILIPS PM3217 (This is a proper scope)
Dual Trace 50MHz Delay Sweep Incl 2 Probes
£400



HC3502
Dual Trace 20MHz 5mV-20V/Div; 0.2 μ Secs - 0.5
Sec/Div. X-Y; X5 magnifier; TV Sync etc
Hardly Used £150 Un-used £200

THE CLASSIC TEKTRONIX 400 SERIES



46B Digital Storage Dual Trace 100MHz Delay £850
46E Analogue Storage Dual Trace 100MHz Delay £395
475 Dual Trace 200MHz Delay Sweep £580
465 Dual Trace 100MHz Delay Sweep £400

- PHILIPS PM3256A Dual Trace 400kHz Dual TB Delay Cursors IEEE £1750
- FLUKE PM3092 2+2 Ch 100MHz Delay TB Cursors £1200
- TEKTRONIX 2465 4 Ch 300MHz Delay Sweep Cursors etc £2000
- TEKTRONIX 2445 4 Ch 150MHz Delay Sweep Cursors etc £1250
- TEKTRONIX 1546B Dual Trace 100MHz Delay Cursors £900
- TEKTRONIX 2235 Dual Trace 100MHz Delay Sweep £800
- TEKTRONIX 2215 Dual Trace 80MHz Delay Sweep £400
- TRAVIS SS5711 4 CH 100MHz Delay Sweep £650
- PHILIPS 3055 2+1 Ch 50MHz Dual TB £475
- GOULD 051100 Dual Trace 30MHz £200 With Delay £240
- GOULD 05300 Dual Trace 20MHz £200

AND REMEMBER ALL OUR EQUIPMENT IS TESTED PROPERLY!



MARCONI 2019A Syn AM/FM Signal Gen 80Hz-100MHz £1800
MARCONI 2019 Syn AM/FM Signal Gen 80Hz-100MHz £1800
MARCONI 2018 Syn AM/FM Signal Gen 80Hz-100MHz £1800
MARCONI 2017 AM/FM Signal Gen 10kHz-100kHz £1750



FARNELL SSG520 Syn AM/FM Signal Gen 10kHz-100MHz £325
FARNELL SSG520 Syn AM/FM Signal Gen 10kHz-100MHz £450
MARCONI 6311 Programmable Stereo FM Stereo £2000
MARCONI 2020S FM Stereo Gen £1000
M.P. 8556A Syn Signal Gen 0.1-9999kHz £1500
M.P. 8540B Phaseloc/Syn Sig Gen 500kHz-512kHz £750
M.P. 8540A AM/FM Signal Gen 500kHz-100kHz £550
PHILIPS PM3513 Programmable Syn Func Gen 0.1kHz-50MHz £1500
PHILIPS PM1592 Programmable Syn Func Gen 0.1kHz-20MHz £1000
M.P. 3375A Syn Function Gen 21MHz £1250
PHILIPS PM1534 Sweep Func Gen 0.001Hz-20MHz Line/Std/Tx etc £400
PHILIPS PM1532 Sweep Func Gen 0.1Hz-20MHz Line/Std/Tx etc £250



CLASSIC AV08 Mk5 in Case with Batteries & Leads £50
FLUKE 770MM 3 1/2 digit with Carrying Case & Leads £60

- RACAL 1998 Counter 1.3GHz £650
- RACAL 1991 Counter/Timer 160MHz £450
- RACAL 1990 Counter 120MHz £300
- 9918 10Hz-560MHz £125
- 9916 10Hz-520MHz £150
- 9904 DC-50MHz £60

- SOLARTRON 7151 DMM 6 1/2 digit IEEE £450
- SOLARTRON 7150 DMM 6 1/2 digit IEEE £300



True RMS

LOOK!

**BRAND NEW OSCILLOSCOPES!
NEVER USED!! LIMITED STOCK!!**



DMS 3850A Digital Storage/DMM
Handheld LCD display 2 Channel 50MS/S. Auto Range. 4 digit DMM/Capacitance/Frequency Counter. Battery Operation or external 7.5-9VDC i.e. AC Adaptor (Not supplied). RS232 Comes in Black Carrying Pouch complete with 2 scope probes: DMM leads, manual.
New Boxed For Only £400



DTS 40 Digital Storage
Dual Trace 40MHz. 20MS/S Storage. Cursors + On Screen Readout. Sweep Delay, Interface etc. etc. Supplied Unused in original box complete with 2 Probes & Manual.
Amazing Value at £400



DTA 20/40/60 Dual Trace
with All Magnification, TV Trig etc. etc. Lots of Specification.
DTA20 Dual Trace 20MHz £225
DTA40 Dual Trace 40MHz - 12KV EHT £300
DTA60 Dual Trace 60MHz - 12KV EHT £375
All unused & boxed supplied with 2 probes & Manual

- FARNELL AP100/30 0-100Vrms, 0-30Amps Aut-ranging £1000
- FARNELL HB925 0-60Volts, 0-25Amps £400
- FARNELL TSV70Mk2 70Volts 5Amps/35Volts 10Amps £260
- FARNELL L12-100 0-12Volts, 0-10Amps £175
- FARNELL L130-2 0-30Volts, 0-2Amps Twice £130
- FARNELL L130-1 0-30Volts, 0-1Amp Twice £130
- THURLEY-THANDAR TSP1820 Precision PSB 18V, 230Amp £275
- THURLEY-THANDAR TSP3222 Programmable 32V, 2Amps Twice GPB Digital £450
- THURLEY PL120 0-30Volts, 0-2Amps GPB Digital £150
- THURLEY PL120 0-30Volts, 0-2Amps GPB Digital £110

Many more power supplies available

NEW AND HARDLY USED



PANASONIC VP8177A FM/AM SIGNAL GENERATOR
100kHz-100MHz. FM 0-100kHz. Output -19dB-99dB AM 0-60%; 32 Preset Memory; Digital Display Frequency & Output.
Un-used £750

PANASONIC VP7637A STEREO SIGNAL GENERATOR
Generates Broadcast FM-RDS/ARI. Preset memory; GP/B Used £400
Un-used £700



KENWOOD FL180A WDW/FLUTER METER 0.003%-10%; Freq 3KHz/3.15KHz RMS/AVERAGE/PEAK; Weighted Filters; Digital Display of rpm; 4 digit Freq Counter (0.01KHz-9.999KHz/0.01KHz-55KHz)
Used £400 Un-used £500



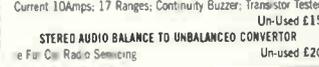
POWER SUPPLY Model HSP3010
0-30Volts, 0-10 Amps Current Limiting, 2 Meters.
Used £160 Un-used £200



GOODWILL GAG-808C AUDIO GENERATOR Sine/Square 10Hz-1MHz in 5 Ranges 0.1% Low Distortion on 5 Steps Output Attenuator
Used £100 Un-used £125



GOODWILL GFC 8010G FREQUENCY COUNTER Range 1Hz-120MHz; 8 Digit Display 15mV RMS Sensitivity
Un-used £75



ANALOGUE MULTIMETER Model HC260TR AC/DC Volts; DC Current 10Amps; 17 Ranges; Continuity Buzzer; Transistor Tester
Un-used £15



STEREOD AUDIO BALANCE TO UNBALANCED CONVERTOR
For Car Radio Sensitive
Un-used £20

Used Equipment - GUARANTEED. Manuals supplied.
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
Telephone: (0118) 9268041. Fax: (0118) 9351696
Callers Welcome 9am-5.30pm Monday to Friday (other times by arrangement)

CIRCLE NO. 121 ON REPLY CARD

New Special Offers

Mini waterproof TV camera 40x40x15mm requires 9 to 13 volts at 120mA with composite video output (to feed into a video or a TV with a SCART plug) it has a high resolution of 450 TV lines. Vertical and 380 TV lines horizontal. electronic auto lens for nearly dark (1 LU) to bright sunlight operation and a small lens with a 92 degree field of view. It focuses down to a few CM. It is fitted with a 3 wire lead (12V in and video out). Now also available with wall mount tilt and swivel case (at the same price) £93.57 + VAT = £109.95
or £80.32 + VAT = £104.95

Board cameras all with 512 x 582 pixels 4.4 x 3.3mm sensor 9-13 volts power supply, and composite video out. All need to be housed in your own enclosure and have fragile exposed surface mount parts. 47MR size 60 x 36 x 27mm with 6 infra red LEDs (gives the same illumination as a small torch would) £50.00 + VAT = £58.75

40MP size 39 x 38 x 23mm spy camera with a fixed focus pin hole lens for hiding behind a very small hole. £57.00 + VAT = £66.98
40MC size 39 x 38 x 28mm camera for "C" mount lens this gives a much clearer picture than with the small lenses. £68.78 + VAT = £80.83

Standard "C" mount lens F1.6 16mm for 40MC £26.43 + VAT = £31.06

High quality stepping motor kits (all including stepping motors) "Comstep" independent control of 2 stepping motors by PC (through the parallel port) with 2 motors and software. Kit = £67.00. Ready built = £99.00
Software support and 4 digital inputs kit £27.00
Power interface 4A kit £36.00
Power interface 8A kit £46.00

Stepper kit 4 (manual control) includes 200 step stepping motor and control circuit £23.00
DTA30 Hand held transistor analyser. It tells you which lead is the base, the collector and emitter and if it is NPN or PNP or faulty (NEW VERSION now not say FETs & SCRs are transistors)
DTA30 £38.34
HMA20 hand held MOSFET analyser identifies gate drain and source and if P or N channel HMA20 £38.34

Speaker cabinets 2 way speaker systems with Motorola tweeters
Speaker dia 15 12 100MRMS
Power rating 250WRMS 175WRMS 100WRMS
Impedance 8ohm 8ohm 8ohm
Frequency range 40Hz-20kHz 45Hz-20kHz 60Hz-20kHz
Sensitivity (W/1M) 97dB 94dB 92dB
Size in mm 500x720x340 450x640x345 315x460x230
Weight 21.1kg 16.8kg 7.4kg
Price each for black vinyl coating £139.95 £99.99 £54.94
Grey finishing £159.97 £119.97 £64.99
(* not normally in stock, allow 1 week for delivery)

Power amplifiers 19" rack mount with gain controls & VU meters
STA300 2 x 190Wrms (4ohm load) 11kg £339.00
STA900 2 x 90Wrms (4ohm load) 15kg £385.00

LED's 3mm or 5mm red or green .7p each .yellow 11p each
Cable ties 1p each. £5.95 per 1000 £49.50 per 10,000

Rechargeable batteries
AA (BP7) 500mAh 0.99 AA 500mAh with solder tags £1.55
AA 550mAh £1.75 C (BP11) 2AH £2.20
C 2AH with solder tags £3.60 D (BP21) 2AH £2.60
D 4AH with solder tags £4.95 PP3 8.4V 110mAh £4.95
1/2AA with solder tags £1.55 Sub C with solder tags £2.50
AAA (BP76) 180mAh £1.75 1/3 AA with tags (plus CT4) £1.95

All products advertised are new and unused unless otherwise stated
Wide range of CMOS TTL 74HC 74F Linear Transistors kits rechargeable batteries, capacitors, tools etc always in stock. Please add £1.95 towards P&P (orders from the Scottish Highlands, Northern Ireland, Isle of Man, Isle of Wight and overseas may be subject to higher P&P for heavy items). VAT included in all prices

JPG Electronics, 276-278 Chatsworth Road, Chesterfield S40 2BH
Mastercard/Visa Orders (01246) 211202 Fax: 550959
Callers welcome 9.30am to 5.30pm Monday to Saturday

CIRCLE NO. 122 ON REPLY CARD

FGM-X Magnetic Field Sensors

**High Sensitivity ± 50 microtesla range
+ 5 volt supply**

**Robust 5 volt rectangular pulse O/P
whose period is directly proportional
to field strength.**

Typical applications:

Compass, field nulling/Gaussmeter applications.
Conventional magnetometry, earth field magnetometry, ferrous metal detectors, internal vehicle re-orientation alarm sensors, external vehicle or ship passage sensors, wreck-finders, non-contact current sensing or measurement, conveyor belt sensors or counters and in conjunction with small permanent magnets, movement and proximity sensors and ferrous impurity detectors for non-magnetic alloys.

For data sheets and application notes contact:

Speake & Co Ltd
Elvicta Estate, Crickhowell, Powys NP8 1DF, U.K.
Tel: 01873 811281/810302 Fax: 01873 810958
Int Tel: +44 1873 811281 Int Fax: +44 1873 810958

CIRCLE NO. 123 ON REPLY CARD

Single-supply op-amps

There are no free lunches in op-amp design. Phil Darrington helps you make the right choice by explaining the trade-offs involved in producing op-amps designed to work from a single supply rail.

In Maxim's application note on the design of operational amplifiers for single-supply working,¹ the clearly heartfelt observation is made that, in engineering, you usually have to sacrifice one aspect of performance to improve another.

How true, and designing an op-amp for use in a piece of equipment that has to be small, inexpensive, miserly in its use of current and yet produce the required performance from a single, low-voltage supply rail is a typical example of a collection of Murphy's Laws. Common-mode input range, output swing, common-mode rejection, noise and all the other little annoyances become bigger ones and the result is that trade-offs have to be made.

Input

Common-mode input voltage range in a single-supply op-amp is of first concern for a circuit designer and the obvious thing to do is to specify a rail-to-rail type – the phrase is claimed as a trademark by Nippon Motorola, so it ought to have capital initials, but not here – sorry. But there are things to watch. A pause here for definitions.

Operational amplifiers allowing inputs only down to the negative rail are referred to as ground-sensing types; those allowing signals to go to either rail are rail-to-rail devices.

And there are others that let the inputs go within a volt or two of positive and down to ground. If the amplifier has a voltage gain of two or more from a signal referred to ground, a ground sensor is probably a good choice and may well work better than a rail-to-rail op-amp, for reasons to do with the use of two differential input pairs in the rail-to-rail type, as shown in Fig. 1.

As the input voltage shifts from one rail to the other, one or the other amplifier pair handles it but, at the crossover, input bias current and input offset voltage can be changed in magni-

tude and polarity; the change in offset has a tendency to increase distortion in comparison with ground sensors unless the offset is trimmed at both ends of the common-mode range.

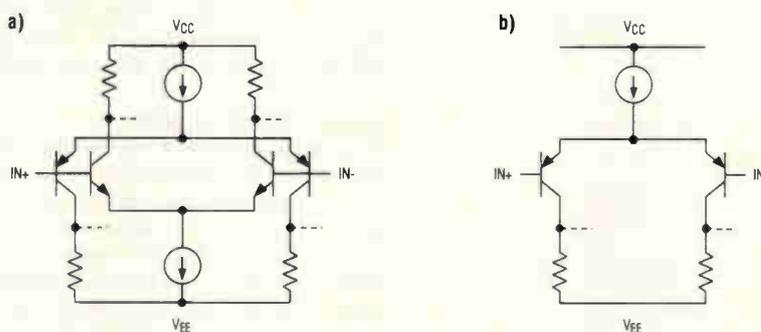


Fig. 1. Two types of rail-to-rail input. That at a) has two differential pairs, which can cause trouble when the input moves from one rail to the other and the amplifier uses one pair or the other. The crossover can change input bias current and offset voltage, which requires careful trimming during manufacture.

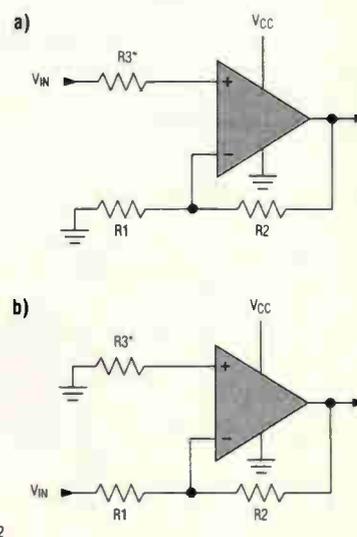


Fig. 2. Normal method of reducing offset-voltage errors by matching impedances 'seen' by each input of the op-amp.

$$*R3 = R1 \parallel R2$$

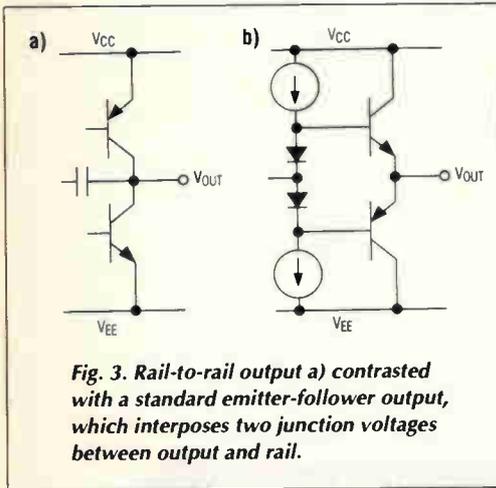


Fig. 3. Rail-to-rail output a) contrasted with a standard emitter-follower output, which interposes two junction voltages between output and rail.

Rail-to-rail op-amps are inherently more difficult to provide with high slewing rates than the ground-sensing variety, simply because the input stage is rather more exotic and is unable to take advantage of the available techniques. It is usual in any op-amp circuit to match the impedances seen at both inputs of the amplifier to match input bias currents and therefore reduce offsets caused by them.

Maxim quotes a change in bias current of 85nA for a 0-5V input voltage swing, while the offset current changes by only ±1nA when the above precautions are taken. In a rail-to-rail op-amp.

Figure 2 shows another way to eliminate input bias current changes, in this case by

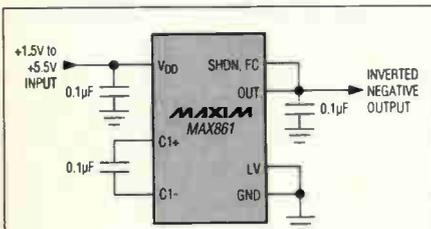


Fig. 4. In extreme cases, where a dual-rail circuit is the only option, this charge-pump provides the second rail by inverting the existing one.

making the common-mode voltage constant at V_{ref}. Output is now,

$$V_{out} = (-V_{in}R_2/R_1) + V_{ref}(1 + R_2/R_1).$$

If R₂=R₁, output is V_{out}=-V_{in}+2V_{ref}, which is 1-4V for inputs of 0-3V. Common-mode voltage is fixed and common-mode rejection errors eliminated.

Output

Since op-amps are – more often than not – required to produce voltage gain, it follows that a rail-to-rail output is needed more than rail-to-rail input. In a single-supply op-amp, the output stage is of somewhat different design to that found in a dual-supply type.

In rail-to-rail output stages, it is common to use a common-emitter stage, while the output of a standard op-amp is usually an emitter-follower pair, Fig. 3. At (a), the common-emitter form has only one junction between rail and output and the output voltage can approach the rail to within V_{CE(sat)}. In the emitter-follower at (b), however, the output gets no closer to the rail than a V_{CE(sat)} and a V_{BE}.

Since saturation voltage depends on collector current, output swing varies and, in fact, never really gets to the rail; it will approach to within tens or hundreds of millivolts.

Cmos output stages have the same problem: drain-source voltage caused by channel current flowing through the finite on-resistance

Load-dependent gain

A further problem with rail-to-rail op-amps is the matter of gain dependence on load current. Common-emitter stages provide gain at fairly high impedance, the output node therefore being included in the compensation network, while the emitter followers used in standard types have less than unity gain and are compensated before the output. In rail-to-rail op-amps, therefore, gain depends on load current and instability with capacitive loads is a possibility.

Once again, trade-offs are needed and in this case the circuitry needed to make the op-amp stable requires more supply current than is the case with standard designs. Nevertheless,

some of Maxim's op-amps with rail-to-rail input and output will drive a 500pF load, the extra circuitry also conferring good large-signal voltage gain into heavy resistive loads.

Charge-pumps

A novel use for the up-and-coming charge-pump circuit² is the provision of bias voltage for an emitter-follower output stage and power to the other stages.

This use of the internal charge pump enables a ground-sensing amplifier inputs to swing from ground to the supply rail; in other words, input and output are of standard form and it is found that such devices perform rather better than rail-to-rail amplifiers, with good cmrr, high gain and stability into capacitive loads. A typical amplifier of this type takes 35mA, has a 200kHz bandwidth and drives a load of 20kΩ and 500pF.

Sometimes, you just have to give in and bow to the inevitable; for the absolute maximum performance it might be necessary to use two supply rails. But, of course, this does not mean that you have to redesign the system power supply for one op-amp; there are ways of making a dual supply from one rail.

An attractive method of obtaining the complementary rail is, again, to use a charge pump. Figure 4 shows the Maxim 861 charge-pump voltage converter accepting a +1.5 to 5.5V input and providing an inverted output equal in magnitude to the input. The device can be made to operate at 13, 100 or 250kHz for more trade-offs: quiescent current, capacitor size and output voltage ripple.

Noise

This is an area where you simply cannot win. There seems not to be a way in which you can have low-voltage, single-supply rails, low noise and low power.

Using low-voltage rails demands lower-noise circuitry just to maintain a reasonable s:n ratio, but low voltage usually means a requirement for low power and lower currents mean more noise. There is no way round the unpalatable fact that, for low noise, an amplifier must dissipate higher power.

Noise sources are shown in Fig. 5, the cir-

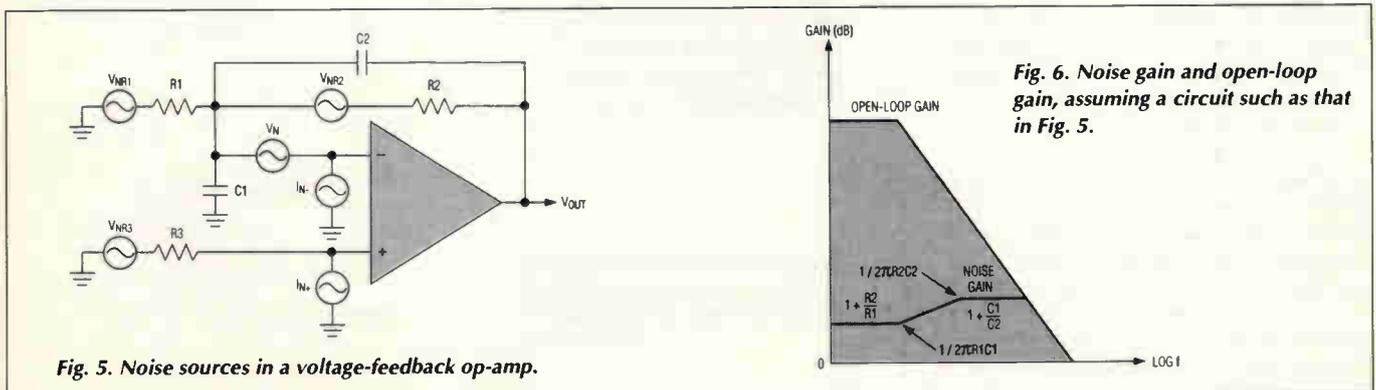


Fig. 5. Noise sources in a voltage-feedback op-amp.

Fig. 6. Noise gain and open-loop gain, assuming a circuit such as that in Fig. 5.

cuit being a voltage-feedback op-amp. Sources in evidence are input voltage and current noise and the thermal noise from R_1 and R_2 , the gain-setting resistors. Capacitor C_1 is the inverting input stray, C_2 limits noise gain and signal bandwidth and R_3 is the impedance-balancing resistor referred to earlier.

As you will see in Fig. 6, noise gain at lower frequencies is $1+R_2/R_1$, which applies up to the first zero at the frequency $1/2\pi R_1 C_1$, from which point it increases at 6dB/octave as far as the pole $1/2\pi R_2 C_2$. From here, the noise gain is equal to $1+C_1/C_2$ until the frequency hits the point at which the open-loop gain of the amplifier is equal to the noise gain, from where the two gains roll off together at 6dB/octave.

Noise due to input voltage, current noise at the non-inverting input and that from R_3 are integrated over the whole closed-loop bandwidth and multiplied by the noise gain. Circuit noise is smallest when an op-amp having a low unity-gain crossover frequency is used.

At the inverting input, current noise and thermal noise from R_1 and R_2 are only integrated over the signal bandwidth. Capacitor C_2 is not used in current-feedback amplifiers and

noise for this type is integrated over the whole closed-loop bandwidth.

Distortion

Since an amplifier's gain falls off at high frequencies, non-linearity of input/output transfer function becomes relatively more important and harmonic distortion increases. At a given frequency, therefore, you get less harmonic distortion if the amplifier is in its more linear region at maximum loop gain, which can be obtained by biasing output away from the supply rails in a circuit such as that in Fig. 7a).

This configuration provides the offset and also inversion or in 7b) which just provides the offset. That of Fig. 7a) keeps the common-mode input voltage constant and so eliminates common-mode non-linearity, useful in rail-to-rail op-amps where the non-linearity is caused by common-mode input changes as one or the other input pair comes into use. ■

References

1. Maxim Engineering Journal, Vol.26.
2. Charge pumps get new life, EW, August 1997.

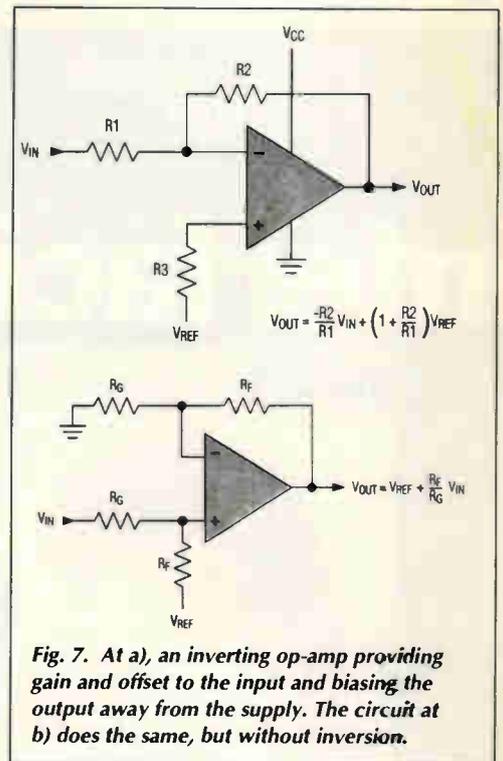


Fig. 7. At a), an inverting op-amp providing gain and offset to the input and biasing the output away from the supply. The circuit at b) does the same, but without inversion.

M&B RADIO (LEEDS)

THE NORTH'S LEADING USED TEST EQUIPMENT DEALER

OSCILLOSCOPES

HP 5411D 500 MHz digitizing scope (colour display)	£2350
HP 54201D 300 MHz 2 channel digitizing (27 channels logic state triggering)	£1750
HP 1740A 100 MHz 2 channel digital storage	£1750
TEKTRONIX 2230 100 MHz 2 channel digital storage	£1750
TEKTRONIX 2220 60 MHz 2 channel digital storage	£1500
TEKTRONIX 2416A 150 MHz 2 channel digital storage	£1900
TEKTRONIX 2445 150 MHz 4 channel GP-IB	£1250
TEKTRONIX 2445 150 MHz 4 channel OPT 05 (1 year TEK cal)	£1750
TEKTRONIX 2346 100 MHz 2 channel autocal	£350
TEKTRONIX 2246A 100 MHz 4 channel autocal	£1000
TEKTRONIX 7903/7A26 x2/7B80 200 MHz 4 channel	£350
TEKTRONIX 7403/7A18A x2/7B53A 4 channel	£600
TEKTRONIX 475A 250 MHz 2 channel	£400
TEKTRONIX 475 200 MHz 2 channel	£400
TEKTRONIX 434 25 MHz 2 channel	£400
TEKTRONIX 465 100 MHz 2 channel opt 05	£350
TEKTRONIX 465 100 MHz 2 channel	£350
TEKTRONIX 434 25 MHz 2 channel storage	£325
TEKTRONIX 2215 60 MHz 2 channel	£325
TEKTRONIX 2225 50 MHz 2 channel	£325
TEKTRONIX 2235 100 MHz 2 channel	£325
TEKTRONIX 1791 504 4 slot mainframe	£1750
PHILIPS PM 3217 50 MHz 2 channel	£425
PHILIPS PM 3055 50 MHz 2 channel	£425
PHILIPS PM 3057 50 MHz 2 channel	£425
PHILIPS PM 3264 50 MHz 4 channel	£300
PHILIPS PM 3263X 100 MHz delay/evens	£400
PHILIPS PM 3310 60 MHz digital storage	£400
IWATSU SS 6122 100 MHz 4 channel with cursors	£400
IWATSU SS 5710 60 MHz 4 channel	£400
NICOLET 4094/4837/43 digital scope	£400
HITACHI V1100 100 MHz 4 channel with cursors	£350
HITACHI V1134 10 MHz storage	£200
GOULD 4035 20 MHz digital storage + remote keypad	£400
GOULD 1401 20 MHz digital storage 2 channel	£400
GOULD OS300 20 MHz 2 channel	£195
GOULD OS4000 10 MHz digital storage 2 channel	£190

SPECTRUM ANALYSERS

TEKTRONIX 494P 10 KHz-21 GHz (1 year cal & warranty)	£9000
TEKTRONIX 492P 10 KHz-21 GHz OPT 001/002/003	£4000
TEKTRONIX 494P 10 KHz-180 MHz	£3000
TEKTRONIX 7L12 10 KHz-1800 MHz + mainframe	£1000
TEKTRONIX 7L5 + L3 OPT 25 tracking gen + mainframe	£1000
TEKTRONIX 491 10 MHz-40 GHz with mixers	£600
TAKEEDA RIKEN TR4172 400 Hz-1800 MHz spectrum/network analyser	£8000
ANRITSU MS610A 10 KHz-2 GHz spectrum analyser	£2750
HP CALAN 3010R sweeping/trace analyser	£1750
HP 8407A/8412B network analyser 0.1-110 MHz	£4000
HP 8903A Audio analyser	£1500
HP 8590A 10 MHz-1.5 GHz spectrum analyser	£4350
HP 8558B/182C 100 KHz-1500 MHz	£1500
HP 8558B/182T 100 KHz-21 GHz	£2500
HP 3582A 0.01 Hz-25.5 KHz dual channel signal analyser	£1800
HP 3562A 64 Hz-100 KHz dynamic signal analyser	£5000
HP 1401/8552B/8553B 10 MHz-110 MHz	£450
HP 1417/8552B/8554B 100 KHz-150 MHz	£1200
HP 1417/8552B/8555A 10 MHz-18 GHz	£1750
HP MARCONI TP2370 30 Hz-110 MHz digital storage (as new)	£1500

SIGNAL GENERATORS

GIGATRONICS 7100 10 MHz-40 GHz sweep generator 1 Hz resolution	£10000
HP 8904A DC-400 KHz multifunction synthesizer	£2500
HP 3314A 0.001 Hz-9.99 MHz function/waveform generator	£1400
HP 3384C 50 Hz-33.5 KHz selective level meter	£1500
HP 8648D 2.3 GHz-13 GHz OPT 001/003 solid state monitor (as new)	£2950
HP 8656A 100 KHz-990 MHz signal generator	£2500
HP 8620C/86220A 10-1300 MHz sweeper	£400
HP 8620C/86230B 1.8 GHz-4.2 GHz sweeper	£1000
HP 8620C/86241A 3.2-6.5 GHz sweeper	£1000
HP 8620C/86242D 5.9-9 GHz sweeper	£1200

HP 8620C sweeper mainframes (as new)	£250
HP 8640B 500 KHz-512 MHz signal generator	£600
HP 8654B 10 MHz-520 MHz RF generator	£300
HP 1208A 100 KHz-500 MHz oscillator	£300
HP 3330B 10 Hz-21 MHz synthesizer/level meter	£400
HP 3320A frequency synthesizer 0.1 Hz-13 MHz	£450
HP 3316A 0.1 Hz-1 MHz function generator	£400
HP 3310B 0.0005 Hz-5 MHz function generator	£200
HP 8005B 0.3 Hz-20 MHz pulse generator	£275
MARCONI TP2018 90 KHz-520 MHz signal generator	£1900
MARCONI TP2022 10 KHz-1000 MHz signal generator	£1800
MARCONI TP2017 10 KHz-1024 MHz signal generator	£2000
MARCONI TP2018 90 KHz-520 MHz RF generator	£2000
MARCONI TP2015 10 MHz-520 MHz	£450
MARCONI TP2008 10 KHz-10 MHz RF generator	£200
MARCONI TP2016 10 KHz-120 MHz (250) TF2016A	£450
MARCONI TP2015 10 MHz-520 MHz	£200
MARCONI TP2018 90 KHz-520 MHz RF generator	£2000
MARCONI TP2016 10 KHz-120 MHz (250) TF2016A	£450
FARNELL 55G1000 100 KHz-1000 MHz synthesized	£1500
FLUKE 6011A 10 Hz-11 MHz broadband signal generator	£1000
ROHDE & SCHWARTZ APN62 0.1 Hz-260 KHz LF gen. (new)	£2000
ROHDE & SCHWARTZ 0.1-2600 MHz sweep generator	£2000
GIGA 6011A 12 GHz analog signal generator	£600
PHILIPS PM5326 100 KHz-125 MHz RF generator	£400
ADNEY 2230A 200 Hz-1 MHz synthesized source	£195
WAVETEK 193 20 MHz sweep modulation generator	£400
WAVETEK 171 2 MHz synthesized function generator	£450
WAVETEK 182 0.002 Hz-2 MHz function generator	£175
SAYOSA MA 30 10 Hz-100 KHz	£175

TEST EQUIPMENT

BALL FRATRON MRT-H rubidium frequency standard	£4000
WAVETEK 1018A log in RF peak power meter DC-26 GHz	£1000
HP 1977E 12 GHz error detector	£250
TEKTRONIX 1141/SPG1/TSG11 pal video generator	£1500
TEKTRONIX 145 pal gen lock test signal generator	£1500
TEKTRONIX 521A vector scopes	£300
TEKTRONIX A492A isolator	£450
ROHDE & SCHWARTZ URE 10Hz-20 MHz RMS voltmeter	£400
SCHLUMBERGER 1702 digital transmission analyser (new)	£500
SCHLUMBERGER AF405 3 tone generator/modulator	£150
EIP 548A 10Hz-26.5 GHz microwave counter	£2250
EIP 331 12.5GHz autohet microwave counter	£250
MARCONI 2960B communications test set	£3250
MARCONI TP2305 mod meter 30 KHz-2.3 GHz	£2000
MARCONI TP2871 data communications monitor	£900
MARCONI TP2810 true RMS voltmeter	£695
MARCONI 4950/8910 10 MHz-20 GHz RF power meter	£800
MARCONI 6593A VSWR indicator	£250
MARCONI 6460/6421 10 MHz-12.4 GHz RF power meter	£420
MARCONI TP2306 programmable interface unit	£250
MARCONI TP2322A 10 Hz-560 MHz frequency counter	£500
HP 459A protocol analyser + HP 1B135A pad	£3000
HP 8508A vector voltmeter	£3250
HP 8570A noise figure meter	£3500
HP 3771A T-distortion test set	£1750
HP W332 serial controller	£1000
HP 1875A normalizer	£190
HP 5180A waveform recorder	£400
HP 3342A 500 MHz-18 GHz microwave frequency meter	£900
HP 3358A/481A 10 MHz-18 GHz RF power meter (new)	£450
HP 3358A/481A 100 KHz-4.2 GHz RF power meter	£400
HP 422A/478A 10 MHz-10 GHz RF power meter	£275
HP 436A RF power meters	£450
HP 8477A RF power meter calibrator	£225
HP 5087A distribution analyser (new)	£2750
HP 3581A 15 Hz-50 KHz selective voltmeters (as new)	£500

HP 333A distortion analyser	£295
HP 11710A down converter	£250
HP 59401A bus system analyser	£200
HP 400E 10 Hz-10 MHz AC voltmeter	£125
HP 3446A 4.5 digit autoranging multimeter	£200
HP 3437A 1.5 digit high speed system voltmeter	£200
HP 3455A 6.5 digit bench multimeter	£495
HP 3468A 5.5 digit multimeter/auto cal (LCD)	£400
HP 5904A signature analyser	£1150
HP 5005A signature multimeter	£200
HP 6291A DC power supply 0-40V/0-5 amp	£185
HP 6448A DC power supply 0-60V/0-1.5 amp	£750
HP 6263A DC power supply 0-30V/0-10 amp	£250
HP 11645B 150 MHz-18 GHz modulator	£250
HP 11582A attenuator set DC-18 GHz	£500
HP 355C RF step attenuators 0-12 dB DC-1 GHz (NEW)	£195
HP 255D RF step attenuators 0-120 dB DC-1 GHz (NEW)	£195
BIRD 8323 30 db coaxial attenuator 100W	£200
BIRD 8922 500W/50 ohm coaxial resistor	£1000
BRADLEY 192 oscilloscope calibrator	£500
KEHO OP1 1 Hz-100 KHz phase meter (new)	£100
SIEMENS D2108 200 KHz-30 MHz level meter	£350
SIEMENS W2108 200 KHz-30 MHz level oscillator	£350
NARDA 3044B 20-3.7 GHz-8.3 GHz 20db directional coupler	£150
SAYOSA APHM 1.5 MHz-2 GHz automatic modulation meters	£175
REDIFON RA500 100 Hz-30 MHz receivers	£400
RACAL RA17L 30 MHz valve receivers	£150
RACAL RA121B 30 MHz receivers	£350
RACAL RA1772 30 MHz receivers	£750
RACAL 9908 1.5 MHz-2000 MHz automatic modulation meter	£300
SYSTRON DONNER 4521010 Hz-20 GHz microwave counter	£750
RACAL DANA 9904 50 MHz universal counter timer	£95
RACAL DANA 9914 10 Hz-200 MHz frequency counter	£95
RACAL DANA 9915 10 Hz-320 MHz frequency counter	£95
RACAL DANA 9916 10 Hz-320 MHz frequency counter	£95
RACAL DANA 9919 10 Hz-1100 MHz frequency counter	£295
RACAL DANA 9908 10 Hz-1100 MHz universal counter timer	£400
RACAL DANA 9911 10 Hz-160 MHz universal counter timer 9 digit	£395
RACAL DANA 992 10 Hz-1300 MHz nanosecond counter	£200
RACAL DANA 9300 RMS voltmeter	£350
RACAL DANA 9301A true RMS RF millivoltmeter	£400
RACAL DANA 4000 microprocessing digital voltmeter	£230
BRUEL & KJAER 2011 phase meter	£400
DATRON 1063 autocal digital multimeter	£600
FLUKE 8505A digital multimeter	£750
FLUKE 8506A thermal RMS multimeter	£1000
FLUKE 3330B prog constant current/voltage calibrator	£450
FLUKE 5200A AC calibrator	£2000
FLUKE 5205A precision power amp	£2750
FLUKE 5440B direct volts calibrator	£4950
RF MICROSYSTEMS INC. AN/TRC-176 VHF/UHF/K&L fixers	£600

Visit our Web site
<http://www.mb-radio.co.uk>
 e-mail info@mb-radio.co.uk

ALL PRICES PLUS VAT AND CARRIAGE • ALL EQUIPMENT SUPPLIED WITH 30 DAYS WARRANTY

86 Bishopgate Street, Leeds LS1 4BB
 Tel: (0113) 2435649 Fax: (0113) 2426881

CIRCLE NO. 124 ON REPLY CARD

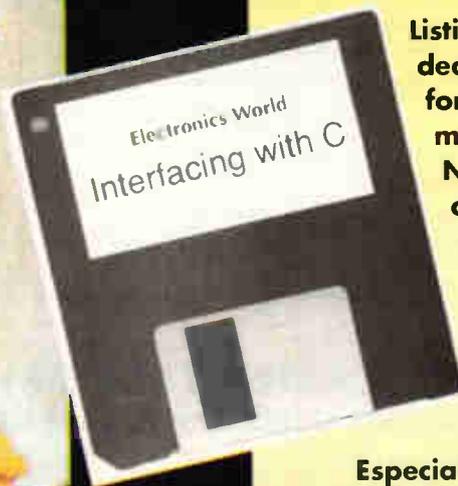
Interfacing with C

**ELECTRONICS
WORLD**
- WIRELESS WORLD

Interfacing



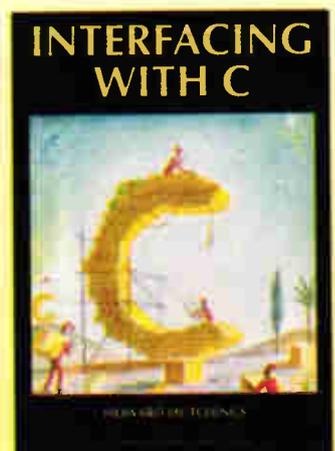
Howard Hutchings



Without an engineering degree, a pile of money, or an infinite amount of time, the revised 289-page **Interfacing With C** is worth serious consideration by anyone interested in controlling equipment via the PC. Featuring extra chapters on Z transforms, audio processing and standard programming structures, the new **Interfacing with C** will be especially useful to students and engineers interested in ports, transducer interfacing, analogue-to-digital conversion, convolution, digital filters, Fourier transforms and Kalman filtering. Full of tried and tested interfacing routines.
Price £14.99.

Listings on disk – over 50k of C source code dedicated to interfacing. This 3.5in PC format disk includes all the listings mentioned in the book **Interfacing with C**. Note that this is an upgraded disk containing the original **Interfacing With C** routines rewritten for Turbo C++ Ver. 3. Price £15, or £7.50 when purchased with the above book.

Especially useful for students, the original **Interfacing with C**, written for Microsoft C Version 5.1, is still available at the special price of £7.50. Phone 0181 652 3614 for bulk purchase price.



Use this coupon to order

Please send me:

Title	Price	Qty	Total
Enhanced Interfacing with C book @	£14.99	£.....
Enh. Interfacing with C book + disk @	£22.49	£.....
Interfacing with C disk @	£15	£.....
Original Interfacing with C book @	£7.50	£.....
Postage + packing per order UK	£3.50	£.....
Postage + packing per order Eur	£7	£.....
Postage + packing per order ROW	£12	£.....
Total			£.....

Name

Address

Phone number/fax

Make cheques payable to Reed Business Publishing Group Ltd
Or, please debit my Master, Visa or Access card.

Card type (Access/Visa)

Card No

Expiry date

Mail this coupon to Electronics World Editorial, Quadrant House, The Quadrant, Sutton, Surrey, SM2 5AS, together with payment. Alternatively fax full credit card details with order on 0181 652 8956 or e-mail them to jackie.lowe@rbp.co.uk. Orders will be dispatched as quickly as possible, but please allow 28 days for delivery.

Dictionary of Communications Technology

With over 9000 entries and 250 illustrations, this book is an invaluable reference work for anyone involved with electronics and communications. Dictionary of Communications Technology provides comprehensive coverage of data and communications and has entries on PC lars, the Internet, communications testing and client-server applications – in 500 pages.

Over 20 major companies helped prepare the Dictionary of Communications Technology, including AT&T, IBM and Digital Equipment Corporation.

Gilbert Held, author of Dictionary of Communications Technology, is an internationally respected author who has used his enormous expertise to make this work one of the most comprehensive sources of telecommunications information.

Please mail this coupon to *Electronics World*, together with payment. Alternatively fax credit card details with order on 0181 652 8111. You can also telephone your order on 0181 652 3614, but only Mondays, Tuesdays or on Friday mornings. Address orders and all correspondence relating to this order to, Electronics World, Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS.

Internet Activities Board (IAB)

that enable them to function as a single, large virtual network. 2. When written in uppercase, Internet refers to the set of interconnected networks that share the same network address scheme and use the TCP/IP protocol.

Internet Activities Board (IAB) The group which sets the technical direction and decides which protocols are a required parts of the TCP/IP suite.

Internet address A 32-bit address which identifies the network to which each computer on a TCP/IP network is attached as well as the computer's unique identification. The three major types of addresses are illustrated below and defined as follows:

A Class A address is for networks that have more than 2^{16} (65 536) hosts.

A Class B address is used for networks that have 2^8 (256) to 2^{16} hosts.

A Class C address is for networks that have fewer than 2^8 hosts.

Internet (IP) addresses

0 1 2 3 4 5 6 7 8 9 10 11

Class A 8 bits network ID, 24 bits host ID

Class B 16 bits network ID, 16 bits host ID

Class C 24 bits network ID, 8 bits host ID

An address with itself, A broadcast set to one, IP address integers separate integers in the value.

Internet Architecture Board

Internet Architect With addressing developing software.

Internet Control portion of the link and control messages and hosts on an

about datagrams back to the originator, ICMP

a series of nine types of messages carried by Internet Protocol (IP) which defines an immediate destination, echo, echo reply, parameter probe, redirect, source quench, time exceeded, time stamp and time stamp reply. Each message has five fields as indicated below:

Field	Size (bytes)
Type	1
Code	1
Checksum	2
Parameters	4
Information	N

Internet datagram The basic unit on Internet.

Internet Engineering Task group in the Internet Architecture Board concentrates on short-term engineering problems.

Internet Network Information A joint NSFNET and NREN

DBa (dBm adjusted)

DBa (dBm adjusted) A unit of noise measurement for a circuit having FIA-line or HA-1-receiver weighting. 0 dBa is noise power of 3.16 picowatts (-85 dBm), equivalent to 0 dBm (-90 dBm or 1 picowatt with C-message weighting) adjusted to FIA weighting.

DBa (FIA) The noise level measured on a line by a noise measuring set having FIA-line weighting.

DBa (HA-1) The noise level measured across the receiver of a 302-type or similar telephone handset measured by a test set having HA-1-receiver weighting.

DRAAU Dial Backup Auto Answer Unit.

DBAO The power level of noise expected at a particular location in a circuit, called "dBm adjusted reference level."

dBm (dBm adjusted)

is the expected measured receive level on our circuit? If we used the formula:

$-3 + (-13 \text{ dBm}) = -16 \text{ dBm}$

DBMS Data Base Management System.

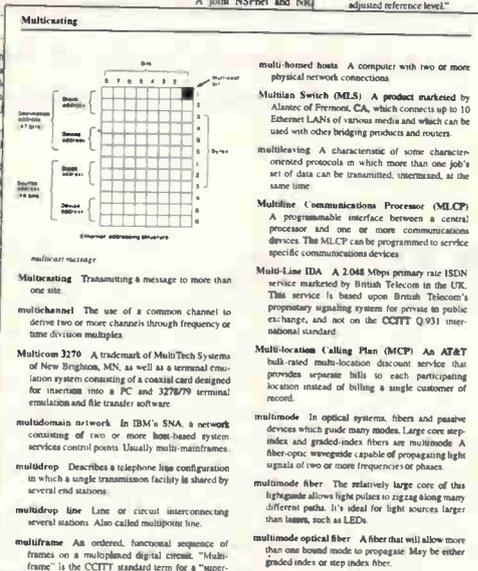
dBmV Decibel millivolt. This measurement of signal in dB relative to 1 mV across 75 ohms is used in cable systems.

dBm The abbreviation for decibel reference noise. In their desire to make things easier for the technician, the early telco engineers created a separate scale for noise that generated larger positive numbers for larger numbers of noise. The zero difference used in describing noise is -90 dBm or 0 dBm. The relationship between these two scales is shown in the following table. It is important to remember that dBm is a measurement of noise. It is also important to remember the relationship, for example 60 dBm is equal to -30 dBm.

dBm	dBm	dBm	dBm
90	0	40	-5
80	-1	30	-6
70	-2	20	-7
60	-3	10	-8
50	-4	0	-9

dBmC The abbreviation for decibel reference noise C-message weighted. Noise contains numerous irregular waveforms which have a wide range of frequencies and powers. Although any noise superimposed upon a conversation has a degrading effect, experiments have shown that this effect is greatest in the mid-range of the voice frequency band. To obtain a useful measurement of the interfering effect of noise, the various frequencies contributing to the overall noise are weighted in accordance to their relative interference effect. This weighting is accomplished through a weighting network or filter. The filter which closely emulates these characteristics is called a C-message weighted filter.

dBmC The abbreviation for decibel reference noise C-message weighted zero transmission level.



Use this coupon to order your copy of Dictionary of Communications Technology

Please send me copies of Dictionary of Communications Technology
 Each copy of the book costs £32.50. plus £4 UK p+p, £8 Europe, £12 ROW per book.

Total amount £.....

Name _____

Company (if any) _____

Address _____

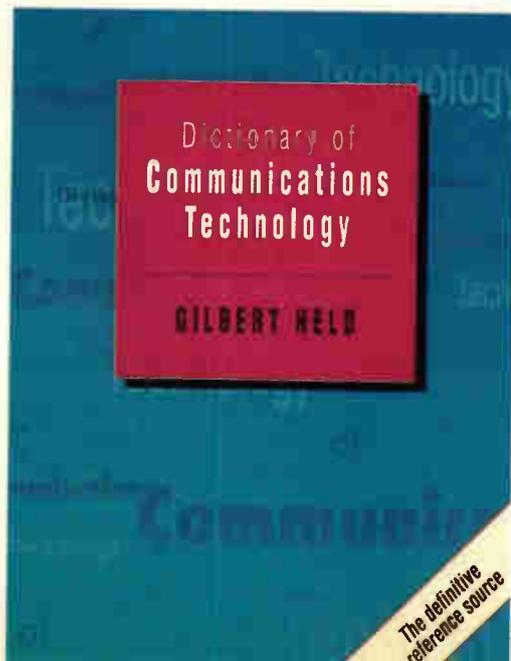
Phone number/fax _____

Make cheques payable to Reed Business Information Group.
 Or, please debit my Master, Visa or Access card.

Card type (Access/Visa) _____

Card No _____

Expiry date _____



Disk camera update

Leslie Warwick looks at how optical disks are beginning to replace magnetic tape in broadcast and domestic video cameras.

NEC has developed the world's first digital optical disk camera capable of broadcast quality recording. A production version is expected to be launched in Japan this autumn. This is the third disk camera to be announced in the past couple of years.

The NEC *Disk Cam* uses a phase-change 12cm disk developed by the company, employing a 680nm laser for reading and writing. Its capacity is 4.12GB per side, which is equivalent to 20 minutes of audio and video – the latter compressed using intra-frame fixed length coding.

Video is recorded in 4:2:2 component form with a sampling frequency of 13.5MHz for luminance and 6.75MHz for the colour difference signals, at eight bits per sample. The

camera uses NEC's 'code-amount' technology to keep the amount of code constant in each frame. This is controlled by the quantising scale code parameter: data activities from small, medium and large macroblocks are adaptively selected and the best QSC value for each block is then calculated.

The general recording rate is 34.3Mb/s with a video transfer rate of 25.8Mb/s. The camera has two channels of PCM audio, with a sampling frequency of 48kHz, 16-bit quantisation. Post-recording is possible. Video capacity of the PAL version will be 3.8GB per side, with 0.2GB for audio and 0.046GB for system data.

And for home use...

The same company is also planning to bring the technology to the consumer market by miniaturising the camera and incorporating an MPEG-2 encoder chip. It is expected that its disk will record two hours of video.

Hitachi will be launching a disk camera using a PCMCIA hard disk in the UK in September at £1800. In addition to full motion video it will also record still images. This will be sold as a consumer product, although it obviously has business uses.

Hitachi has developed a single chip integrating the 300 000 components necessary to handle all camera functions, including real-time MPEG-1 and high speed JPEG encoding/decoding and playback. This lsi CODEC chip uses a three-layer 0.5µm cmos process, and has a power consumption of 500mW.

Image resolution is said to be greater than 352x240 dots. The 260MB disk can store up to 2880 JPEG images – or 1000 with ten seconds of MPEG audio each – 20 minutes of MPEG-1 video and audio, or four hours of audio alone.

Built-in 'Media Navigation File' management enables video clips to be arranged into folders or deleted, with files itemised on a 1.8in liquid-crystal colour viewfinder screen and selected for playback. A video output provides connection to a television or video recorder.

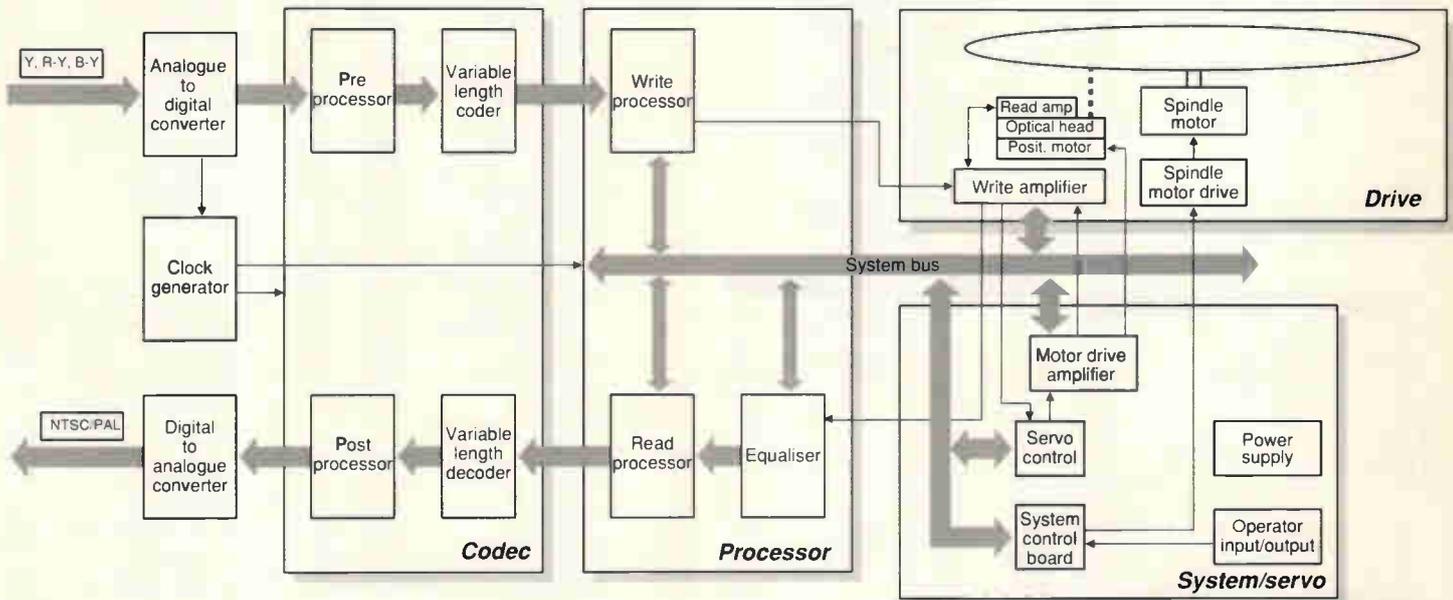
For pcs, there is an ISA interface kit to connect to an ISA bus, and an ECP kit for connection to a parallel port. Alternatively, the disk can be inserted into a computer's PCMCIA slot.

Ikegami's EditCam is broadcast quality and has integral 2 or 4Gbyte hard disk together with comprehensive non-linear editing facilities.



Disk Cam – a broadcast quality camera incorporating optical disk technology for picture and sound recording.





NEC Disk Cam. Component video from the camera section is digitised and passes via the codec and processing modules to the drive section for recording onto the phase-change technology disk. For reading, the process is reversed, culminating in a PAL or NTSC output signal.

NTSC National Television System Committee
PAL Phase Alternation by Line colour television system

Broadcast quality alternatives

Avid and Ikegami were the first to develop a professional disk camera, using their *CamCutter* recording and editing module designed to attach to the rear of a dockable camera and accept a pack containing two hard disks. Ikegami makes the camera equipment while Avid is responsible for the editing technology. That was in 1995; but just before its launch the following year they decided to redesign the system, and a new launch is imminent.

Last year though Ikegami launched the *EditCam* camcorder in which the *CamCutter* is an integral part. Two versions of the sealed and shockproof disk pack are now available, 2.2GB or 4GB, the larger allowing up to 40 minutes of recording.

Video is recorded in 8-bit 4:2:2 component form, compressed at 7:1. Four 48kHz 16-bit audio channels are available – although fewer can be used to increase recording time.

Both *EditCam* and *CamCutter* provide complete non-linear editing facilities, video switching and audio mixing using buttons and an liquid crystal data panel. Files are stored using the Open Media Framework, or OMF, interchange format.

This potential for randomly accessing any part of the disk, allowing recorded clips to be viewed, modified and rapidly edited into sequences – either on-site or in a studio – is the major advantage of the professional disk cameras. The consumer and business models on the other hand fit in nicely with the growing trend for multimedia.

The disadvantages are that disks are more expensive than tapes and their capacity is relatively limited. However, other companies are quietly developing disk cameras, so it's a trend that is obviously going to continue. ■



Incorporating a single chip carrying the 300 000 components necessary to handle all camera functions – including real-time MPEG-1 coding/decoding – Hitachi's disk camera has a 260MB disk expected to give 20 minutes of MPEG-1 video and audio recording.

NEW STOCK

PROFESSIONAL 19" INSTRUMENT CABINETS:

Manufactured by: **KNURR**

BRAND NEW & PACKED

H = 6U

D = 480mm £65.00

H = 3U

D = 480mm £55.00

H = 6U

D = 280mm £60.00

H = 3U

D = 280mm £45.00

Adventest TR4132	Spectrum Analyser 1-1GHz	£1,800.00
Aeritalia Type TE307	Electric & Magnetic Field Sensor	£150.00
Bird	Qo-axial Attenuator 30dB 50 2KW	£300.00
General Radio 1265A	DC Power Supply 0-400V 0-5A	£475.00
General Radio 1308A	Audio Oscillator + Power Amplifier	£1,500.00
General Radio 1633A	Incremental Inductance Bridge	£375.00
HF Multicooper HP2225A	1 input 8/16 outputs 1-40MHz	£300.00
HP2225A	Thermaprinter HP1B	£95.00
HP2488A	Thermaprinter RS323C	£95.00
HP5342A	Switch Control Unit	£800.00
HP5342A	18GHz Microwave Frequency Counter	£1,200.00
HP5808A	Vector Voltmeter	£2,500.00
Marconi TF2015/2171	10MHz-520MHz with Synchronizer	£275.00
Megeer PAI 2	Portable Appliance Tester inc. CAL	£420.00
Philips PM3305	Digital Storage Oscilloscope 35MHz	£375.00
Philips PM3352A	Digital Storage Oscilloscope 50MHz	£1,200.00
R&S 7PW + E3 PI	Vector Analyser 0.3-2GHz	£2,000.00
Racal 5081	S-520MHz Synthesised Signal Generator	£375.00
Racal Dana 9478	Frequency Distribution Unit	£200.00
Racal Dana 9702	Spectrum Analyser 1-1GHz	£1,300.00
Racal RA1784		
+ MA1072	Remote Controlled HF Receiver	£500.00

MICROWAVE

Continental Mic Digital Microwave	Transmitter Control VLM TR-240-1/1	£750.00
HP H 752A	12GHz TX/RX (new)	£1,200.00
HP H 752A	Directional Coupler 3dB	£150.00
HP H 1691D	Variable Attenuator 0-50dB 8-12.4GHz	£170.00
HP11692D	Dual Directional Coupler	£900.00
HP11720A	Power Modulator 2-18GHz	£700.00
HP11722A	Sensor Module	£600.00
HP33304A	Programmable Attenuator 18GHz 0-11dB	£175.00
HP33305A	Programmable Attenuator 18GHz 0-110dB	£175.00
HP33320A	Attenuator 11dB	£250.00
HP33320B	Attenuator 21dB	£250.00
HP33322A	Attenuator 110dB	£250.00
HP3335D	VHF Attenuator 120dB DC-1GHz	£300.00
HP532B	Frequency Meter	£200.00
HP536A	Frequency Meter 3.7-12.4GHz	£200.00
HP5411A	2GHz-5GHz Test Set	£250.00
HP8405A	Vector Volt Meter	£250.00
HP8410B		£200.00
HP8414A		£175.00

GOOD SELECTION OF 18-20 GHz COAXIAL SWITCHES IN STOCK: £65.00 EACH

HP8502A	Transmission/Reflection Test Set	£750.00
HP8743B	500kHz-1.3GHz	£600.00
HP8745A	Reflection-Transmission Test Unit 2-12.4GHz	£600.00
Marconi 6019/2	S-Parameter Test Set 0.1-2GHz	£200.00
Marconi 6030/10	Calibrated Variable Attenuator 12.4-18GHz	£200.00
Marconi 6052/3	Directional Coupler X Band	£200.00
Marconi 6052/3	Rotary Vane Attenuator 8-12-12.4GHz	£120.00
HP860-6910	Power Meter 10MHz-20GHz	£900.00
Maury Microwave NEC	Sliding Transmission 80dB up to 20GHz	£600.00
Racal 9303	Passive 50 50GHz TX/RX	£500.00
Tek TR502	True RMS Level Meter	£700.00
Wavetek	Tracking Generator	£800.00
Wavetek	X Band WG16 10ft Lengths	£30.00
Wavetek	Adapter APC-7 SMA (new)	£25.00
Watron	87450 VSWR Bridge 2-18GHz	£600.00
Watron	64NF50 VSWR Bridge 3-8GHz	£400.00

OSCILLOSCOPES

Gould 4030	Digital Storage 20MHz 20MS/S	£350.00
Gould OS300	20MHz	£120.00
Hitaich	VC6015 D.S.O.	£300.00
Hitaich	V222 20MHz	£225.00
HP54111D	500MHz Digital	£1,950.00
HP54200A	50MHz Digital	£750.00
HP54501A	100MHz Digital	£1,400.00
Iso-Tech	ISPB40 40MHz	£300.00
Iso-Tech	ISPB40 40MHz	£225.00
Iwatsu DMS6430	Digital Memory	£475.00
Iwatsu SAS8130	Waveform Analyser DC-3.5GHz	£1,500.00
Leader	LB-50 20MHz	£200.00
Philips	PK3217 50MHz	£250.00
Philips	PK3340 20Hz Digital	£3,000.00
Philips	PK335A 60MHz D.S.O. 100MS/s	£1,200.00
Philips	PK3262 DC-100MHz	£250.00
Tek 2215	60MHz	£350.00
Tek 2225	50MHz	£375.00
Tek 2235	100MHz	£600.00
Tek 2236	100MHz	£750.00
Tek 2245A	100MHz	£950.00
Tek 2336	100MHz	£750.00
Tek 465	100MHz	£350.00
Tek 466	100MHz	£300.00
Tek 475	200MHz	£425.00
Tek SC502	15MHz	£300.00
Tek TDS420	150MHz 4 Channel 100MS/S	£2,950.00
Teleup	D61A 10MHz	£75.00

SIGNAL GENERATORS

Adret 7100B	300kHz-650MHz	£700.00
Adret 740A	0.1-560MHz	£750.00
Cushman CE12	Two Tone Generator	£150.00
Farnell DS62	Synthesised 0.1MHz-110kHz	£185.00
Farnell PS61000	10kHz-1GHz	£1,200.00
Flann 4311A	12-18GHz	£350.00
Fuke 6010A	10kHz-11MHz Synthesised	£175.00
HP11710B	Down Converter (HP8640A)	£275.00
HP214B	Pulse Generator 100V 2A	£1,200.00
HP3235A	Synthesizer Generator 1Hz-21MHz	£1,500.00
HP4204A	Oscillator 10Hz-1MHz	£125.00
HP654A	Test Oscillator 10MHz	£225.00
HP8005B	0.3Hz-10MHz	£300.00
HP8008A	10Hz-200MHz	£450.00
HP8015A	1Hz-50MHz Pulse	£450.00
HP8165A	Programmable Signal Source	£1,200.00
HP8620C		
+HP8622B	0.01-2.4 GHz Sweeper	£1,500.00
HP8642M	0.1-2100MHz	£12,500.00
HP8647A	250kHz-1000MHz	£2,300.00
HP8684B	5-4-12.5GHz	£1,950.00
Marconi 2019A	80kHz-100MHz	£1,450.00
Marconi 2022	100kHz-1GHz	£1,250.00
Marconi 6057	Signal Source 5-5-8.5GHz	£200.00
Marconi 6059A	12-18GHz Signal Source	£200.00
Racal 9053	Two Tone	£120.00
Racal 9084-9934A	0.01-104MHz	£900.00

Racal 9087	100kHz-1.3GHz	£2,300.00
Syston Donner 1702	Audio-1GHz	£600.00
Tek 504	0.001-240MHz	£300.00
Tek FG501A	2MHz Function	£250.00
Wavetek 1080	1-100MHz Sweep	£300.00
Wavetek 157	Programmable Waveform	£150.00
Wavetek 159	Waveform Generator 1Hz 3MHz	£380.00
Wavetek 171	Synthesizer/Function	£400.00
Wavetek 185	Sweeper/Function 0-5MHz	£350.00
Wavetek 2001	1-140MHz	£600.00
Wavetek 907A	7-12 GHz	£900.00
Wiltron	Sweeper 4 12 4Hz	£500.00

PLOTTERS/RECORDERS

HP Colour Pro	Draft Master RX	£500.00
HP Draft Pro DXL	7575A	£450.00
HP7475A	Plotter RS232	£150.00
HP7550A	Plotter	£250.00
Racal Recorders	4DS & 7DS	from £200.00
Roland	X-Y Plotter DXY-1300	£120.00

AERIAL FACILITIES EQUIPMENT:

Receiver Splitter Amplifier	Type RSA-460-4M	Price: £250.00
Bandpass Duplexer	Type BPD-453-460-6N	Price: £300.00
Transmitter Cavity Resonator	Type SC-450-2N	Price: £190.00
Transmitter Cavity Resonator	Type SG-450-2N c/w DT-453-2NV	Price: £190.00

DATA/TELECOMS

Anritsu BT (Fluke) MS334A	PCM Error Detector	£120.00
Bifurum T1020	Network Transmission Performance Analyser	£500.00
Cushman CE24 FX	Selective Level Meter	£400.00
Datlab DL1000	Programmable Transient Recorder	£250.00
GN Elm EPR31	PCM Signalling Recorder	£5,000.00
HP1350A	Graphics Translator	£200.00
HP1631D	Logic Analyser	£650.00
HP3336A	Synthesizer/Level Generator	£1,300.00
HP3497A	Data Acquisition/Control Unit	£400.00
HP3586B	Selective Meter	From £850.00
HP3717A	70MHz Modulator/Demodulator	£90A
HP37201A	HP IB Extender	£380.00
HP3720A	HP IB Extender	£300.00
HP3762A	Data Generator	£350.00
HP3763A	Error Detector	£800.00
HP3764A	Digital Transmission Analyser	£3,200.00
HP3770B	Telephone Line Analyser	£200.00
HP3780A	Pattern Generator/Error Detector	£1,100.00
HP3781A	Pattern Generator	£500.00
HP3782A	Error Detector	£500.00
HP4935A	Transmission Tester	£1,100.00
HP4984A	In-Service Transmission Impairment Measuring Set	£90A
HP5005B	Signature Tester	£950.00
HP5006A	Signature Analyser	£50.00
HP6942A	Multi-programmer	£200.00
HP8170A	Logic Pattern Generator	£600.00
HP8954A	Transceiver Interface	£600.00
Iwatsu DM2350	Digital Memory 10 Bit/20MHz	£400.00
Marconi 2828A	Digital Analyser	£200.00
Marconi 2829	Digital Analyser	£200.00
Marconi 2831	Channel Access Switch	£200.00
Marconi OA2805	PCM Regenerator Test Set	£250.00
Marconi TF2019C	Noise Generator Many Filters Available	£250.00
Marconi TF2032C	Noise Receiver	£250.00
Marconi TF2808/2	Pattern Generator and SLMS (Brand New/Revised)	£120.00
Marconi TF2807A	P.C.M. Multiplex Tester	£200.00
Marconi TR2830	Multiplex Tester	£200.00
Millgrove	NI612A VTR In-line Mixer	£75.00
Phoenix	5500A Telecommunications Analyser	£1,500.00
Racal 202.205	State Logic Analyser	£150.00
Schlumberger	7700 140 m Bits Pilemeter/Generator	£125.00
Schlumberger	7710 Mainframe Set 347/40 M Bits	£125.00
Schlumberger	D7155 Level Meter/31515 Tracing Oscillator	£150.00
Siemens P2032	Bit Error Measuring Set	£900.00
Tek 834	Programmable Data Comms Tester	£150.00
Thurby	LA4800 Logic Analyser	£500.00
W&G	SPW15 Level Meter	£800.00
W&G	SP12 Level Generator	£300.00
W&G	SPW12 Level Meter	£90A
W&G	PCW2-3 PCM Test Set	£300.00
W&G	SBG-1 SSB Level Generator	£150.00
W&G	DLM3 Data Line Test Set	£900.00
W&G	SPW19 Level Meter	£2,500.00
W&G	MU3 Test Point Selector	£90A
W&G	PJM-1 PCM Jitter Meter	£250.00

SIGNAL ANALYZERS

AD 352	FFT Analyser	£380.00
B&K 2033	Signal Analyser	£2,000.00
HP1621+HP8557A	Spectrum Analyser 01-350MHz	£800.00
HP1621+HP8558B	Spectrum Analyser 100kHz-1.5GHz	£1,350.00
HP334A	Distortion Analyser	£250.00
HP339A	Distortion Measuring Set	£1,200.00
HP3581C	Selective Volt Meter	£600.00
HP3582A	0.02Hz-25 999kHz Spectrum Analyser	£1,500.00
HP8983B	Audio Analyser	£3,200.00
Marconi 2305	Modulation Meter	£2,000.00
Marconi 2380	400MHz Spectrum Analyser	£3,500.00
Marconi 2601	True RMS Voltmeter	£300.00
Marconi 2955	Test Set+2860 TACS Unit	£2,400.00
Marconi TF2370	110MHz Spectrum Analyser	£600.00
R&S	SMU20 Z1	£400.00
R&S	Ure RMS Voltmeter	£800.00
R&S CM552	Comms Sampling Monitor	£6,500.00
Racal 9302	RF Network Analyser	£350.00
Spectral Dy SD37	FFT Analyser	£1,800.00
Tek 7L12	100kHz-1.8GHz	£800.00
Tek DA4084	Programmable Distortion Analyser	£700.00

SPECIAL OFFERS

FARNELL POWER SUPPLY
TYPE: 60V25-0-60V 0-25A
METERED - BRAND NEW
£400.00

MARCONI TF2015 + TF2171
10-520MHz AM/FM SIGNAL GENERATOR
UP TO 200mV e.m.f. OUTPUTS
£250.00

Adret	5104 Driving Synthesizer 90 120MHz	£125.00
Bornin	824D Modulation Meter	£200.00
Farnell	E350 Stabilized Voltage Supply	£120.00
Farnell	RB1030/35 Electronic Load 1KW 30A 35V	£300.00
Farnell	TSV70 Mk2 Stabilised Power Supply	£180.00
Farnell	RTS2 Recorder Test Set	£200.00
Fuke	8520A Digital Multi Meter	£250.00
Fuke	8850A Digital Multi Meter	£150.00
Giga	GR1011A 12-18 GHz Microwave Signal Generator	£150.00
Giga	GU1298A 2-8GHz Microwave Signal Generator	£150.00
Hamia	RF/2305 Receiver/Expander	£200.00
HP	11713A Attenuator Switch Driver	£980.00
HP	1741A 100MHz Oscilloscope	£300.00
HP	1742A 100MHz Oscilloscope	£275.00
HP	181A Milan Frame c/w 1840A+1825A	£125.00
HP	3480A RMS Volt Meter	£170.00
HP	3570A Network Analyser 50Hz-13MHz	£150.00
HP	4333A Distribution Analyser	£300.00
HP	435A Power Meter	£175.00
HP	435B Power Meter	£250.00
HP	498A Microwave Amplifier 1-2GHz	£125.00
HP	5315A Universal Counter 100MHz	£200.00
HP	5328A Universal Counter 100MHz	£120.00
HP	5363A Time Interval Probes	£150.00
HP	8412B Phase Modulator Display	£175.00
HP	8443B Tracking Generator/Counter	£250.00
HP	8445B Automatic Prescaler	£300.00
HP	8552B IF Section	£250.00
HP		

56k modems EXPOSED

How realistic are the claims of the 56kbit/s modem makers? Are we being built up to a download heaven only to find data crawling out of the Net? Steve Bush investigates.

You sit there, crying in frustration, as the image you are downloading dribbles on to the screen at 1.4kbit/s.

The answer has to be a new modem, one of those nice new 56kbit/s gadgets. That should speed things up – or will it? 56k modems seem to be the way to get ISDN-like 64kbit/s performance without paying for a special connection to the network, but the situation is not as simple as some would claim.

First, there is the question of which 56k standard to plump for. Two were initially proposed and implemented. At the beginning of 1997, K56flex and X2 were slugging it out like Betamax and VHS – although not necessarily in that order. This was preventing potential users from buying 56k modems for fear that they would tie-up with the loosing protocol. The situation even caused a mini-boom in the sales of older V.34 28.8kbit/s modems.

Luckily for everyone, the International Telecommunications Union has stepped in, got hold of both proto-standards, and proposed a compromise called V.90. Being neither K56flex or X2, but related to both, modem makers have all had to do some work, but not a prohibitive amount.

The result is saleable production 56k modems which either conform to either K56flex or X2 initially, but will be upgradeable to V.90 on-line. The upgrades should happen soon, now that the ITU has ratified V.90. The individual modem makers just need to finalise their V.90 implementation code. Straight V.90 modems are expected to appear on the shelves this March.

Does line quality matter?

Line quality is the other big factor determining how much data can be transmitted between terminals. "Modems can achieve 56kbit/s as long as there is only one digital-to-analogue converter in the communication chain," said Annick Evenepoel of pc card modem maker Xircom.

In reality, this means that only data from a fully digital Internet service provider or the like has a chance of achieving the full rate. This must then stay in digital format until the subscriber's local street box, where the one d-to-a conversion is allowed before the final analogue line to the user.

Data in the reverse direction has to use the local analogue line and be a-to-d converted, precluding 56kbit/s traffic. The back channel is therefore limited to more



56k on the cards... Xircom's CEM56. It combines a 56kbit/s modem with Ethernet at 10 or 100Mbit/s and a 9.6kbit/s link to plug into a mobile phone. 56kbit/s modems achieve full data rate as long as there is only one d-to-a converter in the communication chain. This is the case when a user downloads data from an all digital Internet service provider through an all digital network where the only d-to-a converter is in the street box near the user. In the backwards direction, and when there is more than one converter, data rate is at most 33.6kbit/s, but: "Something to remember about 56k modems is that they make better 33.6k modems," claims a Xircom spokeswoman.

conventional V.34 coding and 33.6kbit/s.

In practice this is not too much of a problem as short requests for data are usually all that is travelling back.

The chance of getting 56kbit/s through the forward channel – assuming that it is all digital – is further diluted by other factors. Devices with characteristics similar to analogue to digital converters – including different types of echo cancelling equipment as well as line boosters or repeaters – are sited by Xircom as reducing the possible data rate.

Satellite links are another problem; they are echo-cancelled to an extreme level and cannot be used at 56k.

With all this against them, international modem transfers using 56kbit/s modems are still claimed to be possible

providing they don't break the 'only on d-to-a converter' rule. Some countries have political reasons for preventing digital trunks crossing their borders, so there is no chance of full speed transmission to them.

Taking all these factors together, and adding in the

congestion that occurs on networks, it should be possible to get some figures on real and expected data transfer rates.

However, network operators seem singularly unwilling to discuss the performance that modems can achieve across their networks for fear of unfavourable comparisons with other companies.

While stressing that it believes its performance matches that of other telecommunication companies for data transfer over the public network, BT in a statement said, "A recent test of modem performance showed that at least nine out of ten calls on BT's network can be handled at speeds of 24kbit/s or greater. These tests are ongoing.

"Historically, performance guarantees on modem calls have not been made because of the complexity and variety of modems themselves and the network equipment which modem calls will pass through."

Signals & Software is a UK-based software modem company that is currently developing a 56kbit/s modems for infrastructure and subscriber use. MD Dave Morley, said: "Despite what the marketing departments claim, I don't believe that anyone has got up to 56kbit/s yet. As of a couple of weeks ago, the best was 48kbit/s and people had been stuck between 45 and 46kbit/s for quite a while. The biggest debilitating effect is bit-stealing by the networks, especially when they are busy."

Even when 56kbit/s is not achievable, modems suited for it are claimed to be better than those that can only handle 33.6kbit/s maximum. "Something else to remember about 56k modems is that they make better 33.6k modems," claims Xircom's Evenepoel. ■

How to get 56kbit/s

Getting 56kbit/s through a telephone line requires a fundamental shift in technique from moving data at 33.6kbit/s. "33.6kbit/s modems use a modified form of quadrature amplitude modulation (QAM)," said Dave Morley, managing director of software modem company Signals & Software, "This technique won't stretch to 56k."

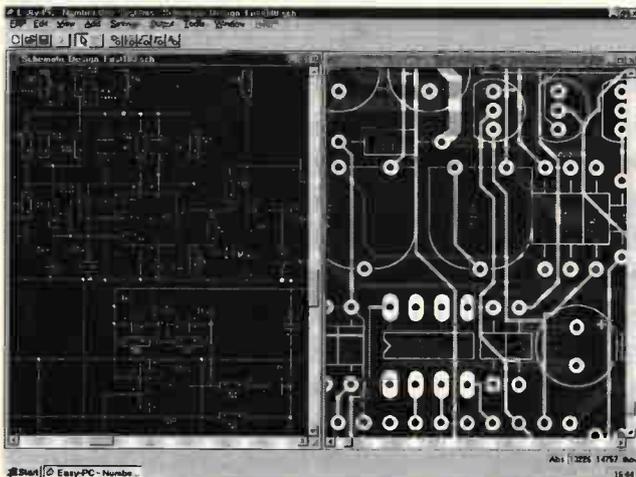
Instead, developers assumed that data will be introduced to the network digitally and stay that way all the way to the pulse code modulation (PCM) D to A codec at the subscribers local street box.

"On the network, data is transmitted at in 8-bit words at 8kHz," said Morley, "This gives a maximum data rate of 64kbit/s. On some systems, notably in America, one bit is stolen for the network clock and the rate comes down to 56kbit/s."

The subscriber's modem therefore has the job of deducing what 8-bit word was presented to the codec by measuring the voltage it produced.

As the voltage has been mangled by the subsequent analogue line between street box and user, the modem's first job is to remove phase and amplitude distortions. This it does by developing an inverse filter during an initial training sequence. It then recovers a timing clock: "The complicated part," according to Morley, and finally regenerate the data stream.

Easy-PC for Windows 95 and NT!



- 4th Generation Schematic Design and Printed Circuit Layout.
- By Engineers, for Engineers.
- Full links to our Analogue, Digital and Electromagnetic simulators.
- NO pin, net or layer limits!
- Fast, Intuitive Operation!
- Track and Component editing - a dream!
- Superb User Interface!
- *Competitive pricing!*

Number One Systems

Write, fax, phone or e-mail for full information.

UK/EEC: Ref: WW, Harding Way, St.Ives, Cambridgeshire, ENGLAND, PE17 4WR. e-mail: sales@numberone.com
 Telephone UK: 01480 461778 (7 lines) Fax: 01480 494042
 International +44 1480 461778/494042

USA: Ref: WW, 126 Smith Creek Drive, Los Gatos, CA 95030
 Telephone/Fax: (408) 395-0249

<http://www.numberone.com>

CIRCLE NO. 126 ON REPLY CARD

adhfm1

SECOND EDITION

EMC

FOR PRODUCT DESIGNERS

Widely regarded as the standard text on EMC, Tim Williams' book provides all the information necessary to meet the requirements of the EMC Directive.

Most importantly, it shows how to incorporate EMC design principles into products, avoiding the cost and performance penalties, meeting the needs of specific standards and resulting in a better overall product.

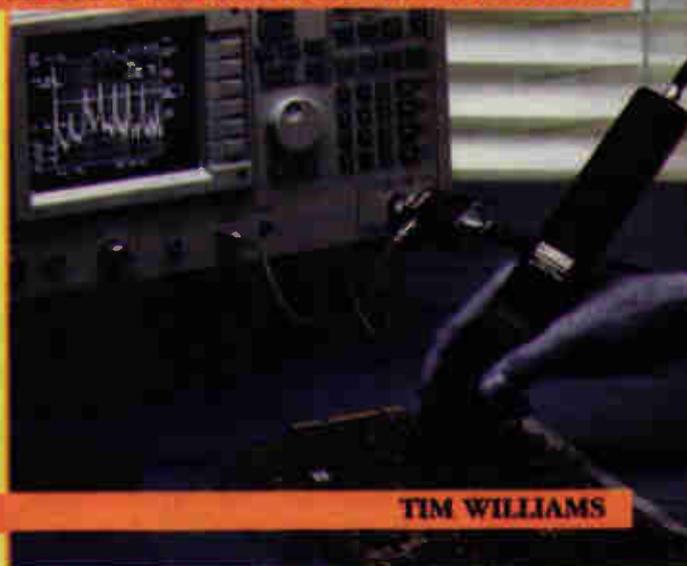
"The title could equally well have been 'EMC Handbook' since the work contains a wealth of reference material on the directive, the standards, measurements and the methods which can and should be used to achieve compliance" *IEE Review*.

SECOND EDITION

EMC

FOR
PRODUCT
DESIGNERS

MEETING THE EUROPEAN EMC DIRECTIVE



TIM WILLIAMS

Please send me copies of EMC for Product Designers at £27.50 each, plus £2.50 UK postage and packing, £5 for EC or £7.50 row. Total amount £.....

Please tick following as appropriate: I enclose a postal order or cheque payable to

Reed Business Information Ltd

or, here are my credit card details

Credit card type Master Visa

Credit card number

Card expiry date

Name of card holder

Credit card statement address.....

.....

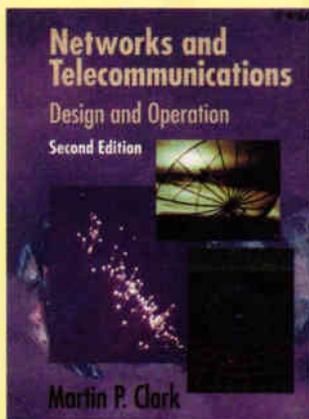
.....

.....Post code.....

Day time telephone number.....

Post your order to Jackie Lowe, Room L333, Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS.

Alternatively Fax your card details on 0181 652 8111



Networks and Telecommunications Design and Operation

Second Edition
Martin P. Clark,
Telecommunications
Consultant, Frankfurt,
Germany

Telecommunications network design and operation is now widely regarded as an issue of business management as well as electrical engineering. In this updated edition, Martin Clark, a pioneer of this perspective, applies it to the increasing complex and diverse realm of voice, and data and multimedia networks.

Written in an accessible style and clearly illustrated throughout, this is a basic, practical and intuitive insight into modern network engineering and sections including:

- Technical accounts of modern voice, data and multimedia networks
- Coverage of ATM, B-ISDN, SDH, mobile radio and satellite networks, Internet and TCP/IP
- Practical aspects of running and setting-up networks
- Running a business based on telecommunications

A text specifically for readers new to the whole subject of telecommunications, and professional telecommunications managers who need an introduction and reference work on all aspects of technology, operational techniques and regulation.

ISBN 0 471 973 46 7

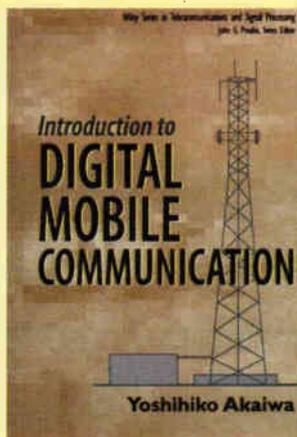
UK £80.50 Europe £86 ROW £105

Introduction to Digital Mobile Communication

Yoshihiko Akaiwa

A comprehensive treatment of the digital technologies that make personal mobile communication a reality

Although today's mobile communication engineers and designers can build upon the advances in digital telecommunications, specific technical requirements - robustness against fast fading,



spectrum and power efficiency, and the demand for low-priced equipment- post new technological challenges that demand creative solutions.

Introduction to Digital Mobile Communications is a comprehensive treatment of the digital technologies that are rapidly spawning new advances and applications. Written by a pioneer in the field, this book covers all the important concepts, from the fundamentals of signal analyses and digital communication to descriptions of the latest transmission systems. Rich in detail and broad in its coverage, this remarkable book:

- Describes equipment and circuit implementation methods and their performance characteristics
- Discusses elements of and methods for digital modulation and demodulation schemes
- Provides practical designs and circuits for spectrum-efficient modulations
- Covers mobile radio channels and digital mobile radio systems
- Includes extensive

- mathematical treatments and mathematical models
- Presents the latest research results with detailed references

This valuable resource provides a solid introduction to mobile radio communication for the students or professional in related fields. Most important, for design engineers and equipment manufacturers, its up-to-date findings will stimulate new research and creative design and system development efforts.

Yoshihiko Akaiwa is a leading researcher in the digital mobile communication field. Currently a professor at Kyushu University, he worked as a researcher for over twenty years at the NEC Corporation

ISBN 0 471 17545 5

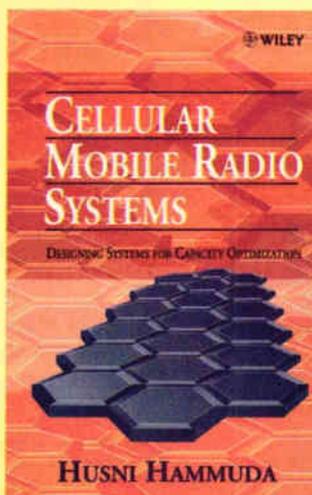
UK £57.50 Europe £60.50 ROW £73

Cellular Mobile Radio Systems

Designing Systems for Capacity Optimization
Husni Hammuda, Ericsson
(UK) Ltd

Rapidly increasing demand for mobile radio frequency subscription is already pushing cellular networks to the point of overload. Of the various methods which are being explored to tackle this problem one of the most notable is the integration of advance modulation and multiple access techniques. In this book, Husni Hammuda, a pioneer of this hybrid, shows how it can be applied in practice to optimise the efficiency of mobile radio cells.

- Provides detailed criteria for



the evaluation of combinations of modulation and multiple access techniques

- Includes primary performance data as well as predictive models
- Theoretical material is explained using examples from first and second generation transmission systems
- Covers recent innovations in personal communications

For the practising cellular communications engineer this is a systematic set of solutions for improving traffic flow in cellular networks. It also includes complete theoretical and case material ideal for post-graduate network engineering researchers.

ISBN 0 471 95641 4

UK £37.50 Europe £39.95 ROW £46.95

Network-Based Images

A Practical Guide to Acquisition, Storage, Conversion, Compression and Transmission
Gilbert Held, 4-Degree
Consulting, Macon, Georgia,
USA

Network-Based Images offers a fresh approach to the acquisition and manipulation of visual images on computer by focusing on the network application side.

This practical Guide explains the methods used to store images electronically and discusses the popular image-based applications, such as storage, conversion and compression. Gilbert Held reviews the procedures used to minimize the effects of other image-based applications to increase efficiency.

This network oriented book provides detailed information on the transmission of images to other systems and includes an overview of the associated problems.

Features include:

- Use of images on LANs includes LAN-based World Wide Web Servers
- Use of HTML image related statements
- Techniques to avoid costly network upgrades
- How to segment LANs
- Network modifications to

counter the bandwidth effect of images upon LAN transmission

Essential reading for network managers and administrators as well as Web server administrators and personal computer users. This book will provide unique coverage of images oriented to efficient use on networks: storage, acquisition, and use in applications

ISBN 0 471 97357 2
UK £37.50 Europe £39.95 ROW £46.95

Stereophonic Sound Recording

Theory and Practice
Christian Hugonnet and Pierre Walder

Recent advances in digital audio have heralded substantial innovations in sound recording techniques and increased the importance of applying the latest microphone techniques. The authors of this book focus on these innovations, giving numerous examples of their use within the framework of an analysis-based recording

provide an authoritative analysis of the subject that offers valuable, practical guidance that will aid the development of new recording methods. Their inside knowledge of the requirements of the phonographic, broadcasting, film and other media industries ensures expert coverage of new products and approaches including:

- recording techniques for all types of microphones
- in-depth analysis of the principles and use of stereophonics
- influence and role of the venue acoustics on the sound recording
- guidelines for mastering and mixing different levels of sound from different sources

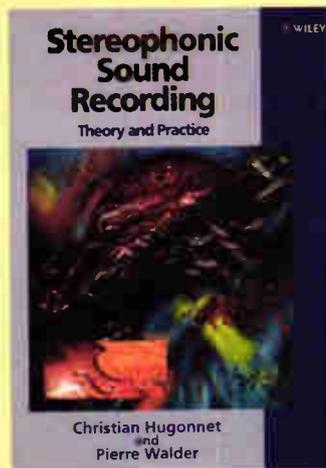
For professional audio engineers, this manual provides systematic advice for getting optimal performance from studio equipment. For students of audio engineering it will form a comprehensive introduction to the area of stereophonic recording, backed up by real-world case studies and a wealth of practical experience.
ISBN 0 471 97487 0
UK £32.45 Europe £34.95 ROW £41.95

Protect Your Privacy on the Internet

Privacy defense tools and techniques you can use right now
Bryan Pfaffenberger

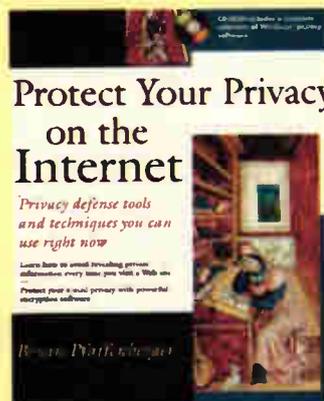
CD-ROM includes a complete collection of Windows privacy software.
Is your complete life story available to anyone with Internet access? It's really not all that hard to snoop in

Continued over page



engineering theory. The book provides a complete overview of well-known sound recording procedures practised worldwide, whilst also presenting a methodology that will provide the reader with an efficient approach to sound recording of classical music, rock and pop music, drama and speech. The widely illustrated theoretical knowledge is presented in clear and simple language.

Building on their considerable experience of creating innovative recording techniques, the authors



All prices are fully inclusive of packaging and delivery

Return to Jackie Lowe, Room L333, Quadrant House, The Quadrant, Sutton, Surrey, SM2 5AS

Please supply the following titles:

Qty	Title or ISBN	Price

Total _____

Name _____

Address _____

Postcode _____

Telephone _____

Method of payment (please circle)

Access/Mastercard/Visa/Cheque/PO

Cheques should be made payable to Reed Business Information

Credit card no _____

Card expiry _____

Signed _____

Please allow up to 28 days for delivery

cyberspace. As more and more business is conducted over the Internet, it has become increasingly difficult for both businesses and individual users to protect private information. Your reputation, Your finances, and your basic right to privacy are on the line every day. What can you do about it?

You can fight back. Protect Your Privacy on the Internet tells you everything you need to know to ensure your privacy and use the same technology that's being used against you to protect yourself. You'll get industrial-strength encryption tools to keep your affairs secret, the way they ought to be.

Bryan Pfaffenberger arms you with privacy defense strategies such as:

- Creating a bullet-proof password
- Getting your name out of the databases
- Cleaning up your browser's trails

Protect Your Privacy on the Internet gives you proven privacy defense strategies and techniques to help you make the Net a safer place to work and play. You'll get the names of Internet privacy organizations that are working to protect your privacy rights and find out what you can do to help. On the accompanying CD-ROM you'll find a collection of Windows Privacy freeware and shareware, including:

Pronto96 - an e-mail program that works in conjunction with encryption software to protect your e-mail

Mutilate - software that thoroughly erases files beyond recovery, even by expert snoopers

Win-Secure-It® - a utility preventing unauthorised access to files on your computer

AMSD Ariadna™ - a full-featured browser that reads tables and Java but ignores "cookies", text files that transparently save where you've been

Random Password Generator - a program enabling you to generate up to 1,000,000 passwords to protect you against unauthorized access to your Internet account

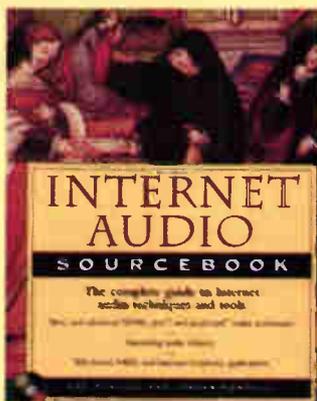
Cyber Patrol™ - parental

control software that prevents kids from uploading personal and demographic information to commercial sites

ISBN 0 471 18143 9

UK £27.45 Europe £29.95 ROW £36.95

Internet Audio Sourcebook



The complete guide to Internet audio techniques and tools
Lee Purcell and Jordan Hemphill

"The World Wide Web has spouted vocal cords, gained a voice, and begun to sing." – Lee Purcell and Jordan Hemphill

Internet Audio Sourcebook offers you a quick, easy way to acquire the knowledge, skills, and some of the tools you need to build cutting-edge audio capabilities into your Web pages, including:

- Music, narration, and sound effects
- Streaming audio for real-time broadcasts
- Automated, spoken-voice instruction
- Audio conferencing and Internet telephony
- MIDI techniques for musical training and analysis

Taking a step-by-step approach, the authors get you up to speed on the latest audio tools and techniques. First they school you in the basics of creating, processing, and storing audio data.

You learn the various methods of working with digital sound and how to use available tools to shape audio content for the Internet. Then they show you how to deliver your digital sound over the Web. They explain the HTML coding used to access audio files and teach you techniques for integrating Java applets,

JavaScript code, and VBScript code into your HTML documents.

Finally, the authors show you how to get the most out of new audio technologies, including streaming audio, MIDI applications, voice synthesis and recognition, and Internet telephony, as well as covering hot new products like the Headspace Beatnik audio engine and Liquid Audio.

The CD-ROM

You get fully functional demos of top-of-the-line sound processing applications, including Sonic Foundry's Sound Forge and Hohner Midia's Samplitude Studio. Authoring tools such as Symantec's Visual Café, Aimtech's Jamba, and Acadia Software's Infuse JavaScript editor are also included.

ISBN 0 471 19150 7

UK £28.45 Europe £31.95 ROW £39.95

Web Security Sourcebook

A Complete Guide to Web Security Threats and Solutions
Aviel D. Rubin, Daniel Geer, and Marcus J. Ranum

The front door is unlocked and wide open. The alarm's not working and no one's home. All of your valuable, money, and intimate details of your life are just sitting inside, waiting to be taken. No, it's not your house, it's your computer.

The Web now penetrates every aspect of our lives, from the home PC to the Business office. But with each advance in convenience comes a geometric increase in vulnerability to the integrity of data and software as well as to the confidentiality of information. Although the flaws inherent in the Web are real, solutions are available. Let Aviel Rubin, Daniel Geer, and Marcus Ranum give you the answers.

Here's a book that's valuable today and indispensable for the future. It includes basic and advanced techniques for client-side and server-side security, browser security, writing secure CGI scripts, firewalls, and secure e-commerce. There's a special appendix that demystifies the complex world of cryptography. And the book comes with access to a dedicated Web site containing

up-to-the minute information on the latest security threats and solutions.

So whether you're a Webmaster trying to close the door on sites and applications, or an everyday user hoping to keep your desktop safe, this is your essential source of:

- Protecting and securing Web pages, search engines, servers, and browsers
- Writing impregnable applets and scripts, and avoiding the dangers inherent in every language
- Using (and abusing) firewalls and cryptographic controls
- Securing commerce and payment transactions

ISBN 0 471 18148 X

UK £27.45 Europe £29.95 ROW £36.95

Encyclopaedia of Acoustics

Edited by Dr Malcolm J Crocker, Auburn University

Sound Information in 167 detailed Chapters. Now there's a new four-volume reference that covers every imaginable area of acoustics, sound and vibration - from the design of a concert hall to the intricacies of the human ear. It's the Encyclopaedia of Acoustics.

In this on-of-a-kind set, edited by well-known acoustical expert Dr Malcolm J. Crocker, you'll get:

- Extensive cross-referencing and indexing
- 2000- plus pages of insights from more than 200 international expert contributors
- An exhaustive examination of the fundamentals of acoustics and vibration in the first two volumes
- A revealing exploration of acoustic applications in Volumes Three and Four
- General Introductions at the start of every section

This up-to-date work is the definitive acoustics resource for students, engineers, scientists, and researchers in the field.

Casebound © 1997, four-volume set
approx. 2,000pp.
(750pps./volume)
ISBN 0471 80465 7

UK £372.45 Europe £384.97 ROW £390

Technically astute or a political fudge? The views differ regarding the outcome of the recent meeting to decide the air interface standard for universal mobile telecommunications system, UMTS – the European third generation mobile phone standard.

Air waves

At the end of January the European telecomms body ETSI held a meeting to choose between two air interface standards: wideband code division multiple access known as W-CDMA, or a combined time division/code division multiple access, TD/CDMA.

The supporters of W-CDMA include Nokia and Ericsson. W-CDMA's principal attraction is that it coincides with Japan's selection for its third generation air interface. However, it is incompatible with the US' CDMA scheme.

TD/CDMA, in contrast, builds on the existing GSM cellular standard and its supporters include Alcatel, Nortel and Siemens.

It exploits the eight time slots of GSM but uses a wider transmit bandwidth. The CDMA component is used to spread eight users within each time slot. Building on GSM is also its main drawback – Japan has deliberately moved away from GSM.

ETSI adopted a solution, called UTRA, which draws on both technical proposals, this after the voting failed to achieve the required 71 per cent. How the outcome has been received is as divided as the voting.

"The performance of the two is the same – the simulations show this. It is generally acknowledged that the issue was not technical." This is how Alistair Urie, Alcatel mobile communications' director of product strategy sees the meeting's outcome.

"This is an excellent solution and is technically most viable," said Eke Persson, Ericsson mobile systems' v-p of marketing and sales. "W-CDMA was chosen on its technical and economic merits and it has the support of the vast majority of [mobile phone] operators as well as Japan."

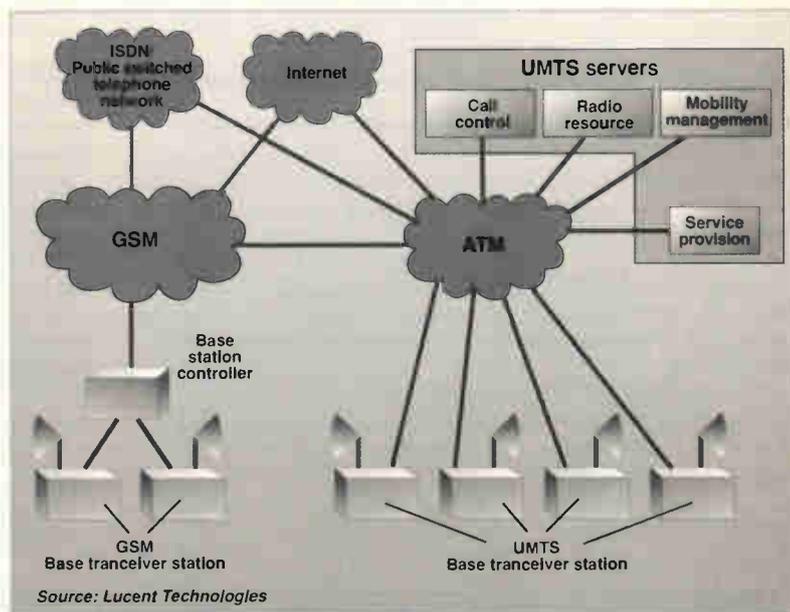
Lucent Technologies' GSM marketing director, Dick Snyder, describes his company as "air interface agnostic". He sees ETSI's decision as the classic outcome of all standards work. "It is not the most elegant outcome to achieve a commercial solution but at least it gets you to the next stage," he said.

Air interface solution

The adopted solution will use W-CDMA technology in the 'paired band' of frequencies, referred to as frequency division duplex. Here, like with GSM, separate parts of the spectrum are used for the up-link and down-link. TD-CDMA is then used in the unpaired band, where the one frequency band is used to transmit and receive – referred to as time division duplex.

"Frequency division duplex will offer a wide area service including voice, multimedia services and high speed data," said Persson. "It can also be used in-doors offering a lower data rate." According to Persson, the tdd mode will be used for different services, such as low mobility applications and for 'private' unlicensed parts of the spectrum. This is equivalent to the cordless standards CT2 or DECT.

For Lucent's Snyder, the outcome is less clear cut: "Based on the points made on the strengths and weaknesses of the schemes before the voting, the proposed solution doesn't address these." He cites the issue of asymmetric services



where data traffic in one direction far exceeds that in the other – downloading from the Web for instance.

"For applications such as mobile Internet browsing, W-CDMA is not particularly good," said Snyder. In contrast, TD/CDMA is, allocating time slots dynamically depending on the data traffic in each direction.

Snyder believes the best part of the meeting's outcome is its flexibility. "Once things are better understood, UMTS can go one way or the other without requiring a vote," he said.

What now?

Having decided on the air interface, all involved agree that there is much work still to be done to sort out the standard's details. The next milestone is in June when the ITU will expect submissions, including one from ETSI, for its ITM-2000 third generation mobile phone initiative.

According to Urie, the UMTS working groups' key task is to change the schemes to satisfy four requirements.

The first goes without saying: the resulting hand-held terminals must be low cost ("If we don't harmonise the two,

Lucent's view of how the fixed line and GSM networks will evolve to include UMTS.

Comparison of access methods			
Access method	Coverage	Services	Capacity
Mobile satellite, LEO	Global	Speech 20kbit/s symmetrical data	Low
GSM	National	Speech 100kbit/s symmetrical data	moderate
UTRA/FDD	Suburban/ Urban	Speech, video 400kbit/s symmetrical data	High
UTRA/TDD	Urban/ Indoor	Speech, video, multimedia 2Mbit/s asymmetrical data	Very high*

* assuming further allocation of unpaired bands in 1999 (WRC' 99)

the handsets will be more expensive.”)

UMTS's deployment will also be patchy at first, claims Urie, and will use much smaller cells than GSM. "There will be UMTS islands in a sea of GSM," he said. Accordingly, UMTS will have to be harmonised with GSM: "The only practical terminal will be a triple mode one supporting the two modes of UMTS (frequency and time division duplex), and GSM. If we harmonise, this will be easy."

Ericsson's Persson talks less of triple mode, expecting to see dedicated phones for each of the two modes. "We should not exclude dual-

mode handsets, though," he said.

Exactly how the two modes will co-exist also has to be resolved. "The current spectrum allocation is 2 x 60MHz and 30MHz unpaired," said Urie. The easiest would be to use the unpaired spectrum for time division duplex but then it could be used anywhere in the spectrum.

Why should the two camps successfully merge their schemes when until recently they were fierce competitors? "Everyone realises the importance of this fast growing industry - the fastest in Europe," said Persson. "Europe is also leading at the moment. It is not in our interest

to fight: the larger the standard the better for everyone: operators, vendors and users."

Urie agrees, pointing out that the mobile phone operators have told the vendors in no uncertain terms that the time for fighting is over.

And what will happen after the submissions to the ITU in June? "The ITM-2000 will be a family of standards," believes Persson. "Designing one and only one standard is a major task and I'm not sure we will succeed in doing that. Anyway, it is the market that is driving the work not the ITU."

Microwave technology that is suddenly big news

Local multipoint distribution services (LMDS) in the US use a microwave-based broadband radio technology that offers data speeds of as much as 45Mbit/s. It is a microwave technology requiring line-of-sight broadcasts to subscribers and the range is limited from two to ten miles. The technology is affected by factors such as rain, which interferes with the microwave link, trees and their foliage, and buildings. These factors require LMDS operators to limit the size of their cells, provide overlapping cells to overcome physical obstacles, and be able to boost the power of microwave transmissions during times of rain.

The technology was first developed almost 12 years ago by electrical engineer Bernard Bossard who received financial backing from the V.S. Hovnanian Group interested in LMDS as a cheap cable TV delivery system.

This led to the creation of CellularVision, the first major provider of LMDS services, operating in the Manhattan district of New York city. The company received backing in 1993 from Philips Electronics, Bell Atlantic and J.P. Morgan.

In an interesting move just two weeks ago, Hewlett-Packard agreed to sell its LMDS business unit to Lucent Technologies which is interested in developing a line of communications equipment for an LMDS market that market research firm Strategis Group predicts will be an \$8bn market within the next ten years.

The sale by HP was surprising since the company was an early pioneer in wireless broadband technologies. Byron Anderson, general manager of HP's Microwave and Communications Group said that the company recognised that without the additional communications products that a company such as Lucent can provide, it would make it difficult for HP to build up much of a business.

Field Electric Ltd.
 Tel: 01837 83736 Fax: 01837 83936
 E-mail: field12b@aol.com
 PO BOX 4, North Tawton EX20 2YJ

NEC 9" Colour Monitor VGA 800 x 600	£35.00
Sony 9" RGB Colour Monitor (Trinitron Tube)	£34.00
12" Colour VGA-SVGA 800x600 Monitors, from	£35.00
14" Colour VGA 640x480 Monitors, from	£45.00
17" Dell Ultrascan SVGA Monitors from	£165.00
Hewlett Packard 7475A Plotter Serial 6 Pen	£86.00
Hewlett Packard 7550A Plotter HP/IB Serial 8 Pen	£199.00
Hewlett Packard 7470A Plotter Serial 6 Pen	£75.00
Roland DXY 980 8 Pen Plotter Serial Parallel	£120.00
Tseng Dual Port SVGA ISA 16 Bit Graphics Card 1Mb runs 2 VDU from 1 PC	£26.00
Adaptec 16 Bit ISA SCSI Cards from	£28.00
1Mb ISA 16 Bit Graphics Card SVGA	£18.00
3 Com Network Cards, various in stock, from	£15.00
ATI Mach 64 PCI 2mb SVGA Card	£26.00
Hauppauge Windows TV Celebrity, ISA 16 Bit Frame, Capture: TV Tuner etc	£39.00
Quad Pro Plus/Tseng etc. PC1 SVGA Graphics, from	£22.00
IBM 3.5" 160Mb SCSI Hard Drives	£27.00
80MB 3.5" IDE Hard Disc Drives (Guaranteed)	£19.95
1-44Mb 3.5" H.D. Disc Drives, from	£8.00
Exabyte Tape Drives 2Gb from	£60.00
Rose PC Switching Boxes, from new	£29.00
Marconi Digital Analyser 2829	£145.00
Marconi Multiplex Tester 2830	£130.00
Wallis Insulation Tester T30	£100.00
Sound Technology 1510A Tape Recorder & Audio Test Set with manual	£375.00
Krohn-Hite 3343 Filter	£85.00
Hewlett Packard 8470A 8412A	£375.00
Hewlett Packard 5345A	£500.00
Hughes Scan Conversion Memory 639	£100.00
Tektronix DAS9100	£175.00
Lambda LK344A FMV 0-60VDC 4AIX	£60.00
386 486 Laptops, please enquire, from	£85.00
Desktop 486 PCs, various specs from	£85.00
Sound Technology 1510A Tape Recorder & Audio Test Set with Manual	£375.00

OVERSEAS ENQ WELCOME. TELEPHONE ORDERS ACCEPTED.
PAYMENT C/C, P.O., CHEQUE etc. C/P DETAILS PLEASE RING.
ALL PRICES INC. 17.5% VAT UNLESS STATED.
WE STOCK A LARGE SELECTION OF EQUIPMENT,
IF YOUR REQUIREMENT IS NOT LISTED PLEASE RING.

CIRCLE NO. 127 ON REPLY CARD

B. BAMBER ELECTRONICS
 5 STATION ROAD, LITTLEPORT, CAMBS. CB6 1QE.
 Phone: 01353 860185 Fax: 01353 863245

Bridge rectifier type W08. 800v at 1.5A. £1 for 10.	Tangential Fans , 240vac, 80mm. £4.00.
Diodes Type 1N4007. 1kv at 1A, £1 for 50.	DIP Switches , 6 Way. £1.00 each.
Klockner Moeller FAZG DIN rail mounting circuit breakers, single pole, 4A, 6A, 16A, 20A, £2 each.	PED Relays . PCB Mount, 2 pole C/O, 5v Type 51SB05T. £1.00 each.
Seiko Epson Super Twist Graphics Blue Mode LCDs 320x240 Pixel Size. 132x103 Overall. £5 each. 3 for £10. No Driver or Details.	Tektronix Oscilloscope type TDS350, Dual channel, 200mhz. 1GS/s. £2200.
Densitron Liquid Crystal Displays, 5 Digit, Type LSH5060RP. £1 each.	Black Star Meteor 600MHz frequency counter, mains or battery. £95.00.
Proximity switches for doors and windows, surface mount, £1 each.	Philips Oscilloscope Type PM3217, Dual Channel, 50MHz. £350.00.
Panel Meters moving coil, 1mA/75mV, size 4 1/4 x 2 1/4, scale marked 0-100, and 0-5, £5.00 each.	Iwatsu Oscilloscope Type SS5121. Dual Channel, 100MHz. £450.00.
Crabtree Ceiling Switches , 6A, Red Cord, £2.00 each. £10 per box of 10.	Time DC Voltage Calibrator Type 2003S. £250.00.
Capacitors , 4.7mfd, 400v, radial electrolytic (Jamicom) 15x10mm £2 per 200.	Time DC Current Calibrator . 0-10mA. £250.00
Varistors , 275V 20J, 5mm pitch, Part No JVR7N431K, £5 per 500.	Dipped Ceramic Capacitors 1nF, 500v, 5mm pitch, £1.00 per 100.
Automotive blade fuses , 5A and 15A. £1 per pack of 5.	Kingshill Power Unit Type NM10300, 100vdc, 3amp. £95.00.
Resistors , CR25. 4W, 4R7, 47R, 470K £5 per box of 5,000.	Avo AC/DC Breakdown leakage & Ionisation tester Type RM215-L2. £400.00.
Weir Bench Power Units Type 460, 0-60v at 1 amp. £70.00.	Image Powersense mains analyser. £600.
Flexible "Goose Necks" used to mount in car computers etc. 14" long. £3.00 each.	Avo Megohmmeter Model RM290. £220.
Wiring Harnesses for car alarms, useful lengths of equipment wire etc, £1 per pack of 4.	Zemco central locking interface kits type SA535 allows the Zemco SA530 vehicle alarm to automatically lock and unlock the vehicle doors by use of the remote transmitter. £5 each.
Hera Foot Switches , 250vac. 3 amp. £4.	Zemco vehicle alarm Biaxial Piezo Shock Sensor Type SA405. £5 each.
Siemens Min Relays Type C1062A307, 12v single pole 10 amp. 3 for £1.	Zemco add on quartz Ultrasonic Sensor Kits Type SA404. £5 each.
Advance Signal Generator Type E2, AM/CW, 100KHz to 100MHz. £75.00.	Rolling Ball Fuel Flow Sensors suitable for Petrol and Diesel. £5 each.
Mains transformers 12v, 2 amp. £2.00 each.	Pin Switches for Car Door/Boot/Bonnet etc. £1 per pack of 4.
Sullivan Decade Resistance Boxes , 4 Way. £20.00 each.	MAIL ORDER ONLY. DELIVERY FREE, MIN ORDER £10. NO VAT. WANTED SURPLUS STOCK

CIRCLE NO. 128 ON REPLY CARD

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

HP New Colour Spectrum Analysers
 HP141T + 8552B IF + 8553B RF-1KHz-110Mc/s - £700.
 HP141T + 8552B IF + 8554B RF - 100KHz-1250Mc/s - £900.
 HP141T + 8552B IF + 8556A RF - 20Hz-300KHz - £700.
 HP141T + 8552B IF + 8555A 10Mc/s-18GHzS - £1200.
 HP8443A Tracking Generator Counter 100KHz-110Mc/s - £200.
HP8445B Tracking Presetator DC to 18GHz - £250.
 HP8444A Tracking Generator • 5-1300Mc/s - £700.
 HP8444A OPT 059 Tracking Generator • 5-1500Mc/s - £950.
HP35601A Spectrum Anz Interface - £500.
 HP4953A Protocol Anz - £400.
 HP8970A Noise Figure Meter + 346B Noise Head - £3.5K.
 HP8755A Scalar Network Anz PI - £250 + MF 180C - £200 Heads 11664 Extra.
 HP8756A Scalar Network Anz - £1000 Heads 11664 Extra.
 HP8757A Scalar Network Anz - £2500 Heads 11664 Extra.
 HP8903A Audio Anz - £1500.
 HP8656A 100KHz - 900 Mc/s, S/G AM-FM - £1450.
 HP3709B Constellation Anz £2k.
 HP11715A AM-FM Test Source - £750.
FARNELL TVS70MKII PU 0-70V 10 amps - £150.
FARNELL PSG 520 S/G 10Mc/s AM-FM - £150.
TEK 475 Oscilloscopes 200Mc/s - £350. 475A 250Mc/s - £400.
MARCONI 6500 Network Scaler Anz - £750. Heads available to 40GHz.
 HP3580A 5Hz-50KHz Spectrum Anz £750-£1000
 HP3582A .02Hz to 25.6KHz Spectrum Anz £1.5k
 TEK 7L5 + L3 - Opt 25 Tracking Gen. £900.
 TEK 7L12 - 100KHz-1800Mc/s - £1000.
 TEK 7L18 - 1.5-60GHzs - £1500.
Mixers are available for the above ANZ's to 60GHz
HP8673D Signal Generator .05-26.5GHz - £15K.
Syston Donner 1618B Microwave AM FM Synthesizer 50Mc/s 2-18GHzs.
 R&S SWP Sweep Generator Synthesizer AM FM 4-2500Mc/s - £1k.
ADRET 3310A FX Synthesizer 300Hz-60Mc/s - £600.
HP5316B Universal Counter A+B.
HP Plotters 7470A-7475A. Up to £250.
HP3730A+3737A Down Converter Oscillator 3.5-6.5GHz.
HP Microwave Amps 491-492-493-494-495-1GHz-12.4GHz - £250.
HP105B Quartz Oscillator + HP5087A Dis Amp £500.
HP6034A System Power Supply 0-60V 0-10A-200W - £500.
HP6131C Digital Voltage Source + -100V ½ Amp.
HP3779A Primary Multiplex Analyser - £200.
HP3779C Primary Multiplex Analyser - £300.
HP1631D Logic Analyser - £500.
HP5316A Universal Counter A+B.
HP8901A Modulation Meter AM-FM - £1.5k.
Marconi TF2374 Zero Loss Probe - £200.
Marconi TF2305 Modulation Meter - £1.5k.
Racal/Dana 2101 Microwave Counter - 10Hz-20GHz - £2k.
Racal/Dana 1250-1261 Universal Switch Controller + 200Mc/s PI Cards.
Racal/Dana 9303 True RMS Levelmeter+Head - £450. IFFE - £500.
TEKA6902A also A6902B Isolator - £300-£400.
TEK FG5010 Programmable Function Generator 20Mc/s - £600.
TEK2465A 350Mc/s Oscilloscope - £2.5k + probes - £150 each.
TEK CT-5 High Current Transformer Probe - £250.
TEK J16 Digital Photometer + J6523-2 Luminance Probe - £300.
HP745A+746A AC Calibrator - £600.
HP11729C Carrier Noise Test Set .01-18GHz - LEF - £2000.
Marconi TF2008 - AM-FM signal generator - also sweeper - 10Kc/s - 510Mc/s - from £250 - tested to £400 as new with manual - probe kit in wooden carrying box.
HP Frequency comb generator type 8406 - £400.
HP Sweep Oscillators type 8690 A & B + plug-ins from 20Mc/s to 18GHz also 18-40GHz
HP Network Analyzer type 8407A + 8412A + 8501A - 100Kc/s - 110Mc/s - £500 - £1000.
HP Amplifier type 8447A - 1-400Mc/s £200 - HP8447A Dual - £300.
HP Frequency Counter type 5340A - 18GHz £1000 - rear output £800.
HP 8410 - A - B - C Network Analyzer 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. From £1000.
Racal/Dana 9301A-9302 RF Millivoltmeter - 1.5-2GHz - £250-£400.
Racal/Dana Modulation Meter type 9009-9008 - 8Mc/s - 1.5GHz - £150/£250.
Marconi RCL Bridge type TF2700 - £150.
Marconi/Saunders Signal Sources type - 6058B - 6070A - 6055A - 6059A - 6057A - 6056 - £250-£350. 400Mc/s to 18GHz.
Marconi Microwave 6600A sweep osc., mainframe with 6650 PI - 18-26.5GHz or 6651 PI - 26.5-40GHz - £750 or PI only £600. MF only £250.
Tektronix Plug-Ins 7A13 -7A14 - 7A18 - 7A24 - 7A26 - 7A11 - 7M11 - 7S11 - 7D10 - 7S12 - S1 - S2 - S6 - S52 - PG506 - SC504 - SG502 - SG503 - SG504 - DC503 - DC508 - DS501 - WR501 - DM501A - FG501A - TG501 - PG502 - DC505A - FG504 - 7B80 + 85 - 7B92A.
Gould J3B test oscillator + manual - £150.
Tektronix Mainframes - 7603 - 7623A - 7613 - 7704A - 7844 - 7904 - TM501 - TM503 - TM506 - 7904A - 7834 - 7623 - 7633 - 7844 - 7854 - 7104.
Marconi 6155A Signal Source - 1 to 2GHz - LED readout - £400.
Barr & Stroud Variable filter EF3 0.1Hz - 100Kc/s + high pass + low pass - £150.
Racal/Dana 9300 RMS voltmeter - £250.
HP 8750A storage normalizer - £400 with lead + S.A or N, A Interface.
Tektronix - 7S14 - 7T11 - 7S11 - 7S12 - S1 - S2 - S39 - S47 - S51 - S52 - S53 - 7M11.
Marconi mod meters type TF2304 - £250.
Syston Donner counter type 6054B - 20Mc/s - 24GHz - LED readout - £1k.
Farnell electronic load type RB1030-35 - £350.
Racal/Dana counters - 9904 - 9905 - 9906 - 9915 - 9916 - 9917 - 9921 - 50Mc/s - 3GHz - £100 - £450 - all fitted with FX standards.
HP180TR, HP182T mainframes £300-£500.
Marconi 6700A sweep oscillator + 18GHz PI's available.
Racal/Dana VLF frequency standard equipment. Tracer receiver type 900A + difference meter type 527E + rubidium standard type 9475 - £2750.
HP432A - 435A or B - 436A - power meters + powerheads to 60GHz.
HP8614A signal generator 800Mc/s - 2.4GHz, new colour £400.
HP8616A signal gen 1.8GHz-4.5GHz, new colour £400.
HP 3336A or B syn level generator - £500-£600.
HP 3586B or C selective level meter - £750-£1000.
HP 8683D S/G microwave 2.3 - 13GHz - opt 001 - 003 - £2.5k
HP 8640B S/G AM-FM 512Mc/s or 1024Mc/s. Opt 001 or 002 or 003 - £800-£1250.
HP 86222BX Sweep PI - 01 - 2.4GHz + ATT - £1400 - £1750.
HP 86290A Sweep PI - 2 - 18GHz - £1000 - HP 86290B - £1250
HP 86 Series PI's in stock - splitband from 10Mc/s - 18.6GHz - £250 - £1k.
HP 8620C Mainframe - £250. IEEE - £500.
HP 8615A Programmable signal source - 1MHz - 50Mc/s - opt 002 - £1k.
HP 8601A Sweep generator. 1 - 110Mc/s - £300.
HP 8349A Microwave Amp 2 - 20GHz Solid state - £1500.
HP 1980B Oscilloscope measurement system - £300.
HP 3455/3456A Digital voltmeter - £400.
HP 5370A Universal time interval counter - £1k.
HP 5335A Universal counter - 200Mc/s - £500.
HP 5328A Universal counter - 500Mc/s - £250.
HP 6034A System power supply - 0 - 60V - 0 - 10 amps - £500.
HP 3710A - 3715A - 3716A - 3702B - 3703B - 3705A - 3711A - 3791B - 3712A - 3793B microwave link analyser - P.O.R.
HP 3552A Transmission test set - £350.
HP 3763A Error detector - £500.
HP 3764A Digital transmission analyser - £600.
HP 3770A AM delay distortion analyser - £400 - + 3770B - £400.
HP 3780A Pattern generator detector - £400.
HP 3781A Pattern generator - £400.
HP 3782A Error detector - £400.
Tektronix 577 Curve tracer + adaptors - £900.
Tektronix 1502/1503 TDR cable test set - £400.
Racal 1991-1992-1998 - 1300Mc/s counters - £400-£900.
Fluke 80K-400 High voltage probe in case - BN - £50-£75.
EIP 545 microwave 18GHz counter - £1200.
Fluke 510A AC ref standard - 400Hz - £200.
Fluke 355A DC voltage standard - £300.
Wiltron 610D Sweep Generator + 61084D PI - 1Mc/s - 1500Mc/s - £500.
HP 8699B Sweep PI YIG oscillator .01 - 4GHz - £300.
8690B MF - £250. Both £500.
Dummy Loads & power att up to 2.5 kilowatts FX up to 18GHz - microwave parts new and ex equip - relays - attenuators - switches - waveguides - Yigs - SMA - APC7 plugs - adaptors.
B&K items in stock - ask for list.
Power Supplies Heavy duty + bench in stock - Farnell - HP - Weir - Thurby - Racal etc. Ask for list. Large quantity in stock, all types.
Marconi 2955 Radio test set + calibration. £2000.
Marconi 2955 + 2958 Tacs radio test set + calibration. £2250.
Marconi TF2015 S/G 10Mc/s-520Mc/s AM.FM. £150.
Marconi TF2016A S/G 10Kc/s-120Mc/s. AM.FM. £150.
Marconi TF2171 or 2173 Digital synchronizer for 2015/2016. £100.
Marconi TF2017 S/G .01-1024Mc/s.AM.FM. High grade. £1500.
Marconi TF2018 S/G 80Kc/s-520Mc/s. AM. FM. £800.
Marconi TF2018A S/G 80Kc/s-520Mc/s. AM. FM. £1000.
Marconi TF2019 S/G 80Kc/s-1040Mc/s. AM. FM. £1250.
Marconi TF2019A S/G 80Kc/s-1040Mc/s. AM. FM. £1500.
Marconi TF2022E S/G 10Kc/s-1.01GHzs. AM. FM. £1500.
Marconi TF2022E As above but as new + Cal cert. £1800.
Marconi TF6311 Microwave Sweep S/G 10Mc/s-20GHz c/w TF6500 amplitude Anz. plus heads 10Kc/s-40GHz. £4K-£5K.
Farnell S/G ESG1000 10Hz-1000Mc/s. AM. FM. £1200.
Farnell S/G PSG1000 10Hz-1000Mc/s. AM. FM. £1300.
IFR 12005 Communications radio test set. £2500.
TF2370 Spectrum Anz's 30Hz-110Mc/s. Large qty in stock to clear as received from Gov-all sold as is from pile complete or add £100 for basic testing and adjustment.
Callers preferred - Pick your own from over sixty dnits.
A. Early Model - Grey - Rear horizontal alloy cooling fins - £200.
B. Late Model - Grey - Vertical alloy cooling fins - £300.
C. Late Model - Brown - Vertical alloy cooling fins - £500.
Marconi TK2373 Extender to 1.25GHz-£400. Brown colour - £500.
H.P. 3325A Synthesized function generator - £1000-£1500.
H.P. 3325B Synthesized function generator - £2500.
H.P. 8505A Vector voltmeter - late colour - £400.
H.P. 8508A Vector voltmeter - £2500.
H.P. 8505A Network Anz 500KHz-1.3GHz - £1750.
H.P. 8505A + 8502A or 8503A test sets - £2000/£2250.
H.P. 8505A + 8502A or 8503A+8501A normalizer - £2500.
H.P. 8557A .01Mc/s-350Mc/s-8558B 0.1-1500Mc/s - 8559A .01-21GHz 182T or 180C-D-T £500-£2500.
Tektronix 492 Spectrum Anz-OPT 3-50Kc/s-21GHz - £3500.
Tektronix - HP Oscilloscopes - 100Mc/s-465-465B-1740-1741 etc - £300.
Phillips 3217 50Mc/s oscilloscopes - £150-£250.
Phillips 3296 350Mc/s IR remote control oscilloscope - £1400.
Hitachi VC6041 Digital storage oscilloscope - 40Mc/s - £500.
Tektronix 2430A Digital storage oscilloscope - 100Mc/s - £2000.
Tektronix 2440 Digital storage oscilloscope - 400Mc/s - £2200.
Tektronix 2245A Oscilloscope - 100Mc/s - £1000.
Tektronix 2445 + DMM - 250Mc/s - £1250.
Tektronix 2445A - 150Mc/s - 4 CH - £1000.
Schaffner NSG 200E Mainframe - NSG203A low volt var simulator - NSG222A. Interface simulator - NSG223 Interface generator - NSG224 Interface simulator - NSG226 Data line simulator - all six items at £1500.
Schaffner NSG200E Mainframe - NSG203E low volt var simulator - NSG222A Interface simulator - all three items - £1000.
LIGHT & OPTICAL EQUIPMENT
Anritsu ML93A & Optical Lead Power Meter.
Anritsu ML93B & Optical Lead Power Meter.
Power Sensors for above MA96A - MA98A - MA913A - Battery Pack MZ95A.
Anritsu MW97A Pulse Echo Tester.
PI available - MH914C 1.3 - MH915B 1.3 - MH913B 0.85 - MH925A 1.3 - MH929A 1.55 - MH925A 1.3GI - MH914C 1.3SM.
Anritsu MW98A Time Domain Reflector.
PI available - MH914C 1.3 - MH915B 1.3 - MH913B 0.85 - MH925A 1.3 - MH929A 1.55 - MH925A 1.3GI - MH914C 1.3SM.
Anritsu MZ100A O/E Converter.
+ MG912B (LD 1.35) Light Source + MG92B (LD 0.85) Light Source.
Anritsu MZ118A O/E Converter.
+MH922A 0.8 O/E unit + MH923 A1.3 O/E unit.
Anritsu ML96B Power Meter & Charger.
Anritsu MN95B Variable Att. 1300.
Barr & Stroud LS10 Light Source.
BT Power Unit 850 - 1300 - 1500.
Photo Dyne 1950 XR Continuous Att. 1300 - 1500.
Photo Dyne 1800 FA. Att.
NKT Electronic OAM30 Att Meter (MN3032TX) 1300 output.
Electro Optic Developments FO-500 TX Laser.
Cossor-Raytheon 108L Optical Cable Fault Locator 0-1000M 0-10km.
Intelco 220 Single Mode Att 1532.
TEK P6701 Optical Converter 700 MC/S-850.
TEK Orionics 7000 Type PI OTDR-103A.
HP81512A Head 150Mc/S 950-1700.
HP84801A Fibre Power Sensor 600-1200.
HP8158B ATT OPT 002+011 1300-1550.
HP81519A RX DC 400Mc/S 550-950.
STC OFTX-3 Laser source.
STC OFRX-3
STC OFR10 Reflectometer.
STC OFSK15 Machine jointing + eye magnifier.
Anritsu ME453L RX Microwave Anz.
Anritsu ME453L TX Microwave Anz.
Anritsu MS420B Network Spectrum Anz.
Anritsu MH370A Jitter Mod Oscillator.
Anritsu MG642A Pulse Patt Gen.
Complete MS65A Error Detector.
System MS02A Timer & Digital Printer.
Anritsu ML612A Sel Level Meter.
Anritsu MS2802A Spectrum Anz 100Hz-32GHz.
Anritsu ML244A Sel Level Meter.
Advantest TR98201 Signal Gen
Advantest TR9402 Digital Spectrum Anz.
Siemens D2108 Level Meter.
Siemens D2150 Bit Error Meter
W&G PCM3 Auto Measuring Set.
W&G SPM14 Sel Level Meter.
W&G SPM15 Sel Level Meter.
W&G SPM16 Sel Level Meter.
W&G PS19 Level Gen.
W&G DA20+DA1 Data ANZ
W&G PMG3 Transmission Measuring Set.
W&G PSS16 Generator.
W&G PS14 Level Generator
W&G EPM-1 Plus Head Milliwatt Power Meter.
W&G DLM3 Phase Jitter & Noise.
W&G DLM4 Data Line Test Set.
W&G PS10 & PM10 Level Gen.

ITEMS BOUGHT FROM HM GOVERNMENT BEING SURPLUS. PRICE IS EX WORKS. SAE FOR ENQUIRIES. PHONE FOR APPOINTMENT OR FOR DEMONSTRATION OF ANY ITEMS, AVAILABILITY OR PRICE CHANGE. VAT AND CARRIAGE EXTRA. ITEMS MARKED TESTED HAVE 30 DAY WARRANTY. WANTED: TEST EQUIPMENT-VALVES-PLUGS AND SOCKETS-SYNCRS-TRANSMITTING AND RECEIVING EQUIPMENT ETC.

Johns Radio, Whitehall Works, 84 Whitehall Road East, Birkenshaw, Bradford BD11 2ER. Tel. No: (01274) 684007. Fax: 651160

HART

The Home of *Hi-Finesse*. Its not what you do, its HOW you do it that counts!.

Hart Audio Kits and factory assembled units use the unique combination of circuit designs by the renowned John Linsley Hood, the very best audiophile components, and our own engineering expertise, to give you unbeatable performance and unbelievable value for money.

We have always led the field for easy home construction to professional standards, even in the sixties we were using easily assembled printed circuits when Heathkit in America were still using tagboards! Many years of experience and Innovation, going back to the early Dinsdale and Bailey classics gives us incomparable design background in the needs of the home constructor. This simply means that building a Hart kit is a real pleasure, resulting in a piece of equipment that not only saves you money but you will be proud to own.

Why not buy the reprints and construction manual for the kit you are interested in to see how easy it is to build your own equipment the HART way. The FULL cost can be credited against your subsequent kit purchase.

'AUDIO DESIGN' 80 WATT POWER AMPLIFIER.



This fantastic John Linsley Hood designed amplifier is the flagship of our range, and the ideal powerhouse for your ultimate hifi system. This kit is your way to get £K performance at bargain basement prices. Unique design features such as fully FET stabilised power supplies give this amplifier World Class performance with startling clarity and transparency of sound, allied to the famous HART quality components and ease of construction. Standard model comes with a versatile passive front-end giving 3 switched inputs, with ALPS precision "Blue Velvet" low-noise volume and balance controls, no need for an external preamp. Construction is very simple and enjoyable with all the difficult work done for you, even the wiring is pre-terminated, ready for instant use! All versions are available with Standard components or specially selected Super Audiophile components and Gold Plated speaker terminals and all are also available factory assembled.

K1100 Complete STANDARD Stereo Amplifier Kit,	£415.21
K1100S Complete SLAVE Amplifier Kit,	£353.62
K1100M Complete MONOBLOC Amplifier Kit,	£271.20
RLH11 Reprints of latest Amplifier articles	£1.80
K1100CM Construction Manual with full parts lists	£5.50

ALPS "Blue Velvet" PRECISION AUDIO CONTROLS.



Now you can throw out those noisy ill-matched carbon pots and replace with the famous Hart exclusive ALPS 'Blue Velvet' range components only used selectively in the very top flight of World class amplifiers. The improvement in track accuracy and matching really is incredible giving better tonal balance between channels and rock solid image stability. Motorised versions have 5v DC motor.

MANUAL POTENTIOMETERS	
2-Gang 100K Lin.	£15.67
2-Gang 10K, 50K or 100K Log.	£16.40
2-Gang 10K Special Balance, zero crosstalk and zero centre loss.	£17.48
MOTORISED POTENTIOMETERS	
2-Gang 20K Log Volume Control	£26.20
2-Gang 10K RD Special Balance, zero crosstalk and less than 10% loss in centre position	£26.98

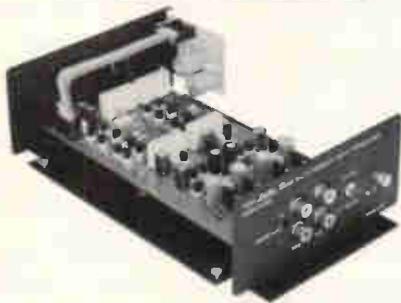
TOROIDAL MAINS & OUTPUT TRANSFORMERS for EL34, 32W VALVE AMPLIFIER

Special set of toroidal transformers, 2 output & 1 mains for the "Hot Audio Power" valve amplifier design described in the Oct. 1995 issue of "Wireless World". Total Wt 4.8Kg. Special price for the set, £99, Post £8
RJM11. Photocopies of the Article by Jeff Macaulay, £2

PRECISION Triple Purpose TEST CASSETTE TC1D.

Are you sure your tape recorder is set up to give its best? Our latest triple purpose test cassette checks the three most important tape parameters without test equipment. Ideal when fitting new heads. A professional quality, digitally mastered test tape at a price anyone can afford.
Test Cassette TC1D. Our price only

SHUNT FEEDBACK PICKUP PREAMPLIFIER



If you want the very best sound out of vinyl discs then you need our high quality preamplifier with Shunt Feedback equalisation. The K1450 also has an advanced front end, specially optimised for low impedance moving coil cartridges as well as moving magnet types. Selected discrete components are used throughout for ultimate sound quality. The combination of John Linsley Hood design, high quality components and an advanced double sided printed circuit board layout make this a product at the leading edge of technology that you will be proud to own. A recent review in "Gramophone" magazine endorsing this view. Bought in kit form our step by step instructions it is very easy and satisfying to assemble, or you can buy a factory assembled version if you wish.

This magnificent kit, comes complete with all parts ready to assemble inside the fully finished 228 x 134 x 63mm case. Comes with full, easy to follow, instructions as well as the Hart Guide to PCB Construction, we even throw in enough Hart Audiograde Silver Solder to construct your kit!

K1450 Complete Kit	£116.58
K1450SA Audiophile Kit	£138.94
A1450SA Factory assembled Audiophile unit	£188.94

"CHIARA" HEADPHONE AMPLIFIER.



Highest quality, purpose designed, 'single ended' class 'A' headphone amplifier for 'stand alone' use or to supplement those many power amplifiers that do not have a headphone facility. Easy installation with special signal link-through feature, the unit uses our 'Andante' Ultra High Quality power supply. Housed in the neat, black finished, Hart minibox it features the wide frequency response, low-distortion and 'musicality' that one associates with designs from the renowned John Linsley Hood. Volume and balance controls are Alps "Blue Velvet" components. Very easy to build, or available factory assembled, the kit has very detailed instructions, and comes with Hart audiograde silver solder. A valuable personal listening option and an attractive and harmonious addition to any hifi system.

K2100 Complete Standard Kit	£112.50
K2100SA 'Series Audiophile' Kit with selected audiophile components	£115.46
A2100SA 'Series Audiophile', Factory Assembled	£115.46
CM2100 Construction Manual	£2.50

"Andante" Linear Technology AUDIOPHILE POWER SUPPLIES

The HART "Andante" series power supplies are specially designed for exacting audio use requiring absolute minimum noise, low hum field and total freedom from mechanical noise.

Utilising linear technology throughout for smoothness and musicality makes it the perfect partner for the above units, or any equipment requiring fully stabilised $\pm 15v$ supplies.

There are two versions, K3550 has 2 $\pm 15v$ supplies and a single 15v for relays etc. K3565 is identical in appearance and has one $\pm 15v$. Both are in cases to match our 'Chiara' Headphone Amplifier and our K1450 "Shunt Feedback" Pickup preamp.

K3550 Full Supply with all outputs	£94.75
K3565 Power Supply for K1450 or K2100	£84.42
A3550 Factory Assembled Full Supply	£147.25

SPEAKER DESIGN SOFTWARE.

VISATON "Speaker Pro 6" is a complete speaker design program for use on IBM machines. Covers cabinet and crossover design and contains a full expandable database of drive units. Earning a "most recommendable" accolade it tests this program is ideal for the professional speaker builder or serious audiophile.
0303 Speaker Pro 6. 3.5"Disk

SPEAKER DAMPING MATERIALS

Polyester Wool and Pure Lambs Wool both have optimal damping properties and are pleasant to handle. Standard 125g bag is sufficient for 20 litres enclosure volume.
5070 Polyester Wool. 125g

SPECIAL OFFER! SOLENOID CONTROLLED FRONT LOAD CASSETTE DECK SFL800

High quality (0.08%W&F) cassette mechanism with capability of using standard or downstream monitor R/P head. Offers all standard facilities under remote, logic or software control. The control requirements are so simple that for many applications not needing all functions manual switches will suffice. Power requirements are also simple with 12v solenoids and 12v speed controlled Motor, total power requirement being under 300mA. Logic control and wiring circuits are included free with each deck.
SFL800 Deck with Standard stereo head

HART TECHNICAL BOOKSHELF

Try us for:- Bigger Range of Books, Better Prices, NO "28 Day Wait"

New Titles.

"A BEGINNER'S GUIDE TO TUBE AUDIO DESIGN" Bruce Rozenbit. A practical book that does exactly what its title says and takes a modern look at valve amplifier construction. 132pp. ISBN 1-88280-13-3	£18.20
"HIGH PERFORMANCE LOUDSPEAKERS" Edn. 5. Martin Collops. Latest edition, just out. A really in-depth coverage of the whole World of speakers and high quality sound reproduction, but entirely readable in style. Just reviewed in "HIFI World". 478pp. ISBN 0-4719-7089-1	£24.95*
"AUDIO ELECTRONICS" John Linsley Hood	£19.95*
"THE ART OF LINEAR ELECTRONICS" John Linsley Hood. 1994	£19.95*
"THE ART OF ELECTRONICS" Horowitz & Hill	£35.00*
"DIGITAL AUDIO AND COMPACT DISC TECHNOLOGY" 3rd.Edn. 0-240 51397 5	£19.95*
"INTRODUCING DIGITAL AUDIO CD, DAT AND SAMPLING" ISBN 1870775 22 8	£7.95
"ACTIVE FILTER COOKBOOK" Don Lancaster	£19.95
"THE ART OF SOLDERING" 0-85935-324-3. 0	£3.95
"TOWERS' INTERNATIONAL TRANSISTOR SELECTOR" 0-572-01062-1	£19.95*
"AUDIO" F.A. Wilson. BP111	£3.95
"HOW TO USE OSCILLOSCOPES & OTHER TEST EQUIPMENT" R.A. Penfold. BP267	£3.50
"THE HART PRINTED CIRCUIT BOARD CONSTRUCTION GUIDE."	£2.50
"A SIMPLE CLASS A AMPLIFIER" J.L.Linsley Hood M.I.E.E. 1969. RLH12	£2.75
"CLASS-A POWER" Single Ended 15W Amp. J.L.Linsley Hood M.I.E.E. 1996. RLH13	£2.50

LOUDSPEAKERS; THE WHY AND HOW OF GOOD REPRODUCTION. G.Briggs. 1949.

"THE LOUDSPEAKER DESIGN COOKBOOK" Vance Dickason. (5th Edn.)	£23.95*
ELECTROSTATIC LOUDSPEAKER DESIGN AND CONSTRUCTION Ronald Wagner BKT6	£15.95
"THE ELECTROSTATIC LOUDSPEAKER DESIGN COOKBOOK" Roger P. Sanders. 1995	£24.95
"BULLOCK ON BOXES" Bullock & White	£10.95
"AN INTRODUCTION TO LOUDSPEAKERS & ENCLOSURE DESIGN" V. Capel. BP256	£3.95
"LOUDSPEAKERS FOR MUSICIANS" BP297	£3.95
"THEORY & DESIGN OF LOUDSPEAKER ENCLOSURES" J.E.Benson	£21.95
"QUICK & EASY TRANSMISSION LINE SPEAKER DESIGN" Larry D. Sharp	£8.95
"THE COUPLED CAVITY HANDBOOK" David Purton	£4.90
"VISATON. HOME HI FI CATALOGUE." Full Specifications and Thiele Small Data on all Drive Units	£4.50
"VISATON. CAR HI FI CATALOGUE." In car guide	£3.50
"VISATON. CABINET PROPOSALS" Book 1. In GERMAN	£6.50
"VISATON. CABINET PROPOSALS" Book 2. In GERMAN	£6.50
"SPEAKER PRO 6." VISATON Cabinet Design Software	£45.51
"SPEAKER PRO 6." Demo Version with drive unit database	£9.28

"VALVE AMPLIFIERS" Morgan Jones. 1995/6	£24.50
THE VTL BOOK David Manley 1994. BKV11	£17.95
MULLARD TUBE CIRCUITS FOR AUDIO AMPLIFIERS BKAA27	£11.95

"THE WILLIAMSON AMPLIFIER." 0-9624-1918-4

AN APPROACH TO AUDIO FREQUENCY AMPLIFIER DESIGN. GEC 1957

AUDIO ANTHOLOGIES, articles from Audio Engineering. Six volumes covering the days when audio was young and valves were king! BKAA3/1 to 6. All £12.95 each

"THE RADIOTRON DESIGNERS HANDBOOK" (CD)

"PRINCIPLES OF ELECTRON TUBES" H.D.Reich PH.D.

"POWER AMP PROJECTS" Anthology. 1970-1989.

"WORLD TUBE DIRECTORY" 1996-7 Sourcebook of valve related products

Fuller descriptions of the contents of all our books is given in our full catalogue, price

Postage on all books, unless starred, is only £2 per book, maximum £4.50 for any number, any size! Starred items are heavy books costing £3.50 to send.

Don't forget NO waiting at HART! All listed books are normally in stock! Just ring with your Credit Card Number for instant despatch!

Fuller Details of ALL kits are given in our List, FREE on request.

Send for Your FREE copy of our LISTS

WILMSLOW AUDIO Tel. 01455 286603 Fax. 01455 286605

All Prices include UK/EC VAT.

HART

At WILMSLOW AUDIO
50 Main St., Broughton Astley
Leicester LE9 6RD

CIRCLE NO. 130 ON REPLY CARD

NEW PRODUCTS CLASSIFIED

Please quote "Electronics World" when seeking further information

ACTIVE

Data converters

Audio d-to-a converter. Burr-Brown's *PCM1716* 24-bit, 96kHz converter is a delta-sigma type to provide a dynamic range of 106dB and a distortion-plus-noise figure of -96dB. A new enhanced, multi-level delta-sigma modulator reduces jitter and improves dynamic performance and an internal digital filter operates at 8x oversampling with selectable fast or slow roll-off. There is also digital de-emphasis, L and R independent digital attenuation, soft mute, zero detect mute, a zero flag and reversible output phasing. Analogue output is single-ended. Burr-Brown International. Tel., 01923 233837; fax, 01923 233979
Enquiry no 501

Discrete active devices

Low-drop, 3.3V Schottkys. A new family of 20C Schottky diodes from IR have a forward voltage drop of 300mV and are intended for use in 3.3V power supplies. Two devices are at present available. The *87CNQ020* 40A type drops 300mV at 40A and is contained in standard, surface-mounted or clip-mounted D-61 packaging; it is rated at 80A and is suitable for 150-300W dc-to-dc converters. The second type, the *47CTQ020*, is rated at 40A and drops 300mV at 20A, being packaged in TO-220, D²Pak or I²Paks. International Rectifier. Tel., 01883 732020; fax, 01883 733410.
Enquiry no 502

Fast mosfet. *FDS9412*, a fast switching SO-8 mosfet by Fairchild, is intended for use in dc-to-dc converters. The company claims that it is over 3% more efficient than standard mosfets in converter circuits, having an $R_{DS(on)}$ of 0.22 Ω at 10V V_{GS} . Total gate charge is around 20nC and switching speed is compatible with >1MHz operation. Gate-source voltage is 30V maximum. Fairchild Ltd. Tel., 01703 211789; fax, 01703 211678.
Enquiry no 503

High-gain transistors. Zetex's Super-beta range of 2.5W, SOT23 transistors now includes two more: the *FZT 1047* and *FZT 1053*. Both have a typical gain of 450 and saturate at 70mV/1A, the 1047 possessing a V_{CEO} of 10V and the 1053, 75V. For higher-current application, the 1047 will handle 5A continuously and 20A in pulses, on resistance being 44m Ω ; the 1053, intended for automotive and industrial

use, has an on resistance of 78m Ω and handles 4.5A continuous and 10A pulsed. Zetex plc. Tel., 0161-627 5105; fax, 0161-627 5467.
Enquiry no 504

Microprocessors and controllers

Smallest eeprom controller. Measuring 26 square millimetres. Microchip's new *PICmicro* eeprom microcontrollers are said to be the world's smallest and still contain 16byte of eeprom for data and 512word otp program memory for the *PIC12CE518*, and 1024word otp program memory and 41byte of user ram in the *PIC12CE519*. There are six multiplexed i/o pins with a 4MHz clock oscillator; 33 single-cycle, single-word instructions; 8-level-deep hardware stack; an 8-bit real-time clock/timer; a watchdog timer and direct led drive. Microchip also offer the *PICmicro Plug-in Library* of virtual peripherals, assembly routines to emulate functions such as 16-bit maths, comms, a-to-d conversion and others. Download from <http://www.microchip.com>. Arizona Microchip Technology Ltd. Tel., 01628 851077; fax, 01628 850259.
Enquiry no 505

Optical devices

White leds. Sloan ag of Switzerland has introduced a range of chip-type, surface-mounted white leds, which have a viewing angle of 120° and take 20mA at a forward voltage of 3.6V to produce a luminous intensity of 200mCd. Roxburgh Electronics Ltd. Tel., 01724 281770; fax, 01724 281650.
Enquiry no 506

Oscillators

Oven-controlled oscillator. Anglia's new *HCD360AT* miniature, oven-controlled crystal oscillator uses an AT-cut 3rd-overtone crystal and performs at a level comparable with more expensive SC-cut types. Output is a sine wave at either 5MHz or 10MHz to within 1×10^{-9} /day, ageing at about 7.5×10^{-6} /year. Power supply needed is 12V dc at 5W for the oven and a 1-6V reference for frequency adjustment over a 2ppm range. To

order, options are Hcmos output, 15V or 18V supply, 4-20MHz output and tighter specifications. Anglia Microwaves Ltd. Tel., 01277 630000; fax, 01277 631111.
Enquiry no 507

PASSIVE

Cameras

Pc card camera. Complete with software on a PCMCIA card, the new camera system for video conferences from Premier Electronics comes with the card, digital colour camera and cables. Installation takes minutes and the system is suitable for point-to-point transmission or for Internet telephone connection. It will also connect using standard ISDN or lans and is H324-compliant. The software allows the computer to be used as a monitor with remote camera control and a test program enables the audio and video format to be changed to PAL, NTSC or SECAM. Frames are grabbable as .BMP files, and video as .AVI form. Premier Electronics Ltd. Tel., 01922 634652; fax, 01922 634616.
Enquiry no 508

Communications equipment

Subscriber line interface circuit. A new slic by Mitel, the *MH88617*, forms a complete analogue transmission and signalling link between a codec and a subscriber line, impedance, balance, gain and loop current all being externally programmable. There is two-to-four wire conversion, power-down and wake-up, with battery feed to the line and off-hook and dial pulse detection. DIP International Ltd. Tel., 01223 462244; fax, 01223 467316.
Enquiry no 510

Speech circuits. Ericsson has introduced two low-cost speech circuits for use in electronic telephones: the *PBL38572/3*, which are similar to the earlier 38570 and 38541 but costing less. 38573 is for use with a constant-current feed at

less than 50mA for the di package and 40mA for devices in the SO form. For an extended current range, the 38572 includes 4-100mA at line voltages down to 2.2V. Functions that depend on the application such as line balance, frequency response and side-tone level are set by external components, although these are kept to a minimum. There is provision for automatic loop-loss correction and the 38572 provides temperature and line-current-compensated supplies for diallers and other circuits. Ericsson Components AB. Tel., 01793 488300; fax, 01793 488301.
Enquiry no 511

Connectors and cabling

High-power rf connectors. For use at powers up to 100kW, and compatible with 0.875in, 1.625in and 3.125in EIA flanges, Deutsch's *Series 480* 50 Ω rf connectors accommodate the three flange diameters in six body sizes to take cable from 0.25in to 4in diameter, of solid, semi air-spaced or foam dielectric and a variety of sheaths and conductor materials. These connectors are designed for use in pressurised systems and conform to BS9210, being fitted with pressure valves and/or blanking plug, flange 'O' ring and coupling bolts where necessary. Typically, vswr is better than 1.02 at 400MHz. Deutsch Ltd. Tel., 01342 410033; fax, 01342 410005.
Enquiry no 512

Crystals

Thin crystals. *TC91* crystals by Total Frequency Control are surface-mounted devices only 2.5mm thick. Frequency range is 3.5-50MHz in fundamental and temperature coefficient and frequency tolerance can be specified to order. Total Frequency Control Ltd. Tel., 01903 745513; fax, 01903 742208; e-mail, eddie @ tfc.co.uk.
Enquiry no 513

Displays

Lcd driver ic. Memory, timing, control and power supply to drive a 128-segment liquid-crystal display for battery-powered equipment are all contained in a single ic, the

Compact camera module. Dyna Image offers a new camera module, with full-feature cmos output in a package measuring 30 by 25 by 30mm. The *DM 450B* interfaces with a pc by way of an EPP/Spp mode parallel port, runs from a 5V dc supply and uses 0.35W. It is based on a 1/3in colour cmos sensor (24-bit, millions of colours) with a resolution of 320 by 240 pixels and uses a standard Video for Windows 95 driver. Requirements are 100MHz Pentium and 16Mb ram minimum, with 24Mb recommended. A monochrome version in the same package is available. Selectronic Ltd. Tel., 01993 778000; fax, 01993 772512.
Enquiry no 509



Please quote "Electronics World" when seeking further information

BU9728AKV by Rohm. Operating voltage can lie between 2.5V dc and 5.5V dc at currents down to 40mA and 0.05µA on standby. Rohm Electronics UK Ltd. Tel., 01908 282666; fax, 01908 282528.
Enquiry no 514

Lcd driver board. A flat-panel lcd driver module by Arcom, the **AIM-104-LCD-3** is a PC/104 device to run VGA crts or lcds, whether mono single or dual scan stn, dual scan colour stn or colour tft. The embedded PC/104 single-board pc has the standard serial and parallel communications functions and dos running in flash eeprom, having 512Kbyte of video memory to give 1024 by 768 format in 16 colours or 640 by 480 in 256 colours. Connection is via a 50-way ribbon cable and software is supplied. Arcom Control Systems Ltd. Tel., 01223 411200; fax, 01223 410457.
Enquiry no 515

P-&-p lcd controller. Inelco announces a new plug-and-play controller card for lc displays, which

produces 23000 colours. It has 512K of on-board dram and comes complete with utility software. Video bios is programmable on-board to allow characteristics such as resolution and refresh rate timing to be tailored to requirements. A facility named Smart Map reproduces colour "intelligently" in a grey scale. The board goes into any 16-bit ISA-compatible pc slot. Inelco Ltd. Tel., 0118 9810799; fax, 0118 9810844.
Enquiry no 516

Filters

Feedthroughs for rfi suppression. Feedthrough capacitors and filters from Schaffner for the suppression of radio-frequency interference come in both ac and dc types and in a wide choice of values and ratings. They provide good attenuation at frequencies to 1GHz and are intended for use in systems with multiple input or output power lines. Current ratings are 10A-200A and all meet IEC 950 (EN60950). **FN 75xx** capacitors for dc use are available in values from 2.2nF to 1000nF and in dc versions from 10nF to 4700nF. They are all of series design to reduce voltage stress on individual elements, so that the ac versions can be used at up to 300V ac. Direct current types are for use to 130V and 2.5kV pulse. Schaffner EMC Ltd. Tel., 0118 9770070; fax, 0118 9792969.
Enquiry no 517

Hardware

Slides. Widney offers two brochures on telescopic slides for equipment cabinets. One of them details slides to carry loads up to 70kg, the other for loads to 320kg and above. Two, three and four-beam types are described, with extensions from 50% to 140% and the range includes versions in aluminium or steel with caged bearings or in nylon-coated material. Widney Enclosures Ltd. Tel., 0121 327 5500; fax, 0121 328 2466.
Enquiry no 519

Feet. More than just feet, really. Richco's **Handy Grips** are soft, sticky pads for use as feet, but also for vibration reduction, cushions between surfaces and as grommets. Richco will supply any shape in various thicknesses on rolls. Richco International Co., Ltd. Tel., 01474 327527; fax, 01474 327455.
Enquiry no 520

Fan. Substantially heartier in performance than the earlier **614**, Papst's new **614H** cooling fan pulls through 46 cubic metres per hour, against the 614's 40. It has an electronically commutated external-rotor dc motor, and integrated electronics for commutation and reverse-polarity protection. There is also protection against blocking and overloading by positive temp. comp. resistor. The fans have ball-bearings,

noise produced is 44dBa and power needed 3.4W. XP plc. Tel., 01734 845515; fax, 01734 843423.
Enquiry no 521

Test and measurement

Portable digital weight indicator. Working with up to four load cells, the **Model 758** weight indicator from Control Transducers will sit on a desk or can be wall-mounted. It is meant for industries such as food, shipping, materials handling and may be organised to suit in respect of capacity, scale and units. The indicator is a full five-digit, seven-segment type with 18mm characters and may be battery powered or use an adaptor from the mains supply. Conversion rate is four per second. It also has a serial printer port. Control Transducers. Tel., 01234 217704; fax, 01234 217083.
Enquiry no 522

1MHz waveform amplifier. Thurlby Thandar's **WA301** amplifier is intended mainly to amplify the output from a function generator to 30V pk-pk emf out of 50Ω, a 600Ω output also being available; it will drive 300mA into a low impedance or a short circuit. Gain is variable between 1 and 10, adjustment being made by a rotary vernier, calibrated at the end stops, and a 20dB attenuator is provided. If output exceeds the ±15V, a led indicates the fact. Thurlby Thandar Instruments Ltd. Tel., 01480 412451; fax, 01480 450409.
Enquiry no 523

Temperature indicators. Two indicators from Lascar lay claim to being the world's hottest and coolest. The **DTM910** uses a Pt100 sensor to measure temperatures between 0 and 200°C to 0.1°C resolution or -200°C and 850°C to 1°C resolution, a PT-type probe being available to make the module a complete system. The second, the **DTM995**, uses a K-type thermocouple and works at temperatures in the -50°C to 600°C range, on-board junction compensation eliminating effects due to ambient temperature. Both types are adjustable by means of 20-turn pots and both are in carriers for bolting in place or panel mounting. Lascar Electronics Ltd. Tel., 01794 884567; fax, 01794 884616.
Enquiry no 525

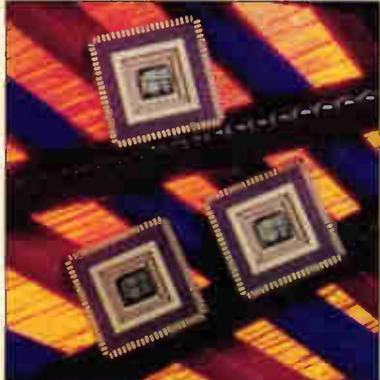
Mixed-signal dso. Yokogawa's **DL2700** is a digital storage oscilloscope having eight analogue signal-capture channels and 32 digital inputs for mixed-signal application. Memory holds up to 16Mword, or 512K to 8M/channel, and sampling is at 500Msample/s. Each channel has a 200Msample/s a-to-d converter and a bandwidth of 150MHz. A dual-zoom display shows the whole captured waveform and two selected parts of it and there is a history function to hold



Encapsulated panel meters. Panel meters in a range by Datel are encapsulated in epoxy resin and are therefore usable in areas in which they are likely to be washed down. The **DMS-20/30/40** meters are in three sizes: 9.4mm, 13.2mm and 14.2mm to provide a choice of low-power or high intensity, with red or green as an option. Differential inputs are ±200mV, ±2V and ±20V to within ±1 count, or ±2 counts for the 20V type. DMS-20 has a power-down function and optional display hold. Display, hold and test are available on all models. Farnell Components Ltd. Tel., 0113 263 6311; fax, 0113 263 3411.
Enquiry no 524

up to 1000 screens, while a sequential store captures signals at 10µs intervals. Maths functions include Fast Fourier transforms and built-in processing allows automatic waveform measurement with histograms, waveform calculations and scaling to convert voltages to physical values. There is a built-in printer and GPIB interface. Martron Instruments Ltd. Tel., 01494 459200; fax, 01494 535002.
Enquiry no 526

Arbitrary waveform generator. A pc-compatible bus card that will carry out 12-bit d-to-a conversion at 80Msample/s, LeCroy's **SigGenCard 1100** converts a digital input to an analogue output waveform, providing arbitrary waveform generation with no need for programming. Conversion rate is faster than the ISA bus, so that digital data is placed in on-board memory and output at a high clock rate, memory being 512Ksample expandable to 16Msample. Data can also be downloaded continuously to the d-to-a converter for process control or manufacturing by the use of dual-port memories on the card, which allow downloading during conversion. Windows software is included, one of its features being the provision of data to create waveforms from equations and from a library. LeCroy Ltd. Tel., 01189 344882; fax, 01189 348900.
Enquiry no 527



75MHz hdtv filter. Forming part of a range of building blocks for digital television, Garfield Microelectronics' **GF2246** filter provides 75MHz digital image data, coefficient input and computation rate needed for the hdtv system. It is suitable for pixel interpolation in image manipulation and filtering and will carry out bilateral interpolation at real time video rates when used with an image resampling sequencer. It consists of an array of four 11 by 10 bit multipliers having individual data and coefficient inputs, feeding a 25-bit accumulator to allow word growth to 25 bits. Users may configure the inputs to accept 10-bit input data or 11-bit coefficient data. Garfield Microelectronics Ltd. Tel., 01256 384300; fax, 01256 384319.
Enquiry no 517

Please quote "Electronics World" when seeking further information

Oscilloscope calibrator. Wavetek's Model 9500/3200 Scope Cal workstation uses the company's active head technique to calibrate oscilloscope bandwidth up to 3.2GHz, no other equipment being needed. The active head senses signal amplitude close to the oscilloscope input and delivers, via an accurate 50Ω path, an input with ac flatness relative to 50kHz of 0.45dB, adjustable from 4.44mV to 2.22V to suit all the input ranges of the instrument under test. Other waveforms receiving the same treatment include fast pulse-testing signals. Five such active heads may be used by one workstation, with no changing of connections being needed. Relevant software is provided. Wavetek Ltd. Tel., 01603 256686; fax, 01603 483670.

Enquiry no 528

Literature

Enclosures. Vero offers the Patina range of small plastic enclosures, moulded in flame-retardant ABS in twelve sizes. They will all take pcbs vertically or horizontally and they can all be provided with an internal copper/silver screen to give a typical

Audio analyser. Now available in the UK is the Portable One Plus Access audio analyser by Audio Precision, which possesses the attributes of the earlier Portable One Plus, but with additional functions. One is the save/recall feature that allows up to 30 instrument configurations to be saved and used again in the future, all time-stamped by the internal clock and calendar. Another is the provision for an amplitude sweep, in which the horizontal trace corresponds to the amplitude of a signal and the Y direction to, for example, distortion. There are also improved print facilities for various types of printer. All these features are available in upgrade form for existing users. Thurlby-Thandar Instruments Ltd. Tel., 01480 412451; fax, 01480 450409.

Enquiry no 529



attenuation of over 60dB at 1MHz or 20dB at 1GHz. Aluminium front panels are provided. Vero Electronics Ltd. Tel., 01703 266300; fax, 01703 265126.

Enquiry no 531

Dsp on the Web. BORES Signal Processing has opened an Internet site to teach engineers the elements of digital signal processing in a practical way, from the basics of the subject, by way of time-domain processing, frequency analysis using Fourier, filtering, practical processing and systems to programming and operating systems. There are ample links forward and backwards and to other Internet sites for further reading. Site address is <http://www.bores.com/courses/intro/in dex.htm>. BORES Signal Processing. Tel., 01483 740138; fax, 01483 740136.

Enquiry no 532

Materials

Heat-shrink tubing. Birch Valley Plastics has a new type of adhesive-lined heat-shrink tube, designed to provide a moisture-proof seal. It is available in black in 1.2m lengths and is approved to Underwriters Laboratory standard 224 Birch Valley Plastics Ltd. Tel., 01752 696515; fax, 01752 696724.

Enquiry no 533

Production equipment

Fluid dispenser. For precision application of all low to medium viscosity fluids in the manufacturing process, the LCL DispensTech TS5620 Diaphragm Valve is meant for use in component assembly in electronics. The valves are available as horizontal or vertical versions for incorporation into semi or automatic systems, in which they operate at frequencies up to 500cycles/min to dispense fluid in volumes from 0.002cc upwards. Fast, positive shut-off is achieved by the short stroke, which is calibrated, and the wet parts last for 5million cycles. Units can be supplied as systems, with controller and reservoir. LCL DispensTech. Tel., 01993 277571; fax, 01993 440273.

Enquiry no 534



Power supplies

Pwm controller. Unitrode's UCC3808 is a 1MHz, low-power, push-pull pulse-width modulation controller for use in half-bridge voltage converters using the established methods of the UCC380x family. It contains control and drive circuits needed for off-line or dc-to-dc, fixed-frequency, current-mode switching power supplies and needs few external components. As a dc-to-dc converter, it will handle 5V dc input to give ±12V dc out at between 1W and 10W; two versions possess undervoltage lockout of 12.5V or 4.3V. The output drivers can supply 500mA peak source current or 1A peak sink. Unitrode (UK) Ltd. Tel., 0181 318 1431; fax, 0181 318 2549.

Enquiry no 535

2.8kW rectifier. With telecommunications in mind, Weir Lambda has introduced the Type WLR2800 ac-to-dc power supply, which is a switched-mode unit accepting a single-phase ac input and providing 24V dc or 48V dc output. It is rack-mounted, fan-cooled and meets the relevant international standards. Options include output trim and output 'droop', which is a method of arranging accurate current sharing. There are comprehensive protection and alarm facilities and the choice of various types of input/output connectors and mountings. Weir Electronics Ltd. Tel., 01243 865991; fax, 01243 868613.

Enquiry no 536

Low drop-out regulators. All four of Rohm's surface-mounted BA028/030/032/038 voltage regulators are rated at dropout voltages of 90mV at 50mA. Ripple rejection is high at 66dB with a small C connected from output to bypass pin and output voltages are 2.8V etc. Power saving is via the output enable pin. Rohm Electronics UK Ltd. Tel., 01908 282666; fax, 01908 282528.

Enquiry no 537

More low drop-out regulators. Amega's AS2804 family of SOT-23 regulators have a tolerance of 1-2%,

130°C lithium cells.

SL500 series high temperature tolerant lithium batteries are available from CMP Batteries Standby Division. Three sizes are half AA, two thirds AA and full AA. Outputs range from 0.65 to 1.5Ah. Operating temperature of this thionyl chloride system extends from -55° to +130°C. Terminal cell output is high, at 3.6V and energy density is up to 675Wh/dm. All components of the cell are optimised for maximum temperature resistance and can withstand continuous temperatures of 115°C (239°F) for 18 months or 85° (185°F) for ten years. Self discharge rate is 1% during a shelf life of up to 10 years. CMP Batteries Standby Division, Tel 01483 359 090, 727684.

Enquiry no 530

quiescent current 500µA at 30mA output and drop-out 500mV at 50mA. They are fixed or adjustable from 2.5V to 6V via the ref/bypass pin, which takes a small external capacitor for noise reduction. Other packages offered are TO-92 and SOT-89. Amega Technology Ltd. Tel., 01256 843166; fax, 01256 842956.

Enquiry no 538

Power regulators. Hybrid switched-mode regulators in Allegro's STR-F6600 series are capable of handling output power from 20W to 300W, a fully-protected control ic and avalanche-rated power mosfet in the package allowing the device to be set to the input voltage and power needed. Three operating modes are provided: a quasi-resonant mode to reduce emi and to confer maximum efficiency; contact off-time flyback for low-power standby; and flyback working in sync. to an external clock. Switching frequency is up to 300kHz. Hysteretic undervoltage lockout and thermal protection are incorporated.

Please quote "Electronics World" when seeking further information

Allegro MicroSystems Inc. Tel., 01932 253355; fax, 01932 246622.
Enquiry no 539

Protection devices

Varistors. *UltraMOV* metal-oxide varistors are particularly suited to the protection from transients of ac-powered equipment. They come in 7, 10, 14 and 20mm radial-lead packaging, having surge current ratings of 1.75kA to 10kA and energy ratings from 12.5j to 400j. Each size has versions handling voltages from 130V ac to 625V ac. Harris Semiconductor UK. Tel., 01276 686886; fax, 01276 682323.
Enquiry no 540

Switches and relays

Indicating rocker switch. From Defond comes the *CRL* rocker switch that gives the effect of illumination without the use of power; there is no light source. What happens is that a red, green or orange flag, very visible, shows through a circular, transparent window to show which position the switch is in. The switch function is spst and it is rated at 8A/250V dc, 16A/125V ac. Roxburgh Electronics Ltd. Tel., 01724 281770; fax, 01724 281650.
Enquiry no 540

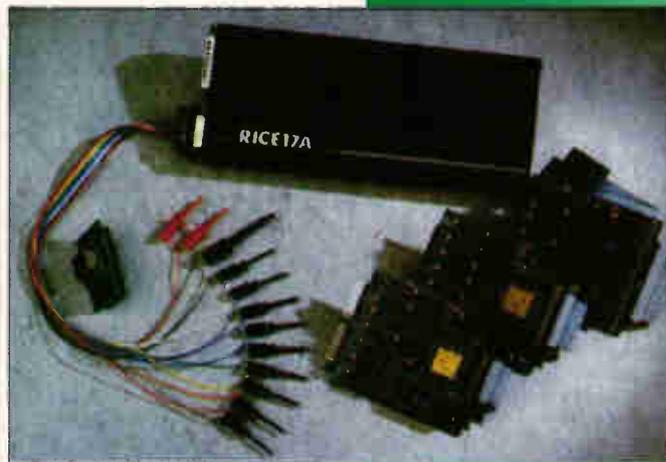
Miniature rotary switch. The *1R3* miniature, surface-mounted rotary switch from EAO-Highland comes in two forms, having either two positions

with an end stop or three positions and no stop. It is meant to be used for setting up equipment and is therefore provided with screwdriver adjustment to avoid accidental turning. Operation is semi snap-action with non-shorting contacts and the unit is sealed to cope with soldering and cleaning. EAO-Highland Electronics Ltd. Tel., 01444 236000; fax, 01444 236641.
Enquiry no 541

Transducers and sensors

Hole-punch solenoids. Solenoids producing enough force to punch 1mm or 2mm holes in paper, card or plastic are on offer from Densitron, who intends them for ticket punching and the like. A profile is ground on the end of the hardened solenoid shaft and a mating die formed on the solenoid base. Densitron Europe Ltd., 01959 700100; fax, 01959 700300.
Enquiry no 542

Mechanical encoders. Grayhill's *Series 25B* mechanical rotary encoders are made to ISO-9001 and military standards and come with up to four decks and a choice of mounting and terminations. Angles of throw vary between 10° for 36 positions and 90°, standard code being quadrature 2-bit, with binary and Gray codes being available in the 16-position version. Continuous rotation or a number of stop positions



may be specified by the user, as may shaft and panel sealing, shaft diameter and different throw angles. EAO-Highland Electronics Ltd. Tel., 01444 236000; fax, 01444 236641.
Enquiry no 543

COMPUTER

Embedded pc. Advantech's compact 486 single-board computer, the *PCM-4825*, has on-board 32-bit svga and lcd interfaces and a 16-bit *Sound Blaster Pro* audio controller. Being about the size of a 3.5in floppy disk, it will find application in Global Positioning systems, cars and portable instruments. A socket is provided for flash disk expansion up to 24Mbyte and there is a PC/104 connector. Optionally, the unit may be provided with a case and an lcd kit. Semicom UK Ltd. Tel., 01279 422224; fax, 01279 433339.
Enquiry no 545

Data acquisition

Faster acquisition. Datal's families of analogue-input data acquisition boards for PCibus, ISA and VME use now contain faster members using a different mode of operation; they are for use with Pentium-based, Windows95/NT computers. The new boards have one a-to-d converter per channel – a speedier method than having a single, multiplexed converter, since each is on-line all the time, there are no delays for the multiplexer to switch and settle and in addition there is no crosstalk. Throughput is now in the megahertz range. The *PCI-416M* is a bus master with state-machine controller and fifo; *PCI-414M* has four a-to-ds and 16K a-to-d sample deep fifo for streaming to ram or disk; and the *PCI-430M* is a floating-point, 40MHz dsp co-processor. There are equivalents for the VMEbus. Datal (UK) Ltd. Tel., 01256 880444; fax, 01256 880706.
Enquiry no 546

Development and evaluation

3V PIC16/17 emulator. Capable of running on a 3V supply, the *RICE17A* emulator from Smart supports all PIC16/17 and PIC12C50X microcontrollers via 'personality' probes, the system including an 8k by 24-bit, real-time trace memory. It overcomes the problem of the extra instruction cycle needed by bondout chips before i/o ports can be updated, updating all ports instantaneously and, to check the working of probes with the latest PIC designs, includes a diagnostic test to check the functional blocks of the emulator. The emulator is complete with MPASM assembler, dds and Windows software. Web address is <http://smart.com.co.uk>. Smart Modular Technologies, Tel. 01908 234030; fax, 01908 234191.
Enquiry no 548

Data communications

Ethernet controllers. Small, low-cost Ethernet controllers by Crystal Semiconductors, the *CS8900/8904* are meant for embedded systems and pc motherboards. The *CS8900* is a 10BASE-T transceiver including buffer ram, transmit/receive filters and a direct ISA interface with 24mA drivers on-chip, the whole Ethernet circuit taking up only 1.5in² of board space while also providing automatic accommodation of traffic patterns and system resources by means of its PacketPage feature. *CS8904* has four endecds and transceivers with active, analogue filters, forming in the one package a four-port Ethernet implementation in under 1in² while supporting full or half duplex operation, automatically selected. Software for a number of operating systems is available. Sequoia Technology Ltd. Tel., 01734 258000; fax, 01734 258020.
Enquiry no 547

Second workstation for £320. Sharedware Ltd can supply a second low-cost workstation to allow its user and the user of the shared workstation to work completely independently. The second station has an independent Windows 95 desktop. The setup consists of a standard Pentium pc running Windows 95 and containing a Sharedware ISA card. This card feeds a remote module for the second workstation. This module connects the second svga monitor, PS/2 keyboard and PS/2 mouse. The card fits into the host workstation and is connected to the remote station module by up to 15m of cable. There is no proprietary operating system in the second station. Both users may access all files and applications on the hard disk at the same time and may also use CD-rom, floppy disk, printer and scanner. In addition both may log on to a network simultaneously, as well as the Internet. Sharedware Ltd. Tel., 01274 401010; fax, 01274 200311.
Enquiry no 544



Surplus always wanted for cash!

THE ORIGINAL SURPLUS WONDERLAND!

THIS MONTH'S SELECTION FROM OUR VAST EVER CHANGING STOCKS

Surplus always wanted for cash!

LOW COST PC's -

SPECIAL BUY 'AT 286'

40Mb HD + 3Mb Ram



LIMITED QUANTITY only of these 12Mhz HI GRADE 286 systems Made in the USA to an industrial specification, the system was designed for total reliability. The compact case houses the motherboard, PSU and EGA video card with single 5 1/4" 1.2 Mb floppy disk drive & Integral 40Mb hard disk drive to the front. Real time clock with battery backup is provided as standard. Supplied in good used condition complete with enhanced keyboard, 640k + 2Mb RAM, DOS 4.01 and 90 DAY Full Guarantee. Ready to Run!
Order as HIGRADE 286 **ONLY £129.00 (E)**

Optional Fitted extras: VGA graphics card	£29.00
1.4Mb 3 1/2" floppy disk drive (instead of 1.2 Mb)	£19.95
Wordperfect 6.0 for Dos - when 3 1/2" FDD option ordered	£22.50
NE2000 Ethernet (thick, thin or twisted) network card	£29.00

LOW COST 486DX-33 SYSTEM

Limited quantity of this 2nd user, superb small size desktop unit. Fully featured with standard simm connectors 30 & 72 pin. Supplied with keyboard, 4 Mb of RAM, SVGA monitor output, 256k cache and integral 120 Mb IDE drive with single 1.44 Mb 3.5" floppy disk drive. Fully tested and guaranteed. Fully expandable
Only **£399.00 (E)**
Many other options available - call for details.

FLOPPY DISK DRIVES 3 1/2" - 8"

5 1/4" or 3 1/2" from only £18.95!

Massive purchases of standard 5 1/4" and 3 1/2" drives enables us to present prime product at industry beating low prices! All units (unless stated) are BRAND NEW or removed from often brand new equipment and are fully tested, aligned and shipped to you with a 90 day guarantee and operate from standard voltages and are of standard size. All are IBM-PC compatible (if 3 1/2" supported on your PC).

3 1/2" Panasonic JU363/4 720K or equivalent RFE	£24.95(B)
3 1/2" Mitsubishi MF355C-L 1.4 Meg. Laptops only	£25.95(B)
3 1/2" Mitsubishi MF355C-D 1.4 Meg. Non laptop	£18.95(B)
5 1/4" Teac FD-55GFR 1.2 Meg (for IBM pc's) RFE	£18.95(B)
5 1/4" Teac FD-55F-03-U 720K 40/80 (for BBC's etc) RFE	£29.95(B)
5 1/4" BRAND NEW Mitsubishi MF501B 360K	£22.95(B)
Table top case with integral PSU for HH 5 1/4" Floppy or HD	£29.95(B)
8" Shugart 800/801 8" SS refurbished & tested	£195.00(E)
8" Shugart 810 8" SS HH Brand New	£195.00(E)
8" Shugart 851 B" double sided refurbished & tested	£250.00(E)
Mitsubishi M2894-63 8" double sided NEW	£275.00(E)
Mitsubishi M2896-63-02U 8" DS slimline NEW	£285.00(E)
Dual 8" cased drives with integral power supply 2 Mb	£499.00(E)

HARD DISK DRIVES

End of line purchase scoop Brand new NEC D2246 8" 85 Mbyte drive with industry standard SMD interface, replaces Fujitsu equivalent model. Full manual. Only £299.00 or 2 for £525.00 (E)

3 1/2" FUJI FK-309-26 20mb MFM I/F RFE	£59.95(C)
3 1/2" CONNER CP3024 20 mb IDE I/F (or equiv) RFE	£59.95(C)
3 1/2" CONNER CP3044 40mb IDE I/F (or equiv) RFE	£69.00(C)
3 1/2" RODIME R03057S 45mb SCSI I/F (Mac & Acorn)	£69.00(C)
3 1/2" WESTERN DIGITAL 850mb IDE I/F Brand New	£185.00(C)
5 1/4" MINISCRIBE 3425 20mb MFM I/F (or equiv) RFE	£49.95(C)
5 1/4" SEAGATE ST-238R 30 mb RLL I/F Refurb	£69.95(C)
5 1/4" CDC 94205-51 40mb HF MFM I/F RFE tested	£69.95(C)
5 1/4" HP 9754B 850 Mb SCSI RFE tested	£89.00(C)
5 1/4" HP C3010 2 Gbyte SCSI differential RFE tested	£195.00(C)
8" FUJITSU M2322K 160Mb SMD I/F RFE tested	£195.00(E)

Hard disc controllers for MFM, IDE, SCSI, RLL etc. from £16.95

THE AMAZING TELEBOX

Converts your colour monitor into a QUALITY COLOUR TV!!



TV SOUND & VIDEO TUNER
CABLE COMPATIBLE

The TELEBOX is an attractive fully cased mains powered unit, containing all electronics ready to plug into a host of video monitors made by makers such as MICROVITEC, ATARI, SANYO, SONY, COMMODORE, PHILIPS, TATUNG, AMSTRAD etc. The composite video output will also plug directly into most video recorders, allowing reception of TV channels not normally receivable on most television receivers* (TELEBOX MB). Push button controls on the front panel allow reception of 8 fully tuneable 'off air' UHF colour television channels. TELEBOX MB covers virtually all television frequencies VHF and UHF including the HYPERBAND as used by most cable TV operators. A composite video output is located on the rear panel for direct connection to most makes of monitor or desktop computer video systems. For complete compatibility - even for monitors without sound - an integral 4 watt audio amplifier and low level Hi Fi audio output are provided as standard.

TELEBOX ST for composite video input type monitors	£36.95
TELEBOX STL as ST but fitted with integral speaker	£39.50
TELEBOX MB Multiband VHF/UHF/Cable/Hyperband tuner	£69.95

For overseas PAL versions state 5.5 or 6 MHz sound specification. *For cable / hyperband reception Telebox MB should be connected to a cable type service. Shipping code on all Telebox's is (B)

DC POWER SUPPLIES

Virtually every type of power supply you can imagine. Over 10,000 Power Supplies Ex Stock
Call for info / list.

IC's - TRANSISTORS - DIODES

OBSOLETE - SHORT SUPPLY - BULK

6,000,000 items EX STOCK

For MAJOR SAVINGS - CALL FOR SEMICONDUCTOR HOTLIST

VIDEO MONITOR SPECIALS

One of the highest specification monitors you will ever see -
At this price - Don't miss it!!

Mitsubishi FA3415ETKL 14" SVGA Multisync colour monitor with fine 0.28 dot pitch tube and resolution of 1024 x 768. A variety of inputs allows connection to a host of computers including IBM PC's in CGA, EGA, VGA & SVGA modes, BBC, COMMODORE (including Amiga 1200), ARCHIMEDES and APPLE. Many features: Etched faceplate, text switching and LOW RADIATION MPR specification. Fully guaranteed, supplied in EXCEL-

LENT little used condition.
Tilt & Swivel Base £475
VGA cable for IBM PC included.
Only **£119 (E)** Order as MITS-SVGA

External cables for other types of computers CALL

As New - Used on film set for 1 week only!!
15" 0.28 SVGA 1024 x 768 res. colour monitors.
Swivel & tilt etc. Full 90 day guarantee. **£145.00 (E)**

Just In - Microvitec 20" VGA (800 x 600 res.) colour monitors.
Good SH condition - from £299 - CALL for Info

PHILIPS HCS35 (same style as CM8833) attractively styled 14" colour monitor with both RGB and standard composite 15.625 KHz video inputs via SCART socket and separate phono jacks. Integral audio power amp and speaker for all audio visual uses. Will connect direct to Amiga and Atari BBC computers. Ideal for all video monitoring / security applications with direct connection to most colour cameras. High quality with many features such as front concealed flap controls, VCR correction button etc. Good used condition - fully tested - guaranteed
Dimensions: W14" x H12 3/4" x 15 1/2" D.
Only **£95 (E)**

PHILIPS HCS31 Ultra compact 9" colour video monitor with standard composite 15.625 KHz video input via SCART socket. Ideal for all monitoring / security applications. High quality, ex-equipment fully tested & guaranteed (possible minor screen burns). In attractive square black plastic case measuring W10" x H10" x 1 1/2". 240 V AC mains powered.
Only **£79.00 (D)**

KME 10" 15M10009 high definition colour monitors with 0.28" dot pitch. Superb clarity and modern styling. Operates from any 15.625 khz sync RGB video source, with RGB analog and composite sync such as Atari, Commodore Amiga, Acorn Archimedes & BBC. Measures only 13 1/2" x 12" x 1 1/2". Good used condition.
Only **£125 (E)**

20" 22" and 26" AV SPECIALS

Superbly made UK manufacture. PIL all solid state colour monitors, complete with composite video & optional sound input. Attractive teak style case. Perfect for Schools, Shops, Disco, Clubs, etc. In EXCELLENT little used condition with full 90 day guarantee.

20"£135 22"£155 26"£185 (F)

SPECIAL INTEREST ITEMS

MITS. FA3445ETKL 14" Industrial spec SVGA monitors	£245
2Kw to 400 kw - 400 Hz 3 phase power sources - ex stock	£950
IBM 8230 Type 1, Token ring base unit driver	£750
IBM 53F5501 Token Ring ICS 20 port base modules	£95
IBM MAU Token ring distribution panel 8228-23-5050N	£550
AIM 501 Low distortion Oscillator 9Hz to 330KHz, IEEE	£550
Trend DSA 274 Data Analyser with G703(2M) 64 io	£6500
Marconi 6310 Programmable 2 to 22 GHz sweep generator	£3750
HP1650B Logic Analyser	£950
HP3781A Pattern generator & HP3782A Error Detector	£1800
HP APOLLO RX700 system units	£175
HP6621A Dual Programmable GPIB PSU 0-7 V 160 watts	£675
HP3081A Industrial workstation c/w Barcode swipe reader	£1850
HP54121A Dc to 22 GHz four channel test set	£650
HP5780A A1 8 pen HPGL high speed drum plotter	£1425
EG+G Brookdeal 95035C Precision lock in amp	£3750
View Eng. Mod 1200 computerised inspection system	£1950
Ling Dynamics 2Kw programmable vibration test system	£2200
Computer controlled 105 v x 560 mm X Y table & controller	£1200
Kelthly 590 CV capacitor / voltage analyser	£1150
Racal ICR40 dual 40 channel video recorder system	£1450
Fiskers 45K 3 ph On Line UPS - New batts Dec. 1995	£3500
ICI R5030UV34 Cleanline ultrasonic cleaning system	£2200
Man Tally M7645 High speed line printer	£1200
Intel 5BC 486/133SE Multibus 486 system. 8Mb Ram	£1150
Zeta 3220-05 A0 4 pen HPGL / fast drum plotters	£1450
Nikon HF-X-11 (Ephiphot) exposure control unit	£550
Motorola VME Bus Boards & Components List. SAE / CALL	£1950
Tri-o 18 vdc linear, metered 30 amp bench PSU. New	£1950
Fujitsu M3041R 600 LPM band printer	£200
Fujitsu M3041D 600 LPM printer with network interface	£3750
Perkin Elmer 2998 Infrared spectrophotometer	£950
VG Electronics 1035 TELETEXT Decoding Margin Meter	£1995
Andrews LARCE 3.1 m Satellite Dish + mount (For Voyager)	£485
Sekonic SD 150H 18 channel digital hybrid chart recorder	£300
Test Lab - 2 ml square quietest acoustic test cabinets	£650
Kenwood 9601 PAL Vectorscope - NEW	

Please call for further details on the above items



19" RACK CABINETS

Superb quality 6 foot 40U
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 louvered 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 to stand singly or in multiple bays. Overall dimensions are: 77 1/2" H x 32 1/2" D x 22" W. Order as:

OPT Rack 1 Complete with removable side panels.	£335.00 (G)
OPT Rack 2 Rack, Less side panels	£225.00 (G)

32U - High Quality - All steel RakCab

Made by Eurocraft Enclosures Ltd to the highest possible spec, rack features all steel construction with removable side, front and back doors. Front and back doors are hinged for easy access and all are lockable with five secure 5 lever barrel locks. The front door is constructed of double walled steel with a 'designer style' smoked acrylic front panel to enable status indicators to be seen through the panel, yet remain unobtrusive. Internally the rack features fully slotted reinforced vertical fixing members to take the heaviest of 19" rack equipment. The two movable vertical fixing struts (extras available) are pre punched for standard 'cage nuts'. A mains distribution panel internally mounted to the bottom rear, provides 8 x IEC 3 pin Euro sockets and 1 x 13 amp 3 pin switched utility socket. Overall ventilation is provided by fully louvered back door and double skinned top section with top and side louvers. The top panel may be removed for fitting of integral fans to the sub plate etc. Other features include: fitted castors and floor levers, pre-punched utility panel at lower rear for cable / connector access etc. Supplied in excellent, slightly used condition with keys. Colour Royal blue. External dimensions mm=1625H x 635D x 603 W. (64" H x 25" D x 23 3/4" W)
Sold at less than a third of makers price !!

A superb buy at only £195.00 (G)

Over 1000 racks - 19" 22" & 24" wide
3 to 44 U high. Available from stock !!
Call with your requirements.

TOUCH SCREEN SYSTEM

The ultimate in 'Touch Screen Technology' made by the experts - MicroTouch - but sold at a price below cost !! System consists of a flat translucent glass laminated panel measuring 29.5 x 23.5 cm connected to an electronic controller PCB. The controller produces a standard serial RS232 or TTL output which continuously gives simple serial data containing positional X & Y co-ordinates as to where a finger is touching the panel - as the finger moves, the data instantly changes. The X & Y information is given at an incredible matrix resolution of 1024 x 1024 positions over the entire screen size !! A host of available translation software enables direct connection to a PC for a myriad of applications including: control panels, pointing devices, POS systems, controllers for the disabled or computer un-trained etc. Imagine using your finger with 'Windows', instead of a mouse !! (a driver is indeed available!) The applications for this amazing product are only limited by your imagination!! Complete system including Controller, Power Supply and Data supplied at an incredible price of only: **£145.00 (E)**
Full MICROTOUCH software support pack and manuals for IBM compatible PC's £29.95 RFE - Tested

LOW COST RAM & CPU'S

INTEL 'ABOVE' Memory Expansion Board. Full length PC-XT and PC-AT compatible card with 2 Mbytes of memory on board. Card is fully selectable for Expanded or Extended (286 processor and above) operation. Full data and driver disks supplied. RFE. Fully tested and guaranteed. Windows compatible. **£59.95 (A1)**
Half length 8 bit memory upgrade cards for PC AT XT expands memory either 256k or 512k in 64k steps. May also be used to fill in RAM above 640k DOS limit. Complete with data.
Order as: XT RAM UG. 256k. £34.95 or 512k £39.95 (A1)

SIMM SPECIALS

1 MB x 9 SIMM 9 chip 120ns	Only £16.50 (A1)
1 MB x 9 SIMM 3 chip 80 ns	£22.95 (A1)
1 MB x 9 SIMM 9 chip 80 ns	£21.50 or 70ns £27.75 (A1)
4 MB 70 ns 72 pin SIMM - with parity	Only £65.00 (A1)
INTEL 486-DX33 CPU	£55.00
INTEL 486-DX66 CPU	£69.00 (A1)

FULL RANGE OF CO-PROCESSOR'S EX STOCK - CALL FOR LIST

FANS & BLOWERS

EPSON D0412 40x40x20 mm 12v DC	£7.95 10 / £65
PAPST TYPE 612 60x60x25 mm 12v DC	£8.95 10 / £75
MITSUBISHI MMF-D6D12D 60x60x25 mm 12v DC	£4.95 10 / £42
MITSUBISHI MMF-08B12D 80x80x25 mm 12v DC	£5.25 10 / £49
MITSUBISHI MMF-09C12D 92x92x25 mm 12v DC	£5.95 10 / £53
PANCAKE 12-3.5 92x92x18 mm 12v DC	£7.95 10 / £69
EX-EQUIP AC fans. ALL TESTED 120 x 120 x 38 mm specify 110 or 240 v	£6.95. 80 x 80 x 38 mm - specify 110 or 240 v £5.95
IMHOF B26 1900 rack mnt 3U x 19" Blower 110/240V NEW	£79.95

Shipping on all fans (A). Blowers (B). 50,000 Fans Ex Stock CALL

Issue 13 of Display News now available - send large SAE - PACKED with bargains!

DISPLAY
-ELECTRONICS-

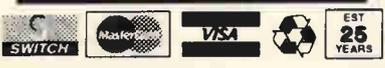
ALL MAIL & OFFICES
Open Mon-Fri 9.00-5.30
Dept WW. 32 Biggin Way
Upper Norwood
LONDON SE19 3XF

LONDON SHOP
Open Mon - Sat 9.00 - 5.30
215 Whitehorse Lane
South Norwood
On 68A Bus Route
N. Thornton Heath &
Selhurst Park SR Rail Stations

NEW DISTEL ©
The Original
FREE On line Database
Info on 20,000 + stock items!
RETURNING SOON!

ALL ENQUIRIES
0181 679 4414
FAX 0181 679 1927

All prices for UK Mainland. UK customers add 17.5% VAT to TOTAL order amount. Minimum order £10. Bona Fide account orders accepted from Government, Schools, Universities and Local Authorities - minimum account order £50. Cheques over £100 are subject to 10 working days clearance. Carriage charges (A)=£3.00, (A1)=£4.00, (B)=£5.50, (C)=£8.50, (D)=£12.00, (E)=£15.00, (F)=£18.00, (G)=CALL. Allow approx 6 days for shipping - faster CALL. Scotland surcharge CALL. All goods supplied to our Standard Conditions of Sale and unless stated guaranteed for 90 days. All guarantees on a return to base basis. All rights reserved to change prices / specifications without prior notice. Orders subject to stock. Discounts for volume. Top CASH prices for surplus goods. All trademarks acknowledged. © Display Electronics 1996. E & O E 066



CIRCLE NO. 131 ON REPLY CARD

In-system programmable logic

Having a logic device that can be altered without removing it from the board makes designing a lot easier and quicker. There's free programming and development software available and the printer port cable needed is described in a data book.

Geoff Newton explains.

Traditionally, programmable logic has had to be pre-programmed in a programmer before it can be used. In-system programmable, or ISP, logic however is programmed – and equally importantly reprogrammed – while mounted on its pcb.

Devices with ISP capability are based on electrically-erasable prom technology and so are readily erased and reprogrammed many times. Programming voltages are generated internally from the normal supply rails.

The basic method of programming is to send the program via a four or five-wire interface from the parallel printer port of the pc using download software running on the pc. It is possible to program a number of devices on a single 'daisy chain,' Fig. 1. Each device in the daisy chain can be selected and programmed without affecting the other devices.

This is one of the rare occasions when new technology is actually of benefit to engineers involved with small and one-off quantities, as well as the larger user. For the smaller business, ISP offers a reasonably affordable route into medium-level integrated solutions with all the benefits of flexibility, simplification and reduced costs. For the larger user ISP programmable logic devices are becoming a viable alternative to application-specific ICs, offering reduced development and lead times, zero non-refundable costs and large reductions in development costs.

Programming hardware for logic devices seems expensive for what it is, and it rapidly becomes out of date. In addition, you need a different adaptor for each device type.

Programmable logic concepts

Each company adopts a different approach to optimising the structure of its products in an attempt to gain advantage over its competitors. Generally though, programmable logic devices have three main blocks, Fig. 2. These are i/o cells, a programmable routing matrix and macro cells arranged in groups of varying size and name.

The macro cell is normally a programmable AND/OR array with one output connected to a register. The register can be bypassed for combinational output, giving direct access to the logic gates. Outputs of the AND array are known as product terms. Some of these can often be used to control set and preset functions and to provide a product term clock for the register.

Currently, the programmable logic used operates synchronously – but as noted on page 10 of the January issue, this may not be the case in the future. With synchronous logic, the register clock is normally derived from a global clock that supplies all the registers in the device. This minimises clock skew and simplifies the design task.

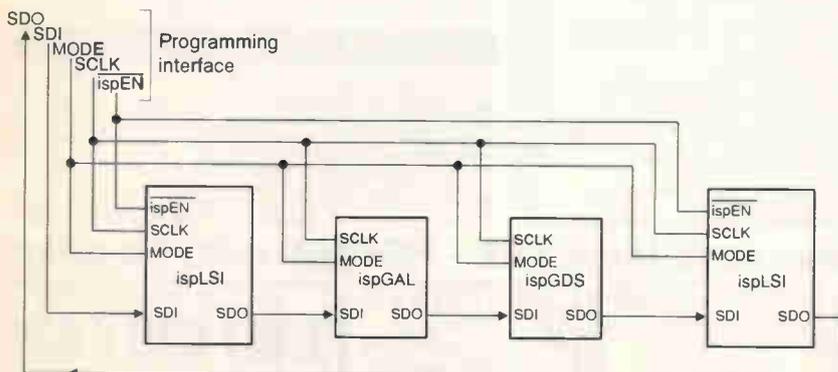
There are trade-offs between speed and complexity, cell size and so on. A large number of product terms optimises better for decoders, multiplexers etc. On the other hand, an exclusive or gate on the input to the register and fast carry chains are better for counters and arithmetic functions.

Design entry

This is a major topic in its own right. Briefly there are two design-entry methods, either by Boolean equation or by schematic diagram. An example of the Boolean equation entry is included in the 22V10 case study later on. It's a bit like writing programs in Pascal – even down to the semi colons.

Schematic capture is a matter of selecting symbols from a list, placing them on the screen and then connecting them up.

Fig. 1. If you have a number of in-system programmable devices on one pcb, they can be daisy-chained to keep the number of connections down. Even though linked serially, each device can be accessed individually.



Continued over page...

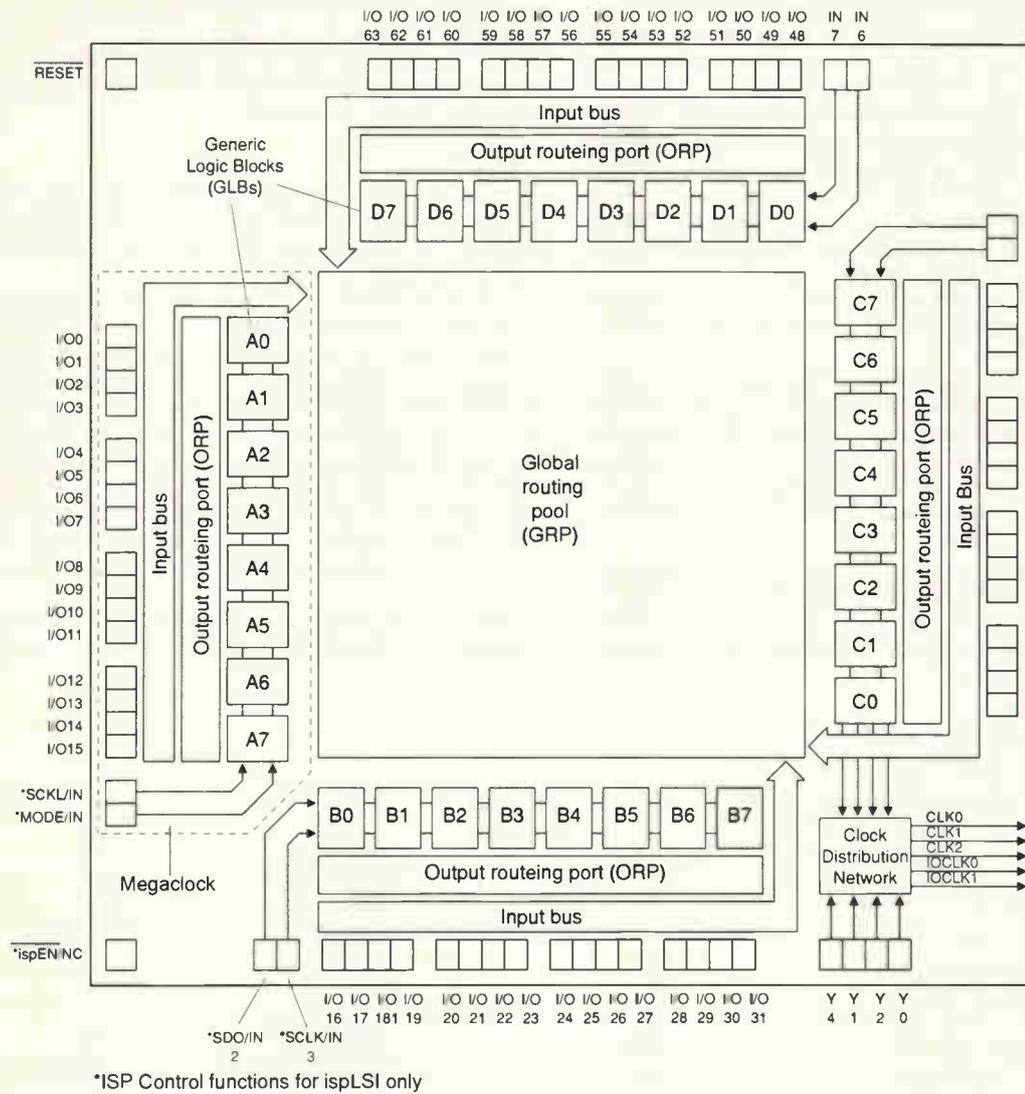


Fig. 2. Generally, programmable logic devices have three main blocks – i/o cells, a programmable routing matrix and macro cells. This is the functional block diagram of a typical programmable logic device – the Lattice 1032. There are 128 macrocells with a total of 6000 pld gates and 64 i/o cells – 64 of the programming pins share dedicated input pins (bottom left) and the fifth is ISP only. The device is housed in 84-pin PLCC or 100-pin TQFP.

What is JTAG?

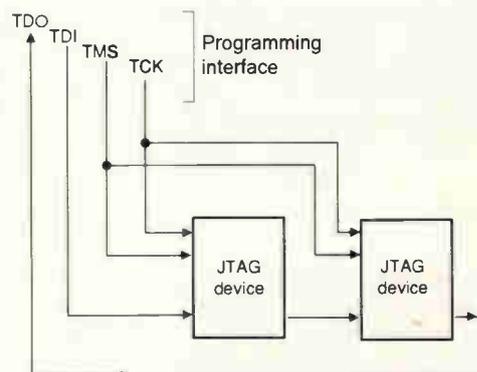
Due to worries about the testability of complex circuits a group was formed called the Joint Test Action Group. The increasing density of components and the tight lead spacing of surface-mount components means that conventional IC testing is becoming ever trickier. The solution devised is to test from within the chip. A shift register and control circuitry is built in so that the states of the i/o pins and the outputs of the core logic can be captured and shifted out for analysis.

Data can also be shifted in and the pins forced to a desired

Mnemonic	Function	Lattice equivalent
TDI	Test data in	SDI
TDO	Test data out	SDO
TMS	Test mode select	MODE
		(serial data is input for commands)
TCK	Test clock	equivalent to SCK
TRST	Test reset	optional reset

state for testing. This is known as boundary scan testing and is defined by an IEEE standard. The connections to the chip are called a test access report, or TAP for short, and a state machine controls its operation.

The technique has now been adapted so that it can also be used for programming in-system programmable devices. Four pins are normally used and there is at least one optional one.



Outline of the JTAG interface. Note the similarities with the Lattice ISP interface.

Blocks of circuitry can be made into a symbol and then incorporated into a higher level diagram. The idea is to produce a top level diagram with the main blocks and below it, successive levels of smaller blocks. The emphasis is on structured design and a systematic approach.

Boolean-based symbols can be incorporated into schematic diagrams and *visa versa*. Macro functions are pre-defined blocks/symbols representing standard ttl functions, counters and other basic logic blocks that can be used in the design. Tri-state outputs do not exist within the pld. Where ttl devices have tri-state outputs, these are converted into multiplexer functions by the compiler.

Compilation and debugging follows design entry, much as it does with programming. Some systems support full simulation and timing.

The design packages available are comprehensive and take a lot of getting used to. Be prepared to spend some time learning how to use the package. A hard copy of the manual would be useful, but not all of the packages have printed manuals. One problem with supplying hard copy may be physical size. Manuals for *Abel/Synario* cd from Vantis for example take 52Mbyte.

The *Abel/Synario* software is a combination of two packages. *Abel* is a hardware description language while *Synario* is a schematic capture package. A restricted copy of this package that can only handle the smallest devices is avail-

able free of charge. It includes downloadable program examples and data books. Altera has also made a version of its excellent *PLS-ES* program available as *PLS-WEB* on the Net.

If you can afford it, buying a fully licensed version of a manufacturer's system is preferable because it brings with it a degree of support and updates.

Programming

Assuming that you have set up the hardware properly, a fairly straightforward download program takes the JEDEC format data files and executes all the algorithms required to erase and program the logic chips.

Each ISP device type has a unique identification code that can be read by the download program. A list of the JEDEC files for the board is created and saved for future reference.

The number of devices that can be programmed is affected by the length of cabling, the pcb trace, and the drive capability of the components involved. Including buffering increases the number of devices that can be programmed.

Without buffering the pc's parallel port has to drive the cable and all of the parallel connected lines such as SCLK/TCK. In addition, the TDO/SDO pin of the last device in the chain has to drive the signal back to the parallel port.

Most cables are buffered at the pc end and so ten devices is about the limit without extra buffering. Cables are supplied

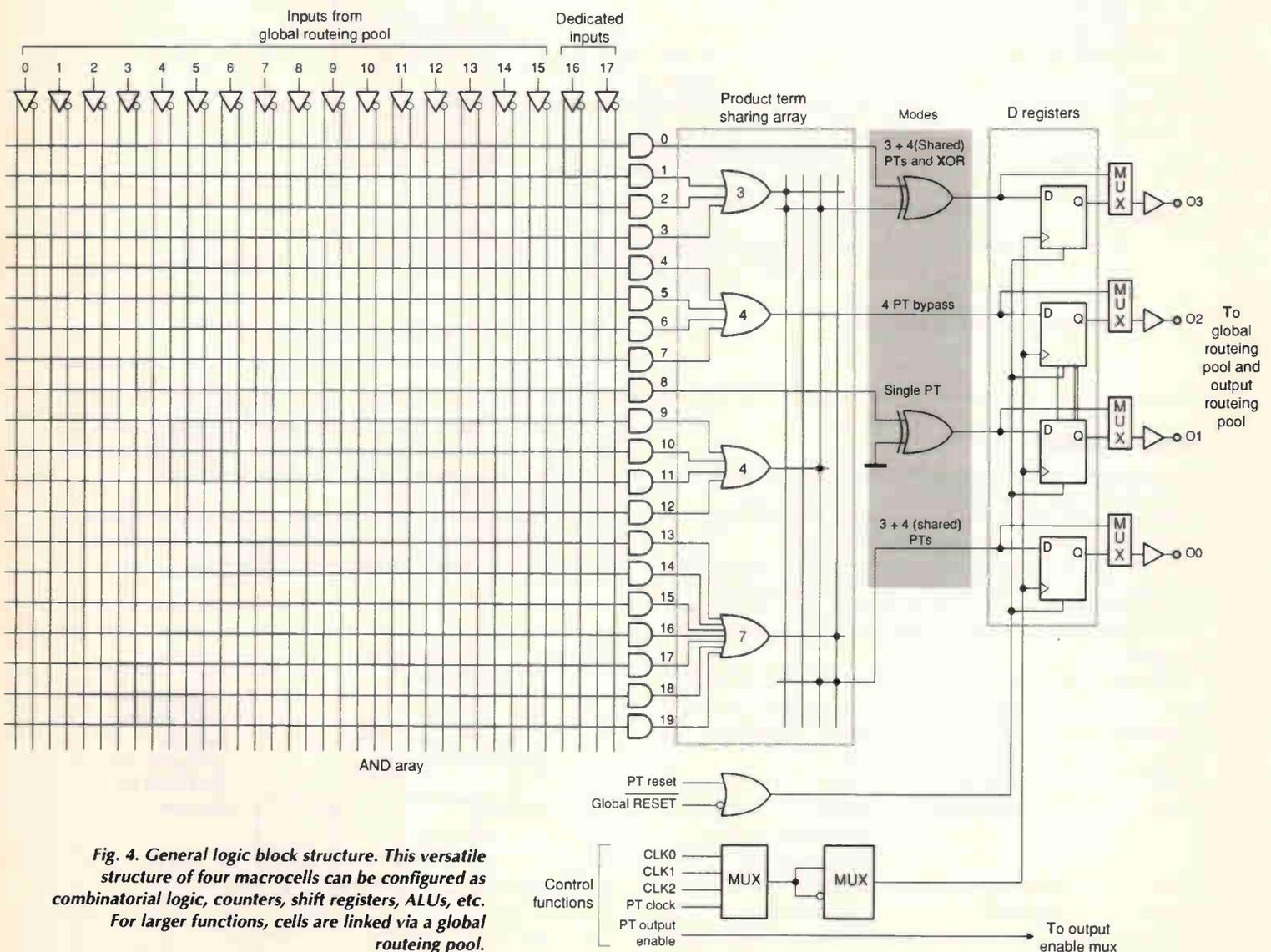


Fig. 4. General logic block structure. This versatile structure of four macrocells can be configured as combinatorial logic, counters, shift registers, ALUs, etc. For larger functions, cells are linked via a global routing pool.

by manufacturers. Lattice and Vantis supply technical details of their cables in data books.

JTAG standard

The JTAG programming and test standard is similar to the Lattice in-system programming method, except that the programming controller is accessed through the JTAG test-access port, or TAP. Special commands are used to switch to the programming mode.

JTAG and Lattice non-JTAG ISP devices can be programmed via the same lead using two loops in parallel. But there is no information on whether chained devices from different manufacturers can be programmed together.

It appears that the devices are hardware compatible but the software from one manufacturer may object to programming another manufacturer's devices.

In Fig. 1, a simple programming chain, SDI and SDO are the serial data in and out paths. The control and clock lines are parallel. The ISP enable signal is not required for small devices. The Lattice serial download cable, which can be used through a 'dongle' if need be, terminates in an eight-pin 0.1 in header connector. The extra pins allow V_{CC} and Gnd power supply lines to be routed to the parallel port adaptor for sensing and to power the buffer.

If the buffer in the adaptor is an HC logic type then it should be possible to work with 3.3V V_{CC} as well as 5V. The lead connects to the adaptor by an RJ45 connector. A second lead is provided with RJ45 connectors at both ends. I used this with a coupler to extend the lead, and was able to program a two-device board without problems.

Each device has a set of shift registers and a state machine to control programming operations. The state machine is moved from one state to another by a set of instructions sent to it by the programming software. These include ERASE, PROGRAMME, VERIFY, FLOWTHRU and NOP type instructions.

Lattice provides C source code for programming, allowing users to programme devices from embedded processors or set up programming routines in a production or test system. All the algorithms appear ready for compilation.

What's available?

Lattice was the originator of the ISP system. Its product range divides into two. The 22V10 is the only ISP device in the low density range. The fastest version can clock at

111MHz with a propagation delay of 7.5ns

The high-density range is expanded frequently and starts with the 1016 which has 16 generic logic blocks, each containing 4 macro cells. The 32 i/o pins each have an optional register giving 96 registers in total and 2000 programmable gates. It is packaged in 44-pin PLCC or TQFP.

Figure 4 shows a typical Lattice macro cell. Each of the four register inputs can take on one of the four modes shown. This is quite sophisticated, but the registers are D type only. Similar devices from other makers are simpler but have registers with T and JK type modes as well. When macro functions are used, this structure becomes completely transparent to the user.

Fig. 5. Altera grid type interconnect structure. This grid-type structure is well suited to bus-oriented designs. Each logic block is in effect a complete 16 macro cell device with its inputs and outputs connected to the grid.

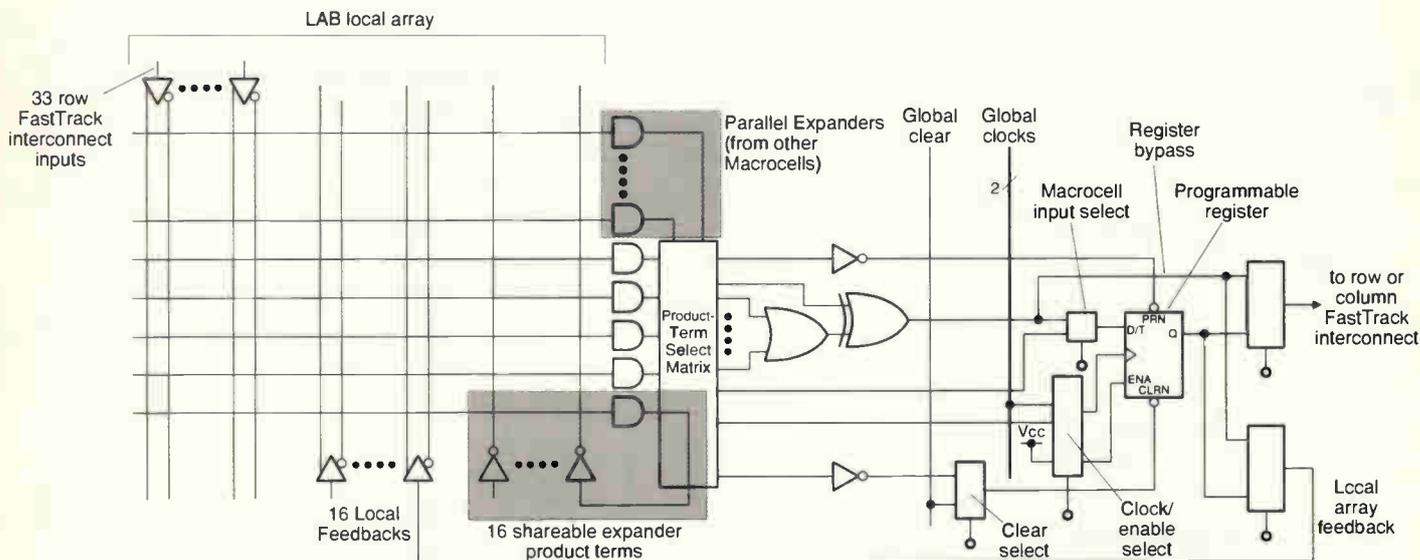
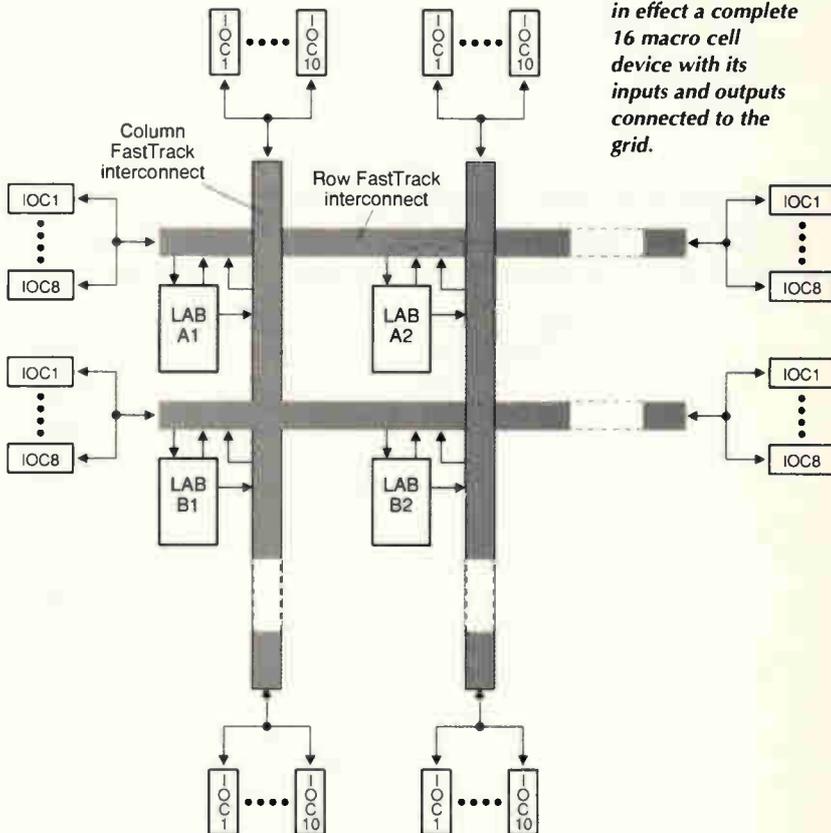


Fig. 6. Max 9000 and 7000 series macro-cell. Local feedback is provided to enable the construction of fast counters etc. and each register clock can be driven by a product term allowing asynchronous design methods.

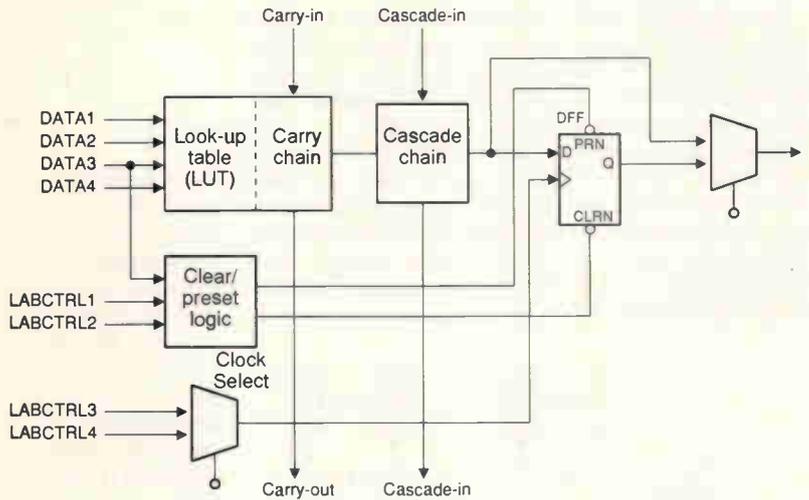


Fig. 7. This macrocell is optimised for arithmetic and counter functions. It has fast carry in and out connections, allowing a registered binary full adder to be implemented in one cell. Counters function up to 270MHz. The look-up table is a bit like a 16-by-1-bit rom, the inputs being the equivalent to the address lines.

The i/o cell has a tri-state output enable and can be configured as a registered or non registered input or as an inverting or non-inverting output. It can also be bidirectional.

The 2000 series offers similar generic logic blocks but has a simplified clock and i/o structure. The 3000 series is JTAG compliant and has twin generic logic blocks – i.e. 8 macrocells with 24 inputs instead of 16 to the AND array.

The 6000 series also has a dedicated ram array and register stack. The 2032 device is now available in an LV version for 3.3V supplies

An *ispGDS* is a digital switch matrix available in three sizes, namely 7 by 9 by 9 and 11 by 11. Each i/o macro cell can be configured as an input, an inverting or non-inverting output, or as a fixed ttl high or low output. Any input can

drive any one or more outputs on the opposite bank. A cell can be used as dip switch replacement, for clock routing, 'plug-and-play' setup, interrupt selection, etc.

Altera now has ISP versions of its 9000 and 7000 series products and the new *Michelangelo* family due to be released this year. The 7000 products have a central programmable interconnect and blocks of macro cells with associated non registered i/o pins.

The 9000, 10k, 8k (*Flex*) and *Michelangelo* devices have a grid arrangement of interconnects with blocks of macrocells in between and i/o cells at the ends, This means that the i/o cells are not closely associated to any of the macrocells, Fig. 5. Also the i/o cells have a register that can be used for input or output signals.

The *Max 9000* and 7000 series are similar and have the normal macrocell structure. Fig. 6, but note the number of programmable nodes around the register.

Multi-voltage devices are also becoming available. With these, the core logic runs at 3.3V to keep the power down while the i/o cells can be powered by either 5V or 3.3V to provide easier interfacing.

As well as in-system programmable devices. Altera has in-system configurable logic. Both 8k and 10k *Flex* devices are in-system configurable, that is they are static-ram based and have to be loaded every time the system is powered up.

When such devices run in 'active' mode, the configuration code is automatically loaded from an eeprom at power on. In passive mode, the device is booted by an embedded processor or main system processor. Both modes can have a parallel or serial data path, supporting the booting of multiple devices.

The macro cells in these devices have only four inputs plus carry in and cascade in. The AND array is replaced by a look up table and each macro cell has four modes – normal, arithmetic, up/down counter and clearable counter mode, Fig. 7.

Mega functions are Altera's answer to programming large devices. The 10k range of devices is expected to reach the 250k gate array size soon and programming them without mega functions would be very time consuming.

Mega functions are an extension of the macro concept. Whereas a macro can represent a shift register or arithmetic logic unit for example, a mega function can describe a complete microprocessor, dsp engine, filter or uart. Such blocks are provided by specialist companies though so don't expect to get them free on a cd.

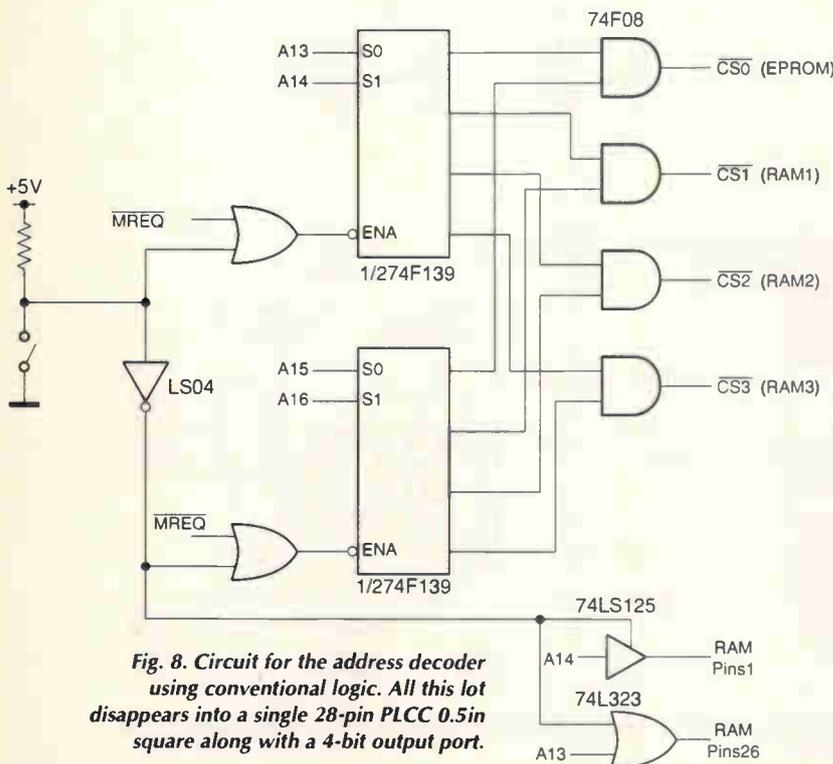


Fig. 8. Circuit for the address decoder using conventional logic. All this lot disappears into a single 28-pin PLCC 0.5in square along with a 4-bit output port.

List 1. Z180 address decoder simplified in a non-ISP programmable logic device file.

```

BEGIN
RAM_P1.OE = RAM32
IF RAM32 THEN
BEGIN
RAM_P26 = A13;
RAM_P1 = A14;
EPROM = MREQ * /A15 * /A16;
RAM1 = MREQ * A15 * /A16;
RAM2 = MREQ * /A15 * A16;
RAM3 = MREQ * A15 * A16;
END;
ELSE
BEGIN
RAM_P26 = 1;
EPROM = MREQ * /A13 * /A14;
RAM1 = MREQ * A13 * /A14;
RAM2 = MREQ * /A13 * A14;
RAM3 = MREQ * A13 * A14;
END;
ENDIF;
    
```

AMD/Vantis

This company has recently introduced ISP versions of its well established range of products. The device architectures available are substantial AND/OR array blocks with 16 macrocells. The blocks interconnect by a central switch matrix.

In-system programmable devices available in the company's 1 and 2 series have an *SP* suffix. All the 4 and 5 series devices are ISP capable and come in 3.3V supply versions.

Able/Synario is provided as part of a starter kit including programming software, a download cable and an ISP board. The parallel port adaptor probably won't work through a 'dongle' because it needs Pin 1, the Strobe pin, for the TRST signal of the JTAG interface.

The *Able/Synario* starter software comes on cd but is "web interactive". This means that it communicates with the Vantis web site for data etc, with the advantage that you have access to all the latest information. But the software does not run on Windows 3.1. You need '95 or NT4.

Philips

This company has concentrated its efforts on reducing power consumption without compromising speed and has now introduced ISP versions of its 128 macro-cell devices which include JTAG boundary-scan facility. Both 64 and 32 cell versions should be available by the time this article appears.

One of the problems with conventional ISP devices is that when the logic within them is heavily utilised and the pins committed to certain functions, compiling the device can be impossible even though the device has the capacity to carry out the extra functions. A claimed feature of the Philips *XPLA* architecture is that unlike its competitors, it allows 100% utilisation.

Proof of the pudding

Assume a *Z180* microprocessor system with a 16MHz clock, an 8K eeprom and up to three 8K or 32K ram chips.

Looking at the difference between the ram chip options, pin 1 is either high-impedance or A_{14} while pin 26 is either CS_2 or A_{13} . Device selection is by A_{13} and A_{14} for the 8K parts or A_{15} and A_{16} for the 32K parts. The eeprom is switched out by the processor memory management unit after boot up.

The traditional logic version requires five separate devices a dip sw and a resistor, Fig. 8. It might work at the required speed but that cannot be guaranteed without prototyping. Relative to a more integrated solution, this circuit requires a lot more board space and assembly effort. The limit of the operating speed is determined by the /MREQ signal having to go through three layers of logic.

Conventional PLD. A non-ISP programmable logic device still requires the resistor and the dip switch, but the remainder of the logic disappears into a single package. The design for the address decoder now becomes an equation, List 1, but since the pld is not reprogrammable, this list has to cover both memory size options.

The pin definitions have been removed and the chip selects are defined active low in the listings.

ISP version. Here, the dip switch and the resistor disappear but you need four pcb tracks and an eight-pin single-in-line plug for programming.

The ISP version of the 22V10 is in a 28 pin J-lead package or SSOP and has the same JEDEC pin-out as its earlier fuse-programmed counterparts. The four in-system programming pins replace the redundant fuse-programming pins and so make no difference to the other connections to the device.

The equation now only needs to cover one memory-size option, List 2. The other option is catered for in a separate but similar file and downloaded as needed. I implemented a four-bit output port in the remainder of the 22V10 but it

List 2. The two address decoder files for the isp22V10 address decoder, 32k ram version first.

```
BEGIN
RAM_P26 = A13;
RAM_P1  = A14;
EPROM   = MREQ * /A15 * /A16;
RAM1    = MREQ * A15 * /A16;
RAM2    = MREQ * /A15 * A16;
RAM3    = MREQ * A15 * A16;
END;
For the 8k ram the pin1 is not enabled therefore hi-z and
pin 26 is permanently logic 1.
BEGIN
RAM_P26 = 1;
EPROM   = MREQ * /A13 * /A14;
RAM1    = MREQ * A13 * /A14;
RAM2    = MREQ * /A13 * A14;
RAM3    = MREQ * A13 * A14;
END;
four bit output port
IF (/RESET) THEN
  IF (IOAD) THEN
    BEGIN
      OUT0 = D0;
      OUT1 = D1;
      OUT2 = D2;
      OUT3 = D3;
    END;
  ELSE
    BEGIN
      OUT0 = OUT0;
      OUT1 = OUT1;
      OUT2 = OUT2;
      OUT3 = OUT3;
    END;
  where IOAD is the decoded write pulse from the i/o decoder.
```

could just as easily formed a wait state generator or any other function needing a similar amount of logic.

In summary

ISP is definitely the way forward. Relatively to its predecessors, it is very easy to use and its advantages are clear. ISP has allowed me to produce circuits and systems that would be impracticable by other methods.

But when choosing an ISP solution, remember that although each manufacturer tries to make life as easy as possible for everyone, its still best to look at all the options. ■

Technical support

Lattice

<http://www.laticesemi.com>, distributor Microcall, 01296 330 061.

Altera

<http://www.altera.com>, distributor Thame Components, 01844 261188 and Ambar Cascom, 012796 434141.

AMD/Vantis

www.vantis.com, 01276 803299

Philips

<http://www.semiconductors.philips.com>, (31) 402737605

Pricing

Currently 1K gate arrays are about £5 to £10 in one offs, rising to several hundred pounds for larger devices. Since free development and programming software can be obtained, information on making your own programming cable is readily available and a small ISP chip is well under £10, getting started can be very cheap. Licensed entry-level systems cost between £200 and £300. Full systems cost thousands.

Apple Recruitment – The Taste of Success

We currently have many vacancies on our books for RF, Microwave and Antenna Design, Development and Test Engineers. Below is a selection of some positions we have on our records:

RF Engineers

Herts

£23-40k

Our client has positions at all levels for engineers with 2.1/1st class honours degrees with a good background in developing *transmitters, receivers, filters, LNAs and amplifiers*.

Hants

£25-36k

Our client is looking for several RF engineers with good degrees and several years experience developing mobile telecommunications systems. Knowledge of CSM would be an advantage.

Berks

£24-36k

Applicants are sought from RF design engineers with a good degree and practical post-grad experience covering some of the following areas – *RF to 2GHz, LNA design, PLLs, GSM, Filters, power amps, VCOs or EMC*.

Hants

£25-36k

Our client is looking for several RF engineers with good degrees and several years experience developing mobile telecommunications systems. Knowledge of GSM would be an advantage.

Kent

£28-32k

Our client is looking to recruit degree qualified RF/Microwave engineers with good post-graduate experience of *LNAs, filters, diversity systems and measurement techniques*.

Beds

£26-34k

A designer of cellular radio products is looking for experienced RF engineers to design receivers up to 2GHz. Familiarity with digital modulation and DSP would be beneficial.

Cambs

£28-35k

Engineers are sought with good degrees and several years post-graduate experience in developing RF circuits and systems. Some of the following skills are needed – *GSM, PCN, DECT, wireless LAN, antennas, superhet receivers, oscillators, synthesisers, amplifiers or EMC*.

Antenna Engineers

Surrey

£23-35k

Applicants should have two years experience in antenna design, ideally at 1-3GHz. They should have knowledge of antenna manufacturing and testing techniques as well as the design of monopole, dipole, helical and planar antennas.

Essex

£26-34k

Our client is looking for qualified engineers with 2 or more years experience in antenna theory and design. You should know antenna arrays as well as near/far field measurements. Knowledge of Radar systems would be a benefit.

London

£26-36k

Our client, a major developer of mobile communications equipment, is looking to recruit a Senior Research Engineer in the field of Antennae and Propagation. You should have a good academic record in a relevant field.

Microwave Engineers

Sussex

£22-34k

A major developer of radar systems is looking for experienced engineers to develop circuits and sub-systems up to 40GHz. Knowledge of antennas would be beneficial.

Hants

£25-38k

Our client is seeking qualified engineers to carry out circuit design and testing with *MIC and GaAs MMIC circuits* (e.g. *low noise amplifiers, phase and gain control units, oscillators and power amps*) with operating frequencies from *0.5 to 100GHz*.

Scotland

£27-35k

We are looking for several microwave design engineers with skills in *oscillator design, amplifiers, filters and mixer design*. Knowledge of *HP EESof* design and layout packages would be of help.

Devon

£22-34k

A major developer of radar systems is looking for experienced engineers to develop circuits and sub-systems up to 40GHz. Knowledge of antennas would be beneficial.

Sussex

£22-34k

A major developer of radar systems is looking for experienced engineers to develop circuits and sub-systems up to 40GHz. Knowledge of antennas would be beneficial.

RF Test Engineers

Surrey

£16-21k

We have several positions for *Test Engineers* with 1 year + experience testing *RF systems* and circuits using *spectrum analysers, oscilloscopes* and other *test equipment*.

Hants

£17-19k

Applicants with experience of testing RF systems and circuits down to component level are sought by our clients.

Northants

£16-20k

With an HNC and 2 years experience of testing RF/Microwave products up to 2GHz, you may just be the individual our client is looking for.

1st/2.1 Degree or Ph.D

Nationwide

£Attractive

Many of our clients are looking for both fresh and experienced graduates/post graduates for positions in RF/Analogue/Microwave design and development.

 **Apple Recruitment**

3 Branksome Way, New Malden, Surrey KT3 3AX

Tel: 0181 549 0100 Fax: 0181 549 9771

email: consult@applerec.u-net.comWeb: <http://applerec.u-net.com/>

ANYWHERE THROUGHOUT BROADCASTING & TELECOMMS, WE'RE ON THE LEADING EDGE.

NTL is the leading network service provider for blue chip companies in broadcasting, telecommunications and emergency services. Our expertise spans total capability in voice, video and data communication. We have an outstanding track record in planning, building and operating highly reliable, mission critical broadcast and mobile communications networks and, as a leading innovator in digital systems, we are set to play an even greater role. Our growth means we now need like-minded Engineers to join us;

SPECTRUM PLANNING ENGINEER

You'll be part of a group responsible for frequency planning and propagation studies for future broadcasting and mobile radiocommunications systems. The group is making major contributions in many areas including the planning of Digital Terrestrial Television in the UK. This is a key role offering a wide range of opportunities in leading edge technologies.

Of graduate calibre, you must have an evident interest in radio propagation and a strong ambition to develop your career in radio coverage and frequency planning. Good computing skills are essential, with experience of programming in C or similar high level languages desirable. You should also have a current driving licence and be willing to travel overseas.

Ref No: 98/cc/035



ANTENNA SYSTEMS ENGINEER

Under the general direction of the Team Leader or Project Manager, you'll provide specialist support through the design, specification, procurement and commissioning of broadcast and communications antenna systems.

With a degree or equivalent in an engineering discipline affiliated to broadcasting, communications or electronics, you must have several years' experience of the design, procurement and installation of broadcast and/or communications antenna's. Knowledge of the principles of Digital Terrestrial Television and Radio Systems is desirable. You must have the fitness and ability to work on tall structures, a clean driving licence and willingness to travel in the UK and abroad. Ref No 98/cc/034

Applications from graduates in a related field may also be considered for a Trainee position within the Group.

In addition to highly attractive salaries, you will enjoy a wide range of benefits including an excellent pension scheme and private health care provision. Our company is exceptional, so are our people, and career prospects are, naturally, likewise.

Please send your full cv including current salary expectations to our consultants: TMP Worldwide, 32 Aybrook Street, London W1M 3JL quoting the appropriate reference number.

Closing date: 27th March 1998.

SALES ENGINEER

DataKinetics Ltd is a rapidly-growing independent UK telecommunications company with a global customer base which includes PTTs and major multi-national equipment manufacturers.

We specialise in telecommunications protocols and, in particular, DataKinetics is a world leader in access products for signalling System No. 7. These products have applications in the rapidly growing markets of Mobile and Intelligent Networks.

We are located in Fordingbridge, Hampshire, on the outskirts of the New Forest. An attractive town, Fordingbridge is a short distance from the south coast and the cities of Salisbury, Bournemouth and Southampton, all of which have good rail links to and from London.

Sales Engineer

A challenging new sales role has been created to help build on our world-wide customer base and continue to exceed targeted business levels. This is a key position within the organisation and requires someone who is self-motivated and responsible with a good knowledge of the telecommunications market and a technical training. Given the international nature of the business, language skills would be particularly welcome, especially Spanish.

To apply for this position, or to find out more information, please contact our retained consultant, Phil Atkinson at:-

Jones Resourcing, The Coach House, Boxwell Road, Berkhamsted, Herts HP4 1AA
Tel: 01442 870770 Fax: 01442 879779.

For further

information

on Recruitment

advertising

call:

0181 652 3620

ENCOURAGING INWARD INVESTMENT TO CREATE JOBS AND WEALTH FOR THE PEOPLE OF SCOTLAND



Scottish Enterprise

Designs on Scotland's Future

Senior Executive

Semiconductor Design - Inward Investment

Central Scotland £22k - £36k Fixed Term: 3 years

Locate in Scotland (LIS) markets Scotland as a location for inward investment. We do this by giving expert advice and assistance to potential investors and by negotiating and delivering investment packages tailored to their needs. With Scottish Enterprise, Cadence Design Systems Inc. and four of Scotland's top universities, we are embarking on an innovative and challenging project - Project Alba.

The project involves establishing the worlds first System Level Integration design complex. It will create a unique environment which will enable companies to undertake world leading "system-on-chip" design with access to the right skills, design tools, methods and supporting infrastructure.

As Senior Executive, you'll work as part of the Project Alba team to develop and secure further design based inward investment. Liaising closely with the twelve international offices of Locate in Scotland across North America, Europe and Asia, you'll project manage the Scottish end of sales activities, designed to attract investment from global electronics and consumer product companies. This will involve using your well developed sales skills to generate interest in Scotland and then to convert that interest to investment decisions. Considerable interaction with partner bodies is vital as you identify and clearly quantify Scotland's benefits in this highly competitive international arena. Involvement in the construction and negotiation of development packages is a further stimulating aspect of your brief.

Your graduate level intellect and sales or marketing background in semiconductors, electronics, or product design will have developed your wealth of project management experience. As such, you'll be familiar with the market and deadline pressures of design management. A global outlook, demonstrated by an appreciation of the needs of foreign investors, will be supported by your first-class interpersonal skills.

Please write with your CV to Robert McDade, HR Group, Scottish Enterprise, 120 Bothwell Street, Glasgow G2 7JP. Closing date: Friday 20th March 1998. Alternatively please apply on-line via <http://www.monster.co.uk>

Scottish Enterprise is committed to achieving equal opportunities.



Working together to make Scotland a better place to live and work



LOCATE IN SCOTLAND



LEADERS IN PRESENCE
DETECTING LIGHTING CONTROLS
Due to continuing growth, we require an additional

ELECTRONICS ENGINEER

The ideal candidate will be highly motivated and capable of original thought. A strong sense of responsibility is essential as the successful applicant will be required to take on product ownership from initial concept, through design and development, to production and customer support.

Applicants must be able to demonstrate a thorough understanding of both analogue and digital electronics including assembler level embedded software.

Apply in writing, stating current and target salary to:

**The Managing Director, Ex-Or Limited
Haydock Lane, Haydock, Merseyside WA11 9UJ**



A member of the DELTRON ELECTRONICS GROUP

Roxburgh EMC is part of Deltron Electronics Plc and is a major manufacturer of RFI/EMC suppression components operating from a custom built factory in Scunthorpe.

The design engineering section is looking for an EMC Engineer to work within the filter design team on an expanding range of customers requirements.

The ideal candidate would have experience in EMC filter design and practice, some knowledge of linear circuitry, ability to work in AutoCad or FastCad is preferable and a working knowledge of inverters and switching power supplies principles would be useful.

If you meet the above requirements, please write with full details and CV to:

Mrs Celia Brown, Roxburgh Electronics Ltd, Roxburgh House, Foxhills Industrial Park, SCUNTHORPE, DN15 8QJ.

Roxburgh Electronics Limited is an equal opportunities employer.

Spectrum Electronic recruitment have the following vacancies for clients with approx. 80 employees.

SOFTWARE ENG. SURREY LONDON BERKS + OTHER LOCATIONS

C++ Embedded systems Rtime data acqu. OOD V X Works Sys Design. Youmton Etc.

SOFTWARE ENG. SURREY MIDDX HANTS + OTHER LOCATIONS

Design of Code & Test Software UNIX C++ MOTIF GUIs

HARDWARE ENGS. HANTS/SURREY BERKS SUSSEX/MIDDX HANTS, OTHER

Various clients require ANA DIG. Design Engs. with experience of FPGAs, PLDs, DSP, VHDL, C, Basic, Pascal CAD. Taking designs from initial concept through development to production.

TEST REPAIR & FIELD SERVICE. ALL AREAS

Good all round Test Repair/Calibration Engs. In-house and world-wide travel inc.

These are a few vacancies that are urgent.

Please call for further details and other disciplines currently on file:

Mike Messina on 01932 221501, Fax: 01932 269100. Eve Wk Ends 01932 242810

CV to Spectrum 37A The Centre, Walton, Surrey KT12 1QY.

BARRIE PORTMAN RECRUITMENT LTD

THE LISTENING AGENCY

TECHNICAL/ENGINEERING - LT.

V C++/MS APPS (contract) - Hants

Analogue/Dig Design/Comm perm - Surrey

RF Design Contract/Perm - Hants

If you are serious about advancing your career or need a new contract send your CV/contact me on:

**01703 276009 TEL/FAX day/evening/weekend
email bportman@globalnet.co.uk**

ELECTRONICSAPOINTMENTS

Electronics World May 1998

Tel: 0181 652 3620

SALES & MARKETING

Technical Marketing Specialist - Embedded Software to £50k package
Our client is a market leader in the supply of Real-Time Operating Systems on an international basis. An opportunity exists for a marketing specialist to take full responsibility for the formulation and implementation of product plans and marketing packages within the automotive sector. This is a senior role and you will need at least three years in an embedded software environment probably in a software development or technical marketing role. Automotive experience will be of particular interest. Extensive European/US travel will be required. Based Wilts.

Field Sales Engineer - Consumables to £30k package
This leading supplier of consumable products to the electronic manufacturing industry wishes to appoint an FSE to develop sales in the SW of England. You will need a technical sales background and an appreciation of electronic assembly/manufacturing processes. Consumables experience would certainly be an advantage. Based M4 Corridor.

European Product Specialist - Embedded Software Design & Test £30k
Our client is the market leader in hardware-assisted embedded software design, debug and test solutions. This role is to provide technical sales support and training to UK and overseas customers and distributors. Some European travel will therefore be required. You will probably be working in a support role for a component manufacturer or distributor with some experience in writing and testing embedded C/C++ and assembler code. Based Bucks.

Field Sales Engineer - Power Supplies £28k package
Our client, a supplier of bespoke power supply systems, is currently experiencing strong growth and wishes to appoint an additional sales executive to develop business with both specifiers and end user customers. This is an excellent opportunity for an experienced sales executive with either a power supply or electrical background to join a small, but highly focused team. Alternatively, this position might suit a field engineer with a desire to move into a commercial role. Flexible Midlands/Southern location.

Product Marketing Manager - Semiconductors c£25k
Our client is a rapidly growing high technology semiconductor distributor. Continued expansion has created opportunities for two additional product marketing managers to take total responsibility for a range of semiconductor products from price and inventory management through to promotional activity and maintaining close links with US based suppliers. You will need a sound electronics engineering background a degree or HND and strong interpersonal and communications skills. Based Hants.

Field Applications Engineer - EMC Filters £25k+
The UK's leading supplier of power products is looking to appoint a technical specialist to work closely with the sales team and with customers to support and develop the sales of EMC/thermal products. You will ideally be qualified to HNC level in electronics with EMC experience gained in a sales or technical support role. In return our client is offering an excellent package, including good basic, commission, fully expensed car/phone, private healthcare and re-location where appropriate. Based Berks.

Sales Office Manager - Components £25k
Do you have internal sales experience gained with either a distributor or manufacturer of electronic components? Do you have a reasonable command of French? If so our client, a well respected manufacturer of electronic components for the communications industry would be very interested to talk to you. Taking responsibility for a small team, the successful candidate will manage all aspects of this busy international sales department. Based Essex.

For these and many more outstanding sales and marketing opportunities please phone or send a copy of your CV with current salary details to Jeremy Boardman at Parkway Search & Selection, 22 Parkway, Welwyn Garden City, Herts AL8 6HG
Tel: 01707 395200 Fax: 01707 395201 E-mail ParkwayUK@aol.com

the
sales and
marketing
specialists

Parkway
Search & Selection

DESIGNS THAT SAVE LIVES

Shandon Scientific Ltd. is a leader in the design and manufacture of instruments for pathology laboratories, developing products for healthcare professionals world-wide.

We now have an opportunity for a keen and professional **Electronics Engineer** to join our team in Cheshire.

Our instruments are designed using microprocessors to control a wide variety of mechanisms and devices. As a key member of a small team, you will have the skills and the opportunity to work across this technology range.

If you are looking for varied and challenging work in an ambitious and successful company, please send your CV to:

Elaine Ellis-Seabridge, Human Resources Officer
Chadwick Road, Astmoor Industrial Estate
Runcorn WA7 1PR
E-mail: elaine.ellis-seabridge@shandon.com
<http://www.shandon.com>

EMBEDDED SYSTEMS ENGINEER

EAST MIDLANDS EXCELLENT PACKAGE

KROHNE are manufacturers of advanced process measurement instrumentation. We seek a degree qualified engineer with 2-3 years' experience in embedded systems, both C/C++ software and digital/analogue hardware.

Please send your Curriculum Vitae to:

Mrs Julie Meehan, Krohne Ltd
Rutherford Drive, Park Farm Industrial Estate
Wellingborough, Northants NN8 6AE

TEST, REPAIR AND ASSEMBLY

All Levels

All Areas

Many of you will probably know my name, but not the company's. As a new organisation specialising in the Recruitment of **Electronic Production Staff**, I urgently need candidates for a wide range of opportunities at companies both large and small throughout the UK.

So if you are just starting to look, or have been looking for some while, you owe it to yourself to see the difference that active marketing can make.

Don't just end up on another mailing list!

Contact **Tony Linehan**
Excalibur Recruitment

6A Pury Hill, Alderton Road, Towcaster, Northants NN12 7LS
Tel: Daytime 01327 811146 or Eves: 01442 212495.
Fax: 01327 811070 Email: ExCalRec@aol.com

EMBEDDED SYSTEM DESIGNERS

We are a medium-size progressive company specialising in electronic assistive technology for disabled, elderly and hearing-impaired people. We require a software/hardware design engineer to take projects through from concept to production.

You should have at least two years' experience and a good working knowledge of analogue/digital electronics, microprocessor-based design and assembly language programming. Experience of any of Z8, Z80, 8051, C++, Windows MFC, Microsoft Access, EMC and ISO9001 quality systems would be an advantage.

Contact Joyce Thomas on: 01296 481591
or alternatively write with your CV stating current salary to:

Possum Controls Limited, Unit 8 Farmbrough Close
Aylesbury Vale Industrial Park, Stocklake
Aylesbury, Bucks HP20 1DQ.

No agencies

CLASSIFIED

Tel: 0181 652 3620

Fax 0181 652 8938

ARTICLES FOR SALE

PCB CAMERAS

B/W 32mm lens or pinhole
£39 +VAT (5+ £35 each)

B/W 42mm with audio lens or
pinhole **£45** +VAT (5+ £39 each)

Colour 42mm twin board with
audio and lens **£115** +VAT

Also Domes, bodies, lenses, switches,
quads, covers, autorecording, PIRs,
pencil and waterproof cameras, monitors,
housings, RF mods (up to CH 69) etc.
Export trans/RX cameras.

HENRY'S

404 Edgware Rd, London, W2 1ED
Tel: 0171 724 0323 Fax: 0171 724 0322
Orders hotline 0800 7316979
email sales@henrys.demon.co.uk
Web "http://www.henrys.co.uk"
Direct orders (subject to status) & most credit cards accepted

TELEPHONE
FAX, EMAIL
OR CALL IN
Open 6 days
a week

POWER SUPPLY DESIGN

Switched Mode PSU
Power Factor Correction
Linear PSU

Lomond Electronic Services

Tel/Fax: 01243 842520
eugen_kus@cix.co.uk

RF & Data/Comms Test Equipment (Ex Govt).

- HP, Tektronix, Phillips, Gould, etc.
- Scopes (20MHz-20GHz DSO),
Analysers, Sig Generators, and other
Items, Manuals, As New.

Cash Offers Invited for URGENT Sale

For Full Details call Victor on:

Tel: 01189 626866 Mobile: 0802 864155

**PLEASE MENTION
ELECTRONICS WORLD
WHEN REPLYING TO ADVERTISEMENTS**

ARTICLES WANTED

WANTED - Old cipher equipment and "spy
radio sets". OZ8RO Rag Otterstad, Hosterkobvej
10 DK-3460 Birkerod, Denmark. Fax: ++45
44681514.

WANTED - W.W.II. German and S.O.E. clandestine
sets, receivers. Also incomplete sets. OZ8RO
Rag Otterstad, Hosterkobvej 10 DK-3460
Birkerod, Denmark. Fax: ++45 44681514.

AUDIO & RF DESIGN - DC to 3GHz

- ◆ Stereo Coders & processors
- ◆ RF Amplifiers & Transmitters
- ◆ Wireless Control Systems
- ◆ 2.4 GHz Audio & VideoLinks
- ◆ Aerial combining Systems

So whatever your need call us!

LIBRA SOLUTIONS

Tel. 0181-428 2776
mnoar@globalnet.co.uk

RF DESIGN SERVICES

All aspects of RF hardware
development considered
from concept to production.

WATERBEACH ELECTRONICS

TEL: 01223 862550
FAX: 01223 440853

SPECTRUM ANALYSER - 100kHz-1800MHz.
Tektronix 7L12 Plug-in, £675. May have spare
mainframe. Marconi TF2008 SIG Gen/Sweeper
10kHz-520MHz, £150. Telonic 2003 Modular
Sweep Generator 100kHz-130MHz, £125. As
above, but 1MHz-1300MHz, £160. Tektronix 611
X-Y Storage Display with Write Through, new,
£70. Marconi TF2700 Portable LCR Bridge, £75.
TF2701 Precision Inductor Analyser with
TM8339 High Current Adaptor, £85. Tel: (01344)
627869.

MICROCHIP - "PICMASTER", Emulator.
Icelab 8031/51 Emulator. Benchtop Vapour Phase
Soldering Machine. Offers. 01395 232658.

AIRCRAFT Rotary Converters, 28V 8000rpm
115V 1ph 1600Hz 360W. Integral regulator. £10.
28V 8000rpm, 115V 1ph 400Hz 770W. External
regulator required. £20. Tel Bristol 0117 979
3883.

HP7000A - X/Y/T Plotter £20. HP5245L 3GHz
£40. Resolver Synchro Angle Indicator £50. Clare
A203B Flash Tester £40. RS 555279 £35. 01476
550826.

VALVES, etc, WANTED

Most types considered but especially KT88, PX4/PX25, KT66,
KT77, EL34, EL37, ECC83. Valves must be UK manufacture to
achieve top prices. Also various valve-era equipment
e.g. Garrard 301.

COURTEOUS, PROFESSIONAL SERVICE

Ask for a free copy of our wanted List.

BILLINGTON EXPORT LTD., Billingshurst, Sussex RH14 9EZ

Tel: 01403 784961 Fax: 01403 783519

VISITORS PLEASE PHONE FOR APPOINTMENT.

ADVERTISERS PLEASE NOTE

For all your
future enquiries
on advertising
rates

Please contact
Joannah Cox on

Tel: 0181-652 3620
Fax: 0181-652 8956

TOP PRICES PAID

For all your valves, tubes, semi
conductors and IC's.

Langrex Supplies Limited

1 Mayo Road, Croydon
Surrey CR0 2QP

TEL: 0181-684 1166
FAX: 0181-684 3056

CAPACITORS

Large volume availability of capacitors
direct from manufacturer in pitch sizes
5, 7.5 & 10. VDC 63, 100, 250, 400 & 630.
 μ F 0.00 - μ F 0.68

For further details please contact:
PALA CAPACITORS

Tel: 01483 565090
Fax: 01483 566050

★★WANTED★★

Test equipment, Electronic Scrap,
Valves, Transmitters/Receivers,
Factory & Warehouse Clearance.
Confidentiality Assured.

TELFORD ELECTRONICS

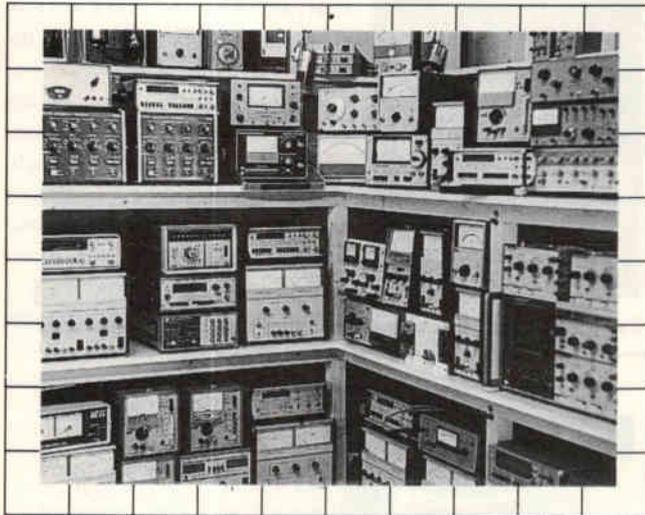
Phone: 01952 605451
Fax: 01952 677978

WANTED - "SPY RADIO SETS", Cipher Gear,
W.W.2 German Sets. W.H.Y.? OZ8RO Rag
Otterstad, Hosterkobu 10, DK-3460 Birkerod,
Denmark. Tel: +45-4281 5205 evenings.

WANTED - PRE-WAR TV. Offered: Network
Analyser HP8505A. Jac Janssen, Hogeham 117D,
NL-5104JD Dongen Netherlands. Fax: +3113
4624684. Thanks



**SUPPLIER OF QUALITY USED
TEST INSTRUMENTS**



CONTACT

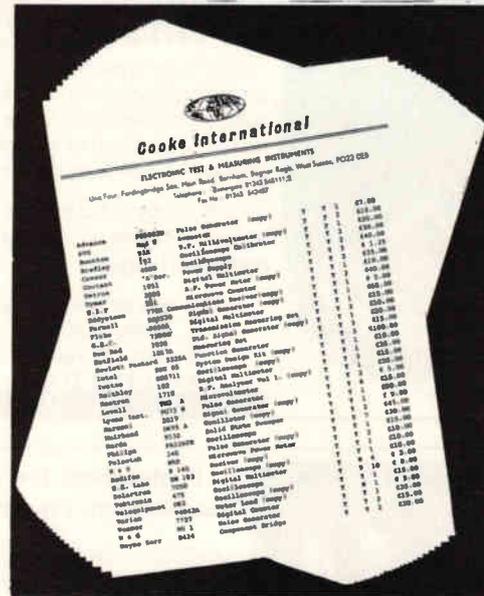
Cooke International

Unit Four, Fordingbridge Site, Barnham,
Bognor Regis, West Sussex, PO22 0HD, U.K.
Tel: (+44)01243 545111/2 Fax: (+44)01243 542457
Web: <http://www.cooke-int.com>
E-mail: info@cooke-int.com

CIRCLE NO. 132 ON REPLY CARD



OPERATING & SERVICE MANUALS



CONTACT

Cooke International

Unit Four, Fordingbridge Site, Barnham,
Bognor Regis, West Sussex, PO22 0HD, U.K.
Tel: (+44)01243 545111/2 Fax: (+44)01243 542457
Web: <http://www.cooke-int.com>
E-mail: info@cooke-int.com

CIRCLE NO. 133 ON REPLY CARD

ADVERTISERS' INDEX

ADEPT SCIENTIFIC	407	NUMBER ONE SYSTEMS	422
ANCHOR	378	OLSON ELECTRONICS	362
B. BAMBER ELECTRONICS	428	PICO	369
CMS	399	PS CONSULTANTS	IFC
CROWNHILL	367	QUICKROUTE	398
DATAMAN	381	RADIO TECH	399
DISPLAY ELECTRONICS	435	SEETRAX	396
EQUINOX TECHNOLOGY	IBC	SPEAKE & CO LTD	412
FIELD ELECTRIC	428	STEWART OF READING	412
HART ELECTRONICS	430	SURREY ELECTRONICS	399
JOHNS RADIO	429	TELFORD ELECTRONICS	340
JPG ELECTRONICS	412	TELNET	383
LABCENTER ELECTRONICS	OBC	TIE PIE	365
M & B RADIO	415	WARTH	369
MILFORD INSTRUMENTS	367	WEIR	375

CABLING SOLUTIONS FROM THE LCD EXPERTS



Trident Microsystems' new LVDS system, provides the cabling solution to overcome all the problems associated with driving Digital TFT over long distances.

Trident's new LVDS system now allows for digital drive of **up to 20 metres in length.**

For further details call
Trident today
Tel: 01737 780790
Fax: 01737 771908

CIRCLE NO. 134 ON REPLY CARD

New for '98 FREE Data Acquisition Software Tool



DAQ Designer '98 from National Instruments, is a free system configuration tool that reduces the complexity and time it takes to configure a PC-based data acquisition system and assures that system developers have the right plug in boards, signal conditioning products, cable assemblies, and software packages for their application.

CIRCLE NO. 135

Call National Instruments now for your **FREE** copy on 01635 523545

CIRCLE NO. 136 ON REPLY CARD

• **ralfe electronics** • exclusively professional T&M •
• 36 Esatecote Lane • South Harrow • Middx HA2 8DB • England •
• (+44) 0181-422 3593 • Fax (+44) 0181-423 4009 •



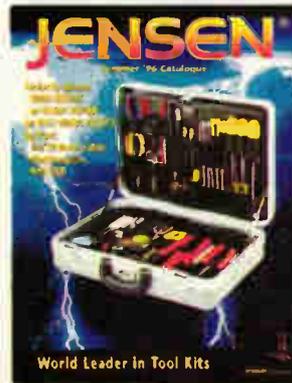
Professional Test & Measurement Equipment

Ralfe Electronics are suppliers of high end, professional T&M equipment on a second-user basis. We specialise in stocking, and sourcing, HP, Tektronix, Marcom etc all ISO9002 quality assured.

Call or fax us for our stock inventory or download it from:
www.ralfe-electronics.co.uk

Tel: +44 0181 422 3593
Fax: +44 0181 423 4009

NEW JENSEN TOOLS CATALOGUE



Colourful new Catalogue, hot off the press from Jensen Tools, presents unique new tool kits for service/support of communications equipment. Also latest test equipment from many major manufacturers. Includes hard-to-find tools, PC/LAN diagnostics, bench accessories, static control, technical manuals and more.

Ring 0800 833246 or
Fax 01604 785573 for a free copy.
Jensen Tools, 10-12 Ravens Way,
Northampton NN3 9UD

CIRCLE NO. 137 ON REPLY CARD



“Following just one year's advertising,
our customer base has increased
by 55% in the UK”

Mr. P Hart
WE Couplings & Coatings

Over 170,000 buyers are using the **UK Kompass Register**
every day to find companies like yours.

Is it you they're finding or your competitors?

To advertise in the next edition, simply fill in the coupon and post it back today to:
Reed Business Information, Windsor Court, East Grinstead House, East Grinstead, West Sussex RH19 1XD

or Fax it on **01342 335747**

Available in book and
CD Rom versions
and also on the
Internet!

www.kompass.com

Please contact me to advertise in the next edition of Kompass.

Title: _____ Initial: _____ Surname: _____

Job Title: _____ E-mail: _____

Company: _____

Address: _____

Post Code: _____

Nature of Business: _____

Tel No: _____ Fax No: _____



The Affordable Solution for 8051 & AVR™ Microcontroller Support Tools

DISTRIBUTORS FOR



IAR Microcontroller Development Tools

C-Compilers, Assemblers, Simulators

8051, Atmel AVR, Hitachi H8

MICRO-PRO DEVICE PROGRAMMER

The complete programming solution!

Supports:

MICROCONTROLLERS

Atmel 89C, 89S, 90S(AVR),
Generic 87C, Dallas 87C520

FLASH MEMORY

Atmel 29C, 49F

SERIAL/PARALLEL EEPROM

Atmel 24C, 25C, 59C, 93C, 28C

CONFIGURATORS

Atmel 17C, Xilinx XC17

Not all devices may be supported within each family.



Only... **£124.95**

Order Code: **MPW-PLUS**

PROFESSIONAL AVR™ MICROCONTROLLER STARTER SYSTEM

System Contents

- Combined Serial & Parallel Device Programmer
- Evaluation module for 8, 20 & 40-pin DIL devices
- In-System Programming (ISP) Cable
- Integrated Windows™ Development Environment
- AVR™ Basic LITE (1k bytes code) Compiler
- AVR™ Assembler
- Mains Power Supply Adaptor
- PC Serial Cable (Connects to PC COM Port)
- Atmel CD-ROM Datbook
- One AT90S1200 DIL Microcontroller

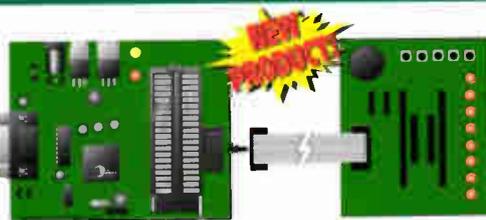


Figure 1

Only... **£99.95**

Order Code: **AVR2-ST**

WRITE IN BASIC RUN IN A FLASH

AVR™ BASIC

- Compiled BASIC generates tight AVR™ machine code
- Not a Run-Time Interpreter; NO code overhead!
- Target speeds comparable with assembler
- Breaks the cost barrier for small projects
- Ideal for educational, hobbyist and professional use

NEW PRODUCT
Order Codes:
AVR-BAS-LITE
AVR-BAS-8K
Only... **£24.95**
and **£149.95**

FLASH 8051 Professional Starter System

System Contents

- Combined Serial & Parallel Device Programmer
- Evaluation module for 20 & 40-pin DIL devices
- In-System Programming (ISP) Cable
- Keil PK51-2K Integrated Windows™ Development Environment (2K code limit). Includes C-Compiler, Macro Assembler, Linker, Hex Creator, Editor & Simulator
- Mains Power Supply Adaptor
- PC Serial Cable
- Atmel CD-ROM Datbook
- One AT89S8252 40-pin DIL Microcontroller

System layout shown in Fig 1 above

Only... **£124.95**

Order Code: **EQ-8051-ST1**

Micro-ISP Series III

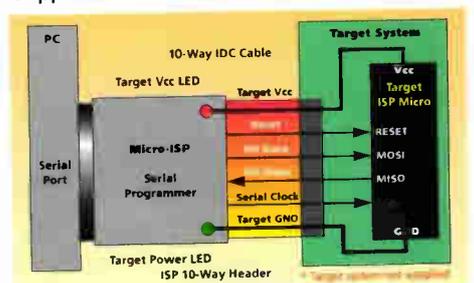
Serial Programming System for the Atmel AVR™ & 89S microcontroller families



NEW PRODUCT

Typical In-System Programming (ISP) Scenario shown below:

Supports: Atmel 89S, 89LS, 90S(AVR)

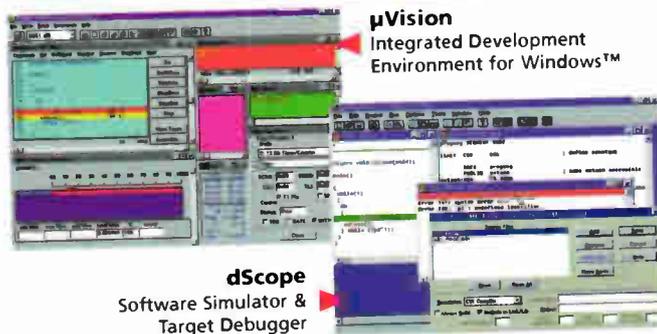


Order Code: **UISP-S3-SYS**

Only... **£39.95**



THE ULTIMATE 8051 TOOL SET



µVision
Integrated Development Environment for Windows™

- Optimising Ansi-C Compiler
- Macro Assembler
- Linker
- Software Simulator
- Integrated Editor
- Hex Creator

Starter Systems supplied with 2K Toolset & Development Systems supplied with 8K Toolset are available for Atmel, Dallas, Siemens, Temic 8051 microcontroller derivatives

dScope
Software Simulator & Target Debugger



The Embedded Solutions Company

3 Atlas House St Georges Square Bolton BL1 2HB England



For sales tel: +44 (0) 1204 529000, fax: +44 (0) 1204 535555, e-mail: sales@equinox-tech.com, Web Site: www.equinox-tech.com

EQUINOX DISTRIBUTORS: AUSTRALIA Farnell +61 2 9645 8888 AUSTRIA Farnell +43 0660 87 75 BELGIUM Alcom Electronics Nv/SA +32 3 227 36 47 BRAZIL Hastec +55 11 522 1799 Anacom +55 11 453 5588 DENMARK Farnell +45 44 53 66 44 EIRE Farnell +353 1 8309277 FINLAND Farnell +358 9 3455 400 FRANCE Farnell +33 474 65 94 66 Newtek +33 1 4687 2200 GERMANY Elektronik Laden +49 52 32 81 71 Farnell +49 89 61 39 39 39 Inetek GmbH +49 7321 93850, MSC Vertriebs GmbH +49 08 9945532 12 GREECE Mikrolec +30 1 5395042 4 HONG KONG Farnell 800 968 280 (HK Direct Toll Free) ITALY Farnell +44 113 231 1311 Grifo Italian Technology +39 51 89 20 52, Newtek Italia +39 2 33 10 53 08 MALAYSIA Farnell +60 3 773 8000 NETHERLANDS Alcom Electronics BV +31 10 4519533 Antratek +31 10 450 4949 Farnell +31 30 241 2323 NEW ZEALAND Farnell +64 9 357 0646 NORWAY ACTE NC +47 63898900 Jakob Hatteland Electronic AS +47 53763000 PORTUGAL Anatronc +35 119 371 834 Farnell +44 113 289 0040 SINGAPORE Farnell +65 788 0200 SPAIN Anatronc SA +34 1 366 01 59 Farnell +44 113 231 0447 SWEDEN ACTE NC +46 8 445 28 70 Farnell +46 8 730 50 00 SWITZERLAND Anatec Ag +41 41 748 32 41 Farnell +41 1 204 64 64 UNITED KINGDOM Abacus Polar +44 1925 626626, Farnell +44 113 263 6311 Rapid Electronics +44 1206 751166 Quarndon Electronics +44 1332 332651 USA Hitools Inc +1 408 298 9077 Newark Electronics +1 800 718 1997, Peachtree Technology +1 770 888 4002 Pioneer Standard +1 888 832 3976

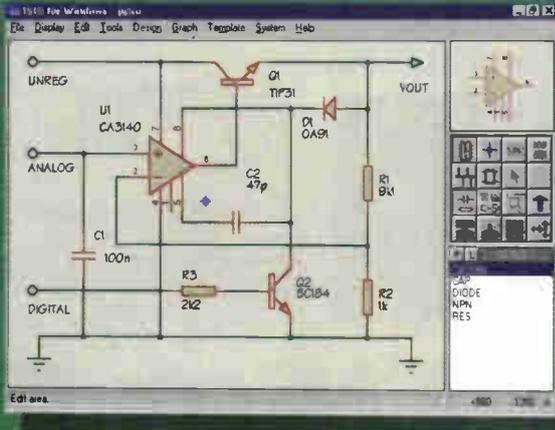
Equinox reserves the right to change prices & specifications of any of the above products without prior notice. E&OE. All prices are exclusive of VAT & carriage. AVR™ is a trademark of the Atmel Corporation

CIRCLE NO. 102 ON REPLY CARD

PROTEUS

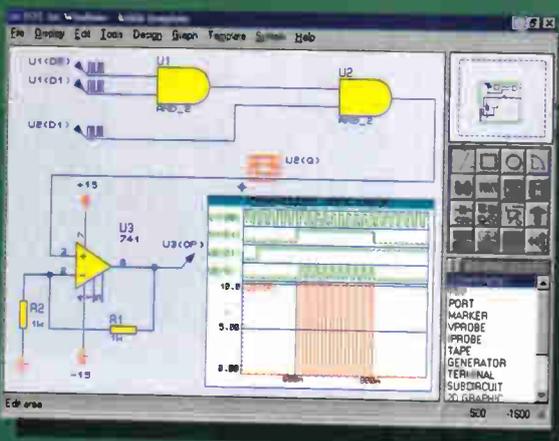
Schematic Capture

NEW Version IV



- Produces attractive schematics like you see in the magazines.
- Netlist, Parts List & ERC reports.
- Hierarchical Design.
- Full support for buses including bus pins.
- Extensive component model libraries.
- Advanced Property Management.
- Seamless integration with simulation and PCB design.

Simulation



- Non-Linear & Linear Analogue Simulation.
- Event driven Digital Simulation with modelling language.
- Partitioned simulation of large designs with multiple analogue & digital sections.
- Graphs displayed directly on the schematic.

The IVth Generation

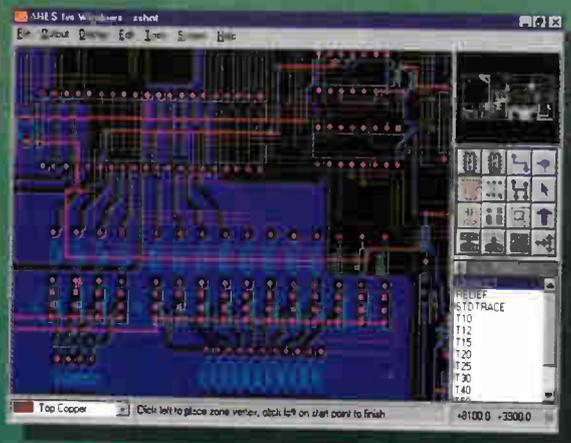
New Features

- Component Auto-Placer
- Pinswap/Gateswap Optimizer
- Background Regeneration of Power Planes
- Enhanced Autorouting with Tidy Pass
- Full Control of Schematic Appearance
- Extensive New Component Libraries

Available in 5 levels - prices from £295 to £1875 + VAT.
Call now for further information & upgrade prices.

PCB Design

NEW Version IV



- Automatic Component Placement.
- Rip-Up & Retry Autorouter with tidy pass.
- Pinswap/Gateswap Optimizer & Backannotation.
- 32 bit high resolution database.
- Full DRC and Connectivity Checking.
- Shape based gridless power planes.
- Gerber and DXF Import capability.

"PROTEUS
is particularly **good**
with its rip-up-and-retry **autorouter"**
EWW January 1997

Labcenter
Electronics

Write, phone or fax for your free demo disk, or ask about our full evaluation kit.
Tel: 01756 753440. Fax: 01756 752857. EMAIL: info@labcenter.co.uk
53-55 Main St, Grassington, BD23 5AA. WWW: <http://www.labcenter.co.uk>

Fully interactive demo versions available for download from our WWW site.
Call for educational, multi-user and dealer pricing - new dealers always wanted.
Prices exclude VAT and delivery. All manufacturer's trademarks acknowledged.