Save 20% on an economical circuit simulator

ELECTRONICS WORLD

INCORPORATING WIRELESS WORLD

JANUARY 2000 £2.55

Temperature logger

ADSL and beyond
Transformers from coaxial cable
Reduce loss in transmission lines
Stereo mic techniques
Better Wien oscillators
Car crash avoidance
THE NEW FORCE IN EDA

The brief was clear. To create a next generation CAD system for electronic engineers that used state of the art desktop integration and customisability together with unrivalled ease of use.

EDS also includes the new CADD object engine with true 3D and flexibility that approaches the power of desktop publishing systems. With its comprehensive drawing and shaping tools, professional support for True Type fonts (even in the PCB stage), high resolution, large design size, polygon fill and shaping tools. EDS represents a genuine advance in EDA price performance. Visit our web site, or call now to find out how EDS can help you.

- State of the art multiple-document user interface offering unrivalled ease of use and customisability.
- OLE 2 support including drag and drop, allows integration with your favorite Office applications.
- Project Wizard and Project Manager make creating and navigating all the documents in your project easy.
- New hierarchical symbol browser, makes creating, editing and managing symbols a breeze!
- High resolution (15um) and large design size (up to 2m x 2m) combined with Intel/Snap makes metric/imperial design mixing easy!
- Unlimited schematic sheets, with full support for data busses, power rails, etc.
- CADCheck automatically synchronises schematic and PCB designs. No more capture errors!
- Unlimited Undo/Redo, print preview and a wide range of import/export options including ODC, CAM, HPGL.
- Up to 32 layers can be assigned to be copper, silk, gold, mask, OIL, mechanical, or annotation layers.
- New CADDObjects engine supports a wide range of graphic objects including professional True Type fonts, object shaping and property support, in-situ editing of symbols, high resolution and arbitrary rotation/scaling of objects.
- Unlimited range of pad and track sizes supported.
- Create flood fills and power planes quickly with the new polyfill tool.
- Fast fully customisable polygonal-algorithmic autorouter.

WORK FASTER
WORK BETTER
WORK EASIER

Electronic Design Studio

£199 $319
Electronic Design Studio Cross Grade
£349 $219
Electronic Design Studio Lite
£49 $79

PLUS Your first double-sided Eurodark PCB produced FREE by Beta-LAYOUT

TRY AND BUY TODAY ONLINE

AT www.quickroute.co.uk

Prices exclude P&P and VAT where applicable.

30 DAY MONEY BACK GUARANTEE

Electronic Design Studio

£199 $319
Electronic Design Studio Cross Grade
£349 $219
Electronic Design Studio Lite
£49 $79

PLUS Your first double-sided Eurodark PCB produced FREE by Beta-LAYOUT

TRY AND BUY TODAY ONLINE

AT www.quickroute.co.uk

Prices exclude P&P and VAT where applicable.

30 DAY MONEY BACK GUARANTEE

Copyright © 1999 Quickroute Systems Ltd. All rights reserved. Prices and specifications subject to change without notice. Overseas distributors wanted!
Over 50% Discount
Professional Electronics Design
EDWin NC

- Genuine, professional EDA software with no limitations! - and YOU can afford it!
- EDWin NC comes from Visionics: one of the longest established, most experienced producers of professional EDA systems, so it's fully proven in professional work.
- Now you can have this best-selling non-commercial version of the software at less than 50% of the normal price, with no limits in its capabilities.
- It does just about everything you could want!

Schematics, simulation, PCB layout, autorouting, manufacturing outputs, EMC and Thermal Analysis. Many more advanced features are available and it runs in Windows 3.x, 95, 98 or NT.

Where's the catch? It's for non-commercial use, but companies may order for evaluation purposes. Prices start from just £59.00 for the basic system!

New
Super Powerful 32 bit version for Windows 95, 98 & NT!

Don't forget - Phone Today for Your 50% Discount!

- EDWin NC Basic: Schematics, PCB Layout, Manufacturing Outputs, Max. 100 Component Database, 500 Device Library.
- EDWin NC De Luxe 1: Basic + Professional Database and Libraries, Arizona Autorouter.
- EDWin NC De Luxe 2: De Luxe 1 + Mix-Mode Simulation, Thermal Analyser.
- EDWin NC De Luxe 3: De Luxe 2 + EDSpice Simulation, EDCoMX Spice Model Generator, EMC and Signal Integrity Analysers.

Plus Postage & Packing UK £5.00; Rest of World £10.00 (only 1 charge per order)
Order hotline: +44 (0)1992 570006 Fax +44 (0)1992 570220 E-mail: swift.eu@dial.pipex.com
Please Visit Our Web Site http://www.swiftdesigns.co.uk

I enclose: £___________ total.

Please allow 28 Days for delivery. Returns are ours.

Cheque/PO/Credit Card:
No

Visa/Mastercard/Eurocard: No

Please allow 28 Days for delivery. Returns are ours.

We are no longer in Business as we receive payments; but please allow 28 Days for delivery. Returns are ours.

Issue Date: [_] [_] [_] [ _] Expiry Date: [ ] [ ] [ ] [ ]

Date: [ ] Signature: [ ]

Address: [ ] [ ] [ ] [ ] Postcode: [ ]

Tel: [ ] [ ] [ ] [ ] evenings.

Swift Eurotech
EDWin NC

First bidirectional semiconductor laser
Bell Labs has unveiled what it claims is the world's first bidirectional semiconductor laser.

The laser emits light at two different wavelengths, or colours, depending on the direction the current flows through it. The direction can be changed by switching between negative and positive voltage applied across the device. Normally current can flow in only one direction in semiconductor lasers.

"It's a radically new concept," said Federico Capasso, head of Bell Labs semiconductor physics research department. "This is one laser that behaves as if it were two."

The laser could find use in detecting pollutants in the atmosphere or for increasing the capacity of light-wave communications systems.

Europe is failing to address high-tech skills crisis
European companies are failing to tackle the shortage of skilled high-tech workers, according to US market research company IDC.

Senior analyst Andrew Milroy said that the lack of a European strategy for resolving the high-tech skills crisis is making the situation worse. European companies could be hurt by other countries which are addressing the skills shortage. For example, in the US large numbers of foreign workers are being allowed to work for local companies.

The shortage of skilled IT professionals is predicted to grow from five per cent in 1998 to almost 20 per cent in 2002. The shortage is made worse by increasing demand for staff with Internet skills as companies focus on the Internet for a wide variety of management and sales applications.

"Demand for skilled labour will continue to grow year on year," said Milroy. "Soon the demand will significantly outstrip supply, leading to inflated salaries, increasing staff turnover, and therefore higher operating costs and lower profit margins."

PROBLEMS IDENTIFYING EUROPEAN EMC STANDARDS?

Get the EMC Master Info CD instead of a consultant for only £ 395

EMC Master Info CD offers complete information on environmental and conducted emissions as well as conducted immunity. Learn how to avoid failures and maximize your success in your projects using comprehensive databases with all current or past directives and standards. Also contains the latest directives from CE/EMC and the US FCC.

Check www.emcmaster.com or call (international): +31-3599-41774

January 2000 ELECTRONICS WORLD

Sugar spurs wireless Internet explosion

Wireless Internet access devices will never be a mass market, says Alan Sugar, chairman of Comet, in a chilling judgment for proponents of the "wireless revolution."

"I am not saying that it's not a wonderful achievement to be able to surf the net from the middle of a field," Sugar says, "it's a great scientific achievement - but so what? In practical terms it's no use whatsoever."

Sugar's attitude is in marked contrast to other electronics industry leaders. Brian Halla, National Semiconductor's CEO, says the industry is "undertaking a shift in product leadership from PCs to wireless communications applications and Internet infrastructure products."

Earlier this month, Dr Tsugio Makimoto, corporate chief technologist of Hitachi told the European Electronics '99 conference that wireless connectivity would spawn a "Nomadic Age."

The UMTS Forum reckoned that a big application for 3G (3rd generation) mobile phone networks would be the provision for travellers of "on the move" access to the Internet and e-mail through wireless links.

Moreover Matsushita, Nokia, Ericsson and Motorola have joined up with Psion to pursue wireless connectivity in portable devices. Last month Microsoft and BT joined forces to provide services and platforms for wireless Internet access, and 3Com announced a similar initiative with Nokia to add wireless capabilities to the PalmPilot.

Sugar will have none of it. "It will be a niche product for highly technically literate people, but there won't be a mass market for it," he said.

Sugar has a ready explanation for all the hype about wireless Internet access.

"It's fashionable to talk about new technologies among people driven by stock options because then people think you're going to sell hundreds of thousands of the product and that drives your share price up," said Sugar. "The game is to drive your
West Midlands plans high-tech cluster

The West Midlands is the latest region to catch the high-tech bug in a plan to set up a technology cluster of businesses. Advantage West Midlands, the region's development agency, has put forward plans to inject new life into the area, which it will present to deputy prime minister John Prescott.

Anthony Parisi, director general of the Federation of Electronic Industries (FEI), commented: "It is a jolly good idea, there is room for a lot more of this kind of thing. Whether you can create a Cambridge-type phenomenon by spending and government policy, I don't know but you have to try." However Parisi added that the country still suffered from a lack of entrepreneurs and a capital market to support them. He said there was also a shortage of people coming out of university with the right type of training. Recently Cadence's design centre in Livingston, Scotland, cut back on recruitment plans because of a serious shortage of engineers.

Referrring to a joint scheme between BT and Coventry University to promote broadband communications technologies such as ADSL, Advantage West Midlands' chairman Alex Stephenson said: "We have taken the initiative recognising the enormous virtue of an enterprise launched here in the West Midlands, and backing it to the hilt."

"As a result," Stephenson added, "the West Midlands will be at the forefront of developments in ADSL."
Europe edges into world semiconductor big league

Two European suppliers have made a strong showing in the latest world semiconductor ranking. Infineon Technologies will grow 34 per cent this year to reach No 7 in the world semiconductor league, according to IC Insights, the Arizona market analysts.

ST Microelectronics is also expected to rise fast – a 19 per cent rise this year – thanks to the boom in flash memories. For the first time in its history, ST is expected to crack the $10 billion barrier this year, climbing to No 9 spot one place above Philips.

Infineon has benefited hugely from the stiffening price of DRAM. The Japanese top ten players, are expected to grow in the middle teens but much of that is because of currency fluctuations. If it were not for exchange rate factors their growth would be in single figures, said IC Insights.

At the beginning of the decade the threesome inhabited the top ten along with Mitsubishi, Fujitsu and Matsushita – a sign of how times have changed for Japan.

World Semiconductor Rankings

<table>
<thead>
<tr>
<th>Rank</th>
<th>Company</th>
<th>1999 Revenues</th>
<th>99/98 Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Intel</td>
<td>$26.14</td>
<td>15</td>
</tr>
<tr>
<td>2</td>
<td>NEC</td>
<td>8.93</td>
<td>15</td>
</tr>
<tr>
<td>3</td>
<td>TI</td>
<td>7.65</td>
<td>22</td>
</tr>
<tr>
<td>4</td>
<td>Motorola</td>
<td>7.34</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>Toshiba</td>
<td>6.75</td>
<td>16</td>
</tr>
<tr>
<td>6</td>
<td>Samsung</td>
<td>5.80</td>
<td>35</td>
</tr>
<tr>
<td>7</td>
<td>Infineon</td>
<td>5.24</td>
<td>34</td>
</tr>
<tr>
<td>8</td>
<td>Hitachi</td>
<td>5.22</td>
<td>14</td>
</tr>
<tr>
<td>9</td>
<td>ST</td>
<td>5.00</td>
<td>19</td>
</tr>
<tr>
<td>10</td>
<td>Philips</td>
<td>4.33</td>
<td>3</td>
</tr>
</tbody>
</table>

Source: IC Insights

Green solder gets green light in Europe

Europe’s electronics industry has sent a message to US suppliers that it has opted for tin/lead/copper alloy as a suitable replacement for lead solders.

The lead-free solder decision also has the backing of the UK board makers and contract equipment manufacturers’ trade association, the PCIF, as well as solder and materials suppliers.

The International Tin Research Institute (ITRI) made the announcement at the opening of its Solders lead-free soldering technology centre.

Lead and other hazardous materials are scheduled to be phased out by the year 2004, under the EU’s Waste from Electrical and Electronic Equipment Directive, which is still at the consultative stage. Because its implications are so far reaching, covering so many aspects of waste recovery and recycling, introduction is expected to be pushed back beyond that date.

Solders’ director of marketing, Dr Jeremy Pearce said: “We are expecting a large number of inquiries, especially from small to medium size electronics manufacturers.”

The centre has also opened an interactive Web site (www.lead-free.org). Cost is not expected to be a major issue in the introduction of lead-free solder, rather the adoption of different manufacturing processes is in the run up to 2001. Because lead-free processes can be degraded by lead contamination from other sources, the changeover has to be comprehensive. Flow-solder baths and re-work stations, etc., are expected to be replaced in the natural course of events.

In a separate move the director of the PCIF, Brian Haken, has taken up with the EC the issue of the automotive industry’s temporary exemption for lead used in car batteries.

News

On yer bike... A bike hire scheme in the German city of Munich is using Dematron matrix touch screens to allow authorised users to unlock the electric motor assisted cycles. The Call-A-Bike scheme uses 2000 cycles, which are locked in racks next to telephone boxes. To hire a bike the user phones the scheme operator and gives credit card details in exchange for a four digit PIN. The PIN is entered on the touch screen allowing the lock to be released.

Paul Gregg

B² SPICE 2000

Not just a pretty interface

Acute results that can be relied on

Full mixed mode SPICE simulation with a host of new and advanced features. Already a favourite with colleges, universities and professional engineers this new release is set to break new ground. As always there is no limit on the maximum circuit size.

For educational users the “Set Defects” option allows a lecturer or instructor to create a circuit or component fault and hide it from students using password protection.

Other new features include:

• Uses the latest SPICE engine for guaranteed accurate mixed mode simulation
• Parameterised ac sweep
• Monte Carlo analyses
• Parameterised transient sweep
• New spice simulations
• SPICE analog simulations
• New noise and distortion analyses
• Improvised features for processing plot families as units
• New menu items to show local maxima, minima, and zero crossings

SPICE 2000 comes with a wide range of pre-designed models and devices spanning a wide range of applications. All models are derived from vendor data and are fully optimised for speed, accuracy and ease of use.

New Analog Models include:

• Gain, summer, multiplier, divider, piecewise linear controlled sources, analogue switch, limiter, zener diode, current limiter, hysterisis block differentiator, integrator, s-domain transfer block, slew rate block, inductive coupling, magnetic core, controlled sine wave oscillator, controlled triangle wave oscillator, controlled square wave oscillator, controlled sine-shape capacitor controller, inductance meter, controlled limiter.

New Digital Models include:

• Gain, summer, multiplier, divider, piecewise linear controlled sources, analogue switch, limiter, zener diode, current limiter, hysterisis block differentiator, integrator, s-domain transfer block, slew rate block, inductive coupling, magnetic core, controlled sine wave oscillator, controlled triangle wave oscillator, controlled square wave oscillator, controlled sine-shape capacitor controller, inductance meter, controlled limiter.

Research House, Norwich Road, Eastgate, Norwich, NR1 4HA
Tel: 01603 872321 Fax: 01603 879010
email: rd.research@aston.co.uk
www.looking.co.uk/spice

*Please add £5.00 postage and packing

All trademarks acknowledged.

New Analogue Models and functions

gain, summer, multiplier, divider, piecewise linear controlled sources, analogue switch, limiter, zener diode, current limiter, hysterisis block differentiator, integrator, s-domain transfer block, slew rate block, inductive coupling, magnetic core, controlled sine wave oscillator, controlled triangle wave oscillator, controlled square wave oscillator, controlled sine-shape capacitor controller, inductance meter, controlled limiter.

New Digital Models

There are so many we have not enough room here to list them. Please see our web site at www.looking.co.uk/spice for a full list.

Only £199.00 ex VAT! Existing users £99.00!

No hidden extras. All libraries included.
ADSL and beyond

Using the existing telephone network to provide megabit-per-second data rates, ADSL is making high-speed digital communications accessible even to domestic users. Geoff Lewis describes ADSL, and its offshoots, outlining where they are at the moment, and where they are likely to go in the near future.

Proposals for Asymmetrical Digital Subscriber Line, or ADSL, first appeared during 1989. They appeared after it had been recognised that data rates in excess of 10Mbit/s were already being achieved over local area networks using twisted pair cables with similar characteristics to those of the copper cables used for the subscriber's final loop of the plain old telephone system - 'POTS'.

By employing frequency-division multiplex (FDM) using radio frequency carriers up to about 1MHz, it was found possible to add data modulation on to the basic system.

Using FDM, it became possible to provide for a two-way simplex communications system and still provide for the simultaneous use of the normal voice telephone band, including fax, Fig. 1. The term 'asymmetrical' is applied to this concept because the two data streams employ different bandwidths and bit rates.

At that time, the concept was seen mostly as a means of delivering video-on-demand (VOD) services to the existing telephone system. The network was expected to act simply as the carrier for third party programming content. Because of the already installed wide-ranging telephone infrastructures, it would be possible to bring the concept on stream fairly quickly. By comparison, the competing cable TV companies could only provide such a service by using the spectrum wasting process of near-VOD (NVOD), where five or six carrier frequencies are allocated to the same programme but with staggered start times.

During the early 1990s many ADSL trials were carried out around the world. These all proved that the service could deliver VOD with adequate image quality using MPEG compressed television signals over the existing telephone network, and with fall VCR type characteristics.

Many other possible services were proposed but the concept failed to influence the broadcasters, the data communicators or the viewing public.

To date, a worldwide ADSL Forum with more than 200 members has been established to drive the system forward. This is now supported by more than fifty ADSL modem manufacturers. Probably the final acceptance of the digital subscriber's line concept depends on its future physical developments.

During the late eighties, the development convergence between television and computing technology, chiefly in the guise of the Internet, provided a new impetus for ADSL expansion. Baseband modems for connecting to a standard telephone line are now capable of bit rates of up to 56kbit/s. This is not far from the best that can be provided by the ISDN system, which is capable of 128kbit/s over the subscriber's final loop.

By using leased lines, the ISDN Basic Rate Access (BRA) can achieve a data rate of 2.048Mbit/s. By comparison, the television system can modulate the copper cables at up to 30Mbit/s - the typical capacity of a given spur. However, since this bandwidth has to be shared with other users on the spur, the average is seldom more than 2Mbit/s.

The maximum bit rate for the ADSL system depends chiefly on attenuation produced by the resistance of the local loop, which increases with distance. In addition, the frequency response falls off at about 0.75dB/kHz.

Most importantly for digital signals, the group delay over this section of the line is practically constant thus producing very little pulse distortion and hence very few bit errors. For a reach of about 2.5km the bit rate can be as high as 6-7Mbit/s, falling to about 2.5Mbit/s over 5km.

By 1998 Kingston Communications had installed an ADSL system in the Hull telephone district to provide the first operational public service in Europe. This has a customer base of some 200000 subscribers.

By mid-2000, British Telecommunications (BT) will have completed the installation of ADSL equipment in 400 digital exchanges to provide a service for up to 600000 domestic and business users. Over the same period, several networks have also been installed in both the USA and Australia.

Up to 1995, most of the standards for ADSL were under the management of the American National Standards Institute (ANSI), with input from the European Telecommunications Standards Institute (ETSI). During the past few months, the International Telecommunications Union (ITU) has confirmed recommendations for a much wider range of operations. The systems now appear under the global banner of xDSL, where a covers a range of options which is referred to collectively under ITU Recommendation G.990. The series describes systems that provide subscriber upstream control/demand bit rates as high as 8Mbit/s and data downstream at rates of 8Mbit/s.

The xDSL family

The sub-division of the DSL group of systems depends largely on the use of the RJ pair of the digital spectrum.

Asymmetrical Digital Subscriber Line (G.992.1). ADSL is the original format from which all the others have been derived. The maximum downstream bit rate can be as high as 8Mbit/s, while the subscriber's demand channel can attain 6Mbit/s. The local loop reaches from 5km up to 8Mbit/s at 3km. The services provide for high-speed Internet access, e-mail and video on demand. This system is targeted at the home, worker (tele-working), domestic consumers and small businesses.

High-speed Digital Subscriber Line (G.992.2). This represents a simplified version of ADSL whereby the modem contains only very limited filtering and is designed for user installations. The downstream bit rate can attain 1.5Mbit/s at about 3 to 4.5km reach, with up to 64kbit/s of user bit rate.

High-speed Digital Subscriber Line (G.992.1). HDSL is designed for business services using two pairs of leased lines to provide EUTI data rates in a symmetrical manner, i.e., 2Mbit/s in either direction. Repeaters are required for systems with local loop lengths greater than about 5km.

HDSL2 is a variant designed for use in the USA. It is bit-rate adaptive and employs a single pair of leased lines.

ISDN Digital Subscriber Line: ISDSL, is a variant of HDSL and is currently under development.

High-speed Digital Subscriber Line: xDSL family systems are under development.
Asynchronous transfer mode system – ATM

The ATM concept was developed for use in broadband metropolitan area networks (MANs) and optical fibre systems. Such is its flexibility, it is also capable of being interfaced to SONET (Synchronous Optical Network). ATM automatically adjusts the network capacity to meet the system needs and can handle data, voice, video and television signals. These are transferred in a sequence of fixed-length data units called cells.

Common standards definitions are provided for both private and public networks so that ATM systems can be interfaced to either or both. ATM is therefore a wide-band, low delay, packet-like switching and multiplexing concept that allows flexible use of the transmission bandwidth and is capable of working at data rates as high as 622.08 Mbit/s.

Each data packet consists of five bytes of header plus 48 bytes of user data. The header contains data that identifies the related cell, a logical address that identifies the routeing, forward error control (FEC) and parity handling and network management functions. Forward error control is supported as it is assumed that the network medium will not generate the error rate below an acceptable level.

All the cells of a 'virtual container' follow the same path through the network. Cells produced by the same path through the network. Cells produced by the same service are sent on a single virtual connection with the same logical address. ASON (Automatic Switched Optical Network) is a further concept developed from ATM that provides for data rates up to 2.3 Mbit/s, sufficient for voice and data traffic, together with videoconferencing using MPEG-2 data compression.

High very high speed DSL (VDSL), is an asymmetrical system developed for use over short length loops. It is sometimes seen as a replacement for the 'last mile' or local loop to provide a direct link to optical fibre sections of the network. The downstream bit rates range from 13 to 52 Mbit/s, with 2.3 Mbit/s in the return channel. The downstream local loop reach ranges 1.3 km at 13 Mbit/s down to 50 km at 52 Mbit/s.

Typical ADSL applications

The loop-length limited downstream bit rate can be employed in a time-division multiplex (TDM) mode. For example, by using MPEG-2 digital compression with suitable channel coding, video signals of various grades can be transmitted directly to the subscriber’s home.

At bit rates of 2 Mbit/s, the downstream channel can provide either three video signals of quality together with digitally stereo coded sound, or with MPEG-2 compression at 6 Mbit/s can provide video with a quality equal to that of a broadcast television transmission. At 8 Mbit/s even high-definition television images are possible.

As an example of the SDH compatibility of xDSL, the subscriber’s upstream channel can operate at either 10 Mbit/s or 56 Kbit/s. Transmission can be divided into three times 2.048 Mbit/s, giving 6.144 Mbit/s or four times 1.544 Mbit/s, resulting in 6.176 Mbit/s, to meet either the European or North American telecommunications standards (EUTI rates).

Current ADSL modems are now equipped with IEEE 1395 (FireWire) and USB (Universal Serial Bus) interfaces and supports the ability to be extended to operate throughout the home. Used in this way, ADSL enables access to the internet from the basic computer into the right into the home worker’s domain.

Basic organization of xDSL

As indicated in Fig. 2, high-pass/low-pass filter combinations are employed at each end of the local loop of an ADSL network in order to combine or separate the two sections of the circuit so as to minimize the effect of mutual interference.

For ADSL systems, the local terminal filtering is minimal to simplify installation for the subscriber. This reduced bit rate system can suffer from interference and noise from the telephone network, often influenced by the number of items of equipment coupled to the subscriber’s network socket.

Amplitude Modulation (QAM), Carrier Amplitude and Phase Modulation (CAP) and Discrete Multi-Tone modulation (DMT). Only DMT requires radio frequency interference, ADSL employs a balanced feed of RF signals to the local loop.

The loop source provides a common RF carrier source, which is divided between the different service providers. This will introduce the need for accurate monitoring of power levels and spectrum management. Could this be the replacement for the local loop as a matter of urgency? If so, then the digital signal processor will have an important role to play in the future.
The UK’s congested roads are not only annoying, they can be lethal. Just listen to Radio 5 Live’s traffic update in the mornings. Help is at hand though, as the big car manufacturers like Jaguar install car crash avoidance systems. Pete Mitchell takes the wheel.

If you believe the adverts on tv, motorists spend all their time zooming along deserted lakes or across deserts, or parked on cliff tops, a few metres apart. Across deserts, or parked on cliff tops, these fantasies, car makers are considering designing-in motorways: lines of hundreds of these conditions, and there has long been talk of adapting the aerospace technologies for collision avoidance, rather than develop rival proprietary systems. So the European Commission is encouraging manufacturers to get together and agree the best technologies for collision avoidance, rather than develop rival proprietary solutions that could fragment the market and delay its introduction.

Jaguar is to use adaptive cruise control with collision avoidance on its XKR sports car, shown above, starting from next year. The system functions either as a conventional cruise control or, in traffic, maintains a safe distance from the car in front. Developed by Delphi, the system uses a 76GHz microwave radar mounted in the nose of the car. It calculates speeds of vehicles up to 150m ahead. As vehicles in front slow down, the Jaguar’s brakes are automatically applied, and audible warnings are given to the driver if the driver in front does something really stupid.

The system then uses this knowledge to perform a much more accurate ‘tracking’ measurement – only 10cm for distances less than 30m. These techniques give the device a range of 80m in good visibility, according to CSEM. In poor visibility, the range depends on conditions – it is not as good as microwave radar, but is about 40 per cent better than the human eye, claims the team leader, Dr Monti. In fact, Fiat didn’t want more than this, says Monti: “They have done simulations that show it’s safest that drivers don’t have a collision warning system that is much more sensitive than their own eyes, otherwise they start to go too fast.”

Microwave radar was the favoured choice for so far because of the rapid availability of components. Mercedes’ top-of-the-range cars already have offer a radar collision-avoidance option, made by ADC. But, according to Monti, it has one fatal drawback: electromagnetic pollution. “Imagine what will happen if in ten years’ time every car on the road is emitting microwave radiation”, he says. Pointing to the current worries about the health effects of these emissions from mobile phone base stations, Whether right or wrong, these fears are real, and are likely to prompt manufacturers to move to optical collision avoidance systems, he says. However, OLMO has the typical limits of pioneering work. Its lifetime, at only six months without maintenance, is rather short. It is also too expensive, with production cost estimated at around £250. The usual chicken-and-egg problem of high unit costs at low volumes before economics of scale are established. So will the manufacturers bite at such sophisticated ‘extras’, as they did with electrically driven braking? Only if they can see a competitive need: within each class of vehicle, there are fewer and fewer functional differences between the leading car brands, says Jaguar technical specialist Paul Mulvaney. “They all have four wheels and all start and stop reliably. Digital technologies create opportunities to incorporate entirely new functions into the basic design.” A lot depends on the manufacturer’s public image. Fiat, which is evidently committed to the collision-avoidance idea, may be planning to use it to push a safety-first theme. Monti says that these car manufacturers are interested in his LIDAR, and believes the whole industry will be offering collision-avoidance systems within two years. Other external assists, such as active suspension using multi-axis silicon accelerometers, or piezoelectrically driven fuel injection jets, may appear more to the technical department. But car makers obsessed with what Mr Jeremy Clarkson calls “those new performance” but it seems unlikely that car makers who encourage drivers to take blind corners at 60mph, as Alfa Romeo did in a recent newspaper advertisement, will have collision avoidance instruments high on their priorities list.
**You Can’t Buy Better!**

**SIGNAL GENERATOR PRICE BLITZ**

**MARCONI 2019A Synthesised Signal Generators**
- 80kHz to 100MHz
- AM-FM-CW LCD Display
- Competitive with Lida etc.
- FULLY TESTED and Warranted
- **NOW ONLY £475.00**

**MARCONI 2022E Synthesised Signal Generators**
- 10kHz to 1010MHz
- LCD Display
- Fitted IEE with covers
- Small and lightweight
- FULLY TESTED and Warranted
- **NOW ONLY £495.00**

---

**Signal Generators**

- **TEK 2445**
  - 10kHz-20MHz 2 Trace/2 Timebase
  - 40MHz-500MHz 2 Trace/2 Timebase
- **TEK 2465**
  - Remote Synthesiser to 120MHz in 0.01Hz
  - 10MHz-520MHz AM-FM SAW
  - Only £295
  - Was £350 .. Reduced, Now Only £250
- **TEK 465M**
  - MARCONI 2019A Synthesised Signal Generators
- **TEK 475**
  - 1Hz to 260kHz with LCD display
  - Synthesised 0.1mHz to 110kHz
  - Complete with Lids etc.
  - FULLY TESTED and Warranted
- **REPORT MONITOR PORTABLE**
  - 9.5ips, cursors, etc. Now Only £595

---

**Oscilloscopes**

- **TEK 2445A**
  - 150MHz Four Trace/Time base
- **TEK 2465**
  - 100MHz Four Trace/Time base
- **GOLDFIELD 0300**
  - 2MHz Dual Trace
  - Dual Timebase
- **HP 1741A**
  - Studio Quality AUDIO Equipment
- **TEK 2445**
  - 100MHz-200MHz 2 Trace/Timebase
- **TRANSMIT 290**
  - Special
  - Now Only £150
- **THS MONTH’S SPECIALS**
  - Philips PMT 177 Scopes
  - DC-50MHz 2 Trace/2 Timebase
  - A R F. Kit, Better Special Offer £725
  - **GOLDFIELD 0330 Scopes**
  - DC-40MHz 2 Trace, Special
  - Now Only £150

---

**Regulated Power Supplies**

- **Thorn Automation**
  - Variable power supply giving 0-40 volts at 0-50 amps DC. + and 15W Tesla lamp testing
  - LmAmps
  - 16VDC
  - Special
  - Now Only £126

---

**Miscellaneous**

- **NELSON 39 DC-20MHz 2 Trace**
  - Timebase
  - New Only £125
- **GOLDFIELD 0500**
  - 6MHz at 10A DC.. . ONLY £20
- **LAMDA Labs**
  - 2MHz-10mA DC.. . ONLY £20
  - LMX12YV 12V at 10A DC... ONLY £20

---

**INSTRUMENTATION**

**NEW SCOPE PROBES**

- 3kHz probe to 100kHz
  - Complete with adapters
  - £25 a pair
  - Only £75

---

**New Equipment**

- **DTA40 Oscilloscope 20MHz**
  - Twin Trace and proves ONLY £225
- **DTA40 Oscilloscope 20MHz**
  - Twin Trace and proves ONLY £225
- **DTG46 Oscilloscope 40MHz**
  - Digital Storage twin channel
  - CURSORS + READOUTS
  - £85
- **SCG50 Synth Clock Gen.**
  - To 50MHz.
  - LED display Only £125

---

**Studio Quality Audio Equipment**

- **Studor A710**
  - Cassette deck with Dolby C, 1 ONLY £25
  - Ultra 4000
  - Report monitor portable, To 8ips
  - 1 ONLY £75

---

**ANCHOR SUPPLIES LTD**

**All prices are EX VAT and Carriage**

**MAIL ORDER A PLEASURE**

The Cattle Market Depot, Nottingham NG2 3GY, UK
Tel: (0115) 986 4902
Fax: (0115) 986 4667
Also at Ripley, Derbys (01773) 579137 and Coalville, Leicestershire (01530) 81880
Visit our Web Site: www.anchor-supplies.ltd.uk email: sales@anchor-supplies.ltd.uk

---

**INSTRUMENTATION**

Cyril Bateman has been enhancing his tanı meter with better protection against charged capacitors. He’s also produced an efficient battery regulator providing ±5V from four AA cells.

Recently I measured every board-mounted aluminium electrolytic capacitor in a piece of test equipment. In just ten minutes, using my tanı meter, I identified 33 capacitors with a tanı in excess of 0.4. Capacitors measuring such a high tanı are worn out and should be replaced.

Aluminium electrolytic capacitors are quite different from any other capacitor type in their construction and failure modes. Usually, the capacitance value of a worn out aluminium electrolytic capacitor is little changed, but its series resistance and tanı will be seriously increased. These failure modes together with the appropriate in-circuit diagnosis methods, were discussed in the May 1999 issue of Electronics World.

Design and development of a new and unique prototype in-circuit capacitor tanı test meter was described in the June issue together with the schematic drawing of the measurement circuit used.

This self-contained prototype meter included a low output impedance 100Hz generator, a floating 5V supply for the PM128 display meter and a stable ±5 volt battery power supply. However, to save space, these additional circuits were not included in the June article.

Since the original design was published, I have made various enhancements to it. The most notable of these is the addition of a further INA118 instrument amplifier, in front of the logic channel LM311 current sensing comparator. Amplification of the tiny

---

January 2000 ELECTRONICS WORLD
voltage dropped across the current sensing resistors, used to identify the phase of the capacitor's current waveform, improves measurement accuracy particularly when measuring smaller value capacitors.

I chose a standard OKW V155 'Shell' case, measuring 158 by 95 by 45 mm. This uncut case has an externally-accessible battery box taking four AA cells. Smaller cases did not provide enough space for the measurement circuitry, batteries and PM128 display.

The prototype's 140 by 74 mm printed board had to be divided into two sub-boards approximately 85 by 70mm, in order to fit into this case, Fig. 1. Both boards are simply interconnected using a seven-way, flat flexstrip jumper cable. In the picture, this cable hides four of the 220uF decoupling capacitors, two on each board.

To complement the above cosmetic improvements, I decided to enhance the meter's 'charged capacitor' protection. In the event these apparently simple changes proved extremely time consuming.

Enhanced charged-capacitor protection
With the range of capacitance values and working voltages used in equipment, it is not possible to provide worst-case protection in a small portable instrument. The tan$\theta$ meter is designed and intended to be used on discharged capacitors. There's more on this in the panel entitled 'Worst-case protection'. Accidental measurement of charged capacitors might however occur so I have provided as much protection as possible within the board size limitations.

Where other protection is not possible, I have used sacrificial fusible resistors. These become open circuit when overloaded, limiting the spread of damaged components and facilitating repairs to the meter.

Measurement circuit protection
Examination of the schematic diagram will reveal that four IN4150 diodes as series-connected back-to-back pairs, are used across the inputs of IC1 and IC2, to limit their differential voltage inputs. These ICs are the two Burr-
Brown INA118 instrument amplifiers previously mentioned. Using two diodes in series ensures that leakage currents do not affect the circuit's normal operation. Fig. 2a).

The INA118s incorporate internal current limiting protection to ±40 volt inputs, both with and without power. The power pack consists of a 100Ω fuse and a 3.3Ω resistor in each INA118. When both fuse and resistor open to the circuit at around 1A peak, I evaluated many other protection options, but all were rejected. Some failed because leakage currents unbalanced the INA118 inputs. In other cases, photo-voltage sensitivity to infra-red from mains lighting introduced an error less small voltage into the INA118.

If you are unfamiliar with diacs, they are four layer devices intended as low-cost triggers for triacs. Being four, the ICs are also used to limit voltages on the transients. The K1700 transformer windings. Unconstrained, this transient process damaging my nickel-plated test protectors, the high peak discharge current stored in the test leads contact the charged capacitor. Voltage from a charged capacitor present to its secondary winding, results in a voltage transient on its primary windings. Unconstrained, this transient could destroy the AD712 used as the 100Ω push-pull output amplifier.

To limit such voltage transients, two INA4002 diodes D3,4,5,6 are also used to limit voltages on the LT001 primary windings. The above measures locate any circuit damage in the event a charged capacitor is measured, but the two range resistors also the range relay contacts, cannot be protected.

Current sensing range resistors are not the measurement capacitor, if a live voltage, is contacted by both test probe, this voltage appears at P1 and hence at the base of R1, but not the relay contact. The other end is held near to 0Vs, via R1 and the transformer, clamped by these IN1402 diodes.

The filter designer to its ‘low range’ range circuits, discharges the relay contacts are open. When subject to a charged capacitor of sufficient capacitance, the sustained discharge current causes the meter to switch to its ‘high range’, closing the relay switches which now protect R1. A much increased discharge current passes through the relay contacts and R1.

In normal use measuring discharged capacitors, the highest current passing through R1 is 50mA. Practical tests, discharging a 1000µF capacitor, pre-charged to various voltages, directly into R1 suggest this 22Ω resistor fails when subject to a single pulse of 2A peak. Similar discharge tests into R1 indicate failures occurring at 9A peak.

Using a fuse between P1 and R1 does not help. The fastest acting ‘FF’ fuses pass a large overload current for a finite time before they rupture. During this time, the range resistors and relay contacts are unprotected. Voltage from a charged capacitor causes the range resistors and relay contacts to pass many times their normal current. Range R3 can be open or closed, the relay contacts weld together, either way, the high peak discharge current R1, indicates failures occurring at 9A peak.

Aluminium electrolytic capacitors are very low leakage devices. They are only measured for impedance, tanδ or ESR using low-leakage measuring circuits. Adding resistance in the test circuit to restrict capacitor discharge current is simply not possible.

Using fuses in series with the test leads does not help. Even the fastest class ‘FF’ fuses pass a large overload current for a finite time before they rupture. During this time the measurement circuit is unprotected.

The alternative approach of ‘crow- barring’ the capacitor voltage to ground also does not help. The fastest semiconductor transient protection diodes take a finite time to turn on and the capacitor takes more time to discharge. At the instant both test probes contact the charged capacitor, that voltage is instantaneously transferred to the measurement circuit. I have experimentally confirmed these effects by discharging 1000µF capacity charged to various voltages up to 50 volts, into the fusible resistors mounted in a test board. Using both series ‘FF’ fuses and shunt 5.8Ω bi-directional 140A rated transient diode protectors, the 22Ω and 2.2Ω, 0.5W fusible resistors still became open circuit.

The 2.2Ω fusible resistors typically fail at 20 to 25V, the 22Ω falling near 50V. Similar results were found testing these resistors both with and without the series fuse and short transient diode protector circuits.

Using lesser, 57A-rated transient diode protectors, the high peak discharge currents destroyed the protection diodes, in the process damaging my nickel-plated test probes.

Since these fuse and transient diodes did not enhance the charged capacitor protection, they are not used in the final meter design.

In summary, the semiconductor transient protection diodes do not help. Also they can handle a 2A peak current. These INA118 in-amps are by far the most expensive integrated circuits used in the meter. The low-cost diodes protect the INA118s by clamping their inputs to some 35V maximum. Ultimately, they blow open the faulty 100Ω fusible resistors to minimise further damage should a seriously charged capacitor be measured.

100Hz generator protection

The 10.1 step-down ratio of the LT1000 provides the low-source impedance test current essential when measuring high value capacitance. Any voltage from a charged capacitor presented to its secondary winding, results in a voltage transient on its primary windings. Unconstrained, this transient could destroy the AD712 used as the 100Ω push-pull output amplifier.

To limit such voltage transients, two INA4002 diodes D3,4,5,6 are also used to limit voltages on the LT001 primary windings. The above measures locate any circuit damage in the event a charged capacitor is measured, but the two range resistors also the range relay contacts, cannot be protected.

Current sensing range resistors do not help. Even the fastest acting ‘FF’ fuses pass a large overload current for a finite time before they rupture. During this time, the range resistors and relay contacts are unprotected. Voltage from a charged capacitor causes the range resistors and relay contacts to pass many times their normal current. Range R3 can be open or closed, the relay contacts weld together, either way, the high peak discharge current R1, indicates failures occurring at 9A peak.

Using a fuse between P1 and R1 does not help. The fastest acting ‘FF’ fuses pass a large overload current for a finite time before they rupture. During this time, the range resistors and relay contacts are unprotected. Voltage from a charged capacitor causes the range resistors and relay contacts to pass many times their normal current. Range R3 can be open or closed, the relay contacts weld together, either way, the high peak discharge current R1, indicates failures occurring at 9A peak.

Send for the Pico Technology PC based test & measurement catalog and software demo disk or visit: www.picotech.com
Seen on sale for £20 each, these high-quality oscilloscope probe sets comprise:

- two x1, x10 switchable probe bodies
- two insulating tips
- two IC tips and two spring hooks
- trimming tools

There's also two BNC adaptors for using the cables as 1.5m-long BNC-to-BNC links. Each probe has its own storage wallet.

To order your pair of probes, send the coupon together with £21.74 UK/Europe to Probe Offer, Electronics World Editorial, Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS. Readers outside Europe, please add £2.50 to your order.

**Specifications**

**Switch position 1**
- Bandwidth: DC to 100MHz
- Input resistance: 1MΩ – i.e. oscilloscope input
- Input capacitance: 40pF + oscilloscope capacitance
- Working voltage: 600V DC or peak AC

**Switch position 2**
- Bandwidth: DC to 150MHz
- Rise time: 2.4ns
- Input resistance: 1MΩ
- Input capacitance: 12pF if oscilloscope input is 20pF
- Compensation range: 10-60pF
- Working voltage: 600V DC or peak AC

**Switch position 'Ref'**
- Probe tip grounded via 9MΩ, scope tip grounded

---

**SPECIAL OFFERS**

**SOLID STATE DIMENSIONAL MEASURING INSTRUMENT**

- **CARTRIDGE-INSERTION TESTER**
  - **Ref.**
  - **Price**
- **DIAL PLANE DIVIDING ENGINE**
  - **Ref.**
  - **Price**
- **MAGNITUDE & PHASE DETECTOR**
  - **Ref.**
  - **Price**
- **DIGITAL COMPASS**
  - **Ref.**
  - **Price**

**SIGNAL GENERATORS**

- **LOGIC SIGNAL GENERATOR**
  - **Ref.**
  - **Price**
- **RF SIGNAL GENERATOR**
  - **Ref.**
  - **Price**
- **SPURIOUS FREQUENCY GENERATOR**
  - **Ref.**
  - **Price**

**COMMUNICATIONS EQUIPMENT**

- **RTS 5042 A / B**
  - **Ref.**
  - **Price**
- **RTS 5042 A / B**
  - **Ref.**
  - **Price**
- **RTS 5042 A / B**
  - **Ref.**
  - **Price**

**OTHER ELECTRONICS TEST INSTRUMENTS**

- **MILLIVOLT METER**
  - **Ref.**
  - **Price**
- **MULTI-METER**
  - **Ref.**
  - **Price**
- **BATTERY TESTER**
  - **Ref.**
  - **Price**

**OSCILLOSCOPES**

- **TEK-1102**
  - **Ref.**
  - **Price**
- **TEK-1102**
  - **Ref.**
  - **Price**
- **TEK-1102**
  - **Ref.**
  - **Price**

---

**Universe Reader Offer:**

**x1, x10 switchable oscilloscope probes, only £21.74 a pair, fully inclusive**

*Additional pairs as part of the same order, only £19.24 each pair.*

Please supply the following:

**Probes**

<table>
<thead>
<tr>
<th>Name</th>
<th>Address</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Postcode Telephone

Method of payment (please circle)

- Cheque
- Credit card

Cheques should be made payable to Reed Business Information.

Please allow up to 38 days for delivery.
Unique Electronics World reader offer

Save 20% on the price of Tina Pro Industrial or Tina Pro Classic powerful circuit simulators

Tina Pro Industrial

The new 32-bit Tina Pro is a powerful yet affordable software package for designing, simulating and analysing electronic circuits. It works equally well with linear and non-linear analogues, digital and mixed circuits. It contains a large library of over 10000 components that you can extend and modify, and a wide range of tools including symbolic analysis. Components include an extensive range of TTL and CMOS devices, most popular semiconductors and interactive models such as displays, keyboards and LEDs. Circuits are constructed by choosing components, which are conveniently grouped in families and connections are made using the mouse and hot keys.

Tina Pro Classic

Tina Pro Classic is identical to Tina Pro Industrial but without some additional utilities. These additional utilities include the SPICE library manager, symbol designer, and the program which creates models from manufacture data.

What's the bottom line?

Tina Pro Classic – save over £30
Normal Price £164
Discounted Price £131
Fully inclusive Price £165.58

Tina Pro Industrial – save over £60
Normal Price £239
Discounted Price £209
Fully inclusive Price £209.58

Prices include UK postage, packing and VAT. Offer ends 1 March 2000.

Tina Pro – 32-bit advanced mixed-mode simulation

Comprehensive analysis tools are included with Tina Pro to test circuits. Analysis results can be displayed in 'Diagram Windows' or in a range of virtual instruments. Desk top publishing tools and powerful text and equation editors can be used to produce professional reports and presentations. Electronic engineers will find Tina Pro an invaluable but easy to use high performance tool.

Are you familiar with CAD? If not, you may think that you still need to get involved with writing uninviting code. Not so. Drag and drop analogue components and digital! I'm into your circuit diagram then see how your circuit performs using simulated instruments including function generators, multimeters, XY plotter, oscilloscope, signal analyser, logic analyser and digital signal generator. Once you've found your way around, you'll soon be including things like noise and distortion analysis in your summaries.

Feature outline

Fully 32bit software for last performance under Win95, 98 or NT
10000+ built in components and 1000+ manufacturer made components in SPICE sub-circuit format
DC analysis includes model voltages, DC transfer characteristic and temperature analysis
AC analysis includes model voltages, time function, and AC transfer characteristic
Symbolic analysis includes DC and AC result, semi-symbolic DC and AC result, AC transfer, semi-symbolic AC transfer, Poles and Zeros, and semi-symbolic transient
Other analyses used include transient, digital step by step, digital timing analysis with glitch control, and noise analysis
Virtual instruments include function generator, multimeter, XY plotter, oscilloscope, signal analyser, logic analyser and digital signal generator
Enhanced SPICE 3F5 compatible algorithms
Massive range of component models including resistor, potentiometer, capacitor, charged capacities, inductors, energy storing inductor, co-planar inducers, diode, Zener, LED, lamp, motor, transformer, transmission line, bipolar transistor (NPN/PNP), MOS transistor (enhancement and depletion mode, N and P channel), JFET (N and P channel), thyristor, IGFET, ideal OPAMP, OPAMP, current source, voltage source, current generator, voltage generator, controlled sources (CCCS, VCVS, CCVS, VCVS), and a full complement of digital components, AC and DA converters, timers, analogue control blocks, seven segment display, keyboards, nonlinear cells, transformers, relays, darlington transistors, optocouplers and voltage regulators and much much more.
New sub-circuits can contain both SPICE macros or schematics Automatic shape creation for subcircuits Schematic symbol editor for creating custom components Customisable component toolbar – add your own components SPICE macros can be used directly from Tina's schematic editor Parameter program extract program to calculate model parameters from catalogue or measurement data

Library manager for extending and maintaining manufacturer made component libraries
New multimeter, oscilloscope and signal analyser components can be added directly onto schematics
Average and RMS values for arbitrary periodic waveforms Enhanced Fourier analysis with both peak and RMS calculation AC analysis now with RMS calculation Conversion of symbolic analysis results into code executable in the interpreter Specify temperature for individual components New fault simulation on digital circuits Multimedia tutorials demonstrate key concepts and features Supplied on CD-ROM with printed documentation
Requires Windows 95, 98 or NT with 8M memory or more.

Overseas readers interested in this offer contact Quickroute for details.
Quickroute Systems Ltd, Regent House, Heaton Lane, Stockport SK4 1BS. Tel. 0161 476 0522, Fax 0161 476 0529 (www.quickroute.co.uk)

Subscribe for 3 years, pay for just 2

Get on board the Easy-PC For Windows revolution!!
Power-Packed PCB Layout for Windows '95/98/NT at Computer Store Prices!!

From £97

33,000 Easy-PC users must be right!!

For more information or a demo disk call Number One Systems on 01684 773662 or Fax 01684 773684
Email info@numberone.com
Number One Systems, at Sightmagic Ltd, Oak Lane, Bredon, Tewkesbury, Glos, GL20 1LR, UK
Visit our WEB site www.numberone.com

Now with optional autorouter!!

CIRCLE NO. 117 ON REPLY CARD
Please enter my subscription for:

Please enter my Visa/Mastercard/American Express/Diners

Card Number

Expiry date

Valid from

Company

Address

Tel. No.

Fax No.

E-mail address

Company VAT registration number

Return your completed form to:

ELECTRONICS WORLD Subscriptions, FREEPOST RCC 2619, PO Box 303, HAYWARDS HEATH, UK, RH1 6JR.

Fax: +44 (0)1444 445447. E-mail: rbi.subcriptions@rbui.co.uk

Credit Card Orders – ( quoting code 121)

Tel: +44 (0)1444 475662

Overseas readers interested in this offer contact Quickroute for details.

Quickroute Systems Ltd, Regent House, Heaton Lane, Stockport SK4 1BS. Tel. 0161 478 0002, fax 0161 475 6695.

Three ways to pay

1. I enclose a cheque for £

2. Please charge my Visa/Mastercard/American Express/Diners Club/Switch/Debit Card (please delete as appropriate)

Card Number

Expiry date

Valid from

Signed

Date

Please invoice my company. Purchase Order No.

Name

Job Title

Company

Address

Tel. No.

Fax No.

E-mail address

Company VAT registration number

Return your completed form to:

ELECTRONICS WORLD Subscriptions, FREEPOST RCC 2619, PO Box 303, HAYWARDS HEATH, UK, RH1 6JR.

Fax: +44 (0)1444 445447. E-mail: rbi.subcriptions@rbui.co.uk

Credit Card Orders – ( quoting code 121)

Tel: +44 (0)1444 475662

Overseas readers interested in this offer contact Quickroute for details.

Quickroute Systems Ltd, Regent House, Heaton Lane, Stockport SK4 1BS. Tel. 0161 478 0002, fax 0161 475 6695.

Three ways to pay

1. I enclose a cheque for £

2. Please charge my Visa/Mastercard/American Express/Diners Club/Switch/Debit Card (please delete as appropriate)

Card Number

Expiry date

Valid from

Signed

Date

Please invoice my company. Purchase Order No.

Name

Job Title

Company

Address

Tel. No.

Fax No.

E-mail address

Company VAT registration number

Return your completed form to:

ELECTRONICS WORLD Subscriptions, FREEPOST RCC 2619, PO Box 303, HAYWARDS HEATH, UK, RH1 6JR.

Fax: +44 (0)1444 445447. E-mail: rbi.subcriptions@rbui.co.uk

Credit Card Orders – ( quoting code 121)

Tel: +44 (0)1444 475662

Overseas readers interested in this offer contact Quickroute for details.

Quickroute Systems Ltd, Regent House, Heaton Lane, Stockport SK4 1BS. Tel. 0161 478 0002, fax 0161 475 6695.
One IC stand-alone temperature logger

This stand-alone temperature logger incorporates a Dallas DS1615 temperature recorder IC. It connects to a PC via its RS232 port for initialising and data downloading. After initialisation, the logger is disconnected and placed in the environment where temperature needs recording, ready to make measurements.

If measurements do not need to start right away, the logger can be programmed to sleep for a while before it starts to log temperature. Scanning interval can be varied from 1 minute to 255 minutes. Up to 2048 temperature records can be stored in the on-board memory.

Temperature to be measured is in the range -40 to 85°C with an error of ±2°C. The real time clock/calendar is divided into two sections, namely the data acquisition/storage section and the RS232 transceiver section.

The circuit diagram, which includes the DS1615, two transistors and a number of passive components. Functionally, the circuit divides into two sections, namely the data acquisition/storage section and the RS232 transceiver section.

Fig. 2 shows the circuit diagram, which includes the DS1615, two transistors and a number of passive components. Functionally, the circuit divides into two sections, namely the data acquisition/storage section and the RS232 transceiver section.

The data acquisition/storage section is based on the DS1615. This is an intelligent IC, capable of receiving various control commands from its built-in universal asynchronous receiver and transmitter, or UART, port. Once the DS1615 is initialised properly, it becomes a stand-alone temperature logger.

Implementation is shown in Fig. 1. The hardware is simple, consisting of a D51615 temperature recorder, two transistors and a number of passive components. The design can be constructed on a single-sided board.

Fig. 3. The DS1615 is a 16-pin device as shown in a). Its internal block diagram is shown in b).
The 1615 in detail
Pin name and functions of the 1615 are described in Table 1.

Figure 4a) shows the internal memory organisation of the DS1615. Each location is eight bits wide. The complete memory locations are from page 0 to page 191 and store temperature records. The value in each 8-bit memory cell is converted into temperature using the following formula:

\[ \text{Temperature} = \frac{0.5 \times \text{byte value}}{8} \]

The asynchronous interface involves transferring the appropriate RTC registers to and from the computer, as shown in Figure 4b). The RS232 interface is used to set up the operating modes. Bit functions of the status register at 000115H are shown in Figure 4b).

The synchronous interface uses two data lines, TX and RX, and has a standard UART data format. Its bit rate is at 4800 baud and communicates via eight-bit word lengths terminated with one stop bit. Parity checking is not used.

The synchronous serial interface is a three-wire bus consisting of –RS, SCLK, and QO (data input/output). This design incorporates programming with a PC's synchronous COM port, the synchronous interface is

 Locations for temperature records.

Temperature=(0.5*byte value in memory area where the user can write an

The 1615 contains a time-of-day clock, calendar, and temperature monitor. Internal temperature data is stored in 64 memory cells. The DS1615 provides a single-temperature alarm that can be programmed to trigger an interrupt. The alarm can be enabled or disabled using the control register.

Control functions of the status register

(b) Bit functions of the status register

- MEM CLR - 1: disable oscillator 0: enable oscillator
- CLR - 1: enable memory clear 0: disable memory clear
- SE - 1: non-zero value in Sample Register, OT pin held low 0: disable oscillator
- RD - 1: read a non-zero value in Sample Register to start logging
- TLE - 1: enable temperature low interrupt 0: disable temperature low interrupt
- THE - 1: enable temperature high interrupt 0: disable temperature high interrupt
- AIM - 1: enable alarm interrupt 0: disable alarm interrupt

(a) Bit functions of the control register

(c) 9-pin male socket viewed from the back of the computer

Pin functions of the RS232 connectors

<table>
<thead>
<tr>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TX</td>
<td>Transmitter data</td>
</tr>
<tr>
<td>RX</td>
<td>Receiver data</td>
</tr>
<tr>
<td>RTS</td>
<td>Request to send</td>
</tr>
<tr>
<td>CTS</td>
<td>Clear to send</td>
</tr>
<tr>
<td>DSR</td>
<td>Data set ready</td>
</tr>
<tr>
<td>DCD</td>
<td>Data carrier detect</td>
</tr>
<tr>
<td>DTR</td>
<td>Data terminal ready</td>
</tr>
<tr>
<td>DTR</td>
<td>Ring indicator</td>
</tr>
<tr>
<td>GND</td>
<td>Data signal line detect</td>
</tr>
</tbody>
</table>
PC sends 55 & 01h. If the logger is not in data logging mode, i.e. MIF=0, temperature is measured and the value is stored in the temperature register in page 0.

Since a temperature measurement takes time, it is advisable to poll the temperature-ready bit, TR, of the status register. This bit being logic high indicates that a temperature measurement is completed and the value is written in the temperature register. If the controller is in the data logging node tube, i.e. MIF=1, the command is simply ignored.

---

### Table 1. Pin functions of the DS1615 temperature recorder.

<table>
<thead>
<tr>
<th>Pin</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vout</td>
</tr>
<tr>
<td>2</td>
<td>VT</td>
</tr>
<tr>
<td>3</td>
<td>NC</td>
</tr>
<tr>
<td>4</td>
<td>+5V source power</td>
</tr>
<tr>
<td>5</td>
<td>+5V source power</td>
</tr>
<tr>
<td>6</td>
<td>+5V source power</td>
</tr>
<tr>
<td>7</td>
<td>COMSEL</td>
</tr>
<tr>
<td>8</td>
<td>+5V source power</td>
</tr>
<tr>
<td>9</td>
<td>+5V source power</td>
</tr>
<tr>
<td>10</td>
<td>GND</td>
</tr>
<tr>
<td>11</td>
<td>+5V source power</td>
</tr>
<tr>
<td>12</td>
<td>+5V source power</td>
</tr>
<tr>
<td>13</td>
<td>+5V source power</td>
</tr>
<tr>
<td>14</td>
<td>+5V source power</td>
</tr>
<tr>
<td>15</td>
<td>+5V source power</td>
</tr>
<tr>
<td>16</td>
<td>VCA</td>
</tr>
</tbody>
</table>

---

### Table 2. The DS1615 recognizes five commands, written into the chip via one of its two serial interfaces.

<table>
<thead>
<tr>
<th>Command</th>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>201h</td>
<td>Write byte</td>
<td>Write a single byte into a memory cell.</td>
</tr>
<tr>
<td>301h</td>
<td>Read byte</td>
<td>Read 32 memory cells in a page.</td>
</tr>
<tr>
<td>401h</td>
<td>Specification test</td>
<td>Poll temperature extremes.</td>
</tr>
<tr>
<td>501h</td>
<td>Read temperature</td>
<td>Measure temperature immediately and store it in the current temperature register in page 0.</td>
</tr>
<tr>
<td>601h</td>
<td>Clear memory</td>
<td>Clear the status register.</td>
</tr>
</tbody>
</table>

---

### Fig. 7. The single-chip temperature logger can be constructed on a single-sided board and housed in a vented box. This figure shows the component layout of the PCB.


Data from the logger is read by the receive data line of the COM port, namely RD. The TX pin of the controller is fed into a voltage translator circuit based on T1 and the output from that circuit is fed into the RD line of the RS232 port.

The DTR line of the RS232 port supplies power to the logger. From Fig. 2 you can see that voltage at DTR is regulated to +5V by D2 to generate a power supply for the DS1615. The RTS line of the port supplies -9V supply to the RS232 voltage translator.

The circuit can be constructed on a single-sided board as in Fig. 7. The circuit board can be housed in a vented ABS box. Fig. 1. The overall size of my implementation of the logger is 70mm by 70mm by 28mm.

Software control

Visual Basic 5 software demonstrating how the controller can read is shown in List 1. From Fig. 6, you can see that there are four control buttons on the screen: 'Initialisation' to initialise the logger, 'Download' to download data from the logger, 'Get temp' to read current temperature when the logger is not in a temperature logging mission, and 'Quit'.

A scanning interval from 1 to 255 minutes is keyed into the text box above the 'Initialisation' button. Before data downloading, a file name should be specified in the text box above the 'Download' button.

Visual Basic 5 provides a Microsoft COMM 5.0 control routine called 'MSComm', which is used to control a PC's COM port. The serial port should be configured for 9600 baud with 8-bit word length and one stop bit. All these parameters can be set in the 'Properties' section of the MSComm control routine. Other parameters are set within the program (see 'From load' procedure in the program).

Initialising the logger

Initialising the logger is quite simple. It consists of the following stages:

• Enable memory clear – write 64 to the control register to set the CLR bit.
• Issue a 'Clear' command.
• Select start method – start with push button or via the host PC. This is selected by setting the SE bit of the control register. In the present program, the push-button start is selected.
• Initialise real-time clock.
• Write various operation parameters into the data logger such as temperature limits, start delay, etc.

• Write a non-zero value to the sample-rate register.

If the logger is programmed to start using the start button, a logging mission will start as soon as the start button is pressed for more than 1.5 second. If the logger is programmed to start under control of the host PC, the sample rate is written into the register, a logging mission starts straight away. In both cases, once a logging mission is started, the onboard LED flashes four times.

An example of how the VB5 program initialises the logger is given in the subroutine 'Command2_Click()'. The logger is programmed to start logging once the start button is pressed. The start delay is set as 0. The first temperature measurement begins when the second register in the RTC rolls from 59 to 60. The delay between two scans can be selectable from 1 to 255 minutes.

Reading a page from the logger consists of the following stages:

• Issue a 'read-page' command.
• Send MB address of the start of the page.
• Sending LSB address of the start of the page.
• Receive 32 data samples, plus CRC bits if appropriate, via the RS232 port.
• Read 32 data bytes, plus CRC bytes if appropriate, from the RS232 buffer into program variables.

The subroutine 'Command2_Click()' illustrates how to read temperature records and histogram data from the logger. Reading data from the logger does not disturb the current temperature logging mission.

Temperature log data

A simple download data from the logger, the program saves the data into a file. The format of the file is DOS text format. Data can be imported into Microsoft Excel and other spreadsheet programs.

Figure 9 shows typical results of temperature log data. Figure 9(a) shows the temperature history as a function of time while Fig. 9(b) shows the temperature histogram. Both were generated by the Excel spreadsheet.

Finally, my thanks to Ian Monroe from Silver Birch Marketing Limited, who supplied samples and technical support for this project.

Technical Support

A complete designer's kit is available from the author. It includes the above-mentioned VB5 software source code and EXE files. Make your enquiry to Dr Peter A. D. Sandifer Drive, Stockport, SK1 8UL, UK. Tel/Fax: 44(0)61 4779593. E-mail: Pan@inter-group.co.uk.

Data Sheets and application notes for the DS1615 are available from the Dallas web site: http://www.dallas.com.

Silver Birch Marketing Limited is one of the Dallas semiconductor's distributors in the UK. Telephone 01480 812606.
Stereo from all angles IV

John Watkinson's previous article looked at how loudspeakers create the illusion of stereo. Now John shows how the requirements of that illusion define the role of the stereo microphone.

The creation of a convincing virtual sound source at some point between a pair of stereo loudspeakers is possible when the loudspeakers reproduce a pair of waveforms with sufficient accuracy in the frequency, time and spatial domains.

Prior to the shading compensator described in my last article, which must be considered as part of the loudspeaker system, must be pair of signals for each sound source that are identical, except for a difference in amplitude which is a function of the direction.

A limitless number of these signals can be linearly added to produce the pair of waveforms fed to the speakers. Some of these signals will be directly from sound sources, others will be due to reflections, reverberation or ambience.

It follows from the above that the job of a stereo microphone is to produce, for each sound source, a pair of audio signals that have no phase or time differences but whose relative levels are a function of the direction of that source.

Again an arbitrary number of sources must be simultaneously handled by linear superimposition. My next article will discuss the additional constraints on distortion performance that linear superimposition in stereo causes.

Crossed-pair microphones

A widely used stereophonic technique involves the use of directional microphones that are coincidentally mounted to avoid timing errors between the signals but with their polar diagrams pointing in different directions. This configuration is known variously as a crossed pair or a coincident pair. Figure 1a shows a stereo microphone constructed by crossing a pair of figure-of-eight microphones at 90°.

I discussed the actual requirement for the variation of relative amplitude with source position in my last article, with the help of Fig. 2. You will see that the configuration of Fig. 1 applies this requirement.

Output from the two microphones will be equal for a sound source straight ahead, because that source will be equally off-axis with respect to both microphones, assuming that their polar diagrams are identical. As the source moves left, it will move closer to the axis of the left-facing microphone, and so the output will increase. At the same time it moves further from the axis of the right-facing microphone whose output reduces.

Consequently, this configuration appears to have the trend that Fig. 2 requires. Assuming that the microphones are mounted at 90° to one another, when a sound source has moved 45° off-axis, it will be in the response null of one of the microphones and so only one loudspeaker will emit sound. Thus the fully left or fully right reproduction condition is reached at 45°.

The angle between nulls in L and R is called the acceptance angle, which has some parallels with the field of view of a camera.

Note that in most listening installations the loudspeakers will subtend an angle of more than 60° to the listener, and so a 90° sound stage is being shrunk into only 60°. This is technically incorrect, but in practice the error is relatively benign.

Loudspeaker directivity

In my experience, the better the directivity characteristics of the loudspeakers, the further apart they can be placed without the ‘hole-in-the-middle effect occurring. The closer the speakers approach 90° apart, the more the listener feels enveloped in the ambience of the recording and indeed the more important the inclusion of a shading compensator becomes.

In the crossed figure-of-eight microphone of Fig. 1, sounds between 45° and 135° will result in a pair of signals that are 'out of phase'. The main consequence of this is the cancellation of low frequencies because the woofers are in one another’s near field. Recording engineers try to avoid placing dominant sound sources in this region. However, in the rest of the audio spectrum, when listening to speakers with good time domain response and directivity characteristics, virtual images can still be formed between the speakers. According to conventional explanations of intensity stereo this should not be possible and indeed on poor loudspeakers it isn’t.

Note that the broadcast engineer has an understandable anhedonia of the phase condition because the mono listener gets nothing! Sounds between 135° and 225° are back-in-phase and are mapped onto the frontal stereo image. Figure 1b shows how the 360° pickup of the microphone is mapped into the stereo image between the speakers. Note that the side zones fold into the centre along the ±45° axis. Some experience of origami is useful here.

The all-round pickup of the crossed eight makes it particularly useful for classical music recording, where it will capture the ambience of the hall. Listening room reverberation will then provide sound from remaining directions.

Chaotic reverberation

Although this is obviously not accurately portrayed by a spatial standpoint, the chaotic nature of real reverberation means that different but still chaotic reverberation can be still possible. Clearly what cannot be achieved with an intensity stereo system is the creation of a dominant sound source that is not between the speakers.

Other polar diagrams can be used: the crossed cardioid is popular for example. There is no obvious correct angle at which cardoids should be crossed, and the actual angle will depend on the application.

Commercially available stereo microphones are generally built on the side-fire principle, with one capsule vertically above the other. The two capsules can be independently rotated to any desired angle. Usually the polar diagrams of the two capsules can be changed.

While ‘end and side’, or M-S, stereo can be obtained by using conventional L, R microphones and a sum and difference network, M-S can be obtained directly using a microphone having suitably oriented capsules. ‘Mid and side’ signals were discussed in my last article.

Figure 3 shows M-S microphones in which the S capsule must always be crossed eight. A variety of responses other than omnidirectional can be used for the M capsule. Note that in the M-S microphone, the fully left and fully right conditions are reached where the polar diagrams cross over, i.e. where M=S and M=-S.

Benefits of the M-S microphone

The M-S microphone has a number of advantages. The narrowing polar diagram at high frequencies due to diffraction is less of a problem because the most prominent sound source will generally be in the centre of the stereo image and this is directly on the axis of the M capsule.

An image-width control can easily be built into an M-S microphone. Adjusting the gain applied to the S signal changes the acceptance angle of the microphone. A favourite microphone technique can be turned into an M-S microphone simply by mounting a side-facing crossed eight above it.

The sound-field microphone

In the sound-field microphone, four capsules are fitted in a tetrahedron. By...
adding and subtracing the summed and subtracted components of each microphone pair will be no phase difference. This will be reproduced by two speakers as a source slightly left of centre because of the small amplitude difference.

If the frequency is reduced slightly, the wavelength becomes longer and the right microphone signal will begin to lead in phase, moving the phantom image right. If the frequency is increased slightly, the wavelength shortens and the right microphone signal lags, moving the image left.

Consequently, the apparent location of the source transient is in disagreement with the location of the sustained sound which itself is highly frequency dependent. The result is that all sources having a harmonic content appear to be very wide.

Where the distance between microphones corresponds to an odd multiple of a half wavelength, the two microphone signals are out of phase. As both ears hear both loudspeakers, the result is a dip in frequency response and no image at all. This comb filtering effect is a serious drawback of spaced microphone techniques and makes monophonic compatibility questionable.

Not stereo, but spacious...

A central source will give identical signals that create a central phantom image. However, the slightest movement of the source off-axis results in time differences that pull the image well to the side. The resulting hole-in-the-middle effect is often counteracted by a third central microphone which is equally fed into the two channels.

This technique cannot be described as stereophonic reproduction because it is impossible for the listener to locate a particular source. Instead a spacious effect is the result.

As there is no scientific basis for the technique it is hardly surprising that there is no agreement on the disposition of the microphones. A great many spacings from a few centimetres to a few metres are used. The rule of thumb that has emerged is that the spacing should be no more than a third of the source width.

There is no science to support the suggestion that stereophonic images by spaced omni-directional microphones, which do exist, are the same; there is some science to suggest why recording engineers would want to use omni-directional microphones.

Loudspeakers tend to be better at reflecting sound to the microphone, so in practical terms these methods simply cannot operate. Where the source is an omnidirectional microphone as opposed to a spaced omni-direc tion al microphone, this tends to collect only the direct sound to the loudspeaker crossover. Consequently in theory and in practice a crossed-eight stereo microphone gives every bit as much audio as an omni-directional microphone.

It should be obvious that a crossed-eight stereo microphone will sound drier than a crossed-eight with the recording microphones on cardioid. The wide spacing between the microphone would preclude the use of a shuffler, which was used, for example in the Stereosonic system, to achieve the required performance.

Crossed eight versus omni-directional

If the stereo system is used, the centre pair is used for the highest frequencies, the outermost pair for the lowest frequencies, and the intermediate pair for the mid-range. The dynamic range issue in each microphone is therefore where the intermediate and the stereo signals are combined by selective filtering.

Because they must allow the overall response to be minimum-phase, the band-combining filters are critical. In many respects the band combining filter is the inverse of a constant voltage loudspeaker crossover.

In my view, the analogue technology of today's components would not have allowed the necessary shuffler to have reached the required performance.

With modern electronics and computer design, this is no longer the case and this approach deserves to be revisited with today's components. Incidentally, the Stereosonic system was the first to identify the need for a shading compensator, a stage which is conspicuously absent from most of today's products.

Blumlein's shuffler

In his early experiments, Blumlein used omni-directional microphones out of necessity, but he was aware that the signals could not be used directly. Instead a patented signal processor, known as a shuffler, was used, Fig. 5.

The shuffler converts phase differences in the input signal and adds together amplitude differences required by the intensity control format. The two microphone signals fed a sum and difference circuit.

The difference signal would have an amplitude proportional to the angle of the source and to the frequency. Frequency dependence was removed with an integrator, prior to another sum and difference stage. The output was used for the L-R intensity output.

The integrator gave a dynamic range problem for the signal processor. If the microphones are close enough to provide a moderate phase shift at the highest audio frequencies, they will give a minute phase shift at the lowest frequencies.

Figure 6 shows the solution. Here, a listener array of omni-directional microphones is used. The centre pair is used for the highest frequencies, the outermost pair for the lowest frequencies, and the intermediate pair for the mid-range. The dynamic range issue in each microphone is thus removed and the three signal bands are combined by selective filtering.

Because they must allow the overall response to be minimum-phase, the band-combining filters are critical. In many respects the band combining filter is the inverse of a constant voltage loudspeaker crossover.
Lead-acid battery that can operate in situ

This float charger carries out a constant-current, constant-voltage charging cycle and is intended for use where the load is always connected, taking power from the mains via the charger or from the battery when mains are absent. The circuit shown takes a 6-cell battery of 35Ah capacity and peak current is 16A (C/10).

The core of the arrangement is a buck regulator with the switching element and freewheel diode arranged to make the positive side common, which enables the use of an n-channel fet operating in current-source mode; no level shifting is needed. It has the drawback that the battery negative is not the circuit negative. A UC3842 regulator maintains 14.4V at 20°C across the battery. The voltage drooped by peak current through R1 is compared with error amplifier output on pin 1 of the regulator and the on time of the cycle adjusted. The components D2, D3, and the base-emitter of T1 clamp the error amplifier output so that the peak voltage across R1 does not exceed 0.25V to limit the charging current to 16A at switch-on with a discharged battery. In this constant-current part of the cycle, T1 lights the yellow led to indicate the fact. Near full charge, error voltage falls and charge current decreases, so that the clamp circuit is inactive and the yellow led goes out.

Voltage feedback from the battery is divided by the number of cells in R14,14 to give a mean cell voltage across R14, the voltage across T15 collector load being used as the feedback to the regulator.

Advantages are that lead length is not a factor in battery-voltage sensing and the temperature coefficient of the transistor, which must be near the battery and away from power semiconductors, supplies temperature compensation.

The LM393 op-amps constitute a fault detector, so that if battery voltage is outside the 10.2-20V area, one of the red leds illuminates and charge current is switched off. Power for the circuit comes from the transformer centre tap to prevent the circuit draining battery current in the absence of mains power.

Ian Benton
Ilkeston
Derbyshire
U64

National Instruments sponsors Circuit Ideas

Over the next 12 months, National Instruments is awarding over £3500 worth of equipment for the best circuit ideas.

Once every two months for the next year, National Instruments is awarding an NI4050 digital multimeter worth over £500 each for the best circuit idea published over each two-month period. At the end of the 12 months, National is awarding a LabVIEW package worth over £700 to the best circuit idea of the year.* The first winner, selected from this issue or the following one, will be announced next month.

About National Instruments

National Instruments offers hundreds of software and hardware products for data acquisition and control, data analysis, and presentation. By utilizing industry-standard computers, our virtual instrument products empower users in a wide variety of industries to easily automate their test, measurement, and industrial processes at a fraction of the cost of traditional approaches.

Software

Our company is best known for our innovative software products. The National Instruments charter is to offer a software solution for every application, ranging from very simple to very sophisticated. We also span the needs of users, from advanced research to development, production, and services. Our flagship LabVIEW product, with its revolutionary, patented graphical programming technology, continues to be an industry leader. Additional software products, such as LabWindows/CVI, ComponentWorks, Measure and VirtualBench, are chosen by users who prefer C programming, Visual Basic, Excel spreadsheets, and no programming at all, respectively.

Hardware

Our software products are complemented by our broad selection of hardware to connect computers to real-world signals and devices. We manufacture data acquisition hardware for portable, notebook, desktop, and industrial computers. These products, when combined with our software, can directly replace a wide variety of traditional instruments at a fraction of the cost. In 1996 we expanded our high-performance E Series product line in PCI, ISA and PCMCIA form factors, shipped our first VXI data acquisition products, and added remote (long-distance) capabilities to our SCXI signal conditioning and data acquisition product line.

Our virtual instrumentation vision keeps us at the forefront of computer and instrumentation technology. National Instruments staff works actively with industry to promote international technological standards such as IEEE 488, PCMCIA, PCI, VXI plug&play, Windows 95/98, and the Internet. More importantly, we integrate these technologies into innovative new products for our users.

NI4050

The NI 4050 is a full-feature digital multimeter (DMM) for hand-held and notebook computers with a Type II PC Card (PCMCIA) slot. The NI 4050 features accurate 5½ digit DC voltage, true-rms AC voltage, and resistance (ohms) measurements. Its size, weight, and low-power consumption make it ideal for portable measurements and data logging with hand-held and notebook computers.

- DC Measurements: 20mV to 250V DC, 20mA to 10A
- AC Measurements: 20mA rms to 2500mV rms, 20mA rms to 10Ams
- True rms, 20mA to 23kHz
- Up to 50 readings/s
- UL Listed
- 5½ Digit Multimeter for PCMCIA

LabVIEW

LabVIEW is a highly productive graphical programming environment that combines easy-to-use graphical development with the flexibility of a powerful programming language. It offers an intuitive environment, tightly integrated with measurement hardware, for engineers and scientists to quickly produce solutions for data acquisition, data analysis, and data presentation.

- Graphical programming development environment
- Rapid application development
- Seamless integration with DAQ, GPIB, RS-232, and VXI
- Full, open network connectivity
- Built-in display and file I/O

*All published circuit ideas that are not eligible for the prizes detailed here will earn the authors a minimum of £25 and, up to £100. The first Nl4050 will be awarded next month for the best idea from the December or January issue.

National Instruments - computer-based measurement and automation

National Instruments, 21 Kingfisher Court, Hambridge Road, Newbury, Berkshire RG14 5AL. Tel (01635) 523545, Fax (01635) 524995

info@ni.com www.ni.com

January 2000 ELECTRONICS WORLD
Robust 5-30V, 10A power supply

Although this design has been around for some time, it has given good service and never failed. It is protected against overload and short-circuits. After the rectifier and reservoir capacitors, the four 2N3055s are in parallel to take a load of up to 10A, the series resistors equalising the current. Regulation is by the µA78GUJC feedback coming via R3. Rs being used to adjust the output and the minimum output set by R11. As regards protection, Tr1 takes care of current limiting. Resistors R2 take a voltage dependent on output current and cause Tr1 to conduct at high current output, cutting off Tr1 and therefore the regulator. Switch Sw1 sets the current limit. Short-circuit protection is by means of the thyristor, a drop in output voltage cutting off Tr1 when it is lower than the reverse voltage and triggering the thyristor to shut down the regulator. Reset is by Sw4 which must also be pressed at switch on.

---

Stepper motor drive has appeal for analogue and digital designers

A Microchip PIC12C508 microcontroller generates pulses in the correct sequences and widths to control the speed and direction of a four-coil stepper motor. The controller outputs the four phases, the sequence being determined by the status of GF3. The built-in RC oscillator sets the pulse width and therefore the speed, which is controlled by R1, C1; the table indicating the result of varying R1 when C1 is 100pF and 0.01µF.

<table>
<thead>
<tr>
<th>Pulse width</th>
<th>C1=100pF</th>
<th>C1=10µF</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1s</td>
<td>7.2µs</td>
<td>5.1ms</td>
</tr>
<tr>
<td>10s</td>
<td>13.6µs</td>
<td>9.4ms</td>
</tr>
<tr>
<td>20s</td>
<td>26.8µs</td>
<td>19ms</td>
</tr>
<tr>
<td>51s</td>
<td>630µs</td>
<td>47ms</td>
</tr>
<tr>
<td>100s</td>
<td>1.25ms</td>
<td>0.9ms</td>
</tr>
<tr>
<td>200s</td>
<td>2.5ms</td>
<td>1.8ms</td>
</tr>
<tr>
<td>510s</td>
<td>6.3ms</td>
<td>4.7ms</td>
</tr>
</tbody>
</table>

The first National Instruments digital multimeter winner, to be selected from four issues, will be announced next month.
In devices needing electrically readable serial numbers, the 24LC00 16-byte eeprom is tiny and provides a 32-bit number. The circuit shown programs the eeprom from a PC's serial port.

Software for programming an EEPROM through a PC's COM port. This C program writes a serial number into the 24LC00. A 32-digit initial number is asked when the program is started. This number is programmed into the 24LC00 by hitting the enter key. The serial number is incremented automatically for next device.

```
#include <stdio.h>
#include <bios.h>
#include <dos.h>

#define MCR 4
#define SDA_LOW Oxfo
#define SCL_HIGH Oxf2
#define SCL_LOW Oxfe
#define MSR 6
#define MCR 4
#define SDA_LOW Oxfo
#define SCL_HIGH Oxf2
#define SCL_LOW Oxfe

int i, j, id_num[32], out_data, port_add, ID_number * /

/* send control */
void send_control(int control_data) {
    outportb(base_addl+MCR, out_data); /* start */
    delay();
    if (get_ack())
        return 1;
    /* send control */
    send_control(SDA_LOW);
    if (get_ack())
        return 1;
    /* send control */
    send_control(SCL_HIGH);
    if (get_ack())
        return 1;
} /* send control */

/* read device */
int read_data(void) {
    outportb(base_addl+MCR, out_data);
    delay();
    if (get_ack())
        return 1;
    /* send control */
    send_control(SDA_LOW);
    if (get_ack())
        return 1;
    /* send control */
    send_control(SCL_HIGH);
    if (get_ack())
        return 1;
} /* read data */

int verify_ic(void) {
    outportb(base_addl+MCR, out_data);
    delay();
    if (get_ack())
        return 1;
    /* send control */
    send_control(SDA_LOW);
    if (get_ack())
        return 1;
    /* send control */
    send_control(SCL_HIGH);
    if (get_ack())
        return 1;
} /* verify IC */

int write_ic(void) {
    outportb(base_addl+MCR, out_data);
    delay();
    if (get_ack())
        return 1;
    /* send data */
    send_control(temp_data) /* send data */
    delay();
    outportb(base_addl+MCR, out_data);
    delay();
    outportb(base_addl+MCR, out_data);
    delay();
    outportb(base_addl+MCR, out_data); /* stop */
    delay();
    return 0;
} /* write IC */

int get_start_num(void) {
    clrscr();
    get_start_num(); /* get initial */
    if (get_ack())
        return 1;
    else
        return 0;
} /* get start num */

/* increase ID number */
void increase_id_num(void) /* increase ID number by 1 */
{ outportb(base_addl+MCR, out_data);
    delay();
    out_data = Ox03;
    if (get_ack())
        return 1;
    /* send control */
    send_control(Ox00);
    if (get_ack())
        return 1;
} /* increase ID number */

int init(void) {
    clrscr();
    print("Enter initial ID number: ");
    find_err=O;
    for (i=O; i<32; i++)
    { id_num[i]=O;
        i++;
    }
    int main(void) {
        init();
        clrscr();
        print("Push enter to program the device. Push Q to quit.");
        for (;;) {
                ((control_data&Ox80) l =O)
            { send_control(i); /* send address */
                if (write_ic())
                    return 0;
                if (read_data!=id_num[i*2+1] * 16+id_num[i*2])
                    find...err=1;
            }
            exit(1);
        } else
            { print("There is an error!");
                find...err=1;
                return 1;
            }
    } /* main */

int write_data(void) {
    for (i=O; i<32; i++)
    { id_num[i]=O;
        i++;
    }
    clrscr();
    print("Push enter to program the device. Push Q to quit.");
    in_put=getch();
    if (in_put==Ox71)
        return 1;
    else
        for (i=O; i<32; i++)
        { id_num[i]=O;
            i++;
        }
    for (i=O; i<32; id_num[i]=O;
        i++;
    }
    clrscr();
    print("Push enter to program the device. Push Q to quit.");
    in_put=getch();
    if (in_put==Ox71)
        return 1;
    else
        for (i=O; i<32; i++)
        { id_num[i]=O;
            i++;
        }
    clrscr();
    print("Push enter to program the device. Push Q to quit.");
    in_put=getch();
} /* write data */

int get_ack() {
    outportb(base_addl+MCR, out_data);
    delay();
    if (get_ack())
        return 1;
    else
        return 0;
} /* get ack */

int write_eeprom(void) {
    clrscr();
    print("Enter initial ID number: ");
    find_err=O;
    for (i=O; i<32; i++)
    { id_num[i]=O;
        i++;
    }
    int main(void) {
        init();
        clrscr();
        print("Enter initial ID number: ");
        find_err=O;
        for (i=O; i<32; i++)
        { id_num[i]=O;
            i++;
        }
        clrscr();
        print("Enter initial ID number: ");
        find_err=O;
        return 1;
    } /* main */

int write_eeprom(void) {
    clrscr();
    print("Enter initial ID number: ");
    find_err=O;
    for (i=O; i<32; i++)
    { id_num[i]=O;
        i++;
    }
    clrscr();
    print("Enter initial ID number: ");
    find_err=O;
    return 1;
} /* main */

int write_eeprom(void) {
    clrscr();
    print("Enter initial ID number: ");
    find_err=O;
    for (i=O; i<32; i++)
    { id_num[i]=O;
        i++;
    }
    clrscr();
    print("Enter initial ID number: ");
    find_err=O;
    return 1;
} /* main */

int write_eeprom(void) {
    clrscr();
    print("Enter initial ID number: ");
    find_err=O;
    for (i=O; i<32; i++)
    { id_num[i]=O;
        i++;
    }
    clrscr();
    print("Enter initial ID number: ");
    find_err=O;
    return 1;
} /* main */

int write_eeprom(void) {
    clrscr();
    print("Enter initial ID number: ");
    find_err=O;
    for (i=O; i<32; i++)
    { id_num[i]=O;
        i++;
    }
    clrscr();
    print("Enter initial ID number: ");
    find_err=O;
    return 1;
} /* main */

int write_eeprom(void) {
    clrscr();
    print("Enter initial ID number: ");
    find_err=O;
    for (i=O; i<32; i++)
    { id_num[i]=O;
        i++;
    }
    clrscr();
    print("Enter initial ID number: ");
    find_err=O;
    return 1;
} /* main */
Efficient thermostat uses 50W bulbs to achieve ±1 °C temperature environment

This design is capable of running four 50W, though greatly under-run, lamps used as heaters, maintaining a temperature setting to within ±1 °C. The IC5V55S, PC5, is used as an oscillator running at around 30kHz with a 50% duty cycle and driving the complementary emitter follower. In turn, the follower drives the power switch to turn the load; one of the 555 devices that has a decent amount of drive capability might well manage without the emitter follower. The diode is only needed if the load is inductive.

Gain of the 558 input stage is 20 times the gain of the 555 oscillator, so overdrive is not an issue. Gain of the 850 input stage is 800 times the gain of the 555 oscillator, so overdrive is not an issue. Gain of the 850 input stage is 800 times the gain of the 555 oscillator, so overdrive is not an issue.

The circuit operates by detecting the temperature change and adjusting the current through the NTC thermistor, which in turn affects the output voltage of the LM358. This voltage is compared with a reference voltage and the error signal is used to adjust the power output of the 850. The output is then fed back to the comparator to maintain the temperature at the desired level. This process is continuous, allowing the thermostat to maintain the temperature within the desired ±1 °C range.

The thermostat is designed to be compact and easy to install, with a small size and a simple design. It is suitable for use in a wide range of applications, including homes, offices, and industrial settings. The thermostat is also designed to be energy-efficient, with a low power consumption and a long lifespan. It is a reliable and effective solution for maintaining comfortable indoor temperatures.
How do I bring this signal back to a 0V base line?

Accepting a ±10V input, this circuit corrects a zero offset of up to ±5V, so that the output is an inverted replica of the input but referred to zero volts. Comparator IC3 detects input polarity and determines the polarity of the voltage applied to the digital potentiometer IC2. If the comparator IC3 output goes high, the resistor RB is connected to zero volts through the pot, so that the potentiometer input is around +5V, when the comparator is low, the pot input is taken to −5V by the comparator pull-down. Voltage at the potentiometer wiper is buffered and taken to IC6b where it counters the voltage from the input, its output being an inverted form of the circuit input. Since the comparators are 5V devices, attenuators reduce the voltage at their inputs, and positive feedback is applied to provide hysteresis.

Momentarily pressing PB1 applied the input to IC3b, which senses the polarity and Q1 of IC4 goes high to allow clock pulses from IC3 to increment the potentiometer IC2, which ramps up or down depending on the control voltage from IC3. The initial error, output of IC2 is compared with the polarity of the potentiometer input in IC5, which selects the direction in which the potentiometer ramps to reduce the error. As the error passes zero, inputs 1 or 2 of IC4, depending on the polarity of the initial error, cause positive-going spikes at its output. These are cleared up in IC5 and used to reset IC6 to zero and stop clock pulses going to IC2. The output is now zero ±50mV, the potentiometer having 100 steps maximum. IC5 in the 50Hz clock, which allows a zeroing time of 2s; a faster process could be arranged, but various noise-reducing capacitors have been selected for that purpose and would need to be reduced for a faster operation.

Switch PB2 provides a manual increment. Dallas Semiconductors have the DS1566 variable-sensitivity pot., which is compatible with the one shown here, the Xicor XSC103, provides higher resolution. There are also the XSC201 logarithmic type, needing a variation in RB, and the 128-step AD5220. No de-bouncing is needed on either switch.

Ian E Shepherd
Wallingford
Oxfordshire
Antennas and Propagation for Wireless Communication Systems

Antennas and propagation are the key factors influencing the robustness and quality of the wireless communication channel. This book introduces the basic concepts and specific applications of antennas and propagation to wireless systems, covering terrestrial and satellite radio systems in both mobile fixed contexts.

- Illustrations of the significance and effect of the wireless propagation channel
- Overview of the fundamental electromagnetic principles underlying propagation and antennas
- Basic concepts of antennas and their application to specific wireless systems
- Propagation measurement modeling and prediction for fixed links, microcells, macrocells, picocells and megacells
- Narrowband and wideband channel modelling and the effect of the channel on communication system performance
- Methods that overcome and transform channel impairments to enhance performance using diversity, adaptive antennas and equalisers.

Antennas and propagation is a vital source of information for wireless communication engineers as well as for students at postgraduate or senior undergraduate levels.

Distinctive features of this book are:
- Examples of real world practical system problems of communication system design and operation
- Extensive worked examples
- End of chapter questions
- Topical and relevant information for and about the wireless industry

How to pay

☐ I enclose a cheque/bank draft for £ (payable to Reed Business Information)

☐ Please charge my credit card

☐ Mastercard ☐ American Express ☐ Visa ☐ Diners Club

Credit Card No: Expiry Date:

Send my order to: [please use capitals]

Name:
Address:

Post Code: Tel: Fax: Date:

Signature of Cardholder

Post your completed order form to:
Jackie Lowe, Room L333, Quadrant House, The Quadrant, Sutton, Surrey, SM2 5AS

Phone your credit card order:
020 8652 3614

Fax your completed order form to
020 8652 8111

email: jackie.lowe@rbi.co.uk

POSTAGE FREE
For air delivery add £5.50 postage

Audio distortion meter

Vern Draper has introduced a Grundig Digital mini meter. The MF900 is an audio frequency meter for measuring distortion, harmonic distortion and noise including rectification, RMS, peak, quasi-peak, noise and interference voltages with a range of 5µV to 86dB. It does not provide a signal source. A digital time constant and bar graph is included and polarized filters allow selection or wideband measurement. Weighting to linear CCIR 468-3 is standard.

Vern Draper Electronics
Tel: 01787 774400
Enquiry No. 501

Touchscreen technique sputters onto glass

A technique for depositing Indian Ti-Oxide directly onto glass has let Denison product touchscreens that only require one layer of polyester and one layer of glass. Called DeniTouch, they use a single chip controller. They can be custom built and, using standard LCDs with integral touchscreen, purhase has been eliminated. They sell applications requiring 0.25 VGA, 128 x 240 and 64 x 240 displays.

Denison
Tel: 01994 739100
Enquiry No. 502

Transient voltage suppressors

AVX has introduced a low capacitance version of its Transguard Indirectly transient voltage suppressor: Celest Antennaguard. It has capacitances below 12pF in an 0603 case size or below 3µF in 0402 or 0603 case sizes. Working voltage is 18V and they operate from -55°C to +125°C. They can protect high gain FETs or output stages of RF sections in mobile phones, pagers and WILAN, reducing a 1kV discharge ESD strike to a level that can be handled by most FETs and preamplifiers. AVX

Tel: 01292 773900
Enquiry No. 805

New products

Antennas and propagation concepts and specific applications of antennas and propagation to wireless communication systems. The board provides a Flex 0000 quad flat-pack device, onboard power conversion and two prototyping areas. One is a 0.254cm matrix area for conventional through-hole devices and the other an uncommitted SMD area for surface mount devices. Access to 24 device pins is possible via bench pins. VME, CompactPCI and standard VME card form-factor board can be supplied. The 1995 sign elements are supplied. Designers can be downloaded from a PC or be plugged into an onboard EPROM by automatic configuration at power-up. A combination version is available. Work has begun on a card that uses M.icron's Alen 25K devices.

Low Power Radio Solutions has released two radio receiver modules based on MDC M3275. The LPR94 and 3 are complete AM receiver modules for upgrading car or domestic devices. They have a low-cost front end to improve selectivity. The LPRM is available at £485 as per MPT 1140 or 433MHz to £750-250. It uses an eight-pin SIL public.

Low Power Radio Solutions
Tel: 01295 709418
Enquiry No. 506

Custom graphics LEDs

A custom graphics LED capability has been announced by Anders Electronics for manufacturers of white and brown goods. Complex icons, different colours and alphanumeric can be combined in one module. Applications include dishwashers, washing machines, microwave ovens and air conditioners.

Anders Electronics
Tel: 01908 615232
Enquiry No. 507
Power amplifier
SiGe Microsystems has introduced a version of its 8-bit power amplifier. The silicon germanium amplifier offers a power performance for class-E 100mW application. The PAM325 is a low power, high efficiency amplifier for audio applications. The amplifier features a high current density and a low cost of ownership. The PAM325 is available in a 5x7mm MSOP eight-pin package.

Surface mount thermistors
Rothwell Components has introduced negative temperature coefficient (NTC) surface mount thermistors. Resistance values are 100, 220, 470, 1k, 2k, 4.7k, 10k, 47k, 68k, 1M, 10M, and 47M. The thermistors are available in various sizes and are rated for temperatures from -55°C to 150°C. Applications include battery packs and temperature compensation of LCDs and TCOS.

Power amplifier
A dual-output stereo amplifier has been introduced by AMP in a single box. The amplifier is designed for use in high-end audio equipment. The amplifier features a high current density and a low cost of ownership. The amplifier is available in a 5x7mm MSOP eight-pin package.

Dual-channel analogue chipset
Infineon Technologies has introduced the first dual-channel avalanche protection for audio inputs and output amplifiers. The chip is designed for use in high-end audio equipment. The chip features a high current density and a low cost of ownership.

Graphic VFD module
Sharp has introduced the Sharp Mini VFD module for use in high-end audio equipment. The module is designed for use in high-end audio equipment. The module features a high current density and a low cost of ownership.

XDSL network processor
Infiny Networks has introduced the Infiny XFX-712S Ethernet interface module. The module is designed for use in high-end audio equipment. The module features a high current density and a low cost of ownership.

DC-DC converter
Mitsubishi Electric has introduced the Tough Series TCI-100D 6-bit dc-dc converter. The converter is designed for use in high-end audio equipment. The converter features a high current density and a low cost of ownership.

Visit our website
www.distel.co.uk
NEW PRODUCTS

Please quote Electronics World when seeking further information

user improve feedback loop performance and use low ESR ceramic capacitors. It comes in an MSOP-8 package.

Micro-Cart
Tel: 01290 320001
Enquiry No 517

CPCI backplanes

APW Electronics has introduced PICMG CPCI 2.1 revision 3.0 specification left and right hand APW Electronics has introduced PICMG CPCI 2.1 revision 3.0 MSOP-8 package.

in tape-and-reel format for use with automated manufacturing systems, system boards must generate seven independent clocks separately. Mixed 32 and 64-clock lines must be matched to within ±1mm, clocking must be without slack. For 38MHz eight-channel systems, clock lines to be within ±1mm to reduce signal skew and improve clock signal integrity, all clock lines must be matched to within ±0.3nH. A maximum of seven independent clocks is allowed. Mixed 32 and 64-clock lines must be matched to within ±1mm, clocking must be without slack. For 38MHz eight-channel systems, clock lines to be within ±1mm to reduce signal skew and improve clock signal integrity, all clock lines must be matched to within ±0.3nH. A maximum of seven independent clocks is allowed.

Chip Inductors for EMI shielding

6LJ chip inductors from Panasonic measuring 1.6 x 0.8mm (0603) are for use in EMI and RF shielding designs, high-frequency immunity and power supplies, they suit mobile phones, handheld instruments and other portable equipment. They are available, and each incorporates a 1.5nH, 100nH at 100MHz. Maximum typical Q factor at 100MHz is 47, and maximum DC current is from 200mA for the 100nH device to 500mA for the 1.5nH inductors. Operating temperature is between -40 and +85°C. They come in tape-and-reel format for use with automated manufacturing systems. Tolerances are ±5% for the rest.

Available from Digital Power, the HPS chip inductor has a ±0.3nH tolerance. The option to search in English, French, German or Spanish.

55/65W supplies

Available from Digital Power, the HPS chip inductor has a ±0.3nH tolerance. The option to search in English, French, German or Spanish.

55/65W supplies

Available from Digital Power, the HPS chip inductor has a ±0.3nH tolerance. The option to search in English, French, German or Spanish.

Available from Digital Power, the HPS chip inductor has a ±0.3nH tolerance. The option to search in English, French, German or Spanish.

PCI-based digital radio

Spectrum has introduced a multiprocessor, TS320C6203 based, digital radio. The Inglisston is a quad PCI DSP system using four Texas Instruments 200MHz, 256MHz, fixed-point C6202 processors. It is suitable for multi-channel, multi-function applications such as signal intelligence, medical and commercial imaging, and third-generation wireless base stations. Each processor contains 3Mbit memory. Also available are complementary DSP and I/O hardware, a design development kit, system management software, and digital radio specific DSP algorithms. The I/O system has one PNI card, two PEM cards and DSP Link3, which provides access to more than 150 IndustryPack modules. Inglisston can also support the 300MHz TMS320C6203 with 16bit memory.

Spectrum Signal Processing
Tel: 0344-802349
Enquiry No 516

BACK ISSUES

Back issues of Electronics World are available, priced at £3.00 UK and £3.50 elsewhere, including postage. Please send your order to Electronics World, Quadrant House, The Quadrant, Sutton, Surrey, SM2 5AS

Available issues

1994
January
April
May
July
August
November
December
February
March
May
June
July
August
September
October
November
December

1995
February
April
May
June
August
September
October
November
December

1996
January
February
March
April
May
June
July
August
September
October
November
December

1999
January
February
March
April
May
June
July
August
September
October
November
December

British Exports Interactive...

If you are looking for British companies to do business with, then we can help you find them in seconds.

This powerful business tool contains:
- Nearly 20,000 of the UK’s leading exporting companies
- 20,000 product and service headings to choose from
- 11 search criteria to help you find the exact company you need
- The option to search in English, French, German or Spanish
- Detailed information on export activities, trade names, agents and agency opportunities
- Printing facility.

British Exports has been publishing quality business information for over 30 years and brings you one of the most comprehensive databases on UK exporters.

The site is free to use, so try it today!!

www.britishexports.com
Please send me a copy of 'Newnes Interactive Electronics CD-ROM', normal RRP £49.99 DISCOUNTED PRICE only £39.99 (postage free)

Simply return this order to:
Jackie Lowe, Quadrant House, The Quadrant, Sutton, Surrey, SM2 5AS.

Name,
Address (for delivery)

Pay by cheque (payable to Reed Business Information)
( ) Visa ( ) Access/Mastercard ( ) Amex
Card Number:
Expiry Date:
Signature

For 200 years the definitive source of UK products & services

www.kellys.co.uk

CALL NOW FOR FURTHER INFORMATION
FREE PHONE 0800 521393

EMC TESTING

For a Full Comprehensive EMC Test Service

- FULL TESTING TO CE MARK FOR EMC
- COMPETITIVE RATES
- FREE TECHNICAL ADVICE

From Design to Compliance

R. N. Electronics are specialist Wireless Design Consultants, this expertise is available to our clients when undertaking EMC testing, AT NO EXTRA COST.

Arnold's Court, Arnold's Farm Lane, Mounthnessing, Brentwood, Essex, CM13 1UH
Telephone: 01277 352219 Facsimile: 01277 352968
e-mail: sales@rnedesign.co.uk http://www.rnedesign.co.uk
SM antennas

Quality of voice or data reception.

Switching path is not subject to RF style metal can ensures that the switching circuits. To operate from the PWA can be used for dual-band applications, such as 900 and 1400MHz GSM, DCS, Amps and CDMA. The wideband printed wire antenna (PWA) is for narrow-band dielectric resonator equipment and reflow soldering. The ORA is shaped like a ceramic block.

SM antenna quality of voice or data reception. Switching path is not subject to RF style metal can ensures that the switching circuits. To operate from the PWA can be used for dual-band applications, such as 900 and 1400MHz GSM, DCS, Amps and CDMA. The wideband printed wire antenna (PWA) is for narrow-band dielectric resonator equipment and reflow soldering. The ORA is shaped like a ceramic block.

SM antennas

Quality of voice or data reception.

Switching path is not subject to RF style metal can ensures that the switching circuits. To operate from the PWA can be used for dual-band applications, such as 900 and 1400MHz GSM, DCS, Amps and CDMA. The wideband printed wire antenna (PWA) is for narrow-band dielectric resonator equipment and reflow soldering. The ORA is shaped like a ceramic block.
**BOOK TO BUY**

**THE INVENTOR OF STEREO**  
The Life and Works of Alan Dower Blumlein

Robert Charles Alexander

---

**10% DISCOUNT**

Reader price £27

Post your completed order form to:
Jackie Lowe, Room 1333, Quadrant House, The Quadrant, Survey, Surrey, SM2 5AS  
Phone your credit card order: 020 8652 3614  
Fax your completed order form to 0181 367 9111  
Delivery please add the following to your order to cover delivery of your books.  
UK customers add £2.50. All other countries add £3.50.

---

**How to pay**  
Blumlein

- I enclose a cheque/bank draft for £________ (payable to Reed Business Information)  
- Please charge my credit card  
  - Mastercard  
  - American Express  
  - Visa  
  - Diners Club  
  - Expiry Date: ________  

Signature of Cardholder: ________  
Send my order to: (please use capitals)  
Name: ________  
Address: ________  
Post Code: ________  
Tel: ________

---

**Contents**

Earliest days  
Telegraphy and telephony  
The audio patents  
Television  
EMI and the Television Commission  
The high-definition television period  
From television to radar  
The story of radar development  
H25 - The coming of centimetric radar  
The loss of Halifax V9977  
Legacy  
To Goodrich Castle and beyond

---

**Transmission-line loss and VSWR**

All electrical sources have an internal resistance or impedance: batteries, the AC power mains, radio transmitters, and signal generators all have some value of internal resistance, Fig. 1. In transmitters and signal generators that value is usually stated as 'output impedance.' The impedance could be any value $Z_{out}=R_{out}+jX_{out}$, where $R_{out}$ is the resistive component and $X_{out}$ is either a capacitive or inductive reactance. In RF circuits other than television the standard system impedance is 50Ω, or simply 50Ω resistive – i.e. not reactive.

A load will also have some value of impedance $Z_{load}=R_{load}+jX_{load}$. Although transmitters and signal generators will control the output impedance so that it is purely resistive, and matches the accepted value of standard impedance – i.e. 50Ω for TV, which is usually 75Ω – the load may vary over quite a range of values of $R$ and $X$.

It is rare to find a load connected directly to the output of a transmitter or signal generator. Most commonly one expects to see a transmission line, Fig. 2, between the source and load. The transmission line also has a characteristic impedance, which is denoted by $Z_0$.

**The beauty of matching**

One of the fundamental facts about connecting source to load is that maximum power transfer occurs when the load and source are matched, i.e. when $Z_{load}=Z_0$. If this is not the case, then not all of the power is delivered to the load.

In a transmitter-antenna system, mismatch means not all of the available power is radiated as a radio signal. In a signal generator test set-up, it means a possibly erroneous measurement – and, rarely, damage to the measuring equipment.

The problem becomes more complicated in real situations because of the increased number of possible mismatches. It is necessary to match $Z_0$ to $Z_{load}$ and $Z_{load}$ to $Z_0$. If a load is not matched to a source, then some of the RF power supplied by the source will not be absorbed in the load. It will be reflected back towards the source. Thus, we must consider with both the applied, or forward, power $P_f$ supplied by the source, and the reflected power, $P_r$, rejected by the load.

**Standing waves**

When the forward and reflected waves of an RF signal combine in the transmission line, they algebraically add, and set up a pattern of standing waves. In the case where $Z_{load}Z_0$ are no standing waves, and such a line is said to be 'tame.' But if $Z_{load}$ is not equal to $Z_0$, then the standing waves emerge, producing a non-zero reflected power, and voltage nodes – and current nodes, incidentally – along the line.

The voltage will vary from a maximum, $V_{max}$ to a minimum, $V_{min}$. The maxima and minima are quarter wavelength apart, and repeated maxima and repeated minima are half wavelength apart. One implication of this situation is that an impedance connected to the end of a transmission line is repeated every half wavelength.

The reflected wave can be defined in terms of a reflection coefficient $\Gamma$:

$$\Gamma = \frac{Z_0 - Z_{load}}{Z_0 + Z_{load}} = \frac{P_f}{P_r} \quad (1)$$

The standing waves are defined in terms of the standing-wave ratio (SWR) $\eta$:

$$\eta = \frac{Z_{load}}{Z_0}$$

---

**Joe Carr explains how to make sure that the coaxial cable connecting an antenna takes as little as possible out of the signal.**

---

January 2000 ELECTRONICS WORLD
wave ratio, which can be calculated from the reflection coefficient.

\[
\text{SWR} = \frac{1 + |\beta|}{1 - |\beta|} \quad (2)
\]

The SWR can also be defined in terms of impedances.

\[
\text{SWR} = \frac{Z_2}{Z_0} \quad \text{if} \quad Z_2 > Z_0
\]

Or,

\[
\text{SWR} = \frac{Z_0}{Z_2} \quad \text{if} \quad Z_2 < Z_0
\]

Finally, SWR can be defined in terms of power.

\[
\text{SWR} = \frac{P_{in}}{P_{out}}
\]

Although SWR can be measured using any of those properties, it is common practice to use the term voltage standing wave ratio, or VSWR as synonymous with SWR. That usage will be observed herein.

A scenario
A young apprentice technician was sent to check out a newly installed low-band VHF - i.e. 30-50 MHz - communications antenna. He returned and told his boss everything that was in order because the VSWR was about 1.66:1, which was less than 2:1, so it met specifications. His boss agreed that the VSWR of <2:1 was within the specification. But the boss knew that low VSWR sometimes conceals deeper problems. The antenna was mounted on a tower, and the tower was up on the crest of a hill. Altogether, there was 250 ft (76.2 m) of RG-8/U coaxial transmission line. On further questioning, the boss discovered that the particular model antenna used on the system had a fixed-point impedance of 300 Ohms. That would infer a VSWR of 300/32=5.77:1, not 1.66:1 that the technician measured. So what happened? The VSWR should be almost 6:1, but it only read <2:1. Why? The solution is in the loss of the transmission line. There are two basic forms of loss in coaxial cable: copper loss and dielectric loss. The copper losses stem from the fact that the copper used to make the inner conductor and shield has resistance. The picture is further compounded by the fact that signal losses are additive.

Cable characteristics
The problem is also seen on receiver systems. Suppose that a 900 MHz receiver is at the end of a 250 ft transmission line. Further suppose that the signal is a repeatable 100 dBm, which in a 50Ω load is -43 dBm. A loss of 6.25 dB would make the power level at the antenna terminals of the receiver -41 dBm -6.25 dB = -45.25 dBm, or about 485 µV, which is still a reasonable signal. But if the signal were attenuated before it is applied to the receiver, then

\[
F_{\text{noise}} = 10 \log \left( \frac{B}{C} \right) \quad (7)
\]

where, B = 10 log [\text{System bandwidth}] and C = [\text{Noise figure}], which can be added to the system noise figure to be

\[
B = \text{LOG}(\delta) = \text{LOG}(\text{900MHz}/100MHz) \quad (8)
\]

Here, B = 9.97 dB and C = 0.10 log [\text{Noise figure}], so

\[
TLL = B + C = 10.07 \quad (9)
\]

Here, B = 9.97 dB and C = 0.10 log [\text{Noise figure}], so

\[
TLL = B + C = 10.07 \quad (9)
\]

The VSWR at the input end of the line, down the hill by the transmitter, is

\[
\text{VSWR} = \text{LOG}(\delta) = \text{LOG}(300/50) = 4.77 \quad (10)
\]

where, B = 9.97 dB and C = 0.10 log [\text{Noise figure}], so

\[
TLL = B + C = 10.07 \quad (9)
\]

Here, B = 9.97 dB and C = 0.10 log [\text{Noise figure}], so

\[
TLL = B + C = 10.07 \quad (9)
\]

Fortunately, certain specialty cables are available with losses about 2.5 dB/100ft (0.082 dB/metre) at 900 MHz. Such cables would produce about 6.25 dB of overall loss, or a ratio of 4:2:1. That cable would deliver nearly 24 W of the original 100 W.

On the receiving side...
The problem is also seen on receiver systems. Suppose that a 900 MHz receiver is at the end of a 250 ft transmission line. Further suppose that the signal is a repeatable 100 MHz, which in a 50Ω load is -43 dBm. A loss of 6.25 dB would make the power level at the antenna terminals of the receiver -41 dBm -6.25 dB = -45.25 dBm, or about 485 µV, which is still a reasonable signal. But if the signal were attenuated before it is applied to the receiver, then

\[
F_{\text{noise}} = 10 \log \left( \frac{B}{C} \right) \quad (7)
\]

where, B = 10 log [\text{System bandwidth}] and C = [\text{Noise figure}], which can be added to the system noise figure to be

\[
B = \text{LOG}(\delta) = \text{LOG}(\text{900MHz}/100MHz) \quad (8)
\]

Here, B = 9.97 dB and C = 0.10 log [\text{Noise figure}], so

\[
TLL = B + C = 10.07 \quad (9)
\]

Here, B = 9.97 dB and C = 0.10 log [\text{Noise figure}], so

\[
TLL = B + C = 10.07 \quad (9)
\]

The linear noise factor due to loss can be converted to noise figure, which can be added to the system noise figure to be

\[
F_{\text{noise}} = \frac{1}{(1 + B/C)} \quad (11)
\]

where, B = 9.97 dB and C = 0.10 log [\text{Noise figure}], so

\[
TLL = B + C = 10.07 \quad (9)
\]

Here, B = 9.97 dB and C = 0.10 log [\text{Noise figure}], so

\[
TLL = B + C = 10.07 \quad (9)
\]

The problem is also seen on receiver systems. Suppose that a 900 MHz receiver is at the end of a 250 ft transmission line. Further suppose that the signal is a repeatable 100 MHz, which in a 50Ω load is -43 dBm. A loss of 6.25 dB would make the power level at the antenna terminals of the receiver -41 dBm -6.25 dB = -45.25 dBm, or about 485 µV, which is still a reasonable signal. But if the signal were attenuated before it is applied to the receiver, then

\[
F_{\text{noise}} = 10 \log \left( \frac{B}{C} \right) \quad (7)
\]

where, B = 10 log [\text{System bandwidth}] and C = [\text{Noise figure}], which can be added to the system noise figure to be

\[
B = \text{LOG}(\delta) = \text{LOG}(\text{900MHz}/100MHz) \quad (8)
\]

Here, B = 9.97 dB and C = 0.10 log [\text{Noise figure}], so

\[
TLL = B + C = 10.07 \quad (9)
\]

Here, B = 9.97 dB and C = 0.10 log [\text{Noise figure}], so

\[
TLL = B + C = 10.07 \quad (9)
\]

The linear noise factor due to loss can be converted to noise figure, which can be added to the system noise figure to be

\[
F_{\text{noise}} = \frac{1}{(1 + B/C)} \quad (11)
\]

where, B = 9.97 dB and C = 0.10 log [\text{Noise figure}], so

\[
TLL = B + C = 10.07 \quad (9)
\]

Here, B = 9.97 dB and C = 0.10 log [\text{Noise figure}], so

\[
TLL = B + C = 10.07 \quad (9)
\]
Transformers from coax

Chris Hancock MSc PhD

Normally, antennas used to transmit RF or microwave power are fed from an unbalanced transmission line with an impedance of either 50Ω or 75Ω. Commonly used transmission line structures are microstrip and coaxial lines. Microstrip lines are often used for hand-held transmitters, such as in mobile phones. Coaxial lines are used to feed antennas in large portable and permanent transmitters, as found in wireless local area networks, base stations, broadcast TV, radio and local microwave links.

In most cases, an antenna requires a balanced feed with respect to ground. This makes it necessary to use a device that converts the unbalanced output of the feed cable to a balanced output required by the antenna.

Depending on the structure used, which is governed by the application, the input impedance of the coax can vary drastically. Ideally, the antenna is designed to present a purely resistive load to the feed line, Table 1. In order to get maximum energy into the antenna, it is necessary to match the impedance of the feed line to that of the antenna input. If there is a reactive element present, then this should be matched at the source. At the same time, it is necessary to provide an unbalanced to balanced condition in order to keep the overall system in a balanced state, as mentioned above. This article presents the basic idea of the unbalanced to balanced converter as well as some extension to the solution suggested to give other desirable effects.

How it works

Figure 1 presents the basic idea of an unbalanced-to-balanced transformer. You can see that the coaxial feed line has an outer conductor that is grounded. The two conductors – inner and outer – are connected to the ground in the same sense, with the same relationship to ground potential. Consequently, this line is termed an unbalanced line.

It is necessary to change from this unbalanced condition to a balanced condition in order to drive a balanced load. A transformer can be used to change the output of the feed cable, such as a dipole antenna. If this was not done, the antenna lead connected to the ground of the feed cable would short out that point of the antenna and impair operation.

Table 1. Typical antenna input impedances

<table>
<thead>
<tr>
<th>Antenna type</th>
<th>Typical input impedance (Ω)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monopole</td>
<td>38</td>
</tr>
<tr>
<td>Turnstile</td>
<td>38</td>
</tr>
<tr>
<td>Vertical half-wave dipole</td>
<td>73</td>
</tr>
<tr>
<td>Hertz - end-fed half-wave dipole</td>
<td>100 to 200</td>
</tr>
<tr>
<td>Log-periodic array</td>
<td>200 to 800</td>
</tr>
<tr>
<td>Folded dipole/conical</td>
<td>300</td>
</tr>
</tbody>
</table>

Standard transformers are of limited use in this type of application due to excessive losses at high frequencies. This limitation can be overcome by using either co-axial, or microstrip, half wavelength λ/2, transmission line structures. You can see from Fig. 1(b) that the inner conductor of the line is tapped at λ/2 from the end. The tap (far end) and the near end of the inner conductor provide two signals of equal amplitude but 180° out-of-phase. Neither of the signals is grounded, hence providing the required condition for balance.

The unbalanced-to-balanced arrangement is shown in a balun. It is reversible in that it functions equally as a balanced to unbalanced converter. As well as acting as a balun, this arrangement also provides impedance and voltage transformation. The principal of operation is shown in Fig. 2. If the load (antenna, etc) is balanced, i.e. R1 = R2, then Rl3 is transformed by the half wave line to a similar value at the junction with the main feed cable, where it is parallel with R22. Current delivered from the feed line, I0, must be double that required in each of the two resistors, i.e. I0 = I1 + I2. Therefore, the sum, R1 + R2, is less than four times the impedance seen at the input, i.e. Rl3 = R1 + R2 = Rl2 + Rl3. Voltages V1 and V2 are equal in amplitude and opposite in phase. If it is assumed that the half wavelength transmission line is lossless, i.e. V1 = V2 = V12, then the difference voltage is twice the amplitude of the input voltage, i.e. Vm = V2 - V1 = 2V12. The relationship between the current, voltage and impedance seen at the inputs and outputs of the transmission line transformer is the same as that for those of a transformer, i.e. given by

\[ V_m = 2V = 2V_1 = 2V_2 \]

(1)

Two practical applications of this arrangement are given shown in Fig. 3. The first shows a 50Ω transmitter source matched to a 500Ω helical beam, or a 500Ω dipole. The second shows a 75Ω transmitter matched to a folded dipole, or conical antenna.

Note that the characteristic impedance of the balanced in these two arrangements is the same at that of the source in order to prevent any mismatch between the transmission line and the unbalanced feed line.

The connection between the unbalanced line and the λ/2 transformer should always be such that a co-axial environment is maintained with an impedance equal to the characteristic impedance of the line and free from discontinuation. If this is not the case you could get a mismatch at the junction and consequently a VSWR of greater than unity on the feed line.

Benefits of multi-section transformers

It is possible to extend the network to comprise multiple λ/2 sections in order to get some interesting and desirable results. Assume, for example, three sections cascaded together as in Fig. 4. The source impedance is 50Ω. Provided that the characteristic impedance of the third section matches the unbalanced output impedance of the second section, the output impedance will be matched to a load of 800Ω.

\[ R_2 = 160R_1 \]

The voltage will be four times the input voltage.

Such a transformer provides a method of driving a balanced, high-current load from an unbalanced, low-impedance source at VHF and UHF. It does so without material limitations experienced using standard iron dust and ferrite transformer cores.

Note that in order to drive the third section, an unbalanced condition is required, which is achieved by using a separate λ/2 section. Transitions starting from the source are: unbalanced-balanced-unbalanced-balanced.

It is sometimes required to solely go from the balanced to unbalanced state. This might be the case in the push-pull output stage of an amplifier, where it may be required to drive a single-ended unbalanced load.

This method can be used to produce high voltages at very high frequencies, where only a low-impedance generator is available.

With this method, it is vital to have each of the sections contained in the network perfectly matched, as in Fig. 4. This is because zero mismatch between junctions, where P=0=VSWR=1, means that all of the transmitted energy will reach the load.

If there are reflections at the junctions then voltage maximums along the line may exceed the dielectric strength of the cable, causing breakdown. Also, at frequencies greater than 1GHz, dielectric losses become large. A high VSWR can lead to dielectric heating at voltage maximums along the line. This could lead to overheating at these points.

The existence of reflected waves means greater power (PF) losses. This becomes an important issue with long feed lengths.

Finally, a high VSWR leads to incoherence and causes the transmission of 'ghosts' when transmitting video and data signals.

Limitations

Taking this theory to the limit, Fig. 5 shows a hypothetical situation where it is required to transform a 50Ω, 50V source to 12.8Ω, 1600V. If a co-axial construction that uses a low density ferrite dielectric with a typical permittivity of 2.2 is considered, then characteristic impedance Z0 is given by:

\[ Z_0 = 138 + j7.2\pi \omega D / d \]

where D is the inner diameter of the coaxial conductor and d is the outer diameter of the inner conductor.

The transformation can be achieved theoretically, using a separate λ/2 section. The problem is that in order to attain the desired characteristic impedance for sections seven/eight and nine, i.e. 3.24Ω and 6.48Ω respectively, the ratios for D/d are 2.4510^6 and 6x10^6 respectively!

A further issue that must be considered is that in this case, that is the breakdown voltage at the final stage; if standard co-ax cable was used then it is likely that it would break down at the voltage maximum, and would most certainly not tolerate a high VSWR.

And in practice

I have made a number of such structures using semi-rigid coaxial cable and from microstrip lines. The main advantage of using microstrip lines is that the characteristic impedance can be easily altered by changing the width of the line.

I should point out though that the normal line impedance range for microstrip is between 20Ω and 125Ω.
Problem one. I needed to match a low impedance 30Ω, 100V source to a load of around 800Ω, 200V. 

A coaxial cable returning back to the source had to be minimized so that there was no live RF voltage on the outer sheath of the coaxial feed cable. The frequency involved was 50MHz.

A 50cm long length of LTF316 coaxial cable was used for the first two sections. The λ/2 length was accurately measured using a Hewlett Packard HP436A, 100kHz to 1.8GHz network/analyser.

A length of cable longer than λ/2 was connected to the analyser’s port one. With the Smith chart option selected, the Z₀ scattering parameter was measured. The cable length was shortened until one complete circumference of the Smith chart was traversed, i.e., 180° rotation from open circuit, towards the generator, and back again.

The line did not exactly follow the outer perimeter of the chart due to loss in the cable at 50MHz; also the open/short was measured using a Hewlett Packard HP8510A, and the results were connected to the analyser’s port one. I needed to match a load of around 200Ω.

Fig. 4. Method of transforming low-impedance source to match high impedance load.

Problem two. In instance two, I needed to match an unbalanced 30Ω source to a 200Ω balanced load at 2.45GHz and provide good isolation between the source and the load.

To achieve this, three pieces of semi-rigid, RG402/U with an outer diameter of 3.5mm and breakdown voltage 1.9kV rms were used for the three λ/2 sections.

A λ/4 microstrip transformer, i.e. impedance inverter, with a characteristic impedance of 100Ω, was used between the second and third λ/2 sections to match the 200Ω output impedance from the first section to the 50Ω of the third section, Fig. 6.

The 100Ω microstrip section was made using RT-Duroid 5880 substrate. This is a non-woven glass microfibre reinforced PTFE composite structure whose permittivity, ε_r, at 10GHz is 2.2 ±0.06. Substrate thickness chosen was 3.175mm (125mil), inner conductor line width was 2.81mm (11mil) for a 100Ω line impedance.

All lines were cut using a sharp scalpel blade, and the widths were adjusted to the desired impedance by removing small slivers of copper from the, initially oversized, lines. The λ/2 and λ/4 line lengths were measured, adopting the same method described in the previous example, but this time using an HP 8573D, 30MHz to 6GHz network analyser.

For the λ/4 line, a 30Ω surface mount load resistor was put on the end of the line to make sure that the line gave a 90° phase shift to traverse half way around the Smith chart. It ended on the centre line at the point: 200Ω, 0/0.

Once the 90° λ/4 length was known, the desired characteristic impedance was easily found by placing a surface mount resistor at the distal end of the line and then adjusting the width to give the desired impedance at the generator end.

Problem three. In the final instance I needed to match a 50Ω source to a 160Ω load at an operating frequency of 2.45GHz. This was achieved by using three low-impedance λ/2 sections, made from microstrip lines, to provide good isolation between the source and load.

There must be minimal standing waves on the lines, hence the VSWR must be kept as close as possible to unity. The solution adopted is shown in Fig. 7. You can see that a λ/4 impedance transformer first transforms the 50Ω source to match a load of 100Ω. This is followed by two 160Ω λ/2 sections, feeding a single 40Ω λ/4 section to transform the output impedance to the desired 160Ω.

For the impedance inverter, a line impedance equal to the geometric mean of the source and load impedance, i.e., (50Ω×160Ω)/2=100Ω, was required.

The material used for this application was an RT-Duroid 6010, non-woven glass ceramic filled PTFE composite, whose dielectric constant at 10GHz is 10.9±0.25.

The substrate height found to be most suitable was 0.64mm (25mil). The combination of high permittivity and small thickness meant that it was possible to fabricate low impedance lines using practically realizable line widths. The line widths and lengths required to achieve the necessary λ/2 sections and the λ/4 transformer are given in Table 2.

In summary

This article has shown that simple λ/2 coaxial and microstrip-line sections can be used to provide both voltage and impedance transformation at the VHF and UHF frequencies commonly used today in advanced communication systems.

The technique has been successfully adopted to provide the unbalanced to a balanced condition required when connecting feed cables to various antenna structures. I have shown that the technique prevents the wave contained within the antenna feed cable from tending to "spill over" the end and travel back over the surface of the cable, causing the outer sheath to have an RF voltage on it.

Finally, I have shown that these networks can be used to provide effective isolation between high power sources and their loads.

References

5. Rogers Corporation Data sheet on RT/Duroid Microwave Laminates, Microwave Materials Division, 100 S. Roosevelt Avenue, Chandler, AZ, USA.
Make better Wien oscillators

On building two Wien-bridge oscillators operating at different frequencies but otherwise identical, a reader asked, "Why are the amplitudes different?" Ian Hickman answers the question, and gives tips on how to get the best out of the circuit.

I recently received a letter from a reader who was puzzled by an unexplained discrepancy. He had designed a two-tone generator for himself, the two audio tones being summed at the virtual earth input of an inverting op-amp stage. This is of course the correct way to do it, as it avoids the production of any intermodulation products due to interaction between the two sources, and switching either tone off has no effect on the level of the other.

The basic circuit

Each tone generator consisted of a Wien bridge oscillator, the basic circuit of which is shown in Fig. 1. Assuming \( R_1-R_2=R_3=R_4 \) and the attenuation from op-amp output back to the non-inverting input is a factor of 3, or 9.54 dB. My correspondent said that he had seen many switching arrangements not shown here - the output level being stable as usual with an R53 thermistor.

The problem was that the output levels of the two oscillators differed, whereas given that the circuitry of each was identical, the designer had expected them to be the same.

Loop gain

The open-loop gain of the op-amp he was using is 500x, i.e. around 300V at 1 kHz, and getting still at the lowest audio frequencies used in his design. So the differential input to the op-amp would be 0.3% or so of the output. Thus the input via the Wien network to the non-inverting input would be virtually identical to that at the inverting input via the thermistor branch. This amounts to one third of the output amplitude, i.e. the closed loop gain is \( \times 3 \). As noted above, the frequency is (ideally) given by \( f = \frac{1}{2 \pi R C} \) so, for example, with components in the Wien network arm having exact values of 10kΩ, 9 µA, the frequency would be 159Hz \((1/2\pi \times 9 \mu A)\).

But note that a more exact expression for the operating frequency is:

\[
\frac{1}{2 \pi \sqrt{R_5 C_5 C_6}}
\]

where \( R_5 \) is the wiper contact resistance. This is due to the wiper contact resistance, which is not negligible - except in the case of wire-wound potentiometers.

The wiper contact resistance is also slightly variable, both in the long term, contributing frequency drift, and in the short term, contributing noise. In the circuit of Fig. 3, the wiper contact resistance is in series with the very high input impedance of the op-amp, and therefore has virtually no effect.

Setting output amplitude

The drive to the thermistor will adjust itself to whatever is necessary, namely to set the attenuation in the negative feedback path to just marginally less than that in the positive feedback path. So including a potentiometer as part of the 270Ω at the inverting input of the op-amp, Fig. 2, will provide an amplitude adjustment, which can be used to set the desired output, after first setting the frequency.

The output amplitude of a circuit such as that shown is determined by the characteristics of the particular R53 thermistor used. The nominal room temperature resistance of this device is 500Ω - or 5.3kΩ, hence the type number - with a ±2% tolerance.

The maximum recommended operating temperature of the thermistor pellet, in its evacuated glass envelope, is 200°C, with suitable derating, at ambient temperatures up to 175°C. Power sensitivity is given by 62.5°C/mW.

What value for \( R_3 \)?

Maximum permitted dissipation at 20°C is 3mW. This is sufficient to drive the device's resistance typically down to 63Ω. Initially I generated them both around 120Ω, driving the thermistor resistance down to about 400Ω. On avoiding any possibility of over-dissipation, the characteristics of the thermistor pellet, with suitable derating, at ambient temperatures up to 175°C. Power sensitivity is given by 62.5°C/mW.

For a thermistor-stabilised Wien bridge audio oscillator, distortion is worst at the lowest frequency. For a thermo, the half period of the sine wave is no longer negligibly short compared with the thermal time constant of the thermistor pellet. Consequently the output amplitude of about 2.5 to 30V peak to peak.

Heavier drive levels to the output will increase the effect, and as the level control loop can become unstable. At higher output frequencies, the loop is well damped, and there is no problem.

Distortion

For a thermistor-stabilised Wien bridge audio oscillator, distortion is worst at the lowest frequency. For a thermo, the half period of the sine wave is no longer negligibly short compared with the thermal time constant of the thermistor pellet. Consequently the output amplitude of about 2.5 to 30V peak to peak.

Heavier drive levels to the output will increase the effect, and as the level control loop can become unstable. At higher output frequencies, the loop is well damped, and there is no problem.

In summary

Thermistor-stabilised Wien-bridge audio oscillators offer good, though not excellent, performance, from a simple and economical design. As always with circuit design, the theory will tell you what you should get, but what you actually get is down to those all-important tolerances.

The various measures outlined above permit the designer to cope with these, finishing up with a circuit tailored to the particular requirement.

Reference

Audiotherapy

May I congratulate you on your comment "Aromatherapy and Audiotherapy", in the October 1999 issue. It needed saying.

I remember a good friend, the late James Moir, saying to me that people seem to prefer belief in magic rather than a solid scientific reality. Aromatherapy can just about accept, as trace elements and compounds can interact with our body chemistry. However, to say I can only accept if our fibs are amplified generate crops of superhuman 'whiskers' along with their audio output. After all, our electrical engineers who manipulate thousands of kilowatts have found that sound's low frequency strata, with all its complex, and often, if not all our audio and radio circuits are prone to an exclusively very short pulses at RF more than twice would really have to redesign pretty well everything. Maybe the cable manufacturers are getting mature.

Meanwhile, in Andrew Emmerison's way, it is all good for business.

Ralph West

France

Musical numbers

Musical numbers: the specialists of the several telephone numbers change soon to realise that any single step alternative would have produced immense chaos. It may be harder to consider that humans are very much creatures of habit and also have a limited ability to remember long numbers. In the UK and elsewhere, telephone companies have experienced the problem by using as few numbers as possible and then systematically divided these numbers into different categories. The high frequency numbers are relatively common and easy to remember. For the low frequency numbers, the first involves the use of one of the two alternatives. Alternatively, DSB may be generated using a discrete chopper amplifier, the limiting factor of this method is bandwidth restrictions of the op-amp gain requirements. DSB is closely related to PAM, while DSB utilizes both phases, PAM utilizes just one phase.

Nicoll Wheeler's question, How did I produce the waveform shown in the photo?

The waveform shown is a 50µs pulse but does not show why it is so, it cannot be precise about frequencies. Looking at the diagram, the high frequency component is about 10 times the frequency of the low frequency component. If the low frequency triangular wave fundamental component was, say, 10MHz then the high frequency sine wave would need to be 2MHz. The waveform shown can be obtained then by multiplying the two in a suitable multiplier stage, such as an analogue multiplier.

Peter Grundman

Germany

Mystery waveform

In reply to Nick Wheller’s letter about his mystery waveform in the letters pages of November’s Electronics World, the waveform can be produced by multiplying a low-frequency sine wave with a high frequency sine wave.

Darren Heywood

Fulbourn

The black diagram shown is one to C. Click Wheeler's question, How did I produce the waveform shown in the photo?

The waveform shown is a 50µs pulse but does not show why it is so, it cannot be precise about frequencies. Looking at the diagram, the high frequency component is about 10 times the frequency of the low frequency component. If the low frequency triangular wave fundamental component was, say, 10MHz then the high frequency sine wave would need to be 2MHz. The waveform shown can be obtained then by multiplying the two in a suitable multiplier stage, such as an analogue multiplier.

Peter Grundman

Germany

Mystery waveform

In reply to Nick Wheller’s letter about his mystery waveform in the letters pages of November’s Electronics World, the waveform can be produced by multiplying a low-frequency sine wave with a high frequency sine wave.

Darren Heywood

Fulbourn

The black diagram shown is one to C. Click Wheeler's question, How did I produce the waveform shown in the photo?

The waveform shown is a 50µs pulse but does not show why it is so, it cannot be precise about frequencies. Looking at the diagram, the high frequency component is about 10 times the frequency of the low frequency component. If the low frequency triangular wave fundamental component was, say, 10MHz then the high frequency sine wave would need to be 2MHz. The waveform shown can be obtained then by multiplying the two in a suitable multiplier stage, such as an analogue multiplier.

Peter Grundman

Germany

Mystery waveform

In reply to Nick Wheller’s letter about his mystery waveform in the letters pages of November’s Electronics World, the waveform can be produced by multiplying a low-frequency sine wave with a high frequency sine wave.
Free Schottky diode

By International Rectifier

With battery-operated and power-efficient circuits in mind, International Rectifier has recently launched a new Schottky power rectifier diode - the 10MG100N - that exhibits a typical voltage drop of only 0.68V when carrying 1.5A peak.

Because of this diode's efficiency - i.e. it dissipates little heat because of its low voltage drop - it has been possible to mount it in a very small package, with a footprint of just 0.1 by 0.2in. As a bonus, this 2.1A, 100V device is suitable for high-frequency power switching. It has a typical junction capacitance of just 38pF with a reverse voltage of 10V and a 1MHz signal.

The SMA-packaged 10MG100N is primarily intended for high-density surface-mount applications, but it serves equally well working between two tracks on the reverse side of a through-hole board.


with this issue*

*UK readers only

A fast 2.1A, 100V Schottky diode in a package measuring 0.1 by 0.2in - the 10MG100N.

Major ratings and characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward current, I_{FD}</td>
<td>2.1A</td>
</tr>
<tr>
<td>Reverse voltage, V_{RR}</td>
<td>100V</td>
</tr>
<tr>
<td>Peak forward current, I_{FSM}</td>
<td>120A</td>
</tr>
<tr>
<td>Forward voltage at 1.5Apeak, T_{J}=125°C</td>
<td>0.68V</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>-40 to 150°C</td>
</tr>
<tr>
<td>Typical junction capacitance C_{J}</td>
<td>38pF</td>
</tr>
<tr>
<td>Maximum thermal resistance</td>
<td>100°C/2W</td>
</tr>
</tbody>
</table>

For more details, visit www.irf.com

---

CROWNHILL ASSOCIATES LIMITED
The Old Bakery, New Barns Road, Ely, Cambs. CB4 7PW
Tel: +44 (0)1353 666709 Fax: +44 (0)1353 666710

Low cost professional quality Smart Card Systems

CHIPDRIVE

This intelligent programmer for Smart Chip cards and memory cards is available from Crownhill Associates Limited and provides the following functions:

- No special equipment is required.
- The card is decoded and all operating parameter information is displayed.
- A true copy of the card memory is made which can be stored for future use.
- A checksum is calculated which can be verified against the card.
- With Crownhill Associates Limited's 'Smart Chip Drive' software, cards can be encoded.

CHIPDRIVE is supplied with a Windows API and full documentation. ChipDrives are used in Biometric and biometric applications to read and write to most popular smart cards, for GSM, FM Pay Phone and Access Control, etc.

FREE CHIPDRIVE Micro £89.95 + P+P £7.50
Excl of VAT

CHIPDRIVE Developer Kit

CDE consists of 52 TQFN containing carbon card readers. Applications and source code examples are available for the development of smart card applications. The kit also includes application software and a demonstration card reader for use with standard PC.

Supported with CHIPDRIVE micro.

FREE GM CARD READING APPLICATION supplied with CHIPDRIVE micro.

http://www.crownhill.co.uk
http://www.edslm2000.com

FREE GM CARD READING APPLICATION supplied with CHIPDRIVE micro.

APPLESTOCK

AppLock

Protect any Windows applications from unauthorized access with Win-AP-APK.

FREE GM CARD READING APPLICATION supplied with CHIPDRIVE micro.

£89.95 + P+P £7.50 Excl of VAT

CHIPDRIVE Micro £89.95 + P+P £7.50
Excl of VAT

Supported with CHIPDRIVE micro.

Smart Cards and Source Code.

Full tech support via Email.

http://www.towitoko.co.uk
http://www.crownhill.co.uk
http://www.edslm2000.com

EUROCARD

Low cost Embedded Control Systems

Custom Design

Micro-Controllers

Logic Controllers

Analog & Digital I/O

CAMBRIDGE MICROPROCESSOR SYSTEMS LIMITED

http://www.cms.uk.com
If now's the time to better your career, then now's the time to visit the new website from Reed Business Information.
Here you'll find thousands of jobs and maybe the answer to all your prayers. We're adding vacancies all the time, to make us the UK's leading recruitment website. Our aim is to have more jobs in more markets than anywhere else. So, if you're looking for a total change, take a look at totaljobs.com and get going.

GaAs takes on SiGe

The once out of favour GaAs technology has given semiconductor makers plenty to laugh about lately, but the time has come when the major design houses are looking elsewhere. So does SiGe fit the bill to be the key high frequency technology for the Year 2000? Richard Ball examines the facts.

The explosion in the use of wireless products such as mobile phones in the last couple of years has left gallium arsenide, or GaAs, semiconductor manufacturers laughing all the way to the bank. At last it seems that GaAs - a much maligned semiconductor technology - has found favour. However, manufacturers and design houses realise its lifetime and opportunity are finite, and that silicon germanium, SiGe - and perhaps even bulk CMOS - will ultimately provide a better fit in large volume markets.

Major GaAs design houses and manufacturers, including Analogics, M/A-COM, RF Micro Devices, TriQuint and Vitesse are starting to use SiGe. During September two firms, M/A-COM and Analogics signed deals with Temic, the Atmel division that manufacturers SiGe chips. Using SiGe, Temic introduced a DECT RF chipset last year and GSM power amplifiers this year. It started shipping in high volume from its flat wafer fab in Germany early this year.

What is significant about both Temic deals is they bring together established RF component experts with Temic's proven SiGe process technology. As Dr Charles Huang, chief technical officer for Analogics describes the move: "Having access to Temic's SiGe facility and technology provides us with an opportunity to complement our existing gallium-arsenide and silicon programmes."

US firm Analogics has been a long time proponent of GaAs, but introduced its first silicon part, a dual frequency synthesiser, in June. The Temic deal continues the shift away from pure GaAs development.

Ron Michels, v-p of the cable and broadcast segment at Analogics says: "Analogics is committed to identifying, developing, and exploiting new process technologies..."
Multi-product wafer service for SiGe

Multi-product wafer service for SiGe, say engineers at Microelectronics, is offering a multi-product wafer (MPW) service for SiGe. Starting in February, AMS will run seven lots of wafers through its fab, the final run in December next year. Untested packaged samples are available after 12 weeks for the SiGe process. The 0.6µm process is based on the firm's mixed signal CMOS process and adds a heterojunction bipolar transistor module.

Why SiGe, not GaAs?

SiGe offers the economies of scale that you get with conventional silicon processing. Producing die on 8 inch silicon wafers gives much cheaper parts than from smaller GaAs wafers - and 0.5µm products are offered. Weighed up against this is the claim by GaAs makers that their technology is cheaper in terms of mask generation.

"In semiconductor manufacturing the cost is primarily capital cost, and the amount of equipment you need relates to the number of masking levels. Our four-level metal process is implemented with 15 masks, bipolar SiGe requires 25 to 30 masks," claims Vitesse's Chris Gardner.

But, when it comes to the crunch, GaAs just uses too much power to be used for anything but low integration parts such as power amplifiers - and SiGe can now even be used for that function. With the trend towards further integration, power consumption is particularly significant. And this is where SiGe triumphs, even over silicon.

Communications applications, says William Pratt, chief technical officer for RF Micro Devices. Vitesse is one of the biggest names in GaAs - the first to offer commercial parts - but even it has succumbed to the reality that SiGe is the way forward.

"We no longer consider ourselves technology snobs, we can also write chips," says Chris Gardner, v-p and general manager of the telecoms division at Vitesse. "If we need SiGe we know the guys at IBM and we can write them a cheque."

Moreover, during the past year, Vitesse has brought three firms that deal in silicon. These include designers of Scenecom, ATM, fibre channel and network processor chips, SiGe would offer excellent power savings in many of these devices.

TriQuint is another name heavily associated with GaAs, producing RF and microwave modules for mobile phones, base stations and satellite systems. The company is reported to be looking at silicon development, where higher integration makes GaAs too expensive.

Whether GaAs is left to a few niche applications, or whether new high volume applications come along that use frequencies that SiGe cannot reach, remains to be seen.

But for now, the shift towards SiGe, and away from GaAs, is well and truly under way. GaAs suppliers will be hoping that SiGe is the joke in the pack, and keeps the laughter flowing during trips to the bank.

So just what level of charged capacitor voltage can be absorbed by the meter without damage resulting?

As with a fuse, the fusible resistors can become open circuits either by a large peak current pulse of short duration or a much smaller current for a longer time. The peak current that flows depends on the voltage on the charged capacitor while its duration depends on capacitance value. The maximum charged capacitor voltage that the meter can withstand varies according to the capacitance value.

It is best to assure the maximum safe voltage is zero, using the meter to measure only discharged capacitors. If sufficient charged capacitor voltage is applied, the ensuing peak current can open circuit the 220Ω and 2.2Ω fusible current sense resistors, Rg, and permanently weld the range relay contacts closed.

Damage to these three components has been confirmed by practical experiments using a prototype meter. Replacing these components restored normal operation.

Using all the above protection measures, a capacitor charged to a very high voltage might store sufficient charge that those integrated circuits most directly connected to the test capacitor are damaged.

To facilitate test and repair of a damaged meter, integrated circuits U1a, U1b, U1c and U1d are mounted in low profile, tinned pin sockets.

Battery power supply

Generating a 4.5V stabilized supply from four AA batteries poses the difficulty that with fresh batteries, the circuit must reduce the battery voltage. As the batteries discharge, the circuit must automatically change power to boost the battery voltage.

So it proved, as with any other power supply, and the battery indication as the batteries became exhausted is essential.

As a result of assembly, I decided to avoid surface mounted components, and used only DIL integrated circuit packages. This was not a problem with the measurement circuits or the 100Hz power supply. Unfortunately almost all the latest power supply circuits are only available in minute surface-mount packages.

A secondary problem lay in the 'shutdown' terminology. Most of the power supply circuits I looked at quoted a 'shutdown' function. In many instances, while the power supply chip itself shut down, it did not disconnect the battery load. The battery continued to supply voltage and current into the meter.

Having tried and rejected a number of power supply circuits, I found a Linear Technology application note titled 'Micropower Buck/Boost Circuits.' This application note discussed the above four cells to 5V power supply problems and suggested a solution.

This used the LT1303CN 8-pin DIL integrated circuit as a boost converter, followed by a discrete linear post regulator. I had previously rejected this IC because when used conventionally, its shut-down circuits do not disconnect the battery load. Battery disconnection is achieved using a post regulator circuit.

This application also claimed a near 80% conversion efficiency. It used surface-mounted diodes, inductors and capacitors, but I wanted to use leaded components.

With a 100Ω resistive load to simulate the tenfouth meter, bread-boarded, this prototype supply looked good. It provided a stable output voltage with inputs from 3 to 6 volts, using my bench power supply. When shut down, no power flowed in this load resistor. I added a test PCB and used the circuit with four AA batteries to power a prototype meter. Disaster; switching noise from the supply interfered with the accurate zero crossing detection of the 100Hz test current waveform.

Power conversion efficiency was less than 65%.

My original six AA battery prototype power supply used a MAX883...
low-dropout linear regulator. This produced little noise and no notable switching transients. The MAX656CPA on-board -5V converter also produces switching transients. These had not troubled my linear regulator but interfered with the LT1303CN8 control circuits. The LT1303CN8 performed much better using my bench supply than when using four AA batteries, whether NiCd or alkaline. Efficiency was improved and with less noise.

Apart from using bonding and not surface mounted parts, I had followed the suggested component values. After initial small failures attempting to add filter capacitance, I decided I needed to more closely replicate the performance of the specified surface mounted parts. Comparative high-frequency measurements suggested two problems. I needed more lower ESR capacitors, together with a larger value switching inductor, and a better power supply PCB layout. The 5V power supply board was redrawn to minimise ground impedance. Capacitor decoupling was improved by using four terminal connection paths, Fig. 3.

Of the capacitors I measured, Oscon types performed well but were expensive and physically much larger than the PCB space I had available. Certain low-ESR capacitors failed to meet their claims. Others were too tall. In the end I chose the lowest cost of these, the Rhythm X5Y. These performed far better than claimed and fitted into space available.

Using these capacitors in the new power board, I wound lower ESR capacitors, together with a larger value switching inductor, and a better power supply PCB layout. The 5V power supply board was redrawn to minimise ground impedance. Capacitor decoupling was improved by using four terminal connection paths, Fig. 3.

Of the capacitors I measured, Oscon types performed well but were expensive and physically much larger than the PCB space I had available. Certain low-ESR capacitors failed to meet their claims. Others were too tall. In the end I chose the lowest cost of these, the Rhythm X5Y. These performed far better than claimed and fitted into space available.

Using these capacitors in the new power board, I wound lower ESR capacitors, together with a larger value switching inductor, and a better power supply PCB layout. The 5V power supply board was redrawn to minimise ground impedance. Capacitor decoupling was improved by using four terminal connection paths, Fig. 3.

Of the capacitors I measured, Oscon types performed well but were expensive and physically much larger than the PCB space I had available. Certain low-ESR capacitors failed to meet their claims. Others were too tall. In the end I chose the lowest cost of these, the Rhythm X5Y. These performed far better than claimed and fitted into space available.

Using these capacitors in the new power board, I wound lower ESR capacitors, together with a larger value switching inductor, and a better power supply PCB layout. The 5V power supply board was redrawn to minimise ground impedance. Capacitor decoupling was improved by using four terminal connection paths, Fig. 3.

Of the capacitors I measured, Oscon types performed well but were expensive and physically much larger than the PCB space I had available. Certain low-ESR capacitors failed to meet their claims. Others were too tall. In the end I chose the lowest cost of these, the Rhythm X5Y. These performed far better than claimed and fitted into space available.

Using these capacitors in the new power board, I wound lower ESR capacitors, together with a larger value switching inductor, and a better power supply PCB layout. The 5V power supply board was redrawn to minimise ground impedance. Capacitor decoupling was improved by using four terminal connection paths, Fig. 3.
applied. The LT1393CN8 requires its shut-down pin be pulled high to turn the power supply off. Since other power-supply circuits shut down when pulled low, two gates of the HEF4049B are used. One houses the other to invert the ICM7242 timed output.

Circuit design revisions
The final measurement circuit schematic is little changed from that published in Electronics World June 1999. Apart from the additional INA118 in-samp already mentioned, the most significant change concerned the 10F and 10nF capacitors. These were originally specified as 1% polypropylene or polypropylene to avoid all possibility of dielectric absorption affecting performance, Fig. 2a).

Following careful compression tests, I found that with the small circuit voltages involved, 250V or 400V rated 5%-tolerance Philips 470 series metalised polyester capacitors, used with 1% metal film resistors performed equally well.

The gains for the two INA118 instrumentation amplifiers and the meter attenuator resistors have been revised. The logic drive level to the sample and hold stage has been adjusted. These changes optimise the linearity of the sample and hold circuits, Fig. 2b).

Some component values have been revised in the 1000Hz generator to ensure repeatability and assist selection of the 0.0% capacitance values needed. I find I can usually select these to better than 0.5% from the quantity of 0.1F and 10nF capacitors required to build a meter. Used with 0.9% 10F value resistors, these capacitance values ensure the specified 1000Hz generator output voltage and 1000Hz frequency.

Main PCB design
Accommodating the various circuit updates has required a total of six printed board iterations. The bottom board that houses all the added protection components is now quite densely populated. The range relay had to be changed from a DIL to a SIL version to make more space available. I have now assembled a good number of the final meter, with all having performed to specification using the calibration adjustments.

References
4. Precision low-power Instrumentation Amplifiers,’ Burr-Brown IC Data Book
5. ‘Micropower Buck/Boost Circuits’ Part 2 Linear Applications Handbook Vol. III.

How the tan meter works
The circuit works by sampling the voltage developed across the capacitor terminals at two discrete time intervals which are separated by exactly 90° of the test waveform.

The voltages developed across the capacitor terminals and the range resistors R1/2 are first amplified to a usable level using two Burr-Brown INA118 instrument amplifiers. The 'X' channel is sampled coincident with the peak of the capacitor's current waveform using a comparator to detect the zero crossing of this current. Comparator output is frequency doubled, then reduced using a CMOS 4044 phase-locked loop and 4018 divider. This results in two equal mark-space ratio square waves. One is at 100Hz and phase locked to the test capacitor current waveform. The second at 200Hz having rising edges coincident with the voltage transitions.

An application of some decoding logic provides the triggering needed to generate the two mark-space ratio square waves. One is at 100Hz having rising edges coincident with the capacitor current transitions, and the second at 200Hz having rising edges coincident with the voltag e transitions. The voltage developed across the capacitor terminals is sampled using the comparator output voltage and 100Hz square wave frequency.

Analysis of some decoding logic provides the triggering needed, to generate the two 80µs-wide sampling pulses used to control the sampling of the 'R' and 'X' channels.

The voltages developed across the capacitor terminals and the range resistors R1/2 are first amplified to a usable level using two Burr-Brown INA118 instrument amplifiers. The 'X' channel is sampled coincident with the peak of the capacitor's current waveform using a comparator to detect the zero crossing of this current. Comparator output is frequency doubled, then reduced using a CMOS 4044 phase-locked loop and 4018 divider. This results in two equal mark-space ratio square waves. One is at 100Hz and phase locked to the test capacitor current waveform. The second at 200Hz having rising edges coincident with the test capacitor current transitions, and the second at 200Hz having rising edges coincident with the voltag e transitions. The voltage developed across the capacitor terminals is sampled using the comparator output voltage and 100Hz square wave frequency.

Analysis of some decoding logic provides the triggering needed, to generate the two 80µs-wide sampling pulses used to control the sampling of the 'R' and 'X' channels.

The volume output from each sample and hold circuit is then sampled by the modified display meter and the result displayed, Fig. 5.

Both sampling times are controlled by the circuit's 'logic' channel. This channel's trigger voltage is indicated by sensing the phase of the capacitor current waveform using a comparator to detect the zero crossing of this current. Comparator output is frequency doubled, then reduced using a CMOS 4044 phase-locked loop and 4018 divider. This results in two equal mark-space ratio square waves. One is at 100Hz and phase locked to the test capacitor current waveform. The second at 200Hz having rising edges coincident with the test capacitor current transitions, and the second at 200Hz having rising edges coincident with the voltag e transitions. The voltage developed across the capacitor terminals is sampled using the comparator output voltage and 100Hz square wave frequency.

Analysis of some decoding logic provides the triggering needed, to generate the two 80µs-wide sampling pulses used to control the sampling of the 'R' and 'X' channels.

The voltage developed across the capacitor terminals is sampled using the comparator output voltage and 100Hz square wave frequency. Analysis of some decoding logic provides the triggering needed, to generate the two 80µs-wide sampling pulses used to control the sampling of the 'R' and 'X' channels.
To reserve your web site space contact Linda Payne

Aquila Vision specialises in supplying and supporting Embedded Microprocessor Development products from PICs to DSPs. We also stock robotics, Linux and general interest CD-ROMs.

http://www.aquila-vision.co.uk

ToF: 020 8652 3621 Fax: 020 8652 8938

We appreciate that cost is an important factor, as you need your company’s name, to promote your site, and a 25-word description. This includes your company’s name, web address and email address.

For 12 ISSUES:
$30 per month.

These enginee...
Transconductance op-amps have properties that make them particularly attractive for applications involving high frequencies and bandwidths. So why aren't they used more often? From Cyril Bateman's searches on the Internet, it seems that we use them more often than we think.

In the October and December issues, I discussed circuits involving operational transconductance amplifiers, or OTAs. The particular schematics highlighted demonstrated particular design functions that would be more difficult to implement using traditional voltage-output op-amps.

While similar to a conventional op-amp, a transconductance amplifier accepts a voltage input to produce a current output. Its gain can be set by altering its transconductance g_m, or its load resistance.

An OTA can perform most of the circuit functions that are possible with normal op-amps, and makes some functions easier to implement. For example, a differential input instrumentation amplifier with good common-mode rejection can be made without needing the carefully matched resistor networks found in the conventional three-op-amp circuit. It was this property that first prompted my investigation.

A transconductance amplifier offers other interesting properties. Used to drive rectifying diodes or optocouplers, it can provide a much increased working bandwidth, compared to that using a voltage-output amplifier. Using a MAX435, the Universidad Pellecnicas de Catalunya, at Barcelona increased the normal 8kHz bandwidth of a 4N25 optocoupler up to 20kHz.

On first introduction in 1969, some writers expected the OTA could even become the dominant technology. Consequently, one might expect that a variety of transconductance amplifier integrated circuits would be commercially available by now, but from memory I found I could name only a few part numbers.

Where to look...

1. IE 5 Bug Parade Continues
2. Circuit widens optocoupler's response to 1MHz
3. 'OTA' Switches Clip Amp
4. Global Semiconductor Datasheet Library
5. Analog Devices Inc
6. Linear Technology Corporation
7. Maxim Integrated Products
8. Burr-Brown Corporation

http://www.bugnet.com/alerts/bug/1ept_1021995.html
http://www.semi.com.tw
http://www.analog.com
http://www.linear-tech.com
http://www.maxim-ic.com
http://www.burr-brown.com

COMMUNICATIONS

High-frequency amplifier

The LT1228 integrated circuit from Linear Technology is described as a 100MHz current feedback amplifier with gain control.

Signal amplification again passes through two distinct circuit stages. The first is a transconductance stage having a gain of g_m controlled by an external current, in similar fashion to the CA3080 illustrated in my October article. This transconductance amplifier produces a 75MHz peak bandwidth. The second stage is a wide bandwidth, current feedback amplifier designed to drive low impedance, coaxial cable loads. With a 100MHz bandwidth and slew rate of 1000V/μs, this output stage is well suited to the transconductance stage.

Fig. 1b. Showing the excellent 8kHz flatness response from 10kHz to 10MHz for this AC coupled line receiver.
with the capacitance at pin one, the input to the current feedback amplifier, to form a pole, further reducing bandwidth.

This circuit's gain can be controlled both by current or an external voltage. This can be provided digitally using a voltage output digital-to-analog converter and voltage to current converter, or more simply by using a digitally controlled potentiometer to reduce $R_i$.

High-gain 10MHz bandwidth amplifier

One difficult design area is attaining high gain over moderate bandwidths and with a high input impedance. You would need such performance for an active-oscilloscope probe for example.

The MAX457 is a dual CMOS video amplifier offering a very high current low capacitance input stage and 70MHz bandwidth. It was designed for use as a low gain 75Ω cable driver for video distribution amplifiers and is unity gain stable.

The circuit is a pin compatible, with eight-pin dual op-amps, with suitable component changes could be used to upgrade many circuits. It provides a 72Ω isolation between amplifiers at 1MHz and differential phase and gain of 0.3% and 0.5% respectively.

While Maxim does not process it as a transconductance amplifier, output current is proportional to the difference voltage at its inputs, with a $G_m$ of 0.6V/μA. Unlike the MAX435 and 436 transconductance amplifiers, discussed in the December issue, the gain for the MAX457 uses the normal non-inverting op-amp two resistor closed loop feedback method. Using a 1kΩ resistor to ground from the inverting input pin, the data sheet lists feedback resistor by desired gain and load impedance.

Its gain bandwidth product, while specified for a 75Ω load, increases with increased load impedance. With unity gain and a 75Ω load, its output is -3 dB at 70MHz. At a gain of two and a 150Ω load, bandwidth becomes 20MHz. Increasing this load impedance to 750Ω and amend the feedback network to give a gain of ten output is now -3 dB at 25MHz, representing an increase in gain bandwidth product from 70 to 250MHz.

As described in A0317.PDF this feature has been used to design a composite amplifier having a gain bandwidth product of 1GHz. This amplifier provides a 10MHz bandwidth at 40dB gain and can drive ±3.3V into a 150Ω load, i.e. a back-terminated 75Ω coaxial cable, Fig. 2a.

Operating with no DC load, the first stage produces its maximum possible voltage gain around 660V/μV. The second amplifier, which drives the 150Ω load, has an open-loop voltage gain of 65V/μV. This results in a total open-loop gain for the composite amplifier of 70dB.

Feedback components shown, together with the phase compensation components, the circuit can oscillate. Download A017.PDF from Maxim's site for full details. However without these phase compensation components, the circuit can oscillate. Of course, the required 40dB gain bandwidth.

Perhaps by now you might think that transconductance amplifiers are always targeted to high frequency use. Not so, my next application by comparison is almost DC.

Current-sense amplifier

A current-sense amplifier using the MAX4172, takes advantage of the transconductance amplifier benefits already mentioned. It uses a differential measurement of the voltage dropped across an external sense resistor to measure the unknown current. Its output is a current proportional to the voltage drop being measured.

The device has a common-mode range of ±3V, regardless of the chip's supply voltage which can be as

As Windows 2000 - previously known as NT5, is announced for release to computer makers in December and the shrinking window version planned for February, yet another Internet Explorer security bug has been uncovered. In the December issue, I reported that Georgi Guninski of Bulgaria had discovered an 'ActiveX' security hole that allowed hostile code buried in a Web page or in an e-mail, to run on a computer without the user's knowledge. Disabling the option 'Active Scripting' prevents this. Alternately a patch can now be downloaded from Microsoft. Now Guninski has reported yet another IE5 bug, making a total of three IE5 security holes he has reported with the space of a month. This latest uses the 'JavaScript Redirect' function with a little domain redirection, to trick IE5 into exposing the files on your computer. Fig. A.

Normally, should an Internet server request access to your data files, IE5 will prevent access. However following suitable domain redirections, ownership of your files can be made unclear and IE5 does not then prevent access. This access will be 'read only' so your files will remain intact, but their contents will have been exposed. Microsoft plans to post another software patch, but in the meantime it recommends users should disable Active Scripting in their 'Internet Options'.

As shown in Fig. A, you can use Explorer 5 to access Internet, review your IE5 Internet ActiveScript settings.

As shown in Fig. A, you can use Explorer 5 to access Internet, review your IE5 Internet ActiveScript settings.

As shown in Fig. A, you can use Explorer 5 to access Internet, review your IE5 Internet ActiveScript settings.

As shown in Fig. A, you can use Explorer 5 to access Internet, review your IE5 Internet ActiveScript settings.

As shown in Fig. A, you can use Explorer 5 to access Internet, review your IE5 Internet ActiveScript settings.
Free Classified Offer: Electronics World, L333, Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS

Please send your completed forms to:

All adverts will be placed as soon as possible. However, we are unable to guarantee insertion dates. We regret that we are unable to enter into correspondence with readers using this service, we also reserve the right to reject adverts which do not fulfil the terms of this offer.

Simply write your ad in the form below, using one word per box, up to a maximum of twenty words. Remember to include your telephone number as one word.

You must include your latest mailing label with your form.

A free offer is available in the UK, all in one easy to use brochure, is now available FREE.

This free offer can advertise their name products.

For the simple solution to your On-Screen Display requirements

With a wide range of colour LCDs, LCD monitors and play and play kits, available in the UK, all in one easy to use brochure, is now available FREE!

It includes information on products ranging from 2.5" monitors to 16.1" colour LCD screens, monitor/colour STN TFTs and touch screen technology from the world’s leading suppliers.

Phone TREN T today for your free copy

Only tick here if you do not wish to receive direct marketing promotions from other companies.

Phone TREN T today for your free copy

To guarantee your own personal copy each month

Save on a 2 year subscription

Subscribe today!
Winradio
TAKING THE EUROPEAN RADIO MARKET BY STORM

Available as either an internal ISA card that plugs into your PC, or as an external (portable) unit. WINRADIO combines the power of your PC with the very latest and greatest, synthesized receivers.

YOU CAN USE WINRADIO® SCANCON™ PC COMMUNICATION RECEIVERS FOR:
- Broadcasting, media monitoring, professional & amateur radio communications, scanning, spot frequency, whole spectrum monitoring, real-time recording, signal conditioning and decoding applications. It’s all you need.
- The units are powered through either your existing 12v supply, or through an optional PCMCIA adapter (for high speed computers).

To receive your completely free (no obligation) info pack and WINRAD™ software emulation demo disk all you have to do is get on the Internet and go to:

Enformatlca Limited, Unit B, Chelford Court, Robjohns Road, Chelmsford, Essex, CM1 3AG, United Kingdom

WRTH 1998 Awards
"Five stars for its mechanical design"
WRTH 1999 Review
"Most Innovative Receiver"

Model Name/Number
WR-1000  WR-1500  WR-3100

Constuction of internals
Yes       Yes       Yes

Construction of externals
Yes       Yes       Yes

Frequency range
0.5-1300 MHz  0.15-1500 MHz  0.15-1500 MHz

Modes
AM, SSB, CW, FM
AM, SSB, CW, FM
AM, SSB, CW, FM

Tuning step size
100 Hz (SSB), 230 kHz (FM)
200 Hz (AM), 3 kHz (FM)
200 Hz (AM), 3 kHz (FM)

IF bandwidths
17 kHz (FM), 250 kHz (FM)
17 kHz (FM), 250 kHz (FM)
17 kHz (FM), 250 kHz (FM)

Receiver type
Pll-based triple-conv., superhet

Scanning speed
10 ch/sec (AM), 50 ch/sec (FM)
200mW
200mW

Audio output on card
8 cards
3-B channels

Max on one motherboard
8 cards
8 cards
8 cards

Dynamic range
85 dB
85 dB
85 dB

IF shift (passband tuning)
±2 kHz

DSP in hardware
No
Yes (ISA card only)

IRQ required
No
Yes (for ISA card)

Scope Spec
Yes
Yes
Yes

Visa
Yes
Yes
Yes

Published software API
Yes
Yes
Yes

Internal ISA cards
£369 inc vat
£569 inc vat
£1169 inc vat

PCMCIA Adapter (external): £59.99 inc vat when bought with 'e' series unit (otherwise: £39 inc vat)

PPS NiMh 12V Battery Pack and Charger: £39 inc vat when purchased with a WINRAD™ receiver (otherwise: £139 inc vat)

The Winradio Digital Suite: £249.95 inc vat when purchased with a WINRAD™ receiver (otherwise: 398.95 inc vat)

To receive your completely free (no obligation) info pack and WINRAD™ software emulation demo disk all you have to do is get on the Internet and go to our website at http://www.broadcasting.com. If you don’t have easy access to the Internet then by all means feel free to telephone us or send a fax.

Enformatlca Limited, Unit B, Chelford Court, Robjohns Road, Chelmsford, Essex, CM1 3AG, United Kingdom

SEE OVER!
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

Dataman S4
- Programs 8 and 16 bit EPROMs, EEPROMs, PEROMs, 5 and 12V FLASH, Boot-Block
- True no-adaptor programming up to 48 pin DIL devices
- 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!
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.