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LIGHT CHASER PROJECT IS EASY TO BUILD

SIMPLE 144MHZ FM TRANSMITTER FOR RADIO HAMS

'VULTURE' CAR ALARM PROJECT • FAX CARD FOR PC'S

SPECIAL FEATURES: PROGRESS IN OPTO-ELECTRONICS

Electronics Australia

Volume 51, No.11

November 1989

AUSTRALIA'S LARGEST SELLING ELECTRONICS MAGAZINE – ESTABLISHED IN 1922

Simple 2m FM transmitter

One of our construction projects this month is a simple low power FM transmitter, in modular form, for the 144MHz amateur band. It puts out over 1 watt, and would be ideal for the newcomer to VHF, who'd actually like to try their hand at BUILDING something! (See page 86)

Vulture car alarm

Another of this month's projects is an easy to build car alarm, which offers just about all of the frills and features found on commercial units – for a fraction of their cost. (See page 80)

On the cover

Julie Harriott and her friend George Vrontas found our new Light Chaser project ideal for creating a disco environment. Developed by Dick Smith Electronics, you'll find it described in the story starting on page 64. (Photo by Peter Beattie)

Features

Entertainment Electronics

Projects and Technical

News and Comment

Departments

MANAGING EDITOR
Jamieson Rowe, B.A., B.Sc., SMIREE, VK2ZLO
TECHNICAL EDITOR
Peter Phillips, B.Ed., Dip.Ed., ECC
PRODUCTION CO-ORDINATOR
Milli Godden
EDITORIAL STAFF
Rob Evans,CET RMIT
Dewald de Lange, B.Eng.
READER SERVICES
Allison Brown
ADVERTISING MANAGER
Selwyn Sayers
CONTRIBUTORS
Neville Williams, FIREE, VK2XV
Ian Pogson, VK2AZN
Ron Cooper
Jim Lawler, MTETIA
Bryan Maher, M.E., B.Sc.
Ken Pohlmann, M.S., B.S.
DRAFTING
Karen Rowlands
GRAPHICS DESIGNER
Brian Jones
ART PRODUCTION
Alana Horak, Larry Leach, Ray Eirth, Ron Farrell
PRODUCTION
Tracy Douglas
ADVERTISING PRODUCTION
Brett Baker, Inga Tettmann
CIRCULATION MANAGER
Michael Prior
PUBLISHER
Michael Hannan
HEAD OFFICE, EDITORIAL & ADVERTISING
180 Bourke Road, Alexandria, NSW 2015
P.O. Box 227, Waterloo 2017.
Phone: (02) 693 6620
Fax number: (02) 693 6613
Representative: Brett Annesley
For reader services see back of magazine.
INTERSTATE ADVERTISING OFFICES
Melbourne: 221a Bay Street, Port Melbourne, Fax No: (03) 646 5494, Nikki Roche
Brisbane: 26 Chermside Street, Newstead, Qld 4006. Phone: (07) 854 1119
Fax No: (07) 252 3692, Bernie Summers
Adelaide: 98 Jervois Street, Torrensville, SA 5031. Phone: (08) 352 8666
Fax No: (08) 352 6033, Mike Mullins
Perth: 94 Hay Street, Subiaco WA 6008. Phone: (09) 382 1369, Fax (09) 388 1186. Estelle de San Miguel
New Zealand: 63-73 View Road, Auckland, New Zealand. Phone: (09) 443 0954.
Fax No: (09) 443 1326, Gordon Marr
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Letters to the editor

AM radio channels

I would like to comment on the letter by Neil McCrae published in the April 1989 issue, on the channel divisions of the broadcast band.

His comments on the spacings of carriers 9kHz apart are welcome, if somewhat self-contradictory. His statement that "there is no compulsion to stay within a +/–10kHz channel" is at variance with the impression of the law held by one of our local broadcast station chief engineers. Not having read the broadcast licence law in detail myself, I believed our chief engineer, who states that their station does in fact have a sharp cut off between 9 and 10kHz, so as to be well down at the 20kHz channel edges.

From the point of view of any one station and any one listener, I still think that the broadcast band at least *appears* to be divided into 20kHz segments, albeit many channels overlap if separated by great distance, even some sharing the identical carrier frequency. (Reminds one of TV co-channel problems in mid-western NSW, in between Channel 8 Orange and Channel 8 Bendigo!)

Regarding plate modulated transmitters – to be sure they are now not used by broadcast stations. The latest transmitter close by uses a very complex semi-digital AM modulation system, giving incredible efficiency. But such sophistication would be inappropriate in our 'Basics of Radio' series, I am sure you will agree. That is why I only described the simplest method. Even though it lacks efficiency, plate modulation claims excellent linearity.

Bryan Maher,
Mermaid Beach, Qld.

Comment: Our apologies for not publishing this letter sooner, Bryan – it became 'buried' under later letters.

Unfair treatment

Although I have been a purchaser of the magazine since about 1952, and a subscriber for the last two or three, I have not always seen eye-to-eye with editorial policies, as your files may show. One should never feel slighted by such disagreements however, they are only part of the game.

I must say that for once I agree with you on the cheap and nasty components sold by some vendors. I refer to the first part of your column 'Forum' in the March issue. I too feel that the market place has shrunk to a few major chains, mini versions of K-Mart if you will. I even read your editorial on the 'world village' in that issue with interest.

But the part lampooning, and berating the unfortunate Mr.Spyker from Karrinyup WA left a bad taste in my mouth. Please if you disagree with a subscriber, even someone from deepest, darkest West Australia, please avoid the cartoons depicting him as a demented yokel. (Incidentally, should you wish to do the same to me, I am portly, wear glasses, and walk with a stoop. To give Beejay even more scope, I came over from New Zealand about 25 years ago.)

A calm and logical discussion is preferable to angry rhetoric, especially in such a well established and respected technical journal as Electronics Australia.

Finally, having handed out a couple of bouquets and a brickbat, I must congratulate you on a reasonably informative periodical. I rate it near the top of the journals I subscribe to, including science fiction, computer and electronics magazines, domestic and foreign. I would however like to see projects for the Amiga series of computers, or some different digital projects, for example a PABX, a way of remotely operating modules from a home computer via the 240V ac lines, an off-switch for children. My complete Santa list is much longer, but perhaps you get my drift.

Alastair E. Miller,
Kyeemagh, NSW

Comment: Thanks for your comments, Mr. Miller. It was not our intention to lampoon or berate Mr. Spyker – Beejay simply gets carried away at times, when he's doing the cartoon. As you may have noticed, he's not exactly flattering to me either at times! We'll see what can be done in terms of the project ideas you give.

Low distortion oscillator

I would like to comment on the modifications to the low distortion oscillator suggested by Mr Bill Jolly, which were described in the August CDI pages.

Firstly, the desirability of a 'linear' frequency scale is not self evident. Such a scale is just as cramped at the low end of the frequency range as the original is at the high end.

The preferred scale for an audio generator with decade ranges is logarithmic, since this gives equal percentage changes in frequency for equal angles of control rotation. Many commercial generators approach this ideal quite closely, by use of specially made semi-log potentiometers as mentioned in the March 1989 article.

Also, the inherent non-linearity of LDRs would dramatically increase the THD, perhaps by 100 times, negating the title of the project. As well the frequency stability would be seriously degraded by the use of LEDs, transistors and LDRs in the adjusting network. These two points were conceded in a telephone conversation I had with Mr Jolly.

As a final note, the matching of the two halves of the dual potentiometer is not at all critical. Tried on the prototype, even a large mismatch was of no effect except at low (below 100Hz) frequencies and then only increased the THD figure by a small amount.

Phil Allison,
Sydney

Quality problem

Buy Australian, we cry – why?

This month I purchased an electronic device for $350.00 which was advertised as 'Proudly Australian Made'!

May I express my disappointment, briefly? The container box was a plain brown affair with the maker's sticker attached; the Operator's Manual was a typed and hand drawn photocopy, badly over-exposed; two of the control knobs wobbled badly through the front panel and upon removing them I discovered burred and rusted shafts, with no bushing to take up the slack.

The same article with a superior finish and priced identically, is also available to us from Japan and, the components are also made in Japan, so why buy Aussie?

R. Morrish,
Rosebud, Victoria.

Feel free to send us a Letter to the Editor if there's a something you believe that *EA's* readers should know. If we agree we'll publish it, but we do reserve the right to edit those that are too long, or potentially libellous.

Editorial Viewpoint

Aussie persistence and ingenuity shine through, again

We have another meaty issue for you again this month, I'm happy to report. And one of the highlights is yet another article reporting on a research breakthrough by Australian scientists – the kind of good news I'm always keen to publish, if only to try and overcome the collective inferiority complex that we Aussies all seem to share.

This month's story is about the development of a new kind of solid state laser diode, by Dr Peter Kemeny and his colleagues at the Telecom Research Laboratories in Melbourne.

I was invited to visit the TRL a few weeks ago, and spent a fascinating time looking over some of the labs and hearing about the various research projects. One area that particularly caught my interest was that of the semiconductor laser group, which turns out to be well and truly at the 'leading edge' of this exciting technology.

Dr Kemeny's invention of a new vertical-axis optical resonator has allowed the group to produce electrically pumped lasers, optical filters and modulators that are probably further advanced than any yet produced overseas, even in Japan and the USA (with research facilities many times greater). This has dramatic implications for the development of future opto-electronic ICs and – further down the line – truly photonic data processing and communications. And it has enormous potential for Australia to become an *exporter* of this technology.

I hope you find this article as interesting and cheering to read, as I did writing it.

Quite apart from this article, you'll find others on different aspects of opto-electronics. There's one on a new high resolution plasma display/input terminal developed in Canada, which has been described as the 'work surface of the future'. And another from Philips on using CCD sensors with pixel and column defects, to produce a really low cost CCTV camera.

Needless to say there's also a strong complement of construction project designs, for those who enjoy the unique satisfaction of building up equipment and being able to boast that "I built it myself!".

As you've no doubt seen from the front cover, one of these projects is a light chaser, to produce a range of moving light patterns for applications such as animated signs and disco lighting. There's also 'The Vulture' – a multi-featured security alarm for cars, offering a range of features normally only found on commercial units many times its price. And there's the first of two articles describing a low-cost fax adaptor card, to turn your IBM-PC or compatible into a fax machine.

Those of you who are radio amateurs should also be happy to see the first of a planned series of simple ham projects: a simple low-powered FM transmitter for the 2-metre band. It's simple and unpretentious, but hopefully it will encourage a few more amateurs to rediscover the joys of building up their own 'rigs'. That's what we're hoping, anyway.

Jim Rowe

What's New In Entertainment Electronics

S-VHS compatible range of CTVs

Panasonic has introduced a new range of colour television receivers, many of which offer features such as S-Video terminal capability, for compatibility with the new S-VHS video recorders, FST tubes and a new 'dome sound' stereo speaker system.

All of the new 63cm, 68cm and 78cm models provide S-Video terminal capability, with separate direct luminance and chrominance terminals. Together with high resolution picture tubes this gives more than 400 lines of horizontal resolution, to deliver optimum results with S-VHS video recorders. The tubes used are Panasonic's 100° FST (flat, square tube) type, which also includes the ART (aberration-reducing triode) electron gun.

The stereo models also provide Panasonic's 'dome sound' system, which uses speakers mounted in internal side enclosures, but with slim vertical sound apertures each side of the tube at the front. This is said to give rather better stereo imaging than side apertures. The internal enclosures are carefully designed to deliver a flat, wide-range response.

The top-of-the-range model TX-3370AR also features a built-in graphic equaliser, 20W/channel audio system, enhanced resolution of 500 lines and digital on-screen display of contrast, brightness, colour, balance, volume and graphic analyser settings. It also provides 50-channel frequency synthesiser tuning, teletext reception, and 64-key TV/video/teletext integrated remote control.

7.5cm pocket TV uses 'active matrix'

Up until recently, LCD screen 'pocket' colour TV receivers have had a noticeable weakness: 'smear' – a smudge or trail left behind by any action on the screen.

Research by Philips in its European laboratories has enabled the development of a new 7.5cm pocket LCD colour TV which uses 'Active Matrix' and thin film technology (TFT) to remove these picture blemishes.

The receiver covers the international VHF and UHF TV bands with 69 channels, and receives both the PAL and Secam-LL systems. It also provides a direct video input, and even has an AM/FM radio receiver for when you want to listen to music or news.

The set is powered by mains, through a car cigarette lighter socket, by internal alkaline non-chargeable or by NiCad rechargeable batteries, with a built-in charger for the NiCads. Weight is less than 500gm, and dimensions are 37 x 164 x 99.5mm.

Headphones from the UK

Offering more than 55 models, the quality British line of Ross headphones is relaunching in Australia.

Ross headphones have achieved considerable success in the UK and a strong following in Europe. This product success is being emulated elsewhere in the world because of the headphones' technical performance, allied with wearing comfort and robustness – backed by a two-year warranty for most models.

Top of the range units offer a frequency response flat from 15 or 18Hz to 32, 25 or 22kHz depending on the model, while all others are rated flat from 20Hz to 20kHz. Impedances are designed from 4 ohms to 32 or 100 ohms. Sensitivities range from 90 to 110dB, according to model.

Attention to detail in the hi-fi stereo phones extends to adding L and R identification in Braille. This design detail also shows up in the swivel joint and gimbal earcup that lets the listener enjoy the quality of the sound for long periods without any distracting discomfort. The high velocity samarium-cobalt drive units with ultra thin, low mass diaphragms give the lightness that contributes to wearer comfort while achieving sound quality.

Stocked by leading hi-fi retailers and Myer department stores, the headphones have recommended prices that range from $20 to $249.

Further information from Ross Electronics, PO Box 917, Lane Cove 2066 or phone (02) 428 1555.

New Sony CD player features 'digital sync'

The new Sony CDP-X7ESD compact disk player features the advanced 'Digital Sync System' signal processing, said to assure highly accurate jitter free playback by eliminating phase errors.

A new limit in noise level has been achieved with the 8FS/45-bit noise shaping digital filter. The digital signal is processed with greater accuracy, resulting in higher resolution, particularly in the lower signal levels.

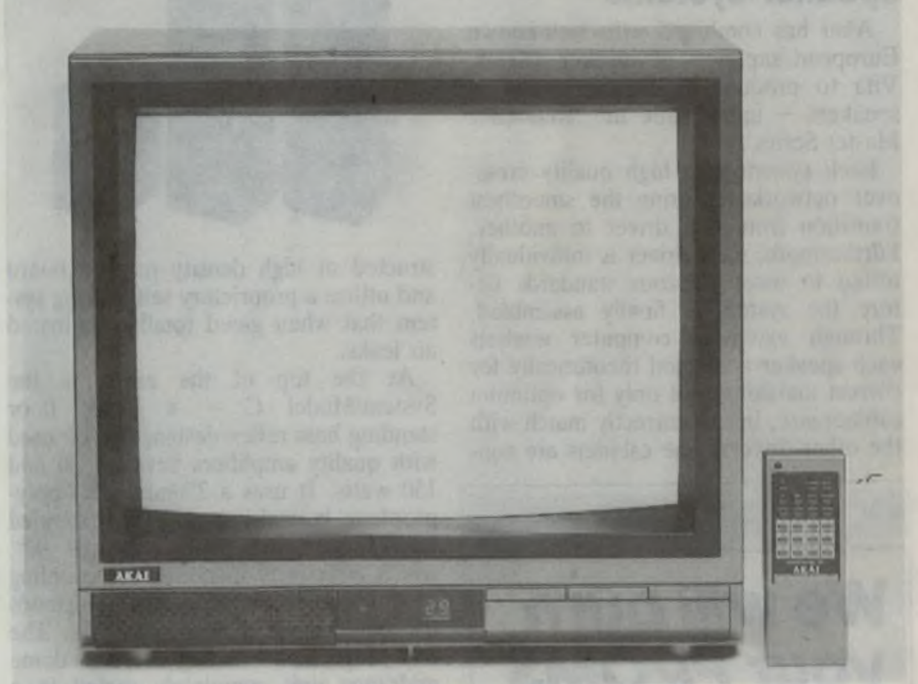
The unit is also claimed to integrate the power supply, mechanism and circuitry in a complete functioning system. Isolation of the power supply transformer prevents vibration and noise from the circuitry. An aluminium diecast base unit and fine ceramic insulators provide additional rigidity and strength to ensure sound that is free of noise and vibration.

There are two sets of gold-plated output terminals, fixed and variable, in addition to balanced line out using XLR connectors for professional use. The unit also provides optical digital output.

The CDP-X7ESD has a range of features that will keep the most fastidious audiophile tranquil. These include; full function IR remote; 'Custom Edit' which allows professional quality personalised editing; and 'Custom File', where three types of customised information can be stored for each disc up to a maximum of 227 discs.

The CDP-X7ESD is aimed at the audio perfectionist and is available throughout the Sony dealer network at a suggested retail price of $2699.

21" colour TV from Akai



Akai has introduced its CTK-211 21" (54cm) colour TV, a 30-channel model with features that include direct video and audio input and an IR remote control.

The CTK-211 is directed towards unit owners, young people in flats, and where a smaller viewing size is required. Also consumers who have midi hi-fi systems and want a medium sized TV to compliment their existing A/V environments.

The FST (flatter, squarer tube) design offers the viewer a flatter image than earlier designs, giving better viewing at positions other than directly in front of the screen.

The CTK-211 is available from selected Akai dealers and department stores and has an RRP of $899. It is covered by a national three year warranty.

Lightweight headphones from Sennheiser

Sennheiser has released a new lightweight headphone set for the professional user, the HD 25.

These closed dynamic units from the world's most respected audio transducer manufacturer, boast a frequency response from 30Hz to 16kHz. They also feature high sensitivity (approximately 105dB) and effective attenuation of ambient noise.

The sturdy finish and trendsetting design are complemented by a split headband for the greatest wearing comfort, making the HD 25 headphone very suitable for studio and outdoor use.

For further information, please contact Australian distributor, Syntec International, 60 Gibbes Street, Chatswood 2067 or phone (02) 406 4700.

Dual cassette deck offers fast reversing

A particularly fast and accurate auto-reverse mechanism has been developed by the European-based Marantz group for its latest twin-cassette deck.

The model SD585 features rotating record/playback heads and an ultra-quick auto-reverse mechanism. Using an infra-red photo sensor, the mechanism takes only 800 milliseconds to reverse the head and tape feed, and continue with recording or playback.

The precision-engineered rotary head assembly flips round instantly, ensuring that precisely the same head gap is used in both directions – and that exactly the same sound quality is maintained.

While the SD585 is a very convenient machine, offering high-speed tape dubbing at twice normal speeds and up to three hours of continuous recording or playback, the emphasis is on sound quality.

Dolby B and C noise reduction systems are employed for the best possible sound quality on both pre-recorded and home-recorded tapes, while potentially tricky bias and equalisation settings are made automatically.

Akai/Vifa speaker systems

Akai has combined with well-known European suppliers of speaker drivers, Vifa to produce its flagship range of speakers – aptly name the 'Reference Master Series'.

Each system uses high quality cross-over networks ensuring the smoothest transition from one driver to another. Furthermore, each driver is individually tested to meet vigorous standards before the system is finally assembled. Through extensive computer analysis each speaker is aligned theoretically for correct matching, not only for optimum cabinet size, but to correctly match with the other drivers. The cabinets are constructed of high density particle board and utilize a proprietary self-locking system that when glued totally eliminated air leaks.

At the top of the range is the System/Model C – a 3-way floor standing bass reflex designed to be used with quality amplifiers between 20 and 150 watts. It uses a 250mm (10″) polyproplene bass driver with an extended bass reflex port swung through 90°, which effectively increases the coupling of the woofer to the port and extends the bass response down to 38Hz. The mid range is handled by a 75mm dome midrange unit completely sealed in a separate chamber, eliminating interference from both the woofer and to a lesser extent the tweeter. The tweeter is a ferrofluid damped dome tweeter featuring a multilayer voice coil on an aluminium former for maximum heat dissipation and power handling.

Middle of the range is the System/Model B – a 2-way infinite baffle, floor or stand mounted system designed for quality amplifiers between 20 and 120 watts. This uses two 250mm (10″) bass drivers together with a 25mm (1″) ferrofluid damped dome tweeter.

Also in the range is the System/Model A – a 2-way infinite baffle speaker designed to be used in bookshelf environments or on stands. Each enclosure utilises a 200mm (8″) bass driver together with a ferrofluid damped dome tweeter. System/Model A is designed for amplifiers with power ratings between 10 and 60 watts.

The Reference Master Series speakers are coverd by a two year warranty and are available at selected Akai dealers and department stores. System/Model C has an RRP of $1299. System/Model B an RRP of $999 and System/Model A an RRP of $699.

Australian-made professional CD player

Local maker of professional audio equipment Consolidated Electronics has launched a broadcast-quality CD player that is physically compatible with current professional cartridge machines.

The new machine is caddy-based, so that the discs are protected for both storage and playing. During play both caddy and disc are totally enclosed within the player, to prevent any risk of mistracking due to bumps. The caddy also protects the disc from dust, significantly increasing air-time reliability.

A linear motor is used for laser tracking, and the drive mechanism incorporates techniques to reduce mistracking.

Servicing is very easy, with only four screws needing to be removed for access to all electronics, and four more for removal/exchange of the drive unit.

Further information is available from Consolidated Electronics, 15A Anderson Road, Thornbury 3071 or phone (03) 484 0791.

Getting the 'Most' with the 'Least':

Australian QRP is alive & well

One of the areas in amateur radio where experimenting and 'home brewing' are still very much alive and well is 'QRP', or very low power operation. There's a special satisfaction in seeing just how far you *can* make a couple of watts travel...

by THOMAS E. KING, VK2ATJ

Some amateur radio enthusiasts dream of operating the ultimate megawatt transceiver, a power hungry box studded with knobs, lights and perhaps a few bells and whistles. Such a dollar draining monster would, of course, not only be able to punch a signal physically through the ether – it could also be used to warm the entire house, heat the evening meal and welcome guests!

A few amateurs know they can do far more with far less, and to prove it they regularly contact other amateurs with miniaturised equipment designed to consume less power than that drawn by a light bulb in a chicken shed. These are the true 'QRP' enthusiasts.

The letters 'QRP' are not an abbreviation; they are a part of the universally acknowledged 'Q' code for radio amateurs, in this case widely accepted as meaning *low power* communications.

But just how low is 'low power' communications? The upper limit is generally recognised as 5W output on CW and 10W output on SSB. Power levels under these limits are not only encouraged, but are tagged with different names.

Output limits of 3W on CW and 5W on SSB is known as 'QRPp', while anything under 1W output in any mode is (naturally enough) in the 'milliwatt' category.

There's considerably more to QRP operation than just reducing power output to near-nil levels. The miniscule RF power available must be efficiently transferred to an optimised antenna, and the operator must employ patience and finely tuned operating skills. And finally it's essential that there is good band propagation.

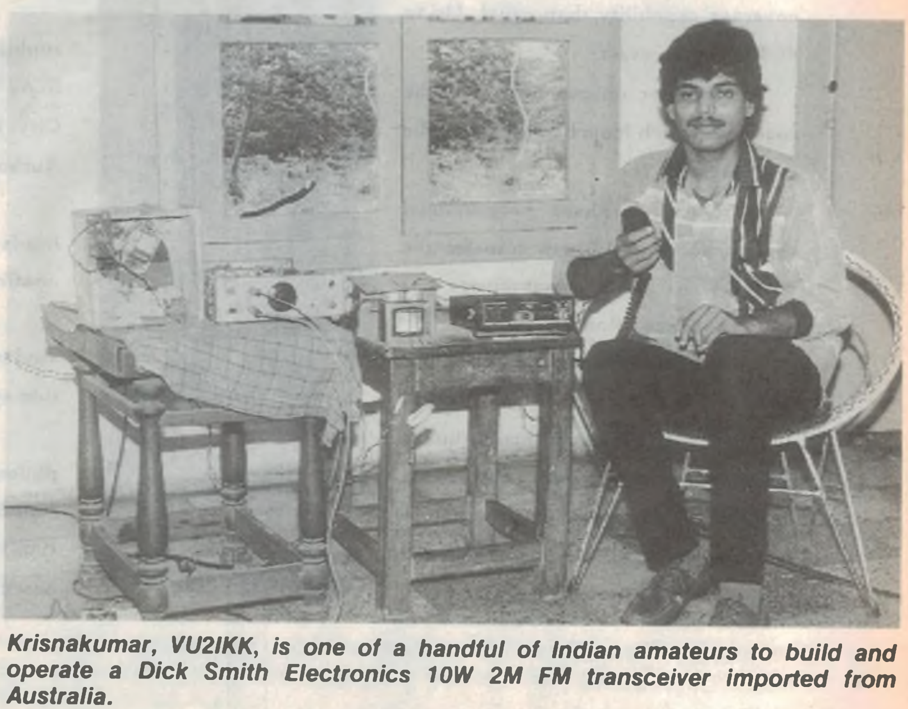
Such a mixed bag of conditions places a great challenge on even the most experienced operator. It's a challenge that most amateurs consider to be the absorbing appeal of QRP operations.

It doesn't matter if amateurs have held a licence for 60 years or 6 hours, they can easily become involved with low power communications.

Most begin to learn about the intricacies of this 'hobby within a hobby' after contacting a radio association catering for such a specialised interest. QRP organisations can be found in many countries where radio amateurs are active: Austria, Belgium, Brazil, Italy, the Netherlands, Spain, West Germany, the United Kingdom, the United States and, of course, Australia.

The British G-QRP Club is the oldest low power communications organisation in existence. The main advantage for Australian amateurs to pay the current membership fee of £5 or US$10 is to receive *SPRAT*, the quarterly journal of the G-QRP Club.

A recent 32-page copy of *SPRAT* contained full details of the 'Alpha' 2W, 80M CW transceiver (including an offer for transceiver and amplifier PCBs), an automatic T/R switch, an 80 or 20m receiver on a 1" PCB (kits are available), a CW filter (again with a kit offer), a novel 'Hover' (horizontal/vertical) antenna, a review of a new book, *The History of QRP* by WORSP, information on QRP awards, field days, commercial ads and DX including notes on a 950mW contact on 3.5MHz between G3CQR and W3PDL, and the story of a British amateur who, in 5 days and with 3W contacted 20 countries – and all without an antenna! His secret was the use of a Z match, the central heat-



Krisnakumar, VU2IKK, is one of a handful of Indian amateurs to build and operate a Dick Smith Electronics 10W 2M FM transceiver imported from Australia.

ing system of his flat and a 4-foot counterpoise.

Full information on the G-QRP Club is available from Chris Page, G4BUE, "Alamosa", The Paddocks, Upper Redding, Steyning, West Sussex BN4 3JW, England.

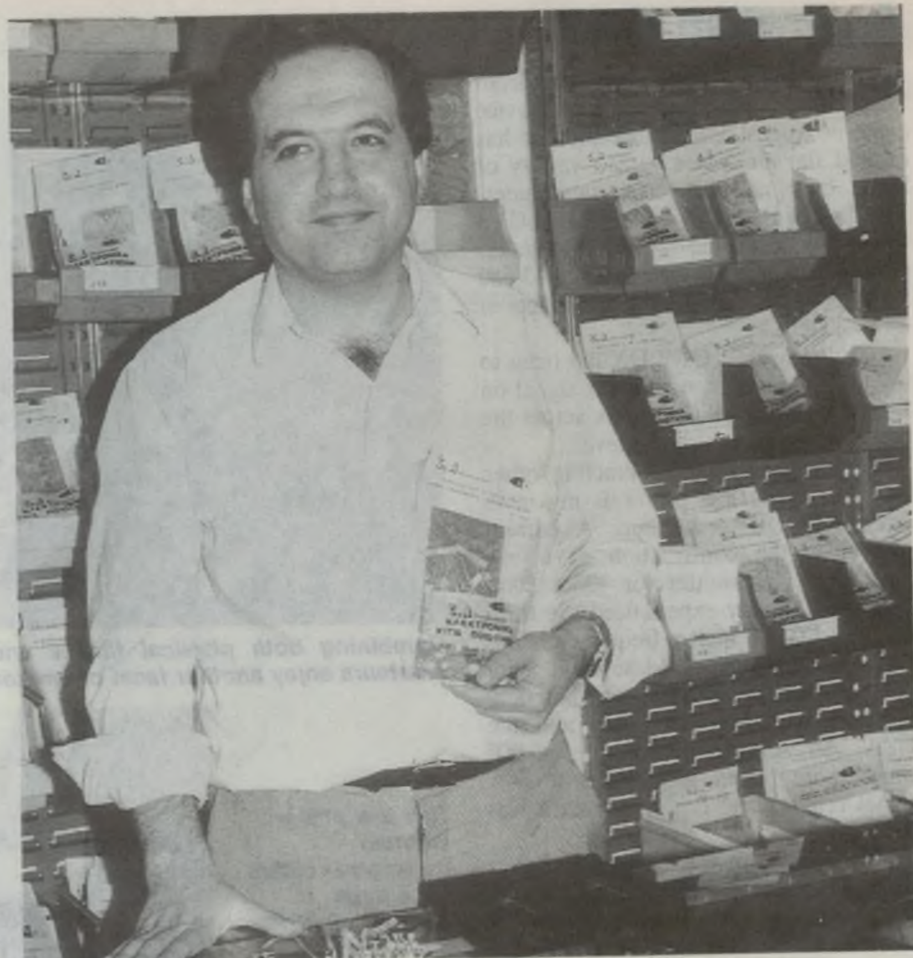
Another organisation devoted to low power operation, this time in the USA, is The QRP Amateur Radio Club International. Bill Harding, K4AKH, 10923 Carters Oak Way, Burke, Virginia USA will supply details of the club and its magazine.

Also in the USA is *MILLIWATT*, the national journal of QRPp, which is devoted exclusively to 'under five watt amateur radio'. Apart from editing the publication Ade Weiss, WORSP, is also responsible for evaluating applications for QRP awards.

In Australia the CW Operators QRP Club is nearing the 125-member mark. Max Brunger VK5OS, of 3 Durham Avenue, Lockleys, SA 5032 is the current organiser for this interesting specialist amateur association. Kevin Zietz, VK5AKZ, 41 Tobruk Avenue, St Mary's, SA 5042 is also able to assist with general enquiries.

Founded in December 1983, the CW Operators QRP Club fosters the growth of this challenging hobby-within-a-hobby by encouraging the design and construction of home built equipment, the experimentation with and construction of antennas, and the study of radio wave propagation.

Round tables on the air are regularly conducted to allow the exchange of ideas by members, as well as other amateurs interested in low power communications. The club's calling frequencies are 1.815, 3.530, 3.585, 7.030, 10.106, 14.060, 21,060 and 28.060MHz.



Displaying one of the QRP radio kits available by mail order to all amateurs, Athens-based C&A managing director Simeon Krizias is positioning his company to be the kit giant of Europe.

A keen QRP operator in Madras, Shrikanth VU2ARQ, built this QRP CW transceiver which has since enabled him to work many European stations.

The CW Operators' QRP Club has an Activity Night at 0900 UTC, Tuesdays on 3.530MHz. As well, the club has an SSB Information Net at 1030 UTC Fridays on 3.620MHz.

The highlight of the QRP calendar is the annual 'VK vs The World CW QRP International Contest'. Certificates are awarded to winners of this competition, set for the second last weekend in November.

The current fee of $10 provides members with a number of benefits including a subscription to the Club's quarterly news bulletin *Lo Key*, published in March, June, September and December. The bulletin has numerous articles on home fabrication of equipment; construction tips and ideas; news from the World QRP foundation (an umbrella organisation of world clubs, constituted to promote and protect the interests of low power enthusiasts); details of QRP nets, awards, kits and contests and information about member's own activities.

One very active QRP club member is

Australian QRP

Peter, VK6BWI. This hobbyist from Witchcliffe, WA passed his Novice exam in August 1985. Since then he has excited the air waves with a variety of home built and converted equipment. The first was a CW rig using a 6GV8 valve. A converted 2-way AM radio putting out a 'massive' 15W on 3.580 and 3.560MHz has provided contacts of up to 300km.

To date his best QRP DX has been to span this continent, with a 4W signal on 80m CW. He regularly works across the 'Bight' using such a power level.

"Self satisfaction in contacting other amateurs using low power is my main interest in QRP," he said. A current project is the construction of a low power CW transmitter for 40 or 20m. Peter has already experienced the thrill of QRP DX on higher frequency bands when he borrowed a Yaesu FT7. With 10W CW on 20m to a longwire antenna, he worked stations in Japan and the USA. An American station using 100 times more power gave Peter a '569' signal report. The report in return was 579!

This WA-based QRP advocate hopes that 3.5795MHz will eventually be recognised and used by Australian amateurs as a homebrewer's technical frequency. Crystals ground precisely to this frequency (the colour subcarrier used for American colour TV) are available through many retail outlets across the country.

The Westlakes Amateur Radio Club in Sydney used this same crystal as the centrepiece of a QRP club project. The tiny transmitter aroused considerable interest in this specialised niche of amateur radio. Further interest in NSW has come from the Wednesday night QRP Net operated by VK2CWH at 0900Z on 3.529MHz.

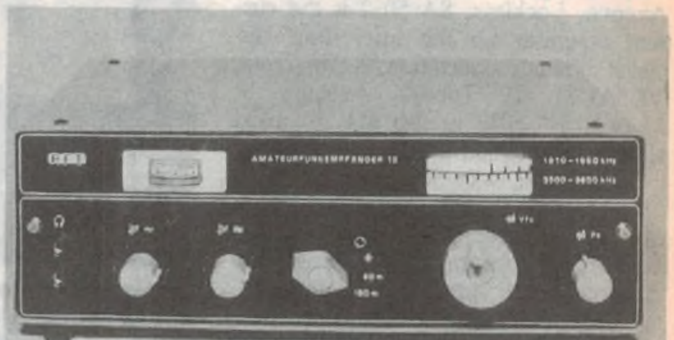
There are over two dozen members of the CW Operators' QRP Club in NSW, who initially look for other low power stations on 3.560, 7.030, 14.060, 21.060 and 28.060MHz CW and 3.985, 7.285, 14.285, 21.385 and 28.885MHz SSB.

A "CQ QRP" on these recognised calling frequencies could herald a continent spanning contact with David, VS6VT in Hong Kong; Vit, UP2BFE in the USSR; Salin, VU2LID in southern India; Enzo, IK2HLB in Italy; Andy, WB2RZU in the northeastern USA or Rai, VK7VV in Hobart.

A 30+ year background as a trained wireless operator helped Rai to easily pass his Novice exam in 1977, although it didn't prepare him for the pursuit of a hobby within a hobby. "The decision for QRP involvement," he noted, " became very easy to make when listening one evening to two QRP operators. A station in Sweden was in contact with an Australian station; both were using Argonauts, a popular commercially manufactured QRP transceiver".

Rai's main station is still the Argonaut 509, but "as I also have many

Combining both physical fitness and QRP 'fox hunting', these Yugoslav amateurs enjoy another facet of amateur radio.



This low power German transceiver caters for a large number of QRP enthusiasts in Europe.

Many amateurs operating QRP, including the award-winning VK7VV in Hobart, have printed special QRP QSL cards.

home brew rigs – that are great fun to use – my operating time is not as great as it used to be, because of the time I spend home brewing. It is part of the intrigue of QRP," he said, "to be able to make contacts all over the world with very basic equipment that you have created yourself."

"Without doubt the most gratifying contact was in my early Novice days, when I worked CT2CH in the Azores on 21MHz with just 2 watts. I often use this contact as an example to prove that it is possible to literally work the other side of the world with flea power," said Rai.

Long distance, low power contacts no longer have overpowering appeal for the Hobart ham. In 1981 he was awarded DXCC QRPp Trophy number 29. (Rai was the first Australian amateur to receive such an award for confirming contact with 100 foreign countries using less than 5W of RF power.)

To date he has contacted 274 countries and territories on CW QRP. "The most enjoyable contacts nowadays," he said, "are the ones that conduct QRP both ways." His two-way QRP country total now stands at 77, so "there is still plenty of challenge left."

Rai has a little way to go before he is in front of an American QRP enthusiast, Ron W8ILC, who has confirming QSL cards for over 300 contacts with foreign countries. And all this with just 1W of SSB output – and, of course, a very good antenna.

Another American made ham headlines for QRP operation nearly 65 years ago. Using a total input power of 567 milliwatts, Major General Loren G. Windom (Windy), W8GZ, the inventor of the well known 'Windom antenna', is credited with contacting Adelaide station 5BG, some 10,000 miles away. His record of 1926 is an early DX achievement, although some spectacular records using far less power are being set almost daily.

For those wanting even greating challenges there is milliwatting, and even microwatting – the art of working DX amateur stations with output powers, respectively, in the order of .001W and .000001W. The only problem with such extremely low power levels is not the transmitting equipment, but finding super sensitive RF power measuring equipment.

Europeans have already set a number of records, with a current outstanding transcontinental contact made on just 43uW (microwatts) – or some 19,600 miles per watt! This is certainly a case for getting more for less! EA

Australian scientists are up with the leaders in

The race to make photonic IC chips

Scientists at the Telecom Research Laboratories in Clayton, Victoria are currently working at the forefront of international research into photonics technology. Among the latest achievements of the TRL team are tiny 'vertical' semiconductor lasers only a few tens of micrometres in diameter, with many advantages over existing types.

by JIM ROWE

It's fairly clear now that in the future, data processing and communications are likely to be carried out using light *photons*, just as much as with the electrons we've used to date. In fact photons may well become even more important, so that the newly-emerging technology of 'photonics' could easily grow in importance to rival electronics.

The reason for this expected dramatic growth in photonics lies in the fact that the world's information processing and communications needs are growing at an enormous rate – calling for processing capabilities and communications capacities that are already approaching the limits of conventional electronics technology.

Only light photons, corresponding to packets of electromagnetic energy at frequencies in the hundreds of terahertz (1THz = 1000GHz) seem to have the speed and bandwidth performance needed for the 'next generation' of communications networks and computers. That's why optical fibres are being used to replace copper telecommunications cables in most of the developed countries, and why lasers are quietly entering many of our homes, inside compact disc players. It's also why CD-ROM disks are becoming popular for computer data storage, offering as they do some 600 times as much storage capacity as a floppy disk of roughly the same size and material cost.

At present, photonics is very much in its infancy, with discrete opto-electronic devices such as lasers, optical modulators and photodetector diodes. However around the world a great deal of effort is going into the development of higher-level devices, such as *opto-electronic integrated circuits* or OEICs, which combine photonic and electronic elements together on the same chips to achieve the benefits of both.

Another goal is to produce *photonic amplifiers* which will amplify light signals directly, without having to convert them into electrical signals and back again. This kind of device would be ideal for the regeneration of signals in fibre-optic cables, for example.

Research into these and other areas of photonics is being carried out in a number of centres throughout the world, including AT&T's famed Bell Laboratories in New Jersey (see box). And Australian scientists are at the leading edge of this exciting new technology – particularly those at the Telecom Research Laboratories (TRL) in Clayton, Victoria.

Dr Peter Kemeny and his colleagues at TRL have recently developed a very tiny semiconductor diode laser in which the optical axis is vertical, with the output light emerging from the top. This makes the new laser not only easier to make and potentially cheaper than existing 'horizontal' diode lasers, but also more suitable for integration into OEICs. Its output is also in a form which can be coupled much more easily into optical fibres.

Dr Kemeny and the rest of the team, led by Dr Garth Price, have also achieved pioneering results with optical modulator and bandpass filter devices, using the same basic 'vertical' construction as the new lasers. Together with the new lasers these devices are expected to make a major contribution to the development of improved fibre-optic communication systems, and very likely the first OEICs as well.

Uni research grant

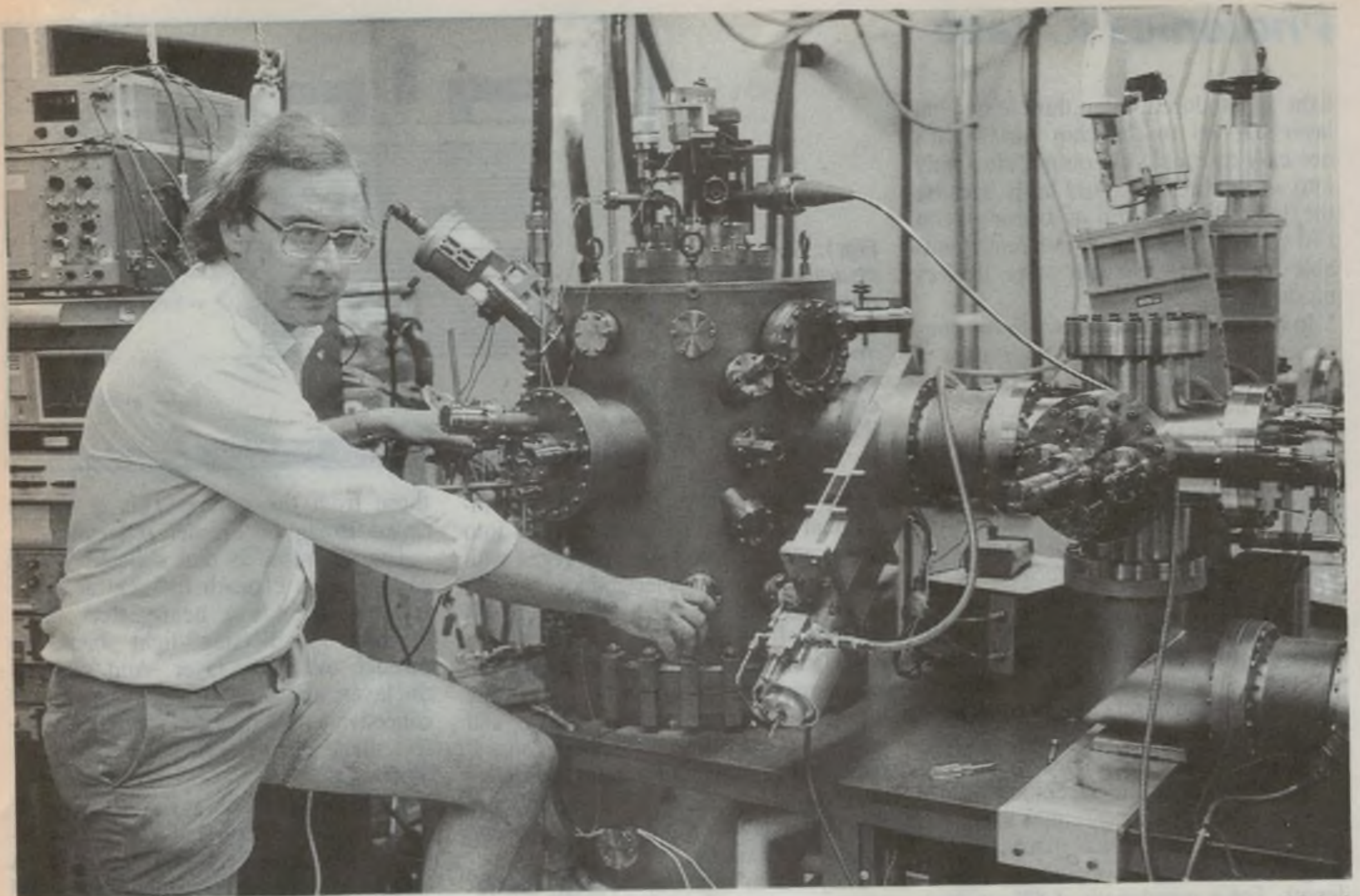
As well as carrying out its own research into photonics, Telecom Australia is also funding other local research into this important 'sunrise' technology. It has recently announced a grant of $900,000, spread over 3 years, to fund photonics research at the University of Melbourne's Department of Electrical and Electronics Engineering.

In announcing the grant, Federal Minister for Telecommunications and Aviation Support the Hon. Ros Kelly said "This research work will take Australia and the world towards one of the ultimate destinies of telecommunications – the totally optical network. But beyond that, the economic implications for the information technology industries are staggering. Just as the silicon chip has been the catalyst for an information explosion in our time, the gallium arsenide chip of photonics technology will spark an equally significant revolution in the closing years of our century."

University of Melbourne Vice-Chancellor Professor David Pennington described Telecom's support as a major contribution to the advancement of Australia's scientific prowess:

"Telecom Research Laboratories have already captured an early international foothold in this visionary area of scientific endeavour", he noted. "Telecom can be commended on its foresight in recognising a crucial research area at an early stage of its development. Australian industry will one day thank Telecom for its keen appreciation and support of technologies which have high commercial potential."

The University's research effort will be directed by Dr Rodney Tucker, recognised as a world authority on the



John Dell, one of the Telecom Research Labs team members, with the TRL molecular-beam epitaxy system which is used to grow the multi-layer wafers for the new vertical lasers.

new technology, who has most recently been engaged in photonics research at AT&T's Bell Labs in the USA. Dr Tucker is an Australian, and in fact an honours graduate of the University. He is returning to take up a Chair at the Department of Electrical and Electronics Engineering, directly responsible for the photonics research.

The University of Melbourne research effort is expected to focus initially on discrete opto-electronic devices such as lasers and detectors. However sometime after 1993 the team is expected to progress to the development of OEICs, and hopefully to pure photonic ICs by around the end of the century.

But enough about the future. Let's look a little more closely at the new vertical-cavity surface emitting semiconductor laser which Dr Kemeny and his associates have just developed, to see how it works.

TRL laser operation

You may recall from basic theory that two things are generally required in order to produce a laser: (a) an 'active' region, in which energy is effectively stored, but accessible to produce light amplification by means of *stimulated emission* of further light; and (b) a system of *positive feedback* which provides sufficient gain to overcome the losses, and produce an overall optical gain of greater than unity. Usually this positive feedback is provided by an optical resonator system.

Broadly speaking, in semiconductor junction lasers the active region is a heavily doped gallium arsenide P-N junction, conducting a fairly heavy current. This means that in the junction region, there are high concentrations of both electrons and holes – producing a carrier 'population inversion'.

It is this population inversion which represents the stored energy, as each electron-hole pair is capable of recombining to produce a light photon, and such a recombination can be triggered off by another passing photon. In other words, stimulated emission can occur.

In conventional junction lasers of the kind used to date, the P-N junction is basically flat, horizontal and parallel to the surface, formed by a traditional process such as epitaxial growth. This means that the primary plane in which lasing can occur is also parallel to the surface.

To achieve the positive feedback needed for an overall gain of greater than unity, two opposite edges of the junction are 'cleaved' along the same basic cleavage plane of the GaAs crystal, producing flat end surfaces at 90° to the active junction region, and accurately parallel to each other.

Because of the different refractive indices of GaAs and air, these flat ends form mirrors, reflecting a significant proportion of the light back inside the junction. And together the two parallel mirrors form what is called a *Fabry-Perot resonator*, which achieves the necessary degree of optical positive feedback to produce continuous lasing.

This type of laser obviously works, but it has a number of shortcomings. It is relatively expensive to make, because the cleaving process required to produce the accurately parallel end mirrors is quite critical. It cannot be done as part of the normal semiconductor fabrication process, but more or less 'manually' afterwards. And the devices cannot be tested before the cleaving is done, because the mirrors are essential for device operation. Hence the overall device yield is fairly low.

Another problem is that because the

Photonics IC race

light is produced in a thin horizontal layer parallel to the chip surface, it's not easy to couple the output efficiently into an optical fibre. And lastly because the laser depends for its operation on two parallel edges, it is not really suitable for integration with other devices inside an IC.

In contrast with this conventional construction, the new TRL laser uses a 'vertical' construction, so that light is emitted from the top of the device and orthogonal to the surface (i.e., at right angles to both X and Y axes). Paradoxically, this is achieved using a structure consisting completely of *horizontal* layers, all of them fabricated on-wafer using the process of *molecular beam epitaxy* (MBE).

Fig.1 shows the basic idea. On the basic gallium arsenide (GaAs) substrate are grown a number of thin alternating layers of aluminium arsenide (AlAs) and GaAs, and these form both the active region and the resonator system.

The first 20 pairs of layers laid down on the substrate are carefully arranged to be each only an optical quarter-wavelength thick, at the operating wavelength. For a wavelength of 870nm, and taking the refractive indices into account, this corresponds to a thickness of around 73nm for the AlAs and 61nm for the GaAs. All of these initial 'lower' layers are doped with silicon, producing N-type material.

After growing these layers another single layer of undoped 'intrinsic' GaAs is grown, in this case either a single *half-wavelength* thick or an integral multiple of this figure. This layer forms the laser's active region.

On top of this is then grown another sequence of alternating quarter-wavelength layers, again AlAs and GaAs but this time only about 16 pairs. Also the layers are now doped with beryllium (Be), to produce P-type material.

Next a heavily-doped P-type GaAs layer is grown on the top, to assist in the formation of the top ohmic electrode. Then a layer of silicon dioxide SiO_2 passivation is added, and etching used to produce windows for the deposition of chromium and gold to form the upper ring electrodes. Layers of nickel, germanium and gold are also deposited on the rear of the substrate, to form the lower ohmic electrode.

A central circular hole is also etched in the SiO_2, to produce the light output window. Finally the wafer is etched away all around the basic laser structures, to produce 'mesa' shapes. The individual devices can then be cut into chips, and mounted into packages with connections to each electrode.

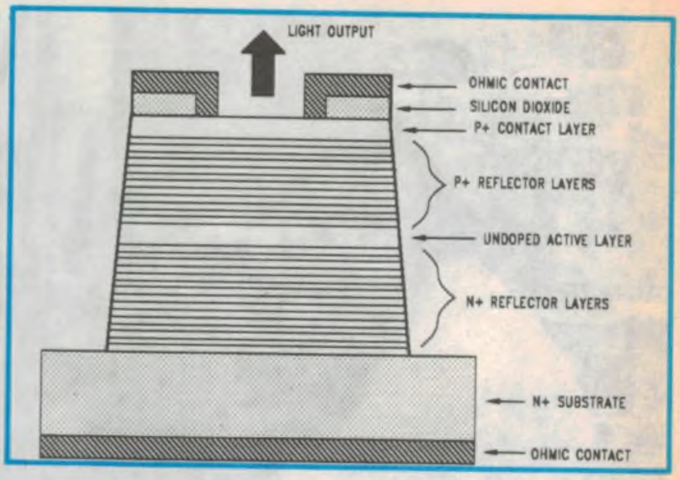


Fig.1: The structure of the new 'vertical' diode lasers invented by Dr Peter Kemeny and produced by the TRL team.

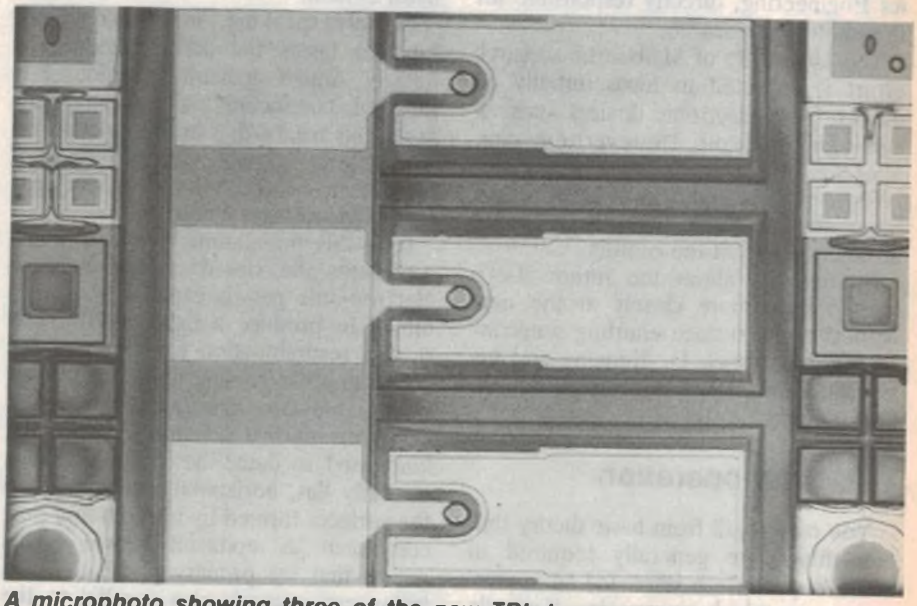
As you can see, the new laser still consists of a P-N junction diode, with a central intrinsic region which forms the active region of the laser. However the P-type and N-type regions above and below this region are effectively 'sliced' into many thin alternating layers of AlAs and GaAs, and it is actually these alternating layers which form the laser's optical resonator.

They act in this way because the refractive index of GaAs is *high* at the wavelengths involved, while that of AlAs is *low*. This causes a relatively high degree of reflection at the interfaces between the layers. And because the thickness of each layer is deliberately made equal to a quarter-wavelength, allowing for the different refractive indices, the reflected waves from each interface will be *in phase* with those from the others. This is usually called 'Bragg' or 'Fresnel' reflection.

The net result is that collectively, all of the layers beneath the central active layer behave as a near-perfect plane mirror – reflecting light back up through the active layer. And similarly the layers above the active layer also act collectively as if they too are a near-perfect plane mirror, reflecting light back down again.

So above and below the active layer we have two 'distributed' but highly efficient optical reflection systems, each orthogonal to the vertical axis – and hence parallel to each other. In short, we again have the necessary Fabry-Perot optical resonator, to produce positive feedback.

The advantages of this new laser structure are quite significant. For a start all of the components for the device are fabricated together on-wafer, producing complete devices which can be tested before they are cut apart into



A microphoto showing three of the new TRL lasers, on a wafer. The actual lasers are the small circular areas at the ends of the centre electrodes.

chips. This should ultimately reduce the cost of laser diodes quite dramatically.

Because the optical reflectors are grown rather than being produced by cleaving, they are also much less critical. It is much easier to make them truly flat and parallel, giving a considerably higher reflectivity – around 99%, compared with less than 50% for the cleaved end mirrors of conventional laser diodes.

As a result of this higher reflectivity, the active region can be relatively *short* along the optical axis. This allows the use of lower current densities, for a given power output.

And of course since the optical output is from the top, and roughly circular in cross-section, it is relatively easy to couple the laser into an optical fibre.

Because the laser doesn't depend for its operation on cleaved edges, this makes it much more suitable for integration than the standard horizontal type. It also opens the way for complete arrays of lasers on a single chip, to produce higher outputs than is currently possible.

In addition to producing lasers using this 'vertical' structure, the TRL group has also developed optical bandpass filters and modulators using virtually the same basic structure. So all in all, it looks to be a very significant development in the race towards OEICs and true photonic circuits.

Fabrication

The carefully controlled thin epitaxial layers of GaAs and AlAs used in the new vertical lasers can be produced using either molecular beam epitaxy (MBE) or metal-organic chemical vapour deposition (MOCVD).

At present, the TRL group is using MBE, as TRL has one of the only two MBE systems in Australia. The other is at CSIRO's Division of Radiophysics in Sydney, as noted in last month's article on microwave and mm-wave GaAs devices.

MBE essentially involves 'spraying' the surface of the heated GaAs substrate with molecules of the various elements (gallium, arsenic, aluminium, silicon, etc.), in a high vacuum. The molecules are directed towards the wafer from heated 'effusion ovens', controlled by shutters. This system allows very accurate growth of crystal layers, virtually one atomic layer at a time – ideal for producing the thin layers needed for the TRL lasers and other optical devices.

One of the problems in producing the new laser is that it relies upon passing current through layers of AlAs, which is not a good electrical conductor unless it is extremely pure. In order to achieve the necessary degree of purity, the TRL group had to completely strip its MBE system down and rebuild it – a process which took around six months, according to team leader Dr Garth Price.

Summary

It will be very interesting to see how opto-electronic chips develop in the next few years. Hopefully the new vertical laser structure invented by Dr Kemeny and developed at TRL will play a key role in this development, demonstrating that Australian scientists and engineers are indeed able to make pioneering contributions to leading edge technology.

In closing, my thanks to Dr Garth Price, John Dell, Stephen Nason and Brian Donovan of Telecom Research Laboratories for their help in producing this article.

Other labs working on vertical lasers

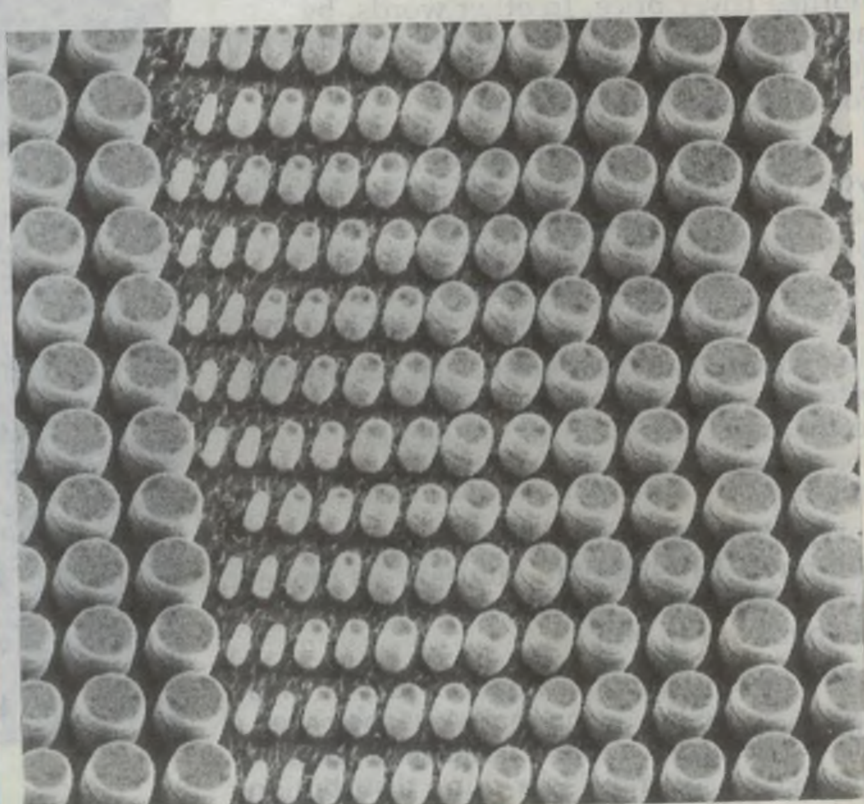
Work on vertical-axis semiconductor junction lasers is proceeding at a number of laboratories around the world, in addition to Australia's Telecom Research Labs in Melbourne.

Researchers at the Tokyo Institute of Technology in Japan produced working devices earlier this year, although these use a rather more complex construction than the TRL devices. The Japanese lasers involve two separate stages of epitaxial growth, and have separately evaporated mirrors rather than the grown layers of the TRL device.

Similarly and more recently AT&T's Bell Laboratories in New Jersey has also produced working devices, in this case using multiple alternating layers of GaAs and AlAs for the reflectors, as in the TRL device. However the Bell Labs devices apparently use some 600 alternating layers – roughly 10 times as many as those used by TRL.

The Bell Labs devices apparently measure between 3 and 5 micrometres in diameter, and are 5.5um high. They require an exceptionally low input current – typically around 1mA – making them very suitable for application in opto-electronic ICs and optical communications.

The picture shows an array of the Bell Labs devices, of varying diameter. According to AT&T one million of the tiny devices can be packed into a chip area of one square centimetre, although no details were given as to the way such an array would be fed with current. (Picture courtesy AT&T Australia)



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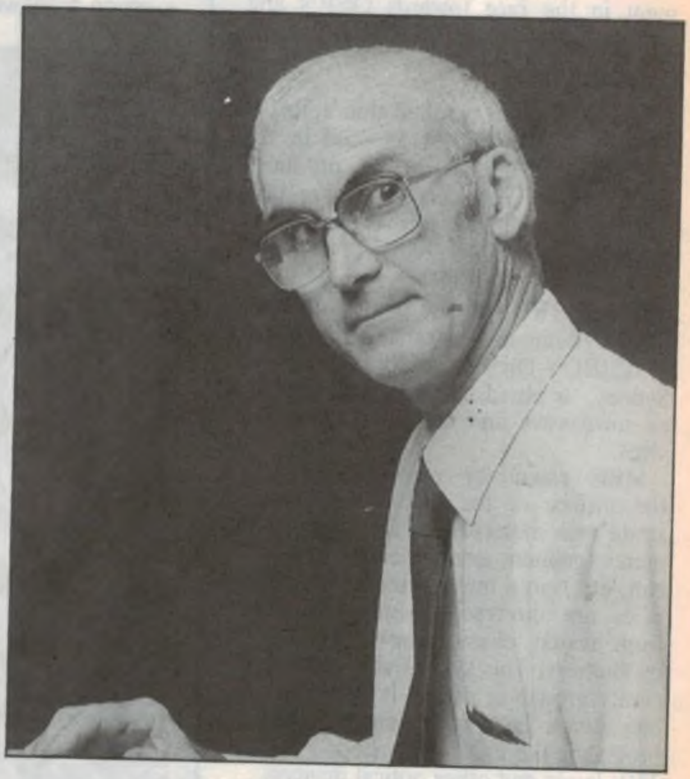

Jim Rowe

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The 'Maggie' — 1: Marconi's mysterious machine

Here's the first of two articles describing the development and operation of Marconi's 'magnetic detector', used to detect received signals in the old spark transmitter days. The second article will describe how to make a working replica of the original...

by PETER R. JENSEN, VK2AQJ

When in 1896 Marconi had taken the work of Heinrich Hertz and turned the latter's 1887 demonstration of the propagation of radio waves into a communication system, there were a number of important devices that made up the apparatus that he used.

One of these was described recently in this magazine – the Ruhmkorff or Induction coil. Although this had certainly been an element of fundamental importance, as in Hertz's experiments, there was another device that had not been employed in the 1887 apparatus, that made it possible for the system to be used as a means of communication. This was the radio wave *detector*. By 1896 such a device had come to be called a 'coherer' and clearly it represented the critical difference between what Hertz and Marconi had used.

In carrying out his experiments, Hertz had to rely on the presence of tiny sparks in the gap of a receiving loop to establish the truth of Clark-Maxwell's equations: a method suitable only for the laboratory. By comparison, the coherer allowed a bell to be rung as the radio waves were detected. To send radio waves in the Morse code and then have a bell sound the code at the receiving end was the key that Marconi used to unlock the door to communication.

However, even in the skillful hands of Marconi, the coherer proved to be a rather temperamental and insensitive device. Relying on the properties of metallic powder to 'clump' together or *cohere* in the presence of a radio frequency current, for six years it was indeed the key to Marconi's success.

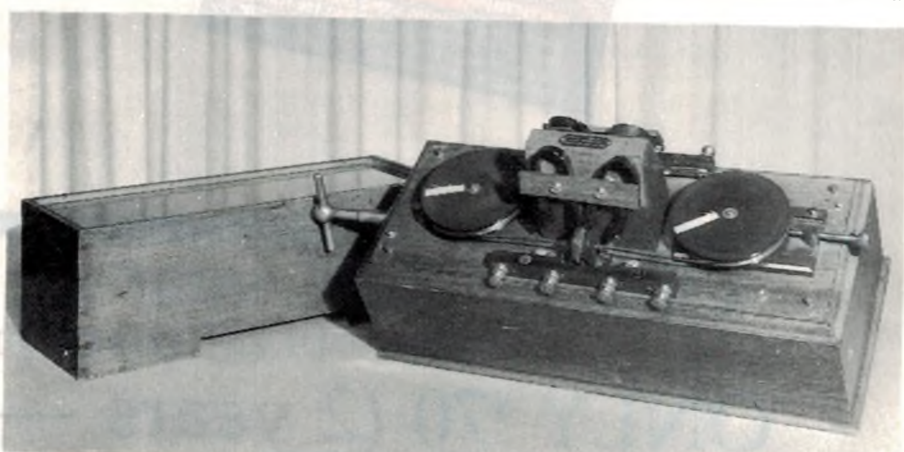
While such a device had existed for quite some time before Marconi's use of it, he was to bring it to as high a level of reliability as it was probably capable of achieving. Improved earlier by Professor Branly and then employed by Oliver Lodge in his experiments of 1894, its use by Marconi caused considerable controversy at the time. However for all that, it was to continue as the most important part of the Marconi system and was only displaced after the successful attempt in 1901 to send a signal across the Atlantic.

When Marconi went to America to conduct his experiments in December of 1901, he took a standard coherer set, together with its paper tape inker – hoping to make a record of the successful crossing of the Atlantic by a Morse signal. Fortunately he also took a very sensitive headphone and an Castelli self-restoring coherer, and it is reputed to be this detector with which the famous 'S's' were heard. By comparison the conventional coherer was quite unable to detect the signals from Poldhu in England, in any consistent fashion.

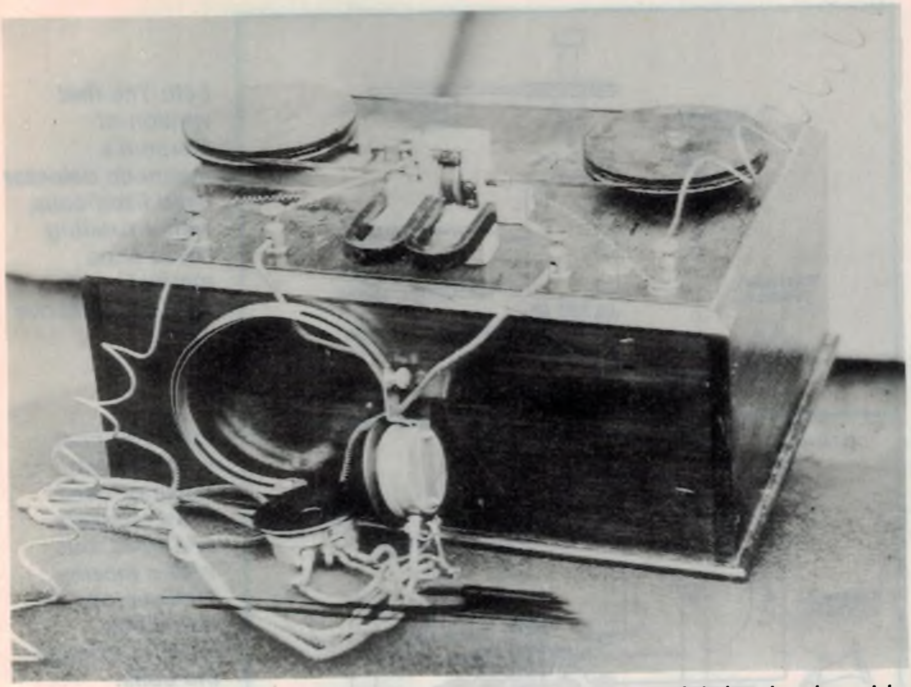
It seems that despite the pronouncement of his success, Marconi must have had considerable misgivings as to his capacity to establish a reliable link across the Atlantic. In February of 1902 he conducted a series of tests of long range communication on the *S.S. Philadelphia*, and managed to achieve reception at up to 1550 miles from Poldhu at night. He also discovered that in the daytime the range of reception was dramatically reduced.

Returning to England in April 1902, Marconi was evidently determined to discover a more reliable detector than the coherer which had proved so unreliable in Newfoundland at the Signal Hill experiments.

Spurred on by a determination to make the America to England connection a viable reality, Marconi, when he had returned to England in April went into seclusion for the best part of a month. During this time he was busily engaged in his laboratory at the Haven Hotel at Poole, and at the end of that



A well-preserved example of a production model 'Maggie', as made by Marconi's company for use in ships and land stations.



Marconi's original prototype of the magnetic detector, which he developed in 1902. It was the standard detector until 1914.

As described in earlier articles in this magazine, the development of an interest in the early period of the development of wireless telegraphy has led me into the construction of a number of 'Spark Wireless' projects. The most recent project has been to create a replica of the Maggie.

The purpose of this article is firstly to describe how the Maggie worked and secondly to reveal how its early users *thought* it operated, in an electro-magnetic sense.

In a second article the mechanical and electro-magnetic elements of the replica will be discussed, together with the presentation of construction details and diagrams.

To describe the principle upon which the Maggie operated, perhaps the best place to turn is to the writings of its inventor, Marconi himself. In his patent application of May 1902, in his usual uncomplicated and lucid style, Marconi said the following about the operation of the detector:

This invention is based upon the discovery that a core or rod of magnetic material, which is not sensibly affected by high frequency oscillations or Hertzian waves under ordinary circumstances, becomes sensitive to them when placed in a varying or moving magnetic field.

Working on this principle, in the event, Marconi developed two different detectors, which can be seen in the accompanying photograph taken in the Science Museum in South Kensington,

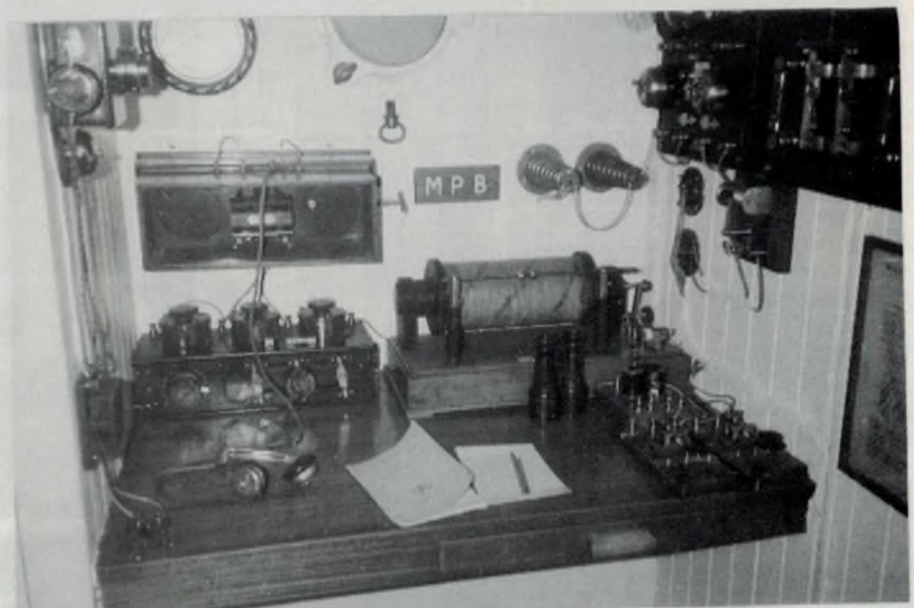
time he had developed a completely new detecting device. This was based on some earlier work by the well known scientist Ernest Rutherford, and Marconi called it the *magnetic detector*. Later it was more commonly and more affectionately known as the 'Maggie'.

A strange mechanical and magnetic device that was little understood by the scientific community for the best part of thirty years after Marconi invented it in 1902, the Maggie was to perform very much as it's inventor had required, being reliable and simple in operation. Also it was somewhat more sensitive than the coherer that it was intended to replace.

It was not only to allow the establishment of the Atlantic communications link, but from 1902 until about 1914 was the standard detector on all ships supplied with the Marconi apparatus. By 1913 it is known that of the 435 ships and 30 shore stations that used Marconi's apparatus, almost all of them used a Maggie as the detector.

In the end the principal reason that the magnetic detector became obsolete was that it was not compatible with the new form of continuous wave propagation that was being developed, using vacuum tubes. It is also true that it was not as sensitive as the crystal detectors which were developed during the 1900's. However, whatever it lacked in this respect it more than made up for in rugged simplicity and reliability.

Evidently in a ship at sea such characteristics were of extreme importance but even more so, in a warship which was firing its guns, it was essential to have a device which was not sensitive to vibration and would not cease functioning as would a 'cat's whisker' crystal detector. Also of considerable benefit to the marine operator was that, because of the electrical ruggedness of the Maggie, it was possible to use the system known as 'break-in' for communication. When the Maggie was replaced by other forms of detectors after 1914, 'break-in' was not to reappear until a considerable number of years after.



A typical ship's wireless room of 1912. Note the magnetic detector on the rear wall to the left, with the transmitting induction coil on the right.

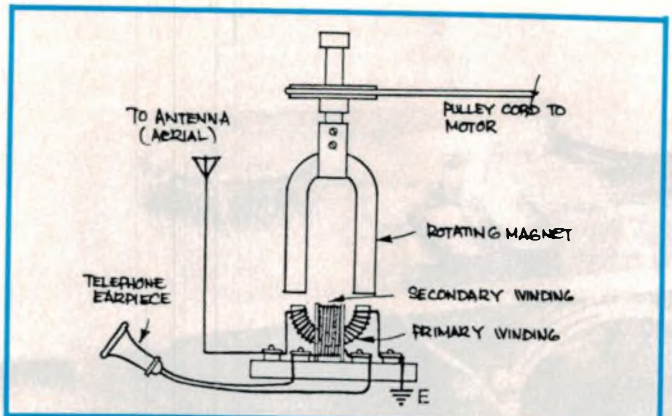
The 'Maggie'

London. Referring to these together with the two diagrams should make the different forms of magnetic detector easy to understand. As it turned out it was the machine which used the moving band of fine iron wires that was ultimately put into commercial production, at the plant at Chelmsford to the North East of London.

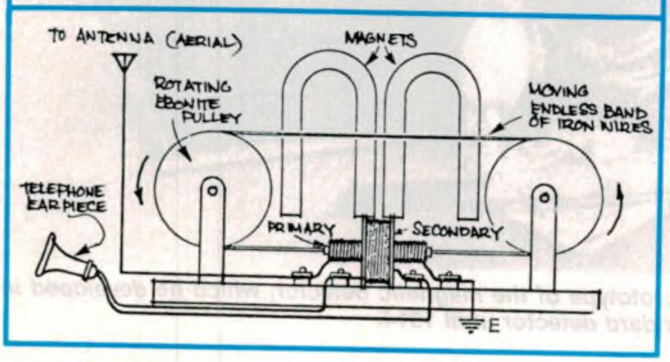
At a much later date and for the benefit of Marconi Marine Operators, the Company produced a handbook written by one of its staff, J.C. Hawkhead. In this publication a much more elaborate description of the operation of the Maggie is given, reading as follows:

In this instrument a band of stranded soft iron wire is kept moving round two insulated pulleys. This band passes in front of the poles of two permanent horseshoe magnets. Now the particles of iron become small magnets under the influence of the lines of force, and as the band is moving it has the power to drag the lines of force along in the direction of its motion.

As the particles of iron pass from the influence of a north pole to that of a south pole, the direction of magnetism is changed. But this change in magnetism does not take place in time with the change in the force producing it. That is to say the particles do not change their magnetism until some time after they have passed the point where the influence of the opposite pole is being exerted.



Left: The first version of Marconi's magnetic detector used fixed coils, with a rotating horse-shoe magnet suspended above them.



Left: The final version of the detector used fixed magnets and coils, but with a moving endless loop of iron wires passing through the coils.

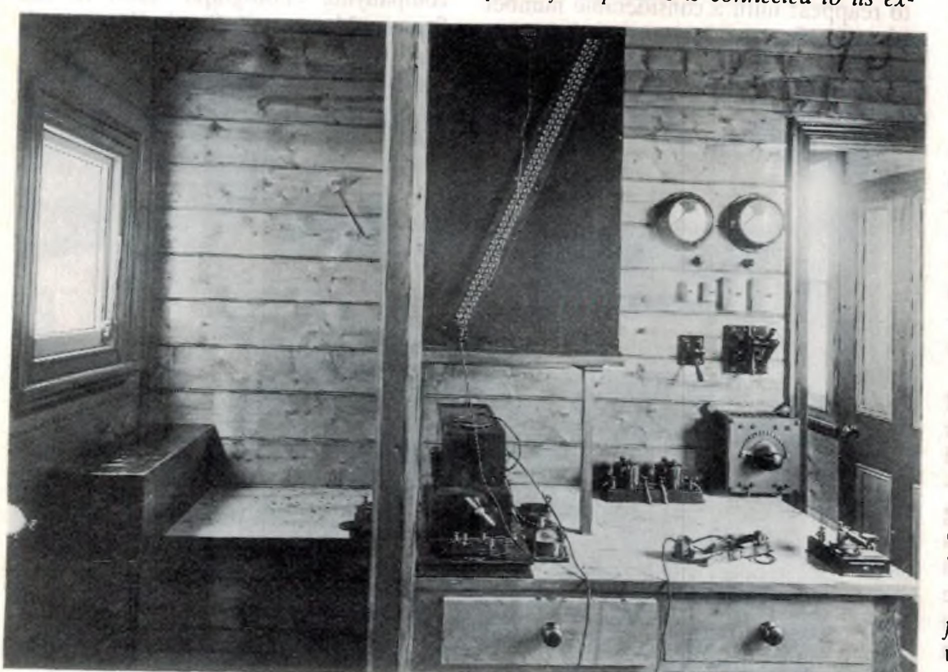
If an oscillating current be passed through a coil of wire wound round the moving band, where it passes in front of the magnets, it has the effect of causing the lag in magnetism to disappear. Such a coil is wound on a small glass tube as shown – and the ends of this coil are connected to the elevated conductor and earth respectively.

A second coil of a much greater number of turns is wound over the first and a pair of telephones is connected to its extremities. When the transmitting station sends out a train of waves, oscillating currents are set up in the receiving aerial, which pass through the primary coil and cause a sudden change in the state of magnetisation of the moving iron band. This change induces a current in the secondary, which passes through the coils of the telephones and causes a vibration of the diaphragm.

Thus just as long as sparks take place at the sending station, corresponding changes will be taking place in the magnetism of the moving band and the diaphragm will be kept in continuous vibration. If the sparks be made for long or short periods representing dashes and dots of the Morse code, sounds of corresponding duration are heard in the telephones.

Somewhat earlier than the Hawkhead description was produced, the Royal Navy, at its experimental station *H.M.S. Vernon*, had made a careful study of the operation of the Maggie. Apart from describing its operation in somewhat similar terms to the Handbook description, the Naval personnel noticed a particular characteristic of the Maggie which distinguished it from other, later, rectifying detectors. As they reported:

The magnetic detector is primarily influenced by the amplitude of the first wave of a train of oscillations and the duration or persistency of the waves has comparatively little effect in increasing the strength of the signals.



Interior of the Devonport wireless station in 1906. The magnetic detector is visible in the centre, end-on and with its winding handle to the front.

Examples of the two different kinds of Marconi magnetic detector, on display at the Science Museum.

This correct appreciation of the manner of operation of the Maggie explained why it was well suited to the reception of spark discharges, with the energy concentrated in the initial burst of waves and with relatively low mean power output. It also pointed to its inappropriate characteristics for receiving continuous waves, as supplied by a valve. Finally it demonstrated the general similarity in operation of the Maggie to the older device that it superseded, the coherer.

Later this Naval appreciation served as the basis of a 'secret' publication, The Wireless Telegraphy Manual of 1917 (but probably based on a previous volume of 1912) which did not become public until 1950.

While such expositions may appear straightforward enough in 1989, scientists of this early period found it impossible to describe the action that was occurring in terms other than the process of hysteresis, where a lag in the magnetisation of an iron core is to be observed when a current is applied initially. Further when the current is removed the magnetic field collapses at a slower rate.

Because the Maggie depends for its operation on the time-varying spatial distribution of magnetisation, while the hysteresis loop involves the spatial average of the magnetisation, taken over the entire piece of material, it is clear that an inappropriate model was frequently used to describe the process after 1902.

As observed by T.H. O'Dell, it was over 20 years before the output of the Maggie was adequately described by Barkhausen, and thereafter was known as 'Barkhausen noise'. Further, O'Dell claims that an understanding of magnetic domains and domain dynamics, which is necessary for a complete description of the workings of the magnetic detector, was not available until 1931.

As with the original invention of Wireless Communication in 1896, one can see the magnetic detector is another good example of Marconi operating as a 'systems' engineer, to make a new device perform a task that the scientific community was unable to describe in any substantial fashion. As always he worked in the manner of many systems engineers and radio amateurs who came after, by a process involving ten percent inspiration and ninety percent perspiration.

In the next article a description of the mechanical operation of the Maggie will be presented, together with a description of the steps involved in creating a working replica.

(To be concluded)

Using Spreadsheets in electronics calculations

Computer-based spreadsheet programs have been around for many years, but most electronics people see them as tools for accountants and managers; certainly not engineers or technicians. But there's certainly no rule that says spreadsheets are for financial wizards only. Properly applied, they make lovely 'electronic scribble-pads' for working out all sorts of interesting things, or simply for storing useful information.

by TOM MOFFAT

A spreadsheet, in case you didn't know, is simply a piece of paper ruled across and down into rows and columns. There may be labels or numbers along the top and down the side to identify the rows and columns. The little box formed where a row and a column intersect is called a 'cell'.

You can write numbers or words in the cells. This arrangement is usually contained on a page in some kind of ledger book, hence the usual financial connotations of a spreadsheet. We all have mental images of the old-time accountant, sitting at his high bench, wearing his green eyeshade, spending endless days adding up all the rows and columns in the ledger book to work out if his company is going broke.

The computer spreadsheet is the modern equivalent of the ledger book. The computer screen is ruled off along the top and down the side, and labelled – generally with letters A, B, C, etc. across the top, and numbers down the side.

Each intersection, or cell, can be used to store information. But now you don't have to write it in a tiny little box, you can store words, or numbers, or quite complicated formulas in each box. And the real power of the computer spreadsheet comes from the fact that **you can include numerical results, calculated in other cells, as part of the formula in a cell you're working on.**

	A	B	C	D
1	1	2	3	6
2	4	5	6	15
3	7	8	9	24
4				45

Fig.1: World's smallest spreadsheet!

Let us illustrate. The world's smallest spreadsheet is shown in Fig.1. If we labelled the columns across the top A, B, C, and D, and the rows down 1, 2, 3, and 4, we would see that the value in cell D1, (6), is the sum of the numbers in A1, B1, and C1. Same goes for the next row down, and the value in D2, and again in D3. Finally all the numbers in column D are added together for form the value in D4 (45).

In the top row, the first three cells are just numbers, entered by the user. But the forth cell, D1, actually contains a formula: A1+B1+C1. Similarly D2 would contain A2+B2+C2, and D3 would contain A3+B3+C3. And cell D4 contains a formula for the sum of all the rows: D1+D2+D3. So the formula in D4 is working with the results from the formulas in D1, D2, and D3.

You can see that changing any of the numbers in the area between cells A1 and C3 will cause the answer in D4 to change. (A1:C3 is called a 'range' of cells.) If our old-time accountant changed a cell, he would then have to re-work his sums across, and then down. But the computer spreadsheet makes all the changes automatically, in a flash! If you changed the first cell from a 1 to a 2, you'd see the screen go flickety-flick and 46 would suddenly appear in cell D4 where 45 was before.

The computer spreadsheet is usually operated so that some cells contain formulas, but what you actually see on the screen is the numbers generated by the formulas. However you can change the spreadsheet to show you the formulas if you want, as when you are designing a spreadsheet.

So what's all this good for, you say! Well, here's a simple example: I have a computer spreadsheet set up to contain details of all the magazine articles I write. Picture it in your mind: information on each article occupies one numbered horizontal ROW. Each vertical COLUMN is set up to show one tidbit about the article in question. So I have Column 'A' arranged to show the filename under which the article's word-processor file is stored. The B column contains a short description of the article. Then in C comes the date it was submitted to the magazine. Column D shows the date the article was published. Note that so far we have only used the spreadsheet as a notebook to store text information.

Now we come to column E (the good part!), a number representing how much the article earned. Column F is the bad part, how much Paul Keating kept from it. Column G is a formula, the E entry minus the F entry, to calculate how much money I *actually made*, less tax. Finally at the bottom is the sum of all cells in Column G, which represents the total state of my miserable wealth at any given moment.

That example shows how part of the spreadsheet is storing simple text notes, and another part of it is storing num-

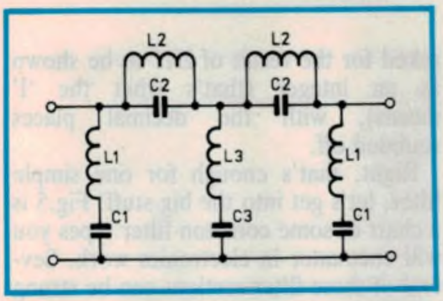


Fig.2: A band-reject filter circuit, from the ARRL Electronics Data Book.

bers and formulas. Now let's apply the same techniques to automate the design of some electronic circuits.

Number crunching

Spreadsheet programs are basically very similar in their operation, and the way their results are shown. The examples here were cooked up with a program called 'SuperCalc' which is a very common and easy to use package. I've been using SuperCalc both in its CP/M and MS-DOS implementations for many years. I've tried some of the really flash and expensive ones like Lotus, but I just keep coming back to good old SuperCalc. It's simple, reliable, and cheap, and now it's even being bundled with some package-deal computer purchases.

If you wind up with an 'unwanted' copy of SuperCalc, consider yourself fortunate. It's going to be very useful. Users of other spreadsheets should find the examples given here are compatible with their systems; the techniques used are very fundamental – there are no special tricks.

Now contemplate Fig.2. This is a circuit for a band-reject filter, taken from the ARRL's *Electronics Data Book*. The filter is designed to reject a whole chunk of the radio spectrum, while letting frequencies outside its target area pass unhindered. To build one of these filters you must know three things: the lower and upper limits of the frequencies you want to attenuate, and the impedance of the circuit it is to connect into.

This example has been designed to attenuate signals from nearby broadcast band transmitters, which would tend to overload the front end of a sensitive communications receiver. It's meant to be inserted into an antenna line of 50 ohms impedence. Any city-dweller with a modern solid-state radio would probably find this circuit very useful.

A fair amount of number crunching is required to design this filter. Without the spreadsheet to help, you would spend a lot of time thrashing about with a pocket calculator. Or if you were a friend of the accountant mentioned above, you would probably have used a (horrors!) slide rule. I must admit I've been there and done that, and to design that filter with a slide rule could eat up a good part of an afternoon.

But with the spreadsheet, you just type in the lower and upper frequencies and the impedance, blink your eyes, and all the appropriate places on the screen are filled in with the correct values.

We will now look at some spreadsheet examples, using SuperCalc. We won't detail the exact commands needed to generate these spreadsheets; you'll find those in the instructions for your own program (if all else fails...). Some spreadsheet programs use pull-down menus, others use a command line, but the results in the end are basically the same.

	A	B
1	BAND REJECT FILTER	
2		
3	Lower frequency F1 (MHz)	.55
4	Upper frequency F2 (MHz)	1.6
5	Impedence (Ohms)	50
6		
7	L1 (uH)	15.14
8	L2 (uH)	9.50
9	L3 (uH)	7.57
10		
11	C1 (pF)	1900
12	C2 (pF)	3029
13	C3 (pF)	3799

Fig.3: A simple spreadsheet to work out values for the filter of Fig.2.

Fig.3 shows what the band reject filter spreadsheet looks like under SuperCalc, exactly as you would see it on your computer screen. You'll notice the 'A' column has been widened a bit, to make room for some nice labels.

To work out a filter design you move the cursor to cell B3, type in the lower frequency in MHz, and then move down to B4 and type in the upper frequency. In this case the numbers define the AM broadcast band from .55 to 1.6MHz, the frequencies you want to get rid of. Finally you type in the nominal impedance of the antenna system and transmission line.

Purists will point out that if the antenna is cut for the short wave bands, there's no way it will be 50 ohms for broadcast band signals. This is true, but a lot worse things are going to happen to the BC signals before they get through the filter! There, that should have stopped a few letters...

Every time you type a new value into cell B3, B4, or B5, you will notice all the other numbers go shuffle-shuffle to end up with new values. Every time you change anything, the spreadsheet recalculates the whole works. (Your program will have a command to stop this if you prefer, so recalculation takes place only when you specifically ask for it.)

With the appropriate values entered into the three 'input' cells, the 'output' cells now contain the correct values for the three coils and the three capacitors needed to make the filter. You will notice that the inductors are shown to two decimal places, but the capacitor values have the decimals rounded off. (Where are you going to get a 1900.02pF capacitor?) The spreadsheet program allows you to format number displays in many different ways.

The capacitor values called for are not standard values, so to build a practical filter you are going to have to fiddle a bit. You could make C1 1800pF, C2 2700 or 3300pF, and C3 3900pF, and you'd be pretty close. You might have to adjust the coil values slightly to compensate.

Of course you could use another spreadsheet to do this for you. You could arrange it to input the high and low frequencies and the impedence, *and* use the capacitor values you specify. It would then calculate only the L's. This would of course require some changes in the formulas.

Speaking of formulas (formulae?), have a look at Fig.4. This is a listing produced by making SuperCalc show the formulas in its cells, instead of just the calculation results. You can type these formulas straight into your own SuperCalc, and probably most other spreadsheet programs as well.

You'll notice the entries for some of the cells begin with quotation marks ("). This signifies that the cell contains text, such as a label for an adjoining cell. Some of the text cells are tagged 'RTR', indicating that the cell has been

```
SuperCalc Ver.  1.05

          BAND REJECT FILTER
A1        = "        BAND REJECT FILTER
B1        = "
A3        = "Lower frequency F1 (MHz)
B3        = .55
A4        = "Upper frequency F2 (MHz)
B4        = 1.6
A5        = "Impedence (Ohms)
B5        = 50
A7 RTR    = "L1 (uH)
B7 $      = .318*B5/(B4-B3)
A8 RTR    = "L2 (uH)
B8 $      = 2*.0796*B5*(B4-B3)/(B3*B4)
A9 RTR    = "L3 (uH)
B9 $      = B7/2
A11 RTR   = "C1 (pF)
B11 I     = 7.96E4*(B4-B3)/(B3*B4*B5)
A12 RTR   = "C2 (pF)
B12 I     = 3.18E5/((B4-B3)*B5)/2
A13 RTR   = "C3 (pF)
B13 I     = 2*B11
```

Fig.4: A listing showing the formulas used in the Fig.3 spreadsheet.

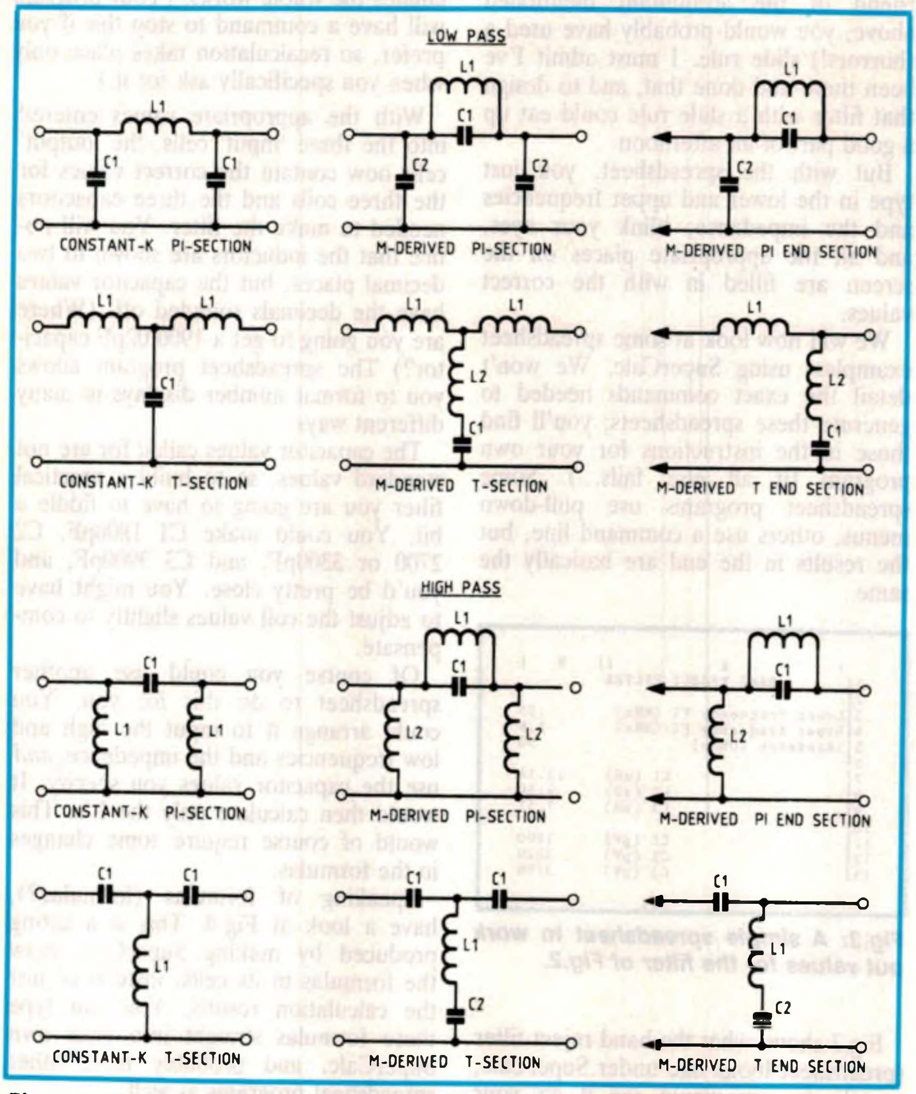


Fig.5: Common LC filter sections used in electronics work.

formatted for right-justified text (looks prettier!). Cells B3, B4, and B5 contain the latest numbers you typed in when using the spreadsheet.

Now to cell B7, which contains a formula. You will see that the contents of other cells are being used here. First B3 is subtracted from B4 (the lower frequency is subtracted from the higher frequency). Then the impedance, B5, is multiplied by 0.318. Finally the result of the multiplication is divided by the difference B4-B3. What you will see on the screen is the result of all of this, and the dollar sign at the start of the entry shows that the display will be to two decimal places (we've actually asked SuperCalc to show it as dollars and cents).

Now if you look at cell B9, you will see that it is using the result of the calculation in B7, simply dividing it by two and then showing the result as dollars and cents to get two decimal places.

Also note cell B11. This shows a number '7.96E4' which has been entered in *scientific notation*. You can also ask your spreadsheet to express calculation *results* in scientific notation, if that suits your application. In this case we've asked for the result of B11 to be shown as an integer (that's what the 'I' means), with the decimal places rounded off.

Right, that's enough for one simple filter, let's get into the big stuff! Fig.5 is a chart of some common filter types you will encounter in electronics work. Several of these filter sections can be strung together to make a sharper filter, and in the case of the m-derived filters there are separate configurations for the middle bits and the end bits. You might want to photocopy the chart, cut it out, and stick it up on the wall near your workbench; it will certainly come in handy.

And would you believe, Fig.6 is the screen display of another spreadsheet. These filters are not 'band' types, so only one frequency is involved. This frequency is entered at B3, along with the the circuit impedance at B4 and the 'm' factor at B5. The 'm' is used in *m-derived* filters. Without going into a big involved explanation, it is sufficient to say that an m-factor of 0.6 is most commonly used. You can of course change it.

As you enter new input values, you will see changes taking place all over the spreadsheet. That is because the spreadsheet is calculating the required L and C values for every filter type in Fig.5, all in one go. The spreadsheet listing in Fig.7 shows that many of the filters use values derived from other filters, so the whole works is interlinked to a certain extent.

This interlinking can be very handy, but there are some pitfalls for the unwary. If you look at cell B8, you will see a formula. Cell B9 contains the same formula, although not divided by 2. So why couldn't B8 simply be B9/2?

The problem here is known as a 'forward reference'. As the spreadsheet

	A	B	C	D	E
1	IMAGE PARAMETER FILTERS				
2					
3	Frequency Fc (MHz) =	1.65			
4	Impedence R (Ohms) =	50			
5	Design parameter "m"	.6			
6					
7	LOW PASS	C1 (pF)	C2 (pF)	L1 (uH)	L2 (uH)
8	Constant K : PI section	1927		9.64	
9	Constant K : T section	3855		4.82	
10	m-derived : PI section	1028	1156	5.78	
11	m-derived : T section	2313		2.89	2.57
12	m-derived : PI end	2056	1156	2.89	
13	m-derived : T end	1156		2.89	5.14
14					
15	HIGH PASS	C1 (pF)	C2 (pF)	L1 (uH)	L2 (uH)
16	Constant K : PI section	965		4.82	
17	Constant K : T section	1930		2.41	
18	m-derived : PI section	1608		9.05	8.04
19	m-derived : T section	3216	3618	4.02	
20	m-derived : PI end	3216		4.52	8.04
21	m-derived : T end	3216	1809	8.04	

Fig.6: A spreadsheet which allows you to calculate values for any of the filter sections in Fig.5.

```
SuperCalc Ver.  1.05

A1 TR     = "IMAGE
B1        = " PARAMETER FILTERS
A3        = "Frequency Fc (MHz) =
B3 G      = 1.65
A4        = "Impedence R (Ohms) =
B4 G      = 50
A5        = "Design parameter "m"
B5 G      = .6
A7        = "          LOW PASS
B7 TR     = "C1 (pF)
C7 TR     = "C2 (pF)
D7 TR     = "L1 (uH)
E7 TR     = "L2 (uH)
A8        = "Constant K : PI section
B8 I      = 3.18E5/(B3*B4)/2
C8 I      =
D8        = .318*B4/B3
A9        = "Constant K : T section
B9 I      = 3.18E5/(B3*B4)
C9 I      =
D9        = D8/2
A10        = " m-derived : PI section
B10 I      = (1-B5'2)/(4*B5)*B9
C10 I      = B5*B9/2
D10        = B5*D8
A11        = " m-derived : T section
B11 I      = B5*B9
D11        = D10/2
E11        = (1-B5'2)/(4*B5)*D8
A12        = " m-derived : PI end
B12 I      = 2*B10
C12 I      = C10
D12        = D11
A13        = " m-derived : T end
B13 I      = C10
D13        = D11
E13        = 2*E11
A15        = "          HIGH PASS
B15 TR     = "C1 (pF)
C15 TR     = "C2 (pF)
D15 TR     = "L1 (uH)
E15 TR     = "L2 (uH)
A16        = "Constant K : PI section
B16 I      = 7.96E4/(B3*B4)
C16 I      =
D16 $      = .0796*B4/B3*2
E16 $      =
A17        = "Constant K : T section
B17 I      = 2*B16
C17 I      =
D17 $      = .0796*B4/B3
E17 $      =
A18        = " m-derived : PI section
B18 I      = B16/B5
C18 I      =
D18 $      = 4*B5/(1-B5'2)*D17
E18        = D17/B5*2
A19        = " m-derived : T section
B19 I      = 2*B18
C19 I      = 4*B5/(1-B5'2)*B16
D19        = D17/B5
A20        = " m-derived : PI end
B20 I      = B19
C20 I      =
D20 $      = D18/2
E20        = E18
```

Fig.7: A listing showing the formulas used in the Fig.6 spreadsheet.

sweeps through and recalculates after some input change, it does so working downwards from the top and from left to right. If cell B8 had the formula B9/2, it would need to use the result from B9. But B9 wouldn't have been recalculated yet; it would still have its previous value. So the answer in B8 would always be wrong.

This problem can be overcome by recalculating the spreadsheet *twice* for every change in input – but this is inconvenient and can be easily forgotten. So B8 is written to get its data only from cells that have already been recalculated. I suppose we could have written B9 as 'B8*2', doubling what had previously been halved. But this seemed to me to be an unclean way to produce good data, involving two extra calculations and two resulting inaccuracies.

Figs. 8, 9 and 10 illustrate another spreadsheet application I have used many times 'in anger'. It uses the application note design rules for the familiar XR-2211 phase locked loop chip to produce a complete frequency-shift keying decoder. The chip has found use in projects to decode weather facsimile, radioteletype, and Morse code, and was the basis of the 'Navimate' weather fax receiver sold extensively in Australia and overseas. The design parameters for that instrument came from the spreadsheet in Figs. 8-10.

```
  |           A                    ||        B  |
 1|
 2|XR2211 Phase Locked Loop Design
 3|
 4|
 5| Data Rate           (Bauds)              600
 6| Mark    Frequency (Hz)    [F1]          2400
 7| Space   Frequency (Hz)    [F2]          1200
 8| Centre Frequency (Hz)     [FO]          1800
 9|
10| Timing Resistor   (K)     [RO]            22
11| Timing Capacitor (uF)     [CO]      .0252525
12|
13| Loop Bandwidth    (K)     [R1]            33
14| Loop Damping      (uF)    [C1]      .0063131
15|
16| Data Filter       (uF)    [CF]          .005
```

Fig.9: Another spreadsheet, to work out values for the FSK decoder of Fig.8.

```
SuperCalc Ver.  1.05

A2      P= "XR2211 Phase Locked Loop Design
A5      P= " Data Rate           (Bauds)
B5       = 600
A6      P= " Mark    Frequency (Hz)    [F1]
B6       = 2400
A7      P= " Space   Frequency (Hz)    [F2]
B7       = 1200
A8      P= " Centre Frequency (Hz)     [FO]
B8      P= (B6+B7)/2
A10       P= " Timing Resistor   (K)     [RO]
B10        = 22
A11       P= " Timing Capacitor (uF)     [CO]
B11       P= 1000/(B10*B8)
A13       P= " Loop Bandwidth    (K)     [R1]
B13       P= B10*(B8/(B6-B7))
A14       P= " Loop Damping      (uF)    [C1]
B14       P= B11/4
A16       P= " Data Filter       (uF)    [CF]
B16       P= 3/B5
```

Fig.10: A listing showing the formulas used in Fig.9's spreadsheet.

To produce an FSK decoder design, you enter the data rate, mark and space frequencies, and then try out some standard resistor values. The spreadsheet does the rest. The XR-2211 is a very docile chip and the design rules actually work first pop! If you like to fiddle around with RTTY and/or fax, you'll find Figs. 8-10 very handy.

Pretty simple mathematics has been used in these examples; all we've done is straight arithmetic and raising numbers to a power. But most spreadsheets have quite extensive maths capabilities. Fig.11 shows all the functions the simplest versions of SuperCalc can handle. If you enter a number in A1, numbers will rattle down through the C column, showing the results of operations labelled in the B column. Some inputs will produce a message 'ERROR', while others will come up with '>>>>>>>>' which means the result has caused an overflow.

Now you should have a good idea of how you can make a spreadsheet program do automated design work. If you're studying electronics you will find it interesting to try all sorts of values for frequencies and impedances. Your results will be instantly shown, and some of the answers might be somewhat surprising. All in all it sure beats the old slide rule!

```
  ½   A   ½½    B   ½½    C    ½
 1½      .9      SQRT .9486833
 2½               INT        0
 3½               ABS       .9
 4½               EXP 2.459603
 5½                LN -.105361
 6½             LOG10 -.045757
 7½               SIN .7833269
 8½               COS .6216100
 9½               TAN 1.260158
10½              ASIN 1.119770
11½              ACOS .4510268
12½              ATAN .7328151
13½                PI 3.141593
```

Fig.11: A listing of the maths functions available in Supercalc.

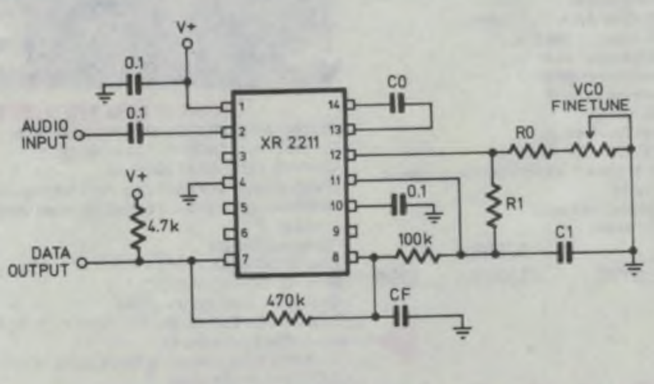


Fig.8: A phase-locked loop FSK decoder circuit using the Exar XR-2211 chip.

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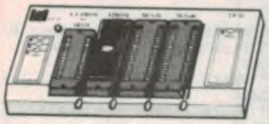

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WITHOUT CABLE

Supports 2 asynchronous communication ports. 50 baud to 9600 baud.

X18026....................$39

RS232 & CLOCK CARD

WITHOUT CABLE

Supports 1 asynchronous communication port. 50 to 9600 baud with Clock.

X18028....................$59

CLOCK CARD

X18024....................$49

PRINTER CARD

Parallel interface for Centronics printers.

X18017....................$29

GAMES I/O CARD

Features 2 joystick ports.(DB15)

X18019....................$29

MULTI I/O & DISK CONTROLLER CARD

This card will control 2 x double sided, double density drives, and features a serial port, a parallel port, and a joystick port or games port. It also has a clock/calendar generator with battery backup

X18040....................$99

I/O PLUS CARD

Provides a serial port, a parallel port and a joystick port, and even a clock/calendar with battery backup!

X18045....................$115

2 M/BYTE EXTENDED MEMORY RAM CARD

X18052....................$225

FLOPPY DISK DRIVE CONTROLLER CARD

These cards will control up to 2 or 4 double sided 360K IBM* compatible disk drives

For 2 Disk Drives

X18005....................$52

4 WAY DISK CONTROLLER

- PC*/ XT*/ AT* compatible
- 1.44 M/B, 1.2 M/B, 720K, 360K Drives

X18006....................$129

HARD DISK CONTROLLER CARDS

X18060 (XT*)....................$129

X18140 (AT*)....................$195

3.5 M/BYTE EXTENDED/ EXPANDABLE RAM AT* CARD

X18056....................$275

CASES

BABY AT* STYLE COMPUTER CASING

Small footprint. Features security key switch, 8 slots and mounting accessories

Size: 360(W) x175(H) x405(D)mm

X11093....................$99

IBM* XT COMPATIBLE CASE WITH AT* STYLING

Features security key switch, 8 slots, and mounting accessories

Size: 490(W) x 145(H) x 400(D)

X11091....................$99

TOWER COMPUTER CASING

Remount your computer to give it that professional look.

- Accepts XT, AT, Baby AT and 386 boards
- Horizontal full height hard disk drive mounting
- Room for 2 x3 1/2" and 2 x 5 1/4" floppy drives
- Full height HDD plus fan mount
- Size: 165(W) x 600(H) x 500(D)

X11105....................$325

ROD IRVING ELECTRONICS

SYDNEY: 74 Parramatta Rd. Stanmore 2048
Phone: (02) 519 3134
Fax: (02) 519 3868

MELBOURNE: 48 A'Beckett St
Phone: (03) 663 6151

NORTHCOTE: 425 High St.
Phone: (03) 489 8866

MAIL ORDER & CORRESPONDENCE:
P.O. Box 620, CLAYTON 3168
Order Hotline: 008 33 5757
(Toll free, strictly orders only)
Inquiries: (03) 543 7877
Telex: AA 151938
Fax: (03) 543 2648

All sales tax exempt orders and wholesale inquiries to:

RITRONICS WHOLESALE -
56 Renver Road, Clayton.
Phone:(03) 543 2166 (3 lines)
Fax: (03) 543 2648

ORDER HOTLINE 008 33 5757 (TOLL FREE)
STRICTLY ORDERS ONLY

POSTAGE RATES:

$1 - $9.99	$2.00
$10 - $24.99	$3.00
$25 - $49.99	$4.00
$50 - $99.99	$5.00
$100 +	$7.50

The above postage rates are for basic postage only. Road Freight, bulky and fragile items will be charged at different rates.

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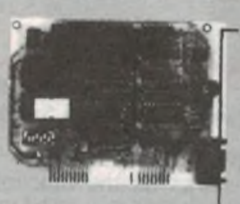


MIDI INTERFACE CARD - DS/401

The MIDI DS-401 Card is the PC standard MIDI interface that runs most popular PC music programs for sequencing, recording, composing, music printing, patch editing, music instruction and many other applications.

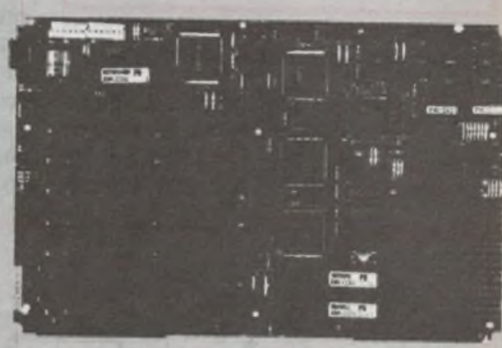
- Run all programs designed for the Roland MPU-401 architecture
- Socketed EPROM for easy user replacement
- 1/3 length (short) card will fit in any computer accepting standard expansion card, including laptops
- Including "Y" cable, external connector box to transport is unnecessary

X18164....................$195

286 NEAT MOTHERBOARD

- Processor: 80286-12, -16MHz or -20MHz (0/1 wait state)
- Co-processor: 80287 (optional)
- CHIPS & TECH NEAT chipsets
- 1-4MB dual RAM socket
- 1-4MB module RAM socket on board
- 640KB-384KB memory relocation
- Three 8 BIT expansion slots
- Five 16 BIT expansion slots
- Memory expansion to 8MB
- Supports EMS 4.0
- Page Interleave Technology
- BIOS: AMI or PHOENIX
- Hardware and keyboard switchable Clock Speed
- LED speed display
- Power Good Signal on board
- Baby size main board

- 16MHz X18090........$700
- 20MHz X18092........$895



386SX 16MHz MOTHERBOARD

- Processor: 80386SX-16MHz (0/1 wait state)
- Co-processor:80387SX-16 (optional)
- CHIPS & TECH NEAT chipsets
- (SMT) Surface Mount Technology for chipsets & CPU
- Supports up to 2MB on board, (Sixteen 44256 and Eight 41256 sockets)
- Three 8 BIT slots
- Five 16 BIT slots
- Memory Expansion Slot
- Optional 2-8MB memory card
- Supports LOTUS-INTEL- MICROSOFT (LIM) Expanded Memory Spec. (EMS) version 4.0
- Supports Page Interleave Mode using 100NS DRAM
- BIOS: AMI or PHOENIX
- Turbo Light and Hardware Reset connector
- Keyboard or Hardware Reset connector
- Power Good Signal on board
- Baby size main board

Catalogue No. X18094....................Only $900

NEW IBM* CARDS

ROD IRVING ELECTRONICS

COMPUTERS

BABY AT* COMPATIBLE COMPUTER! 2M/B RAM $2,195

- Final assembling and testing in Australia!
- 4 M/Byte Main Board, 2 M/Byte fitted
- Switchable 8/10/12 MHz
- 1.2 M/Byte Floppy Disk Drive
- 80286 CPU
- Colour Graphics Display Card
- 8 Slots
- Floppy & Hard Disk Controller
- Printer Card and RS232
- Keyboard
- 200W Power Supply
- Manual
- 6 Months Warranty
- Size: 360(W) x 175(H) x 405(D)mm

With 20 M/Byte Hard Disk.$2,195
With 40 M/Byte V.C. H.D....$2,395
With 80 M/Byte Hard Disk..CALL

IBM* XT* 640K RAM TURBO COMPATIBLE COMPUTER

Check these features and our prices. We're sure you'll agree they're exceptional value for money!

- Final assembling and testing in Australia!
- Fast TURBO Motherboard
- AT* style keyboard
- Tested by us for 24 hours prior to delivery!
- 8 Slot motherboard
- 12 months warranty!
- 150W power supply

640K RAM TURBO COMPATIBLE COMPUTER

2 x 360K Disk Drives, Multi-function Card, Colour Graphics, Disk Controller, 1 Serial, Parallel Port (Clock)..................$1,050

WITH 20 M/BYTE HARD DISK:
& single 360K Disk Drive..$1,450
& dual 360K Disk Drives...$1,600

WITH 40 M/BYTE HARD DISK:
& single 360K V.C. H.D......$1,775
& dual 360K V.C. H.D.........$1,925

RAM

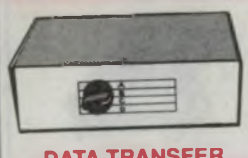
SUPER FAST DYNAMIC RAM

- 4164-120ns
U20832....................$4.50
- 4464-100ns
U20842..................$10.00
- 41256-80ns
U48262..................$12.30
- 41256-100ns
U48260........................$10
- 1MB-100ns
U48265..................$28.95
- 1MB-80ns
U48270..................$33.95

STATIC RAM

- 6116
U20950..................$5.50
- 6264-10
U20952..................$19.95
- 62256-10
U20954..................$39.95

I/O ACCESSORIES

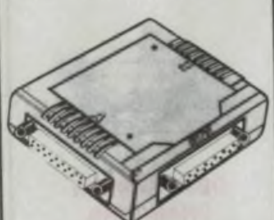


DATA TRANSFER SWITCHES

If you have two or four compatible devices that need to share a third or fifth, then these inexpensive data transfer switches will save you the time and hassle of constantly changing cables and leads around.

- No power required
- Speed and code transparent
- Two/Four position rotary switch on front panel
- Three/Five interface connections on rear panel
- Switch comes standard with female connector

2 Way RS232
X19120........................$59
4 Way RS232
X19125........................$79
2 Way Centronics
X19130........................$69
4 Way Centronics
X19135........................$79
RS232 2 X 2 Auto Switch
X19140........................$79
Centronics 2 x 2 Auto Switch
X19145........................$79



POCKET AUTO AB SWITCHES

- Pocket size, auto-scanning
- Allows 2 PCs to share one printer
- Serial model: MS-201 - Host-powered

X19150..................$79.95

POCKET AUTO AB SWITCHES

- Pocket size, auto-scanning
- Allows 2 PC's to share one printer
- Parallel model: MP-201 - Protocol transparent

X19155..................$89.95

CENTRONICS PLUG

- 36 Way Centronics Plug to 36 Way Centronics Plug

P19013..................$29.95

CL21 COMPUTER LEAD

- 25 pin D Plug to 25 pin D plug
- all pins wired straight through (removable terminals)
- Length 1.5metres.

P19007..................$36.95

CL23 COMPUTER LEAD

- 25 pin "D"plug to 25 'D'socket
- All pins wired straight through (removable terminals)
- Length 3 metres

P19012..................$49.95

DISK BOXES

DISK STORAGE UNITS

- 80 x 3 1/2" - Lockable
C16038..................$16.95
- 40 x 3 1/2 "- Lockable
C16035..................$14.95
- 40 x 3 1/2 " "Eclipse"
C16040....................$8.99
- 120 x 3 1/2 "- Lockable
C16039..................$21.95
- 50 x 5 1/4 "- Lockable
C16025..................$14.95
- 100 x 5 1/4 ""Eclipse"
C16042....................$9.95
- 100 x 5 1/4 "- Lockable
C16020..................$15.95
- 120 x 5 1/4 "- Lockable
C16028..................$19.95

MONITORS

20MHZ COMPOSITE MONITOR

- Z Din, Green
- Composite input from RGB Card

X14516....................$150

DUAL SCAN SAKATA MONITOR

- Amber - both TTL and Composite input

X14538....................$199

HARD DISK

REMOVABLE CARTRIDGE HARD DISK

Ricoh R260 20 M/Byte Removable Hard Disk is a sub-system for AT or 386 systems. Extra 20 M/Byte cartridges are available. To enable the end user to build a library that can be safely locked away. Or taken to another site that is using the same sub-system. It's the ultimate in hard disk back up systems or for transport ability of data.

Includes a cartridge
X20022..................$1,274

Extra 5 1/4" 20 M/Byte cartridge for disk (Ricoh RH5260)
X20024....................$220

VERBATIM DISKS

(ALL PRICES PER BOX OF 10 DISKS)

DESCRIPTION	1-9 BOXES	10+ BOXES
3 1/2" 1S/2D	$32.95	$29.95
3 1/2" 2S/2D	$37.95	$34.95
3 1/2" 2S/HD	$78.95	$74.95
5 1/4" 1S/2D	$21.95	$19.95
5 1/4" 2S/2D	$25.95	$23.95
5 1/4" 2S/4D	$33.95	$31.95
5 1/4" 2S/HD	$33.95	$31.95

VERBATIM DATALIFE PLUS

Teflon* Coated

(ALL PRICES PER BOX OF 10 DISKS)

5 1/4" DS/DD

	1-9	10+
C12522	$29.95	$27.95

5 1/4" High Density

	1-9	10+
C12523	$38.95	$35.95

CHEAP DISKS

"NO BRAND" DISKS

Now you can buy absolute top quality disks that are also the cheapest in Australia! They even come with a lifetime warranty, which indicates the quality of these disks. So why pay 2-3 times the price for the same quality?
Packs of 10, D/S D/D without boxes, or brand name, just their whitepaper jacket, and index label. (5 1/4" disks includes write protects)

(ALL PRICES PER 10 DISKS)

5 1/4" 2S/2D "NO BRAND" DISKS

10+ DISKS	100+ DISKS	1,000+ DISKS
$6.00	$5.75	$5.50

5 1/4" HIGH DENSITY DISKS

(DOUBLE SIDED)

10+ DISKS	100+ DISKS	1,000+ DISKS
$23	$22	$21

3 1/2" 2S/2D "NO BRAND" DISKS

$21

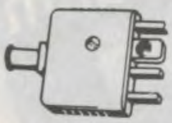
3 1/2" 2S/HD "NO BRAND" DISKS

10+ DISKS	100+ DISKS	1,000+ DISKS
$65	$59	$53

Suitable for IBM, PS/2, Macintosh, Atari, etc.

ROD IRVING ELECTRONICS

TELEPHONE CONNECTORS



TELEPHONE PLUG
AUSTRALIAN
- Solderless Terminal lugs
- Colour: Cream

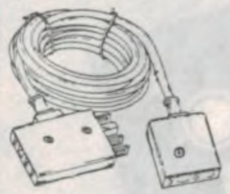
Y16016....................$4.95

TELEPHONE INLINE SOCKET
AUSTRALIAN
- Solderless terminal lugs
- Colour: Cream

Y16018....................$4.95

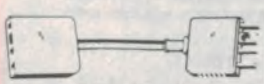
TELEPHONE DUAL ADAPTOR
- Australian plug to 2 Australian sockets
- Length: 10cm
- Colour: Cream

Y16014....................$12.95



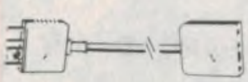
TELEPHONE DUAL ADAPTOR
- Australian socket to 2 Australian plug/ socket
- Length: 10 metres
- Colour: Cream

Y16015....................$11.95



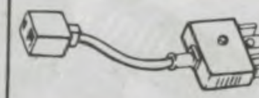
TELEPHONE EXTENSION CABLES
- Australian plug to Australian socket
- Colour: Cream
- Length: 10 metres

Y16012....................$11.95



TELEPHONE EXTENSION CABLES
- Australian plug to Australian socket
- Colour: Cream
- Length: 5 metres

Y16010....................$12.50



TELEPHONE ADAPTOR
- Australian plug to U.S socket
- Length: 10cm
- 6 way/ 4 contact
- Colour: Cream

Y16026....................$6.95

TELEPHONE ADAPTOR
- U.S. modular wall socket
- 6 way/ 6 contact
- Screw terminating
- Colour: Cream

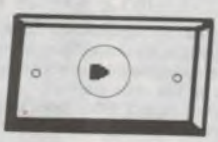
Y16002....................$3.95

MODULAR DUAL OUTLETS
- Single cable input to 2 modular socket outputs
- Surface mounting
- Screw terminating
- Colour: Cream
- 6 way/ 6 contact

Y16004....................$4.95

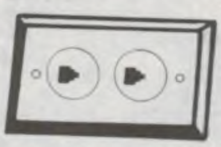
SURFACE MOUNT SOCKET
- U.S. modular surface mount socket
- 6 way/ 6 contact

Y16003....................$4.95



FLUSH MOUNT - SINGLE SOCKET
- Wall plate with modular socket
- Standard Australian size plate
- 6 way/ 6 contact
- Colour: Cream

Y16005....................$3.95



FLUSH MOUNT - DUAL SOCKET
- Wallplate with two modular sockets
- Standard Australian size plate
- 6 way/ 6 contact
- Colour: cream

Y16006....................$4.95

TELEPHONE EXTENSION CABLE WITH REEL
- Allows 15 metres of telephone cable to be neatly wound in a portable storage container
- Colour: Cream

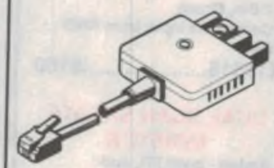
Y16013....................$24.95

TELEPHONE EXTENSION CABLE
- Australian socket to U.S. plug
- 6 way/ 4 contact
- Length: 5 metres
- Colour: Cream

Y16017....................$8.95

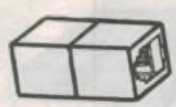
TELEPHONE CURL CORD
- Length: 1.8 metres
- Colour: Black

Y16020....................$3.45



TELEPHONE EXTENSION CABLE
- Australian plug to U.S. plug
- 6 way/ 4 contact
- Colour: Cream
- Length: 2.5 metres

Y16029....................$6.95



TELEPHONE INLINE JOINER
- U.S. socket to U.S. socket
- Colour: Cream

Y16037....................$3.95

TELEPHONE EXTENSION BELL
- Allows you to hear the phone ringing when you are outside
- Colour: Cream

Y16042....................$29.95

GENDER CHANGER

CENTRONICS GENDER CHANGERS
- Saves modifying or replacing non- mating centronics cables.
- All 36 pins wired straight through.

X15663	Male to Male
X15661	Male to Female
X15664	Female to Female

....................$29.95

RS232 GENDER CHANGERS
- Saves modifying or replacing non-mating RS232 cables
- All 25 pins wired straight through

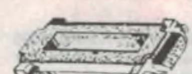
X15650	Male to Male
X15651	Male to Female
X15652	Female to Female

....................$11.95 each

DB15 GENDER CHANGERS
- Saves modifying or replacing non-mating DB15 connenctions
- All 15 pins wired straight through

X15645	Male to Male
X15646	Male to Female
X15647	Female to Female

....................$14.95



DB9 GENDER CHANGERS
- Saves modifying or replacing non-mating DB9 connections
- All 9 pins wired straight through

X15640	Male to Male
X15641	Male to Female
X15642	Female to Female

....................$14.95

RS232 NULL MODEM ADAPTORS
- Pins 2 and 3 reversed
- All 25 pins connected

X15657	Male to Male
X15658	Male to Female
X15659	Female to Female

....................$11.95

9 PIN TO 25 PIN CONNECTOR ADAPTORS
The perfect solution!
Features gold plated pins
- DB9 Plug to DB25Socket

X15668....................$10.95
- DB9 Socket to DB25 Plug

X15669....................$10.95

RS232 MINI PATCH BOX
- Interface RS232 divices
- With male to female 25 pin inputs
- 25 leads with tinned end supplied

X15653	Male to Male
X15654	Male to Female
X15655	Female to Female

....................$12.95

GENERAL

PLASTIC UTILITY BOXES
Available with metal or plastic tops.

METAL TOP
- 150 x 90 x 50mm

H10101....................$4.50
- 195 x 113 x 60mm

H10102....................$6.25
- 130 x 68 x 41mm

H10103....................$2.95
- 83 x 54 x 28mm

H10105....................$1.95
- 120 x 65 x 38mm

H10110....................$2.95

PLASTIC TOP
- 150 x 90 x 50mm

H10111....................$4.95
- 195 x 113 x 60mm

H10112....................$6.95
- 130 x 68 x 41mm

H10113....................$2.90
- 83 x 54 x 28mm

H10115....................$2.25
- 120 x 65 x 38mm

H10120....................$2.95

(Less 10% for 10 or more cases)

MU SERIES PANEL METERS
DIMENSIONS LISTED BELOW

Q10500	MU45 0-1MA	$16.50
Q10502	MU45 50-0/50uA	$16.50
Q10504	MU45 0-100uA	$16.50
Q10505	MU45 0-50uA	$16.50
Q10510	MU45 0-5A	$16.50
Q10515	MU45 0-10A	$16.50
Q10516	MU45 0-20A	$16.50
Q10518	MU45 0-1A	$16.50
Q10520	MU45 0-20V	$16.50
Q10525	MU45 0-30V	$16.50
Q10530	MU52E 0-1A	$18.95
Q10533	MU52E 0-5A	$18.95
Q10535	MU45 VU Metre	$17.95
Q10538	MU65 0-50uA	$23.50
Q10540	MU65 0-1mA	$23.50
Q10550	MU65 0-100uA	$23.50
Q10560	MU65 0-20V	$23.50

JOYSTICKS

JOYSTICK FOR IBM*

Features selectable "spring centring" or "free floating". Electrical trim adjustments on both axis. 360 degree cursor control

C14205....................$49.95

APPLE* COMPATIBLE JOYSTICK

Ideal for games or word processing. Fits most 6502 "compatible" computers.

C14200....................$39.95

APPLE* IIE & IIC SERIES COMPATIBLE JOYSTICK

These joysticks have adaptor connectors to suit the Apple II, IIc, IIe and II+ computers. Features include selectable "spring centring" or "free floating". Electrical trim adjustments on both axis, 360° cursor control and dual fire buttons.

C14201....................$49.95

DUST COVERS

DUST COVER

Keep your computer and accessories free of dust and grime while not in use

XT* Cover Set

C21066....................$14.95

AT* Cover Set

C21068....................$16.95

MODEM

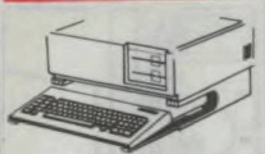
ALLEGRO 24.24 SA MODEM

The first of a new generation of smart modems is here!

- Auto Dial Commands
- Auto Answer CCITT V25 Compatible, Auto Disconnect timeout: Hayes compatible
- Auto Range Selector: 300/1200/2400
- Modem capability: V21, V22, V22bis, Bell 212, Bell 212A
- High Performance: Better than 95% for binary transfers at Signal to noise ratio of 21dB and Receive data level- 34dB
- Telecom Approval C88/37/37a
- 12 month warranty

X19082....................$459

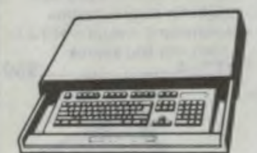
KEYBOARD ACCESSORIES



KEYBOARD SLIDE-AWAY

Slide your keyboard neatly away when not in use. Gives you more desk space. Securely holds any keyboard, wide or narrow.

C21083....................$64.95

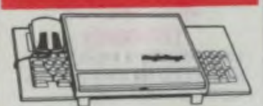


KEYBOARD STORAGE DRAWER

Stores keyboard under the PC or monitor conveniently out of the way. Fits PC/AT keyboard or 2 3/4"(H) x 22 1/4"(W) x 9 1/2"(D)
- YU - E21B

C21081....................$84.75

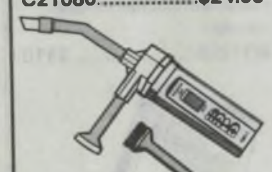
P.C ACCESSORIES



MAGIC STAGE

A working bench for your Mouse.
- High quality ABS plastic and anti-static rubberised top
- Stationary holder
- Includes pull-out shelf for Mouse
- Dimensions: 280 x 260 x 25mm
- Fits over keyboard

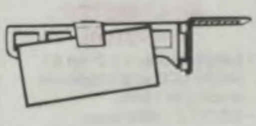
C21080....................$24.95



MINI VACUUM CLEANER

Use it to clean:
- Computer keyboards
- Printers
- Video recorders
- Computer circuit boards

C21087....................$14.95



GRIP CLIP COPY HOLDER

- Attaches to the top of your monitor
- Put your copy right where you need it spring clip to hold paper
- Velcro at mount for easy removal

C21065....................$14.95

PRINTERS & ACCESSORIES

STAR NX1000C COLOUR PRINTER

- 120 C.P.S, Near letter quality
- Colours- Red, Violet, Blue, Green, Yellow, Orange, Black

C22045....................$695

STAR 2410 PRINTER

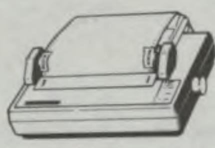
- 47 CPS letter quality Pica
- 24 Pin letter quality
- 142 CPS Draft Pica

C22046....................$995

PANASONIC KX-P1081 DOT MATRIX PRINTER

- 120 C.P.S.
- Pica or Elite character set
- Print Modes: NLQ, Dot Graphics, Draft, Proportional Font
- Reliable and Compact
- Proportional Printing
- Logic Seeking
- 1K Printer Buffer

C22050............only $495

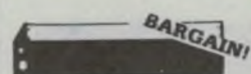


EPSON LX-800 PRINTER

- NLQ Mode
- 180 C.P.S. & 25 C.P.S.
- Tractor or friction feed
- Proportional printing
- Convenient push button control panel
- Standard Parallel interface

C22054....................$489.95

RIBBONS



PRINTER RIBBONS TO SUIT:

- CP80, SX80, DP80, BX100, BX100, MB100

	1-9	10+
C22036	$19.95	$17.95

- MX80, FX80, RX80, FX800, MX70, MX80, LX800

	1-9	10+
C22031	$16.95	$15.25

- MX100, FX100, RX100,LQ1000

	1-9	10+
C22002	$19.95	$17.95

- LX80

	1-9	10+
C22003	$12.95	$11.95

- C ITOH 8510-1550

	1-9	10+
C22051	$13.95	$12.50

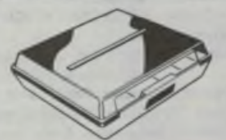
NATIONAL PANASONIC KXM110 PRINTER RIBBON

C22034....................$19.95

PRINTER STAND

"AUSTRALIAN MADE"
- Restores order to your work area
- Conveniently stacks paper printout in document tray automatically
- Made of plastic coated steel
- Suitable for most printers
- Excellent value at this price

C21056....................$34.95

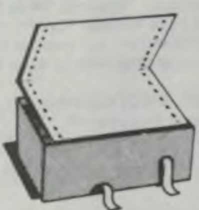


ENCLOSED PRINTER STAND

- Transparent cover makes it easy to check on paper supply
- Paper can be fed from the centre or the rear according to the design of the printer
- Removable drawer which allows paper to be changed without moving the printer
- Retractable rear basket makes print-out collection fast and convenient
- Suitable for maost printers

C21055....................$49.95

PAPER



COMPUTER PAPER

Quality paper at a low price!
2,000 sheets of 60 gsm bond paper
- 11 x 9 1/2"

C21001....................$41
- 15 x 11"

C21011....................$59.95

RIBBONS

RIPPER STRIPPER

Remove ugly paper feed edges quickly and cleanly with this simple little gadget

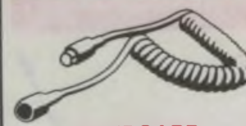
C21085....................$14.95

COPY HOLDER (YU-H32)

- Adjustable arms allows easy positioning
- Copy area 9 1/2" x 11"
- Sliding line guide
- Clamp mounting

C21062....................$39.95

LEADS



KEYBOARD EXTENSION LEAD

5 Pin Din plug and socket

P19038....................$6.95

COMPUTER EXTENSION POWER LEAD

P10254....................$11.95

MONITOR EXTENSION LEAD

P19032....................$9.95

ROD IRVING ELECTRONICS

SYDNEY: 74 Parramatta Rd.
Stanmore 2048
Phone: (02) 519 3134
Fax: (02) 519 3868

MELBOURNE: 48 A'Beckett St
Phone: (03) 663 6151

NORTHCOTE: 425 High St.
Phone: (03) 489 8866

MAIL ORDER & CORRESPONDENCE:
P.O. Box 620, CLAYTON 3168
Order Hotline: 008 33 5757
(Toll free, strictly orders only)
Inquiries: (03) 543 7877
Telex: AA 151938
Fax: (03) 543 2648

All sales tax exempt orders and wholesale inquiries to:
RITRONICS WHOLESALE -
56 Renver Road, Clayton.
Phone:(03) 543 2166 (3 lines)
Fax: (03) 543 2648

ORDER HOTLINE
008 33 5757
(TOLL FREE)
STRICTLY ORDERS ONLY

LOCAL ORDERS & INQUIRES
(03) 543 7877

POSTAGE RATES:

$1 - $9.99	$2.00
$10 - $24.99	$3.00
$25 - $49.99	$4.00
$50 - $99.99	$5.00
$100 +	$7.50

The above postage rates are for basic postage only. Road Freight, bulky and fragile items will be charged at different rates.

Errors and omissions excepted. Prices and specifications subject to change.

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VISA MasterCard

ROD IRVING ELECTRONICS

ROD IRVING ELECTRONICS

VIDEO ACCESSORY

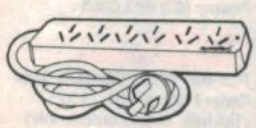
VIDEO/ AUDIO TRANSMITTER

A small compact unit that allows transmission of video and audio signals (RF) to any TV set or VCR within a range of 30 metres (100''), simply by tuning in on Channel 11. Can be used as a transmitter for a video camera. With power on LED, on/off switch, audio and video leads and supplied with and AC adaptor.

- Transmission: VHF, channel 11 (PAL)
- Video Input: 75 ohms, 1V p-p
- Audio Input: 600 ohms
- Output Control: Audio-video fine adjustment
- Power Sources: 9V battery or power adaptor
- Accessories:
  - RCA to RCA audio lead
  - RCA to BNC video lead
- Size: 70(W) x 85(D) x 28(H)mm
- Weight: 170 grams

A16150..................$95.95

240V ACCESSORY



CLICK SURGE BUSTER

6 PROTECTED POWER OUTLETS

Ideal for protecting personal computers, video equipment, colour TVs, amplifiers, tuners, graphic equalisers, CD players

SPECIFICATIONS:

- Electrical rating: 240V AC, 50Hz, 10A
- 3 x Metal Oxide Varistors (MOV)
- Maximum clamping Voltage: each MOV: 710 volts at 50 amps
- Response time: Less than 25 Nanoseconds.

X10086..................$69.95

CPF CONTINUOUS POWER FILTER (SPIKE ARRESTOR)

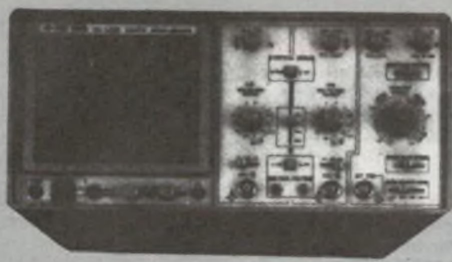
The CPF Power Filter provides a protective electronic barrier for microcomputers, printers, telephone systems and modems electronic typewriters, audio and stereo systems and other sensitive electronic equipment. CPF' responds instantly to any potentially damaging over-voltage, ensuring safe trouble free operation.

SPECIFICATIONS:

- Electrical rating: 220-260 volts (AC) 50Hz 10 Amp
- Spike/ RFI Protection: 4,500 amps for 20m/ second pulses
- Maximum clamping voltage: 275V differential mode

X10088..................$69.95

NEW CRO'S



20MHZ DUAL TRACE OSCILLOSCOPE

CRT DISPLAY

- 150mm rectangular

VERTICAL DEFLECTION

- Deflection Factor: 5mV to 20V/ Div on 12 ranges in 1-2-5 step with fine control
- Bandwidth DC: DC to 20MHz (-3dB)
  AC: 10Hz to 20MHz (-3dB)
- Operating Modes: CH-A, CH-B, DUAL and ADD (ALT/CHOP L202 only)
- Chop Frequency: 200KHz Approx.
- Channel Separation: Better than 60dB at 1KHz

TIME BASE

- Type: Automatic and normal triggered in automatic mode, sweep is obtained without input signal
- Sweep Time: 0.2μ Sec to 0.5 Sec/ Div on 20 ranges in 1-2-5 step with fine control and X-Y
- Magnifier: X5 at all ranges

TRIGGERING

- Sensitivity Int: 1 Div or more
  Ext: 1Vp-p or more
- Source: INT, CH-B, LINE or EXT
- Triggering Level: Positive and Negative, continuously variable level; Pull for Auto
- Sync: AC, HF Rej, TV (each + or -) at TV Sync. TV-H (line) and TV-V (Frame) sync. are switched automatically by SWEEP TIME/Div switch.

HORIZONTAL DEFLECTION

- Deflection factor: 5mV to 20V/ Div on 12 ranges in 1-2-5 step with fine control
- Frequency Response: DC to MHz (-3dB)
- Max input Voltage: 300V DC + AC Peak of 600Vp-p
- X-Y Operation: X-Y mode is selected by SWEEP TIME/ Div switch
- Intensity Modulation Z Axis: TTL Level (3Vp-p~50V) + bright, - dark

OTHER SPECIFICATIONS

- Weight: 7Kg Approx
- Dimensions: 162(H) x 294(W) x 352(D) mm

Q12105..$695

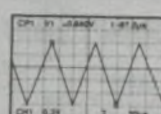
40MHZ READ-OUT OSCILLOSCOPE

CRT DISPLAY

- 150mm rectangular

VERTICAL AMPLIFIER (CH1 and CH2 identical)

- Operational Modes: CH1, CH2, ADD, DUAL, ALT, CHOP
- Sensitivity: 5mV-5V/ Div 3% in 1-2-5 steps
  1mV-1V/ Div x5% x5MAG
- Bandwidth DC: DC to 40MHz (-3dB)
  AC: 5Hz to 40MHz (-3dB)
- Rise Time: Less than 8.7nS



Ex. Readout Display

HORIZONTAL AMPLIFIER

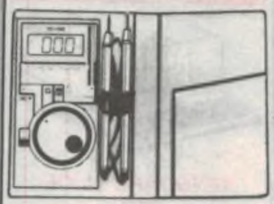
- Operating Modes: X-Y operation CH1-X axis, CH2-Y axis
- Sensitivity: 5mV-5V/ Div± 3% in 1-2-5 steps
- Input Impedance: 1MΩ±2%, 25pF±3%
- Bandwidth DC: DC to 1MHz (-3dB)
  AC: 5Hz to 1MHz (-3dB)

TIME BASE

- Sweep Method: AUTO, NORM, SINGLE
- Sweep Time (A): 0.2μs-0.5S/ Div±3% in 1-2-5 steps (X1 only)
  (B): 0.2μS-0.5mS/ Div±3% in 1-2-5 steps (X1 only)
- Magnified Sweep: 10 times±5%, Max 20ns
- Linearity: ±3% or better

Q12107..$1,695

TEST EQUIPMENT



MULTIMETER (YF-100)

- Autoranging for DCV, ACV, OHM & continuity measurement
- AC DC 0 - 500 Volts
- 10mm thickness & 80g light weight for easy operation
- Dimension & weight = 108 x 54 x 8mm and 60g approx

Q11264......................$69

MULTIMETER (YF-3000)

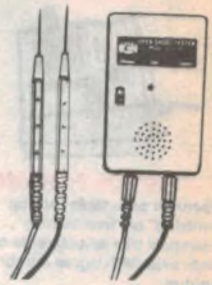
- Large display 3 1/2 digit 0.5" height LCD for easy readout
- AC DC 0 - 1000 Volts
- Auto/manual range select easy to operate
- Automatic low battery" - + " display for battery indication
- Memory-comparative function available for allowance within ±5% f.s
- Warning sound for overload and conductance
- Dimension & Weight = 170 x 80 x 33mm, 260gram approx
- Data hold function for easy readout

Q11268...................$110

MULTIMETER (YF-2100)

- Large display 4 1/2 dgt 0.5" height LCD with maximum reading of 19999
- AC DC 0 - 1000 Volts
- Automatic polarity."-" display for negative input
- High over-load protection for all ranges
- Over load display, the highest digit "1" or "-1" alone glows
- Power consumption 20mW approx.
- Dimension & weight = 162 x 86 x28mm and 200g approx

Q11266......................$199



SHORT TESTER

- Instantly shows the open/short position of PCB
- It can test whether PCB or solid wire open/short by Buzzer

Q11276................$22.95

LOGIC PROBE (LP-2800)

- Useful for TTL or CMOS has high and low indicator leds and also with pulse memory.
- This is a very handy tool for the hobbyist or serious technician for tracing those hard to find faults on logic boards.

Q11272...............$34.95

LOGIC PULSER (LP-540H)

- Can be used directly to inject a signal into logic circuits without removing IC
- Compatible with TTL, DTL, RTL HTL, MOS and CMOS

Q11274.................$42.95

DIGITAL METER (YF-120)

- Autoranging operation
- Data-hold for easy readout
- Full range protection
- 0-500 volts AC-DC
- 0-20 MΩ
- Dimension & weight =133 x 29 x 17mm and 60g approx

Q11270...................$98.95

SOLDERING IRON

ROYEL SOLDERING STATION

The all solid-state heat sensor and control unit allows the selection of the appropriate soldering tip idling temperature. The very high-powered element (relative to the size of the tool) will replenish heat drained from the tip during each soldering operation and will recover the tip temprature moments after the tip is lifted.

- Zero voltage switching
- Zero tip potential
- Aux ground connection
- For soldering irons- CT6 (3mm Tip), CT7 (5mm Tip)

T12570.........................$225

ADCOLA SOLDERING IRON RS30

(12 WATT)

- 3mm tip
- 240V operation
- 3 months warranty
- Safety Standards Approved

T12625...................$39.95

ADCOLA SOLDERING IRON RS50

(16 WATT)

- 5mm tip
- 240V operation
- 3 months warranty
- Safety Standards Approved

T12630...................$36.50

ROYEL DUOTEMP SOLDERING IRONS

The DUOTEMP range are designed to idle with a normal tip temperature of 360°C, without its button depressed. In this mode they are ideal for delicate work such as printed circuit boards. With the button depressed, the power is doubled allowing much heavier work to be completed, or a rapid temperture recovery from larger joins. (Note: This mode cannot be used continuously). A range of 6 long-life tips are available.

Features:
- 240V operation, no transformer required
- Safety Standards Approved
- 6 months warranty

ROYEL DR-30

(21 WATT)

- 3mm tip

T12640..................$47.50

ROYEL DR-50

(30 WATT)

- 5mm tip

T12645...................$49.50

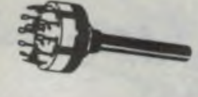
ROYEL DR-60

(40 WATT)

- 6.5mm tip

T12650...................$54.50

GENERAL COMPONENTS



ECONOMY ROTARY SWITCHES

- 1 Pole 2-12 Pos. S13021
- 2 Pole 2-6 Pos. S13022
- 4 Pole 2-3 Pos. S13033
- 3 Pole 2-4 Pos. S13035

1-9	10+
$2.95	$2.75

EPROMS

2716	$12.50
2732	$8.25
2764	$8.95
27128	$8.00
27512	$17.95
27C64	$8.95
27C128	$12.50
27C256	$15.50

UV EPROM ERASER

Erase your EPROMs quickly and safely. This unit is the cost effective solution to your problems. It will erase up to 9 x 24 pin devices in complete safety, in about 40 minutes (less time for less chips)

- Chip drawer has conductive foam pad
- Mains powered
- High UV intensity at chip surface ensures EPROMs are thoroughly erased
- Engineered to prevent UV exposure
- Dimensions 217 x 80 x 68mm

Without timer
X14950...........................$119
With built-in timer
X14955...........................$129

10 JUMPER LEADS

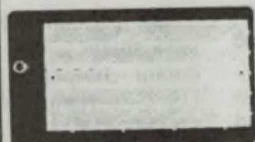
Set of 10 high quality leads with alligator clips. Approximately 450mm long.

W12000.....................$5.95

10 JUMPER LEADS

Set of 10 high quality leads with alligator clips. Approximately 450mm long.

W12000.....................$5.95



BREAD BOARDS

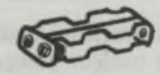
This inexpensive range of modular interlocking units enables a quick, easy way of experimenting with new circuits and ideas. There are two main units consisting of a terminal strip or distribution and a Central plug-in unit.

- 100 holes
P11000.....................$2.75
- 640 + 100 holes
P11007...................$14.95
- 1280 + 100 holes
P11010...................$26.95
- 2560 + 700 holes
P11018...................$69.95

TRIACS & SCR

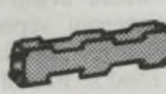
SC141D	$1.95	SC142E/Teccor		C103B/MCR100-6	$0.90
C106B	$0.90	S4008L Triac	$2.25	C106D	$1.50
C122D	$2.50	SC146D	$2.85		
SC141E	$1.95	SC150D	$5.35		
SC142D	$2.50	SC151D	$2.95		

AA BATTERY HOLDERS

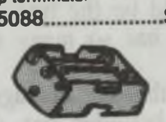


BH23
2x AA back to back, snap terminals.
S15085......................$0.50

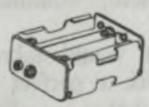
BH43
4x AA back to back, snap terminals.
S15090......................$0.95



BH43L
4x AA ,2 rows of2 back to back, snap terminals.
S15088......................$0.85

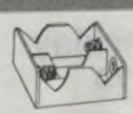


BH63
6xAA ,3 each back to back,snap terminals.
S15092......................$1.25

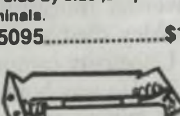


BH83
8x AA, 4 each back to back,snap terminals.
S15094......................$1.95

'C' BATTERY HOLDERS

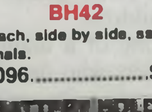


BH22
2xC side by side ,snap terminals.
S15095......................$1.50



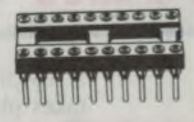
BH42
4xC each, side by side, sanap terminals.
S15096......................$1.75

'D' BATTERY HOLDER



BH21
2xD .Side by side,snap terminals.
S15097......................$1.95

BH41
4xD .2each side by side, snap terminal.
S15098......................$1.95



GOLD INSERT LOW PROFILE IC SOCKETS

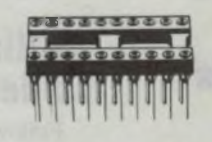
- Gold machined pins
- Extremely high quality
- Anti-wicking
- Ideal for professional use or where field service components is required.

Cat.no.	Description	1-9	10+
P10620	8 pin	$1.20	$1.10
P10624	14 pin	$1.60	$1.40
P10626	16 pin	$1.90	$1.80
P10628	18 pin	$2.00	$1.90
P10630	20 pin	$2.20	$2.00
P10632	22 pin	$2.40	$2.20
P10634	24 pin	$2.60	$2.40
P10640	28 pin	$2.90	$2.70
P10644	40 pin	$2.95	$2.75

LOW PROFILE IC SOCKETS

Save a small fortune on these "Direct import" low profile ic sockets! PCB mounting solder tail. All tin plated phosphor bronze or berryllium and dual wipe for reliability.

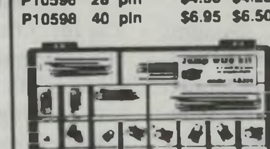
Cat. No	Description	1-9	10+
P10550	8 pin	$0.20	$0.18
P10560	14 pin	$0.25	$0.20
P10565	16 pin	$0.25	$0.20
P10567	18 pin	$0.40	$0.35
P10568	20 pin	$0.40	$0.35
P10569	22 pin	$0.40	$0.30
P10570	24 pin	$0.40	$0.30
P10572	28 pin	$0.50	$0.40
P10575	40 pin	$0.50	$0.40



WIRE WRAP IC SOCKETS

These quality 3 level wire wrap sockets are tin-plated phosphor bronze

Cat no.	Description	1-9	10+
P10579	8 pin	$1.50	$1.20
P10580	14 pin	$2.50	$2.25
P10585	16 pin	$2.50	$2.25
P10587	18 pin	$2.95	$2.75
P10590	20 pin	$3.25	$2.95
P10592	22 pin	$3.40	$3.20
P10594	24 pin	$3.95	$3.65
P10596	28 pin	$4.50	$4.25
P10598	40 pin	$6.95	$6.50



JUMP WIRE KIT (KS-350)

Contains:
14 kinds of length from 0.1" to 5" with different colors
Q11278......................$19.95

CRYSTALS

CRYSTALS

Y11000	1MHz	$11.50
Y11003	1.8432MHz	$7.50
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Silicon Valley NEWSLETTER . . .

DRAM chip heist

Recently, four masked men entered the offices of Micronics Computers in Sunnyvale and held several of its employees at gun point.

Instead of money, the bandits were out to steal the company's supply of DRAM chips. And why not? The chips weigh just 5 grams, and are worth US$10-20 on the open market. They could easily have carried off the company's entire supply of tens of thousands of DRAMs, not to mention hundreds of Intel 286 and 386 processors.

Fortunately, the heist was thwarted, when one company executive locked himself up in his office to call the police. The desperate thieves tried to shoot the lock out of the wooden office door. But after several attempts, they panicked and took off. "Those guys watched too much television. The lock was only scuffed," said a company security official.

This attempt is, however, only the latest in a series of chip robberies. Several months ago, another group of gunmen hauled off more than US$500,000 worth of DRAMs and other chips from an unidentified computer maker in the Valley. And nearly half a dozen chip heists have occurred in Los Angeles in the past year.

Hot battery provides 75W for 30 years

A battery, the size of a six-pack of beer, that provides 75-watts of non-stop energy for up to 30 years?

A small Oregon company, Peripheral Systems has announced the development of just such a revolutionary battery, and has already been granted a patent for the invention. But commercial use of the battery may be many years away, as it contains highly radioactive materials.

According to Peripheral Systems chairman Philip Talbert, the term 'battery' is somewhat misleading. Although the unit, like all batteries, has no moving parts, it "is fundamentally a radioisotopic generator. It doesn't just store electricity, it generates it."

The key to the invention is the use of a by-product of nuclear fission that takes place inside nuclear power plants. The by-product is Strontium-90.

Unlike the deadly Plutonium which requires heavy shielding to prevent contamination, the radioactive particles emitted by Strontium-90 have such low intensity that they can be stopped by a single sheet of aluminium foil.

Talbert conceded that it may take as much as two more decades before his nuclear batteries would become available in some commercial applications. But in the short-term, the batteries could provide an ideal source of energy for a host of defence and aerospace systems including satellites. "We believe the military would be the first market, because defence has so many applications."

It is estimated that the Pentagon uses some 3 million batteries per day, or close to a billion per year. "This could be a real breakthrough. When they are ready, we'll be there," commented one Navy engineer.

Talbert said it would take several more years of work to perfect the company's battery so that it can offer a variety of sizes, from the 75-watt prototype to units the size of beer kegs that could produce up to 500 or more watts continuously.

William Shockley is dead, at 79

Following a bout with cancer of the prostate, controversial transistor inventor William Shockley died at his home on the Stanford University campus.

Shockley was 79. He was born in Palo Alto, the son of a mining engineer, and one of the subjects of Louis Terman's study of gifted children.

Shockley was one of a team of three Bell Lab researchers who developed the solid state transistor in December 1947. The transistor remained a largely useless invention, and Shockley was able to buy the patent from Bell Lab for just US$23,000. With the patent, and financial backing from Beckman Industries, Shockley set up his Shockley Semiconductor transistor firm in Palo Alto.

Shockley quickly attracted a team of the most brilliant engineers in the US. But after only two years, eight top managers, including Robert Noyce and Gordon Moore walked out to start up Fairchild Semiconductor.

The move left Shockley embittered and his company never recuperated.

In 1958, Shockley joined the faculty at Stanford as a professor of electrical engineering. Shortly afterwards, Shockley alienated himself from virtually the entire planet with his racial views. Convinced that blacks are inherently less intelligent than whites, he suggested that black men should have themselves sterilised in order to prevent further regression of the human race due to faster reproduction in the black community.

Shockley also supported and took part in the creation of a sperm bank to which only people with very high intelligence could become donors. Until just a few days before his death, he continued to study data and write papers that supported his racial views.

At Stanford, James Gibbons, Dean of Engineering, said it would be a shame if Shockley's huge contributions in the engineering field would forever remain overshadowed by his controversial genetic research conclusions.

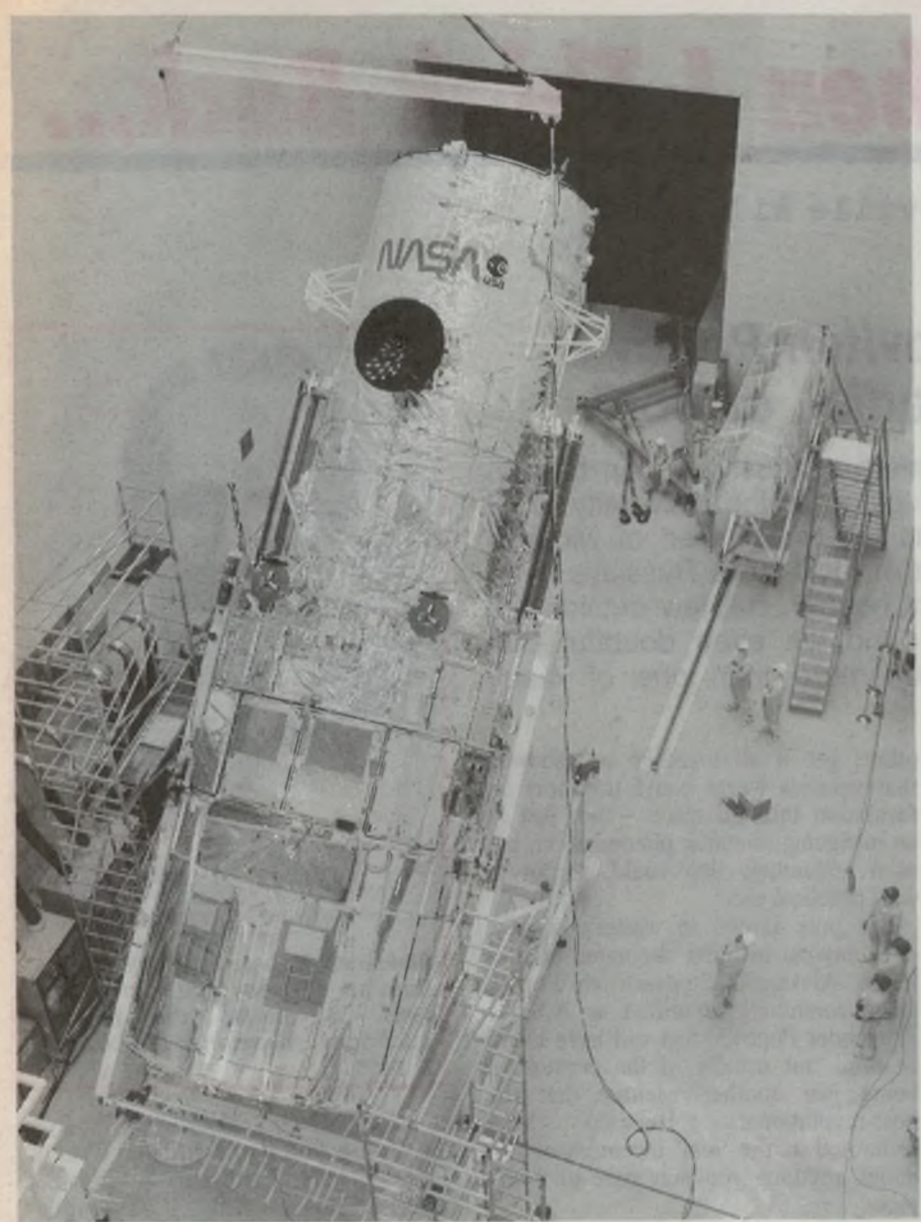
"He invented the transistor and many other related devices. Without his creativity and inventiveness, it is hard to tell where we would be today," Gibbons said.

US chip execs attack, defend US Memories

The president of one of Silicon Valley's smaller, but fast-growing semiconductor companies sharply criticised the US Government for considering giving US Memories an exemption from strict US anti-trust laws.

T.J. Rodgers, president of Cypress Semiconductor, told the House Judiciary Subcommittee on Economic & Commercial Law that the argument that the US semiconductor industry is under attack from Japan "is just a smoke screen to gain a competitive advantage."

The argument has been used frequently by backers of the US Memories joint DRAM venture, to persuade Congress to clear the start-up of any anti-trust violations.



NASA recently tilted the Hubble Space Telescope over to a horizontal position, for final testing before its launch on March 26, 1990 via the space shuttle. Designed by Perkin-Elmer and weighing 12.5 tons, the telescope has a primary mirror just under 8' in diameter.

The Subcommittee is evaluating plans to allow a large number of US chip and computer makers to build a large memory chip maker that must provide the US market with a large and secure supply of leading-edge DRAM memory chips.

Some smaller chip makers, like Cypress oppose the formation of joint efforts like US Memories and Sematech, because they are simply too small to afford joining such groups.

National Semiconductor president Charlies Sporck immediately rose to defend the formation of US Memories, Sporck said that while the US has more chip start-ups than any other country, the overall US industry is rapidly losing marketshare against Japan: "the little guys simply can't do the job."

He added that while collective efforts like US Memories may be a high-risk gamble, they stand at least some chance against the giant vertically integrated chip makers in Japan.

Harris keeping Intersil

After six months of negotiating with up to half a dozen firms, Harris Corporation said it has decided to keep Intersil, which it acquired last December as part of the purchase of General Electric's semiconductor operations. "In the course of the negotiations, we have determined that the opportunity from integrating Intersil is greater than the opportunity for selling this operation," said Jeff Peters, general manager of Harris' commercial products division.

As part of the integration of Intersil, Harris would continue to operate the company's Silicon Valley facilities, although some minor lay-offs can be expected.

Industry analysts said they were surprised Harris had come to such a conclusion after trying to sell the Intersil unit for six months. They agreed the prospective buyers did not come up with acceptable offers.

"My best guess is that they didn't get the price they wanted." said analyst Jay Samstag.

Hoya buying Micro Mask

In an increasingly worrisome string of Japanese investments in Silicon Valley, one of the area's oldest semiconductor equipment firms, Micro Mask announced it has agreed to be acquired by Hoya in a deal worth US$23 million in cash.

The acquisition will give Hoya its first direct presence in the US photomask market. Already, Hoya is the world's leading supplier of photoplates, which are used by companies like Micro Mask to produce photo masks.

Micro Mask's decision to sell out to its Japanese supplier is sending yet another shockwave through the embattled US semiconductor equipment industry. Like Perkin Elmer's recent decision to sell its semiconductor equipment operations at a time when that group is showing healthy profits and strong sales increases, Micro Mask's current performance makes an acquisition an unlikely choice.

During its most recent quarter, sales rose 30% to US$7.4 million, as earnings tripled to US$1 million. But Hoya, with some $640 million in annual sales, offered to pay $10 a share for Micro Mask, a premium of nearly 60% over the $6.88 current trading level of the company's stock. For most shareholders, such offers are too good to refuse, and the company had little choice but to accept the seemingly generous offer.

US industry officials, however, fear that with each Japanese acquisition of a US equipment and materials company, their industry becomes weaker. It also makes it increasingly difficult for the remaining small independent firms to compete with their Japanese counterparts, which in most cases are part of much larger vertically integrated conglomerates.

When I Think Back...

by Neville Williams

Aleksandr Stepanovitch Popov – The 'Inventor of Radio', or not?

If Soviet propaganda is to be taken seriously, a man born in the Urals in the 1850's and educated at the University of St Petersburg – A.S.Popov – was the real 'father' of wireless telegraphy and the real 'inventor of radio'. The Russians even set aside a day each year in his honour. But few outside the Soviet Bloc accept the claim, and it's even doubtful that Popov saw himself as anything more than one of many pioneers.

No, I certainly don't remember Popov directly – because, to do so, I would need to have been around for more years than I already have. But Popov's name does crop up at odd times and, in searching through available references for the preparation of this background article to the relevant period, I've gained a better understanding of his place in electronics history.

Ask any number of reasonably informed enthusiasts who to credit with the invention of wireless/radio/electronics, and most will answer – correctly – that there never was one single inventor. Over many long years, a whole retinue of scientists and experimenters have worked out and demonstrated the basic principles of what has since become the world's most pervasive technology.

Pressed for more information, they might come up with names like Michael Faraday, Heinrich Hertz, Joseph Henry, Samuel Morse, Sir Charles Wheatstone, James Clerk Maxwell, and others who made notable contributions to the science of wireless communication, particularly in the latter half of the last century.

Their ability to recall these and other pioneers is not due to a retentive memory, but to the fact that many of them have been immortalised by having their names chosen to identify various fundamental electrical quantities.

Sir Oliver Lodge is remembered for his long life and his colourful mix of science, technology and metaphysics. Guglielmo Marconi comes to mind as the person who, perhaps more than any other, got it all together and showed that wireless waves could transport information through space – not just as an intriguing scientific phenomenon, but as a technology that could be put to very practical use.

But only rarely, in western society, does anyone mention the name of Professor Aleksandr Stepanovitch Popov, more commonly identified as A.S. or Alexander Popov. Most will have heard of him, but usually in the context of being just another scientist that the post-revolutionary Russians have promoted as the 'real' inventors of just about anything you may care to nominate.

Never immortalised

A modern table of electrical units reads like a nineteenth century who's-who, but to the best of my knowledge, you'll search in vain for a 'Popov'. The one whimsical suggestion I've heard along these lines is that the name might lend itself to the guaranteed minimum service life of electronic components. Some, for example, might carry a maker's rating of 5 years Popoff!

Seriously, however, Alexander Popov may well have been the unfortunate posthumous victim of his own country's promotion and other countries' prejudice. Whether or no, he has certainly been relegated to a minor role in most western texts dealing with electronics history.

I can't recall, personally, when Popov's name first came to my notice but there is no doubt about the date of an article which I elected to file from the British journal *Electronics Weekly*: June 12, 1963. Written by an unnamed 'Special Correspondent', it was entitled 'The Popov Claim – Who was the inventor of wireless telegraphy?'.

Aleksandr Popov, as pictured on a Russian amateur QSL card circa 1961. It carries the banner: A.S.Popov, Inventor of Radio, May 7. 1895.

Illustrating the article, and reproduced herewith, is a Russian radio amateur's QSL card which carries the legend: 'A.S. Popov, Inventor of Radio, May 7, 1895'. The timing of the article suggests that the author was a British amateur who had received the card as the result of a contact on or around Russia's annual radio day – first proclaimed in 1945, 50 years after the year that wireless communication supposedly became a reality.

By contrast, it is noted in the article that (in 1963) Popov rated only six lines in the British Museum's *History and Development of Radio Communication*.

Born in 1859, Popov was virtually a generation ahead of Marconi (1874-1937) but was nevertheless his contemporary in respect to the historic transmission and reception of wireless teleg-

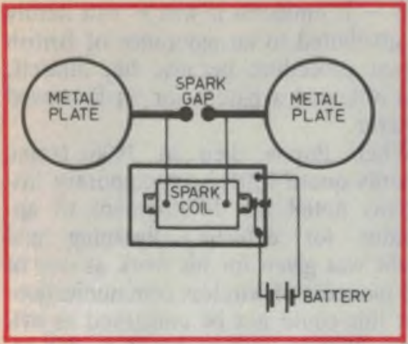


Fig.1: The original Hertz oscillator, with a wavelength possibly as small as 1" (2.5cm or 12GHz).

Fig.2: The original Hertz resonator, or receiving loop.

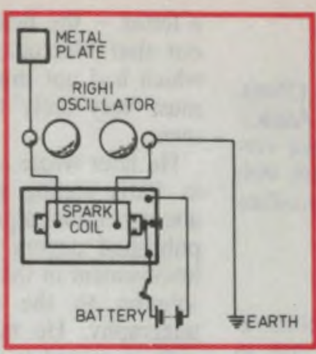


Fig.3: An early Marconi transmitter, based on the ideas of Augusto Righi.

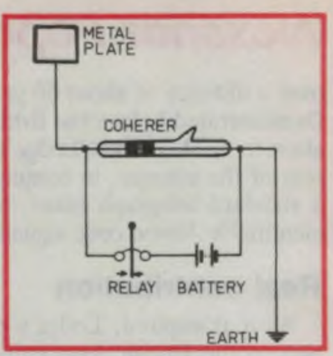


Fig.4: An early Marconi receiver showing an evacuated, sealed coherer.

raphy signals in the 1890s. But whereas Marconi had a flair for publicity and the opportunity in Britain to benefit by it, Popov was less fortunately placed.

Existing foundations

He certainly made an important contribution to the early technology of wireless telegraphy but, like Marconi, Lodge, Tesla and others, Popov was really building on foundations already laid by other researchers such as Oersted, Faraday, Maxwell and Hertz.

As Professor of physics at Kings College, London (1860-1865) Maxwell had met Faraday and had the opportunity to rethink Faraday's ideas from the viewpoint of a specialist mathematician. Maxwell subsequently returned to his Scottish Estate to work on his *Treatise on Electricity and Magnetism*, in the course of which he was able to predict the existence of electromagnetic waves, and to suggest their likely properties. This was around 1870.

In 1888, the German physicist Heinrich Hertz was able, in turn, to verify Maxwell's theory and to demonstrate in a practical way the existence of wireless waves. (Figs.1 & 2). While doubtless aware of the wider implications of his work, it was, to him, primarily academic research that needed to be pursued in its own right, rather than as the means towards a particular technological objective.

Hertz subsequently discovered that incoming wireless waves could be detected with the aid of a glass tube containing two contacts and a quantity of metallic filings. With no natural affinity for each other, the filings would clump together or 'cohere' spontaneously in the presence of high frequency energy to form a more effective electrical conductor. (See separate panel)

Edouard Branly, Professor of physics at the Catholic University of Paris, refined Hertz' 'particle' device into a so-called *coherer* which could react to an encoded sequence of incoming wireless pulses – with a little manual assistance: it had to be 'de-cohered' by gentle tapping after each pulse, so that it would be ready to respond to the next one!

In London, about the same time, Sir Oliver Lodge had also followed up Hertz' findings and worked out a system for receiving Hertzian wireless waves

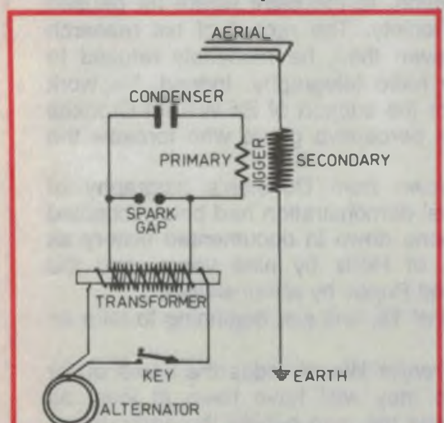


Fig.5: Again, from a turn of the century publication, circuit details of a then-typical spark transmitter.

What was a coherer?

A basic problem which faced the pioneers of wireless communication was how to discern and demonstrate the presence of incoming electromagnetic energy. Initially, Hertz used a metal loop with the two ends, terminating in polished brass balls and separated by a minute air gap (Fig.2). In the presence of sufficient incoming electromagnetic energy, small sparks could be seen in the gap. It could not respond to typically weak signals.

The *coherer* was the first 'detector', as such, but one that was limited to the reception of coded (telegraphy) transmissions. Magnetic detectors, crystals and thermionic diodes came later.

It consisted, essentially, of a horizontal glass tube containing two metallic contacts, with the intervening space lightly filled with metallic filings and/or dust. Over the years, copper, iron, brass and zinc were all used, but the most favoured mix appeared to be 95% nickel and 5% silver. (See Fig.4)

In its normal state, contact between the filings in a 'particle' coherer was such that it presented a relatively high overall resistance, with very little current flowing through the associated coherer/battery/relay circuit.

In the presence of high frequency energy, however, the particles tended to clump together or 'cohere', presenting a much lower resistance. In other words, it operated rather like a switch, turned on by the arrival of a high frequency pulse.

When this occurred, current from the associated battery would register on a meter or, as indicated, operate a relay and a telegraphic printer. Experienced operators, however, often preferred to listen to the incoming clicks on headphones, because they were better able to distinguish between deliberate man-made signals and the erratic crackle of atmospheric static.

Early coherers needed to be tapped by the operator to de-cohere the particles ready for the next pulse – a slow and tedious routine. Improvements by Branly, Marconi, Lodge, Popov and others involved the nature of the particles, and the physical configuration of the tube and contacts. The provision of a magnetic tapper to de-cohere the particles automatically after each burst of signal resulted in the more convenient 'self-acting' coherer.

The ultimate coherer, referred to in Marconi's biography, was a self-acting type using mercury rather than discrete particles.

over a distance of about 60 yards (55m). Demonstrated before the British Association in 1894, it used Lodge's own version of the coherer, in conjunction with a standard telegraph inker, to produce identifiable Morse code signals.

Real contribution

As it transpired, Lodge's demonstration to the British Association came to the notice of Alexander Popov in Kronstadt. By this time Popov had graduated from the University of St Petersburg.

In his biography of Marconi (*Guglielmo Marconi*, Heron Books, 1970), David Gunstan confirms that in 1895, one year before Marconi migrated to Britain, Popov had effected a number of improvements in a receiver that he had set up to study storm activity.

He had added an automatic tapping device to the Branly coherer, to restore the filings to a loose state after each signal pulse. He had also introduced a relay into the coherer circuit to operate an inker, and erected an elevated aerial to improve weak signal pickup.

Reflecting this work, Gunstan records that, in December 1895, Popov appended a note to the paper which he had written in that same year that read:

"I entertain the hope that, when my apparatus is perfected, it will be applicable to the transmission of signals by means of rapid electric vibrations – as soon as a sufficiently powerful generator of these vibrations is discovered."

In January 1896, Popov described his experiments to the Physico-Chemical Society in a paper entitled 'Apparatus for the Detection and Recording of Electrical Oscillations'.

According to a note in the Society's records, he also gave a series of short demonstrations at a Society meeting on March 24, 1896. But unfortunately the original records do not indicate the nature of the demonstrations. At about the same time he had also been been experimenting with Rontgen rays (X-rays).

Seeds of controversy

Popov spent the summer of 1896 at Nizhniy Novogorod, where he installed one of his storm detectors. It was while there that he heard about Marconi's demonstrations of radio signalling over a distance of several miles. He was obviously startled, that the prediction in his note of a few months earlier had been fulfilled so soon.

Returning to Kronstadt, he published a letter – the first of many – pointing out that Marconi's receiver, details of which had not thus far been published, must 'very likely' be quite similar to his own.

He later wrote a letter for publication in Paris stating that, apart from the abovementioned paper, he had no other published papers that could verify his involvement in the search for a practical solution to the problem of wireless telegraphy. He made no claims whatever in regard to wireless transmission, presumably because most of his research had been into naturally occurring electromagnetic phenomena.

These statements were repeated in a letter to a British magazine. Significantly, he did not claim that Marconi had copied his receiver, but simply that the two were nearly identical.

Nor did he seek to contest the Marconi patent 12039 (1896) relating to receivers with elevated aerials. This omission – if omission it was – can hardly be attributed to an ignorance of British patent procedure because he, himself, had obtained a patent for an improved coherer.

When Popov died in 1906 (some records quote 1905), contemporary historians noted his development of apparatus for detecting lightning and credit was given for his work as one of the pioneers of wireless communication. But this could not be construed as evidence that he was regarded as the actual inventor of wireless telegraphy.

Popov & propaganda

That claim came much later, according to the *Electronics Weekly* article, when an official of the Soviet Weights and Measures Department, V.S.Gabel, wrote a commemorative article for *Wireless World* about Popov in 1925, specifically mentioning Morse communication by wireless.

The unfortunate Professor Hughes

If anyone had reason to complain about his treatment by the scientific establishment of his day, it could well have been David Edward Hughes.

Emigrating to America with his family at age 7, he received his early education in Bardstown, Virginia. In 1857, he devised a new form of printing telegraph and, 20 years later, back in London, he developed an improved version of Bell's microphone. Sir Oliver Lodge once described him as 'a man who thought with his fingers'.

But David – by now Professor – Hughes had also become interested in what he called 'aerial' transmission and, in 1879, set out to discover for himself the true nature of electromagnetic waves.

In the process, he succeeded in transmitting signals from one room to another in his Portland St home, using his own transmitter and receiver and his own version of a coherer. He succeeded later in capturing signals over a distance of 500 yards (460m), with a portable receiver and a clockwork mechanism set up in the house to trigger the transmitter.

In February 1880, Professor Hughes arranged a demonstration for the President of the Royal Society, a Mr Spottiswoode, together with two secretaries, Professor Huxley and Sir George Stokes. They were duly impressed but, when it came to the point, Stokes refused to accept Hughes' presentation, asserting that what he had demonstrated could all be put down to 'ordinary induction effects', which they already understood.

Hughes was devastated by their rejection, to the point where he refused even to write a paper for the Royal Society. The record of his research remained unpublished for years and, even then, he resolutely refused to accept any credit for his research into radio telegraphy. Indeed, his work may well have remained unknown but for the support of Sir William Crookes – notable in his own right as one of a perceptive group who foresaw the ultimate possibility of television.

Ironically, most of the above is drawn from Dunstan's biography of Marconi; the more so because, if Hughes' demonstration had been accepted by the Royal Society, he would have gone down in documented history as the man who anticipated the findings of Hertz by nine years, and the supposedly rival inventions of Marconi and Popov by about sixteen!

In fact in 1879, Marconi was still a lad of 15, and just beginning to take an active interest in 'electric waves'.

For good measure, the writer in *Electronics Weekly* adds the name of Sir Henry Jackson, as someone else who may well have been at least as deserving of recognition as Popov. He was the man behind the early use of radio telegraphy on ships of the Royal Navy but, at the time, it was all top secret.

When the claim was queried, Gabel quoted as his source letters from O.D. Khvolson, V.K. Lebedinsky and V.V. Skobelcyn, who all stated that they had been present at the demonstration before the Physico-Chemical Society on March 24, 1896. They recalled that a Morse code message had been received on Popov's apparatus and chalked letter by letter on the blackboard, spelling out the words 'Heinrich Hertz'.

In their minds, there was no doubt that what they saw had been a practical demonstration of wireless telegraphy.

The claims have been maintained ever since. Twenty years later, in 1945, on the 50th anniversary of an earlier but undocumented presentation at the St Petersburg University, May 7 was officially proclaimed in Russia as 'Radio Day' in memory of Aleksandr Stepanovitch Popov, the 'inventor of Radio'.

It would appear from the *Electronics Weekly* article that the Russian claim prompted an engineering-level investigation of the matter, firstly by Professor Howe and later by Charles Susskind of the University of California, using original sources. Susskind published his findings in the *Proceedings of the IRE*, in an issue identified only as 'recently' in the *Electronics Weekly* article.

Susskind's firm findings were reportedly that:

1. On the basis of printed publication, the claims for Popov must fail.
2. If any one person is to be regarded as the inventor of radio telegraphy on documented evidence, it must be Marconi.
3. While there is indirect evidence that Popov did demonstrate the transmission of intelligence by radio, there is comparable evidence that Marconi did so – though not to a scientific audience – at an even earlier date.

The *Electronics Weekly* writer refers to the above findings, but stresses that the claims made on behalf of Popov are not supported by Popov's own actions in not contesting or even disputing the Marconi patents. At most, he claimed parallel and contemporary research.

Popov's own attitude

In this context, David Dunston, in his biography of Marconi, quotes an incident involving the Italian warship *Carlo Alberto* in 1902. It was in British waters for the coronation festivities for King Edward VII, and was being fitted with wireless by Marconi. When the naval review had to be postponed when Edward fell sick, the *Carlo Alberto* was ordered to Kronstadt with Marconi and his equipment still on board, so that King Victor Emmanuel could visit the Czar. I quote:

There was one very significant caller to the cruiser, as she lay in Kronstadt Harbour. Helped on board by an Italian sailor he said: "I want to pay my respects to Marconi, the father of wireless". He was Alexander Stepanovitch Popov, another pioneer worker in radio, who had discovered as early as 1895 that a coherer could detect the presence of storms from a distance.

In view of the fact that Popov has been widely given credit for the invention of wireless himself, and in the Soviet propaganda is usually named as the only pioneer worthy of mention, his remark on that day on July, 1902, needs to be remembered.

Dunstan also records that, when Marconi married in 1906, Popov sent the couple a sealskin coat and a silver samovar – scarcely the action of an embittered man.

Perhaps the reality that emerges from all this is that the question at the head of this article is, itself, out of order. Many pioneers over many long years contributed to the theory and technology of wireless/radio communication, each largely building on the work of others. Even to rank them in order would be difficult enough, but to nominate any one of them as the real inventor of radio would be a highly dubious exercise.

It would appear that, around 1895, Popov and Marconi had ended up with very similar receiving technology, but directed towards quite different objectives. Popov was a mature scientist, interested primarily in the electrical phenomena evident during thunderstorm activity. The idea of applying the technology to communication was an interesting possibility to be pursued as and when time permitted.

But to the young and ambitious 21-year old Marconi, wireless meant exactly what the term implied: communication without wires – as an end in itself. Marconi was an innovator in his own right, but he was also a visionary and entrepreneur. By its very nature, what he did attracted the publicity which he both needed and enjoyed.

But Marconi didn't *invent* wireless/radio communication either. He had the vision to pick up the strands of nineteenth century research, add quite a few of his own and bring them all together into what the world needed – practical and rapid communications across and between continents and with ships at sea.

FORUM

Conducted by Jim Rowe

Letters of support on audio, but an amateur who's hopping mad!

Following our August discussion of dubious claims made by audio and hifi marketing people, a number of further readers have taken up my invitation to write in with their comments. There's also been one more response on the subject of amateur radio – and it's from a reader who very definitely DOESN'T agree with what I said...

As you may recall, I ended the August column with a discussion of a claim made by Andrew Goldfinch of Leisure Imports, regarding the 'directionality' of his QED 'Incon' audio interconnection cables. After expressing doubts both that such a cable *could* be directional, and that we'd find such a characteristic desirable, if it were so, I ended up with the question: "But what do other readers think – am I being too reactionary?"

The first correspondent who wrote in reply to this was Mr Bert Heinemann, of Fairfield in NSW, who makes it fairly clear not only that he didn't find me too reactionary, but that he would have been very unhappy if I *hadn't* taken the line I did. Here's what he wrote:

For my part, no – you certainly weren't being too reactionary!

In a magazine dealing with a technology, an editor commenting on any proposition has a duty to examine it in the light of the objective laws relating to that technology. These laws exist whether we like it or not, and whether we know it or not.

In this case, the application of impedance matching and signal to noise ratio considerations would have been near the centre of the problem. To have NOT raised these questions in examination of Andrew's assertions would have put EA in the public position of dumb acceptance of an audio setup which would not be reproduceable. At least we now have a situation where the readers can weigh up in a more measured way if their money will be well spent in replacing their audio cables.

It appears to me that this problem will probably remain in the insoluble basket. Any instruments would be presumably subject to the same 'distortions' in their wiring as would the amplifiers to which they were connected.

Your approach is in line with all editors of EA, from John Moyle's time – and I've been a reader since then. I definitely approve!

Thanks, Bert, it's nice to get that kind of support. I certainly *try* to maintain the emphasis on objectivity that has been traditional in *EA* for so long, and established so effectively by people like John Moyle and Neville Williams.

Like you, though, I suspect that some of these topics are likely to remain unresolved for some time. And probably for the reason you give: that the instruments and measurements which may be proposed by the 'objectivists', to try and resolve the debates, are likely to be rejected by the 'subjectivists' as supposedly subject to the same 'distortions' which the people in this camp believe they can hear in the audio systems or components concerned. And so it goes on.

It's a pity that audio engineering in particular seems to have polarised into these two fiercely opposed ideological camps, one apparently convinced that the ear is the only true judge of reproduction – with test instruments either irrelevant or misleading – and the other side tending to take the opposite view, that if our current instruments can't measure a problem, it doesn't exist.

Surely neither of these extreme views is correct. We do need objective measurements and sound theoretical analysis, but along with them we need to remember that with audio, our ears are the ultimate judges rather than a bunch of test instruments.

In the past, it has often been the 'golden eared' subjectivists who have prompted their more objectivist colleagues to delve deeper into the theory, and develop new and more refined

measurement techniques, by insisting that they could hear subtle effects which were not registered by existing technology. Similarly it has almost always been the hard-nosed objectivists, with their rigorous measurements and erudite analysis, who have been able to isolate the causes for signal distortions noted in vague terms by their subjectivist friends, and as a result find the ultimate solutions.

This leads me to think that we need both kinds of approach – providing they can be used to complement each other, rather than compete for our total allegiance.

I guess most readers won't be surprised to learn that my personal leaning tends to be closer to the 'objectivist' end of the spectrum. Certainly I tend to feel much happier about a phenomenon if it can be measured, and explained according to a logical theory. I admit to being uncomfortable with, if not bewildered by, many of the explanations and descriptions of audio system performance given by the more extreme subjectivists. But I still regard listening as the final 'acid' test, because of the complexities involved.

But let's pass on to the next letter, which came from Mr J. Hancock of Morphett Vale in South Australia. Mr Hancock sees similarities between some of the claims made for exotic audio cables and the alleged discovery of a new kind of radiation early this century, in France:

After reading the debate regarding the advantages of various audio cables, it puts me in mind of the N-ray affair.

I first encountered this affair in an article by I.M.Klotz in the Scientific American, volume 242, May 1980, page 122. It transpires that in 1903, after the discoveries of alpha rays, beta rays and X-rays, the scientific air was tense with excitement and discovery. Much investigation was being carried out into the properties of these phenomena, and among the investigators was a Professor Renee Blondlot.

During his investigations into X-rays,

Prof. Blondlot noticed that during a particular experiment there was an enhancement of a spark, which could not be caused by any known ray. This must therefore be due to another type of ray. He named this new ray the N-ray, after his home city of Nancy. After he published his results many other scientists around the world confirmed his discovery, and subsequently published papers about the properties of N-rays.

However one scientist who failed to confirm the existence of N-rays in his own experiments was Robert William Wood, Professor of Physics at Johns Hopkins University. To further investigate this effect, Wood went to France to visit Blondlot in his laboratory.

After many demonstrations, Wood failed to perceive the intensity changes due to the presence of the N-rays. During one experiment in a darkened laboratory, Wood surreptitiously removed an aluminium prism that was supposed to deflect the rays. This had no apparent effect on the rays, as the other scientists still claimed to see the effect of the N-rays without realising that the prism had been removed. Wood returned to America convinced that N-rays did not exist.

There seems to me to be a similarity between the N-ray affair and the audio cable affair. They both involve effects for which there is no objective scientific evidence. Both of the effects depend upon the observations of experts, which observations are contradicted by other experts. Both claim to have a basis in science, but this basis is highly questionable.

Before I believe the claims of the experts upon whose perceptions I am expected to rely, I would like to see a little objective evidence to support these claims. Until then, I would suggest that people buy figure-eight power flex and spend their hard-earned money on something with a little more objective benefit.

Thanks for your comments too, Mr Hancock. I can't say that I was aware of the 'N-ray affair', but it certainly sounds as if there are similarities. I guess the moral is that it's easy to be misled into finding what you're looking for, if you're not extremely careful.

Scientists and engineers are no more immune from this effect than anyone else, of course, and that's why the so-called *scientific method* has been evolved over the years – to try to ensure that it doesn't happen. I guess the scientific method wasn't all that strong back in 1903, though, so perhaps we shouldn't be too hard on Professor Blondlot.

But you can't make the same excuse for the claims made by some of today's audio experts. Perhaps that's why some of those experts, notably those on the subjectivist side, tend to scorn things like scientific method as 'irrelevant'.

I certainly agree with Mr Hancock that when a matter seems to boil down almost completely to the opinion of experts, with little if any objective evidence, it's time to worry. Or at least, to treat the subject with a healthy dose of skepticism – especially when the experts can't even agree among themselves.

And so to the third letter which came in response to the August column, from well-known Victorian radio amateur and equipment designer John Day, VK3ZJF (who is also the Technical Director of Stewart Electronic Components). John sent me a very interesting letter, which is a bit long to reprint here in its entirety. However here's a reasonable sampling, which includes the main points he makes:

I've just been sitting having lunch, while reading Forum in the August issue, and couldn't restrain myself from offer-

ing a few comments about some of the issues raised.

1. AC mains polarity is not just an issue of noise distribution. It would be well to bear in mind that much equipment, whilst switching both active and neutral lines, only fuses one. The fused line MUST be connected to the active line, regardless of 'sonic correctness'.

2. AC mains leads are of exceedingly variable quality, not just in terms of cable but of connector attachment. As a general rule I find that the terminations of cable within three-pin plugs is not adequate. Maybe we should always (as I do) remove the three-pin moulded on plug and replace it with a correctly wired and firmly terminated conventional plug.

3. Now to the jewel in the crown of many of the 'golden eared', speaker cables. Objectively or otherwise, it can only be said that the speaker cable business is beset with more than its fair share of grossly exaggerated and unsustainable claims. Get some of them to try this one:

Set up a system with 'Monster Cable', 4-square-mm automotive cable, 2.5-square-mm solid conductor building cable, RG213 coax with one length for each side of the circuit, figure-8 electrical flex and low cost 'speaker' flex. If your results are the same as mine, the 4-square-mm automotive cable wins every time! Why? The answer is obvious: cable resistance.

After that, get the golden ears to look inside some of their favourite commercial speaker systems and see what is used to connect the terminals to the back of the drivers. Usually (in my experience) it's figure-8 electrical flex, or heavy hookup wire – of the unidirectional, single crystal, high conductivity oxygen-free copper type, naturally! (Tongue now leaves cheek!)

4. Now for the piece de resistance – unidirectional low level cables. Again a simple A-B comparison usually knocks out all of the golden ears.

Set up two well constructed amplifiers (I used a pair of AEM-6000 systems). One system using conventional cables, in my case Tandy cheapies (with no disrespect), which can be changed for 'golden ear specials', and the other system with 100% shielded coax cables on BNC connectors. Everyone can pick the Tandy cheapie, but no one has yet twigged to the coax!

I suggest from this that efficiency of the shielding, resistance of the conductors and the contact resistance of the connectors are the important things.

Try this for size. I had a neighbour who used an arc welder a lot at night. My golden eared friends of the day always thought the RG-213 coax sounded better than Monster Cable speaker leads – the reason being that the interference from the welder wasn't getting in.

One day I was asked what had changed in the system. The answer was that I had removed the cheap hookup wire inside the speaker boxes and replaced it with 2.5-square-mm super flexible test lead cable, to reduce the lead resistance.

Remove the silly little terminals on the back and use good quality 30A binding posts on the amplifier and the speakers – unless you use the coax, in which case 'N' connectors are just about ideal. Remember, though, to use one cable for each side of the circuit. The screen of each coax should be connected to shield ground at the amplifier end, not audio ground.

My own research over a number of years has pointed out a few fallacies which have been unthinkingly perpetuated by the golden ears. Rarely, if ever, do they take into account all possible external influences when evaluating such things as leads. Ideally an objective result can only be achieved when the work is conducted inside a screened enclosure, to provide an electromagnetically neutral environment.

As for capacitor sound, valves versus transistors and a few others of that ilk, maybe they are better left alone!

Thanks for your comments too, John. I note your first point about the need to fuse the active lead, in order to meet safety requirements. Like me, you no doubt wonder if the people who undertake to find the optimum 'polarity' for amplifier mains cables bother to re-wire the fusing, and if necessary the switching as well. Somehow I'd be surprised if they do...

I can't say I've struck trouble myself with moulded-on mains plugs, but I have heard of other people who have. Your idea of chopping them off and fitting a standard plug correctly does seem to be the right remedy, especially if there's any hint of trouble.

Your A-B tests with heavy-duty automotive cable and coaxial cable are also very interesting. This kind of test is certainly the only way to resolve some of these questions – especially if the tests are carried out 'double blind', so that neither the subjects nor the experimenter who relates with them knows the exact conditions for any specific listening segment (only a second experimenter, controlling the conditions behind the scenes). That way, there can't be any subtle clues given to 'lead' the responses.

I'm not all that surprised that John has found automotive cable to stand up very well against even the fancy speaker cable, because like him I tend to think that it is mainly a matter of cable resistance. Nor am I surprised to hear that high-grade coax performs well, even for speaker leads. After all it's well known that because of the large amounts of negative feedback applied around most modern amplifiers, RFI and other noise can easily enter the amplifier via the speaker leads.

So shielding may well achieve a worthwhile improvement in the signal-to-noise ratio of reproduction, even when there *isn't* an arc welder next door!

Perhaps we should all be using shielded speaker leads in our hifi systems, as John Day seems to be suggesting, using high-quality coax and suitably reliable low-resistance connectors. Mind you, probably the one advantage of using traditional figure-8 type flex for speaker leads is that because the two leads are close together, most of the common-mode interference will tend to be cancelled.

John's point about the connecting wire used inside speaker boxes is also a valid one. There's not much point going to all sorts of lengths to improve the main cables between the speaker boxes and the amplifier, if the boxes themselves are wired with crummy lightweight hookup wire. In fact that leads one naturally to consider the coils in the crossover network – shouldn't these be wound from really solid wire as well, and perhaps fitted inside shielding cans as well?

One may well ask, I think, where it all ends. Perhaps we should all be going to a lot more trouble than most of us have gone to in the past. But then, assuming we did, how many of us could really tell the difference? I wonder.

Anyway, that's probably enough about audio subtleties for the present. Let's pass on to the other letter that turned up this month, from a reader who very definitely *didn't* concur with things I had written.

Indignant ham

The reader concerned was Neville Thomas, VK5XD, who is apparently Broadcast Officer for the South Coast Amateur Radio Club, in South Australia. And he apparently took great exception to both my original discussion of amateur radio in the April issue, and then the follow-up discussion of other readers' responses in the July issue.

Here are some highlights from his letter itself, which gives at least some idea of the depth of his feelings:

You might well head your Forum column in July as covering the 'initial' response. I hope you get buried alive in protest mail!

Please find attached a copy of the weekly RTTY and PACKET broadcast issued by the South Coast Amateur Radio Club in which the Editorial discusses your 'stir'.

I am writing to you as Broadcast Officer for the SCARC to let you know I respectfully consider your opinion on Amateur Radio experimentation stinks! I have directed my Editorial as an open letter to you and forwarded same by mail as I expect you don't yet know about the sophisticated amateur developed, owned and operated Packet message storage and forwarding system operating world wide.

While the Editorial is entirely my own personal opinion and can therefore not represent that of the SCARC committee or its members, I am able to assure you that your name was 'mud' today.

I think that gives you the idea. Plenty of righteous indignation, liberally sprinkled with invective and underpinned by the assumption that I was entirely ignorant of amateur RTTY and packet radio activities. (I wasn't, as it happens...)

In short, a fairly classical reaction of the kind one tends to get when you're perceived as having attacked a 'sacred cow' – with rather more heat than light.

By the way, have you ever noticed that when someone says "I respectfully consider..." or "With all due respect..." it usually means they're about to do just the opposite, and insult you? Funny, that.

There's also a sprinkling of the same kind of emotion here and there in Mr Thomas' Editorial, as you'll see. I don't have the space here to reproduce it in full, but as he does raise some interesting points that are indeed relevant to the original discussion, I'm quoting as much as I can. After his initial introduction to set the scene, he proceeds thus:

I think Jim is quite wrong. He has missed out somewhere on the gradual change in direction that amateur radio has taken in the past 20 years. The days of building one's own big black box are long dead and gone. Of course people are going to want the highly sophisticated commercial equipment with its at-

tendant low price, quality and reliability. What possible purpose is there in even attempting to emulate commercial standard transceivers with one's limited resources at home? Sorry Jim, if you're still dabbling with 50's technology in a 90's environment maybe you should let someone else have a crack at the Editor's job!

Amateur radio is as different today from what it was in the 50's as is the technology of the two eras. The diversity of new modes introduced since then, the introduction of new technology and the ready availability of microcomputers has turned the hobby upside down. Individuals all over the country are using nice, new flashy commercial boxes to do the easy bit – RF transmission and reception. It is WHAT THEY ARE DOING WITH THE COMMERCIAL BOXES that is experimental.

Who said amateur experimentation is dead? I wonder if Jim has read the recent Electronics and Wireless World article 'Putting AX25 To Work'? This well-respected UK publication certainly recognises the experimental work being undertaken by amateurs, when it pours accolades upon its amateur developers. The developer of the original CCITT X25 protocol, Eric Scace is even an amateur. Jim my boy – your argument is looking a bit thin!

Where was Jim Rowe when the umpteen amateur radio satellites which have been placed in orbit were being developed, built and launched? Is he not aware of the major work undertaken by amateurs in the field of space technology – digitalkers, PACSAT, MICROSATS, earth imaging, tracking software and equipment, etc. Has he never heard of well respected amateurs like Jim Miller, G3RUH and the marvellous work he has achieved, and our own Graham Radcliffe, VK5AGR? Come on fella – get with it.

Perhaps Jim has never heard of the excellent work undertaken by Peter Martinez (G3PLX) on AMTOR, now about 10 years old. Is there any danger Jim has come across the vast ocean of amateur radio software, that can turn a simple

8-bit computer like a Commodore 64 into a sophisticated communications terminal? Would it be too much of a shock for poor old Jim if he was exposed to an Amiga 500 running SSTV, or displaying the latest hi-res weather satellite pass?

Experimentation dead? What a lot of cock 'n bull. I think you should be made to eat a Shepparton TNC220+ (the results of the efforts of the Melbourne Packet Users' Group). A video could be taken for showing on every amateur built TV repeater in Australia. Amateur slow scan TV pictures of you choking on the pointy bits could be sent to others (in full colour of course).

CoCo NUTS to you Mr Rowe ... de Nev. T (VK5XD).

Well – that last image of me being forced to eat a packet radio terminal unit on amateur TV is pretty graphic, don't you think? I guess it's Mr Thomas' high tech and 'sophisticated' equivalent of giving me a tar-and-feather job.

It just shows you, these radio hams can get rather nasty when you have the temerity to even question an aspect of their activities. I only hope that Mr Thomas and his mates haven't been working on an amateur ICBM, or I could be in real trouble!

Seriously, though, as I said in my first article I didn't *want* everyone to agree with me. So in that sense it's good to get some critical response at last, even if in this case it *is* laced with rather more invective than logical reasoning. Can't have everything we want in this life, can we?

Of course I didn't suggest that there were no amateurs still carrying out experimentation. Of course there are, and they've achieved a lot. As Mr Thomas notes, all sorts of good work has been done in a variety of areas – packet radio, satellite communications, radio fax and so on. Certain groups of amateurs have also been very active in marrying the two technologies of radio communications and microcomputers. That's fine – and as someone with a well-known interest in both areas, I'm the first to applaud their efforts.

But the point I *was* making was that I believe the amateurs doing these things are nowadays a relatively small percentage of the whole – perhaps about 3%, or say 500 among the 18,000-odd licensed hams in Australia. The rest of them seem to have either lost interest altogether, or simply bought one of Mr Thomas's 'nice, new flashy commercial boxes' and have settled down to 'do the easy bit' (his words) of RF transmission and reception – mainly chatting about the weather and 'the rig 'ere' with their old mates. Which is fine if that's what they want to do, of course, but to my mind it isn't much different from CB radio. I suspect that deep down, Mr Thomas might even agree with me...

So quoting a few outstanding ham radio experimenters and pioneers may make great grandstanding, Mr Thomas, but it doesn't really prove me wrong. I wish it did.

You may well be right that amateur radio is now quite different from what it was in the 1950's, with radio gear itself now almost incidental and best bought off the shelf rather than built up oneself. But if that's the case, why bother forcing hams to study how transmitters and receivers work? In fact why bother to make them get an amateur radio licence at all, if they're just going to be buying and using a few commercial boxes?

You may as well just treat them the same way as CB operators, following Mr Thomas's line of reasoning. After all, we don't need to pass an exam and get a licence to use a phone, a modem or a fax machine.

If all the 'real' action in amateur radio is now involved with ever more 'sophisticated' (Mr Thomas certainly seems to love that word) ways of sending information through those black boxes, as he claims, and the radio link itself is no longer of any great interest, then I can see why so many young people have been attracted to hobby computing and data communications. Why would they bother getting a ham radio licence?

Perhaps that's why the average age of all radio amateurs in Australia, the USA and Europe has now become no less than 51. Amateur radio is more and more becoming a hobby for old men, it seems. The young people are presumably going straight to where the action is, and forgetting all this radio 'nonsense'.

Perhaps Mr Thomas *is* right, and playing with transmitters, receivers, antennas and similar 'unsophisticated' equipment is old fashioned and corny. Perhaps he's also right in suggesting that you can't do anything worthwhile unless you go out and buy a shiny multi-band, multimode commercial transceiver with a 'low price' tag of typically two thousand dollars.

But if he is, I suggest that amateur radio as such really *has* died.

Frankly, I hope he's wrong. What about you?

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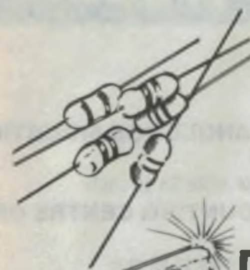

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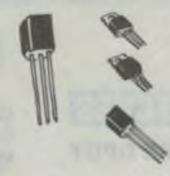

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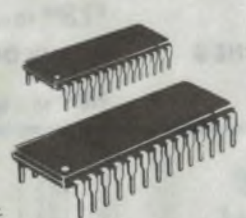

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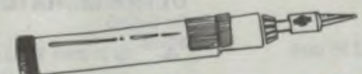

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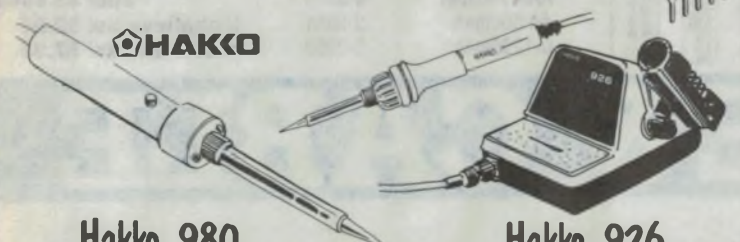

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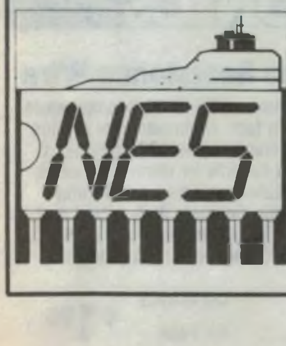

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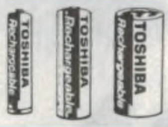

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- Audio Cable
- Cable Wrap (Spiroband)
- TV & Communications Cables
- Data & Computer Cables
- General Purpose Cable
- Telephone Cable

Great discounts are available for whole roll purchases. We also stock a great variety of colours in hook-up and coax cables. You'll even find a fantastic range of specialist cables like Kynar wire wrap wire, teflon coax and polyurethane coated winding cables in ready to go packs. If you can't find the wire you need, ask our staff - we're bound to have it!

DICK SMITH ELECTRONICS

"Big Stuff" - Super OFC!

Outstanding Speaker Cable

Extra high quality, extra thick (256 conductors), low loss and made from Oxygen Free Copper for superb performance! If you don't believe cable can make an audible difference to your Hi-Fi system, "Big Stuff" will change your mind. It's fantastic for long runs!
Cat W-2015

100m or More $2.25/m **$2.95/m**

Cuprothal Resistance Wire

Suitable for the construction of all wire wound resistors, small heater elements, shunts, etc where the wire temperature is below the incandescent temperature. Also perfect for emitter resistors in high power amplifiers. Can be cold or hot worked and is highly resistant to corrosion. Wire Size: 28 B&S (0.32mm diam.) Solderable: Yes. Resistance: 6.092 ohms/m. Non Magnetic (45% Nickel, 55% Copper). Maximum continuous service temperature: 540 degrees C.
Cat W-3200 4m Pack **$1.10**

Nichrome Resistance Wire

The ideal resistance wire for high temperature applications! In fact, Nichrome wire retains its high performance up to 1200 degrees C which makes it suitable for electric furnaces, temperature heaters and high temperature tubular elements. Consists 80% nickel and 20% chromium. 0.32mm diam. (28 B&S). Resistance at 20 degrees C: 13.4 Ohms/m.

Cat W-3205
4m Pack **$1.95**

JUST WHAT THE AUDIOPHILE ORDERED!

New Speakers?

Whether you're building a new speaker system or wanting to improve the old with more efficient drivers, here's a fantastic range of quality speakers that give great sound.

They're all high compliance speakers offering smooth transition right across the frequency range. Featuring large magnets, polycarbon cones and foam surround free-edge suspension system. The result - it's music to your ears!

300mm (12")
Coil Impedance: 8 Ohms
Rated input Power: 40 Watts
Maximum Input: 80 Watts
Free Air Resonance: 25Hz +/- 5Hz
Upper Frequency Limit: 6KHz
Sensitivity: 96dB @ 1Watt, 0.5m
Magnet weight: 848g
Cat C-2040 **$79**

250mm (10")
Coil Impedance: 8 Ohms
Rated Input: 40 Watts
Maximum Input: 80 Watts
Free Air Resonance: 40Hz +/- 8Hz
Upper Frequency Limit: 6KHz
Sensitivity: 94dB/W +/-3dB @ 1 Watt, 0.5m
Magnet Weight: 848g
Cat C-2041 **$69**

200mm (8")
Coil Impedance: 8 Ohms
Rated Input: 30 Watts
Maximum Input: 60 Watts
Free Air Resonance: 40Hz +/- 8Hz
Upper Frequency Limit: 8KHz
Sensitivity: 92dB/W +/-3dB @ 1 Watt, 0.5m
Magnet Weight: 502g
Cat C-2034 **$49**

162mm (6 1/2")
Coil Impedance: 8 Ohms
Rated Input: 30 Watts
Maximum Input: 60 Watts
Free Air Resonance: 55Hz +/- 11Hz
Upper Frequency Limit: 6KHz
Sensitivity: 87dB/W +/-3dB @ 1 Watt, 0.5m
Magnet Weight: 283g
Cat C-2042 **$29**

25mm (1")
DOME TWEETER
Coil Impedance: 8 Ohms
Effective Frequency Range: 2Hz-20KHz
Sensitivity: 100dB/W +/-3dB @ 1 Watt, 0.5m
Magnet Weight: 152g
Cat C-2044 **$19.95**

High quality gold Interconnecting Cables

You can spend hundreds or even thousands of dollars on Hi-Fi and video equipment only to limit it's potential sound and visual quality by using 'cheap' connectors. It's a little like buying a Porsche and using standard grade petrol. With the amazing **Pheonix** range of inter-connecting cables on you'll finally get the quality you've already paid for, yet never realised. Add to this the anti-corrosion factor and you'll get years of trouble free service.

Description	Cable Length	Cat No	Price
Audio (RCA-RCA)	1m	C-1305	**$16.95**
Audio (RCA-RCA)	2m	C-1309	**$19.95**
Shielded (RCA-RCA) OFC	1m	C-1312	**$34.95**
CD Cable (Shielded) OFC	9m	C-1314	**$49.95**
Video (RCA-RCA) OFC	1m	C-1316	**$19.95**
Video (BNC-BNC) OFC	1m	C-1318	**$22.95**
A/V (RCA-RCA) OFC	2m	C-1320	**$44.95**

Want The Best Sound? Gold Series Plugs & Sockets

When you want the best sound from your music system then you'll go straight for the gold. For a better, long lasting inter-connection, high quality Dick Smith Electronics gold flash metal plugs and socket for the astute audiophile.

6.5mm Mono Plug
Cat P-1163
$2.50 10 up $2.25

6.5mm Stereo Plug
Cat P-1167
$2.95 10 up $2.65

RCA Line Socket
Red Cat P-1411
Black Cat P-1413
$1.95 10 up $1.75

RCA Bulkhead Mount Socket Red
Cat P-1431
Black Cat P-1432
$3.95 10 up $3.55

6.5mm Right Angle Plug
Cat P-1164
$4.95 10 up $4.45

RCA Plug Red
Cat P-1425
Black Cat P-1427
$1.45 10 up $1.30

2.5mm PINS
Push terminal pins.
2 pair
Cat P-1390 $15.95

SPEAKER WIRE PIN CONNECTOR
14 to 8 AWG wire. 24Kt Gold. OFC. 2 Pair
Cat P-1392
$15.95

BANANA PLUGS
1 Pair. Metal
Cat P-1382 $17.95/pr

BANANA PLUGS
2 Pair. Plastic
Cat P-1384 $15.95

SPADE LUGS
2 Pair.
Medium Cat P-1386
Large Cat P-1388
$5.95/Pk

RCA SOCKET - BNC PLUG
Cat P-1380 $7.95

Pro-Series Plugs and Sockets

NEUTRIK

Professional quality plugs and sockets by one of the world's most reputable suppliers to industry and music. Once you pick up a Neutrik plug or socket, you know you're holding the best you can get.

PLUG MONO 6.5mm
Cat P-1578
$5.95

PLUG STEREO 6.5mm
Cat P-1580
$8.95

PLUG RIGHT ANGLE 6.5mm
Cat P-1582
$10.95

LOCKING LINE SOCKET STEREO 6.5mm
Cat P-1584
$8.95

LOCKING PANEL SOCKET STEREO 6.5mm
Cat P-1586
$9.25

Makes PCB Interconnection Easy! Pin Header Plugs, Sockets & Arrays

Lasting quality Pin Headers/sockets all with standard 2.54mm pitch, gold flashed for longer life.

25-WAY Snap off. SIL
Cat P-2726
$3.30 10 or more $2.97

25-WAY Snap off. DIL
Cat P-2728
$4.25 10 or more $3.80

JUMPER SHUNTS
Pack of 5.
Gold flash.
Cat P-2730 $1.95

LOCKING PIN HEADERS

2-Way SIL
Cat P-2732
50c 10 or more 45c

3-Way SIL
Cat P-2736
85c 10 or more 70c

12-WAY SIL
Cat P-2740
$2.25 10 or more $2.03

3-WAY PLUG SIL. IDC
Cat P-2738
$1.25 10 or more $1.13

12-WAY SIL IDC
Cat P-2742
$2.55
10 or more
$2.30

HEADER PLUGS IDC
No Crimping or Soldering!

2-WAY PLUG SIL IDC
Cat P-2734
80c 10 or more 72c

DICK SMITH ELECTRONICS

With Antenna Deal!
Bargain AM CB

An exceptional value AM CB that's now even better value -you get a special deal on a mobile antenna! Quality construction and reliability are built in. Intended for mobile use it comes with mounting hardware and microphone. With optional power supply it can even be used as a base station.

Features:
- **Compact (Only 160 X 44 X 122mm)**
- **All 40 channels**
- **Maximum legal power**
- **Built-in noise limiter**
- **Digital channel readout & power/ strength indicators**
- **Easy to operate**

Cat D-1450

Just $89 with $10 saving on D- 4076 5ft antenna pack at $14.95

Extra Range with....
PRO 640e AM/SSB CB

uniden

With the incredible Uniden Pro 640e AM/SSB CB, you know you've purchased the most advanced mobile radio you can get! Operates over any of the 40 AM, 40 USB or 40 LSB frequencies, has maximum legal power and instant access to channel 9.

Stunning design with pushbutton selection for Ch9/ANL/SWR/PA/HI-Cut & RF attenuation. LED channel readout and clear LED indicators for TX/RX and LED meter for S/RF/SWR give you all the information you need at a glance. A powerful 7 watt audio stage makes itself heard above noisy environments. Comes complete with mounting hardware and quality microphone.

Cat D-1480

$369

-2 Year Warranty-

The Amazing 3-In-1 Modular Tool System....

- **It's a DRILL**
- **It's a SOLDERING IRON**
- **It's a SCREWDRIVER**
- **It's RECHARGEABLE!**

A fantastic tool that makes a great gift for hobbyist, handyman and tradesman alike. It's really three tools in one! Modular components fix to a rechargeable battery pack (handle) and in seconds you can switch from a soldering iron to a drill, from a drill to a reversible screwdriver, etc. etc.

It's easy to handle and the pistol grip action leaves one hand free to make working a breeze! Comes complete with assorted drills, screwdrivers, solder accessories and charger.

Cat T-5712

Only $99

Professional Quality & Performance!
DSE Soldering Station

Work is so much easier with the right tools! A temperature controlled soldering iron gives you all the flexibility and speed you'll need to get the job done. Features fully variable temperature control (around 200-500 degrees Celsius) with temperature meter so you know what's happening at a glance. It's fully approved by the energy authority and comes complete with a superb, well balanced iron, lightweight iron holder, cleaning sponge, instruction manual and full servicing information.

Cat T-2000

Just $135

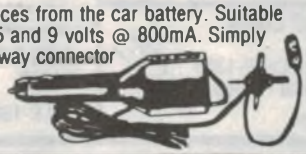
POWER SUPPLIES AND CHARGERS

3 Voltages!
Car Voltage Converter

Save batteries and run your portable devices from the car battery. Suitable for high current devices. selectable 6, 7.5 and 9 volts @ 800mA. Simply plugs into the cigarette socket. Includes 4-way connector and battery "snap".

Cat M-9584

$15.95



Slimline Battery Charger

ARLEC

Designed to charge the two most popular batteries - AA and 9 Volt. Can charge up to 8 penlight (AA) NiCads and 2 X (Volt batteries at once. Includes indicator LED for each cell.

Cat M-9512

$39.95

6 Voltage Selections!
Versatile Power Supply

The ideal power supply to have around the house. Select any one of six voltages - 3, 4.5, 6, 7.5, 9 & 12V (@ 300mA). Covers most household appliances.

Cat M-9526

$18.95

3,6,9V @ 200mA
Power Supply

Here's a great way to save money on batteries for all those appliances around the house! Three of the most used voltages makes it ideal for a huge range of battery powered equipment.

Cat M-9525

Just $17.95

With Overload Protection!
3,6,9,12V DC @ 1 AMP

This ones not only great for the home but also perfect for the workbench. With Dc connections via screw terminals on front of unit for easy connection and disconnection. Ideal for alarm systems, intercoms etc.

Cat M-9530

Only $29.95

Ideal For Trucks!
24/12V Convertor

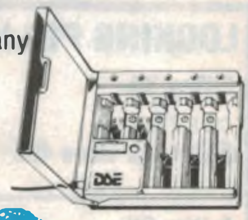
A sturdy regulated supply that's perfect for running CB's, stereo systems, etc in trucks with 24 volt systems (even some caravan parks supply 24V). Gives 13.8V @ 2 amps DC. Suitable for in-dash or under-dash mounting. Comes with mounting hardware and instructions.

Cat M-9810

$69.95

Up To 8 Batteries At Once!
Bargain Nicad Charger

A great way to save money on batteries and make sure you've always got power when you need it! The DSE Charging Cabinet charges all the most common batteries, up to 8 at once, in any combination - AAA, AA, C, D & 9 volt. With indicator lights for each cell and reverse polarity protection. It's mains operated and comes with built-in test meter.



Cat M-9505

Only $39.95

DICK SMITH ELECTRONICS

LOOK WHAT YOUR COMPUTER CAN DO!

Play Music!
Creative Music System

The Creative Music Synthesizer card simply plugs into your IBM compatible and allows you create your own stereo sounds. With 12 channels (Voices), stereo output, 32 preset instruments and a stereo amplifier to drive speakers, headphones, etc.
Define your own instruments, play background music, create albums of your favourite tunes and play them in any sequence or compose your own music...it's fantastic!
Cat X-2020

$299

Talking With...
The Speech Thing

How long since your computer's had a good conversation? "Speech Thing" is a complete hardware and software package which adds sound capability to your PC.
Converts text (either from keyboard or ASCII files) to high quality speech. Simply plug Speech Thing into the parallel port and keyboard (comes with adaptors) - and it doesn't interfere with their operation. Can be used in conjunction with the 'Voice Master' (X-2038) to sample and edit digital sounds.
Cat X-2036

$149

IBM AT Compatible 80286 Motherboard

Building your own computer or upgrading the old one? Our new 12MHz motherboard is the way to go for the ultimate computing power. DRAM not included.
Look....
• Expandable to 1Mb using 256K chips • Expandable to 4Mb using 1Mb DRAM chips • Keyboard or hardware selectable 8/12MHz operation • Six 16-Bit and Two 8-Bit expansion slots. • Selectable for RAM speed - 80 or 100 nanosecond • Selectable from 0 wait states on read operations (with 80 nanosecond RAM) • Socketed for 80287 Co-processor • Performance - 13.7 using Norton S.I. • Battery backed real time clock on board • AMI Bios ROM's included • 0K RAM supplied
Cat X-1002

$499

Tell It What to do!
Voice Master

How often have you wanted to tell your computer what to do? With Voice Master you can give it verbal commands. You want DOS? Just TELL the computer and it'll get it for you.
Comes complete with headset and software which allows you to experiment with voice recognition. With it you can set up to 256 different voice activated keyboard macros. Installation requires an 8-bit expansion slot. The perfect match for "Speech Thing"!
Cat X-2038

$199

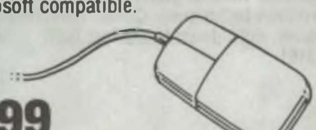
RS-232 Multilink Adaptor

A complete in-line tester/ adaptor which makes complex and time consuming Serial connections a breeze! Comes fitted with 25 pin male connector and 25 pin female connector. With jumper pads and wires, 24 in-line switches and 8 bicolour LED's which monitor the lines and tell you at a glance when you've got it right.
Cat X-2654

$49.95

With Dr Halo!
Bargain Super Mouse

Outstanding quality at a bargain price! Plugs into any serial port and comes with 9-25 pin adaptor. Complete with set-up disk, drivers, manual, Dr Halo paint program, mouse Pad and 'mouse house' so you can pack it away when not in use. Fully Microsoft compatible.
Cat X-3805

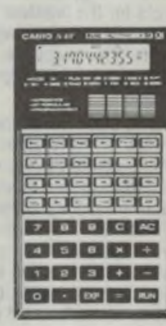


Only $99

Bus Version. Saves your Serial port.
Cat X-3806 **$129**

With Electronics/ Electrical Formula!
Casio fx-61f Calculator

It's one of the most useful tools anyone working with electronics could have. With 27 of the most used electronics formulas built-in! Resonance frequency, impedance, voltage/current gain...everything! Includes 74 scientific functions, 10 digit display, programming functions ....it's unbelievable.
Cat V-3828



Just $79.95

Quality Disk Drives

Easy to install in any IBM compatible! Great value half height floppy disk drives in all of the available configurations. Can be installed as an internal drive or externally (with optional case.)

3.5" Disk Drives
720K Version. Needs DOS 3.2 or higher. **$249**
Cat X-2220
1.44Mb Version. Needs DOS 3.3 or higher. **$299**
Cat X-2221
5.25" Floppy Disk Drives 360K **$199**
Cat X-8012

Arcade Quality!
Commodore/Atari Joystick

It's almost indestructible! Uses microswitches for the ultimate in speed and reliability. With twin fire buttons.

It uses the same mechanism they use in arcade machines...so you can be sure it's built to last...and last..and....!
Cat X-3831

WITH 3 YEAR WARRANTY!

$54.95

IBM/Apple Joystick

Versatile, fantastic value and it can be used on either IBM or Apple II compatible computers. Lightweight and comfortable it's the best way to get into those fast action games.
Cat X-3570

Just $39.95

COMPUTER PROBLEMS? Call our exclusive **COMPUTER HOTLINE** on (02) 888 2002 for the solution!

DICK SMITH ELECTRONICS

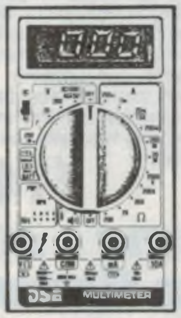
TEST INSTRUMENTS

Includes Battery Check!

3.5 Digit With TR, Diode & Continuity

A bright change for the toolbox! Includes all the usual ranges, current to 10A and resistance to 200megs... Plus a continuity checker with a fast 100ms response time, a diode and transistor checker and battery checker (it tests under actual load conditions). Takes a single 9V battery (and tells you if it's low) and comes complete with a flip down handle that doubles as a stand.

Ranges:
DCV: 0.2, 2, 20, 200, 1000V
ACV: 0.2, 2, 20, 200, 650V
DC: 200uA, 2, 20, 200mA, 10A
AC: 200uA, 2, 20, 200mA, 10A
Resistance: 200, 2k, 20k, 200k, 2M, 20M, 200M
Transistor Check: Hfe
Diode Check: 1mA, 3.2V
Continuity: Buzzer
Battery Checks: 1.5V(@ 200mA), 9V(@ 6mA)
Cat Q-1445



A Good One!

$84.95

Unbelievable Features and Value!

20MHz Dual Trace CRO

It's just astounding at the price! The DSE Dual Trace CRO with inbuilt component checker has features you'd be lucky to find on models which cost much more. It's a professional quality dual trace with outstanding performance, an economical price...and looks to match!

Features 20MHz bandwidth (-3dB), single or dual trace modes, dual trace in chopped or alt. mode, 2 probe sets, inbuilt component checker - for capacitor, inductors, transistors, diodes, zeners, etc, and more!

Specifications:
DC-20MHz (-3dB), with < 17.5ms rise time and 3% overshoot
Deflection: 5mV/div to 5V/div in 10 calibrated steps
Accuracy: +/-3%
Timebase: 0.1us/div to 2/div in calibrated steps
Triggering modes: peak or normal from either/ both channels or external
Trigger sensitivity: 0.5V/div
Sweep delay: 0.1us to 10ms in 6 steps
Cat Q-1260

Value! $995

What's more, we'll be selling this model next year. Beware of cheap clearance models!

NEW KITS SOON TO BE RELEASED!

Simple FM Transmitter For The 2Mtr Band

NEW

The first in a great new series of easy to build projects for the amateur radio enthusiast. It's designed to make setting up and construction easier so the novice can more readily follow the operation and therefore gain more confidence in its use.

The solid state NBFM transmitter module produces over 1 Watt at 144MHz. The operation is simple where the signal from a microphone is amplified to form a modulation input of a variable-frequency crystal oscillator. The oscillator frequency, around 24MHz, is multiplied in two stages, first a tripler ... then a doubler to 144MHz. The resulting signal is amplified through several stages before being fed to an antenna. Short form kit contains components and PCB.
Cat K-6010

A Much Improved Light Chaser

It's miles ahead of previous models! Our new Light Chaser is low in cost, easy to build, incredibly flexible and it's designed with safety in mind.

Providing 6 different chasing patterns, 8 speeds, an enhanced front-panel monitor display and the ability to run lamps to a total of 2400 watts. When the design was first conceived by our R & D Department safety was considered paramount, so it was decided the best way to achieve this was to build a 'dedicated' chaser. This also allows many more functions to be incorporated without getting into complex construction techniques. Comes complete (full form), right down to the last bolt!
Cat K-3161

NEW

Incredibly Small!

FM Wireless Microphone

NEW

This one is great! The FM Wireless Microphone is small enough to be inserted into a matchbox, can be tuned to operate at around 90MHz (On your FM receiver), incredibly stable, extremely sensitive circuitry and relatively easy to build. It's fantastic!

You can use it as a bug (when you're playing around) or even as a link between, say, workshop and house, etc. Comes as a short form kit with components and PCB. Also includes batteries.
Cat K-5006

Communications On & Between Bikes!

FM Radio Intercom For Motor Bikes

NEW

This has to be the best device for motorcycles since they replaced horseshoes with wheels! A true FM intercom which allows communication between passenger and rider as well as between bikes. Not only that, but it also doubles as an FM receiver for your favourite radio station.

The transmitter and receiver are housed in a small case which fits in the jacket pocket. The speaker and microphone are fitted in the helmet. As well, the microphone is voice activated to save switching. Beware though, it is not easy to build and is best tackled by someone with a sound knowledge of kit construction. Comes complete - ready to assemble with all components, board, mic, speaker and case. Powered by three penlight batteries (not included).
Cat K-6020

DICK SMITH ELECTRONICS
PHONES
TOYS & LEARNING
SECURITY
AUDIO
COMMUNICATIONS
COMPUTERS
HOME ELECTRICALS

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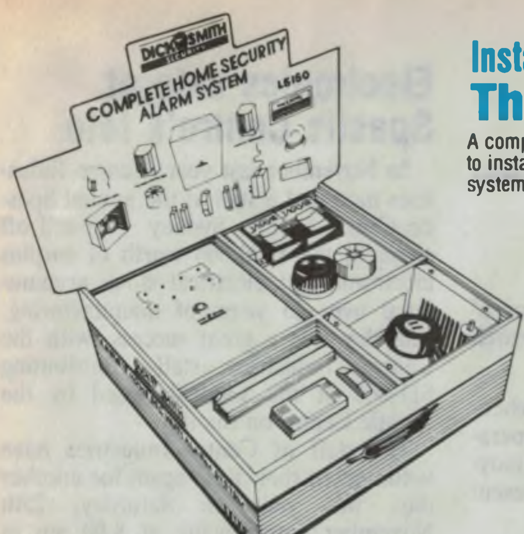
'Dick Smith Electronics - Still Full of Surprises'



Install Your Own Professional System

The Complete Home Security Pack

A complete, professional quality security system in a carry-away pack. You'd be surprised how easy it can be to install yourself. And it's outstanding value! There's everything you need for a comprehensive home security system....and we mean everything!

Look What You Get...

- High quality 4 Sector Control Panel - The heart of the system.
- 2 Passive Infrared Detectors - for large area surveillance. Eg. Hallway, entrance, room.
- 2 Reed (Magnetic) Switches - For window and door protection.
- Siren Horn and heavy Metal Cover with tamper protection.
- Internal Screamer, Panic Button and Strobe Light
- Back-up Battery, Power Supply and 100m of Cable
- Plus Deterrent Stickers and Installation Manual.

Cat L-5150

ALL This For Only

$599

Ideal for Home Units!

Complete Wireless Security

Our "wireless" home alarm is ideal anywhere wiring is difficult or impractical - the system offers complete security and can be installed in little more than an hour -and you don't need an extensive tool-kit to do it.

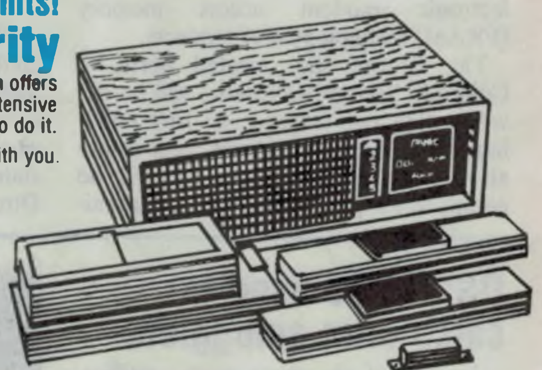
What's more, when you move house, you can easily pack it up and take it with you. Comes With....

Central Control Unit - simply plugs into the mains and is left on a shelf or in a cupboard.

Two Magnetic Sensors - easily fitted to doors or windows.

Passive Infrared Detector - for installation in entrance-way, hallway, room, etc.

Remote Controller - allows you to operate the system from the palm of your hand, just like your VCR, etc. Cat L-5125



Just $399

WE'VE A GREAT RANGE OF TV ANTENNAS!

Economical Indoor

If you're lucky enough to live in a strong reception area, then this is all you'll need for a good picture. These old-faithful spiral antennas have been doing a great job for yonks. Cat L-4010

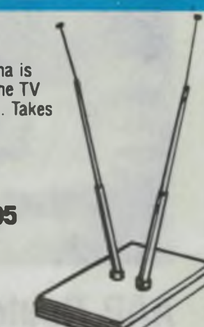
That's Value!

$9.95

Rabbit Ears

Perfect where an outdoor antenna is too much trouble. Just sits on the TV and can be adjusted in seconds. Takes arms for maximum adjustment. Cat L-4015

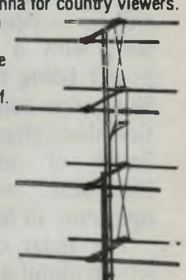
$19.95



Phase Array Antenna

A superb long distance VHF antenna for country viewers. Made from high quality corrosion resistant materials for longer life. Gives you the chance to get those stations which are normally out of your reach. Easy to install yourself. Cat L-4025

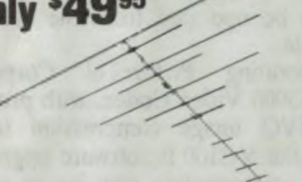
$129



Budget UHF/VHF Antenna

An fantastic low price for a combined UHF/VHF antenna that's ideal for metropolitan or good reception areas.... and you can easily install it yourself! Made from quality corrosion resistant materials for longer, trouble free life. Cat L-4001

Only $49.95



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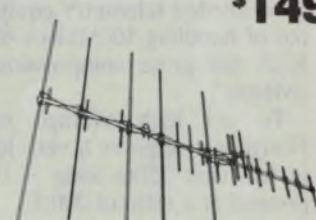

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DICK SMITH ELECTRONICS

News Highlights

Ramtron building US manufacturing, R&D facility

Ramtron Australia's US based microelectronics subsidiary, Ramtron International Corporation, has broken ground on a new A$26 million headquarters, manufacturing and R&D facility. The 68,000 square foot building will be dedicated to the development and manufacture of Ramtron's ferroelectronic random access memory (FRAM) technology and products.

The 32-acre site, located north of Colorado Springs, Colorada, will be developed in two stages. The first building, on a 6-acre landscape, will house all of Ramtron's personnel and will be equipped for pilot production of sub-micron feature size FRAM products on 6″ silicon wafers plus on-going research and development activities.

Completion of the building is scheduled for June 1990. When fully operational the facility will house 220 employees, more than triple Ramtron's present workforce of 65.

"The construction of this new manufacturing facility signals product commercialisation of FRAMs and with it Ramtron's entry as a major force in the worldwide semiconductor industry," stated Mr Brian Harcourt, Managing Director of Ramtron Australia.

Electronics sale at Spastic Centre's fete

In November last year, Centre Industries mounted a stall at the annual Spastic Centre Fete in Sydney – to sell off some of the $400,000 worth of surplus electronic and electrical stock accumulated over 25 years of manufacturing. The day was a great success, with the Centre Industries stall contributing $11,000 of the $30,000 raised by the Spastic Centre on the day.

The staff of Centre Industries have volunteered their time again for another day, this year on Saturday, 25th November commencing at 8.00 am in the Spastic Centre grounds, Allambie Road, Allambie Heights.

As well as surplus stock from Centre Industries, this year bargain hunters will also be able to pick from electronics stock and instruments, donated to the Spastic Centre by various suppliers.

DSP chips used to catch drug smugglers

In one of the more exotic applications, GE Government Services in the USA, is using Inmos DSP chips in a drug-smuggling radar system being developed for the US Customs Service.

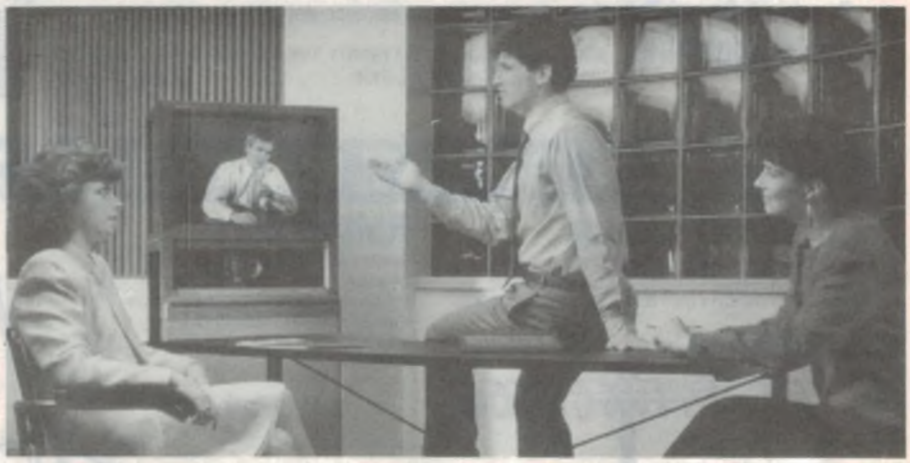
The pulse-compression radar system will be suspended from a tethered aerostat, with a maximum of 1.5kW of power being transmitted via the tether. But pulse compression yields a resolution that otherwise would have required 3mW of input power, says Jim Houyouse, senior engineer at GE's operation in Melbourne, Florida.

The radar can pinpoint an object to within about a twentieth of a mile. Each of six correlators, or processors, in the radar contains 18 Inmos A100 DSP chips.

"We would have had a tough time building it without the A100s," says Houyouse. "Weight and power are important. If we couldn't have put it inside the airborne system, we would have needed telemetry equipment capable of handling 100Mbits/s of telemetry. With the pulse compression, we need 1Mbit/s".

To get high average power, says Houyouse, requires a very long pulse – in this case 150us long – that is compressed at a ratio of 200:1.

DSPs come into play because of their high-speed multiply-accumulate capability, and the Inmos A100 proved especially appealing because of its pipeline-processing, dual-register architecture.



AAP Reuters cuts the cost of teleconferencing

Teleconferencing – or two-way video communications – has been available for a number of years. However, prospective users were faced with high entry costs for equipment and the dedicated telecommunications bandwidth required to operate the system.

This has meant that, until recently, the technology for teleconferencing has generally only been available to videoconferencing bureau operators or to companies with considerable excess telecommunications capacity. However, now AAP Reuters Communications, in conjunction with the US company PictureTel Corporation is offering a new development in dial-up teleconferencing. The PictureTel V-3100 Videoconferencing System supports two-way full motion video, audio and graphics and data communications, at data rates ranging from 56 to 384-kbps on digital networks.

Compact and portable, the unit is neatly styled for use in any meeting environment, from a small conference room to a board room. It is flexible enough to address most teleconferencing requirements. The system is easy to use, with a simple push-button panel that can be operated from the conference table.

Incorporating PictureTel Corporation's C-3000 Video Codec, with proprietary HVQ image compression technology, the V-3100 is software upgradeable to accommodate new image compression techniques, including the proposed CCITT PX64 standard.

The system is compatible with both today's digital networks and future ISDN networks.

Federal Government Grant for optoelectronics R&D

A $1,178,000 grant to aid research and development that will underpin the next generation of optoelectronic communications and sensor technologies has been announced by the Government's Industry Research and Development Board.

The University of Sydney's Optical Fibre Technology Centre and BHP's Research Laboratories in Melbourne will be the principal research and commercial partners in the project, which will run for three years from July 1989.

Support for the theoretical aspects of the work will be provided by the internationally renowned Optical Sciences Centre at the ANU.

Other commercial partners are Australian Optical Fibre Research, of Fyshwick ACT; Fibernet Pty Ltd, of Rowville Victoria; and OTC Australia.

The Applications Specific Optical Fibres (ASOF) Project aims to develop materials, fibre design and fabrication technologies to underpin the next generation of optoelectronic communications and sensor technologies.

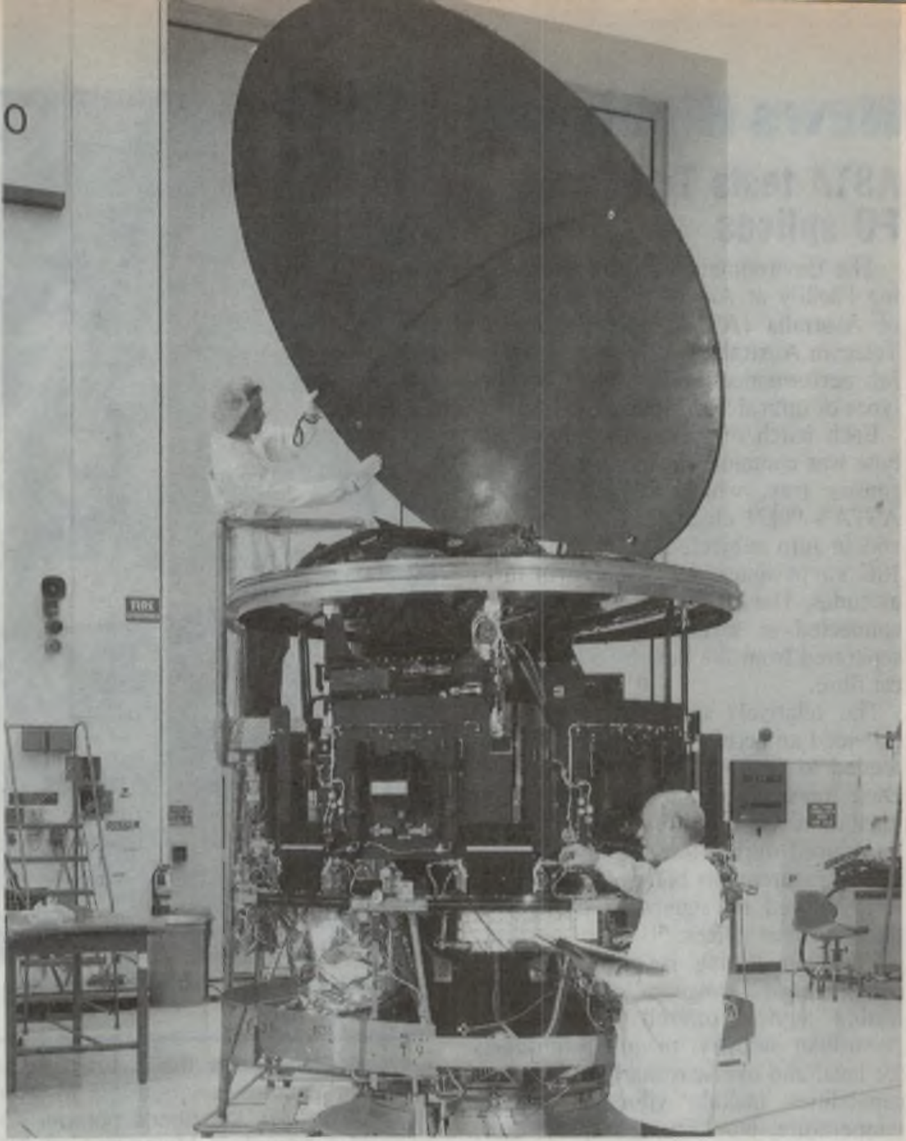
New semiconductor supplier formed

A new semiconductor and equipment supply company has been formed, with offices in both Melbourne and Sydney.

Principals of the new firm are Tony Coward, formerly General Sales Manager for Parameters in Melbourne, and John Owens, MD of Control Devices, who jointly bring to it some 60 years of experience in the industry.

Already the new firm has secured distribution rights for the extensive range of specialised VLSI devices made by the dynamic Winbond Electronics company in Taiwan, as well as the data conversion and acquisition products of Micro Networks (USA), the power converters and supply products of Power Cube (USA), and the aerospace instrumentation and data communications equipment of Metraplex Corporation. They will also be distributing the Analog Devices range of real-time interface cards, signal conditioning modules and isolation amplifiers.

The Melbourne address of Priority Electronics is Suite 7, 23-25 Melrose Street, Sandringham 3191 or phone (03) 521 0266. In Sydney it is at Suite 2, 25 Chard Road, Brookvale 2100 or phone (02) 905 6024.



Technicians conducting final tests on Marcopolo 1, British Satellite Broadcasting's first DBS satellite, which was launched by Delta rocket in late August. The satellite was built by Hughes Aircraft Company's Space and Communications Group at El Segundo, California.

Plessey develops integrated in-flight entertainment system

Plessey Avionics in the UK has developed an Integrated Flight Entertainment and Services System, which uses a fibre-optic LAN to link multi-purpose terminals at each passenger seat.

Each user terminal is based on a Motorola 68030 microcomputer, with a 5" diagonal colour LCD display screen and hand-held control unit which effectively combines a telephone, mouse, keyboard and credit card reader. The terminals are linked via a 100 megabit/-second fibre-optic LAN, which provides not only entertainment but also communications facilities: movies and video games, telephone calls, hotel and transportation bookings, the opportunity to buy from on-screen merchandising catalogs and so on.

At the heart of the system is a file server/CPU based on two 68030-based computers, with video and audio players and other associated equipment. The fibre-optic LAN uses a multi-level architecture, with concentrators distributing data to each group of 20 seats. Each concentrator has 8 megabytes of memory, while the individual seat units each have 2MB.

Plessey estimates that with the system, the average passenger on an international flight is likely to spend between $20 and $30 using its facilities and services. Apparently it has already signed up UK charter airline Paramount Airlines to install the system in its planes, while Pan Am and other international carriers are also said to be interested.

News Highlights

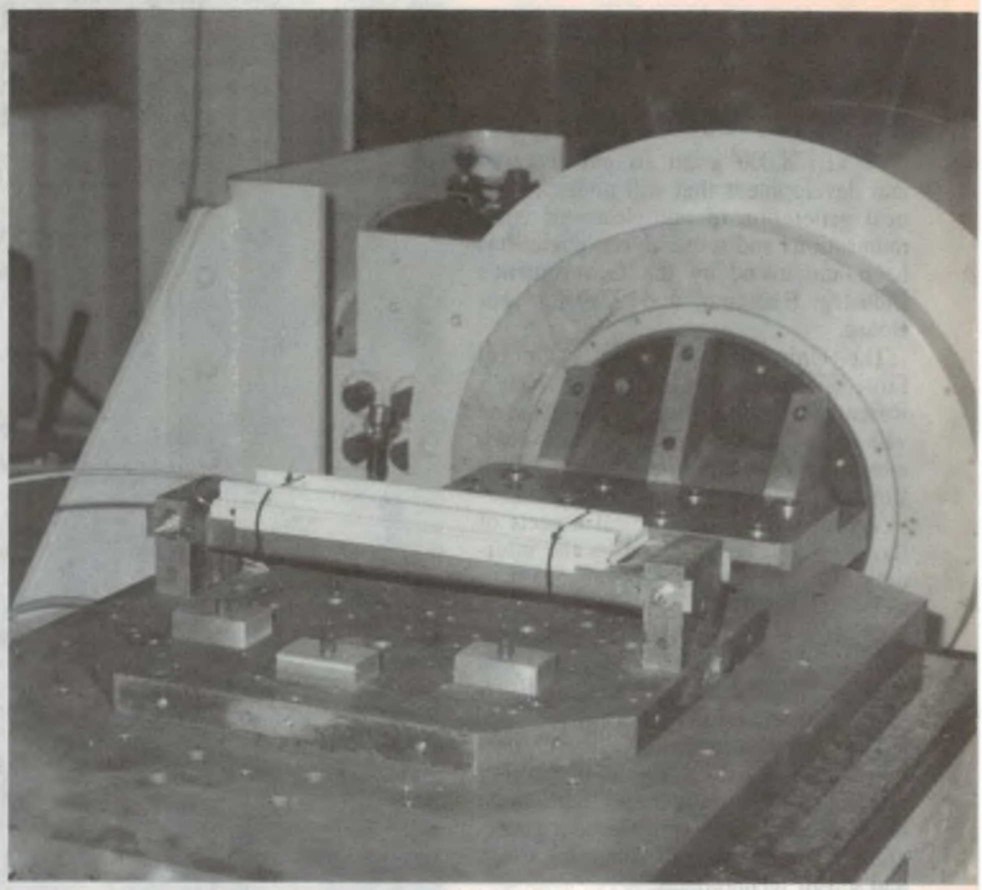
ASTA tests Telecom's FO splices

The Environmental Engineering Testing Facility at AeroSpace Technologies of Australia (ASTA) recently assisted Telecom Australia with vibration testing for performance evaluation of various types of optical fibre splices.

Each batch of splices of a particular type was contained in its own splice organiser tray, which was mounted on ASTA's 90kN electromagnetic vibrator and in turn subjected to 76 minutes of 10G swept sinusoidal vibration in three attitudes. The splices in each batch were connected in series, with each splice separated from the next by 50m of optical fibre.

The relatively severe vibration level provided an accelerated test that was intended to represent decades of service. Data transmission bit error rate instrumentation was used to detect any errors introduced during the vibration testing. Loss measurements before and after the tests showed no significant changes in the error-free splices.

Vibration testing is only one of a comprehensive range of environmental testing services offered by ASTA to Australian industry, to qualify products for local and overseas markets. The test capabilities include vibration, shock, temperature, humidity, salt spray, dust, rain, altitude, solar radiation and EMC/EMI.



Austpac ready for Group 4 fax

Telecom Australia has successfully completed testing of Group 4 facsimile over the Austpac network.

Austpac Marketing Manager, Mr Phil Hetherington, said: "When Group 4 fax becomes established, Austpac will provide a cost-effective service for customers who need to send high quality facsimile documents around Australia or to international destinations."

The tests, using the Canon L-3100 Group 4 fax machine, involved a variety of test material, including picture, condensed text and standard size text, using 200 or 400dpi (dots per inch) he said. The timing of calls was measured from the moment they were set up to the time they were cleared.

Group 4 transmission over Austpac provides comparable copy quality as current Group 3 fax over the Public Switched Telephone Network, at about twice the speed.

News Briefs

- ***Hawk Electronics***, the Australian distributor for Inmos (of Transputer fame) has moved it Sydney headquarters to larger premises at 56 Kennedy Street, Picnic Point 2213, with the phone number now (02) 792 2000. The company has also opened a branch in Melbourne, at 818 Whitehorse Road, Box Hill 3128, phone (03) 895 0591, and in South Australia at 213 Greenhill Road, Eastwood 5063, phone (08) 274 3739.
- US video signal processing company Robot Research Inc has appointed ***Javelin Video Surveillance Systems***, based at Rydalmere in Sydney, as its agent for the Australasian market. Javelin will support existing owners of Robot Research equipment via its offices in most mainland states.
- The well-known 'Technikit' range of products and accessories are now manufactured and marketed by ***Jiloa Pty Ltd***, whose address is at rear of 22 Royal Avenue (PO Box 73), Glenhuntly 3163 or phone (03) 571 6303. The current product range includes the PX1 passive AM loop antenna and the AT4SW 'Amplituned' shortwave antenna. Credit cards are accepted.
- Recently formed optical submarine cable maker ***Alcatel PCC*** has officially opened its engineering, research and manufacturing facilities at Liverpool, southwest of Sydney. The new facility will be involved in making the optical repeaters for the Tasman 2 fibre-optic cable between Australia and New Zealand.
- California-based test instrument maker Systron Donner has appointed ***Anitech*** as its exclusive sales and servicing agent in Australia. Systron Donner is regarded as a world leader in the field of microwave instrumentation.
- Philip Crosby, an executive trainee with ***MACE Ltd*** in Rydalmere, NSW has won a scholarship at the fourth annual awards ceremony of the Australian Institute of Export. Mr Crosby will use it to study at UNSW for the Diploma in Export Management.
- Dudley Marshall Agencies, Townsville agent for soldering equipment maker and tool supplier ***Scope Laboratories***, has moved to larger premises at 9 Camuglia Street, Mount Louisa 4814 – phone (077) 74 5777.
- ***Adelaide-based Lastek***, supplier of lasers and optical/opto-electronic equipment, has moved to 400 King William Street, Adelaide.

Sydney gets master-controlled floral clock

The first master-controlled floral clock in Australia has been installed at the Resort Hotel Macquarie, in North Ryde – located on the corner of Epping and Herring Roads. This is actually the fourth floral clock in Australia, however the first controlled by a masterclock with an accuracy of 0.1sec per day.

The clock is built to last, with a stainless steel shaft and cast iron body filled with oil for maintenance free operation. The whole mechanism is larger than a car gearbox and will resist the strongest wind.

Supplier Hertz Electronics employs a crystal controlled masterclock to maintain the clock's impressive accuracy.

Installation of a floral clock requires a standard 240-volt power supply and a niche in the ground where the movement operates. The clockface is designed by a landscape architect and executed by garden contractors.

The installation of the clock in North Ryde was actually filmed by Channel 9 for the viewers of 'Burke's Backyard'.

Datacraft to develop NTU for Telecom

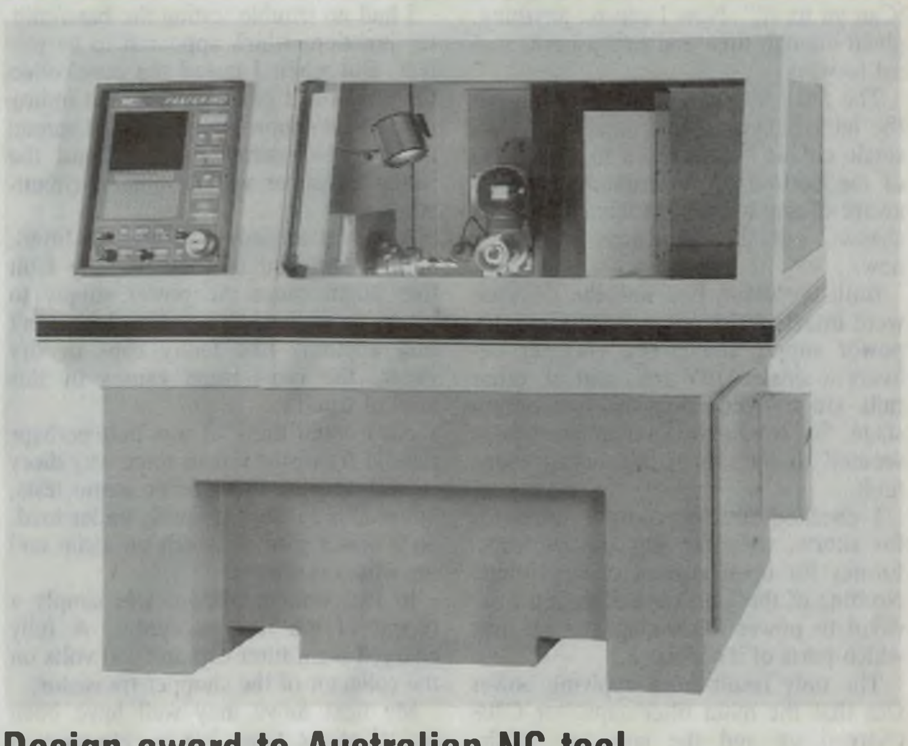
Melbourne-based data communications company Datacraft Limited, has been awarded a major contract by Telecom Australia for the development of advanced communications equipment for Telecom's Digital Data Network.

Over the next 12 months Datacraft will develop a new high speed Network Termination Unit for Telecom, which is expected to lead to the company being contracted to manufacture and supply up to 20,000 of the devices a year over a five year period in a contract worth an estimated $25 million.

Datacraft's Group Managing Director, Dr Laurie Mackecknie, said he was delighted with the company's success in winning the Telecom tender against considerable competition.

Network Terminations Units (NTU) are used to connect customers' data equipment to Telecom Australia's Digital Data Network. At present, there are in excess of 50,000 NTUs in use in Australia, operating over a four wire (two twisted pairs) system at speeds up to 9.6 kilobits per second. The new devices will operate over a single twisted pair at speeds up to 19.2-kbps.

In order to achieve such performance the latest two wire echo cancelling technology has been utilised. The design centres on two VLSI integrated circuits developed specially by Datacraft. These provide the necessary functions and the ability for the new equipment to interface successfully with existing Telecom equipment.



Design award to Australian NC tool

Victorian and manufacturer of computer numerical controlled (CNC) machinery, Australian NC Automation, has won a prestigious Australian Design Award for its ANCA Fastgrind CNC Tool and Cutter Grinder.

Totally manufactured at the ANCA factory in Bayswater, Melbourne, the Fastgrind allows machine shop staff to sharpen their cutting tools to consistently high standards. It features a built-in digitising system which automatically measures the complex geometric shapes of a modern cutting tool, to accurately establish tool parameters. Grinding then starts within seconds.

The machine uses a non-compound configuration which ensures accuracy, plus the 4-axis simultaneous movement necessary to produce today's complex cutting tools. At the same time it uses simple, easy to follow instructions in normal shop language.

After the launch of the Fastgrind in Chicago in late 1986, some $3.8 million in orders were received during the first two years.

The Serviceman

In unfamiliar territory, try to be especially careful!

This month I have two stories that show quite clearly how your Serviceman is anything but infallible. The first story reveals an altogether too carefree approach to an unfamiliar model. And I guess the moral turns out to be, if you don't know it very well, keep your wits about you!

A Sanyo model CTP3618 colour TV came in a few weeks ago via a delivery service, with a cryptic note attached saying simply 'Don't go!!'. The implication of these two words was obviously 'Can ya fix it?'. Now I can fix anything, given enough time and enthusiasm, so I set to work.

The 3618 uses an 80P chassis, one of the later Sanyo models. It is built on a single circuit board, fitted to the centre of the bottom of the cabinet. I wasn't aware of any unusual problems with the chassis, but there's always something new...

Both the mains fuse and the DC fuse were intact, which seemed to rule out a power supply fault. The chopper delivers a single 110V rail, and all other rails are derived from the line output stage. So 'NoGo' with undamaged fuses seemed to indicate a line output stage fault.

I checked the line output transistor for shorts, then the line output transformer for open circuits or dry joints. Nothing of the kind showed up, so I decided to power the set up and see just which parts of it *did* work.

The only result from applying power was that the main filter capacitor C308 charged up and the collector of the chopper transistor acquired the full 350 odd volts delivered by the bridge rectifier. There was no other activity of any kind.

Even after I switched off, the voltage remained on the capacitor and the transistor. (Even after five minutes the voltage had only dropped by five or ten volts. It was going to take a long time to get rid of the other 340 or so volts!)

I thought at the time that this was quite unusual, but I didn't associate it with the true fault. Instead, I elected to test the chopper transistor to see if it had gone open circuit. Although I had never seen one of these sets before, I guessed that an open chopper transistor would leave the supply charged up. So a test of the transistor seemed the logical next move.

I had no trouble testing the base/emitter junction, which appeared to be perfect. But when I tested the base/collector junction, I got a short circuit indication. What's more, the short had spread to the base/emitter junction, and the whole transistor was now short circuited.

A new transistor was quickly fitted, and I continued to look for any fault that might cause the power supply to refuse to deliver the goods. I couldn't find anything like faulty caps or dry joints, the most usual causes of this kind of trouble.

All I could think of was that perhaps the old transistor was in some way dicey – still hanging in there on static tests, but unable to work properly under load. So it was a case of switch on again and see what eventuated.

In fact what happened was simply a repeat of the first encounter. A fully charged main filter cap and 350 volts on the collector of the chopper transistor.

My next move may well have been logical at the time, but in retrospect it was just asking for trouble. In fact, if I had stopped to think about how this circuit worked, I would have twigged to the fault without any further ado.

Without giving any thought to the charged capacitor, I began to check the continuity of the various windings on the transformer. I was particularly interested in the feedback winding, connected to the base of the transistor.

As it turned out, all three windings on the primary side were intact, so then I tested for an inter-winding short circuit. I had no trouble with the test between the feedback and control windings, but when I came to test between the main and feedback windings, there was a loud click and my meter flicked savagely up to full scale.

It was only then that I remembered the charged cap, and my first worry was for the well-being of my meter. Fortunately, it had survived the abuse, and I continued with my search for the cause of the failure.

One thing I did find was that the cap was now completely discharged. I couldn't believe that all those joules had gone through my meter without hurting it, so with some apprehension, I tested the new transistor. It was shorted.

It was then that I sat down to consider the theory of operation for this switchmode supply. If I had done this earlier, I would have saved two transistors and avoided the risk to my meter.

This circuit uses a self-oscillating switching transistor. At switch-on, the transistor is biased on via R302. It begins to draw current through winding 1-8 on the transformer, and consequently a magnetic field begins to build up around the core.

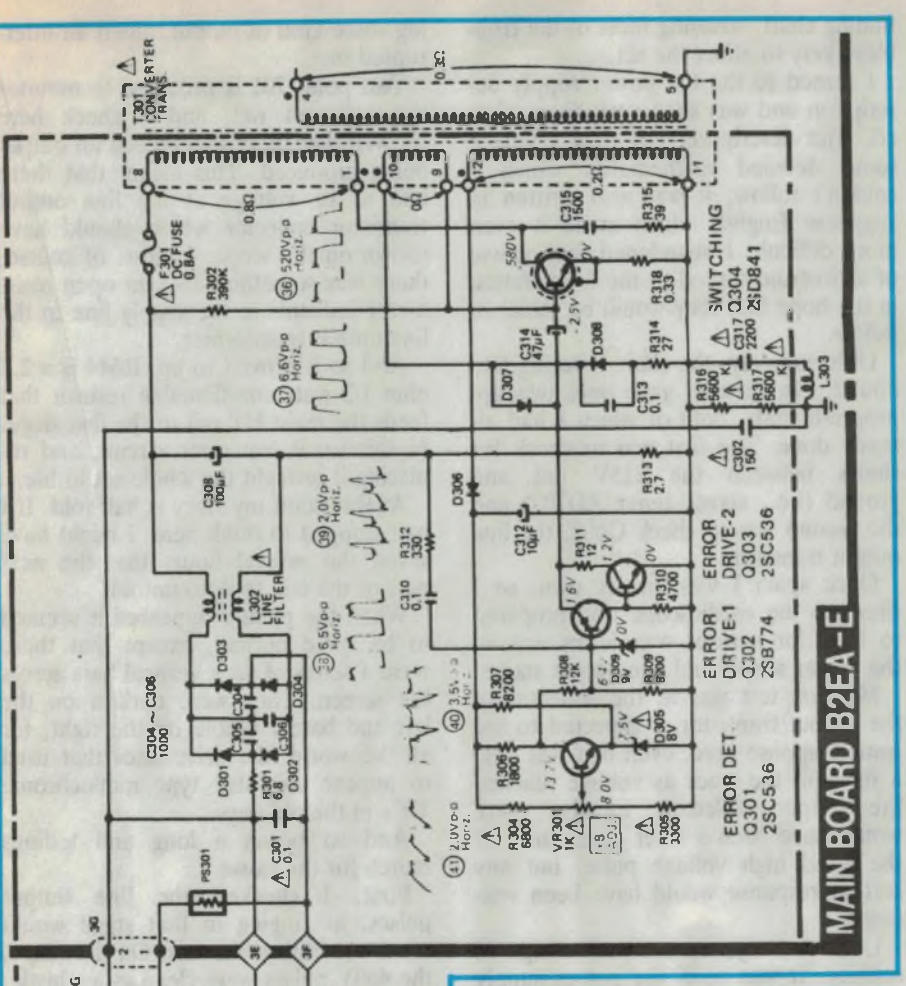
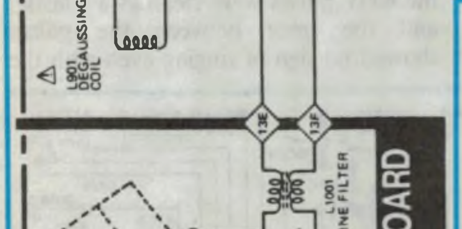
This field induces a voltage in the feedback winding 9-10, which is polarised so as to produce positive feedback and hence oscillation. The transistor is alternately turned hard on (saturated) and then hard off (blocked) again, chopping the current in winding 1-8 and hence the magnetic flux in the transformer core. As a result, an output voltage is induced in output winding 4-5.

Control of the output is effected by a voltage generated in winding 11-12, processed by the error amplifier around Q301-303, and used to control Q304's conduction via capacitor C314. Apart from the effect of leakage in C314, the control circuit would have no bearing on the problem I was facing with this set.

Now, think about this. What would happen if R302 was open circuit? Right! Without this forward DC bias, the chopper could never get started; and this was exactly what was happening here. A new transistor, a new R302, and we were off and running.

All that remains to be explained is why the set killed the transistors when I tried to test them for breakdown.

It happened like this. The transistor was sitting there with a fully charged

The schematic for the switching power supply in the Sanyo CTP3618 colour TV set. Q304 is the main switching transistor.

100uF 350 volt electrolytic capacitor across it. When I tested the base emitter junction with the negative probe to base, nothing happened. But when I reversed the probes to put positive on the base, the transistor went into full conduction and took the whole of the charge in one hit.

It's probable that the impedance of my meter prevented sufficient current flowing into the base to drive the transistor into saturation. So it had a severe disipation problem and took the easy way out. By short circuiting, it ended its worries – but started mine.

Hiccups again

The problems encountered with that Sanyo could be charged to inexperience. However the next story is a tribute to sheer carelessness – mine.

I realise that readers of these pages are looking for solutions to complex technical problems, and the story that follows is hardly complex enough to qualify. But sometimes simple tasks are made hard by a sloppy approach and woolly thinking. So let this cautionary and embarrassing tale be a lesson to you!

The set concerned was a Kriesler 37-104, fitted with a Sharp 9C140 chassis. The complaint was "No sound or picture, but it's making a funny noise".

Sure enough, on the bench it was making the familiar 'tick, tick, tick' of a hiccupping power supply. I've never struck this behaviour in a Sharp before, but there always has to be a first time. So I set to work.

The usual cause of hiccupping is an overload condition on the main HT rail. It is commonly a shorted tripler, or a leaky or shorted line output transistor. Less often the trouble is a short on one of the secondary rails derived from the line output transformer – and even less frequently, a shorted turn in the line output transformer itself.

There are some other, very rare faults that can cause hiccupping but (almost) all are concerned with short circuits causing excessive current on the main HT rail.

I bracketed 'almost' because in early Sony receivers hiccupping was caused by the opposite fault – over voltage due to lack of load on the supply. In Sony sets excessive current causes a shut-down rather than hiccupping.

So, faced with a hiccupping Sharp chassis, my first thought was over current. And my first test was the line output transistor.

I always test the transistor first, because it is generally the easiest thing to get at. All it requires is access for one probe on the collector, and a suitable ground for the other.

There should be no sign of leakage between collector and ground, at least when measured on ohms x1 or ohms x10. Some sets will show a bit of leakage when tested on ohms x100, but the leakage must be in the megohm range if it is to be considered normal.

In the case of this Sharp, the leakage seemed to be in the order of only a few hundred ohms, so clearly the transistor was doubtful. I wasted no time in removing it from the chassis for a more exact test.

On the bench I knew I had a dud, because the leakage between base and emitter was very heavy, only about 40 ohms instead of many hundreds of ohms. And although the base/collector junction seemed to be OK, the collector/emitter still tested as leaky as it had been in the chassis.

I tossed the old transistor into a jar under the bench and selected a new 2SD380 as a replacement. Although I didn't know it at the time, I had already made one serious mistake, and this choice of transistor was the second error in as many minutes.

(Incidentally, the 'jar under the bench' resulted from a boast by a colleague that he replaces more TO-3 transistors than I do. I challenged him to a duel and whoever fills their jar first will

The Serviceman

get a dozen bottles from the loser!)

After fitting the new transistor, I gingerly switched on. The loud bangs that sometimes accompany the firing up of a new repair have left me with a profound apprehension at this point in any job. In this case my worries were groundless, because the only noise was a 'tick-tick-tick' from the power supply – still hiccupping.

This was a real let-down, because I had checked around the line stage for any faults likely to causc the demise of the first transistor, and this should have revealed any trouble that could cause hiccupping. Clearly I had missed something, although I couldn't imagine what it might have been.

After thinking the problem over for an hour or two, I decided that perhaps the line stage was working OK, and that the fault was in the power supply. There could be a fault in the error amplifier that would cause hiccupping.

Unfortunately, there was no way I could be sure of this without having a copy of the circuit diagram and/or the full service manual. So I took the steps necessary to acquire the needed documents.

This particular manual turned out to be very comprehensive, with a full technical description of the various parts of the chassis and a fairly detailed fault-finding chart, covering most of the troubles likely to afflict the set.

I turned to the the power supply description and was soon very disappointed. The description not only involved some detailed mathematics which I couldn't follow, it was also written in Japanese English which made it even more difficult. I abandoned that course of action and turned to the fault charts, in the hope that they would be easier to follow.

Unfortunately, the chart covering 'No Sound, No Picture' gave only two appropriate tests, both of which I had already done. The first was to check for shorts between the 115V rail and ground (i.e., across zener ZD702) and the second was to check Q602, the line output transistor.

Once again I was on my own, so I fired up the oscilloscope and prepared to look for various waveforms around the power supply and line output stages.

My first test was at the collector of the output transistor. I expected to see some response here, even if it was only a jump in the trace as voltage reached the output collector. Ideally, there would have been a brief appearance of the usual high voltage pulse, but any sort of response would have been welcome.

Unfortunately, there wasn't a sign of activity. It was as if the power supply was dead. Yet the supply continued to hiccup, which meant that it was producing some kind of output, albeit an interrupted one.

Test point 701 is provided to monitor the 115 volt rail, and a check here showed that there was indeed an output being produced. This meant that there had to be voltage at the line output transistor collector which should have shown on the scope. Unless, of course, there was something like an open resistor or inductor in the supply line to the line output transformer.

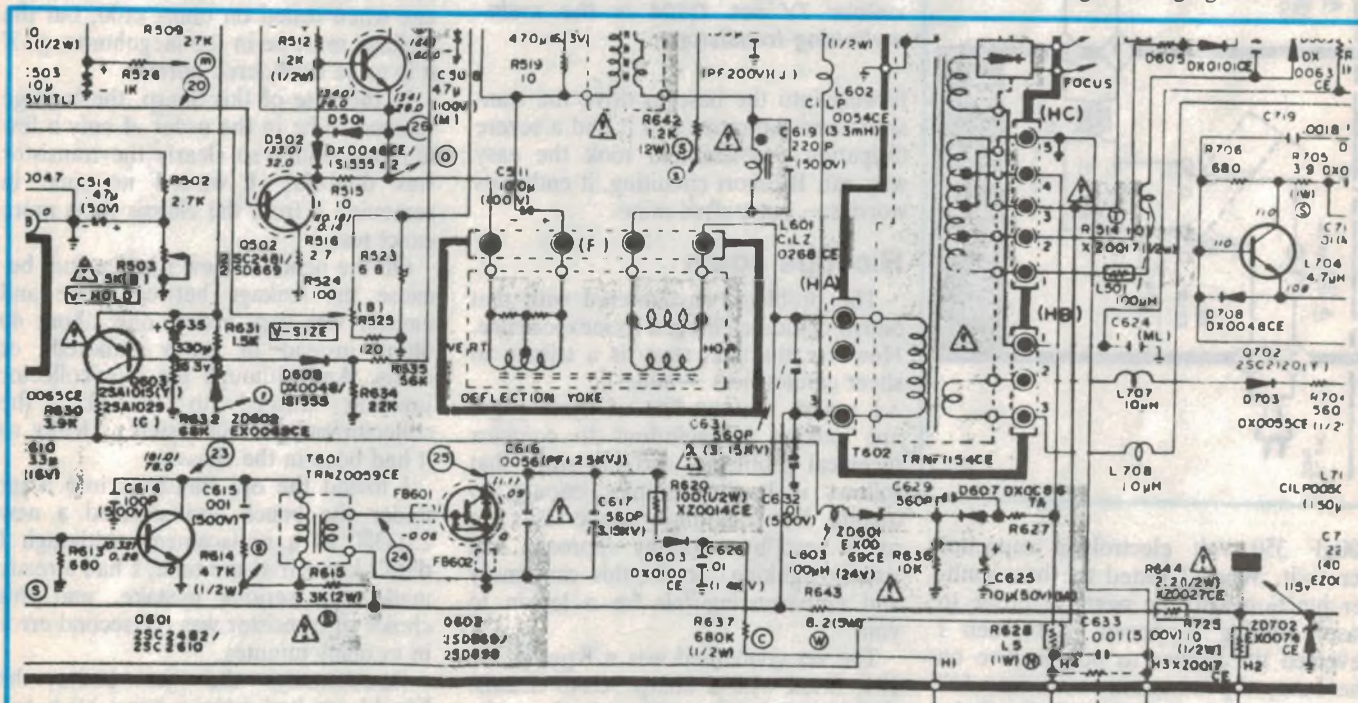
And so it proved to be. R644 is a 2.2 ohm 1/2 watt non-flamable resistor that feeds the main HT rail to the line stage. In this set it was open circuit, and replacing it brought the whole set to life.

At this point my story is half-told. If I had stopped to think here, I might have saved the several hours that the next part of the tale took to unfold.

When the picture appeared it seemed to be quite normal, except that there were a series of dark vertical bars across the screen. They were darkest on the left and barely visible on the right, for all the world like drive lines that used to appear on valve type monochrome TV's in the old days.

And so began a long and tedious search for the cause.

First, I checked the line output pulses, as ringing in that stage would cause something like this. On the scope, the 460V pulses were clean as a whistle, and the trace between the pulses showed no sign of ringing even with the



The line output section of the Sharp 9C140 chassis, as discussed in this month's second story. Line output transistor Q602 is circled.

sensitivity turned up to something like 10V per division.

Next, I went over the subsidiary rails and replaced their bypass capacitors. I replaced a 10uF 160V electro on the picture tube base board, and another electro on the 12V rail to the tuner and IF strip. All to no avail.

I examined the video waveforms on the scope and although I could clearly see the ripple that was causing the pattern on the TV screen, I could find no sign of what was causing it. I replaced the IF chip as well as the video processor chip, but all I did was to waste my time.

Then I came across a clue. While retuning one channel, I found that there was a setting of fine tuning that almost completely eliminated the bars. But they were back as soon as I closed the tuning compartment door. Eureka!

After all this time and trouble, it seemed to be nothing more than a wrong AFT setting. A quick twiddle with T209 and T210, the AFT coils, and the lines were almost invisible. But only 'almost'!

At this point I could have sent the set back. The owner would not have noticed the lines, if I didn't point them out. But that is not my way of working. I had to find out what the trouble was, not just cover it up.

But I had worked over every part of the set that could cause trouble! I sat there, peering at the circuit diagram and trying to imagine what I could possibly have missed. Then it hit me.

Q602, the line output transistor, was shown on the diagram as a 2SD869 (or 2SD898) but more importantly, when I looked closely it was shown as having an internal diode, something the 2SD380 which I had used does not have. What's more, the 869 also has a built-in base/emitter resistor, of some 40 ohms.

Back in the early stages of this job I had presumed that b/e leakage, and the apparent c/e leakage had indicated a faulty transistor. In fact, the transistor may well have been faultless – but it was now lost among 300 or more assorted 'dead' TO-3's in the jar under the bench.

And this is where I got my come-uppance. I had no 2SD869 (or 898) in stock, and I had to tip out all the corpses and search through them for the recent addition.

There were scores of 2SD350s and dozens of 2SD389s. Stacks of BU108s, 126s and 326s. There were 2N3055s and 2SD1161s and many other TO-3 types. In fact, I was quite surprised to see just how many different types of transistors I have replaced over the years.

After wading through that heap of scrap metal, I finished up with no less than three transistors, two 2SD869s and one 2SD898, all of which tested OK by the new criteria which I have now adopted for these types.

Clearly, I had been caught by similar troubles in the past and had rejected perfectly good transistors. After straightening out the pins and cleaning the old heatsink compound off the case, one of these transistors was fitted to the present Sharp chassis and that removed the last trace of the vertical bars.

Probably my worst mistake with this job was when testing the original transistor for collector/emitter leakage. Obviously, I tested only one way and saw the internal diode forward conduction as leakage. If I had reversed the meter probes, as I usually do, I would have found an open circuit which would have alerted me to my mistake.

And that really is the end of the story. I spent something like a whole day on the one job, simply because I kept working on without really thinking about what I was doing. The only good thing to come out of this farce is the knowledge that Sharp, as well as Sony sets, can hiccup when the load is taken off the power supply.

I would really be too ashamed to relate the foregoing stories if the lesson to be learned was not so important.

In the service workshop, there is just no place for a worker with his brain in neutral. Keep yours in gear until next month, please! EA

Fault of the month

Sony KV1830-AS

SYMPTOM: Won't start up. Power supply hiccupping, with slow plopping sound from speaker. Hiccupping continues for a short time after power is switched off.

CURE: Line output SCR (SG613) open circuit. In this set, hiccupping results from over-voltage, not overcurrent as in most others. If the SCR was shorted, set would shut down without hiccupping.

This information is supplied by courtesy of the Tasmanian Branch of The Electronic Technicians' Institute of Australia (TETIA). Contributions should be sent to J.Lawler, 16 Adina Street, Geilston Bay, Tasmania 7015.

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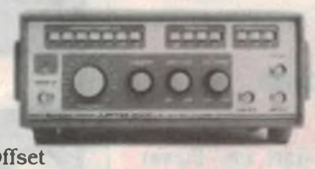

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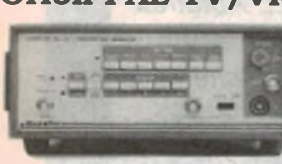

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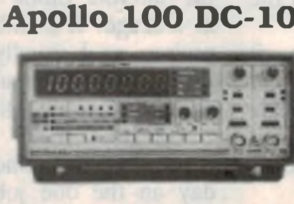

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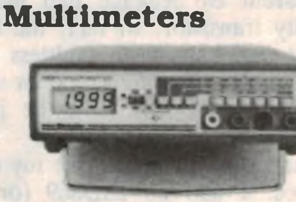

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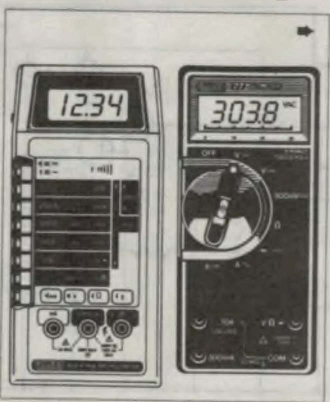

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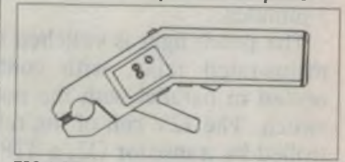

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80i-410

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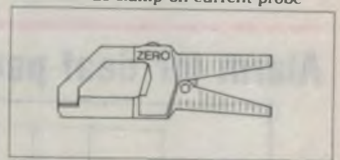

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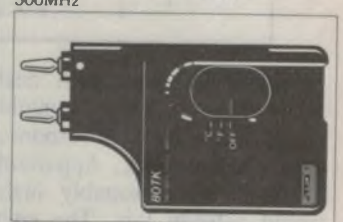

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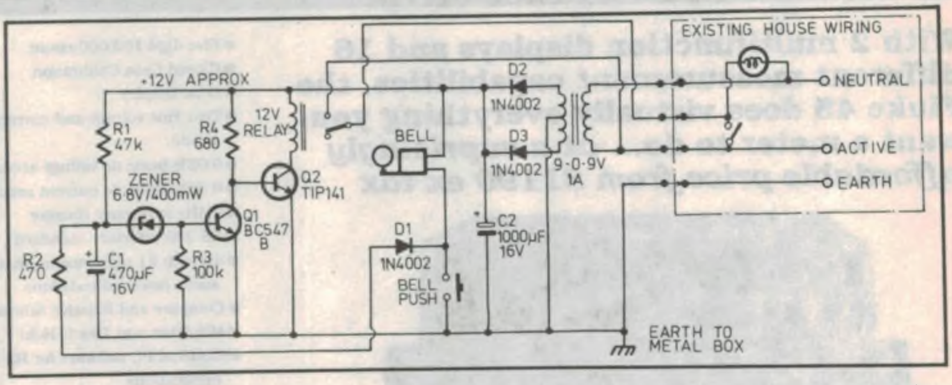
Circuit & Design Ideas

Interesting circuit ideas from readers and technical literature. While this material has been checked as far as possible for feasibility, the circuits have not been built and tested by us. As a consequence, we cannot accept responsibility, enter into correspondence or provide constructional details.

Doorbell pushbutton turns on porch light



How often have you returned home late at night, and found it difficult to locate the right front-door key in the dark? This circuit is designed to save such hassles, by turning on the front porch light as soon as the bell push is operated, and keeping it on for around 2 minutes.

The porch light is switched by a small mains-rated relay, with contacts connected in parallel with the normal light switch. The 12V coil of the relay is controlled by transistor Q2, a TIP141 which is normally held off by Q1, a BC547B. Q1 is held on by forward bias from the charged 470uF capacitor, via the 6.8V zener diode. Due to the voltage drop across the zener and the base-emitter junction of Q1, the normal voltage across C1 is around 7.5V, with current supplied by 47k resistor R1.

When the bell push is operated, the bell works in the normal way. However capacitor C1 is also rapidly discharged, via 470 ohm resistor R2 and diode D1. As a result, the forward bias is removed from Q1, which turns off and allows Q2 to conduct, turning on the relay and porch light.

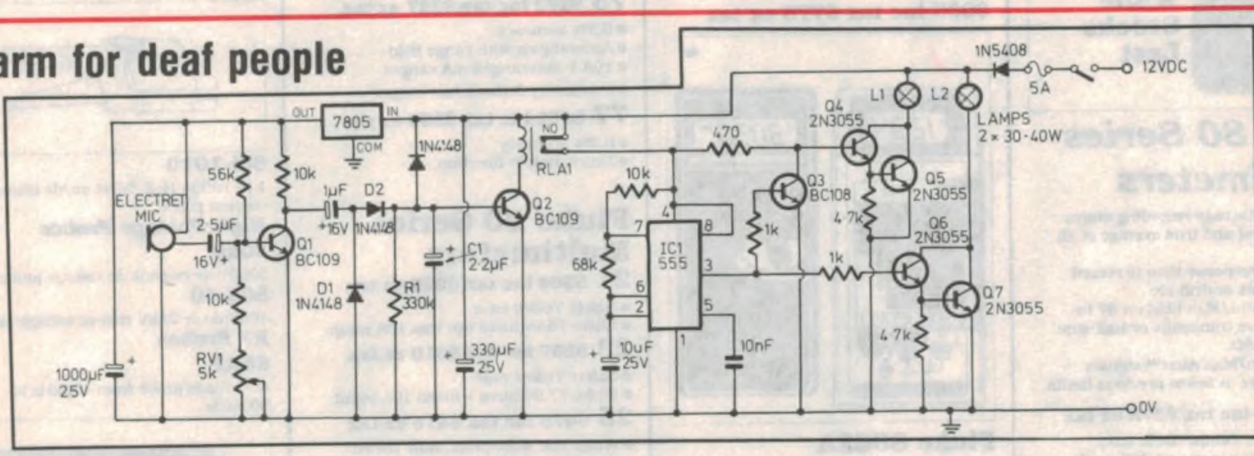
The light remains on for the time taken by capacitor C1 to recharge via R1, as D1 prevents it from recharging via the bell.

For safety I built all of the circuitry in an earthed metal box, mounted up in the roof. Note that the power transformer should be a type designed to operate continuously.

Stewart Farrant,
Edgewater, WA

$35

Alarm for deaf people



Friends of mine with deaf children asked me to design something which would wake them, in response to an ordinary alarm clock. Apparently a flashing light of reasonably high intensity would achieve this. The circuit shown here was developed, and has been in use quite satisfactorily now for about 10 months.

As you can see it consists of an electret microphone with audio amplifier Q1, a signal rectifier and relay driver around Q2, a flasher oscillator using IC1 and lamp driver circuits using Q3-Q5 and Q6-Q7. The electret mic is placed so that it is very close acoustically to the clock's alarm.

When the alarm goes off, the mic produces a signal which is amplified by Q1, whose gain is adjusted via RV1 to set sensitivity. The amplified signal from Q1 is rectified by diodes D1 and D2, and then used to turn on relay driver Q2. This operates the relay, which applies +12V to the flasher IC and the lamp driver bias circuits.

IC1 is a 555 wired in astable mode, so that its output pin 3 switches about twice each second. When the output is high, it turns on transistors Q6 and Q7, wired as a Darlington pair and driving lamp L2. At the same time Q3 is also turned on, shorting the bias to Q4 and hence holding off the Q4-Q5 Darlington pair.

On the other hand when the output of IC1 goes low, Q6 and Q7 are turned off, extinguishing L2. But Q3 is also turned off, restoring the bias to Q4-Q5 and allowing these to turn on, lighting lamp L1. Hence the two lamps flash alternately, while the alarm is sounding.

I used two 40W car headlight lamps for L1 and L2, which were placed either side of the bed to ensure that at least one is effective.

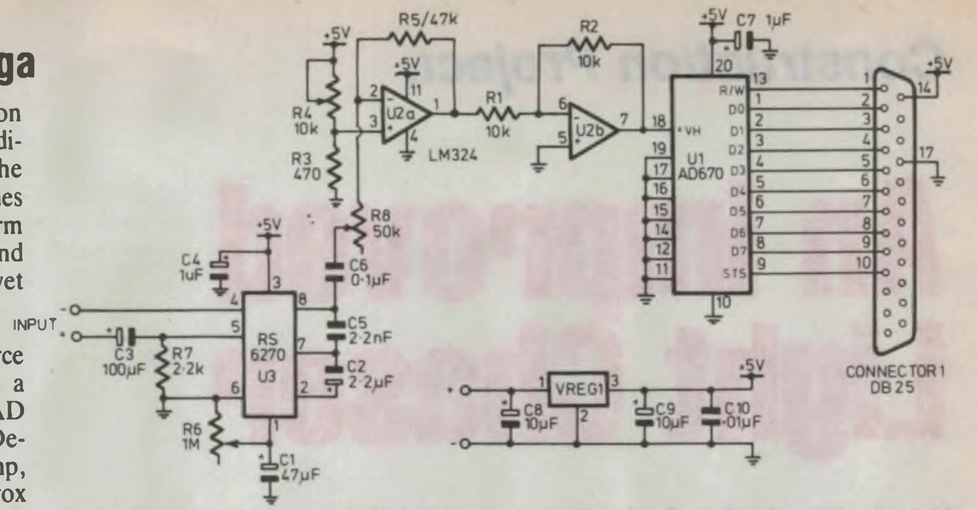
The circuit draws about 4 amps when flashing, but very little in standby mode. The 7805 regulator is to prevent audio instability due to supply line variations when the lamps are flashing. The complete unit was built into a diecast box, with the output transistors Q5 and Q7 mounted on the lid for heatsinking.

Colin Leonelli,
Ingham, North Qld.

$40

Audio digitiser for Amiga

Here is a rudimentary data aquisition unit which can be interfaced either directly with a microprocessor or via the parallel port of a computer. It provides an 8-bit digital output and in its form presented here, is used as an audio and ultrasonic digitiser. It is a simple yet very flexible device.



Input can be from a line-level source (must have floating ground) or from a microphone. Its first stage is a VOGAD (Voice Operated Gain Adjusting Device), really just a glorified AGC amp, which maintains an output of approx 90mV. By varying R6 the amount of AGC action can be changed from full to defeated.

Second is a stage amplifier comprising U2a and b. R4 and R3 set a DC bias level, about which the AC will sit and R8 changes the gain of the stage. The A-D converter is the AD670 and is configured to receive a strobe signal from the host computer to use as a clock. The absolute maximum sample rate which can be achieved with this device is 100kHz.

In this case it is interfaced to a computer via the parallel port. Pin 9 of the AD670 need only be connected if the software reading the port requires an 'End of Conversion' signal.

The device here is powered via the 5V pullup line of the Amiga parallel port, but if not used with the Amiga, pin 14 of the DB25 can be disregarded and in this case the alternative supply shown can be used, with its power derived from a 6 to 9 volt plugpak.

It should be enclosed in a shielded box with a minimum length of ribbon cable. As it is particularly sensitive, shielding is paramount.

M Katona,
Mount Isa, Qld

$40

Reading remote keypads in a hostile environment

This system was devised to input data to a microprocessor-based control system from four separate 8-key keypads, in a 'noisy' industrial situation. Reliability and noise problems precluded the use of DTMF encoding/decoding chips.

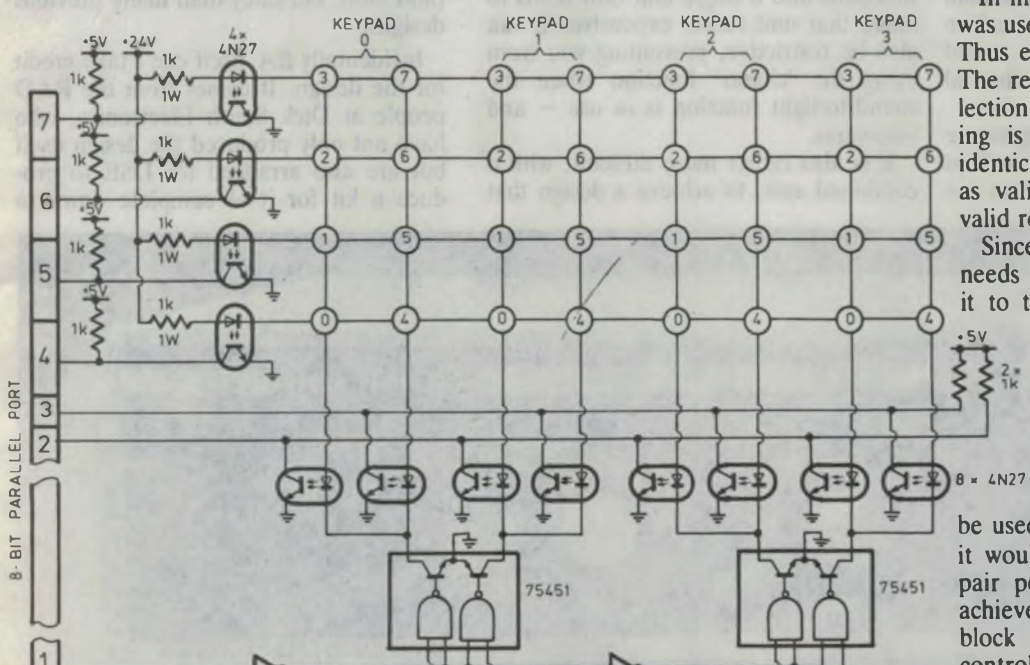
The circuit schematic shows how the keypads are connected to an 8-bit parallel port, with bits 0 & 1 configured as outputs to select one of four keypads, and bits 2 – 7 configured as inputs to read the data.

Each keypad is a 4 x 2 matrix with the four 'rows' common to all keypads. These rows are supplied with +24V via optocouplers. The two 'columns' of each keypad go to 0V via optocouplers and the 75451 driver.

When a key is operated, on the selected keypad, one 'row' opto and one 'column' opto will be energised in series. The optos pull the input lines low so we should see a zero in bit 4,5,6 or 7 and another zero in bit 2 or 3. This data can then be used to access a lookup table to get the key number.

In my application an interrupt routine was used to read one keypad every 2ms. Thus each keypad gets read every 8ms. The results are left in a buffer for collection by the main program. Debouncing is performed by waiting for two identical reads before marking the result as valid. Note the 'no key' is also a valid result.

Since each keypad is a 4 x 2 matrix it needs a minimum of 6 wires to connect it to the controller. 3-pair cable could



be used but for maximum noise imunity it would be best to use 10-pair with a pair per key, the 4 x 8 matrix being achieved by stripping on the terminal block where the cables come into the controller.

Dr Henry Choke,
Ringwood, Vic

$45

Construction Project:

An Improved Light Chaser

Here's the design for a three-channel light chaser which has many advantages over previous designs. It provides six different chasing patterns, eight speeds, an enhanced front-panel monitor display and the ability to run lamps up to a total of 2400 watts. At the same time it's easy to build, low in cost and designed to be particularly safe in operation.

by JIM ROWE

Moving light patterns are now firmly established as part of our technology-linked lifestyle. Retailers use them to attract customers' attention, entertainers use them to augment and enhance their performance, and nowadays even a home birthday party seems dull and unexciting unless there's the visual dynamism introduced by a set of lights flashing around the room.

It's not altogether new, of course. Back in the 1920's they developed the rotating mirror ball, suspended above the middle of a dance floor or nightclub and with coloured spotlights beamed on it so the rotating mirror facets would produce a myriad of coloured flashes all around the room.

Mirror balls and similar gadgets are still in use, of course, but nowadays most of our dynamic light displays are produced electronically. And as many readers will already know, the device used to generate many of those moving visual patterns is the *light chaser*.

A number of designs for light chasers have been described previously in *Electronics Australia* and other magazines, sometimes purely as such and in other cases combined with circuitry performing a sound-to-light function. An example of such a combined unit was our Musicolour IV, of August 1981.

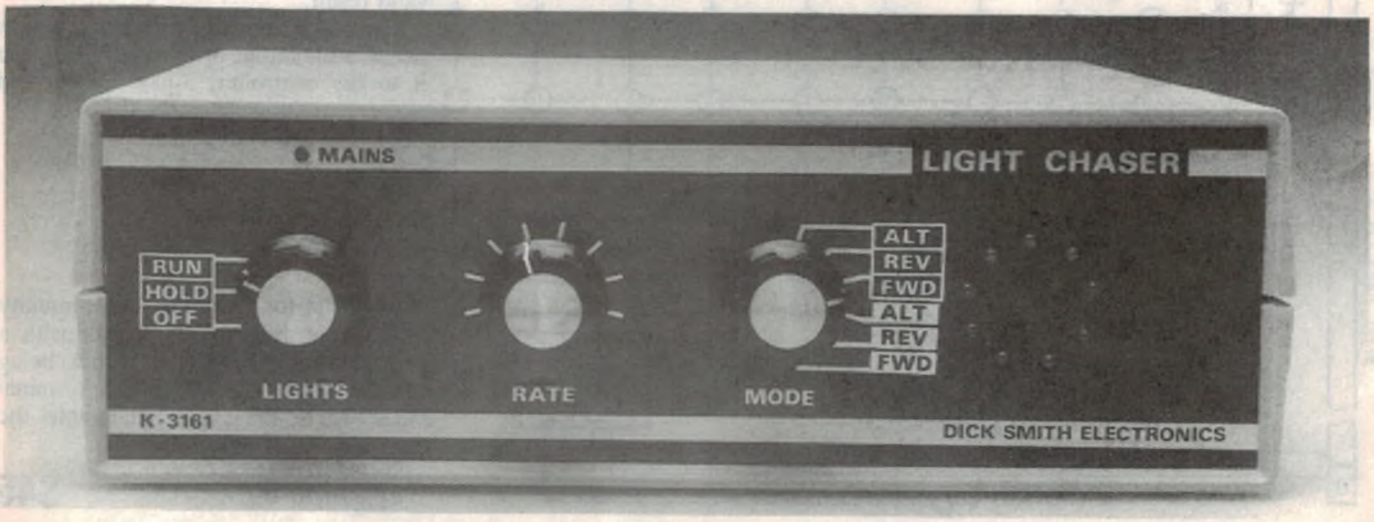
Unfortunately combining the two functions into a single unit now tends to make that unit rather expensive. It can also be restrictive, preventing you from using the 'chaser' function when the sound-to-light function is in use – and vice-versa.

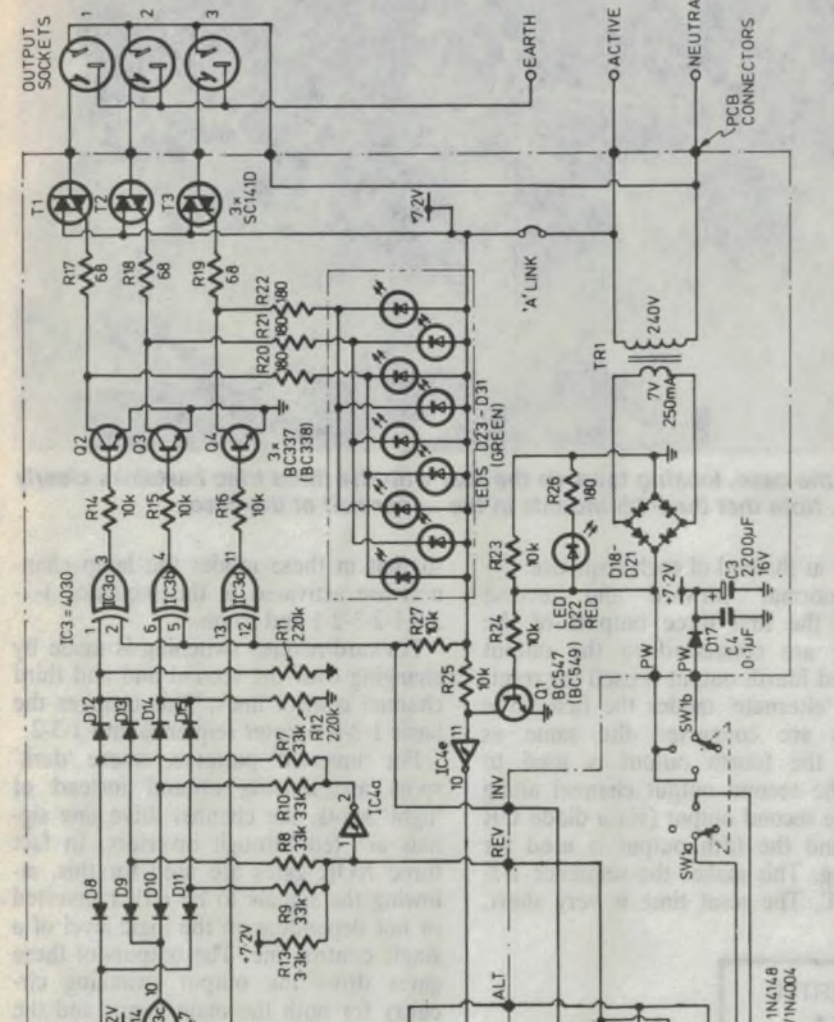
It is also rather more difficult, with a combined unit, to achieve a design that is as safe as other equipment. This type of unit inherently involves circuitry which switches mains power, and therefore must 'float' at mains potential. Although various isolation barriers can be provided, the need to switch from one kind of function to the other can make it hard to provide a level of user protection which guards completely against things like internal breakdown in front-panel switches, etc.

Happily this problem tends to be rather easier when a single-function device is involved, particularly if the right techniques and components are used.

The new light chaser design described here has accordingly been designed as a dedicated chaser. This has allowed it to be provided with an excellent range of functions and facilities, while at the same time being low in cost, remarkably easy to build and also a good deal safer (and more fail-safe) than many previous designs.

Incidentally *EA* itself can't take credit for the design. It comes from the R&D people at Dick Smith Electronics, who have not only produced the design itself but are also arranged for DSE to produce a kit for it – complete down to





As you can see from this schematic, the circuit is quite straightforward.

the last nut and bolt. So building it up exactly as shown in the photographs should be particularly easy. I'm told that the kit (DSE catalog number K-3161) is priced at $99, which seems good value for money.

It should be noted that because the design comes from DSE, things like the PCB pattern and front-panel design are proprietary. This means that other firms will not be able to provide these items, although individual readers are of course free to make their own if they wish to do so.

What it does

The chaser has three channels. Each channel can be connected individually to a lamp load drawing up to 6 amps, determined by the rating of the SC141 triacs used to perform the actual switching. This corresponds to more than 1kW per channel, although the total loading on all three channels of the unit must not exceed 10A (2400W).

It provides six different modes of 'chasing'. These consist of forward and reverse with a single channel lit and two extinguished at any instant; forward and reverse with two channels lit and one extinguished at any instant; and normal and inverted 'alternate' modes, where either one or two channels are lit, and the movement automatically alternates back and forth. These options are selected by the 'Mode' switch, SW2. Table 1 shows the various patterns available, assuming a set of 12 main lamps connected to the three channels in normal 123-123-123-123 sequence.

Similarly there are eight different operating speeds, ranging from about one transition per second to around 30 per second. In other words, from almost 'too slow' to fast enough for the chasing motion to become a blur – with plenty of intermediate settings. The speeds are set by 'Rate' switch SW3.

To make it especially easy to adjust the chaser for the desired lighting effects, even when the main lights are out of sight (as with a display sign), the front panel features a small circular display of nine green LEDs. These are connected in 123-123-123 sequence, so that they mimic very clearly the behaviour of the main display.

In addition to the different modes and rates, any of the lighting patterns may be held or 'frozen', at the flick of main run control switch SW1. The lights can also be turned off with this switch if desired, although it should be noted that this does not remove mains voltage from inside the chaser itself. A small red mains indication LED is provided

Light Chaser

on the front panel, as a reminder of this.

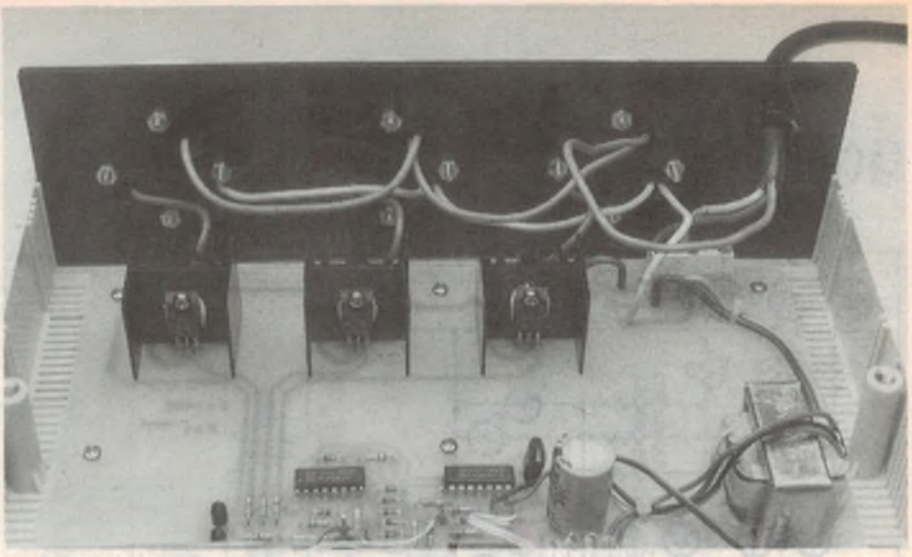
Needless to say, the power cable of the chaser itself should be removed from the outlet for safety, before it's case is opened to carry out any servicing. More about this later.

How it works

Fig.1 shows a block diagram of the light chaser. As you can see it consists of a clock oscillator, a zero crossing synchroniser, a counter, switching for pattern selection and rotation mode, and the actual driving/switching circuitry for the lamps.

The clock oscillator produces a square wave signal of a period equal to the duration of the on-time of each output channel (in non inverting mode). This square wave signal is fed to the zero crossing synchroniser, which re-times the switching transitions so that they occur on the zero crossings of the AC mains – to ensure that the chaser switches the lamps cleanly, and doesn't generate RFI (radio frequency interference).

The mains-synchronised signal is then used to clock the counter, the outputs of which are used as the actual sequential switching signals for each output channel line – and also for resetting the counter at the end of each sequence.



Inside the case, looking towards the rear with the three triac heatsinks clearly visible. Note that the PCB mounts in the upper half of the case.

In 'normal' forward and reverse modes, the first three outputs of the counter are connected to the output lines and fourth output is used for reset. In the 'alternate' modes the first three outputs are connected the same as above, the fourth output is used to drive the second output channel along with the second output (via a diode OR gate) and the fifth output is used for resetting. This makes the sequence 1-2-3-2-RST. The reset time is very short, so that in these modes the lamp channels are activated in the sequence 1-2-3-2-1-2-3-2-1 and so on.

Forward-reverse switching is made by changing over the second and and third channel control lines. This changes the basic 1-2-3 counter sequence into 1-3-2.

For 'inverted' patterns, where 'dark' spots are moving around instead of 'light' spots, the channel drive line signals are fed through inverters. In fact three XOR gates are used for this, allowing the signals to be either inverted or not depending on the logic level of a single control line. The outputs of these gates drive the output switching circuitry for both the main lamps and the front-panel display LEDs.

Now for a look at the circuit schematic in more detail.

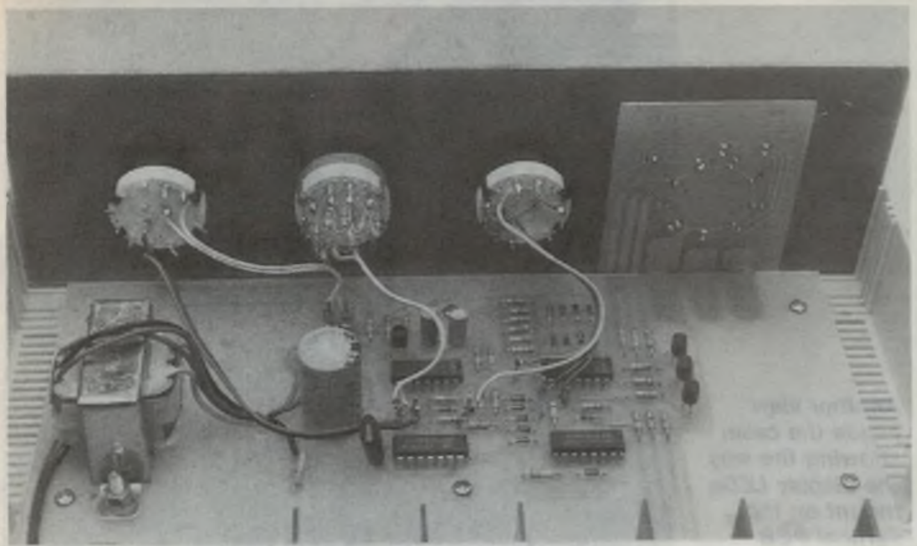
The clock oscillator employs inverter IC4d, part of a 74C14 hex Schmitt inverter. This is used as a relaxation oscillator, with frequency set by capacitor C2 and the feedback resistors selected by rate switch SW3.

The signal from the oscillator is fed to the D (data) input of flipflop IC2, a 4013. The clock input of IC2 is fed with 100Hz pulses synchronised with the 50Hz mains AC, derived from the rectified but unfiltered output of the power supply bridge D18-21. Resistor R24 couples the bridge's 100Hz output to the base of T1, which switches on and off to provide some squaring-up. The output of Q1 is then fed through IC4e, another Schmitt inverter, which provides the final rectangular pulses to IC2.

The effect of these pulses is to ensure that although the Q output of IC2 follows the signal applied to its D input from the clock oscillator IC4d, its

1. FORWARD NORMAL	4. FORWARD INVERTED
––––*––*––	–**–**–**–**
–*––*––*––*–	*–**–**–**–*
––*––*––*––*	**–**–**–**–
––––*––*––	–**–**–**–**
–*––*––*––*–	*–**–**–**–*
.	.
.	.
2. REVERSE NORMAL	3. REVERSE INVERTED
––––*––*––	–**–**–**–**
––*––*––*––*	**–**–**–**–
–*––*––*––*–	*–**–**–**–*
––––*––*––	–**–**–**–**
––*––*––*––*	**–**–**–**–
.	.
.	.
3. ALTERNATE NORMAL	6. ALTERNATE INVERTED
––––*––*––	–**–**–**–**
–*––*––*––*–	*–**–**–**–*
––*––*––*––*	**–**–**–**–
–*––*––*––*–	*–**–**–**–*
––––*––*––	–**–**–**–**
–*––*––*––*–	*–**–**–**–*
––*––*––*––*	**–**–**–**–
–*––*––*––*–	*–**–**–**–*
––––*––*––	–**–**–**–**
.	.
.	.
* light on	– light off

TABLE 1: The six light patterns available from the chaser, as selected by mode switch SW2. The 'inverted' patterns have moving 'holes' instead of bright spots.



Another view inside the case, this time looking towards the front. Note the small vertical PCB at the right, to support the display LEDs.

switching transitions only occur at the exact instants that the mains waveform is passing through zero voltage. In other words, the effect of IC2 is to *synchronise* the clock signal with the mains, for zero-voltage switching.

Incidentally the reset input of IC2 is used to stop the clock pulses, to hold or 'freeze' the chaser outputs. Normally this input (pin 4) is held high and inactive by R28, but when SW1 is turned to the hold position, pin 4 is grounded at IC2 clamped in the reset state – effectively stopping the clock.

The output of IC2 is fed to IC1, a 4017, which is the sequencing counter. IC4f, D2-D7 and R3-R6 are used for the alternate mode switching. When the input of IC4f is pulled down through SW2, the voltage on the anodes of D3 and D4 is also pulled low via R3. This prevents the counter from being reset with the fourth output, causing it to proceed to the fifth count and reset itself then (for 'alternate' mode).

When the input of IC4f is high, the fourth output of the counter is able to control the voltage at the reset pin 15, via D3 and D4. This causes the counter to reset on the fourth count (for normal mode).

A similar switching scheme is used for combining the second and fourth counter outputs for alternate mode, using D5-7, R5 and the output from IC4f, with IC3c used as a buffer for the combined output.

Incidentally the purpose of R2, C1 and gate IC4b is to reset the counter when the power is first applied to the chaser, to ensure that the counter 'gets off on the right foot'. When power is first applied the output of IC4b applies a logic high to the reset input of IC1, via D1, until capacitor C1 charges up via R2. Then the output of IC4b falls low, and the reset pulse is removed for normal circuit operation.

The same kind of diode gating system as before is used for the forward-reverse switching of the second and third output lines, using D8-15, R7-10 and IC4a.

The XOR gates IC3a, IC3b, IC3d are used to either buffer or invert the three channel control lines, as required for either 'normal' or 'inverted' patterns. Whether the signals are inverted or not depends on the control voltage fed to the second inputs of these gates, controlled by SW2b and pullup resistor R27.

The outputs of the XOR gates drive switching transistors Q2-Q4, which are BC337/338 devices. These transistors switch the display LEDs D23-31, via limiting resistors R20-22, and also the gates of the triacs (T1-3) which switch the main lamp loads.

The low voltage DC required by the chaser circuitry is provided by a simple power supply using a 7.5V/250mA transformer and bridge rectifier system. The only slight complication is the use of additional diode D17, to isolate the reservoir capacitor C3 from the bridge output and allow Q1 to access the 100Hz component of the 'raw' bridge output.

Mains indicator LED D22 is also connected across the bridge output, via series limiting resistor R26.

As you can see, all of the circuitry inside the chaser unit floats at mains potential. In fact the positive supply rail is connected directly to mains active. However a removeable link 'A' is provided, which allows the connection to mains active to be removed when desired. This makes it possible to test the functioning of the complete circuit in complete safety, providing the three external lamp circuits are unplugged. All logical tests can be done using the display LEDs on the front panel.

Construction

All of the circuitry of the chaser is housed in a plastic utility case, measuring 256 x 190 x 82mm. Even the front and rear panels of the case are of plastic, for safety. In fact since the front-panel controls all have plastic bushes and spindles, and the rear outlet sockets have concealed mounting screws, the chaser is effectively double insulated when fully assembled.

As can be seen from the pictures, the three control switches are all of the rotary type and are mounted on the front panel. Along with them are the mains indicator LED, and the nine-LED circular pattern display adjacent to mode switch SW2. On the rear panel are simply the three outlet sockets, plus the chaser's main power cable entry.

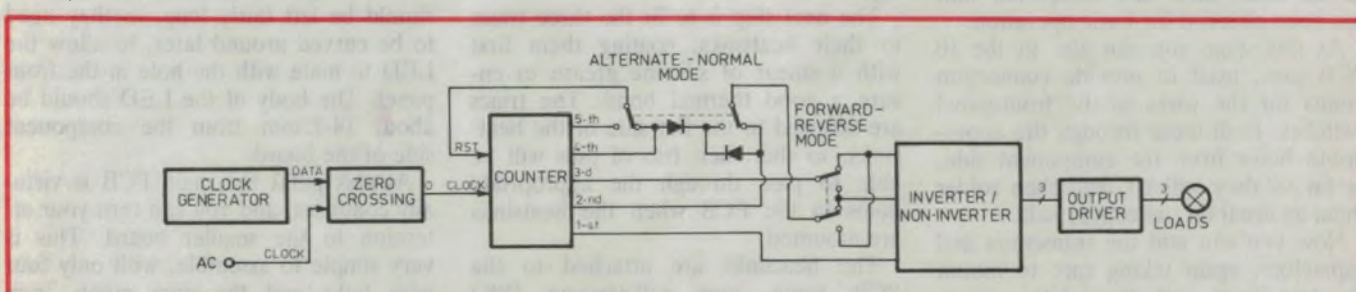


Fig.1: The block diagram, showing how forward/reverse and alternate/normal switching is achieved.

Light Chaser

Inside the case, most of the circuitry is mounted on a reasonably large horizontal PC board, measuring 220 x 155mm and coded ZA-1432. This board actually mounts inside the top section of the case, and operates upside down. A second smaller board measuring 69 x 55mm and coded ZA-1433 is mounted vertically behind the front panel, and mounts the display LEDs.

The six connections between the two boards are made by direct soldering between the pads provided. The solder joints also support the smaller board physically, along with the bodies of the nine LEDs themselves – which locate in matching holes in the front panel. As the LEDs are really the only components on the smaller PCB, apart from four small wire links, this mechanical arrangement is more than adequate.

The small power transformer is mounted directly on the main PCB at the right-hand end looking from the front, using 4mm machine screws, nuts and star washers. The three triacs with their finned extruded heatsinks also mount directly on the PCB, along the rear.

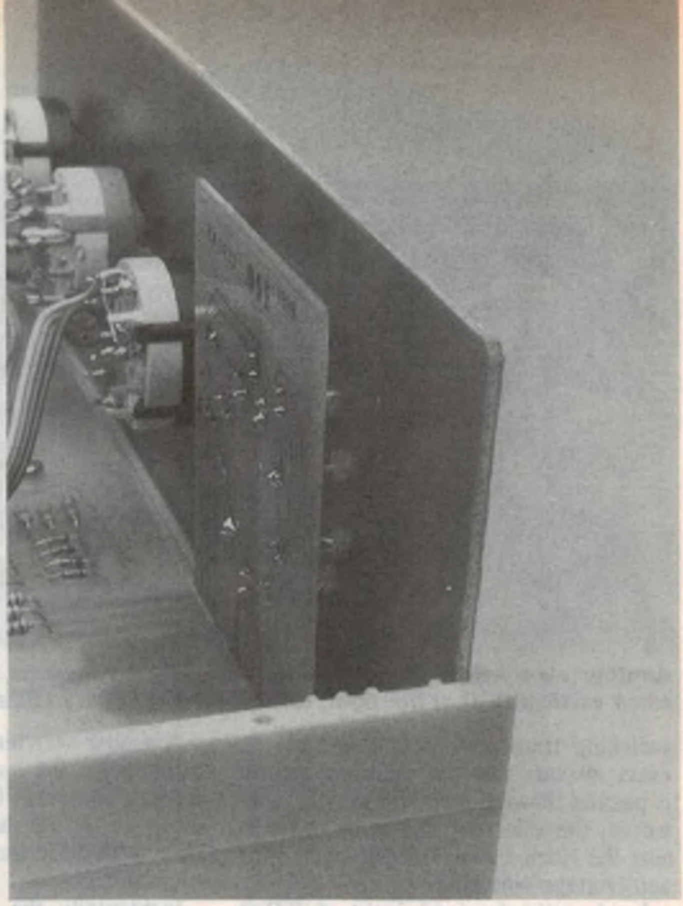
Most of the remaining components are mounted towards the front of the main PCB, well away from the triac heatsinks. This can be seen in the photographs, and also in the wiring diagram.

Note that the oscillator timing resistors R29-R36 are not mounted on the PCB, but directly on the rear contact lugs of rate switch SW3.

To begin assembling the unit, first check the PC boards to ensure that there are no bridges between tracks or other obvious faults. Then fit the low-profile components, such as the resistors and diodes – making sure that the diodes are fitted with the correct orientation. You can also add the five small wire links, near the low-power circuitry – but not the insulated 'A' mains link, over near the back of the board. This is added later, after the completed unit has been checked for basic operation.

As this stage you can also fit the 10 PCB pins, used to provide connection points for the wires to the front-panel switches. Push these through the appropriate holes from the component side, as far as they will go, and then solder them as usual on the copper side.

Now you can add the transistors and capacitors, again taking care to mount the transistors and electrolytic capacitors with the correct orientation. Then you can add the mains terminal block at the rear right of the PCB.



Another view inside the case, showing the way the display LEDs mount on the vertical PCB behind the front panel.

The power transformer can now be added to the board, with its blue and brown primary leads exiting on the side towards the adjacent board edge. These leads are taken along the TOP of the board, to holes just to the front of the terminal block. Note that the same leads are also tied down with a nylon cable tie, which passes through the two 3mm holes just near the right-hand end of the terminal block.

The transformer's two red secondary leads connecting to the PCB holes nearest the rectifier diodes D18-21, while the unused yellow and black leads connect to the three 'dummy' holes and pads to the rear of reservoir capacitor C3. Again a nylon cable tie is used to ensure that none of these secondary leads can 'wander' and become a source of trouble; as before the tie passes through two 3mm holes, just to the right of C3.

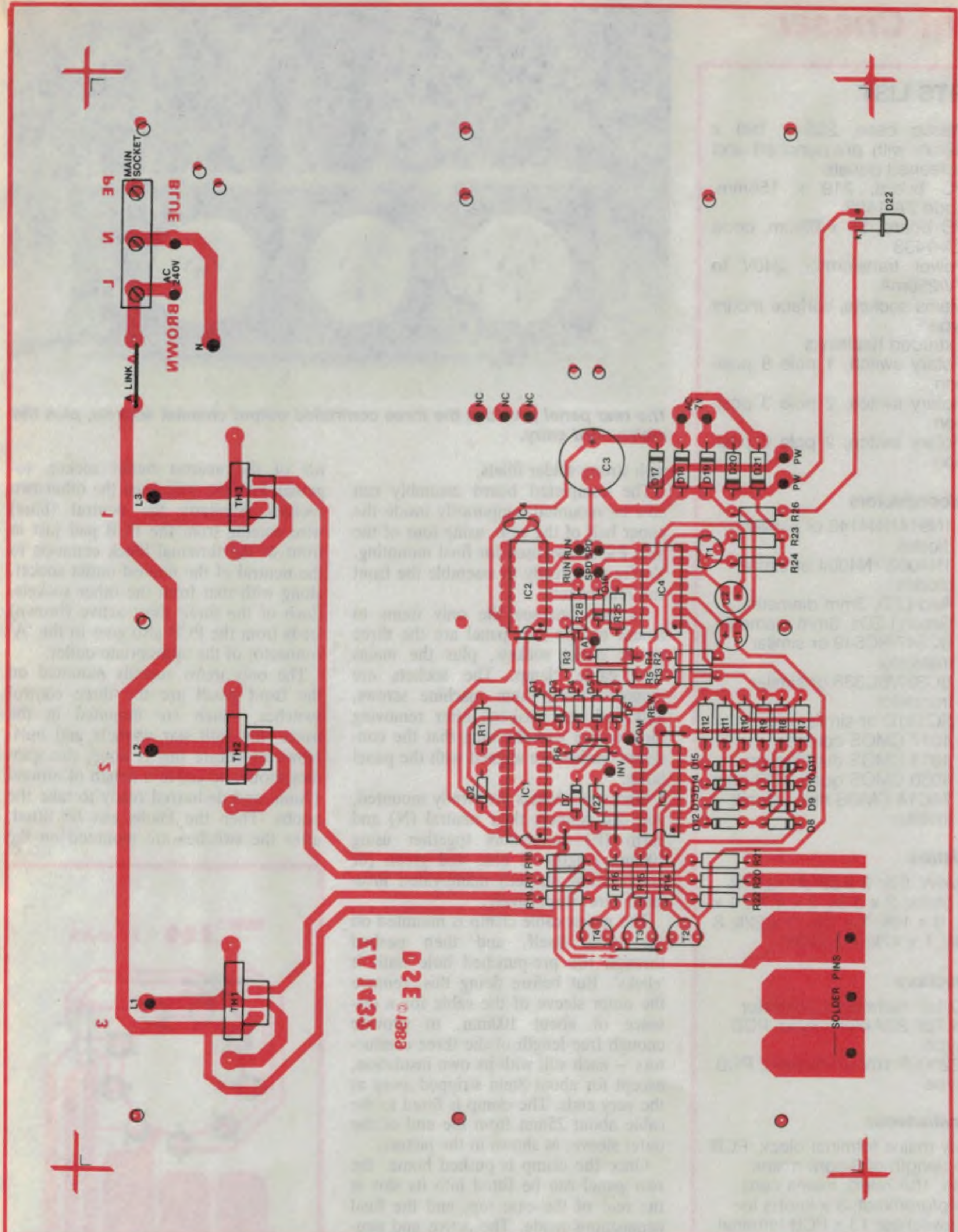
The next step is to fit the three triacs to their heatsinks, coating them first with a smear of silicone grease to ensure a good thermal bond. The triacs are screwed to the flat side of the heatsinks, so that their trio of pins will be able to pass through the appropriate holes in the PCB when the heatsinks are mounted.

The heatsinks are attached to the PCB using 3mm self-tapping (PK) screws, which pass up from underneath the board through the holes provided and bite into the ends of the small slots provided in the extrusion, on the finned side. This is done with the triac pins simply passed through the small central holes, without soldering. Then after the screws are driven home to attach the heatsinks firmly, the triac pins are soldered to their pads.

It's a good idea at this stage to fit an 80mm length of *brown* insulated mains wire to each of the three channel output pads on the board, just to the rear of each triac heatsink. These will then be ready to connect to the mains outlets, when the unit is finally assembled. Similarly you can fit a similar length of *blue* insulated mains wire to the 'neutral' connection pad, just to the front of the pads for the mains link 'A' (next to the terminal block).

The red mains LED can now be added to the front of the board, with its anode towards the right-hand end of the board. Note that the leads of the LED should be left fairly long, as they need to be curved around later, to allow the LED to mate with the hole in the front panel. The body of the LED should be about 14-15mm from the component side of the board.

At this point the main PCB is virtually complete, and you can turn your attention to the smaller board. This is very simple to assemble, with only four wire links and the nine green 3mm LEDs arranged in a circle with their *anodes* innermost. The LEDs should be



The overlay diagram for the main PCB, showing where all of the components are placed.

mounted on the board with their plastic bodies about 5mm from the top of the board, and as close as possible to the vertical – in both axes.

The two boards can now be soldered together, with the corresponding copper pads accurately aligned and the small board positioned so that its top edge is 62mm above the top (component side) of the main board. The small board should also be positioned so that it is at 90° to the main board in both axes (or as close as you can get). When this is all achieved, solder between the corresponding pads so that they are bridged

PARTS LIST

1 Plastic case, 255 x 190 x 82mm with pre-punched and screened panels
1 PC board, 219 x 155mm, code ZA-1432
1 PC board, 55 x 69mm, code ZA-1433
1 Power transformer, 240V to 7V/250mA
3 Mains sockets, surface mount type
3 Extruded heatsinks
1 Rotary switch, 1 pole 8 position
1 Rotary switch, 2 pole 3 position
1 Rotary switch, 2 pole 6 position

Semiconductors

16 1N914/1N4148 or similar diodes
5 1N4002/1N4004 or similar diodes
1 Red LED, 3mm diameter
9 Green LEDs, 3mm diameter
1 BC547/BC549 or similar transistor
3 BC337/BC338 or similar transistor
3 SC141D or similar triac
1 4017 CMOS counter
1 4013 CMOS dual flipflop
1 4030 CMOS quad XOR gate
1 74C14 CMOS hex Schmitt inverter

Resistors

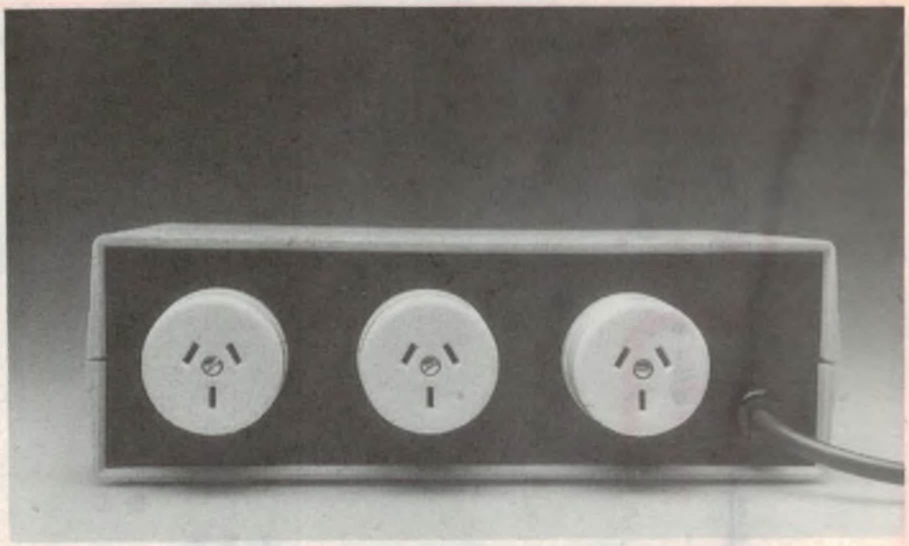
All 1/4W, 5%: 3 x 68 ohms; 4 x 180 ohms; 2 x 3.3k; 2 x 4.7k; 1 x 6.8k; 9 x 10k; 1 x 15k; 1 x 22k; 8 x 33k; 1 x 47k; 4 x 220k.

Capacitors

1 0.1uF metallised polyester
2 4.7uF 25V electrolytic, PCB type
1 2200uF 16V electrolytic, PCB type

Miscellaneous

3-way mains terminal block, PCB type; length of 3-core mains cable, 10A rated; mains cord clamp/grommet; 3 x knobs to suit switches; 13 x PCB terminal pins; 2 x 4mm machine screws with star washers and nuts; 2 x nylon cable ties; 3mm screws, star washers and nuts; connecting wire, solder, etc.



The rear panel provides the three controlled output channel sockets, plus the mains cord entry.

with strong solder fillets.

The completed board assembly can now be mounted temporarily inside the upper half of the case, using four of the nine PK screws used for final mounting. You're then ready to assemble the front and rear panels.

As you can see the only items to mount on the rear panel are the three power outlet sockets, plus the mains inlet cable clamp. The sockets are mounted using 3mm machine screws, nuts and star washers, after removing their covers and checking that the connector bushes are aligned with the panel holes.

Once the sockets are firmly mounted, you can connect their neutral (N) and earth (E) connectors together using 100mm lengths of blue and green (or green/yellow striped) mains-rated insulated wire, respectively.

The mains cable clamp is mounted on the cable itself, and then pushed through the pre-punched hole until it 'clicks'. But before doing this, remove the outer sleeve of the cable for a distance of about 100mm, to provide enough free length of the three conductors – each still with its own insulation, except for about 8mm stripped away at the very ends. The clamp is fitted to the cable about 25mm from the end of the outer sleeve, as shown in the picture.

Once the clamp is pushed home, the rear panel can be fitted into its slot in the rear of the case top, and the final connections made. The active and neutral leads of the mains cable go to the terminal block, with the neutral (blue) wire to the centre connector, and the brown (active) to the left connector.

The earth (green) mains wire of the cable goes directly to the earth connector of the nearest outlet socket, together with the wire from the other two sockets. Similarly the neutral (blue) wire coming from the PCB pad just in front of the terminal block connects to the neutral of the nearest outlet socket, along with that from the other sockets. Each of the three short active (brown) leads from the PCB also goes to the 'A' connector of the appropriate outlet.

The only items actually mounted on the front panel are the three control switches, which are mounted in the usual way with star washers and nuts. However before this is done, the spindles should be cut to a length of around 12mm, and de-burred ready to take the knobs. Then the knobs can be fitted, after the switches are mounted on the

And finally, here's how the small display board is wired up.

panel.

Rate switch SW3 also has the resistors R29-R36 mounted directly on its connection lugs, and this is also best done before the switch is mounted on the panel. Note that the resistors each have one pigtail looped around, to form a 'U' with its legs spaced to suit the switch lugs. The other pigtails are cut short, as shown in the picture.

The connections between the switches and the main PCB are run in lengths of insulated wire about 110mm long, cut from ribbon cable. These leads can be fitted to the switches on the panel, before the panel is offered up to the case.

This can now be done, taking care that the nine display LEDs at one end and the mains indicator LED at the other fit into their matching holes. As before the panel fits into the slot in the case top, and to do this you may need to remove the temporary screws holding the PCB assembly in place.

Finally the leads from the switches may be soldered to their appropriate PCB pins, and your chaser is ready for testing.

Note that at this stage, the mains active link 'A' should NOT have been fitted to the board. The covers should also have been re-fitted to the three mains outlets on the rear panel, but these outlets should NOT have any loads plugged in. We don't want to lose a single reader or constructor!

If these points are all in order, switch the rate switch SW3 to its mid position, the lights switch SW1 to its 'run' position, and the mode switch SW2 to one of its two 'Fwd' positions. Then, after making sure that everything is well clear of the chaser's innards, plug its mains cord into the power.

If all is well, the red mains LED should glow immediately. Some of the green display LEDs should also glow, and the pattern produced by these should be moving around the display. There should be no signs of distress, no smoke, no smell or whatever – if you get any of these, or 'no glow' from the LEDs, turn off fast and check for a wiring error.

Assuming that things are OK so far, try adjusting the rate switch. This should vary the rate at which the pattern moves around the display, from quite slowly to almost too fast to see.

Similarly with the mode switch you should be able to make the pattern reverse direction, alternate back and forth, or do all of these things in 'inverted' (dark for light) fashion. And finally with the lights switch you should be able to either freeze the display, or turn it off altogether.

If all of these functions check out correctly, you're ready to turn off, unplug from the power, fit the 'A' link, and complete the assembly of the case. Your chaser will now be complete, and ready to use with your lamp loads.

But if on the other hand you've struck trouble, it's time to unplug and check everything over again. The odds are that you've made a wiring error, perhaps with the wiring between the switches and the PCB. The only other likely possibility is that you've fitted one or more components to the PCB the wrong way around.

Note that with the 'A' link still left off the board, you can actually use a multimeter or scope to troubleshoot on the board, with power applied. But make sure that there are no loads plugged into the rear outlets, to link the 'neutral' with any of the triacs (just in case the power point isn't wired correctly, and the neutral isn't't!). Providing this is done, troubleshooting can be done quite safely.

So if ever you need to service the chaser later on, simply remove the 'A' link and unplug the loads. EA

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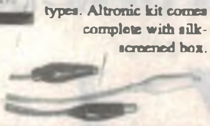

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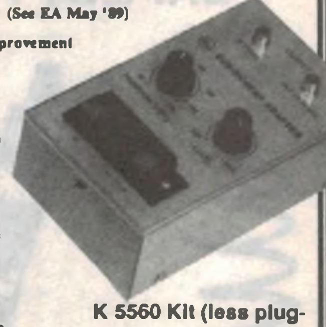

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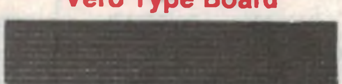

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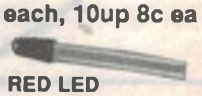

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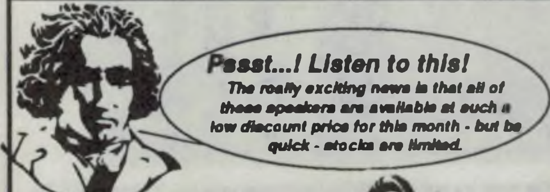

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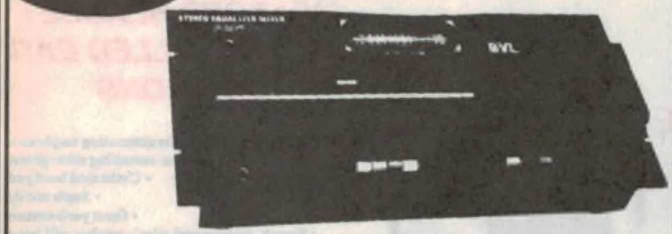

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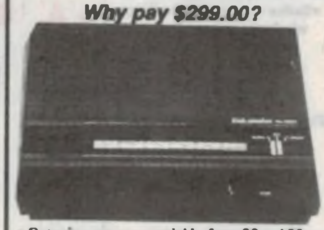

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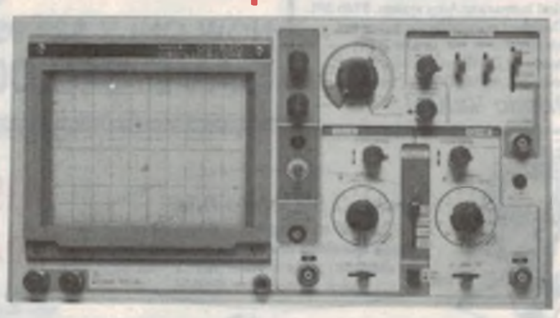

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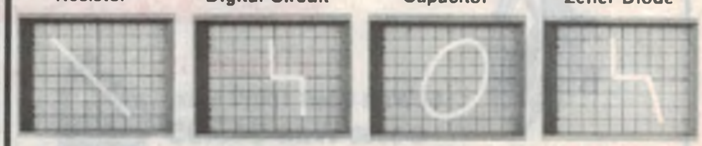

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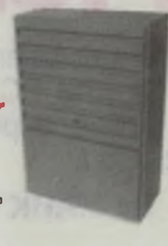

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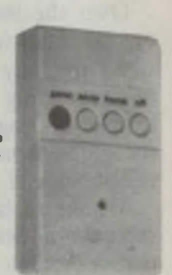

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A fax adaptor card for PCs - 1

This is the first of a pair of articles describing an easy to build fax adaptor card for IBM PC compatible personal computers. This introductory article explains how fax works, to set the scene for the card itself.

by MARK CHEESEMAN

Over the last few years, the facsimile or fax machine has quietly revolutionised the way a modern business operates. Sending text, line art and even simple photographs across the city or the globe is now as simple as making a telephone call.

A modern fax machine is really three separate devices in one box – a scanner, a modem and a thermal dot-matrix printer. Recent developments in the technologies used in the scanner and modem sections of the device have dramatically reduced the cost of fax machines, putting them within the reach of virtually any business.

Fax machines of one sort or another have been in use for many years, for applications which required images to be transmitted far more quickly than physical transport systems could handle. Weather bureaus around the world used them to transmit weather maps, and indeed, weather satellites transmit facsimile pictures which are then received by the appropriate ground stations. Accurate weather maps detailing approaching storm conditions can save lives, and the quicker these images can be delivered to those who can make use of them, the better the chances of minimising the cost of a storm – in both monetary and human terms.

The press has also been a heavy user of fax machines for many years. Pictures of events happening around the world could be 'transmitted by wire' to newspapers as fast as the story which accompanied them.

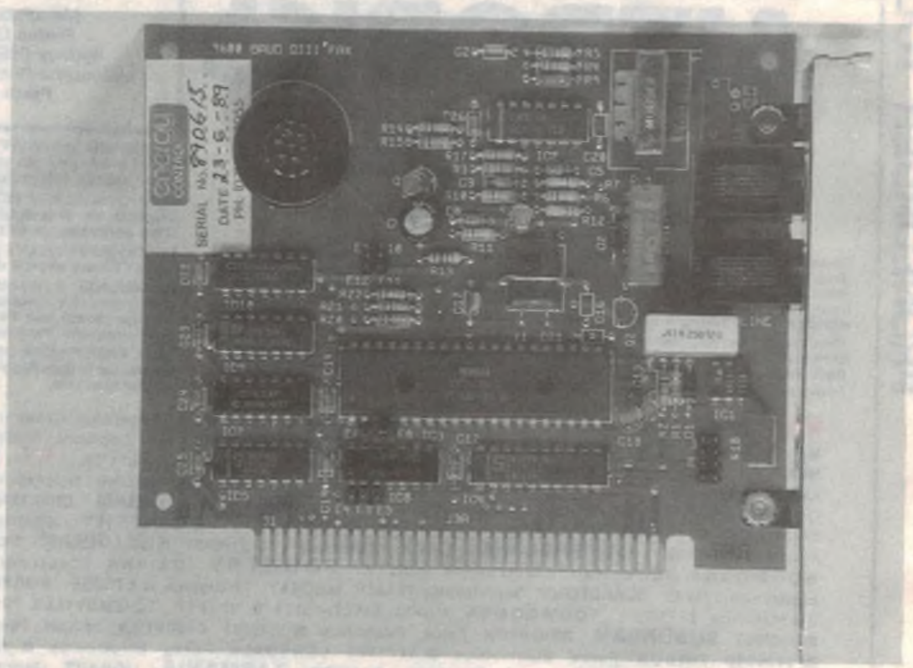
However early facsimile machines were not nearly as inexpensive or easy to use as a contemporary office fax. The original image was usually wrapped manually around a drum, and a light was bounced off the image, and converted to a varying voltage by some form of photo-electric sensor. This voltage was in turn modulated so that the range of possible light intensities was converted into a range of frequencies compatible with the phone system. As the drum rotated on its axis, the photo sensor traced out a line of the picture around the circumference of the drum.

The photo sensor also moved slowly, parallel to the drum's axis of rotation, so that during each successive rotation of the drum the sensor would trace out the next 'line' of the image. Another drum at the receiving end, rotating in synchronism with the transmitting drum, carried a piece of photographic paper or film, which is exposed by a beam of light modulated by the photo sensor at the transmitting end. The light beam also moved parallel to the drum's axis in sync with the transmitter's photo sensor, producing a copy of the original image on the receiving paper. The image was then developed using ordinary photographic processes.

Clearly, the need to develop each received image before it could be used limited the usefulness of such machines to applications which really needed images transmitted quickly.

One variation used thermal paper at the receiving end. A stylus reproduced the path of the photocell at the transmitting end, and the received image was virtually 'burned' onto the paper at the receiving end. Although the resolution was not as good as the photographic system, and the transmission of greyscales was not possible, the convenience of obtaining an instant copy at the receiving end greatly outweighed the disadvantages.

Quite recently, a new technology has emerged which allowed the mechanics of the transmitter to be greatly simplified. Charge-coupled devices (CCDs) are a solid state optical sensor which has become quite popular in domestic video cameras, resulting in reductions in both the size and power consumption of these appliances. Because a large number of individual CCD elements can be combined in a single small package, their advantage in fax machines is that a



Here's the fax card for PCs, to be described next month.

This new PhoneFax 1000 from Kambrook combines a phone, answering machine, fax and photocopier in the same compact desktop unit.

single CCD chip can capture an entire line of the image at once, eliminating the one of the axes of mechanical movement required in the process.

With a CCD sensor, the original is passed under the sensor, a line at a time, and the CCD captures each of the lines in turn, before the stepper motor moves the page to the next scan line on the original. The sensors used in the 'Group 3' (G3) standard have a horizontal resolution of 200 dots per inch (dpi), which is roughly the same as a 24 pin dot-matrix printer.

The vertical resolution can be adjusted to one of three values, depending upon the detail which needs to be transmitted. The 'normal' resolution is 96dpi, while 'fine' resolution is double this value (192dpi), and 'extra-fine' resolution is double again, or 384dpi.

Selection of the desired resolution is accomplished manually at the transmitting end, and simply determines the size of the steps that the stepper motor takes for each scan line on the original. The stepper motor at the receiving end also steps with the same increment, so that the image is not stretched vertically when high resolution is used.

The data communications modem in a modern G3 fax machine is usually capable of a wide range of speeds, from 2400 to 9600 bits per second. As facsimile transmissions are half-duplex (after the connection is established, the data only needs to travel in one direction), the requirements for high speed modems are not as stringent as they are for full-duplex communications. This has given rise to a large number of inexpensive modem chip-sets (and some single-chip devices), further helping to reduce the cost and thus increase the accessibility of fax machines.

The modem, in common with most computer modems these days, is capable of auto-dial, auto-answer and auto-ranging (baud rate selection), so that the operator does not have to have any skill beyond that required to make a telephone call. Faxes are usually also equipped with a number of memories for storing frequently called numbers, and other features such as auto re-dial on busy numbers, polling, password protection (to prevent junk faxes), and many more too numerous to list here.

The output device in most fax machines these days is a thermal dot-matrix printer, of the type used for some time as computer printers. They have the advantage of quiet operation, while giving adequate resolution for most applications. The down-side is that they need special thermal paper, which is more expensive than plain paper, and doesn't look as good. The resolution of the printer is the same as the sensor in the transmitter, so that the image retains its original size throughout the transmission process.

Some (more expensive) fax machines use laser engines (of the type found in laser printers) as their output devices. These use plain paper as their output medium, with the advantage of the better appearance which that medium offers when compared to thermal printer paper. Of course, up-keep is also more complicated, requiring regular toner recharges and other maintenance tasks to be completed regularly, as do laser printers and photocopiers.

Standards

It should be obvious to anybody who has been frustrated by digital compatibility problems, that for such an international network to have any hope of working, a set of standards must be defined and adhered to. To this end, the CCITT has defined standards defining both the actual modulation schemes used over the phone line, and also the broader aspects of how the two fax machines establish the connection and then transfer the data in an intelligible form.

CCITT V.29 is a synchronous standard which runs the line at 2400 baud, half duplex, using QAM (quadrature amplitude modulation). Depending upon the quality of the line, the number of bits sent during each signalling period is either two, three or four, giving data rates of 4800, 7200 or 9600bps respectively (see text box: *Bits, Bauds and bps*).

The V.27ter standard is the other standard modulation scheme for faxes. Again, it is a synchronous standard, but runs at 1600 baud, falling back to 1200 baud when required, and using PSK (phase-shift keying) rather than QAM. At 1600 baud, tribit encoding is used, giving a data rate of 4800bps, while at the 1200 baud speed, dibits are sent for a data rate of 2400bps.

The bit error rate (BER) achieved on a given line falls as the number of bits transferred at a time is reduced, and the fax machines automatically determine the optimum speed to use while maintaining an acceptable BER. Also the V.29 4800bps rate performs better over a given line than does V.27ter at the same rate, so the former is preferable if both ends are V.29-equipped.

Essentially what two modern V.29-equipped fax machines do, in establishing a call, is test the BER initially using the V.29 standard at 9600bps. If this gives a suitably low BER, they continue operating at this data rate, but otherwise they begin dropping to lower rates until an acceptable BER is achieved. If none of the three V.29 rates achieves this, they will drop down to the V.27ter 2400bps rate.

Fax cards

Since facsimile systems share a lot of technology with personal computers, it is not surprising that a number of fax cards have emerged to allow PC clones (and also Macintoshes) to send and receive faxes, communicating with other fax cards or ordinary fax machines. These cards contain a V.29/V.27ter modem and all the required support circuitry to allow the computer to drive the modem, and make it appear as an ordinary fax machine as far as the line is concerned.

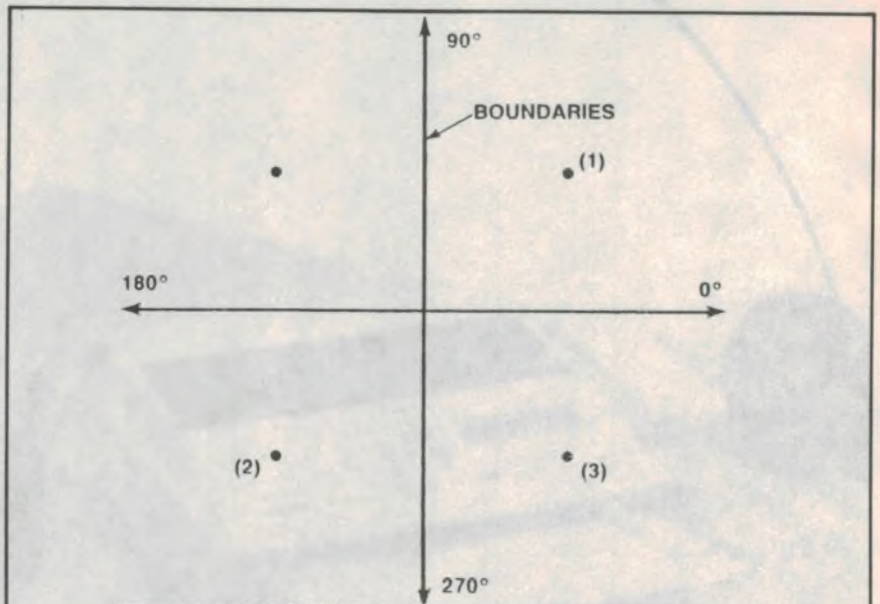
A fax card is significantly cheaper than a fax machine, because the scanner and printer are not included. It is assumed that the computer has a printer to allow incoming faxes to be printed out if desired, or they may simply be displayed on the screen. Text and graphics can be generated using ordinary word processors and drawing packages, and then transmitted as a fax.

Many fax cards allow you to scan in letterheads and signatures, by sending them to your computer from an ordinary fax machine (if you don't have access to a fax machine to do this, you can use Australia Post's *Faxpost* service to do it). These images are then merged with your text by the included software, and the recipient will never know that you don't have a real fax machine. Some fax cards even have their onboard processor, so that they can operate in the background, without disrupting the normal use of the computer.

If all this has made you eager to get *your* computer talking to fax machines, then the second of these articles in next month's *Electronics Australia* may be of interest to you.

Using a new chip from Yamaha and a handful of other components, we will be presenting a construction project for a fax card which can be plugged into an expansion slot of an IBM PC, XT, AT or compatible, and gives you the ability to send and receive faxes using your computer. Received faxes may be displayed using any IBM-supported graphics adapter, or printed out on an Epson-compatible printer.

Bits, bauds and bps



DIBIT VALUES (1200)	BIT VALUES (600 BPS)	PHASE CHANGE
00	0	+90°
01	—	0°
11	1	+270°
10	—	+180°

Fax machines make use of modems (modulator/demodulators) to transfer digital information over analog telephone lines, in the same way as computer modems do. The information is in binary form, and the speed at which the data is transferred between the two points is known as the bit rate, measured in bits per second, or bps.

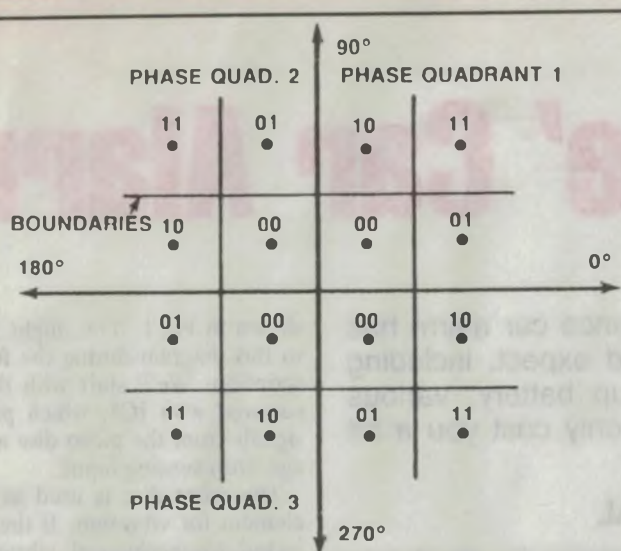
The signalling rate is that associated with the speed of operation of the communications channel itself, and is not directly related to the amount of information being transferred. Signalling rates are measured in baud, and the maximum signalling rate over a given channel (either radio or hard-wired) is limited by the bandwidth of the channel.

In simple modulation schemes (such as the 300bps V.21 standard), the bit rate and baud rate are identical, as the bits are sent one at a time. However, as more bits need to be sent at a time, more complex modulation schemes need to be used. For example, the common V.22 standard uses phase-shift keying (PSK), and encodes each possible combination of two-bit pairs (known as dibits) into one of four different phases of the carrier. Thus, with the 600 baud signalling rate used in V.22, the data rate is actually 1200bps. The use of a 600 baud signalling rate allows two channels to exist within the one voice channel, allowing full-duplex communications. If three bits are encoded at once, they are called tribits, and so on.

The so-called 'eye pattern' for V.22 BPSK is shown in Fig.1, with each dot representing the carrier phase and amplitude for a particular bit combination.

The faster V22bis standard uses yet another form of modulation, which is a combination of AM and PSK, and is called Quadrature Amplitude Modulation, or QAM. In this particular implementation of QAM, four bits are sent simultaneously, with each possible combination of bits encoded as one of 16 possible phase/amplitude combinations. Its eye pattern is shown in Fig.2.

The requirements for FAX machines differ somewhat from those required by most computer applications, as information only needs to be transmitted in one direction at a time. This means that the entire bandwidth of the line can be used to transmit data in one direction, and so higher baud rates are possible. So with a given number of bits being transferred at once, a correspondingly higher data rate is obtained, such as those described in the main article.



DATA IS ENCODED IN QUADBITS. THE FIRST TWO BITS OR DIBIT SELECT ONE OF FOUR QUADRANTS. THE SECOND DIBIT SELECTS ONE OF FOUR POINTS IN THAT QUADRANT, AS SHOWN BELOW.

FIRST TWO BITS IN QUADBIT [2400 BIT(S)] OR DIBIT VALUES [1200 BIT(S)]	PHASE QUADRANT CHANGE	
00	1 — 2 2 — 3 3 — 4 4 — 1	90°
01	1 — 1 2 — 2 3 — 3 4 — 4	0°
11	1 — 4 2 — 1 3 — 2 4 — 3	270°
100	1 — 3 2 — 4 3 — 1 4 — 2	180°

One component required in modems using PSK and QAM is a *scrambler*. This device encodes (or scrambles) the transmitted data so that long strings of zeros or ones in the data stream do not cause loss of synchronisation at the receiving end. This is because PSK and QAM both depend on the receiver catching the phase changes in the carrier, in order to regenerate a clock signal at the receiving end. An extended period without phase changes will eventually cause the receiver to lose sync with the transmitter, causing loss of data.

The operation of the scrambler basically ensures that, regardless of the content of the data stream, phase changes occur at a high enough rate to maintain sync between the two ends. One result of this is that each bit of the scrambled signal is derived from more than one bit of the actual data stream, and at the other end the descrambler re-generates each bit of the original data stream from several bits of the incoming data. This means that an error in the transmission of one group of bits will affect several groups of bits at the receiving end, so that a single error tends to corrupt more than one bit of the received image. EA

Construction Project:

The 'Vulture' Car Alarm

Worried about your car? This top performance car alarm has all the state of the art features you would expect, including optional remote control operation, back up battery, various sensors and lots more. Best of all, it will only cost you a bit more than a full tank of petrol.

by BRANCO JUSTIC and JEFF MONEGAL

The media keep reminding us that car burglary is on the increase, and some sources claim it is one of the fastest growing industries around today. Statistics show that a car is broken into or stolen every 7 minutes or so in NSW, causing many people to invest in one of the large range of electronic alarm systems currently available. However some of the top models can run into $600.00 or more – money that the average motorist can ill afford.

Vulture to the rescue! You can build and install this top performing alarm for a fraction of the cost of a commercial system. It has features that are found only on top-line models and will easily hold its own with systems costing many hundreds of dollars more.

Although this unit can be used as a self-contained alarm, it can easily be combined with our UHF remote control to produce a car alarm that is comparable to even the best of commercial car alarms. As well, a small crystal locked ultrasonic movement detector that can be used in conjunction with this system is being developed for description in a forthcoming issue.

But what about the basic unit, as presented this month?

The Vulture has numerous features, starting with a piezo vibration detector that will sense any attempts to jack up the car or tow it away. It will also respond to glass breakage and the bumps and bangs so commonplace in supermarket car parks. However, the circuit has been designed not to false trigger from movement due to the passing of large trucks or from the effects of heavy wind and rain.

The unit has multiple inputs, to suit all types of vehicle wiring. For example, GMH switch the negative side of the interior light, while Ford switches the positive. Inputs are also provided for bonnet and boot sensors. And to foil the individual who thinks disconnecting the battery will disarm the unit, there is provision for a back up battery. An onboard trickle charger is also included, to ensure the back up battery is always ready for action.

And there is a flashing dash lamp (of course) to indicate that the system is armed. The lamp will remain on continuously after a trigger has been initiated, and will be off when the alarm is disarmed.

A current sensing (or voltage drop sensing) input is included to detect any load imposed on the battery such as that caused by the interior light, starter motor, headlights or brake lights. Using the current sensing inputs instead of the door switch inputs greatly simplifies installation.

The circuit includes inputs that provide an entry delay, as well as inputs to accept positive or negative going pulses. By leaving out one capacitor all inputs will respond without a delay, such as would normally be used if a remote control arming device is used.

Consistent with today's noise pollution laws, the unit also has automatic turn off for the siren after a period of around 45 seconds. However, the unit will be re-armed after this delay, ready to respond to any further trigger inputs. So with all these features, we are sure you will agree the Vulture is a top class car alarm system. The prototypes were field tested in several cars and no problems were found in any installation.

Circuit details

Although the circuit looks complicated, it is easy to understand when it is broken down into a block diagram as shown in Fig.1. You might like to refer to this diagram during the following description. We'll start with the block associated with IC5, which processes the signals from the piezo disc and the voltage drop sensing input.

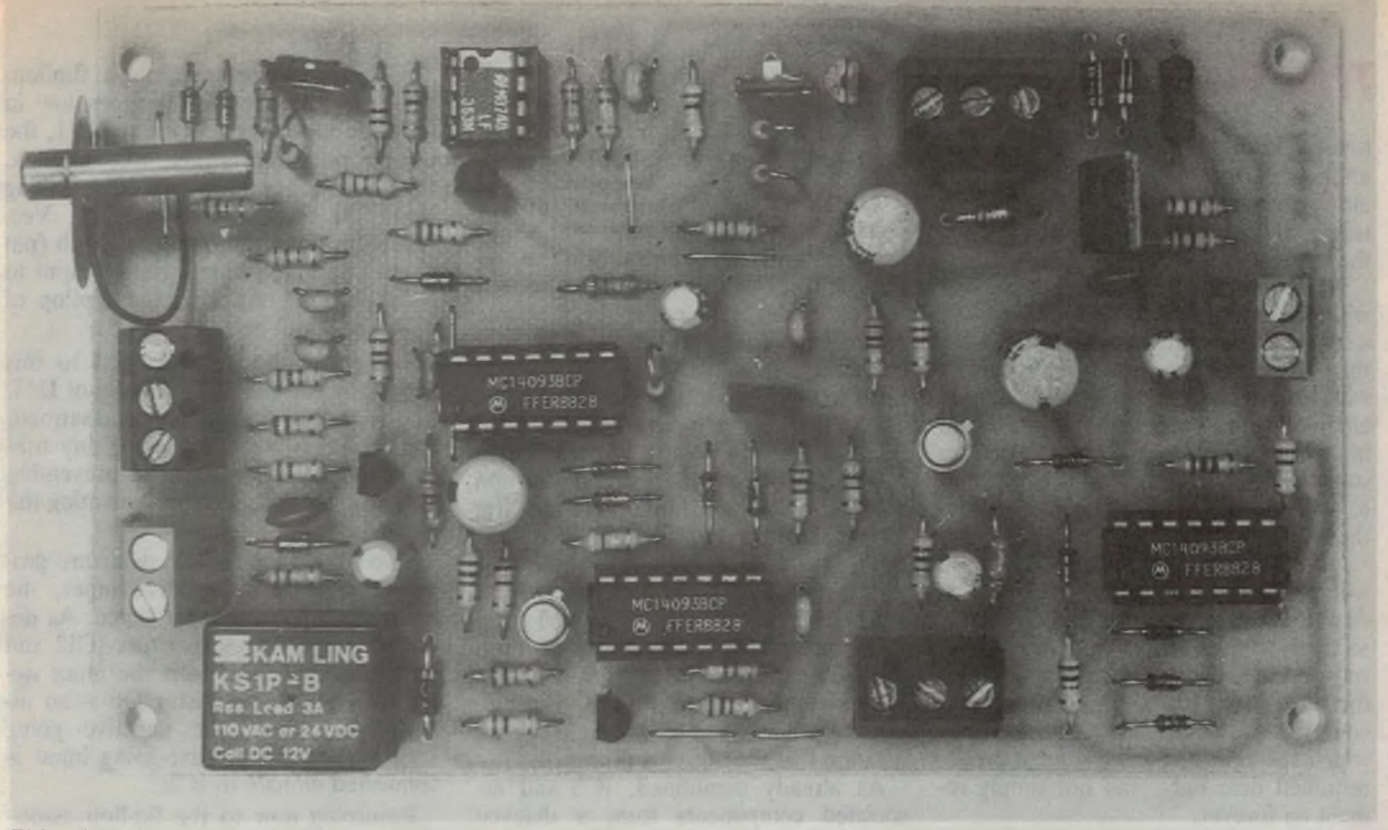
The piezo disc is used as the sensing element for vibration. If the disc is subjected to mechanical vibration, it will produce a voltage proportional to the amount of movement. The disc is connected to the non-inverting input of IC5a, which is wired as a comparator with its reference adjustable via VR1. If the voltage produced by the disc is high enough to exceed the reference, pin 1 of IC5a (output) will swing high, switching on Q1. This produces a negative going trigger pulse at the collector of Q1, shown as point Z on the circuit diagram.

The voltage drop sensing input is provided by the connection from the car's 12V supply to the inverting input of IC5b, via C2. Whenever the battery is required to supply an electrical load, such as the interior light, a short duration negative going pulse is produced at the positive terminal of the battery. IC5b is also wired as a comparator, but this time the reference is connected to the non-inverting terminal, adjustable by VR2, which therefore also determines the sensitivity of this input. The voltage at the inverting terminal is determined by the potential divider of R7 and R8, and is normally slightly higher than that at the non-inverting terminal as set by VR2.

If the negative going pulse from the battery causes the voltage at the inverting input of the comparator to fall below the reference, the output of IC5b (pin 7) will become high, turning on transistor Q2. The collector of Q2 shares the same load resistor as Q1, and again a negative pulse will occur at point Z. That takes care of the piezo and voltage sensing inputs; now for the rest of the circuit.

Switch inputs

The next section is that associated with IC1a-b, which accepts trigger in-



This photo shows the prototype PCB of the Vulture car alarm. The links referred to in the text are soldered on the track side.

puts from the switches connected to protect the boot, bonnet and doors. The door switches are those used to operate the interior light, necessitating the provision of inputs for both positive or negative edge triggering. As already described, some cars switch the positive lead (Ford is one) while others switch the common (negative) lead. This section provides no entry delay and would be used if the alarm was being armed or disarmed by remote control, such as with a UHF switch.

Negative-going trigger inputs are applied through C5 and C6, in turn connected to the input of IC1a which is wired as an inverter. The action of C5 and C6 is to accept the step input, but to pass on only the *transition* when the signal falls from +12V to ground (negative going). Diode D5 ensures the input to IC1a is held to a value no higher than 9V, the value of the supply voltage used within the alarm circuit.

A positive-going signal is connected to R20, and if this input is at 12V (i.e., input activated), transistor Q3 will be turned on via R20. Under this condition, the collector voltage at Q3 will drop, and the negative-going transition will be passed on to IC1a via C7. Thus, activating any of the three inputs will cause pin 11 (output) of IC1a to produce a positive output pulse.

Before describing the delayed input section, it is better to now look at the remainder of the circuitry associated with IC1, starting with the method used to arm or disarm the unit.

The alarm is enabled or disabled with a switch connected between the 'arm' input and ground. A UHF remote controlled switch can be used instead of an actual switch if required, in which the relay associated with the UHF receiver replaces the mechanical switch otherwise required.

The alarm is in the disabled state when the 'arm' input is held low. Under this condition, diode D8 is forward biased, connecting R27 to ground. This prevents C11 from charging, in turn holding pin 1 of IC1d low. IC1d and IC1c form a monostable (timer) and if pin 1 of IC1d is low, the output will be high, regardless of the logic level on the second input of IC1d. This holds transistor Q4 off, preventing the siren relay from operating.

Returning now to the non-delay input section, it can be seen from the circuit that IC1b inverts the output of IC1a. In the event that a trigger signal is received, pin 11 of IC1a will go high, sending the output (pin 10) of IC1b low. This action will trigger the monostable, causing the output (pin 4) of IC1c to go high and the output (pin 3) of IC1d to go low, turning on Q4, Q5 and the relay. The low now on pin 3 of IC1d is fed back to IC1b via D6 and R24, discharging C9 and maintaining a

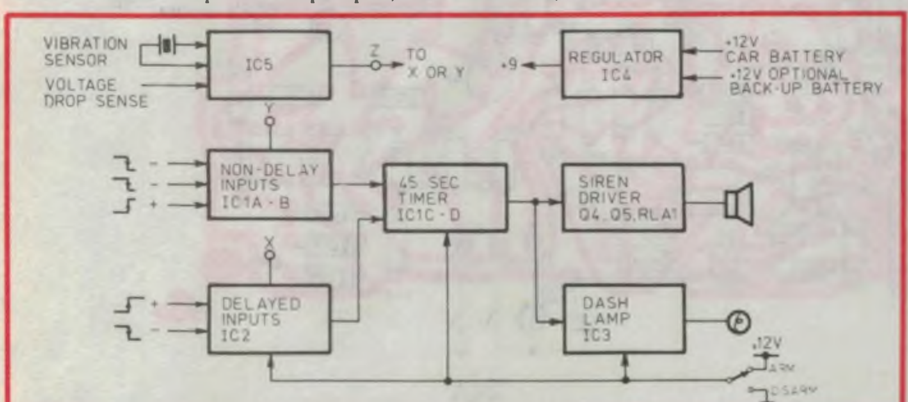


Fig.1: The block diagram of the Vulture car alarm shows how each section interconnects. The ICs associated with each block are also indicated to relate this diagram to the circuit.

The Vulture Car Alarm

low to keep the output of IC1c high after the trigger pulse has finished. This also effectively prevents any further trigger pulses from the inputs affecting the monostable.

While the output of IC1c is high, C10 will charge through R25, taking around 45 seconds with the values shown. After this delay, the input at pin 2 of IC1d will return to a low, as the lack of charging current through R25 will result in a zero voltage drop across it. As a result, the output of IC1d will be set back to a high, turning off the transistors and the relay.

Once the output of IC1d is a high, D6 will be reverse biased, allowing C9 to charge via R23. This will take about 2 seconds, after which the alarm will return to the armed state, ready to accept further trigger signals. This arrangement conforms with noise pollution laws, in which the alarm will sound for a predetermined time only, and not simply remain on forever.

Finally, pin 1 of IC1d is connected to a timing network comprising R26 and C11. This network provides a one-second delay after the unit is armed, allowing time for the vibration and current sensing inputs to stabilise, preventing false triggering.

IC2 and IC3

The circuit involving IC2 provides a delay for the trigger inputs, and would be used where an entry delay is required. If the unit is to be armed with a hidden switch, rather than by a remote switch, the door switches, and as later described, point Z from Q1, would need to be connected to this section.

The dash lamp indicator is operated by IC3. The arm input is also connected to pin 8 of IC3b, which, in conjunction with IC3a forms a flipflop. If the arm input, and hence pin 8 of IC3b is low, the output of IC3a (pin 11) will be low. As a result, pins 1 and 2 of IC3c will be held low by diode D16. IC3c and IC3d form the astable multivibrator to flash the dash lamp, and if IC3c has its inputs held low, the astable will be disabled, causing the dash lamp to be held off, indicating that the alarm is disarmed.

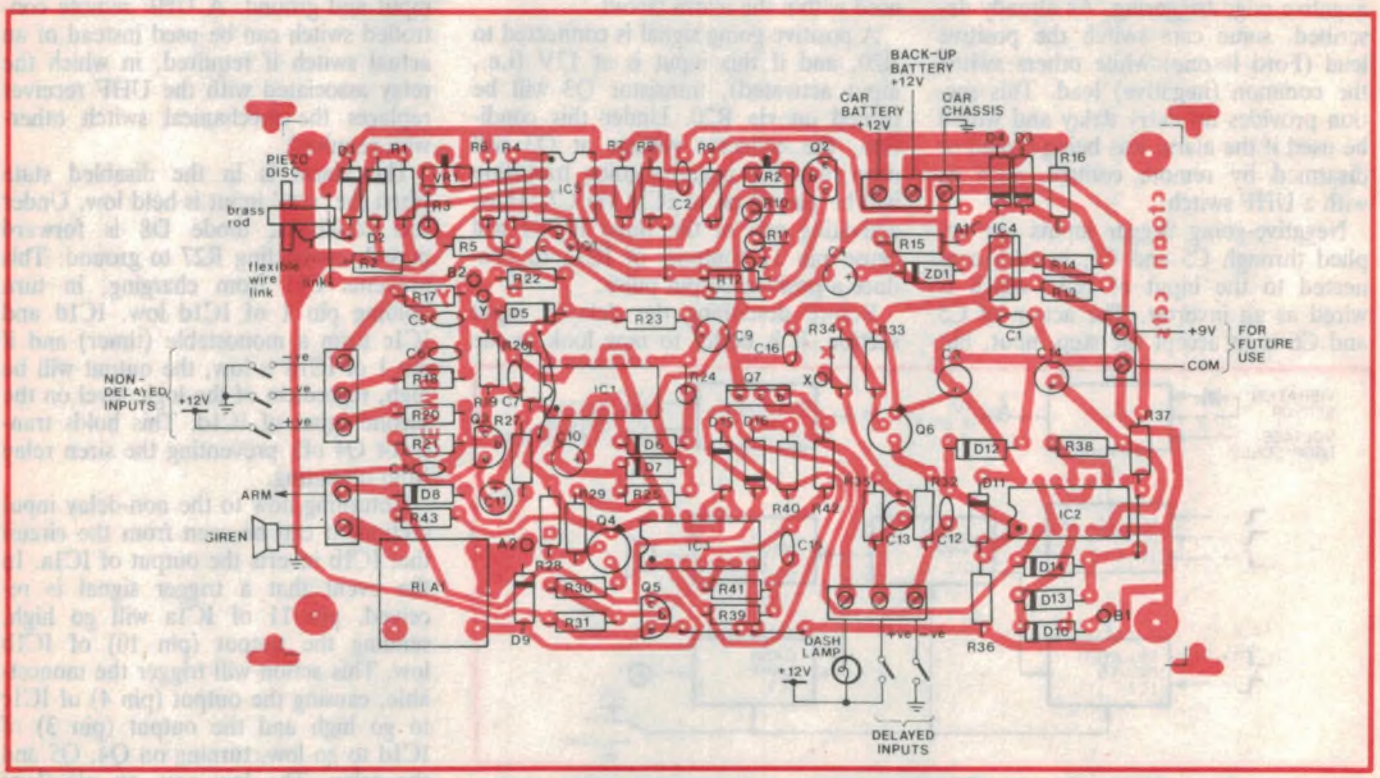
As already mentioned, IC2 and associated components form a delayed trigger circuit. However, if the system is armed and disarmed via a UHF remote control, then C14, the timing capacitor may be left out. This removes the delay feature and the delayed inputs can then be used as extra non-delay trigger inputs.

IC2c and d are wired as a flipflop. When the output of IC2a goes low in response to a trigger input at pin 1, the flipflop output (pin 11), will go high. C14 now charges up via R38, taking about 10 seconds to reach 1/2 Vcc. After this time, the output of IC2b (pin 4), will go low, giving a trigger input to IC1a via D10. As well, the flipflop of IC2c and d will be reset via D13.

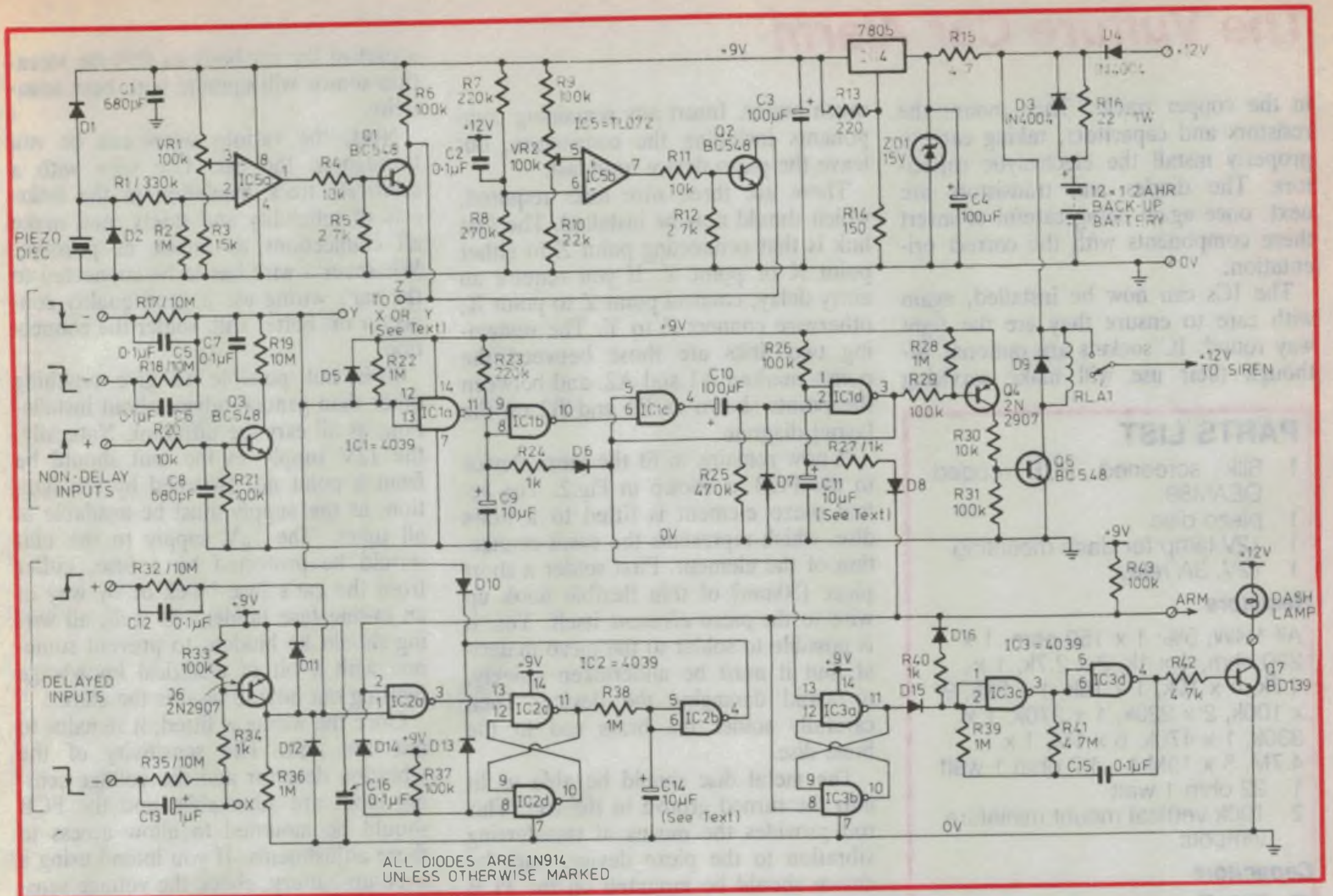
The arm input also connects to this flipflop at pin 2 of IC2a by way of D14, so that when the system is disarmed, the flipflop is reset, cancelling any trigger that may be active, and preventing further input triggers from activating the alarm.

Two trigger inputs with delay are provided, one for a negative input, the other for a positive input signal. As described previously, capacitors (C12 and C13) are used to convert the input signal to a pulse. Transistor Q6 is an inverter to accept the negative going input, while the positive-going input is connected directly to IC2a.

Returning now to the flipflop associated with IC3a and b. Whenever the alarm is triggered, pin 11 (output of IC3a) will be set high, forward biasing D15. This will place a high on the input to IC3c, disabling the astable and turning on the dash lamp. As a result, the lamp will remain on, indicating that the



The layout diagram. The wire links required should be connected once all components have been fitted. Three links are required; one from Z to either X or Y as described in the text, another from A1 to A2 and the third from B1 to B2. Also, take care with the vibration sensor.



The circuit diagram. The circuit uses CMOS logic ICs and has a range of inputs to accommodate positive or negative going signals from the door, boot and bonnet switches. Delayed or non-delayed sensing is also incorporated, and the unit can be armed or disarmed with a remote controlled switch.

alarm has received a trigger input during the owner's absence. As already described, the flipflop around IC3a-b will be reset when the unit is disarmed.

However, if both diodes D15 and D16 are reverse biased, (unit armed, no trigger), the oscillator of IC3c-d will operate, flashing the dash lamp, thereby indicating the system is armed.

The whole system

The power supply section involves IC4 and its associated circuit. D3 and D4 are used to isolate the car battery from the optional back up battery. Under normal conditions the back up battery is charged via R16 from the car's 12V system. Components ZD1, C4 and R15 suppress spikes on the 12V line. IC4 is a standard 3-terminal 5 volt regulator, with its reference terminal held about 4 volts above the common line, giving a supply rail (Vcc) of about 9 volts to the unit. The voltage divider R14 and R13 provides the required 4V to the reference input of the regulator. The back up battery should be a 1.2Ah/12V rechargeable gel cell.

As mentioned before, exit and entry delays can be included if required. Installing C14 will add the entry delay of 10 seconds, while a value of 47uF for C11 will provide an exit delay of about 10 seconds. If you choose to arm the system via a hidden switch, therefore requiring the entry and exit delays, a wire link must be included from point Z to point X. This then connects the vibration and voltage sensing inputs to the entry delay circuitry, giving the necessary time delay required to allow legal entry with subsequent disarming of the alarm.

If you fit a remote control switch to arm or disarm the unit, then the link can be installed from Z to Y. This allows these sensors to trigger the alarm instantly, providing a more rapid response to any tampering that may be occurring.

The voltage drop sensor will detect the interior lamp being turned on when any door is opened, so connection is not necessary to all the door switches. Naturally, if the interior lamp is blown then the current sensor will not work from the door switches, although it will respond to the starter motor, headlights or other loads.

Construction

Start by giving the PCB a close inspection for shorts between, or breaks

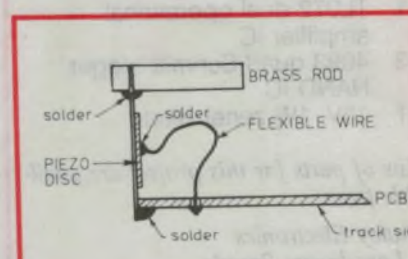


Fig.2: Details showing how the piezo vibration detector is fitted to the PCB. A short length of flexible hook-up wire, soldered to the face of the piezo element connects the active face of the element to the PCB. The brass weight is soldered to the piezo sensor disc as shown, after which the device can be soldered to the PCB.

in the copper tracks. Then mount the resistors and capacitors, taking care to properly install the electrolytic capacitors. The diodes and transistors are next, once again being careful to insert these components with the correct orientation.

The ICs can now be installed, again with care to ensure they are the right way round. IC sockets are optional, although their use will make servicing much easier. Insert any remaining components including the connectors, but leave the piezo device until last.

There are three wire links required, which should now be installed. The first link is that connecting point Z to either point X or point Y. If you require an entry delay, connect point Z to point X, otherwise connect Z to Y. The remaining two links are those between the points marked A1 and A2, and between the points shown as B1 and B2 on the layout diagram.

It now remains to fit the piezo device to the PCB as shown in Fig.2. The actual piezo element is fitted to a brass disc, which represents the earth connection of the element. First solder a short piece (30mm) of thin flexible hook up wire to the *piezo element* itself. Yes, it is possible to solder to the piezo material, but it must be undertaken quickly, to avoid damaging the device. Then carefully solder the brass rod to the brass disc.

The metal disc should be able to fit into the turned groove in the rod. This rod provides the means of transferring vibration to the piezo device, and the device should be mounted on the PCB so that the rod is at the top of the disc. Next solder the brass disc to the earth track of the PCB at the location indicated on the layout diagram.

Finally, check your work for any faults such as component orientation, poor solder connections or shorts between adjacent tracks. If all is well, the unit can now be bench tested.

All that is required is a power supply of around 13V, which can be connected to the unit as shown on the layout diagram. Each input can be tested by momentarily connecting them to either ground for the negative sensing inputs, or to the +13V for the positive going inputs. Touching a 12 volt light bulb across the power supply terminals should trigger the current sensor, while hitting the bench with your hand should trigger the vibration sensor.

Installation

Installation of the unit is the most difficult part, as cars are not the best of environments to work in. The PCB needs to be mounted somewhere out of sight, but at a point where any vibration can be sensed by the piezo element. Once a suitable location has been decided for the unit, securely bolt it to the selected spot. It must be strongly mounted on a metal section, preferably a part of the car body so that the vibration sensor will operate with best sensitivity.

Next, the various wires can be run throughout the car. Use wire with a relatively thick insulation in the interests of reliability and safety, and make all connections as secure as possible. Wherever a wire has to be connected to the car's wiring use a good quality connector or, better still, solder the connection.

It is not possible to give anything other than general advice about installation, as all cars are different. Naturally, the 12V supply to the unit should be from a point not switched by the ignition, as this supply must be available at all times. The 12V supply to the unit should be protected by a fuse, either from the car's fuse block or by way of an in-line fuse holder. As well, all wiring should be hidden, to prevent someone with a bit of electrical knowledge figuring out how to disable the alarm.

Once the wiring is fitted, it remains to test the unit. The sensitivity of the vibration detector and the voltage sensing input are adjustable, and the PCB should be mounted to allow access to these adjustments. If you intend using a back-up battery, check the voltage sensing trigger when the back-up battery is fully charged.

The siren is operated from a relay with a contact rating of 3A. It is usual to fit a separate siren, rather than rely on the car horn, although the 3A rating is too low for driving a car horn directly anyway. The siren is best mounted out of sight, to prevent a thief disconnecting it. One rather unfriendly approach is to fit another siren inside the cabin, to make illegal occupancy uncomfortable, even unbearable.

Finally, to enhance everything, the hazard light flasher unit described in the August issue could be fitted to cause the blinkers to flash during the alarm condition. One has to make life as difficult as possible for car thieves, so anything to draw attention is almost essential.

But don't forget to set the alarm every time you leave the car, even if it is only for a short time. The best of alarms can only work if they are turned on.

Finally, kits of parts for this project are available from Oatley Electronics, which also provides a back-up service for repair and fault finding. The kit includes a screen printed circuit board, all the components, the piezo vibration detector and brass weight.

PARTS LIST

1 Silk screened PCB coded OEAM89
1 piezo disc
1 12V lamp for dash mounting
1 12V, 3A relay

Resistors

All 1/4W, 5%: 1 x 150 ohm, 1 x 220 ohm, 4 x 1k, 2 x 2.7k, 1 x 4.7k, 4 x 10k, 1 x 15k, 1 x 22k, 9 x 100k, 2 x 220k, 1 x 270k, 1 x 330k, 1 x 470k, 6 x 1M, 1 x 4.7M, 5 x 10M.1 4.7 ohm 1 watt
1 22 ohm 1 watt
2 100k vertical mount miniature trimpots

Capacitors

2 680pF ceramic
7 0.1uF mono
1 1uF electrolytic
3 10uF 16V electrolytic
3 100uF 16V electrolytic

Semiconductors

13 1N914 diodes
3 1N4004 diode
4 BC548 NPN transistor
2 2N2907 PNP transistor
1 BD139 NPN transistor
1 7805 voltage regulator
1 TL072 dual operational amplifier IC
3 4093 quad Schmitt trigger NAND IC
1 15V, 1W zener diode

Kits of parts for this project are available from:

Oatley Electronics
5 Lansdowne Parade,
Oatley West, NSW 2223.
Phone (02) 579 4985
Postal address (mail orders):
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PCB and components kit......... $39.90
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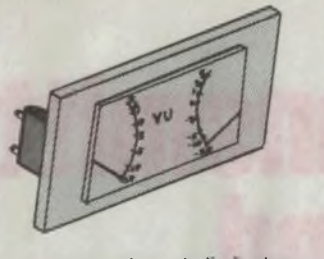

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BARGAIN KITS BARGAIN KITS BARGAIN KITS

Construction project:

Simple FM transmitter for the 2m band

This is the first in a planned series of simple, easy to build projects for those who wish to get started in amateur radio at minimum cost. We start the ball rolling with this solid state NBFM transmitter module, which produces over 1 watt at 144MHz.

by DEWALD DE LANGE

In the latest breed of commercial amateur radio transceivers, features such as microprocessor control with station programming have become commonplace. These modern marvels are undoubtedly very convenient, but in the process half the fun has disappeared from the world of amateur radio. Namely, the satisfaction to be gained from building your own equipment.

Rather than imitate commercial units, this equipment should be of a more basic design. Besides easing the construction and setting-up, the novice can more readily follow the operation of such circuits and therefore be more confident in their use.

These projects will therefore suit the newcomer who wants to try for themselves the satisfactions of amateur radio, without spending hundreds of dollars on equipment initially.

We intend dividing the basic transmit and receive functions into separate modules that can be assembled according to individual needs. In this article we present a 1W FM transmitter for the 2 metre VHF band. In future issues we will be looking at receiver modules for this band and also other amateur bands.

Circuit description

The block diagram in Fig.1 explains the operation of the circuit. The signal from a microphone is amplified to form the modulation input of a variable-frequency crystal oscillator. The oscillator frequency around 24MHz is multiplied in two stages, first a tripler and then a doubler, to 144MHz. The resulting signal is then amplified through several stages before being fed to an antenna.

The complete circuit is shown in Fig.2. The design has been divided between two small PC boards. The audio amplifier and crystal oscillator are illustrated in Fig.2(a), followed by the frequency multiplier and RF amplifier in Fig.2(b). Using these separate boards makes the layout more flexible and would also make it possible to replace the oscillator board with a multi-channel version, as a possible future improvement.

The audio signal from a microphone is amplified by IC1 and IC2 to the rather higher level required for the biasing of varicap diode D1. The gain is determined by the ratio of R2 to R3 and R5 to R6. For the values shown the gain is set to 1660, which should be adequate for the average dynamic microphone.

The 12V supplied to the positive input of IC1 through R1 sets the average voltage over the varicap diode, as this DC level is maintained through both op amps. The audio frequency response is limited by bandpass filtering: R3 with C4 and R6 with C8 gives a low-pass cutoff of 110Hz, while R4 with C5 and R5 with C7 sets the high frequency roll-off

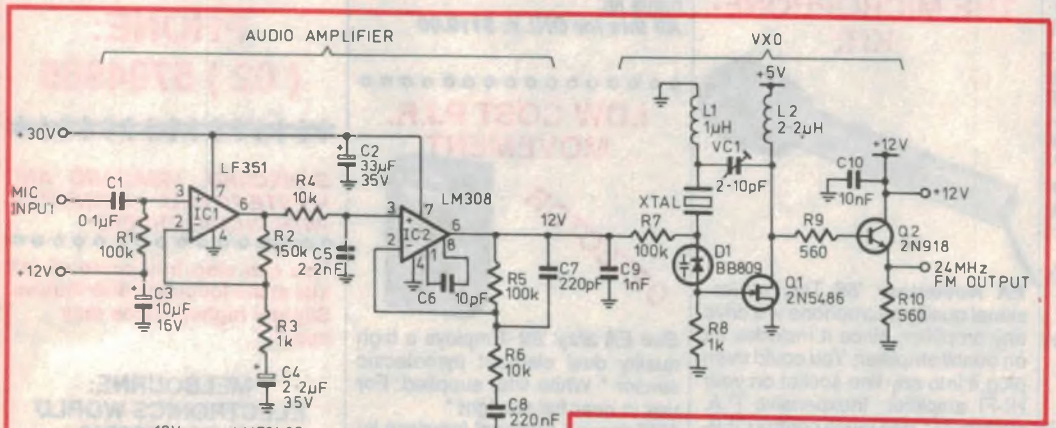


Fig.2a (left): The audio amplifier and crystal oscillator circuit.

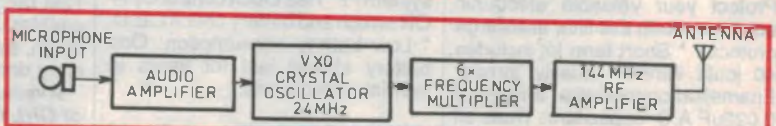
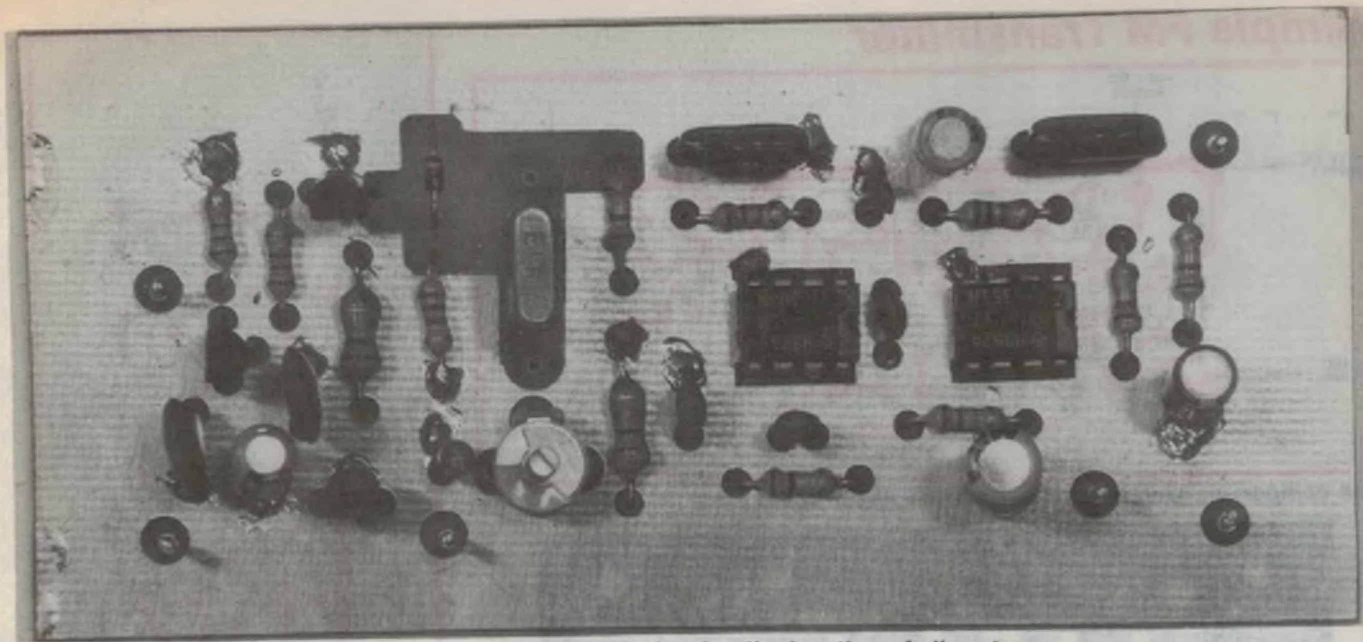


Fig.1: The operation of the transmitter can be divided into these functional blocks.



An enlarged view of the audio/crystal oscillator board, showing the location of all parts.

to 4.6kHz.

The crystal oscillator around FET Q1 is based on the Hartley configuration, with L1, VC1 and L2 forming a tuned circuit. The values of these components have been selected so that a 3rd overtone crystal cannot be tuned to its fundamental or the other overtones.

Varicap diode D1 changes the capacitance in series with the crystal, which creates the required frequency modulation. The maximum frequency shift away from the centre frequency is called the peak deviation. In the case of a crystal operating at its third overtone the peak deviation obtainable is rather limited.

It is for this reason that multiple crystals and a selector switch were not employed. The extra stray reactances would restrict the deviation to a very low level.

A buffer stage is added to give the oscillator a high impedance load. This is achieved with transistor Q2 in a common-collector configuration.

The oscillator output signal of around 24MHz signal is subsequently fed to the frequency multiplier chain shown in Fig.2(b). Transistor Q3 takes the frequency from 24MHz to 72MHz and Q4 doubles that to the final 144MHz.

The multiplication is achieved by applying a relatively short pulse to a tuned circuit. When the pulse disappears the tuned circuit continues to oscillate for a while at its resonant frequency. In our circuit, transistor Q3 is pulsed on momentarily, creating an oscillation in the tuned circuit L3, C16 and VC2. Although this tends to decay, additional pulses arrive regularly to maintain the

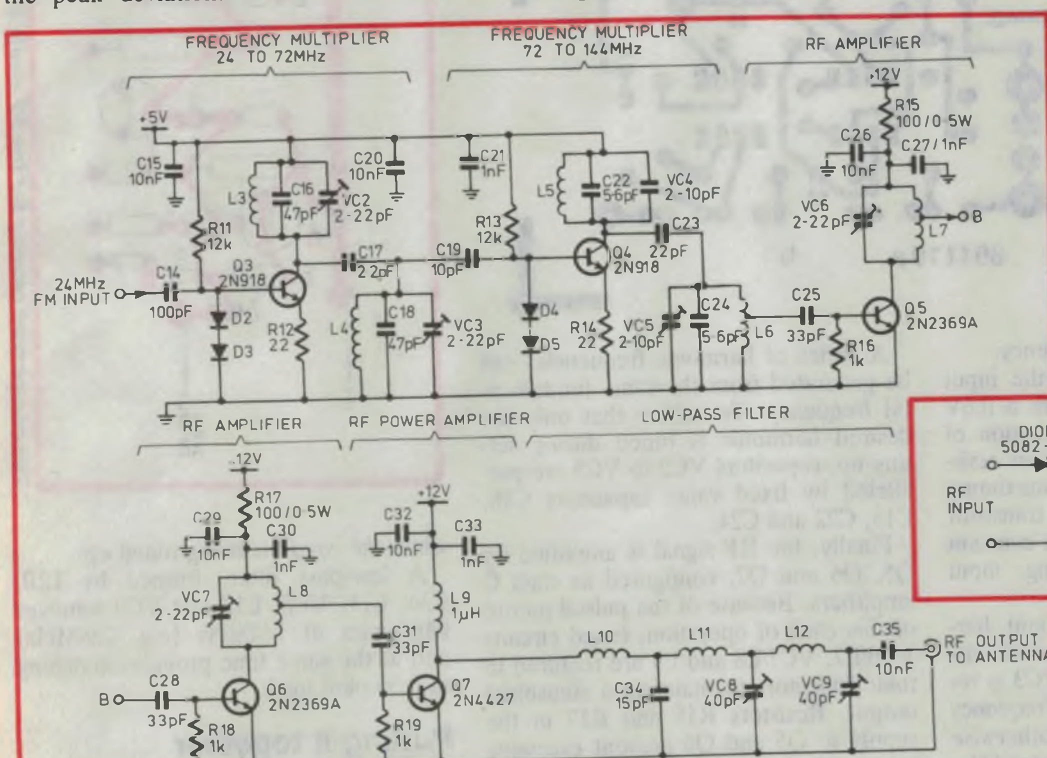


Fig.2b: The frequency multiplier, RF amplifier and output filter circuitry.

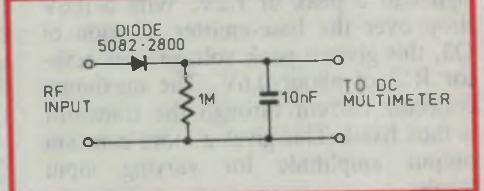
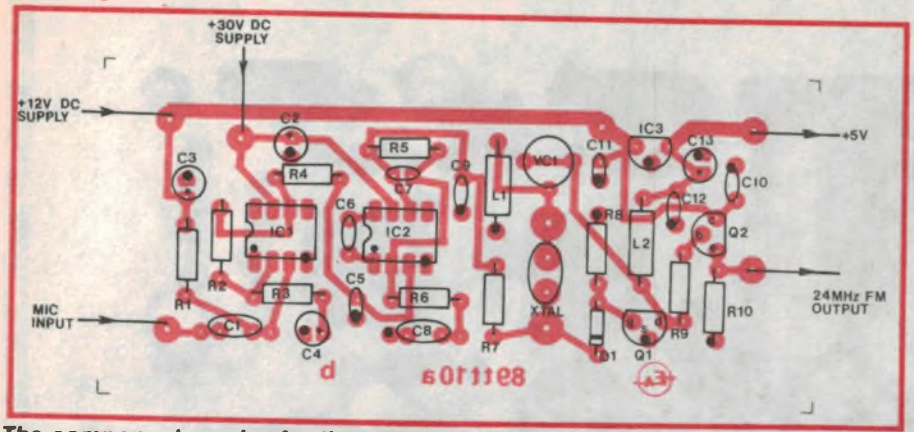
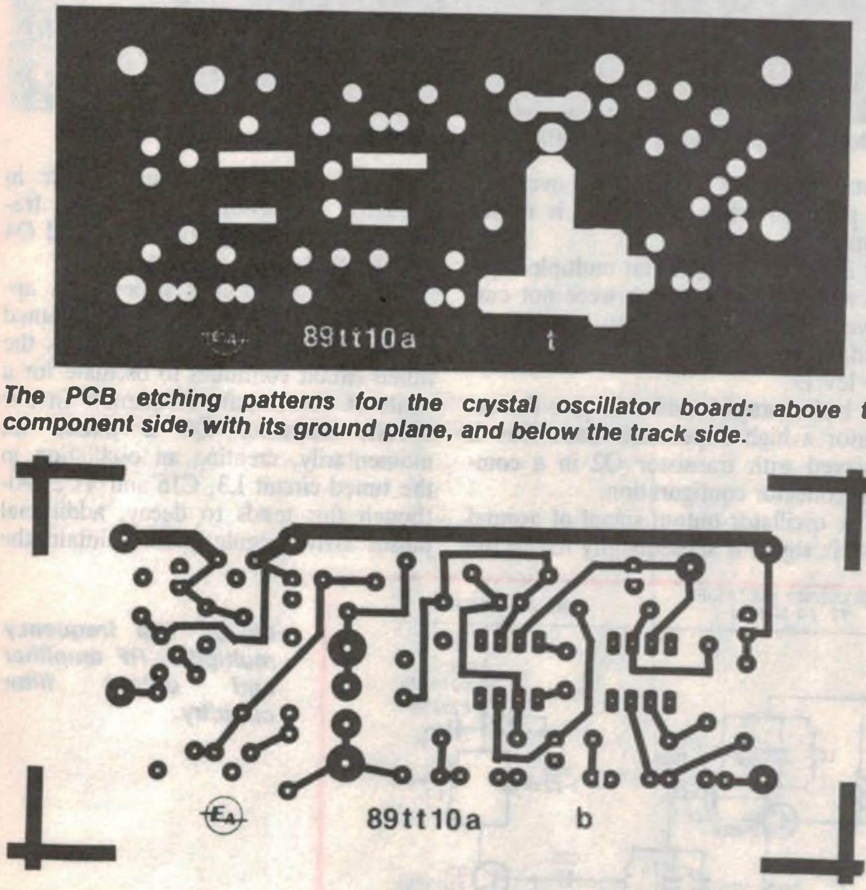


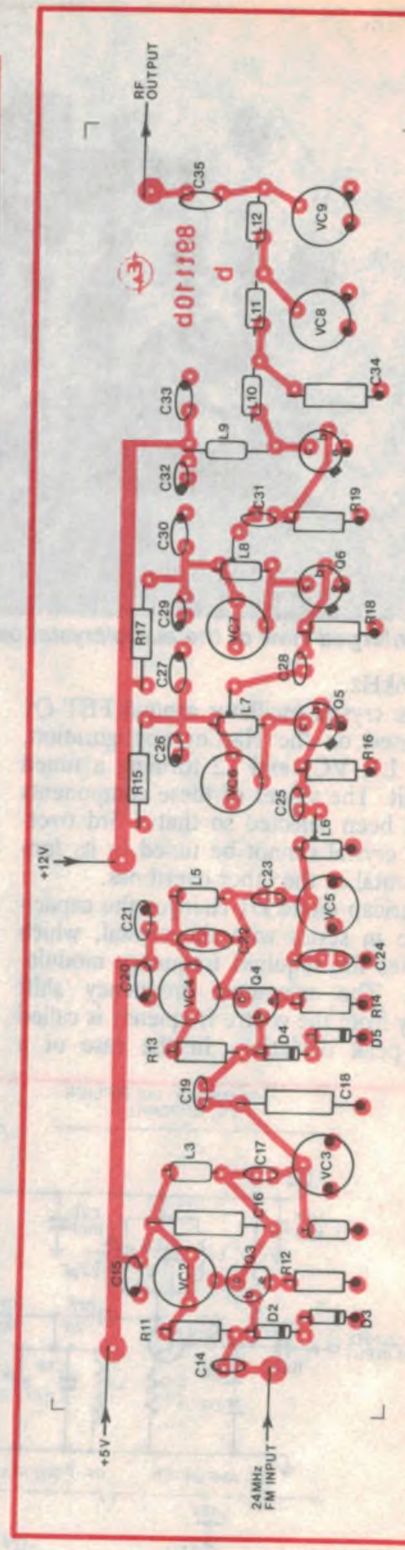
Fig.3: A suggested RF detector probe for the setting-up procedure.



The component overlay for the crystal oscillator board.



The PCB etching patterns for the crystal oscillator board: above the component side, with its ground plane, and below the track side.



The component overlay for the RF multiplier and output board.

oscillations at the output frequency.

Diodes D2 and D3 clamp the input signal to a peak of 1.2V. With a 0.6V drop over the base-emitter junction of Q3, this gives a peak voltage over resistor R12 of about 0.6V. The maximum collector current through the transistor is thus fixed. This gives a more constant output amplitude for varying input levels.

To further purify the resultant harmonic frequency, a second tuned circuit, formed by L4, C18 and VC3 is required. A further doubling in frequency to 144MHz takes place in an otherwise identical stage formed by transistor Q4.

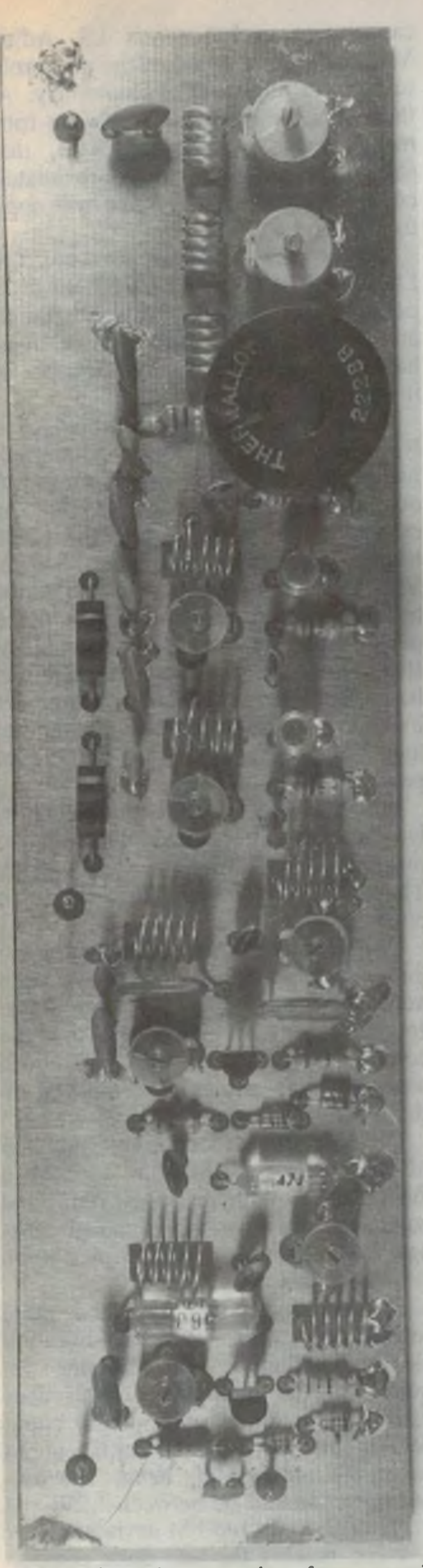
A series of harmonic frequencies can be generated from the same fundamental frequency. To ensure that only the desired harmonic is tuned during setting-up, capacitors VC2 to VC5 are paralleled by fixed value capacitors C16, C18, C22 and C24.

Finally, the RF signal is amplified by Q5, Q6 and Q7, configured as class C amplifiers. Because of the pulsed nature of this class of operation, tuned circuits VC6/L7, VC7/L8 and L9 are required in their collectors to maintain a sinusoidal output. Resistors R15 and R17 in the supply to Q5 and Q6 prevent excessive power dissipation in these transistors while the circuit is being tuned up.

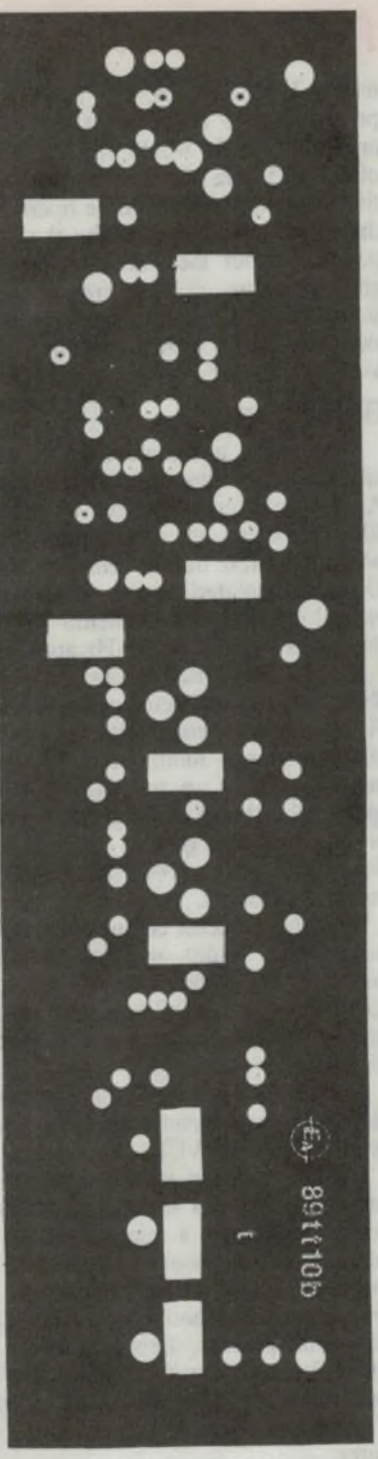
A low-pass filter, formed by L10, C34, L11, VC8, L12 and VC9 removes harmonics of 144MHz (e.g. 288MHz) and at the same time provides matching to a 50 ohm load.

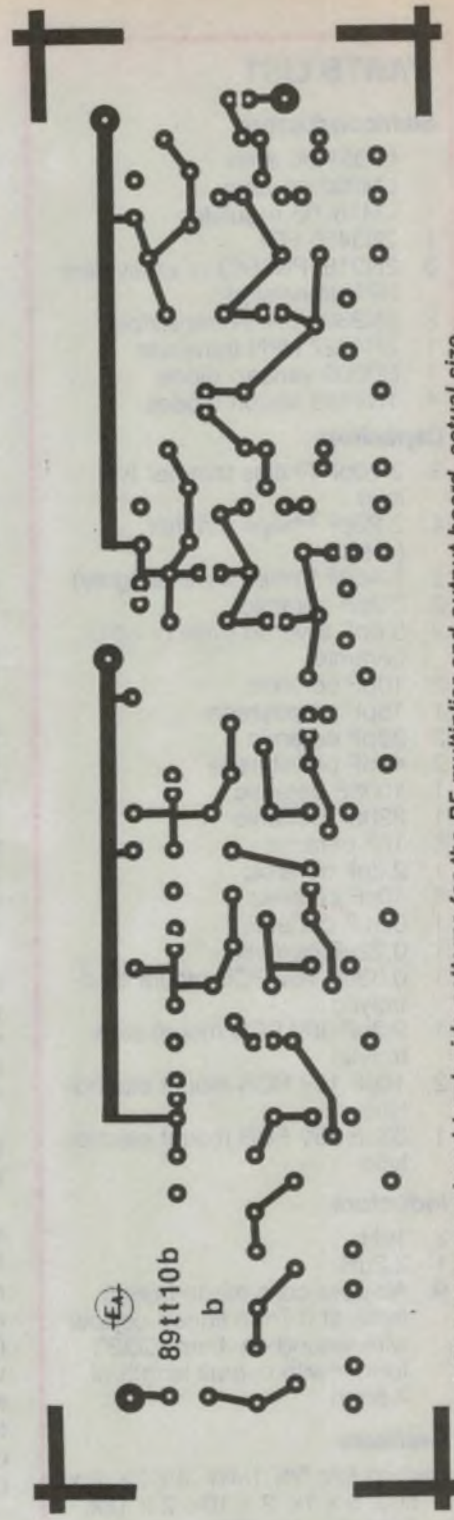
Putting it together

To ease construction, standard com-



A view of the completed multiplier board, again to guide you in duplicating it. Note the way the coil tappings have been soldered.





J: The component and track side patterns for the RF multiplier and output board, actual size.

ponents have been used as far as possible. The only exceptions are the 9 coils that have to be wound, namely L3 to L8 and L10 to L13. Fortunately these are all identical. As indicated in the parts list, they are made by winding 5 turns on a 4mm former, with the spaces between the windings equal to the wire thickness.

Inductors L6, L7 and L8 are tapped by soldering a wire to the appropriate winding on top of the coil. In the case of L6 the tap is made 4.5 turns (or the 4th wire counted on top) from the grounded end. With L7 and L8 the tap is 1.5 turns (2nd wire) from the positive rail.

The trimmer capacitors used in this project are of the Philips plastic dielectric type. Those used in the prototype unit were obtained from Rod Irving Electronics, but other outlets may well be able to supply them as well. The only other component that may be difficult to source is the varicap diode BB809. We obtained this from Geoff Wood Electronics, but again it may also be available from other suppliers.

Note that all ground connections are soldered to the top side of the board. External connections can be made easier by soldering PCB pins in these positions. Remember to clip a heatsink on Q7, before switching on the power.

The crystal frequency required is exactly one sixth of the desired final trans-

PARTS LIST

Semiconductors

1 LF351 op amp
1 LM308 op amp
1 LM78L05 regulator
1 2N5486 FET
3 2N918, PN3563 or equivalent NPN transistors
2 2N2369A NPN transistors
1 2N4427 NPN transistor
1 BB809 varicap diode
4 1N4148 silicon diodes

Capacitors

3 2-10pF Philips trimmer (yellow)
4 2-22pF Philips trimmer (green)
2 5-40pF Philips trimmer (grey)
2 2.2pF ceramic
2 5.6pF silvered mica or NPO ceramic
2 10pF ceramic
1 15pF polystyrene
3 33pF ceramic
2 47pF polystyrene
1 100pF ceramic
1 220pF ceramic
5 1nF ceramic
1 2.2nF ceramic
8 10nF ceramic
1 0.1uF ceramic
1 0.22uF ceramic
1 0.33uF 16V PCB mount electrolytic
1 2.2uF 35V PCB mount electrolytic
2 10uF 16V PCB mount electrolytic
1 33uF 35V PCB mount electrolytic

Inductors

2 1uH
1 2.2uH
9 Air-core coils made from 5 turns of 0.7mm tinned copper wire wound on 4mm (5/32") former with overall length of 7.5mm

Resistors

Carbon film 5% 1/4W: 2 x 22, 2 x 560, 5 x 1k, 2 x 10k, 2 x 12k, 3 x 100k, 1 x 150k
Carbon film 5% 1/2W: 2 x 100

Miscellaneous

1 PCB coded 89tt10a, dimensions 105 x 48mm
1 PCB coded 89tt10b, dimensions 191 x 48mm
1 Quartz crystal on desired frequency in the range 24.000-24.666MHz
1 TO-5 clip-on heatsink
10 PCB pins

FM Transmitter

mitted RF frequency. For example, the primary voice channels at 146.45MHz and 146.55MHz would require crystals of 24.4083MHz and 24.425MHz respectively. Or the unit could be operated on the input frequency used by the 2m repeater in your local area. Reference 1 gives a listing of these frequencies. A socket would allow crystals to be swapped easily, provided their required load capacitance is of the same order.

Setting up

Testing the audio amplifier and crystal oscillator board is quite simple. Apply the supply voltages of 12V and 30V. Connect an oscilloscope to the board's 24MHz output (emitter of Q2). Using an isolated alignment screwdriver, adjust trimmer capacitor VC1 so that an AC signal at 24MHz appears.

If a suitable oscilloscope isn't available, use an RF detector probe as in Fig.3, in conjunction with an ordinary high-impedance multimeter. For probing frequencies up to 144MHz a high speed Schottky diode (e.g. 5082-2800) is preferable, but a general purpose signal diode such as the 1N4148 may still give acceptable results.

With this detector circuit connected to the 24MHz output, oscillations will be noted by an increase in the measured voltage above the DC bias level of 4.4V (minus the voltage drop over the detector diode).

A frequency counter would be desirable to set the correct crystal frequency, by adjustment of VC1.

The next section to test is the audio amplifier. Apply a small signal, around 1kHz, or connect a microphone to the mic input of the board and monitor the amplified signal at the output of IC2 (pin 6). There should be large signal variations present, between about 1V and 29V, with a rest value of 12V. If this is not the case, follow the progress of the signal through the preceding circuitry.

That is as far as we can test the first board. To commission the multiplier and RF amplifier board will require rather more tuning.

Apply the regulated 5V from the first board, as well as the 12V supply. If you intend swapping crystals, use the one with the highest frequency for the setting-up procedure. Connect the 24MHz signal to the input and a 50 ohm dummy load, that can handle 1.5W, to the antenna output of the board.

Place the RF detector probe circuit (or a 100MHz oscilloscope with a low capacitance probe) across L3. Adjust VC2 for a peak signal. Move the probe to L4 and adjust VC3 accordingly. As there is some interaction between trimmer capacitors VC2 and VC3, they should be adjusted to approximately equal capacitance. The same will apply to VC4 and VC5.

Repeat the exercise for L5/VC4, L6/VC5, L7/VC6 and L8/VC7. In these cases we are dealing with tuned circuits at 144MHz and the probe you use must have a capacitance of only a few pF, or it will 'pull' the tuning.

With the probe connected across the RF load (or using a power meter), adjust VC8 and VC9 for maximum power out. To eliminate the capacitive loading effects of the probe during the initial tuning, readjust all the trimmers from VC2 through to VC9, with the probe left on the output and tuning for a peak. With the antenna connected instead of the load, VC8 and VC9 should be readjusted for maximum power delivered. The detected voltage over the load should be 11V, for an output power of 1.2W.

With the whole circuit tuned correctly, the transmitter should draw in the order of 250mA from the 12V supply. The 30V supply only require about 3mA.

That completes the setting-up procedure. Any problems would have been noted during the tuning of each stage. In such an event, make sure that the correct component values have been used and the soldering completed in that part of the circuit.

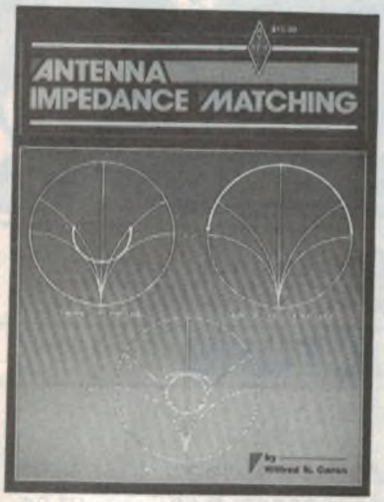
The ultimate test for the transmitter is of course done by listening to it on a 2m receiver. With just a 50 ohm load connected, there would be enough leakage from the transmitter to pick it up several metres away.

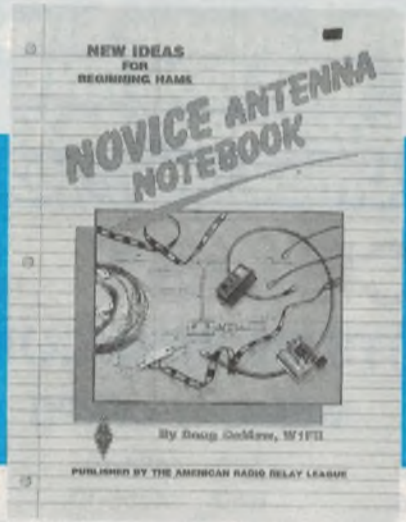
The prototype unit operated quite satisfactorily, with voice communication clearly intelligible. The filtering required in the multiplier section does limit the operating bandwidth to about 6MHz, but that is still sufficient to cover the 144-148MHz band. The output power should be between 1.2W and 1.5W. The measured FM deviation is +/—4kHz, making the unit quite compatible with most standard NBFM receivers.

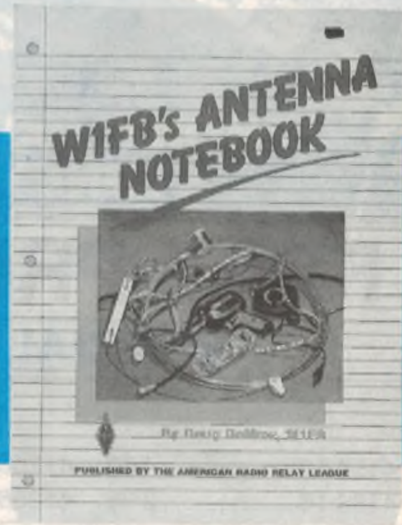
Finally, our thanks to Rex Callaghan of the R&D Department at Dick Smith Electronics, for his kind assistance in the development of this project.

Reference 1: *Amateur Radio* (Journal of the Wireless Institute of Australia), February 1989 issue, pages 23 and 30.

Books & Literature







Antenna matching

ANTENNA IMPEDANCE MATCHING, by Wilfred N. Caron. Published by the American Radio Relay League, 1989. Hard covers, 216 x 284 x 20mm. ISBN 0-87259-220-0. Recommended retail price $30.00 including postage.

A new hardcover book from the ARRL, and one that *doesn't* seem to be written by a ham. The author is certainly well qualified to write on this subject, though, having spent most of his long career in both the US Army Air Force and then private industry designing, installing and testing a wide variety of antenna systems – including those for aircraft and spacecraft.

The idea behind the book is to provide both radio hams and professional antenna designers with a sound basic text and reference on impedance matching techniques. And as you'd expect from an ARRL publication, the emphasis is on practical application of the techniques concerned, although in this case there's also quite a respectable amount of basic theory and maths.

Much of the book is devoted to use of the Smith Chart, which is of course a very effective tool in solving impedance matching problems. And there's quite a good introduction to the Smith Chart and how it is used, presented in chapter 3. The only problem here is that the chart and some of its concepts have already been used in chapter 2, to discuss transmission line characteristics!

This makes the logical flow a little disjointed. The author also has the rather disconcerting habit of using the contraction 'mHz' to mean megahertz, instead of the more usual and standard 'MHz'. But overall, these are not major criticisms of what is essentially a well-written and valuable work.

Of particular interest is chapter 6, for example, which presents step-by-step worked solutions to 11 different matching problems. The review copy came from Stewart Electronic Components, which can supply it directly to readers via mail order. The company's mail address is PO Box 281, Oakleigh 3166, or phone (03) 543 3733. (J.R.)

Antenna notebooks

NOVICE ANTENNA NOTEBOOK, by Doug DeMaw W1FB. Published by the American Radio Relay League, 1988. Soft covers, 210 x 278mm, 130 pages. ISBN 0-87259-207-3. Recommended retail price $16.00.

W1FB'S ANTENNA NOTEBOOK, by Doug DeMaw W1FB. Published by the American Radio Relay League, 1987. Soft covers, 210 x 278mm, 130 pages. Recommended retail price $16.00.

Two fairly recent additions to the ARRL book list, and both authored by well-known US amateur M.F. 'Doug' DeMaw, W1FB – for some years editor of the *ARRL Handbook*, and a prolific writer on amateur topics. They're both intended to be introductory books on antenna theory and practice, concentrating on basics and simple antenna designs rather than the more esoteric varieties. These are left for the full-scale *ARRL Antenna Book*.

As the name suggests, the Novice Notebook is written especially for the newcomer. It deals with basic antenna theory, building and using dipole antennas, selecting and using feedlines, building and using vertical antennas, loops and straight wire antennas, choosing and using beams, selecting and building support structures, and practical hints and kinks.

The Antenna Notebook is not greatly different, but goes a little further into both the theory and the practicalities – seeking to dispel many of the popular misconceptions. It deals first with fundamental antenna behaviour, then building and using dipoles, single-ware antennas, simple verticals, loops and arrays, limited-space and 'invisible' antennas, matching networks, special antennas and making simple measurements.

Both books are written in W1FB's usual friendly, easy to read style, with concise presentation of the material. They're also clearly printed, directly from high quality word-processor printout with clearly drawn diagrams.

In short, a couple of very handy little volumes on antennas, for the amateur's reference shelf – and good value for money at the prices quoted.

The review copies came from Stewart Electronic Components, which can supply them directly to readers via its mail order service. The company's mail address is PO Box 281, Oakleigh 3166, or phone (03) 543 3733. (J.R.)

Using scopes

OSCILLOSCOPES: HOW TO USE THEM, HOW THEY WORK, by Ian Hickman. Revised second edition, published by William Heinemann, 1987. Soft covers, 137 x 215mm, 133 pages. ISBN 0-434-90738-3. Recommended retail price $17.95.

First published eight years ago, this book has become firmly established as a readable, down to earth introduction to scopes and how they're used. A measure of its appeal may be gauged from the fact that it was first reprinted, then updated for the second edition, and then revised and updated again for this latest edition.

Mind you, at the rate that scope technology is developing nowadays, any book on the subject tends to be out of date almost as soon as it comes off the presses!

Luckily this book is mainly devoted to the basic principles of scope operation and use, so that it really hasn't dated too much. The chapters deal with elementary concepts, the basic oscilloscope, advanced real-time scopes and scopes for special purposes such as storage and digital sampling types. There are also chapters describing basic use of a scope, accessories and finally a couple which give a good introduction to scope operation and the circuitry inside a typical modern example.

The author is British, and the book is a little slanted to the UK scene – with the odd reference to standard frequency signals from Droitwich, etc. There's also a list of UK scope suppliers, which won't be all that much use out here. But on the whole, it's a very readable and worthwhile introduction to scopes and how they're used.

The review copy came from Federal Marketing, which is currently offering it to readers via the mail-order service advertised elsewhere in this issue. (J.R.)

New range of low cost rack cases

Directly imported by Jaycar Electronics, these classy cases are available in five different sizes and feature the rack-mount style of construction.

Most constructors are painfully aware of the ever-increasing price of component hardware, and in particular, the cost of the metalwork needed to house a project – in fact it's not uncommon for the metal cabinet to soak up over half of the funds required to build a piece of gear. So if a cost saving can be made at this stage, you can enjoy a significant reduction in the overall price of a completed project.

With this in mind we welcomed the chance to have a look at Jaycar's new range of cabinets, as shown in the accompanying picture. As you can see, they range from quite a large size which should cope with the most muscle-bound stereo amplifier or power supply, down to a moderately sized unit which might ideally suit test instruments for example. These two cabinets at the extremes of the range measure 430 x 292 x 123mm, and 254 x 177 x 72mm respectively, not including the front panel.

In the case of the large cabinet, the front panel is constructed of 3mm aluminium measuring 482 x 127mm – which is the standard international width for rack-mount cases, but lies just below the recognised three-unit height spacing. The next size down shares the same dimensions as the larger unit, with the exception of its 100mm height, which is slightly larger than the 2-unit spacing.

The middle of the range box offers a low profile, with body dimensions of 430 x 203 x 63mm and a 482mm (standard width) x 70mm (slightly less than 2-unit) front panel, which would nicely house a stereo preamp for example. After that, the second smallest cabinet measures 355 x 203 x 98mm, and has a 406 x 100mm front panel. By the way the smallest unit has a front panel measuring 305mm x 75mm.

While the front dress panels of the complete range are constructed of black anodised aluminium, the sides, top and bottom panels are formed from sheet steel which is finished in a matching powder-coat finish. This and the actual case construction seem quite durable, and should handle all but the roughest treatment. Also, to assist air flow around the internal circuitry, the larger models offer cooling vents in the top and side panels.

The cabinets normally arrive in an unassembled 'flat pack' form, and may be easily put together using a standard Philips head screwdriver. The end result has quite a professional appearance – even the aluminium handles look the part, as well as being functional (for a change).

Last but hardly least, the price of each cabinet – ranging from smallest to largest – is $39.50, $49.50, $49.50 (again), $65.00 and $75.00. So amongst other rack cabinets, this new range represents attractive value for money, and although the panels don't comply with the international sizing standards they should suit virtually any application.

Needless to say, the cabinets may be purchased at your nearest Jaycar store, or via their toll-free order line on (008) 022 888. (R.E.)

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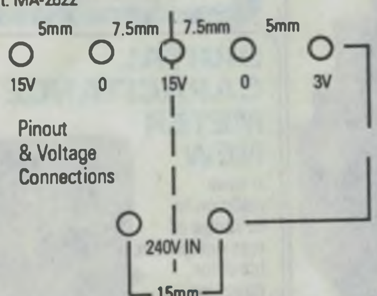

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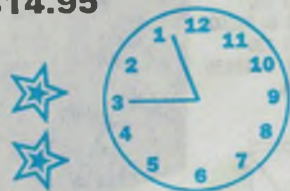

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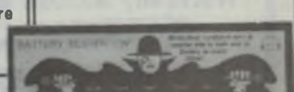

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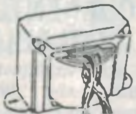

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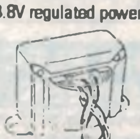

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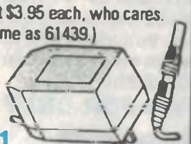

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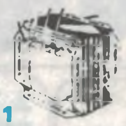

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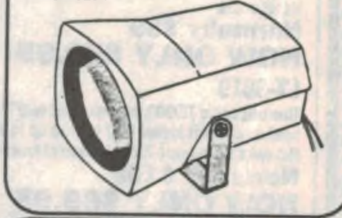

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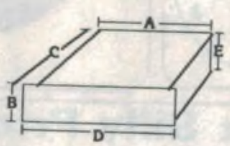

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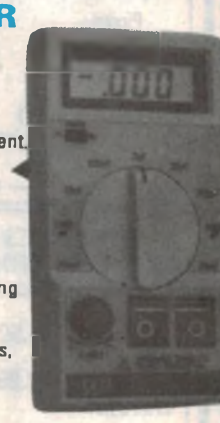

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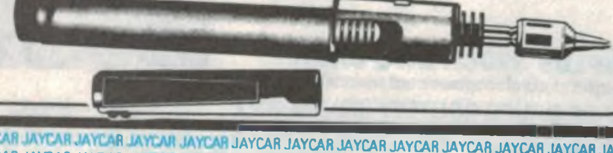

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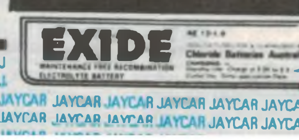

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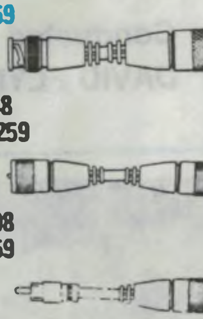

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SPECTRUM

Communications News & Comment

Conducted by DAVID FLYNN

Train network on track

Work on the NSW State Rail Authority's multi-million dollar telecommunications upgrade has reached the halfway mark.

When completed, the project – worth an estimated $10.5 million – will give the SRA one of the biggest private communications networks in Australia.

The major component is replacement of the railway's overloaded telephone system, which used antiquated cross-bar and step-by-step exchanges. In its place will go an Ericsson MD110 PABX system, which will then become the backbone of the SRA's network.

As the MD110 has inherent ISDN capabilities, this will allow the SRA to combine voice and data signals between SRA headquarters and all staffed stations. These will be connected via a trunk network with optical fibre and microwave links.

One of the NSW State Rail Authority's latest 'Tangara' electric trains. Soon the SRA's telecomm network will be upgraded to match them...

Hot competition, cold cash

With the inflated television market now being brought down to earth, the latest battle-ground is radio.

The Federal Government's recent and controversial 'auction' of new FM licences for capital cities netted some $105 million. And there's more where that came from. Tendering for the two Sydney AM-FM conversion licences was held over to October (due to potential problems with the late shift of WIN-TV from channel 4 in Wollongong), while one of the Adelaide bids was below the set reserve bid and has been re-opened.

Based on the successful tender figures to date (ranging from $5m to $32m), these three licences could yield an additional $80m or more.

These figures also include transfer of AM facilities to the Government, for use in extending the PB (Parliamentary Broadcast) and RPH (Radio for the Print-Handicapped) networks into the mainstream AM band.

The first AM-FM convert to go to air is expected to be Melbourne station 3KZ (new callsign unknown, although a signature of 'KZ-FM' is likely), who plan to fire up on January 1, 1990.

Another newcomer to FM is the ABC's highly-successful youth radio service, with Sydney station 2JJJ to be networked through a string of capital cities and regional centres by the end of next year.

This will also mark the fifteenth anniversary of Triple-J, which began on AM as 2JJ in 1975, and made good its intention to be as alternative as can be – arousing much anger in conservative circles when they broadcast meeting places for anti-Government rallies following the Whitlam sacking of that year.

JJJ is now estimated to reach 15% of Sydney's 10-17 year-old audience, and 20% of the 18-24s.

Cities in line for the unique 'JJJ experience' – shock treatment may be the best word for it – are Melbourne, Perth, Darwin, Adelaide, Canberra, Newcastle and Hobart.

RI's to be on-the-spot!

After many years of talk and many months of rumours, on-the-spot fines have been introduced for 'offences against the Radiocommunications Act', says the Department of Transport & Communications.

Typical of the new fines is that imposed for operating an unlicenced CB radio – $50. For the more serious offences, fines of up to $2000 can be imposed.

The fines can be issued for operating an unlicenced transmitter or behaving in 'an antisocial manner'. Also at risk are people who possess an unlicensed transmitter for the purpose of operating it – so you don't have to be caught in the act, so to speak.

The scheme will operate in a similar manner to that used by State police for on-the-spot traffic offences. Departmental officers will issue an infringement notice to offenders, who must pay the fine within 14 days or elect to have the matter dealt with in court.

The fines are in addition to the existing option to prosecute for offences, although the Department believes that by removing the necessity to go through the courts they will reduce public expense of legal representation and free the courts themselves for more serious charges.

Remote TV seeks more funds

Australia's three DBS TV services have called for increased government funding, claiming it is essential to their continued provision of TV services to remote regions.

Following rises in Aussat transponder costs to the present $4.8 million per annum, and with a further increase expected before the current financial year is out, the licensees are reported to be struggling to meet costs.

Although the remote TV and radio service was designed to be commercially viable, its limited reach – covering 80% of the continent but only three percent of the population – has not enthused advertisers, whose support is vital.

Three commercial DBS services are presently operating – Golden West in WA, Imparja on the central footprint (SA/NT) and QSTV in Queensland. The south-eastern (NSW-Victoria-Tasmania) licence is not currently allocated.

Beyond extra funds, other options for the stations include using lower power (12 watt) transponders and sharing their spectrum with commercial radio services for the same remote areas.

The fax on TV?

More information has come to hand about 'TV fax', noted briefly last month. Japan's powerful and prophetic Telecommunications Association expects it to become another in a long line of new communications mediums.

Harnessing unused portions of the television broadcast signal in the same way as teletext, TV fax will enable householders to receive wide- or narrow-interest facsimiles through a special receiver/printer.

Such devices have already been demonstrated by Sharp, Sanyo and Matsushita, and use digital technology to decode and display A4 size documents and photographs. The fax can produce the traditional hard copy, or 'soft copy' onto the TV screen itself, and both methods are claimed to offer the speed and clarity of the standard Group 3 machines.

'Conditional access' options will also allow some messages to be available to only a select group of users.

Possible applications of TV fax include the down-loading of recipes, news and information, promotional offers and the like.

Meanwhile, on the home front Austel has been instructed to investigate 'junk fax' – unsolicited fax messages which are becoming more common with each week.

In announcing the move, Minister for Telecommunications & Aviation Support Ros Kelly claimed that junk fax not only costs the recipient large amounts of money through the cost of fax paper, but also ties up the fax machine from more important information.

SBS spreads its wings

The uniquely Australian multicultural broadcaster SBS will expand its television network to nine new regional cities, commencing in 1991.

In announcing the expansion plan, Minister For Transport and Communications Mr Ralph Willis said that the government was pleased to be able to proceed with the extension of services following the decision to establish SBS as an independent corporation.

SBS Television will be progressively extended to the Latrobe Valley, Bendigo, Ballarat, the Darling Downs (Toowoomba), the Spencer Gulf (Port Augusta, Whyalla and Port Pirie), Darwin, North-Eastern Tasmania, Cairns and Townsville.

Most of these areas will also benefit from the government's equalisation program, which will provide them with three commercial TV channels in addition to the ABC, so the inclusion of SBS Television in their viewing fare will make their services truly 'equal' to those of capital city viewers.

SBS and the newer commercial stations will of course all transmit on UHF, and will be joined in many instances by ABC-TV and the existing commercial broadcaster as part of the Band II clearance plan.

Paging – alive and beeping

Despite the non-stop growth of the cellular telephone market, pagers are still a viable and popular communications medium – with nearly three times as many subscribers as Mobilenet.

A large factor is not just their cheaper cost, but that pagers neither present nor fulfill the temptation of calling someone on rather non-urgent matters, unlike cellular phones.

Over the last 10 years pagers have gone from tone-only transmission to multi-tone, alphanumeric and voice services. Also becoming established are in-house private paging systems, the latest generation of which use conductive coupling to replace limited radio coverage, and allow telephone calls to be made and received via wireless access to the PABX.

Luckily, Australia has well co-ordinated paging systems, but what of the problems of countries even more technology-hungry than ourselves?

Hong Kong is a case in point. On a per-capita basis, more citizens of Hong Kong use pagers than those of anywhere else in the world. In this teeming, crowded and very commercial city, pagers have been the ideal way to keep in touch.

A recently-completed three-year plan has successfully merged dozens of services and suppliers with over 500 separate transmitters and 14 different frequencies, and all operators have agreed to a common paging system to further streamline the arrangements.

In Europe, the reverse holds true – less than one percent of the workforce uses pagers. This might be surprising for such a mobile community, before considering that most of these trips take people across numerous borders and into countries with incompatible paging systems.

The solution is the digital 'Ermes' system, which the EEC hopes will open up a market worth $5m by the end of the century.

Ermes will operate in a 200kHz window at 169.6MHz, and is slated for a staggered introduction from 1992 to 1995, by which time it will reach 80% of Western Europe's population.

Ermes may also be combined with CT3 handsets, not only alerting CT3 users to the need to make a phone call but giving them the means to do so.

'Trouble at mill' for CT2?

While Telecom continues Australian trials of the cordless CT2 telephone system, the European CEPT is concerned that the spread of CT2 will damage the long-term potential for a common European digital CT standard.

Following the issue of four licences for network providers in the UK, the 900MHz CT2 service is also planned to commence in France, Italy, Spain and West Germany, and as such possibly becoming a defacto European-wide system.

The CEPT, which represents the communications authorities of most European countries, has preferred to develop its own third-generation 1.6GHz CT3 specifications, with the aim of establishing a single network in which users can roam from one end of the continent to another.

CT3 is also seen as the possible first step towards a true pocket communicator, using satellite links.

Companies or organisations with communications news items which they believe would interest our readers can send them directly to David Flynn, PO Box E160, St James 2000.

Frequency Modulation in practice

This month we compare FM with AM, and investigate the two principal methods of generating FM in practice: indirect via phase modulation, and the Crosby direct system.

by BRYAN MAHER

Continuing our foray into frequency modulation, FM, to put things into perspective let's compare some essential differences between amplitude modulated (AM) and FM transmitters.

In AM transmitters, the following apply:

1. The amplitude of the transmitted RF wave changes proportionally to the amplitude of the audio signal.
2. The carrier frequency is constant.
3. As AM modulation alters the RF amplitude and envelope shape, only linear class B RF power amplifiers may be used following the AM modulator stage.
4. As frequency multiplier stages are non-linear, frequency multiplication cannot follow the modulation stage.
5. For the above reason, the AM modulator stage is either the penultimate or final RF power amplifier.
6. With the basic linear plate modulator method described in chapter 4 of this series, the above comment implies the need for a high power audio modulator. More complex modern digital modulation techniques work with a lower power audio signal.
7. Crystal master oscillators are almost universally used, as AM only changes RF amplitude, not the frequency.
8. Due to the varying amplitude during amplitude modulation of the RF carrier, 'nasty' high voltage peaks occur in the final RF power amplifier. High voltage breakdown or flashover can occur unless suitable precautions are taken in design. Also power dissipation rises during modulation peaks, causing extra heating in transistors and/or vacuum tubes.

In contrast, FM transmitters tend to be characterised by the following:

1. The frequency of the transmitted RF wave changes proportionally to the amplitude of the audio signal.
2. The amplitude of the transmitted RF signal is constant.
3. Because in FM the RF amplitude is constant, any number of class C (non-linear) RF power amplifiers may follow the modulation stage. (Class C amplifiers are more efficient than linear class B stages)
4. For the same reason, any of the class C RF power amplifiers may also be frequency multipliers.
5. From the above, it follows that with FM the modulator is usually an *early* stage of the transmitter.
6. Being an early stage, the FM modulator operates at very low power.
7. Although desired for centre frequency stability, crystal oscillators are difficult to frequency modulate. Therefore many *indirect* FM methods have been developed.
8. As frequency modulation does not change the RF signal amplitude, no nasty high voltage or power dissipation peaks occur in RF power amplifiers.

The differences in block diagram layout of AM and FM transmitters largely follow from the above points. This should be clear from Fig.1.

Frequency deviation

In FM systems when the audio signal at frequency fa is at its maximum amplitude, the RF signal will be changing up and down in frequency as far as it can go. How far depends on circuit design. For any one system this maximum RF frequency shift is called the *frequency deviation*, denoted by 'delta' (Δ).

Frequency deviation = Δ
= max. RF frequency shift

If for example, the audio frequency fa is 10kHz, then when this signal is at maximum amplitude the RF frequency will be deviating up and down by +/-ΔHz, 10,000 times per second. The value of Δ will depend on circuit design.

In the last chapter we looked at three methods of direct FM generation, where the frequency of the oscillator itself is changed by the modulation. Where the oscillator is a crystal, it may be difficult to produce sufficient linear frequency deviation. Yet crystal control of the RF centre frequency fc is highly desirable for stability. More frequency deviation,

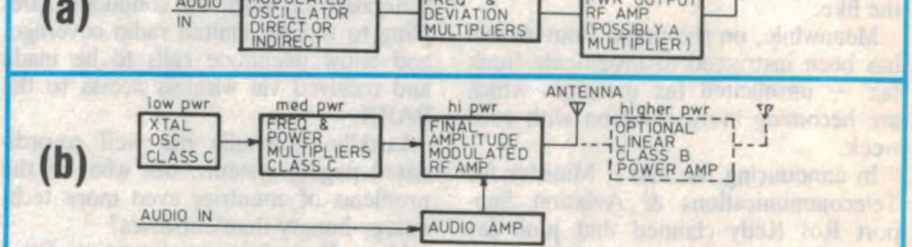

Fig.1: Block diagrams of an AM transmitter (a) and an FM transmitter (b). Note how the audio is introduced late in the AM transmitter, but very early in the FM transmitter.

still with crystal control of fc, can be obtained by various methods of indirect frequency modulation. But first we must define a few more terms.

Modulation index

The *modulation index*, symbol mf, is the ratio of RF deviation, Δ, to the frequency fa of the audio signal which caused that deviation. In symbols:

$$mf = \Delta/fa$$

where mf = modulation index
Δ = RF deviation
fa = audio frequency.

We note that some textbooks use other symbols, such as 'Δf' instead of Δ, 'beta' instead of mf and 'fm' instead of fa.

For example if in a certain FM transmitter output the RF centre frequency fc is 110MHz, the audio frequency fa is 10kHz and the frequency deviation Δ is 75kHz, then the modulation index is given by:

$$mf = \Delta/fa = 75kHz/10kHz = 7.5$$

Now in the same system, if an audio frequency of 50Hz produces the same deviation, then

$$mf = \Delta/fa = 75kHz/50Hz = 1500$$

From this we see that high audio frequencies produce low values of modulation index, but low audio frequencies can give high values of modulation index.

100% modulation index

Recall that 100% modulation had a strict meaning in AM, as above that figure terrible distortion results from overmodulation.

FM is different, as there is no strict limit on modulation index mf. We note from the definition that 100% modulation index would mean full design audio volume, producing maximum RF deviation using the lowest intended audio frequency. That is,

$$\text{max mf} = \text{max.}\Delta/\text{min.fa}$$

At the other end of the audio scale we define the *deviation ratio* as the value of the modulation index when the audio frequency fa is a maximum. That is,

$$\text{Deviation ratio} = \text{max.}\Delta/\text{max.fa}$$

NBFM and WBFM

In practice we find that FM systems divide into two types: *narrow band FM* or NBFM, where the deviation ratio is very small, and *wide band FM* or WBFM, where the deviation ratio is very large.

Narrow band FM has been pursued by amateur radio devotees, using a frequency deviation of +/-2.5kHz originally; then +/-15kHz; later +/-5kHz was adopted as a standard.

Note that NBFM has no noticeable advantage over AM in noise rejection characteristics.

At times AM amateur radio rigs can give problems, due to their HF and VHF transmissions breaking in on neighbours' broadcast AM receivers. In some cases the problem has been fixed by the amateur operator changing his rig to NBFM.

Commercial FM radio broadcasting stations use WBFM in the final transmitted signal, though NBFM stages will often be found early in their transmitters.

Indirect FM generation

One system of indirect FM generation is shown in Fig.2. This is basically the configuration used by Armstrong in his 1933 FM transmitter, generating FM through the indirect step of phase modulation. The audio signal from microphones and preamplifiers is integrated in Q1, before being passed into a phase modulator Q3.

A fixed frequency crystal oscillator Q2 feeds a sinewave RF signal at a constant frequency f1, about 250kHz, into the phase modulator.

Whereas an oscillator can be frequency modulated, an amplifier cannot. But an amplifier *can* be phase modulated! This fact is at the heart of Armstrong-type FM systems.

We note that in Fig.2 the oscillator Q2 is not modulated. Rather it is the non-linear RF amplifier Q3 which is phase modulated, by the integral of the audio signal. Hence Q3 is referred to as a phase modulator.

Audio integration

Recall we said in the last chapter that phase modulation and the resulting frequency modulation are not proportionate. The integrator Q1 in the audio signal pathway corrects this error. The RF phase at B is now in sympathy with the *integral* of the audio signal. The output of the phase modulator will thus consist of frequency changes linearly proportional to audio amplitude.

Let us first consider the overall scheme indicated by the block diagram; later we will look into the details of the various stages used.

Frequency deviation

Assume that the RF output to the antenna is specified as centre frequency fc close to 110MHz, with a maximum frequency deviation of 100kHz. Nowhere near that deviation is possible in the output of a phase modulator. In fact to keep linearity distortion below 1%, only a small shift in the RF phase is allowable. Too large a phase shift in a tuned RF modulator also produces some unwanted amplitude modulation.

A small phase shift in the modulator, enough to produce a maximum modulation index of 0.5, will maintain linearity and keep residual AM down to 5%. This AM will be removed by the following tuned frequency multipliers Q4 to Q7, leaving a pure FM signal.

The equation for modulation index ($mf=\Delta/fa$) has a maximum value for lowest audio frequency fa. If the minimum audio frequency is specified as 50Hz, then

$$\text{max. mf} = 0.5 = (\Delta/fa)$$
$$\text{max } \Delta = (0.5).(50Hz) = 25Hz$$

If the phase modulator, Q3 in Fig.2, produces a maximum frequency deviation Δ of 23Hz, then the low distortion requirements are met.

Note that this value of frequency deviation, produced by the phase modulator, is extremely small compared with the required value of deviation at the transmitting antenna – 100kHz.

Deviation multiplication

Fortunately the RF frequency multipliers Q4 to Q7 and Q10 to Q13, as well as multiplying the carrier frequency also multiply the frequency *deviation*.

However the frequency multipliers do not change the rate at which the deviation occurs, so they do not interfere with the audio content.

To multiply a deviation of 23Hz at the modulator, up to the required 100kHz deviation at the antenna, demands a multiplication factor of 4374.

We will describe multipliers in more detail later. For the moment, consider an RF frequency multiplier as a non-linear class C tuned RF power amplifier with an output tank circuit which is tuned to a harmonic of the input frequency.

As the efficiency of a multiplier decreases at higher harmonics (i.e., higher multiplication factors), multiplication by 2 or by 3 is usually used. These are called frequency *doublers* and *triplers*. To achieve a deviation multiplication by 4373 we choose a group of four triplers,

WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR CHIPS ...

Frequency modulation

Q4 to Q7 followed by three triplers, Q10 to Q12 and one doubler, Q13. This gives a multiplication factor of (3x3x3x3) x (3x3x3) x 2, or

81 x 27 x 2 = 4374

The final frequency deviation at the antenna will now be 4374 times the modulator deviation of 23Hz, or 100,602Hz – which satisfies the output requirement.

Output frequency

Wide awake readers will immediately see a big catch in the whole scheme, as the crystal oscillator frequency f1 (250kHz) is also multiplied by 4374. Yes, straight frequency multiplication by 4374 would give an extremely high output frequency. Indeed:

250kHz x 4374 = 1.09350GHz

Now that's fine if you want gigahertz output in the UHF region and if your multipliers and transmitting antenna will respond at that frequency. But in our case we don't, and they won't! No, we require output in the 110MHz region.

Oh yes – Major Armstrong saw that problem way back in 1933! So he did something about it. Recall that the ubiquitous Major was also into superheterodynes, which use mixers and downshift of frequencies (refer to chapter 6).

Following Armstrong's scheme our block diagram of Fig.2 incorporates a mixer Q8 and oscillator Q9. The output of multiplier Q7 has a centre frequency of 20.25MHz, with frequency deviation Δ of 1863Hz. This is mixed in Q8 with the 18.213MHz fixed frequency signal from Q9.

Q8's output will thus contain those two input frequencies, along with two new frequencies – being their sum and their difference.

We tune the input tank circuit of the following stage Q10 to the *difference* frequency, 2.037MHz (i.e., 20.25MHz – 18.213MHz), rejecting all other frequencies.

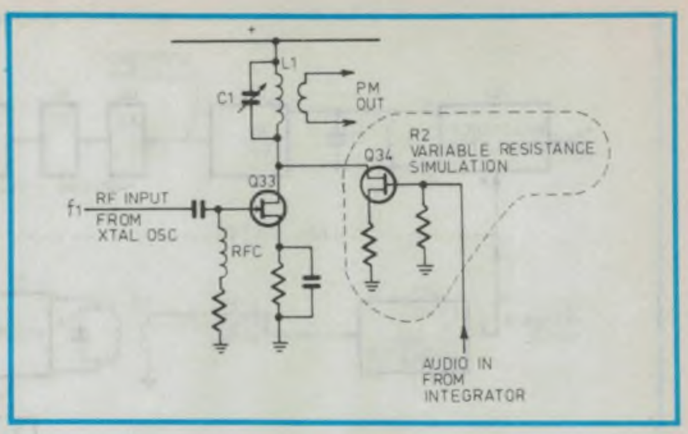

Fig.3: A simple phase modulator using simulated variable resistance R2 imposing losses upon the C1-L1 tuned circuit.

Note that although this mixing system has effectively shifted our carrier frequency at Q8 down from 20.25MHz to 2.037MHz, the frequency deviation is unchanged. It still remains at 1863Hz – an important point.

The three triplers Q10 to Q12 followed by the final doubler Q13 combine to multiply the signal frequency by a further 54 times. The mixer output centre frequency, 2.037MHz, and its deviation, 1863Hz, are both multiplied.

The output of Q13 to the transmitting antenna therefore has a centre frequency and deviation given by:

$$fc = (2.037\text{MHz} \times 54) = 109.998\text{MHz}$$

$$\Delta = (1863\text{Hz} \times 54) = 100.602\text{kHz}$$

The final power output stage, Q13, has to provide all the power drive to the antenna. To increase efficiency Q13 is used as a doubler, (rather than a tripler).

Notice that although our system begins with narrow band FM (i.e., small deviation) at Q3, the multiplication transforms this to wide band FM (large deviation) at the output of Q13.

Having now seen the overall picture of the transmitter, let us look in more detail at the phase modulator.

Phase modulator

Any circuit capable of shifting the phase can perform the phase modulation function. One possible choice is a simple tuned RF amplifier with variable losses.

When a tuned amplifier is fed from a fixed frequency oscillator, the amplifier cannot directly change the frequency. But if the losses of the amplifier's tuned circuit are increased, the amplifier is detuned; i.e., its natural frequency is reduced, causing a delay in the phase of the signal.

Fig.3 shows an abbreviated circuit illustrating the concept. Q33 with L1 and C1 form a tuned RF amplifier. Q34 is an N channel JFET, acting simply as a variable resistance which adds losses to the L1-C1 tuned circuit.

When Q2's gate is driven more positive by the audio signal, Q34 conducts more and so appears as a reduced resistance. Call this apparent resistance R2.

L1-C1 is no longer tuned to f1, the frequency of the RF input signal. The losses caused by the pseudo-resistance R2 reduce the frequency to which L1-C1 is tuned, to a lower frequency f2

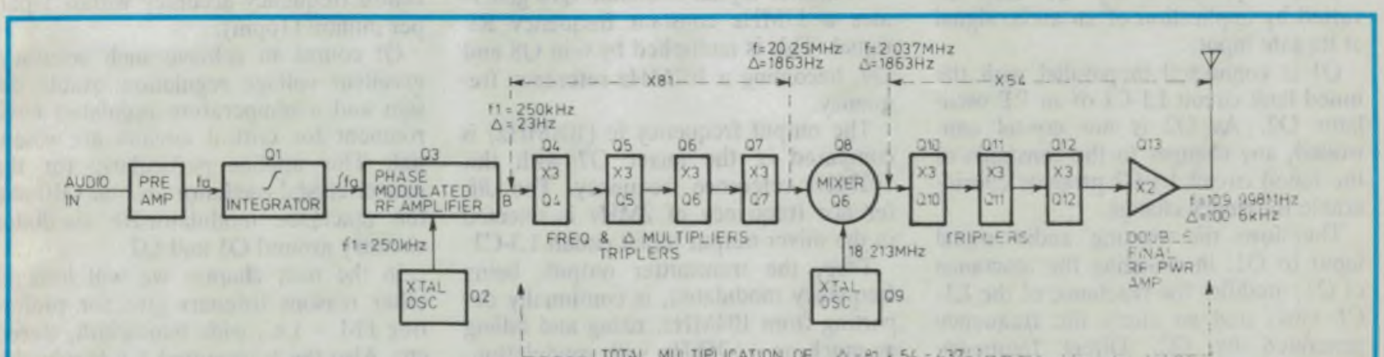

Fig.2: Block diagram of an indirect FM transmitter using phase modulation from the integral of the audio. Note how the initial very small deviation is multiplied along with the carrier frequency.

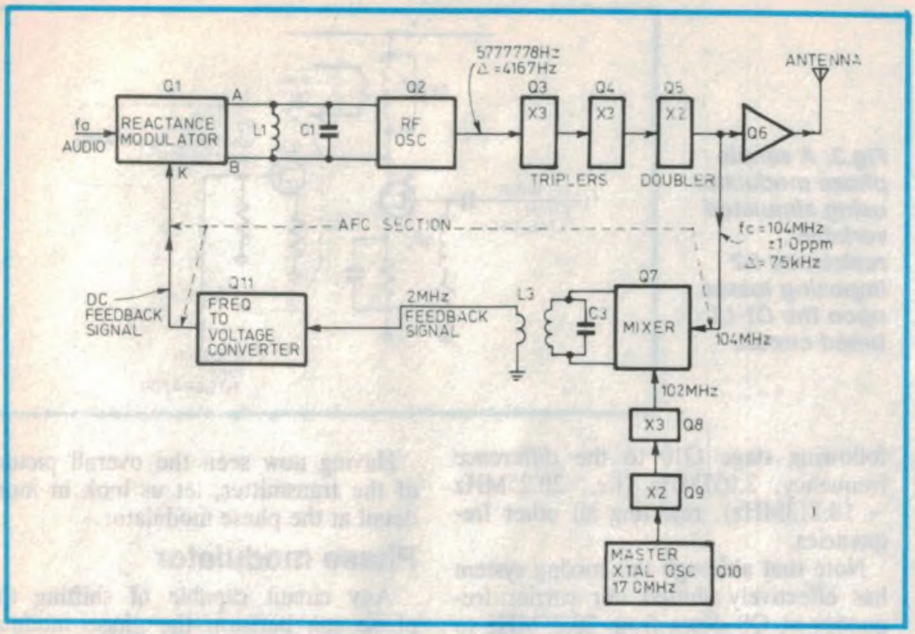

Fig.4: Block diagram of an FM transmitter using the Crosby system of automatic frequency control (AFC), to compare the average value of the output frequency against a crystal master oscillator.

where:

$$f2 = \sqrt{(2\pi f1)^2 - (R2/2L1)^2}$$

This detuning of the amplifier retards the phase of the signal f1, giving phase modulation (PM). The PM signal output may be taken by any one of a number of methods; here we have shown low impedance link coupling.

Crosby direct FM

Another method, the Crosby direct FM system is a popular choice for FM broadcast stations. Fig.4 shows the essential components.

Q1 is a reactance modulator as described in detail in chapter 10. Q1 is essentially an amplifier transistor with considerable capacitive negative feedback added. This reactive feedback makes Q1 appear as a variable reactance at points A and B.

The value and phase of this pseudo-reactance presented by Q1 may be varied by application of an audio signal at its gate input.

Q1 is connected in parallel with the tuned tank circuit L1-C1 of an RF oscillator Q2. As Q2 is not crystal controlled, any changes to the constants of the tuned circuit L1-C1 produce considerable frequency change.

Therefore the varying audio signal input to Q1, in changing the reactance of Q1, modifies the reactance of the L1-C1 tank, and so alters the frequency generated by Q2. Direct frequency modulation of Q2 is thus obtained, with the changes in frequency of Q2 proportional to the audio voltage.

As before, frequency and deviation multiplication by frequency doublers and triplers Q3 to Q5, raises the centre frequency to 104MHz, and multiplies the deviation to the required 75kHz.

The final RF power amplifier, Q6, for maximum efficiency and high power output does not multiply the frequency.

A transmitter based simply on Q1, Q2 and the frequency multipliers Q3 to Q5 and power output stage Q6 would be possible. But such a simple system would be unsatisfactory, lacking sufficient stability of the centre frequency fc because this is derived from a simple L-C stabilised oscillator.

To stabilise the centre frequency fc the automatic frequency control section (the lower half of Fig.4) is added.

Crosby AFC

A master crystal oscillator Q10 generates a 17MHz constant frequency RF signal. This is multiplied by 6 in Q8 and Q9, becoming a 102MHz reference frequency.

The output frequency fc (104MHz) is compared in the mixer Q7 with this 102MHz reference frequency. The difference frequency of 2MHz is selected in the mixer output tuned circuit L3-C3.

True, the transmitter output, being frequency modulated, is continually departing from 104MHz, rising and falling as much as +/-75kHz with modulation. But recall that all signals from microphones and other audio sources finish up AC coupled. This implies that audio signal waveforms always contain equal amounts of positive and negative energy – in other words, they have an average value of zero.

Because of this fact, as the output frequency of the FM transmitter at Q6 swings up and down with modulation, it contains equal amounts of energy above and below the centre frequency 104MHz.

So it is the *average* value of the transmitter output frequency which is compared in the mixer Q7.

The 2MHz output from the mixer is fed to a frequency-to-voltage converter Q11. This converter (sometimes called a frequency *discriminator*) produces a DC output voltage proportional to input frequency.

When the input frequency to Q11 is exactly 2MHz, the DC output voltage is zero. Frequencies slightly above 2MHz produce positive DC output from Q11 while frequencies slightly below 2MHz give negative DC output.

This DC output from Q11 is used as a kind of negative feedback, controlling the current flowing in the reactance modulator transistor Q1. Control is such that with a DC input of zero volts at point K, Q1 sets the average frequency of Q2 to 5.777778MHz.

Should the average frequency of Q2 drift upwards, producing higher than 104MHz transmitter output, the difference frequency (i.e, output from mixer Q7) is higher than 2MHz. This produces positive DC output from the converter Q11, which when fed to the reactance modulator at K causes a change in reactance of Q1 – bringing the frequency of the oscillator Q2 back down to the proper figure.

Should the frequency of Q2 drift downwards, similar action with the potentials reversed lifts Q2 back to its correct centre frequency.

Such a system is popular with broadcast FM stations because it can maintain centre frequency accuracy within 1 part per million (1ppm).

Of course to achieve such accuracy, excellent voltage regulation, stable design and a temperature regulated environment for critical circuits are essential. This applies particularly for the master crystal oscillator around Q10 and the reactance modulator/RF oscillator circuitry around Q1 and Q2.

In the next chapter we will look at other reasons listeners give for preferring FM – i.e., wide bandwidth, stereo etc. Also the transmitted RF bandwidth and sidebands, which are particularly important in amateur radio and two-way communications. Bye.

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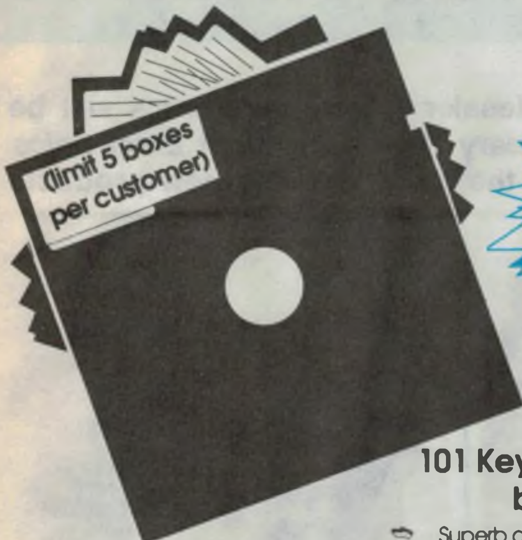

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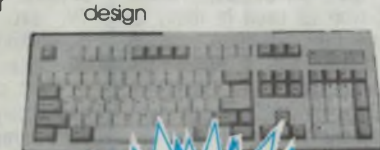

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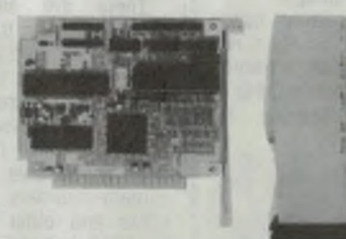

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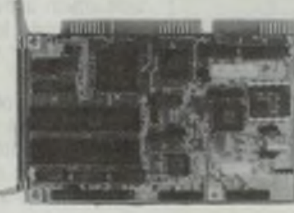

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Exclusive to Electronics Australia:

Sneak Preview of Arista's

Well-known Australian electronics distributor and wholesaler Arista Electronics will be bringing out its brand-new 1990 catalog with the January Digest issue of *Electronics Australia*. Here's an exclusive preview of just a few of the many exciting new products you'll find in the catalog, to whet your appetite:

If you're the proud owner of a video camera or camcorder, you'll no doubt be very interested in Arista's two new compact and highly portable video lights — the DVL1 and dvl2. Both operate from rechargeable battery packs, making them suitable for outdoor use as well as indoors.

The DVL1 is the smaller unit and is one of the world's smallest video lights, weighing a mere 60g (2oz). It uses a 6V/10W halogen lamp with dichroic mirror, providing white light at 3200K, and runs for over 30 minutes from the rechargeable belt-pouch battery (supplied). Also supplied with it are interchangeable 'spot' and 'flood' lenses, a right-angle extension bracket and an adjustable extension bracket. Very handy — and it will be priced at only $194.95!

The DVL2 is a little larger, but still weighs only about 150g (5oz) without the battery pack. It uses a brighter 6V/20W halogen lamp and mirror, and runs for over 30 minutes from a fully charged Sony NP-22 or similar video camera battery — which plugs directly into the back. It fits directly onto the camera accessory shoe, and swivels vertically for flexibility. Priced at only $199.95, it will come complete with battery pack and charger.

Speaking of rechargeable battery packs, Arista will also be stocking exclusively a new range of 'Dual Voltage' brand nickel-cadmium battery packs suitable for replacing those in many popular brands of camcorder. For

The new DVL-2 Video Light.

The DV-8022H NiCad battery

example there's the DV-8022H, which replaces the NP-22 type as used in many of the Sony models; the DV-8066, which replaces the NP-55 and NP-77 types; the DV-7044P, which suits many JVC, Panasonic and Zenith models; the DV-2022, which suits Hitachi, Toshiba and RCA models; and the DV-7022, which suits other JVC and Telefunken models as well as the Panasonic PV-100D.

There are also rechargeable lead-acid packs, such as the DV-1919, with a capacity of 12V/2Ah to suit various Canon and NEC camcorders; the DV-1235, with a capacity of 12V/3.5Ah, to suit larger video camcorders and also cellular phones; and the husky DV-1240, which has a capacity of 12V/4.0Ah and is suitable for running large video camera-recorders, cellular phones, video lights and other high-drain equipment. The DV-1240 includes a charging LED, automatic overload protection and resetting, and comes complete with a shoulder carrying strap.

AV transmitter

Still on the subject of accessories for video recorders, another exciting new item in Arista's 1990 catalog is the AVS30 Audio-Video Transmitter, a very compact little unit which allows you to distribute audio and video signals to any UHF-equipped TV set in your home or the office — without the need to run cables.

Measuring only 120 x 83 x 40mm, the AVS30 accepts audio and video signals from a VCR or camcorder and uses them to modulate a low-power carrier on UHF channel 30, radiated from a small built-in telescopic whip

The AVS30 AV Transmitter

antenna. They can then be picked up on any TV set within a 10-30 metre radius, depending on intervening walls or other structures. Incidentally the AVS30 conforms to DOC specification MS315, so operation is completely legal.

Powered from a 12V/300mA AC power adaptor (supplied), it features adjustable video and audio gain controls as well as adjustment of the output carrier frequency, to ensure the best possible results. It will come complete with video and audio connection cables, in a small protective vinyl pack, for the very attractive price of only $89.95.

Portable IR sensor

The PIR90 Security Sensor

Leaving video gear, another very handy new item in the Arista range is a very compact portable security sensor: the PIR90. This is a passive infra-red detector, which

1990 Catalog

senses the movement of any heat-generating body in its range. This helps to prevent false alarms.

Measuring only 108 x 70 x 35mm, the PIR90 comes complete with built-in swivel mounting bracket which allows it to be mounted on a wall, and aimed in any desired direction. It can cover a 12m x 12m room, and can be set to either sound a 'ding-dong' chime for 5 seconds, when movement is detected, or a 'siren' sound which persists until the unit is turned off. It operates from a 216-type 9V battery, which fits neatly inside the case.

An excellent little unit for home and office security, as well as making a great entry sensor for shops. And it will sell for only $64.95!

Wall speakers

Moving on, another couple of new Arista items which should interest audio and hifi enthusiasts — as well as architects and builders — are the WSB525 and WSB650 wall-mounting speaker systems. These are two-way full range woofer/tweeter speaker systems, complete with crossover network, which are assembled onto very attractive flush-mounting wall plates to allow them to be built into wall cavities.

The smaller WSB525 unit features a 5-1/4" polypropylene cone woofer with foam surround, 10oz magnet and high-temperature voice coil, coupled with a 1" polyimide dome tweeter. The two give an overall response from 60Hz to 21kHz in the 'infinite baffle' provided by a typical wall, and are rated for up to 60 watts input, with a nominal impedance of 4 ohms and a sensitivity of

The WSB525 Wall Speaker

90dB at 1W/1m. Crossover frequency is 3kHz, with a first-order crossover network using an air-cored inductor.

Overall dimensions of the WSB525 are 279 x 191 x 70mm, and its front escutcheon/frame is ABS plastic, finished in decorator white with a strong perforated metal grille also finished in white. It will sell for $199.95.

The WSB650 is a little larger, and features a long-throw 6-1/2" polypropylene cone woofer which also has a foam surround, 10oz magnet and high temperature voice coil. The tweeter is a 1" high efficiency soft dome type, and together the two provide a response from 50Hz to 22kHz, again in an 'infinite' baffle. Power rating and sensitivity are as for the smaller unit, but with a nominal impedance of 8 ohms and a crossover frequency of 2.5kHz. The crossover network is in this case a second-order type.

Dimensions of the WSB650 are 307 x 219 x 84mm, and it is finished in the same colour and styling as the WSB525. It will sell for $279.95.

Both systems are fitted with red and black spring terminals at the rear for connection of the input, and come with matching rear mounting plate. They can be fully fitted from the front.

Pocket DMM

The DMM1 Pocket DMM

If you're often called upon to test pieces of equipment unexpectedly, Arista's new DMM1 Pocket Digital Multimeter should be of great interest. That's because it's positively TINY, measuring only 106 x 51 x 12mm, and with a weight of only 100g. Together with its permanently-fitted test leads it fits inside a neat little vinyl wallet measuring only 121 x 78 x 15mm — small enough to slip easily into most shirt pockets!

Despite this, it's a full-featured 3.5-digit MM, sporting a high contrast liquid-crystal display with clear 11mm-high digits and features such as automatic or manual ranging, a range hold button, automatic polarity and overload sensing plus low battery indication.

There are four ranges each for DC and AC volts, with full-scale readings of 1.999V, 19.99V, 199.9V and 450V in both cases. For resistance measurements there are also five ranges, with full-scale readings of 199 ohms, 1.999k, 19.99k, 199.9k and 1.999M respectively. A built-in beeper can also be used for continuity checking, sounding for any resistance of less than 200 ohms.

The DMM1 consumes only 5mW of power in operation, and runs from two LR-44 (SR-44) button cells. For only $74.95 it also represents excellent value for money, and Arista expects stocks to almost fly out the doors, as soon as they arrive!

Bench type DMM

Still on the topic of digital multimeters, another interesting new product in the 1990 Arista catalog is the DMM5. unlike most modern DMMs this is especially designed to operate on the workbenh, with the LCD display in clear view without having to prop it up precariously against something.

Measuring 94 x 90 x 74mm, the DMM5 has a 3.5 digit display and includes a tester for bipolar transistors as well as a full array of voltage, current and resistance ranges. It also includes a diode check range and an inbuilt continuity beeper.

The DMM5 Benchtop DMM

There are five DC voltage ranges, with full-scale readings of 199.9mV, 1.999V, 19.99V, 199.9V and 1000V. For AC volts there are four ranges, with full-scale readings of 1.999V, 19.99V, 199.9V and 700V. There are also three current ranges each for both DC and AC, for full-scale readings of 19.99mA, 1.999A and 10A. Resistance is covered by six ranges, with full-scale readings of 199.9 ohms, 1.999k, 19.99k, 199.9k, 1.999M and 19.99M.

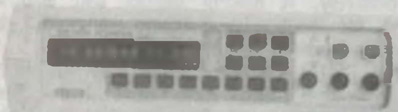
The DMM5 is fuse protected on all except the 10A current ranges, and is fitted with a 'hold' button to store an important reading. It will be priced at $129.95.

And that's about all we have space for, this month. We'll give you a few more sneak previews of the new 1990 Arista Electronics Catalog in next month's issue...

In the meantime, if you need any information on the existing Arista range of products, this is available either from your existing Arista dealer or direct from:

Arista Electronics Pty Ltd, Unit 16, Slough Estate, Holker Street, Silverwater 2141. Phone (02) 648 3488 or fax (02) 684 4010.

New Products...



6.5-digit benchtop DMMs

Prema, the West German high precision digital multimeter manufacturer, offers two 6-1/2 digit multimeters with a 24-hr DC voltage accuracy of 4ppm. Both models feature 0.0004% basic accuracy, an extensive set of resident mathematics programs, 1Gohm input resistance and user friendly display and controls.

The model 5001 provides both DC and AC voltage and current plus resistance (two wire), with 4ppm DC accuracy and 100nV resolution, 6-1/2 digits, selectable integration times from 50ms to 10s and series/common mode rejection better than 60/140dB. Resistance ranges are from 200 to 12M, with 1mohm resolution. It is priced at $2204, which includes GP-IB control as standard.

Model 6001 provides the features and specifications of the 5001, as well as four wire resistance and direct reading PT-100 temperature with 100uohm resolution and a tolerance of 0.05°. It is priced at $2649.

Further information from Emona Instruments, 86 Parramatta Road, Camperdown 2050 or phone (02) 519 3933.

Digital storage/ analog scope

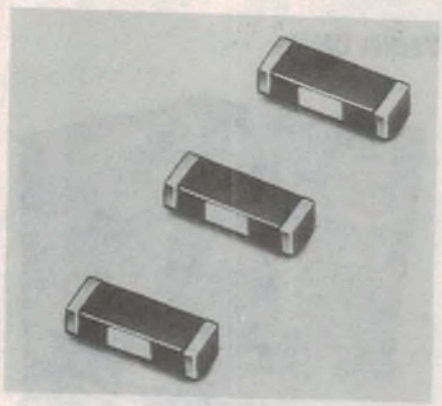
The Hitachi VC-6015 digital storage oscilloscope can be used as both a conventional oscilloscope and a digital storage scope.

By changing the display mode, the VC-6015 can be used as a 10MHz, dual trace oscilloscope. Pretriggering allows capture of events before the trigger point. The pretrigger position may be set at 0, 2, 5 or 8 divisions, and the trigger point is displayed on the CRT as an intensified point, allowing the user to determine its relationship to the captured waveform.

The free run mode may be used to continuously observe repeating events, and the display time may be varied between 1 to 5 s. A hold function maintains one stored waveform while another is captured.

A recording function enables a pen recorder to be used to create a hard copy of stored waveforms. The waveforms stored in memory channels 1 and 2 may be simultaneously output to a pen recorder to provide a hard copy record of the waveforms. An X-axis sweep signal usable with X-Y recorders is also output during this recorder output period.

For further information, contact IRH Components, 32 Parramatta Road, Lidcombe 2141 or phone (02) 648 5455.



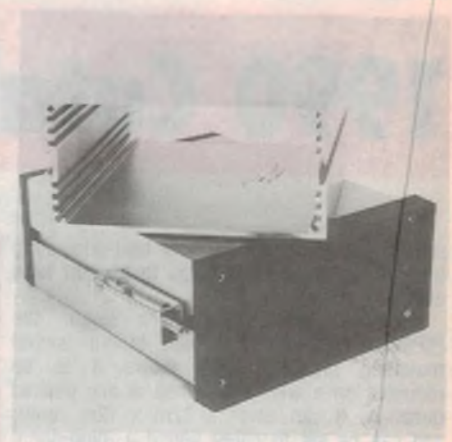
Surface mount EMI filters

IRH components has just released the new Muraia NFM41R series of surface mount EMI filters, a true surface mount capacitive EMI filter in 'T' configuration, with compact dimensions of 4.5 x 1.00 x 1.00mm.

Rated for 100 volt DC operation and with 300mA/DC current handling capacity, the NFM41R series comes in capacitances from 22 - 22,000pF in the E3 series.

The devices are suitable for high speed digital circuits in processors and peripherals.

For further information contact IRH Components, 32 Parramtta Road, Lidcombe 2141 or phone (02) 648 5455.



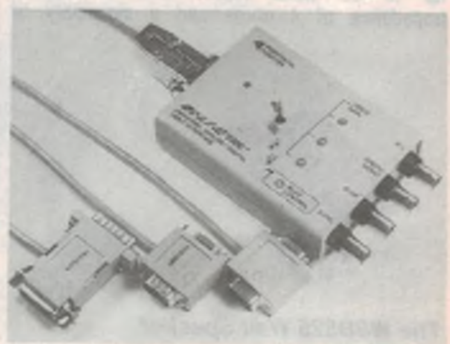
Panel mount Instrument case

AIC's Panel Mount Instrument Enclosure is 100% Australian made and is suitable for housing instruments or electronic equipment. These include digital displays, controllers, alarm modules, thermocouple selectors etc.

The instrument case is very rugged and can easily be sealed to IP standards. The enclosure comprises an aluminium extrusion section, plastic front and rear bezels and two mounting clips.

The aluminium extrusion can be supplied in various standard lengths or to custom sizes. The front bezel size is 48 x 96mm and the instrument is installed into a standard panel cut out of 45 x 92mm.

Further information from Amalgamated Instrument Co., 7/21 Tepko Road, Terrey Hills 2084 or phone (02) 450 1744.



Universal video interface

Inline has introduced the IN2000 Universal Analog and Digital computer/video interface, designed to provide the complete solution for connecting your computer to a large screen video projector or monitor.

The IN2000 is fully automatic and will adjust to any computer video signals, replacing all interfaces currently available on the market.

Just by changing input cables you can connect IBM PC, EGA, CGA, PS/2 EGA, Apple, Mac, or Mac II computers to a compatible projector of your choice. IN2000 will accept analog, digital or ECL video signals, composite or separate sync, sync-on-green or any other video signals produced by different computers. Compatibility with different computers is achieved by using the IN51XX monitor loop-through cables, which have been specially designed to route video signals from computer to interface without interferring with the local monitor.

Price of the unit is $895.00, excluding tax.

For more information contact A.V. Technology, 18 Mavron Street, Ashwood 3147 or phone (03) 836 7500.

Integrated thermometer-printer

The AP-700 series thermometer printers are the latest addition to the Anritsu range of high-performance multi-function thermometers.

These compact integrated thermometer printers can provide instantaneous temperature data and a printed record including the time and date of the reading.

Features of the new units are compact size (weighs only 350 grams); displays all data: temperature, lapsed time, print interval, date; five print intervals from 3 sec to 60 minutes; selectable lapsed time or absolute time with each temperature print (where absolute time is printed, date is also recorded); sequential numbering of manual temperature readings; automatic display test and low voltage indication; and compatibility with Anritsu interchangeable probes.

The printer is supplied with a robust carrying case.

For further information and prices contact Electromark, 43 Anderson Road, (PO Box 184), Mortdale 2223 or phone (02) 570 7287.

Stainless side cutters, pliers

Jaycar Electronics is now stocking two high quality handtools, featuring stainless steel non-magnetic construction with cushioned handles and spring release. Both tools are from Unikrafts, and are direct imports.

The TH-1890 side cutters are 115mm (4-1/2″) in length, and are designed for true flush cutting. They are of sturdy construction, comfortable to use and suitable for cutting copper wire up to 1.5mm in diameter.

The matching TH-1893 long-nose pliers are 140mm (5-3/8″) long, and feature half-round jaws for working in confined areas. The construction is again sturdy and the pliers are comfortable to use.

The tools are priced at $12.95 each and are available from all Jaycar outlets.

Multi-turn cermet trimpots

NSD Australia has released a range of Beckman Industrial square multi-turn helitrim cermet trimming potentiometers.

The new products, Models 64 and 68, incorporate clutch-action stops, a rotational life of 200 cycles, plus a range of side and top adjust features.

Model 64 is 0.25 of an inch square and 0.165 of an inch thick, while the Model 68 is 0.375 of an inch square and 0.195 of an inch thick. Model 64 has a resistance range of 10 ohms to 1M while Model 68 has a range of 10 ohms to 2M. Both products have a minimum insulation resistance of 1,000M.

Model 64 has an electrical travel of 15 turns, while Model 68 is 20 turns.

For additional information, contact NSD Australia, 205 Middleborough Road, Box Hill 3128 or phone (03) 890 0970.

Compact digital multimeter

With the Circuitmate DM27 digital multimeter from Beckman Industrial, a user can check almost any component, including diodes, transistors, resistors, or capacitors. This can be done without carrying around a toolbox full of equipment because the DM27 has a built-in logic probe, continuity tester, frequency counter, LED and diode checker and a transistor tester.

The DM27 provides five frequency ranges including 2MHz and 20MHz, all of which are overload protected to 500-VAC/VDC.

Five capacitance ranges from 2nF to 20uF measure a wide variety of capacitors. The DM27 is also a full featured digital multimeter, with resistance ranges from 200 ohms to 200M, both AC and DC voltage ranges, AC and DC current ranges including a 10A range, and an audible continuity beeper.

Zero adjustment is automatic on all functions. The multimeter is lightweight at only 311g and battery life is typically 100 hours.

For further information, please contact Anitech Instruments, 1-5 Carter Street, Lidcombe 2141 or phone (02) 648 4088.

Large temperature display

Amalgamated Instrument Company has recently added a Large Digit Temperature Display to their range of Australian made products.

The instrument, which is housed in an IP65 weatherproof enclosure, is suitable for monitoring temperature in areas normally associated with mechanical gauges, i.e., in tanks and vessels located in outside locations.

The unit is easy to install and comes complete with mounting brackets, batteries (which last for at least 2 years) and a temperature probe.

Temperatures from -50 to 150°C can be measured and are easily visible on the (1") 25.4mm liquid crystal display. Options include specialised temperature probes and an AC power pack.

Further details from Amalgamated Instrument Co, 7/212 Tepko Road, Terrey Hills 2084 or phone (02) 450 1744.

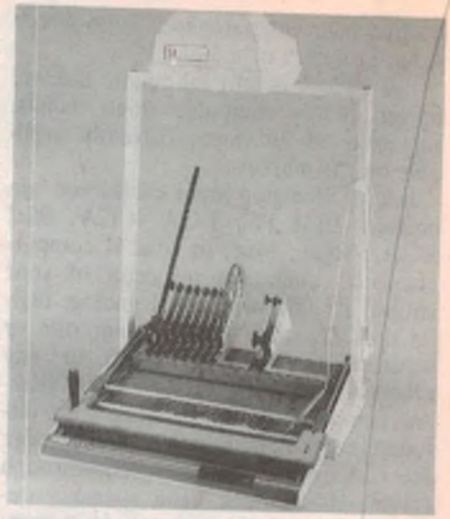
Light-guided SMT workstation

Using technology from its range of light guided assembly stations Litescan, now release the 2200 SMD – standalone microprocessor controlled bench mount system, especially designed for surface mount production lines.

The Litescan 2200 SMD features an integral vacuum pencil controlled from the hand grip on the ergonomic sliding arm rest. This allows the operator maximum dexterity to pick and place components accurately and quickly.

The feeder rack can be fitted with up to 20 standard reel or tube dispensers, and moves backwards and forwards to accommodate varying board sizes. LED's indicate the source of the component and the optional LCD display provides the operator with additional component handling and assembly instructions.

Up to 40 additional LED indicators



can be controlled for bulk trays. Also a rotary carousel can be fitted if required.

Component position information is fed to the Litescan 2200 SMD from an IBM compatible computer. Original data may be created from a CAD file, using a digitiser or by directly teaching the machine with a simple step and learn method. Once programmed the host can be detached, as the system features non volatile memory.

For further information contact Computronics, 31 Kensington Street, East Perth 6004 or phone (09) 221 2121.

1MHz digital storage scope

The new Hitachi VC6020 digital storage oscilloscope features a 1MHz sample rate on both channels, together with memory depth of 1024 words/channel. It also features a GPIB/IEEE488 interface as standard, analog output for an X-Y or chart recorder, and the ability to operate as a 20MHz realtime dual channel instrument.

Normal display is a 6" CRT with internal graticule and 2kV accelerating potential. Digitising capabilities are a 1MHz sampling rate on both channels simultaneously (twin ADCs), giving a maximum useful signal frequency of 250kHz/channel. The memory depth of 1024 words/channel provides 100 points per horizontal division, while the 8-bit vertical resolution provides 256 points in that direction.

Further information is available from IRH Components, 32 Parramatta Road, Lidcombe 2208 or phone (02) 648 5455.

Fibre optic microscope

The new Scopeman fibre optic microscope is a portable unit which combines electronics and fibre optic illumination and offers four sizes of magnification ranging from x50 to x400.

The fibre optic head is flexible on a

1.75 metre cable. The viewing head is totally enclosed and is available for either straight or side viewing. No adjustment of the focal point is necessary for the standard lens, due to the direct contact method built in as part of the design.

The Scopeman has capabilities for interfacing various facilities such as still video recorders, colour video printers or computers with image filing systems. It is available with either NTSC or PAL output.

A brochure describing the product is available from Clarke & Severn Electronics, PO Box 129, St Leonards 2065 or phone (02) 437 4199.

New Products

Pocket microscope with built-in light

Scope Labs has just released this new 30x magnification pocket microscope, which includes a simple focussing system with four element lens. Weighing about 80 grams, the unit provides a wide field of view which is lit by its own power source.

Trade price is expected to be approximately $41.00, plus tax.

For further information contact Scope Laboratories, 3 Walton Street, Airport West 3042 or phone (03) 338 1566.

DSP prototyping card

The FB-320 Interactive DSP Software prototyping system for the Texas Instruments TMS320 family is now available from Energy Control International.

The FB-320 system includes a Spectrum Signal Processing Inc TMS32020 or TMS320C25 board, with 24K 16 bit words SRAM, Poly Forth, System Source Code and extensive applications software support. The system is compatible, with 128K RAM and Dos 2.0 or higher.

Key system features include a full-range of addressing on the TMS320; an interactive, incremental programming environment; and an extensive library of programmer aids and utilities.

For more information contact Energy Control International, 26 Boron Street, Sumner Park, Brisbane or phone (07) 376 2955.

Interface cards for PC compatibles

A wide range of A/D, D/A, programming and interfacing cards for PC-XT-AT compatible computers is available from Boston Technology.

Included in the range are combination D/A and A/D cards, EPROM programmers, signal conditioners, multi-channel serial interfacing cards, relay control cards, prototyping and extender cards as well as more specialised types such as a strain gauge amplifier, a thermocouple amplifier/digitiser and a digital to synchro/resolver converter.

For further information contact Boston Technology, PO Box 415, Milsons Point 2061 or phone (02) 92 4765.

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An RS-232 interface is standard, for connection to PCs, printers and modems, while an IEEE-488.2 interface is available as an option.

For further information please contact: Philips Test & Measurement **NSW** (02) 888 0416, **Brisbane** (07) 844 0191, **Melbourne** (03) 235 3666, **Adelaide** (08) 348 2888, **Perth** (09) 277 4199, **Auckland** (09) 894 160, **Wellington** (04) 889 788.

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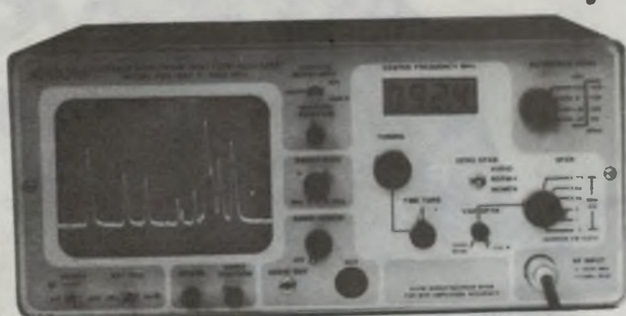

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Like any ACL product, this spectrum analyser has been bench and field tested by the best technicians in the business to ensure that you get years of power packed performance.

For further information on the PSA-65A RF Spectrum Analyser, or to arrange an obligation-free demonstration, contact ACL today on (03) 842 8822.

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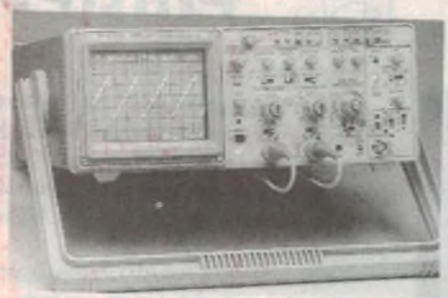

Portable 50MHz DSO

The new Tektronix 2211 digital sampling oscilloscope builds on the feature set of the popular 2200 series oscilloscopes and provides 50MHz bandwidth and 20-MS/sec sampling rate per channel. The new scope also offers 8-bit vertical resolution and 4K record length per channel, together with on-screen cursors, CRT readout, and a hardcopy serial interface.

The 2211 provides on-screen readout of both front-panel scale factors and cursor measurement results. It also supplies trigger voltage level readout. With this feature, users can set the voltage level for the trigger point and read it directly on screen. This is especially useful for single-shot waveform capture, or for triggering on a voltage spike when babysitting in a process-control application.

The RS-232-C serial interface adds further flexibility to the 2211, providing easy hardcopy documentation of information being displayed on-screen. Both Epson and HPGL-compatible serial printers and plotters are supported, with a selection of print formats. The 2211 also supports 4-colour printout when connected to an appropriate plotter such as the Tektronix HC-100 serial printer.

Further information from Tektronix Australia, 80 Waterloo Road, North Ryde 2113 or phone (02) 888 7066.

Wire wrap wire

Queensland based manufacturer Versa Electronics has commenced production of wire wrap wire to meet the requirements of the Australian electronics industry.

Versa claims to supply the highest quality silver plated solid copper conductor wire wrap wire, processed using the latest computer controlled equipment, at most competitive prices.

Both pre-stripped and spooled wire are available in ten colours: blue, red, yellow, black, green, violet, orange, white, brown and grey. Pre-stripped and cut wire are available in 30 AWG and 26 AWG Kynar. Standard production lengths are from 6.25cm up to 25.4cm in 1.27cm multiples. Wire length is overall length of wire including 2.54cm exposed wire lead for wrapping. Any size strip up to 3.98cm can be made, and special wire lengths can be produced to suit user requirements.

For further information, contact Versa Electronics, 64 Rumrunner Street, Mermaid Waters 4218 or phone/-fax on (075) 52 6870.

Bench-top power supply

Designed for the experimentalist, Kepco's new series MSK bench-top supply offers 100 watts of stable, adjustable DC in combinations 0-10V at 10A; 0-20V at 5A; 0-40V at 2.5A and 0-125V at 1A.

The MSK features two LCD digital displays for setting the voltage and current limit, and then displaying the actual voltage and current being delivered. It also provides a 'preview' switch which allows the operator to preset the output limits before applying power to the load.

Further information is available from Elmeasco Instruments, 18 Hilly Street, Mortlake 2137 or phone (02) 736 2888. EA

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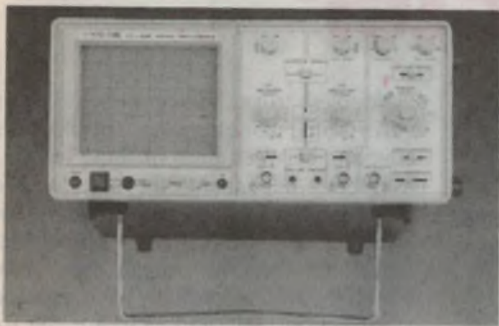

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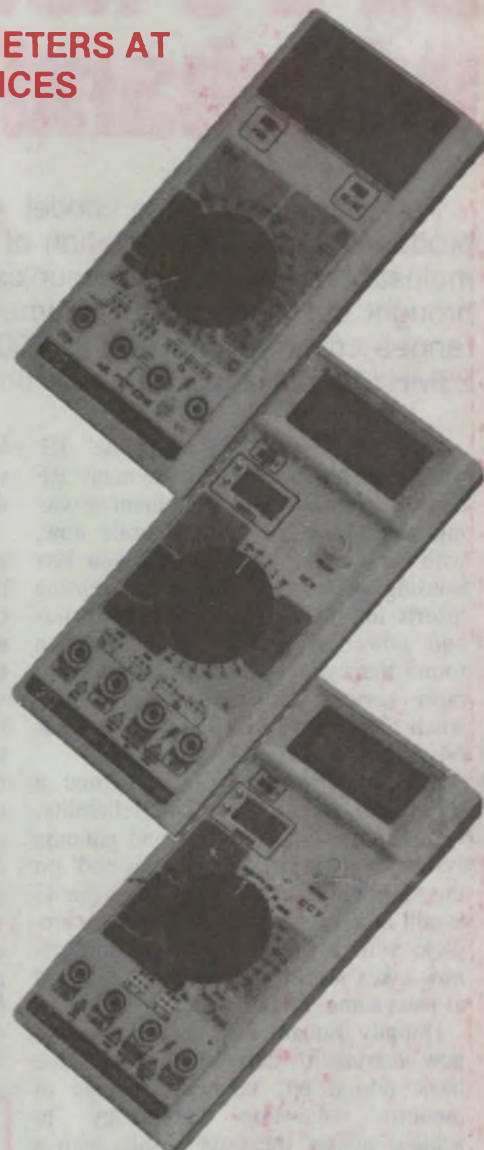

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- TRANSISTOR TEST
- COUNTER
- QUARTZ CLOCK
- HIGH ACCURACY
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ETS 1001	90 001	1 x	same		45		20		15		1.2	48.24
ETS 1002	90 002	1 x	as		70		15		20		2.0	61.20
ETS 1003	90 003	1 x	Scope		100		10		30		3.0	67.68
ETS 1011	90 011	10 x	10		15.0		100		3.0		1.2	57.48
ETS 1012	90 012	10 x	10		16.5		80		4.0		2.0	81.72
ETS 1013	90 013	10 x	10		19.5		60		5.0		3.0	89.28
			1x	10 x	1 x	10 x	1 x	10 x	1x	10 x		
ETS 1111	90 111	1 x / 10 x	same	10	55	16	15	100	35	3	1.2	55.80
ETS 1112	90 112	1 x / 10 x	as	10	75	18	10	80	50	5	2.0	105.48
ETS 1113	90 113	1 x / 10 x	Scope	10	100	20	5	60	70	7	3.0	114.12

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Bird's new 4304A wideband wattmeter

For many years the model 43 directional RF wattmeter produced by Bird Corporation of Cleveland, Ohio has been a mainstay of the radio communications industry. Now Bird has brought out a modified instrument which provides five power ranges covering from 5W to 500W FSD for frequencies from 25MHz to 1GHz, with a single broadband line element.

The Bird model 43 'Thruline' RF wattmeter has been a part of many RF development labs and equipment servicing workshops for quite a while now, with its familiar polished wooden box housing an array of plug-in line sensing inserts for the various frequency bands and power levels. A few have even found their way into the 'shacks' of our more serious and canny radio hams, when they've turned up among the gear on offer at auction sales.

The model 43 has justly earned a reputation for accuracy and reliability, with countless transmitters and antenna systems having been 'given the nod' on the strength of its readings. And the 43 is still available, although its price complete with a full set of sensing inserts now takes it a little beyond the reach of at least some potential users.

Happily though, Bird has developed a new instrument, derived from the same basic design but taking advantage of modern solid-state technology to achieve almost the same results with a single sensing element. As a result, the new model 4304A covers measurements from about 25MHz to 1GHz and power levels from below 1W to 500W, for a significantly lower cost than its predecessor.

Like the model 43, the new meter is a directional wattmeter. That is, it measures the RF power flowing in either direction along a short section of transmission line, which is connected in series with the line under test. And it does this by using Bird's tried and proven 'Thruline' technique, which involves a very short coupling line mounted in a precision sensing insert (see Fig.1). This is rotated through 180° to measure either the forward or reverse power levels in the main line, as desired.

In the model 43 each frequency band and power range involves a different one of these precision sensing inserts, calibrated for optimum performance and accuracy. However in the 4304A there is a single element, locked in position so that it can only be rotated to the two measurement positions (although there is also a central 'meter damped' position, to prevent meter damage during transport).

Like the model 43 the new meter is completely passive, but to adapt the single sensing element to cover such a wide power range, it incorporates an electrical range switch and a set of multipliers mounted on a small internal PC board. Each range multiplier includes a preset pot for accurate calibration.

Needless to say this approach does involve some compromises. Because the coupling between lines of finite length is frequency dependant, the sensitivity of the 4304A's single element tends to fall away at low frequencies. The fall-off tends to become significant below 100MHz, and accordingly Bird provides a correction table and chart for the frequencies involved. By 50MHz the meter readings must be multiplied 1.3, while this figure rises to 2.15 at 25MHz.

Even with the electrical range switching and correction chart, the final accuracy is not quite as good as with the model 43 – although still more than adequate for many applications. The rated accuracy between 100MHz and 512MHz is +/–6% of FSD, and +/– 7% from 512MHz to 1GHz and also from 25MHz to 100MHz after correction using the chart.

This applies to all frequency ranges, although Bird notes that the 4304A cannot be used with power levels over 150W between 800MHz and 1GHz, due to the risk of damaging the sensor element due to overheating.

With the same precision-machined sensing line system as the model 43, the instrument also offers the same commendably low (and stable) insertion loss

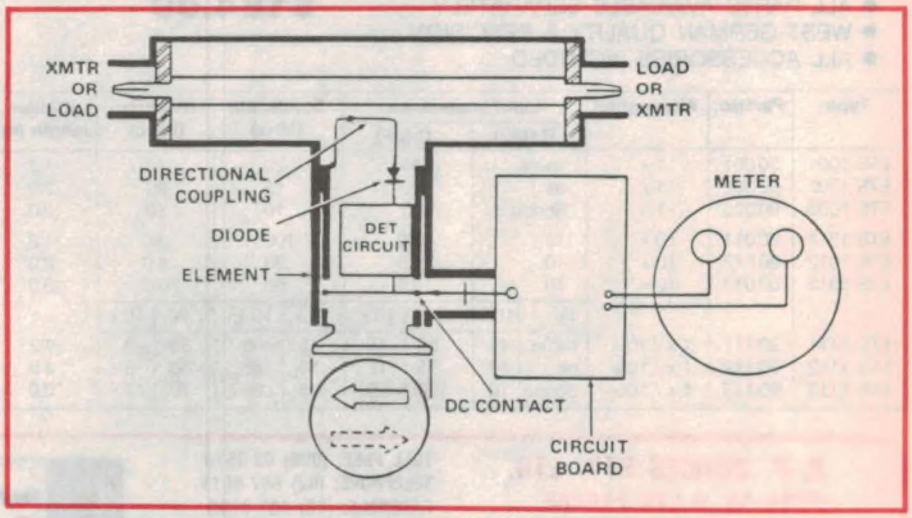
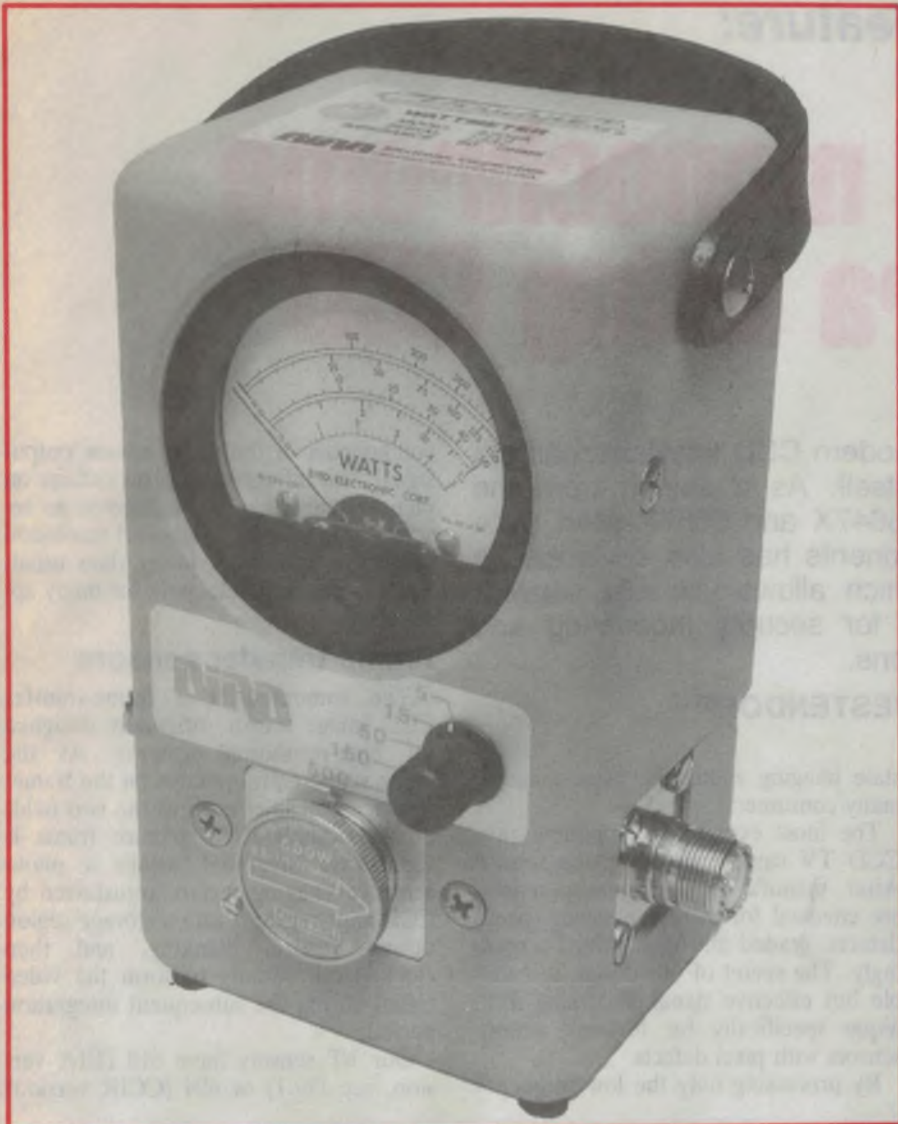


Fig.1: The model 4304A's basic sensing and measuring system.



the appropriate correction factor had to be applied. Overall the results were well within the rated tolerances for both instruments, suggesting that the 4304A is very comparable with its older and more expensive brother for most measurements.

Needless to say with the same basic physical construction, it also offers the same high level of reliability and stability, coupled with low insertion loss.

And of course in many ways it's more convenient to use than the model 43. There's no need to change sensing inserts when you change power levels or frequency bands – just flick the range switch from time to time to get the most accurate reading. Of course there's still the need to swing the insert around as before, for the forward and reverse power measurements.

The price is also rather more convenient, too, although it's still not exactly a steal: the recommended retail price is $890 plus tax. All the same, it should represent a more affordable 'compromise', for those whose budget won't stretch further to a model 43.

The unit reviewed came from distributors RF Devices, of 1/9 Lyn Parade, Lurnea 2170 or phone (02) 607 8811. (J.R.)

and VSWR. With the SO-239 'UHF' sockets normally fitted the insertion loss up to 512MHz is less than 0.1dB, and still less than 0.15dB at 1GHz. Similarly the VSWR is less than 1.08 to 512MHz, and less than 1.12 at 1GHz.

These figures become even better with the optional 'N' series connectors, the loss falling to 0.13dB and the VSWR to less than 1.07 at 1GHz.

The new instrument comes in the same compact but rugged aluminium diecast housing as the model 43, measuring 175mm high by 99mm deep by 101mm wide, without its line connectors. As before the housing is fitted with a folding carry strap, and has rubber shock-absorbing feet on both the bottom and rear for either vertical or horizontal operation. The rear panel carries a handy chart to convert from forward and reverse power readings to VSWR, and also the low frequency correction factor table.

As mentioned above, female SO-239 sockets are fitted as standard, but female 'N' connectors are available alternatively if desired, on special order. The connectors are easily changed, in fact, this only involving removal of four screws for each.

The actual meter movement is very sensitive – 20uA FSD. However it is shock mounted, and this along with the 'damping' position of the sensing element allows the instrument to withstand quite a deal of rough use. Provided that you remember to turn the insert to the right position when you move it around, of course!

In use

We tried the sample 4304A out on a variety of frequencies and at various power and VSWR levels, mainly using a known model 43 for comparison.

Its readings proved to be closely comparable, although at the low frequencies

Opto-Electronics Feature:

Low cost monochrome TV camera using CCD

The most expensive item in a modern CCD television camera is the image sensing device itself. As a spinoff from the development work for its new 5647X and 5657X solid state camera modules, Philips Components has also developed a signal processing technique which allows low-cost sensors with pixel defects to be used for security monitoring and similar less demanding applications.

by THOMAS WESTENDORF
Philips Components

For applications such as home-surveillance cameras, video phones, door security systems, automotive rearview systems, etc., many of today's CCD TV cameras are over complicated and thus needlessly expensive. Many potential camera applications have never been exploited because TV cameras, of any sort, are simply too expensive. For these reasons, Philips Components has designed a monochrome CCD camera that brings all the advantages of solid-state imaging within the price range of many consumers.

The most expensive component in a CCD TV camera is the image sensor. After manufacture, all image sensors are checked for picture element (pixel) defects, graded and then priced accordingly. The secret of our design is a simple but effective signal-processing technique specifically for low-cost image-sensors with pixel defects.

By processing only the low frequency components of the image-sensor output signal, the influence of pixel defects on picture quality can be reduced to an acceptable level. The horizontal resolution of such a camera is lower than usual, but it is perfectly adequate for many applications.

Frame-transfer sensors

The camera uses a frame-transfer CCD image sensor, originally designed for high-resolution cameras. As the name suggests, it operates on the frame-transfer principle: each of the two fields of the complete TV picture frame is separately integrated within a photo sensitive imaging region, transferred by CCD shift registers into a storage region during vertical blanking, and then clocked out serially to form the video signal during the subsequent integration period.

Our FT sensors have 610 (EIA version, see Fig.1) or 604 (CCIR version)

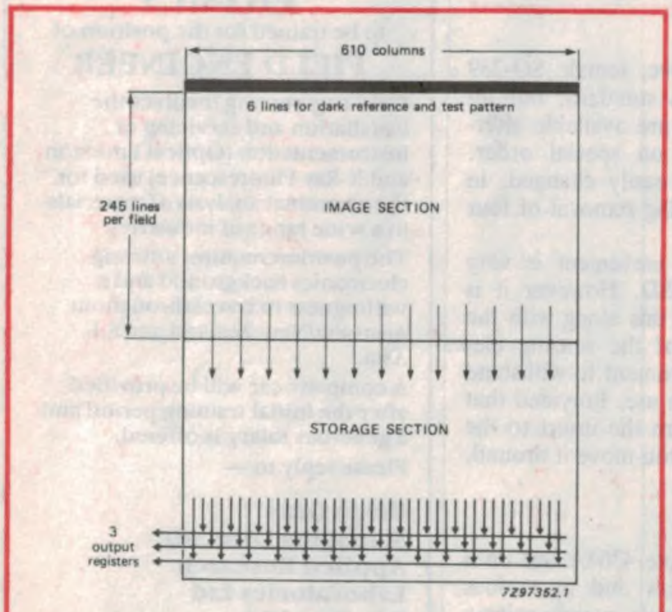


Fig.1: The basic operation of Philips' frame-transfer (FT) CCD image sensors. This is the EIA version; the CCIR version provides 604 columns and 288 lines/field.

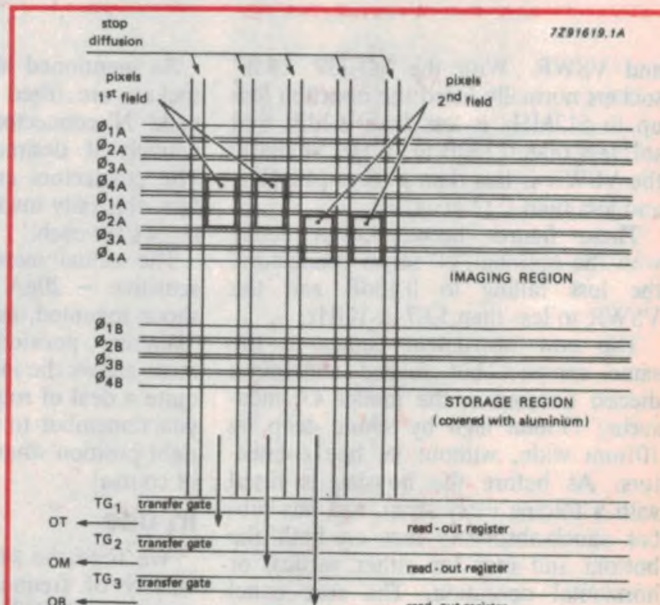


Fig.2: The charge transport system used in the FT sensor. Pixel charge packets for the columns are read out via three readout registers.

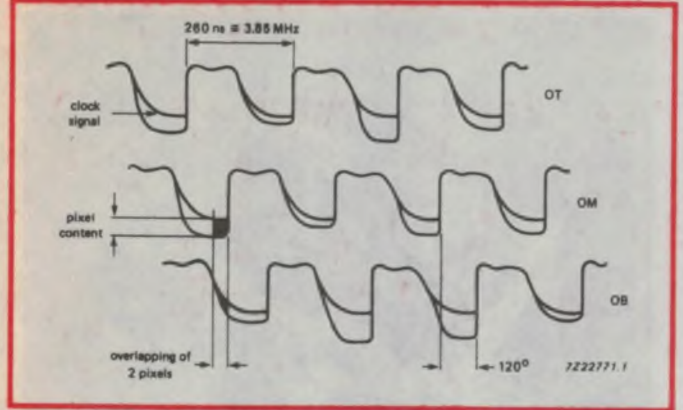


Fig.3: The three sensor output signals provide some overlapping between adjacent pixels.

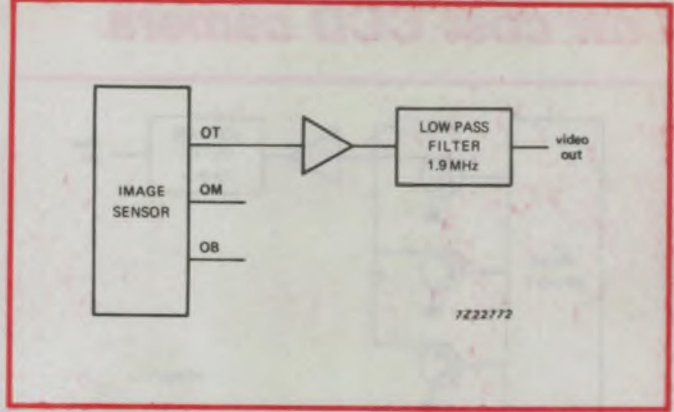


Fig.4: Where high resolution is not needed, one way around sensor defects is to use only one sensor output.

pixels per line and this, of course, determines the horizontal resolution of the sensor. The photosensitive image region and the storage region are connected by 610 (or 604) CCD shift registers running vertically through both regions.

These registers, separated by stop diffusions, define the pixel width, separate the lines in both the image and the storage regions, and transport the light-generated charge from the image region to the storage region.

The number of lines in the sensor is dictated by the TV-standard: a sensor for the 525-line (EIA) standard has 245 active lines (6 more for black-level reference), and for the 625-line (CCIR) standard, 288 lines. Since two fields are used to form an image frame, each frame comprises 490 x 610 pixels for EIA or 576 x 604 pixels for CCIR.

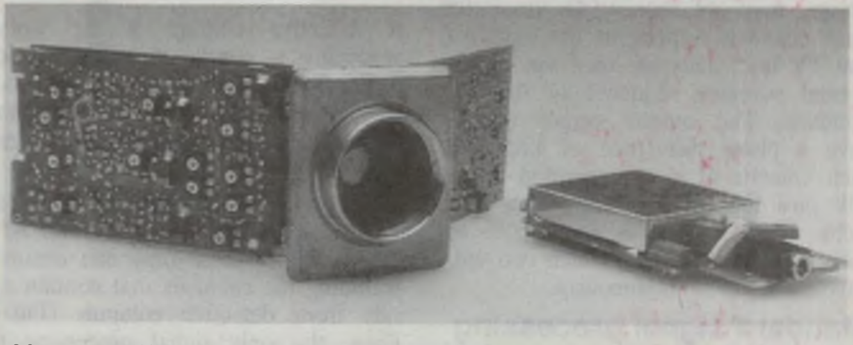
When the image section of the sensor is illuminated, light generates electron-hole pairs and the electrons collect under the positive electrodes of the CCD-registers. In the vertical direction, pixels are separated by the negative electrodes of the registers to form the lines of a field. The electron charge is integrated in the imaging region during a field period of 16ms for an EIA sensor (18.36ms for CCIR).

During the vertical blanking period (about 1.6ms), the charge is rapidly transferred (within 0.5ms) to the storage section using the shift-registers. In the next field period, a new image is collected in the imaging region while charge from the storage region is read out line by line (during the horizontal blanking period).

During each horizontal blanking period, the charge content of the storage section is moved downward by one line, and the bottom line is transferred into three read-out registers and then read out (Fig.2). Each read-out register is connected to every third vertical shift register, so each reads out about 200 pixels of any line.

This arrangement has two advantages:

- it allows a much higher horizontal pixel density than would a single read-out register, in which the finite width of the gate electrodes limits the minimum horizontal spacing between charge packets. With three shift registers, the spacing is effectively reduced threefold;



New Philips full-performance camera modules

'Big brothers' of the low-cost monochrome TV camera module described in this article are the new Philips 56470/2/4 monochrome and 56570/4 colour TV camera modules, which are similar in size but offer considerably higher performance.

Based on the use of selected higher quality versions of the same basic NXA1011 CCD image sensor device used in the low-cost camera, the high performance modules offer the same very compact construction as their economical relative, at prices which still compare very favourably indeed with other cameras. Typical 1-off prices for the monochrome models range from $618 tax for the model 56470, fitted with a zero-defective-pixel CCD sensor, down to $560 for the model 56474 with a sensor having no more than 10 defective pixels. Similarly the model 56570 colour module with zero pixel defects sensor costs $1060, while the 56574 with no more than 10 defective pixels costs $960. These prices are all plus sales tax if applicable.

All modules are complete except for an external 12V DC power supply, deliver standard composite video (1V p-p) and are designed to take a standard C-mount lens. Performance specs for the monochrome modules include a pixel resolution of 588 x 604, horizontal resolution of 450 lines, video bandwidth of 5.8MHz (–6dB), and a minumum illumination of 0.02 lux for acceptable pictures. Similarly the colour modules provide 576 x 780 pixels, horizontal resolution of more than 350 lines, video bandwidth of 3.5MHz (–6dB) and a minimum illumination of 0.25 lux for acceptable pictures. All modules provide for automatic or external gain control and internal, free-running or external sync.

We hope to review samples of the modules in a forthcoming issue of the magazine. In the meantime, further information is available from Philips Components, 11 Waltham Street, Artarmon 2064 or phone (02) 439 3322.

Low cost CCD camera

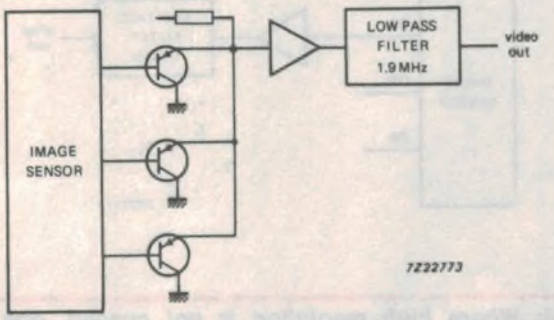
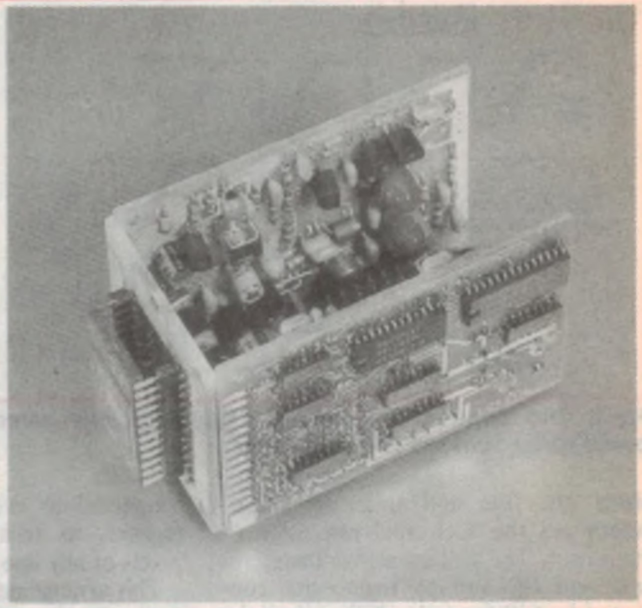


Fig.5: Another low-cost solution is to combine the three output channels, as shown above.



Prototype of a low-cost camera using an image sensor with pixel defects, and simplified signal processing.

- it allows selective separation of charge packets within each line and thus, with stripe filters over the imaging region, it allows the device to be used as a colour image sensor.

The read-out registers have separate outputs (output top (OT), middle (OM), and bottom (OB)) and the charge, read out sequentially from the three channels, represents the signal of one TV line; lines are read out in the normal scanning sequence of the TV standard. The output signals (Fig.3) have a phase difference of 120° and each consists of clock-generated cross-talk plus the pixel content. The duty factor of the signals is about 50% so there is a short time in which two outputs are active simultaneously.

Standard signal processing

For EIA and CCIR sensors, with about 200 picture elements per read-out register, a clock frequency of 3.8MHz is needed to read out the charge in the standard TV-line period (52us). This means the maximum signal bandwidth per channel is 1.9MHz (Nyquist's theorem).

To obtain the maximum possible resolution from this sensor, signals of the three channels have to be sampled sequentially for multiplexing, at a clock frequency of 11.4MHz (3 x 3.8MHz). The maximum bandwidth of the multiplexed signal is then 5.7MHz (corresponding to 610 or 604 pixels per line).

In this kind of signal processing, the three channels have to be well matched to avoid 3.8MHz clock components in the video signal: there should be no differences between the sensor output stages or between the three channels of the signal processing circuit.

Low-cost processing

With standard signal processing, defective pixels in the sensor result in black or white spots on the TV picture. A defective column is far worse, producing a black or white vertical stripe. To be able to use sub-standard sensors and still obtain an acceptable TV picture, a different method of signal processing is necessary.

In applications where high-resolution is not required, an easy solution is to use the signal from only one channel, excluding the channels that contain signals from defective columns (Fig.4). Then, the only signal processing required is a low-pass filter to limit the bandwidth to the Nyquist frequency of one channel (e.g. 1.9MHz, corresponding to about 200 pixels per line). Since sub-standard sensors usually have only one or two defective columns, this technique is easy to employ and quite satisfactory.

A more effective solution is possible using the signals from all three channels without a special sampling and multiplex circuit: the signals are combined in a common load circuit (see Fig.5). The bases of the PNP transistors are connected to the sensor output signals, the emitters are connected together, and the collectors are connected to ground.

When a transistor's base potential falls below that of the emitter, the transistor is switched on. Fig.3 shows that a sensor output signal has its lowest voltage when a pixel is being read out. For most of this period, the other two outputs have a higher potential so this circuit automatically combines the pixels from the three channels sequentially.

When two channels are active simultaneously, the contents of two adjacent pixels are simply averaged so the resolution isn't as good as using a sampling technique (the bandwidth falls below 5.7MHz). However, the effect of a defective pixel is thus reduced by its charge being averaged with that of a normal pixel.

If a sensor has a defective column, the error signal is mainly in the upper range of the output signal's frequency spectrum (3.8MHz). By low-pass filtering the output signal to about 2.7MHz, a value sufficiently below the disturbing vertical stripe frequency, the influence of defective pixels can be further reduced to obtain an acceptable TV picture.

Circuit details

The basic construction we recommend to build a low-cost camera uses all three output channels of the image sensor, as described above. Refer to Fig.6 for the circuit description.

The Master Clock, a crystal oscillator, generates the frequency reference for all timing circuitry: 22.5MHz for CCIR, AND 22.657339MHz for EIA. This frequency is divided by nine (74HC163) to provide the clock drive for the Sync Pulse Generator (SAA1043T), which in turn provides the EIA or CCIR standard sync signals for the sensor (including vertical and horizontal blanking, vertical and horizontal drive, and composite sync).

The sync pulse generator controls the multi-norm pulse pattern generator (MNPPG). The MNPPG (an

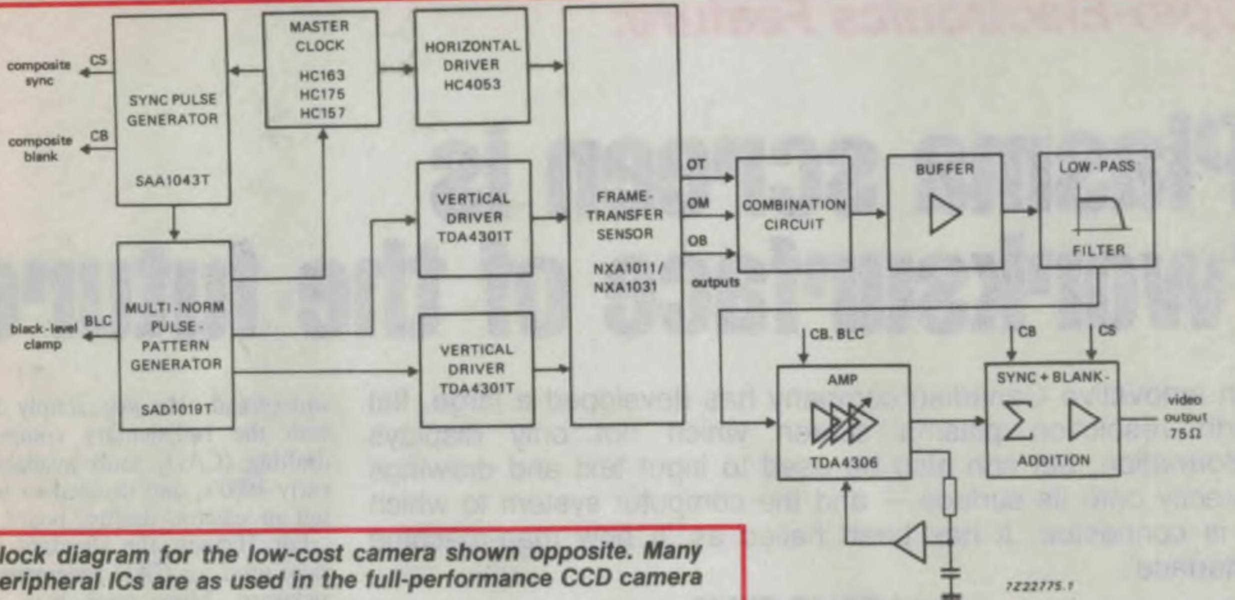


Fig.6: Block diagram for the low-cost camera shown opposite. Many of the peripheral ICs are as used in the full-performance CCD camera modules.

SAD1019T IC, developed specifically for our FT sensors) generates all the clock pulses for the sensor, except those for read-out. The output levels from the MNPPG are too low to drive the sensor's vertical shift registers directly, so vertical drivers (type TDA4301) are needed to boost the clock signals.

The fast horizontal drive pulses for the read-out registers are derived from the master clock directly: the master frequency reference is divided by six (74HC175) and used to provide three 3.8MHz (3.76MHz in practice) clock signals with 120° phase difference, during read-out. The pulses are fed to the sensor via a multiplexer (74HC157) and a horizontal driver (74HC4053). The MNPPG is also connected to the multiplexer so that normal transport pulses can be fed to the sensor during blanking, and read-out pulses during the active visible line period.

The three sensor output signals (OB, OM and OT) are combined using discrete transistors (see circuit in Fig.5). The result is an inverted-image signal, which is then amplified and low-pass filtered to reduce the influence of defective pixels/pixel columns, as described in the previous section. The low-pass filter has a cut-off frequency of 2.7MHz, but the slope of the cut-off is not steep enough to completely remove all 3.75MHz signal components, so an additional 3.76MHz notch filter is used. Fig.7 shows the frequency characteristic of the notch and low-pass filter combination.

After filtering, the signal is fed through a multi-stage master-gain (MG) amplifier (type TDA4306) which also provides black-level clamping and AGC over a range of 1:125. The AGC voltage is derived from the video output signal.

A final stage, with 75 ohms output impedance, adds sync and blanking pulses to provide a standard video signal at the output.

Note: The low-cost NXA 1011/04 CCD sensor device on which this camera design is based is available from Philips Components for $45 plus tax, in 1-off quantities. Sets of the peripheral ICs required are also available, for $109 plus tax, again in quantities of 1-2.

Further information is available from Philips Components, 11 Waltham Street, Artarmon 2064 or phone (02) 439 3322.

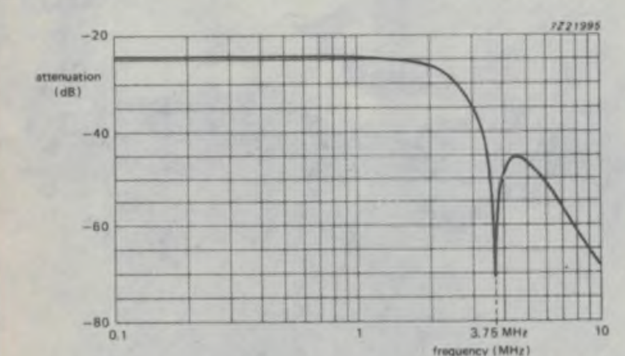


Fig.7: Frequency characteristic of the notch filter and low-pass filter combination. The specs for the simplified camera are at right.

Camera specification

Image sensor:	NXA1011/04 (CCIR) or NXA1031/04 (EIA)
Bandwidth:	2.7 MHz (at −6 dB)
Resolution:	
horizontal	250 TV lines
vertical	350 TV lines
Minimum sensor illumination:	0.4 lux (for −6 dB output voltage)
Signal to noise ratio:	42 dB (at 5 lux sensor illumination)
Gamma correction:	0.6
Automatic gain control (AGC) range:	1:125
Output signal:	1 V_{p-p} video (+700 mV white, +300 mV sync), 75 Ω
Temperature range:	−20 to +60 °C
Power supply	
current:	142 mA
voltage:	12 V

Opto-Electronics Feature:

Plasma screen is 'worksurface of the future'

An innovative Canadian company has developed a large, flat high resolution plasma screen which not only displays information, but can also be used to input text and drawings directly onto its surface – and the computer system to which it is connected. It has been hailed as 'a new man-machine interface'.

by LESLIE ELLIS

According to proponents of the Big Bang theory, for a few minutes after this momentous occasion that created our universe, all existing matter was in the form of plasma. Things haven't changed much since then – scientists estimate that 99% of matter in the universe is plasma.

A far-sighted Canadian company is using this ubiquitous matter to develop a revolutionary computer interface. Plasma Computer Products of North Vancouver has built a very large, flat, high resolution plasma screen, which not only displays information, but can be used to input information (text, drawings) directly onto its surface.

Although plasma is not as common on earth as elsewhere in the universe, PCP hopes to change this. Today, we can see plasma in lightning bolts, in the glow of the Northern Lights or Southern Aurora, and in neon signs or fluorescent tubes. Within the next three years, PCP president Charles Haynes hopes many users of computer-aided drafting or desktop publishing will be working on a large plasma-filled surface every day.

Plasma has a number of definitions, but for the purposes of this article, we mean a form of gas with about equal amounts of charged and neutral particles. Webster's dictionary calls it 'a collection of charged particles containing positive ions and electrons which exhibits some properties of a gas, but which differs from a gas in being a good conductor of electricity.'

Plasma was PCP's technology of choice for a number of reasons: it emits a steady light, unlike the flickering light from a common cathode ray tube (CRT); it is flat, allowing for large screens and for digitising directly on-screen; it's durable, transparent, lasts five times longer than CRTs, can be viewed from any angle (unlike liquid crystal displays) and has very high resolution capability.

When Charles Haynes first began developing what SFU vice president of research Tom Calvert has identified as 'a new man-machine interface', the pioneering architect had no idea that applications of his invention would be so widespread. He was simply frustrated with the rudimentary computer-aided drafting (CAD) tools available in the early 1980's, and decided to build himself an 'electric' drafting board.

For Haynes, the standard input devices used for CAD programs were too awkward. Mice, track balls, digitising pads and joysticks are all somewhat inadequate tools, developed to replace a simple pen or pencil with something that a computer would accept input from. It would be so much more natural to draw directly onto a drafting table, and find a way to make a computer record this.

The next big problem for Haynes was the standard screen: a fragile, flickering box that could display a very limited amount of information. To adapt to the small display area, software developers

The PCP plasma workstation has a resolution of more than 3.5 million pixels, effectively forming an 'electric drafting board'.

have developed pulldown menus and windows to layer information onscreen. But users of CAD and desktop publishing spent a great deal of their time zooming in and out to get to the information they want. A large screen displaying all graphics, text and menus needed is the simple solution.

Haynes ignored those who told him that all he needed to do, to make the most of CAD, was learn to use the programs better. He formed Alpha Scientific Research in 1984 to develop his simple solution. He was awarded $5.5 million in scientific research tax credits by the Canadian Government, which he put to good use. He not only developed the large plasma worksurface, but also construction management software, scanners, a database and a device to turn a blueprint machine into a computer printer.

The screen was displayed at the Canada Pavilion during Expo '86. Tom Becher, who was in charge of finding appropriate display material for the pavilion, said "I was looking for products that would give the public an image of the future. This was the best example I could find of the worksurface of the future." He was so impressed, he joined the company.

Others have since been impressed by the product, including the Canadian military, which has purchased two development models for $500,000. The purchase is part of the military's updating of technical communication systems for land-based forces, which the Conservative government has targetted for major expenditures in the 1990's. The army plans to use the screen's transparent properties to superimpose current computer data onto maps placed under the screens.

Other groups which have expressed strong interest in the product include the Vancouver Police Department, Knowledge Network, Siemens, Canadian Pacific Railway, and the Greater Vancouver Regional District.

Potential applications include engineering drawings, architecture, mapping, public information displays, desktop publishing, air traffic control, vehicle location and dispatch, factory automation and process control. According to Haynes, "It's hard to find a niche where people say this isn't specific or usable. We have to discipline ourselves and focus on specific markets."

Some time in the future, Haynes hopes to see his plasma screen made into the ultimate executive desk. The user could have all necessary information at his or her fingertips – from reports and drawings to a phone, directory, memo pad, fax machine, scanner... all on a clean, flat desk with no paper in sight. And any of these functions or pieces of information could be used or altered right on the desktop with a simple digitising pen.

PCP president and driving force behind development of the plasma workstation is Charles Haynes, an architect who became frustrated with existing CAD systems.

The desk, however, is not an application under consideration in the near future. The technology to create it is available today, but at a price beyond the reach of all but the highest executives.

According to PCP marketing director Robert Belhouse, the next task at hand for the company is an initial public offering for which they have already received approval. With the $600,000 PCP plans to raise, they will build six preproduction units to generate orders from key suppliers in the target markets identified.

"Some have already approached us", said Belhouse. He would like to nett ten orders of 1,000 units each. The large screens (24" x 32") will sell for about $10,000 each. That comes to a grand total of $10 million in orders.

On the strength of that commitment, Haynes hopes to attract a second round of financing to set up manufacturing facilities for the proprietary components of his product: the large-scale digitiser and the plasma display card.

Just as a CRT requires a video card to enable the computer to display its information onscreen, a plasma screen also requires a means of addressing the system. But the plasma card inherently

Plasma screen

makes more sense. Video cards must translate the digital information in a computer's memory to analog information a CRT can display. The plasma card maintains the digital mode, as the plasma screen's display is digital.

"It's almost like a snapshot of the computer's memory", said Becher.

If plasma displays make so much more sense than CRT's, why is no one else producing them for the market? Actually almost 30 different companies are now working on flat panel technology, but only PCP is working with a large, high-resolution format.

"The rest of the flat panel industry is pursuing the portable television and laptop computer marketplace", said Haynes. They are both huge markets: there were 80 million TVs sold in the US alone last year, and the laptop computer market-place is also a high-growth area.

An interesting exercise is to look at the resolution projections for future flat panel displays. Stanford Resources predicted in October 1988 that by the year 2000, commercial plasma display panels might reach a resolution of up to 3 million pixels for large metre-size displays. PCP's large screen already has a pixel count of more than 3.5 million, allowing for unheard-of detail in a large format display screen.

PCP could take its plasma expertise and enter the booming market for television and computer screens, but as Belhouse points out, "We have a good market opportunity (in the large interactive screens) with no competitors." The CAD market alone was $8 billion last year, large enough for PCP's purposes.

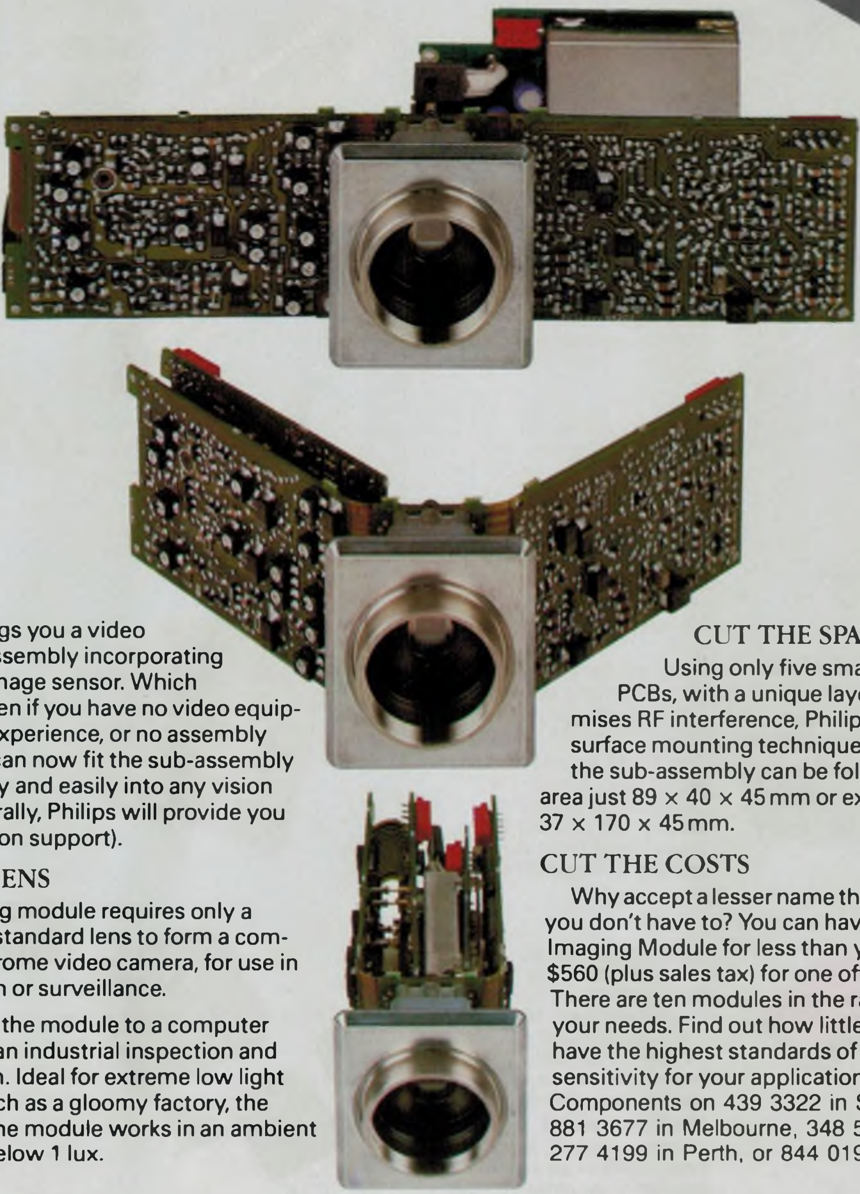
Eventually, they predict, all CRT's will be replaced by flat screens, but at present manufacturing costs prohibit this. Flat screens cost about five times more to produce today than a CRT. Not only that but the software to drive the large screens has yet to be developed for most applications.

But Haynes notes that flat screens are not inherently more expensive or difficult to build than CRT's, which have been mass-produced for decades. His product is "just a piece of glass with wires running through it." Once critical economies of scale are obtained, we can say goodbye to the picture tube.

If Haynes succeeds in his corporate goals, plasma will before long occupy slightly more than 99% of the universe.

MAKE YOUR OWN VIDEO CAMERA – NO EXPERIENCE NECESSARY!

ALSO IN COLOUR



Philips brings you a video camera sub-assembly incorporating a solid-state image sensor. Which means that even if you have no video equipment design experience, or no assembly facilities, you can now fit the sub-assembly module quickly and easily into any vision system. (Naturally, Philips will provide you with information support).

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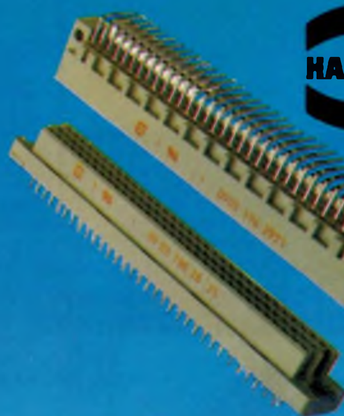

HARTING

Sophisticated production techniques results in proven high reliability of Hartings extensive range of Euro/DIN 41612 Connectors.

Their performance Level 1 Series have been successfully tested by Telecom Research Laboratories and may be used in Equipment made for Telecom Australia.

The same high quality is evident in Hartings SEK, flat cable connectors and in the HAN, Heavy Duty, rectangular connectors where Harting are renowned as market leaders.

WECO

Weco are specialists in the manufacture of terminal blocks with a range of over 10,000 products.

These include Connectors for printed circuits, Terminal Strips and Tab Connectors for Panel/chassis mounting, ceramic terminal blocks including Explosion and Firedamp, proof types.

Recent developments have been a range of Electronic Modules for use on mounting rails to DIN EN 50022-035 and 045.

Also the new series 120 and 150 Multilift screw connectors for printed circuits featuring lift terminals that guarantee high pressure contacts and allow countless wire disconnections.

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Since 1949 Methode have been providing reliable, cost effective interconnection products for use in Military, Aerospace, Computer Telecommunication, Industrial and Automatic applications.

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A new range of Microcircuit Sockets, PLCC and SIM/SIP have been introduced for through board and surface mount applications.

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Wilhelm Westermann are recognised as the world leader in the development and manufacture of miniturised plastic film capacitors. Materials used include polyester, polycarbonate, polypropylene and the new polyphenylene sulfide for high frequency applications.

In addition their MP3, Metallised Paper, Capacitors are internationally approved for use across the mains in RFI suppression applications.

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Opto-electronics news and new products

Low cost wavelength meter

Burleigh Instruments has released the Wavemeter Jnr, a new addition to its existing range of wavemeters. The Wavemeter Jnr uses a scanning Michelson Interferometer to provide continuous wavelength measurement of laser sources to an accuracy of one part in 10,000, over the range 400-1100nm. An option is available to extend the wavelength range to 1800nm.

Output is updated every 200ms and is displayed in wavelength or wavenumber units for vacuum or air. Output is also available via the standard RS-232 interface.

The Wavemeter Jnr provides an affordable and convenient solution for wavelength measurement of tunable dye or diode lasers. For those requiring greater accuracy, Burleigh's standard wavemeters provide measurements to one part in one million. Also available are a broad range of Fabry-Perot systems and spectrum analysers.

For more information contact Laserex Scientific, 7 Greenhill Road, Wayville 5034 or phone (08) 271 7966.

Vacuum fluorescent displays

The IEE 'FLIP' 36X0-14-020 and 36X-16-020 are vacuum fluorescent alphanumeric display modules, arranged as one line of 20 characters. The bright blue-green colour is filterable to blue, green, aqua or yellow.

The characters are formed using a large 0.59" (15mm) or 0.35" (9mm) 5 x 7 dot matrix, which allows easy viewing from a distance and over a wide viewing angle, and allows the representation of both upper and lower case characters, numerals, and punctuation.

The full 96-character ASCII font can be displayed and this can be altered to include the characters necessary to produce ECMA General European, German or Scandinavian fonts all under software control.

All control, refresh and display functions of the modules are executed by a dedicated on-board microprocessor. A miniature on-board DC to DC voltage converter provides all the voltages necessary to light the vacuum fluorescent display, while allowing the FLIP 1 x 20 modules to operate from a single 5-volt power supply.

For further information contact M.B & K.J Davidson, 17 Roberna Street, Moorabbin 3189 or phone (03) 555 7277.

Broad-range opto supplier

Kingfisher International of Glen Waverley is now offering an enhanced capability in fibre optic communications, and is able to offer a one stop source capability for many different types of fibre optics related activities.

A broad range of opto-electronic components are available at 850, 1300 and 1550mm wavelengths – from inexpensive silicon detectors, to lasers for coherent communications, Opto-electronic devices, PCB level data links and data link modules are available for equipment manufacturers.

A wide variety of fibre optic test and installation equipment is also available, e.g. light sources/power meters, OTDRs and pulse measurement equipment, most available in both field and laboratory grades and various price ranges.

For more information contact Kingfisher International, 14 Excalibur Avenue, Glen Waverley 3150 or phone (03) 233 5998.

Supertwist LCD

The Handoks HDM 16216H-U10 is a 2-line x 16-character supertwist alphanumeric liquid crystal display with a character height larger than normal – a very viewable 8.09mm. This display is ideal for those applications where the normal 4 or 5mm character height is not sufficient.

The extra advantage of this display is its very wide viewing angle and high contrast, due to the use of supertwist technology. Viewing angles of up to 100° are now available.

The option of electroluminescent backlighting adds further versatility to this new display. Driving is via an 8-bit parallel interface, while power supply is single +5V rail. The HDM 16216H-U10 provides all this at a very competitive price.

For further information contact M.B & K.J Davidson, 17 Roberna Street, Moorabbin 3189 or phone (03) 555 7277.

Fibre optics project kit

Newport Corporation has released a project kit which explores fibre optic techniques and applications from first principles to advanced communications and sensor systems. Comprising research quality Newport components, the kit is an ideal way for educators, technicians and researchers to obtain skills and hand-on experience with the principles of fibre optic devices.

The cornerstone of the kit is Newport's fibre optics applications handbook, containing extensive tutorial material together with comprehensive instructions for the ten projects which make up this self-contained fibre optics course. Projects include introductions to the properties of fibres, methods of coupling and splicing, construction of a two-channel communications link, and investigation of the use of fibres as sensors to measure changes in parameters such as temperature and pressure.

The kit comes complete with all required equipment, including optical breadboard, lasers, positioners, fibre and tools.

For further information contact Spectra-Physics, 2-4 Jesmond Road, Croydon 3136 or phone (03) 723 6600.

Fibre-optic video network

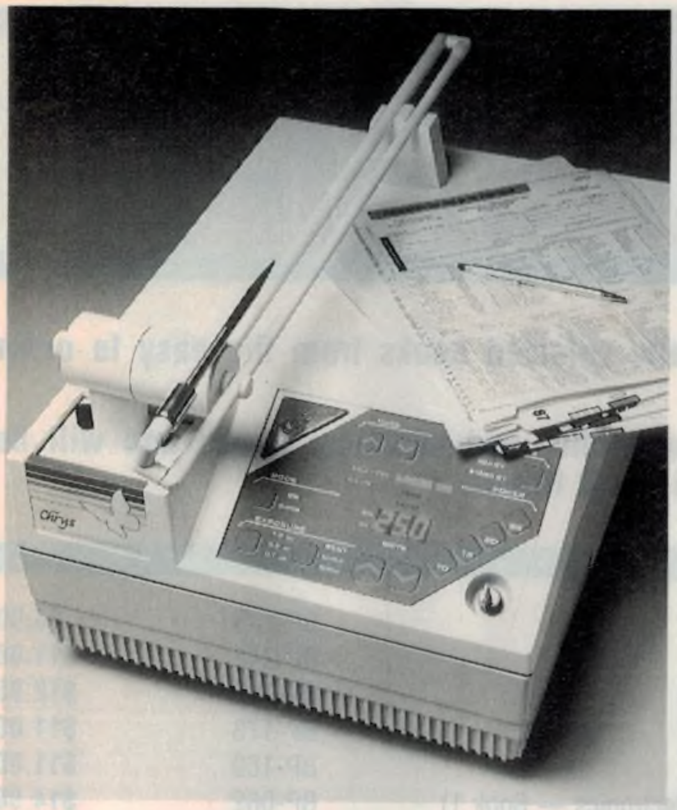
Optical Systems Design, Sydney based manufacturer of fibre optic communications systems, and the University of Queensland's Prentice Computer Centre have jointly developed an advanced audio-visual communications system for use by the University's lecturing staff.

The system allows lecturers in any one of approximately 30 lecture theatres on the campus to play video tapes at a central audio/video library, on monitors in their lecture theatre. The system provides program video and audio from the library to the theatre and full duplex intercom audio and data between the two.

The system currently has an operator in the library loading one of several VCRs with program material requested by the lecturer, after which the lecturer has full control over the machine.

Optical Systems Design developed the fibre optic interface modules to slot into the University's fibre optic network. University staff developed all control hardware and software.

Further information from Optical Systems Design, 2 Villiers Place, Dee Why 2099 or phone (02) 982 6633.



Compact surgical CO_2 lasers

California Laboratories Inc. (CLI) of the USA has recently appointed Laser Electronics as exclusive distributor of the Chrys Laser in Australia and New Zealand.

The Chrys Laser is based on a novel, proprietary, and patented laser resonator concept. This so-called 'Matrix Laser' technology allows the achievement of high power output, while significantly reducing the size and weight of the laser relative to the competition. The Chrys surgical laser incorporates a 25W (at tissue) carbon dioxide (CO_2) laser into the industry's smallest full-function surgical laser package.

CLI has patented (and has additional patents pending on) the 'matrix laser' technology, which is based on the concept of a multiply-folded waveguide resonator for gas lasers. A common monolithic slab of stable material is used to maintain the laser resonator precisely, with no tolerance stackup problems, and simplified laser resonator mirror alignment. This structure allows the laser power to be scaled with area rather than with length. Such a concept could be extended into a three-dimensional array of folded resonators, to achieve very high laser power in a small volume package.

Advantages of the CLI laser concept are significantly smaller size, lower cost, manufacturability in high volume, higher power capability (for a given size package), long-life sealed-off operation, and extremely low maintenance due to the unit's ruggedness. The concept is applicable to any hgh-gain gas laser system.

The Chrys carbon dioxide surgical laser produces 30W, generated in a laser head measuring a few inches on a side; this power level usually requires a laser head length of 30" or more. CLI has developed matrix laser manufacturing technology, and proved that these lasers can be assembled reliably in typical medical laser startup volumes.

Further information is available from Laser Electronics (Operations), PO Box 359, Southport 4215 or phone (075) 53 2066.

Electronics Australia

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Vintage Radio

by PETER LANKSHEAR

Vintage remote control

Today, wireless remote control of domestic electronic equipment is commonplace, but before the advent of solid state and digital technology, this concept was generally in the realm of science fiction. However, even 50 years ago, there were remarkable exceptions – including American Philco's two radio controlled receivers.

Included in the Philco 1939 range were two console broadcast receivers, the 14 valve 39-116 and the slightly less elaborate 11 valve 39-55, which were capable of remote operation from a small control box. This provided a selection of 8 preset stations, volume control and switch off. Today this specification would be considered to be minimal, but when it is realised that this was achieved with a control unit containing a single triode valve, we can only be impressed by Philco's engineering ingenuity.

Both models were housed in austere but handsome cabinets, that could be the centrepiece of any collection. In 1939, with import and tariff controls firmly in place, few of these receivers would have been imported into Australasia, and to find one today would be quite an achievment. It seems that Beggs, the New Zealand franchised Philco dealers, procured two for display at the 1939/40 Centennial Exhibition. One of this pair, a 39-55 has survived.

Telephone dial control

In the pre-semiconductor and digital era, the universal control system was the combination of the mechanical pulse generator dial and electro-mechanical stepping selector or 'Strowger' switch used for the automatic telephone. This technology was the basis of the ingenious Philco 'Mystery Control' remote control.

The controller is contained in a wooden box about 230 by 180mm, topped by a large rotary telephone type dial. Inside is room for batteries, the dial mechanism and a one valve oscillator, its 150mm-diameter coil acting as a transmitting loop aerial.

Two receivers in one

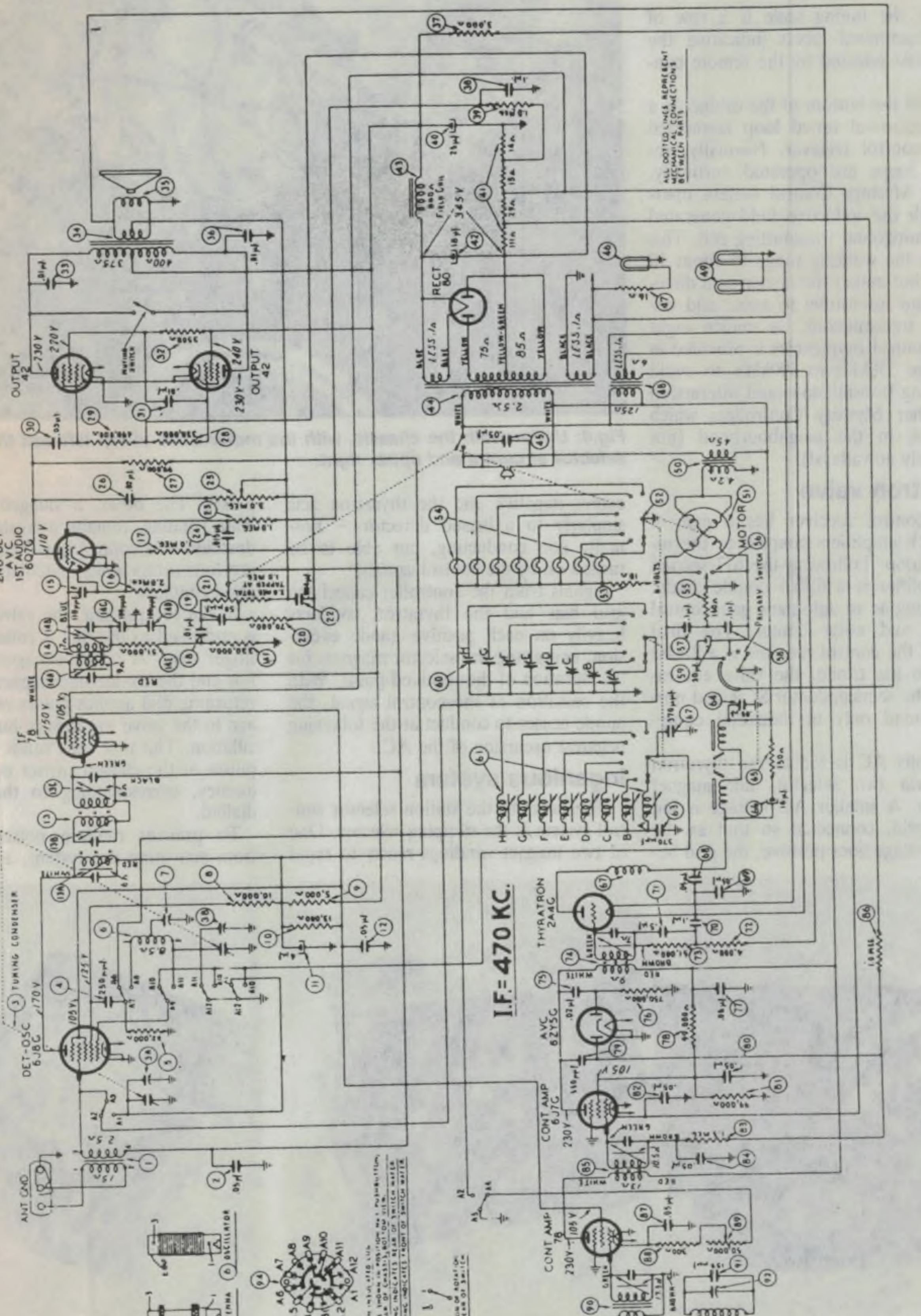
The console cabinet houses a chassis incorporating two receivers. At one end is a special purpose TRF which I will describe shortly. The main receiver is a more or less standard superheterodyne, similar to push button tuned radios of the period.

Of interest is the push-pull output stage with an early example of negative feedback tone control. Whilst the 39-166 used a conventional triode phase splitter, the 39-55 derives the drive for the second output valve from the screen grid of its companion, as can be seen. The feedback for the tone control is taken from a tapping on the secondary of the output transformer.

At each end of the tuning scale are two edge driven knobs controlling tone, volume, tuning and the remote/manual switch. With the exception of the volume control, manual operation is conventional.

The volume knob activates a switch controlling a bi-directional motor, connected through a gear train to a standard 'pot' with mains switch. Upwards pressure on the knob raises the volume. Downwards pressure reduces volume and if sustained, eventually switches the receiver off.

Fig.1: The well-proportioned 39-55 reflects the awareness, by 1939, of the need for a shallow cabinet in avoiding the worst resonances. This plus a 12" speaker and push-pull audio amplifier with negative feedback results in good sound reproduction.



The main circuit. Note the push-pull audio amplifier, with its novel phase splitting system and negative feedback. The control receiver section is at lower and centre left.

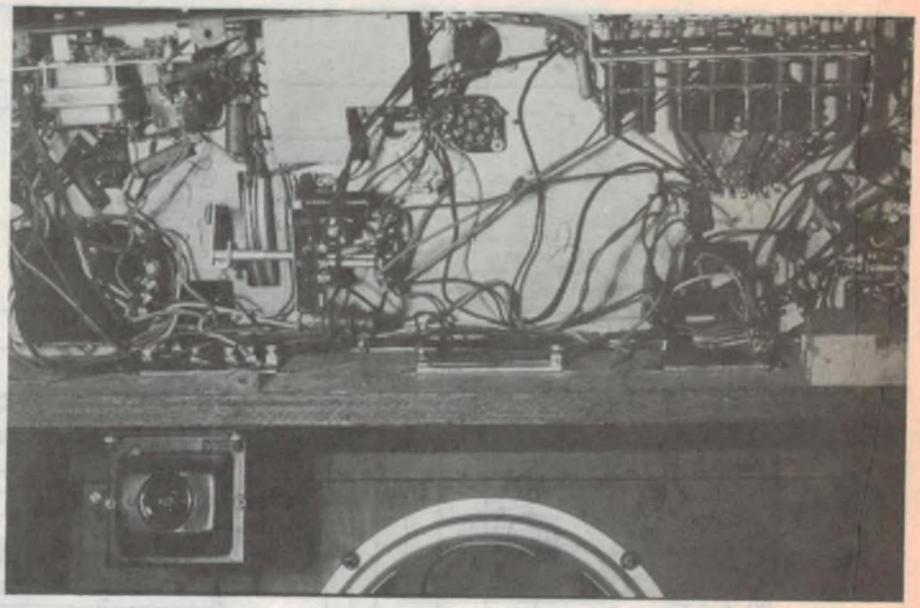


Fig.4: Underneath the chassis, with the motor drive at top left and the tuning selector at centre and upper right.

Below the tuning scale is a row of eight illuminated labels indicating the station last selected by the remote control.

Around the bottom of the cabinet is a large horizontal tuned loop connected to the control receiver. Normally, receiving loops are operated vertically, but the Mystery Control system operates with the inductive field generated by the horizontal transmitting coil. This confines the working range to about 10 metres, but makes the system non directional and insensitive to noise and unwanted transmissions. A choice eight preset control frequencies is provided in the range 350kHz to 390kHz, to avoid interfering transmissions and interaction with other Mystery Controllers which might be in the neighbourhood (not very likely nowadays!).

Thyratron valve

The control receiver has a pair of tuned RF amplifiers coupled to the receiving loop. Following the 6J7 second RF amplifier is a 6ZY5 double diode, functioning as an automatic gain control rectifier and noise limiter. The final valve of the control receiver is a 2A4G thyratron gas triode, the valve equivalent of the semiconductor SCR and normally found only in industrial equipment.

110 volts AC is fed to the thyratron anode via two selector unit magnet windings. A smaller AC voltage is fed to the grid, connected so that as the anode voltage goes positive, the grid becomes negative and the thyratron acts similarly to a biased detector – normally non conducting, but able to be turned on by the control signals.

Signals from the controller cancel the grid bias and the thyratron conducts heavily on each positive anode excursion, energising the selector magnets for the duration of the received pulse. With the cessation of the control signal, the anode ceases to conduct at the following negative excursion of the AC.

Ingenious system

The heart of the station selector control system is the stepping selector. One of two magnet windings reacts to rapid pulses. The other, a slugged slow release winding, remains activated for the duration of a control signal train. There are four rotary arms matched by sets of fixed contacts.

In the control unit, the valve filament is energised as the dial is rotated to the finger stop. A clutch engages a governor and the contact mechanism, and the returning dial applies pulses of HT voltage to the valve to produce bursts of oscillation. The unit thus sends a train of pulses at the chosen carrier control frequency, corresponding to the number dialled.

To prevent random noise impulses from activating the system, a single re-

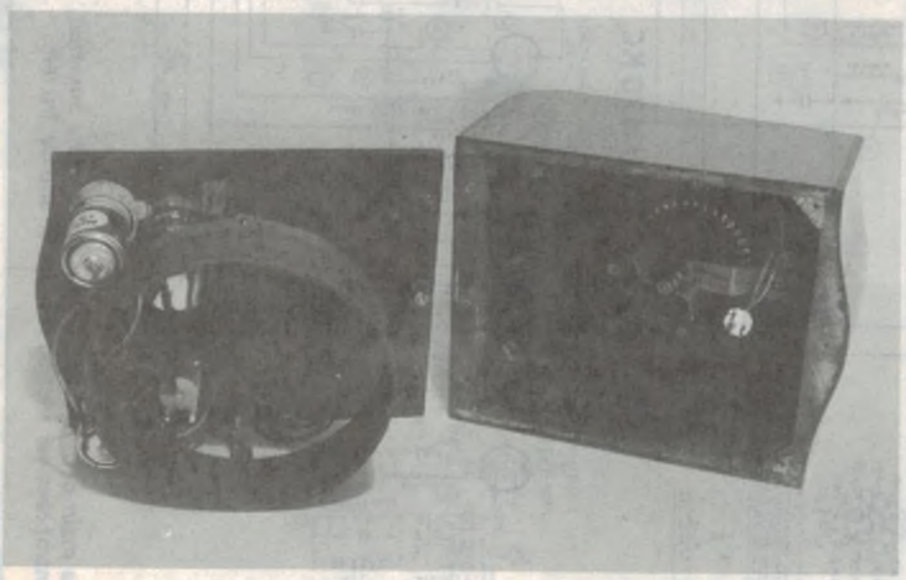
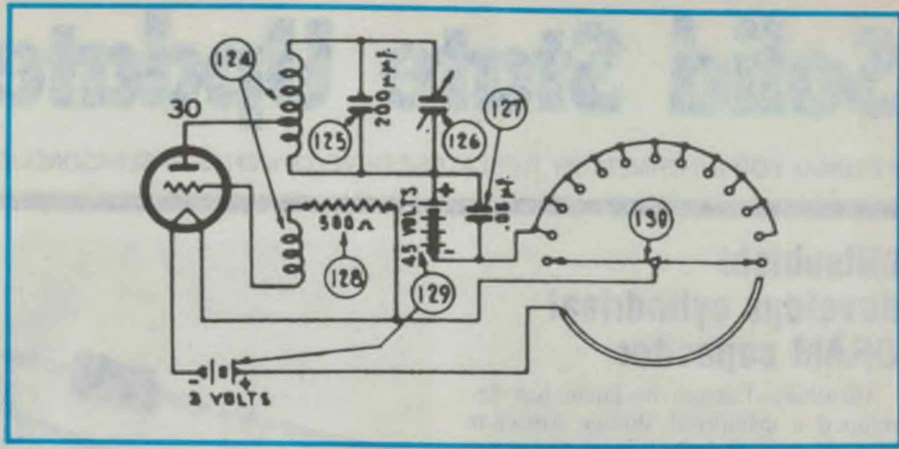


Fig.3: Inside the controller, with the dial in the lid and the oscillator in the base. The oscillator coil is also the transmitting loop.

Fig.2: The control box – designed for table operation rather than hand holding!

ceived pulse steps the selector switch to the first contact, which is blank. Consequently an extra pulse is added to all trains. At the commencement of a train, the slow release magnet engages the selectors. A mechanical interlock permits the first three pulses to activate only the volume control selector. Four or more pulses return the three station selectors to the first station position, and then step them round to the position dialled.

As the selector arms come to rest on the contacts associated with the required station, one set switches various preset capacitors for aerial tuning. The second set similarly switches inductors for the local oscillator tuning, while the third set switches the indicator lamps. The arms remain in position until reset by the controller.



The control transmitter circuit — a simple 1-valve oscillator pulsed by a telephone-type dial.

Volume control

Control of volume with the first selector section is very ingenious. The finger stop on the dial doubles as a push button. If this is depressed during dialling, the transmitter produces a continuous carrier at the conclusion of a pulse train. This has the effect of holding in the slugged magnet of the receiver's selector, holding the volume selector in position.

If the selector is on contacts 2 or 3, the volume control motor is energised for as long as the push button is pressed. Contact 2 (the 1st dial position) raises the volume. If the button is held down long enough on the 3rd contact, as well as reducing volume, the motor will operate the on/off switch and the receiver will be switched off.

Unique effort

The system is surprisingly reliable, with a similar range to a modern infrared controller, but the Mystery Controller has one advantage. It is able to operate through walls!

Although wired remote control systems were common, I know of no other wireless radio controllers, and Philco itself did not perpetuate the system. By 1939, television was taking off in America and World War II was just around the corner. Engineers with the ability to design the Mystery Control would soon have been engaged in less frivolous activities.

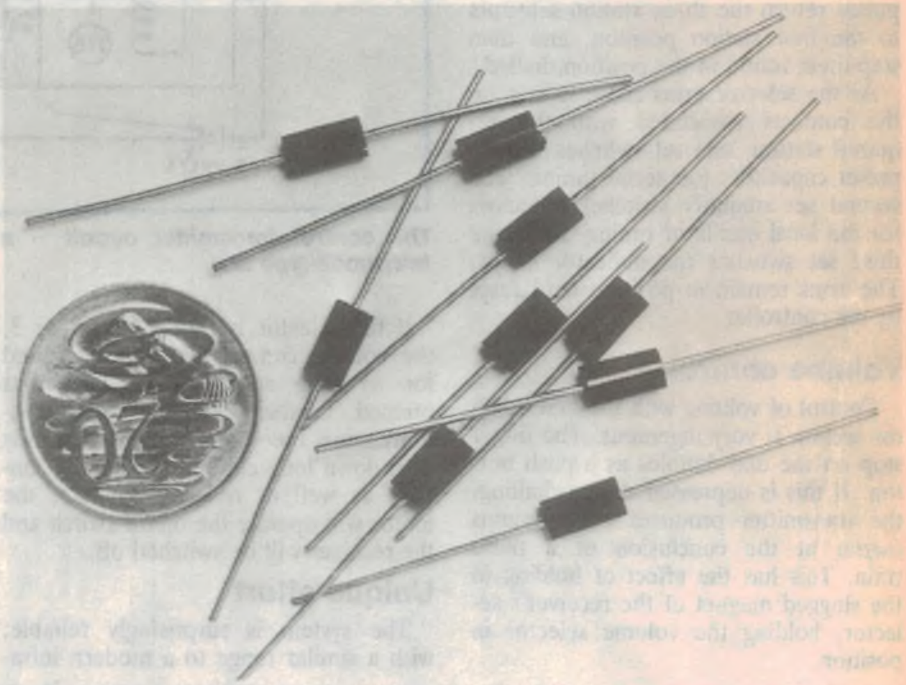
Solid State Update

KEEPING YOU INFORMED ON THE LATEST DEVELOPMENTS IN SEMICONDUCTOR TECHNOLOGY

Mitsubishi develops cylindrical DRAM capacitor

Mitsubishi Electric in Japan has developed a cylindrical storage capacitor with an area of only 1.5um^2 and a capacitance of over 30fF (femtofarad), a capacitance/area ratio more than double that available from the T-shaped capacitors used in the company's 16Mb DRAM. As a result the new structure is said to be suitable for memory cells in a future DRAM of 64 megabits capacity.

The cylindrical structure used for the capacitor is formed by depositing a nitride layer on the SiO_2 film using CVD, and then etching using both plasma and wet etching processes. The current structures measure 1.5um in diameter, with a wall thickness of 0.2um and a height of 1.5um; this gives a capacitance of 35-40fF. The projected dimensions for a 64Mb DRAM are about 0.75um diameter, with a thickness of 100nm.

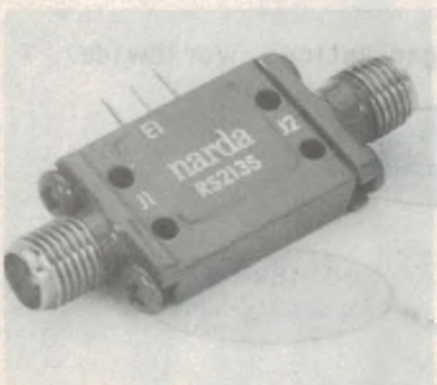


Silicon surge suppressors

Transhield, a range of silicon surge suppressors from Lucas Industrial Measurement are purpose-built silicon devices which clip voltage transients and are therefore normally connected in parallel with the equipment or circuit they are intended to protect. Because under non-surge conditions they exhibit a high impedance, the normal operation of the equipment is unaffected.

The suppressors, which have sharp breakdown voltages, low slope resistances, fast response times, high surge capability and long-term voltage stability, are available with breakdown voltages between 6.8V and 440V (higher breakdown voltages can be supplied). They are available in four electrical configurations and in five basic body outlines.

Further information is available from Multicorp, 35 Wells Street, Redfern 2016 or phone (02) 698 5238.



Miniature drop-in pin switches

Narda has introduced drop-in SPST and SP2T hermetically-sealed PIN switches with removable SMA connectors.

Models RS213S, RS213Ds, RD123S, and RS123DS are designed to operate in a drop-in configuration up to 18GHz. Units can be purchased with or without integral hybrid drivers.

For specifications on Narda's complete PIN switch product line, contact Anitech, 1-5 Carter Street, Lidcombe 2141 or phone (02) 648 4088.

1 Mb,512kb CMOS EPROMs

With the addition of the new UV-erasable devices, National Semiconductor's line of high-performance CMOS EPROMS now spans all densities from 16k to 1-megabit.

The new 1-megabit CMOS EPROM, designated the NMC27CO10, is organised in a 128K x 8-bit configuration. It is offered in four different access times ranging from 150 to 250 nanoseconds. Plans call for a second 1Mb EPROM organised in a 64K x 16-bit configuration, to be qualified shortly. Both devices will be offered in 120ns.

National's NMC2751A, meanwhile, is a 512K CMOS EPROM organised in a 64K x 8-bit configuration. Available now in access times ranging from 170-250 nanoseconds, plans call for the device to also be offered in 90, 100, 120 and 150ns access times soon.

The fast access times of the new CMOS EPROMS are achieved via clocked sense amps featured in the devices. Power consumption for both the 1Mb and 512K EPROMS is 110mw maximum and only 55mw while in standby mode.

For further information, contact IRH Components, 32 Parramatta Road, Lidcombe 2141 or phone (02) 648 5455.

Fast settling dual op-amp

National Semiconductor's new LM6218 fast-settling dual operational amplifier is the latest addition to a growing family of high-speed analog products built with the company's VIP (vertically integrated PNP) technology. The process provides the new dual op amp with major performance advantages in the areas of precision, speed, and bandwidth.

The LM6218 uses slew enhancements with a unique mirror circuitry to achieve 0.01% settling time of 400ns. This opens up applications in data-acquisition systems where 12-bit precision is required.

In addition, the LM6218 offers a better open-loop gain of 500,000, a lower offset voltage of 3mV and improved input bias current than earlier VIP products like the LM616/4/5 op amps and LM6121/5 buffers. Its slew rate is 140V/us, and its unity-gain bandwidth is 17MHz.

Solid state relay

The Potter & Brumfield model EOMZ is a low cost, 15A RMS 'Hockey Puck' style solid state relay. It is footprint and mounting compatible with Potter & Brumfield's SSRT and SSR series and other competitive 'Hockey Pucks'.

Features of the EOMZ include 0.02 to 15A RMS output, 3 to 32 V/DC input, zero or random voltage turn-on and 4000V RMS optical isolation.

Typical applications include on and off control of AC loads such as motors, generators, lights and heaters.

For further information, contact Tecnico Electronics, 11 Waltham Street, Artarmon 2064 or phone (02) 439 2200.

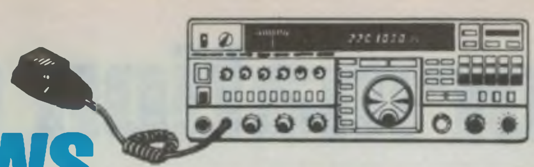
Low-noise CMOS op-amps

The TLC2201 op-amp from Texas Instruments combines the noise performance of the lowest-noise JFET amplifiers with the DC precision available previously only in bipolar amplifiers.

Using TI's advanced LinCMOS process, these devices have input impedance levels that meet or exceed levels offered by topgate JFET and expensive dielectric-isolated devices. They can operate in either single-supply or split-supply configurations.

Further information is available from Texas Instruments, 6-10 Talavera Road, North Ryde 2113 or phone (02) 887 1122.

Amateur Radio News



Help in watching for intruders

From the new WIA Federal 'Intruder Watch' Co-ordinator Gordon Loveday VK4KAL comes a request for assistance from Australian amateurs, whether WIA members or not, in monitoring the exclusively-amateur HF bands for detection of transmissions by government, commercial and military services.

This monitoring is carried out throughout the world as part of International Amateur Radio Union (IARU) activities, and is administered by the WIA in Region 3.

VK4KAL is interested in hearing from any amateurs who can devote as little as 1 hour per week to monitoring. SWL's are welcome also. Information required includes frequency, time (UTC), date, mode if known, and identification if possible.

Full information and log sheets are available from A.G. Loveday VK4KAL, 'Aviemore', Rubyvale 4702.

Amateur MicroSats being launched

Six new amateur radio satellites are due to be launched into orbit this month on November 10, from the European Space Agency in Kourou, French Guiana, via a powerful Ariane IV rocket.

Four of the new satellites have been dubbed 'MicroSats', because of their unusually small cubic dimensions – 9" on a side. This makes them tiny by

Contacts through ground-based repeaters are not permitted, although simplex contacts can be pre-arranged via repeaters. Each WIA member worked on either the 30 metre, 17 metre and 12 metre bands will count as two contacts, for the award.

For the contact to be valid, it must include the WIA membership number of the member involved, and the number must be logged. This number can either be the one which appears on the WIA membership certificate, or the 6-digit number on the address label of the WIA journal *Amateur Radio*, sent to members each month.

To claim the award, a log extract must be submitted showing the callsigns and membership numbers. Claims should be made to the WIA 80 Award Manager Ken Gott, VK3AJU, 38A Lansdowne Road, East St.Kilda, Victoria 3183. The cost is A$5.00 for claimants in VK, P29, ZL and Oceania. All others should submit US$5.00, or eight IRCs.

New prefixes in the Pacific

The ITU has allocated the call prefix V6 to the Federated States of Micronesia, which were formerly one of the users of the KC6 prefix. Amateur stations will use callsigns from V63AA to V63ZZ.

Also the call prefix V7 has been allocated to the Republic of the Marshall Islands (formerly KX6). Amateurs will use callsigns from V73AA to V73ZZ.
comparison with the huge military and commercial satellites, and they are said to represent the state of the art in terms of low cost and high efficiency.

The design and construction of these MicroSats has been co-ordinated by the Radio Amateur Satellite Corporation (AMSAT), in collaboration with the ARRL and the Tucson Area Packet Radio Association – all non-profit organisations dedicated to furthering the state of the art in amateur radio communications.

AMSAT has been responsible for the design and construction of numerous OSCAR satellites over the past 20 years, and last year organised the successful launching of OSCAR-13.

The MicroSats represent a major departure in design philosophy from previous satellites, which were getting larger and heavier. Until recently launching was provided essentially free of charge, but nowadays AMSAT has to pay the full cost.

WIA 80 Award

A special award is being offered to mark the 80th Anniversary of the Wireless Institute of Australia, which is in fact the world's first and oldest national radio society.

The award is open to all radio amateurs and shortwave listeners, and will operate from November 1, 1989 until December 31, 1990. To qualify for the award, those living in Australia (except VK9 and VK0) need to contact (log) 80 members of the WIA. All others need contact only eight WIA members.

Information centre

Conducted by Peter Phillips

Now for the answers!

In the August edition I presented quite a few reader enquiries in the hope other readers could assist. I have since received a number of responses, particularly on portable fluorescent lamps and plant watering systems, so I'm pleased to be able to present some of these letters. There are also numerous letters on the topic of 'Who invented radio', again replies to a question posed by a reader. So thanks for the response – it's nice to get a few answers for a change.

On the subject of reader letters, I also have several that are somewhat outside the intended scope of this section of the magazine. It seems a few readers think we at *EA* not only have the time, but the capacity to provide technical answers for almost anything. Oh! that this was the case...

Sorry folks, but we can only help with *EA* projects, and then only if you send us $5.00. We have to draw the line at projects from other magazines, kits that have never been published in *EA* and particularly the general 'please help' questions on how to modify, adapt or interconnect commercial appliances. Unfortunately there are only 24 hours to a day.

Also I again ask those requiring technical help to refer to the Reader Services inset, usually printed on the last page of the magazine. Quite a few readers think that all they need supply is a stamped address envelope for us to provide a written reply. All we will do in this case is consider your letter for inclusion in these columns, which, on reflection, must be worth at least 41 cents anyway. So keep writing, I value your letters and hope that the constraints we have to make are not too onerous.

FM microphone

The first letter concerns the FM microphone published in June. Remember that edition? It has my son on the front cover, grasping the prototype microphone. The letter raises a problem that the kit suppliers, Oatley Electronics are aware of. Here's the letter:

I write after having constructed the 'improved' wireless microphone kit. On testing the unit, I found that its performance was very much less than expected.

The unit certainly modulates and radiates, but I found that it plonks out signals on three or four spots across the FM band, and adjusting the variable capacitor seems to make very little difference to the tuning. Also RV1 seemed to make little difference to the audio level obtained, which was very weak. Oatley Electronics were unable to supply the correct unidirectional mic insert, so I used an omnidirectional one I ratted from an old tape recorder. (K.P., Willetton WA)

I contacted the proprietor of Oatley Electronics, who has advised me that the first 15 or 20 kits sent out had the wrong ferrite cores due to a mistake by the wholesaler. These cores can be identified by having a slot *across* the axis of the core, rather than in line with the axis. Any constructor who has purchased a kit with the wrong cores, and has accordingly encountered the same problems, can ring for a free replacement. Also, I am advised that supplies of the electret microphone insert are now in stock.

I have also been urged by the proprietor to ask readers to refer any problems concerning Oatley Electronics' kits directly, rather than to *EA*. The reason is probably fairly obvious, but readers may not be aware that Oatley Electronics provide a full back up service, including repair or fault finding of any kits sold by them. For this reason, some of the projects produced and sold by Oatley Electronics are printed without the PCB pattern, in the form a proprietary project. We at *EA* certainly don't mind – it gives us more time to concentrate on our own projects. OK, now for some horticulture.

Watering systems

I have a number of letters answering reader requests about watering systems, including one from England. But first I have to admit to having mislaid the address of a correspondent whose letter was published in these columns in the June 1989 issue. The correspondent is now known only to me as B.H., from Sway Gap WA. If Mr B.H. could contact me at the magazine, I would be pleased to pass on a letter I have received offering assistance to his enquiry concerning adapting an IBM computer to control a reticulation system. Alternatively, B.H., or anyone else with a similar need could contact Cas Systems, 13 Downing Street, Brighton, 5048, or phone (08) 296 6816 after 7.00pm. My apologies to both B.H and Cas Systems for my inefficient filing system.

By now, B.S., of Bungendore NSW (correspondent to these columns in the August edition) will have received a pile of replies I have forwarded to him concerning his question about some form of moisture sensor to control a misting system in his greenhouse. The letter from England contained two project articles from, I suspect, an English electronics magazine, as well as some components to allow B.S. to construct these projects. Not bad, eh!

Our thanks to B.M. from Middlesex, England. This correspondent also wonders if there are any other *EA* subscribers in England.

Included in the replies are a range of suggestions, one of which was mentioned by several readers. I will present this idea, as submitted by one of the writers, as it is a rather simple solution to the problem of sensing moisture:

A possible solution to sensing moisture is to use a mechanical method rather than an electronic one. The moisture sensor consists of a paddle, approxi-

mately the size of a table tennis bat, constructed from fencing wire with a fly wire mesh as the surface of the bat. The bat is then fixed to one end of an arm made from tubing, while at the other end of the arm a counterbalance weight is attached. The whole assembly is then pivoted and the weight adjusted so that the paddle is barely in the 'up' position. A mercury switch is also fitted to the arm, arranged so that it is 'on' when the arm is up.

When the sprinkler system is turned on, moisture will collect on the paddle, and once sufficient water has been trapped by the mesh, the arm will fall, opening the mercury switch. After a while, the water will evaporate from the paddle and the arm will return to the up position.

Obviously the mercury switch needs to control a solenoid valve, probably via a suitable relay. (N.J., Kilsyth Vic)

Thanks to N.J. for this idea. Another correspondent, namely B.J. from Nambucca Heads, NSW, suggests the same idea, and mentions that he has seen it in operation at a local commercial nursery. He also uses this scheme himself, with great success. Simple but effective.

Other ideas sent in include electrodes immersed in a pot of earth and the use of a commercial moisture detector. There are no shortage of methods, it seems.

The next pile of letters refer to another question raised in the August issue.

Portable fluorescent lights

Following the request by P.B. of Rockhampton for information concerning the operation and repair of a 12V fluorescent light, several letters have arrived confirming similar problems with such devices. It seems the reliability of portable fluorescent lights leaves a lot to be desired. The correspondents all agree that repair is generally impossible, and that the transformer is usually the problem.

It also appears that *EA* has never published such a project, unlike some of our competitors. I hope to rectify this, and I have already put out a few feelers to source the transformer that would be needed. The circuitry is not difficult, and such a project is no doubt likely to be popular. However, a suitable transformer is required, at a reasonable price.

The good news is that I may have found the answer. So for now, keep reading *EA*, and hopefully we will come up with a 'home brewed' circuit that will be more reliable than the commercial models.

Velocity factor

The next letter starts by asking a question, but really provides not only an answer but food for thought on the topic of transmission lines.

Is the velocity factor of 'air dielectric' coaxial cable affected by air humidity? This question arose when I trimmed a section of low loss 75 ohm cable to resonance as indicated by minimum reflected power. The frequency of operation was in the 70cm band, and I performed the task in the shack where the temperature was around 5° higher than outside, meaning the humidity was therefore probably lower.

But when I tested the cable in free air outside, on a high humidity, drizzly day, the resonance of the cable was about 3MHz lower than that previously obtained.

Returning to the shack, I took measurements from the tip of the plug to the other end of the coax (actually the braid had been removed) and found the velocity factor to be around 0.63. When the cable was installed in its final location (outside, in the higher humidity) and retrimmed to resonance the velocity factor, using the same measuring techniques, came out to be 0.66.

Probably other factors were contributing, but it will be interesting to see if a seasonal drift of resonance occurs! (I.C., VK5KIC)

Velocity factor is a term radio transmission devotees would know, but I have to admit to resorting to a reference book to refresh my memory. The term refers to the reduction in the speed of transmission of electromagnetic waves, caused by the dielectric in a transmission line.

In free air, or more correctly, a vacuum, the velocity of a radio wave (and light) is equal to 3×10^8m/sec. The dielectric constant of a vacuum is unity, and other materials have a higher dielectric constant depending on their nature. It is the dielectric constant of the materials used in a transmission line that causes the velocity of the wave to reduce, giving velocity factors of 0.9 down to 0.6.

The important point is that as velocity is equal to frequency times wavelength, any change in velocity, assuming frequency remains constant, will result in a change in the wavelength. This becomes important where a piece of transmission line is being used as a *stub* to tune out the reactive component of the terminating impedance. It is this situation I suspect I.C. is referring to.

Interesting stuff, and very complex if you need to get into the maths of the whole topic. Whether I.C. is right about the effects of humidity on an 'air dielectric' cable I don't know, although it sounds feasible. Anyone with more knowledge of this?

Who invented radio?

Again I refer back to the August issue, in regard to a question by B.H., from Dapto NSW. The question is, who invented radio? As one writer puts it, 'A learned discourse on this subject could fill many pages of your excellent magazine, for many issues...'

Because space is limited, here is a brief summary of the main points from the various correspondents who have written to me on this topic.

All of the correspondents agree that no one person can be held responsible, and they all attribute Marconi as merely one of the developers. As R.M., from Newcastle NSW puts it, 'Marconi can be no more attributed to inventing radio that Sir Isaac Newton can be to inventing gravity.' Rather, R.M. suggests Marconi merely used vision to correlate the efforts of others into a 'shrewdly calculated and commercialised venture.'

Another correspondent offers a summary of events concerning the development of radio, which I have condensed as follows:

Who invented radio? Indeed nobody invented it – it simply evolved. In 1863 Maxwell suggested the existence of electromagnetic waves. In 1866 Johannes Sorenson sent wireless signals to a ship anchored offshore. His report was treated as a joke, but the original equipment was later found in 1933, tested and found to work. Sorenson was then posthumously knighted by the King of Denmark.

Then, in 1887, Sir Oliver Lodge produced short waves, one year earlier than Hertz. At the time, the discovery was not announced, as the British Admiralty wanted it kept secret, although later Lodge was granted a patent. In 1893, Tesla produced long waves, and forecast the possibility of wireless communication. In 1894, Lodge demonstrated his 'Etheric wireless telegraphy', while later in the same year Marconi sent the first recorded messages through space.

The following year, Alexander Popov, using Hertz's oscillator connected to a coherer (invented by Branly), demonstrated the transmission of messages by wireless. In 1897, Marconi claimed to be

Information Centre

the first to transmit signals between ships at sea 20km apart. Tesla demonstrated radio control of a model boat in New York, in 1898. In the same year, the British Admiralty released details of Lodge's system, and Lodge was subsequently knighted in 1902. Finally, Marconi shared the Nobel prize with Karl Braun in 1909. (K.J., Nelly Bay Qld)

I have also received a very good description on Dolby A, B and C, in response to a reader question in the August edition. I hope to present this letter next month, but for now I need to take up the remaining space with some errata that has come to our attention.

House alarm errata

The following letter, much condensed from the original, is from a correspondent who attempted to construct the Two-sector House Alarm published in the April 1989 issue. It seems there are a few errors in the article which need sorting out. First, here's the letter:

I am writing after having just put together the Two-Sector House Alarm presented in the anniversary issue of your magazine. I am no electronics expert, although over the years I have constructed about a dozen projects, most of which went quite nicely when completed. After purchasing the kit from Altronics, I was concerned to note that the kit did not include the siren or the momentary push button. Altronics have since advised me that the siren is not a part of the kit, and that EA has incorrectly created an expectation in the minds of constructors.

However, when I started to construct the kit, I began to find several anomalies. In summary, it seems the photo of the prototype, the circuit, the layout diagram and the parts list all disagree with each other. For example, where's C14 on the circuit? Is C14 correctly polarised on the layout? What are the values of C1 to C4, and how about C13? And what about the unlabelled components and the link (next to RLB) shown in the photo of the prototype?

I have since figured a few things out and finally built the unit. However, I read 13V at the anode of D16, not 16V as shown, and I need to leave the two 47k resistors in series with the sensors for the alarm to trigger. Also, I only get a 6-second delay on the entry delay circuit. But when I try the panic button, before turning the key to the 'armed' position, I find it won't latch on and IC1 gets very hot if I hold the button on.

Any suggestions? In fact I think I've done very well getting this far, considering all the mistakes. I think this is evidence of the slapdash attitude that is turning hobbyists away from kit building, and for me, building projects from your magazine. It seems to me that you are not really checking these things out thoroughly enough before going to print. I know kit suppliers carry some of the responsibility, but it is your magazine, and you reap the benefits of good projects. (T.A., Ascot Vale Vic).

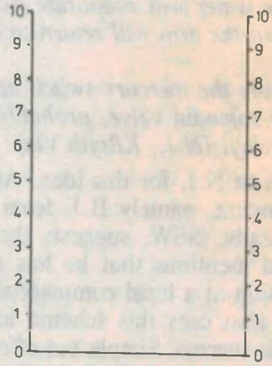
It is difficult to justify ourselves with this one, as indeed there are a few problems. The project was supplied to us virtually ready to print by Altronics. We would normally be far more involved in a project supplied by a contributor, in that we would organise all the diagrams and the checking thereof. The completeness of this particular project as presented meant we had far less than our usual involvement, and therefore little to flag possible errors.

I agree with T.A. that this is no excuse, although I hope he won't feel so disenchanted to no longer try any other projects we produce. As an *EA* staff member, I can certainly attest to the amount of checking that goes on, and of the number of mistakes we do find. But it seems we let our guard down at the wrong time, in an attempt to publish our largest edition ever. Anyway, here is a list of errata supplied by Altronics.

The diode at pin 11 of IC2d is D3, type 1N4148; D16 is type 1N4002; D13 is shown incorrectly orientated on the layout; the resistor below RV4 on the layout is R23; C1 to C4 are all 1uF tantalum, not 0.1uF as shown on the circuit diagram; C11 should connect to earth, not +12V as shown on the circuit; C13 is a 1uF tantalum; C14 is a 100uF electrolytic across R22, +ve to 12 rail and is incorrectly orientated on the layout. The link adjacent to RLB on the photo is not needed, it was only for development purposes. Also, the outline shown for Q6 on the layout diagram is not intended to suggest that Q6 is a different package to the other transistors.

The 16V value indicated on the circuit will be read at the cathode of D16, not the anode as shown on the circuit. A 47k resistor needs to be across the inputs for the alarm to function correctly.

What??



Here's an 'oldie but a goodie'. Using the nomogram shown, determine the parallel combination of a 2.2k and a 4.7k resistor. No calculators now, just a ruler and pencil.

Last Month's What??

The answer to last month's teaser is R1 = 125 ohms, R2 = 250 ohms. Here's how I found the answer... (Note that '//' means 'in parallel with').

1. Let R2//500 = Rx and R1//500 = Ry. Using the voltage ratios given, R1/Rx = 3/4 = 0.75, meaning R1 = 0.75Rx. Similarly, R2/Ry = 5/2 = 2.5 and R2 = 2.5Ry.

2. Using the equation to find the resistance of two parallel resistors of product/sum, Rx = (500R2)/(R2+500) and Ry = (500R1)/(R1+500). OK, now to put this all to work.

3. Because R1 = 0.75Rx, R1 = 0.75(500R2/(R2+500)). This gives R1 = (375R2)/(R2+500). Rearranging this equation gives R1R2 = 375R2-500R1.

4. Using the same process, this time using the relationship of R2 = 2.5Ry, we get R1R2 = 1250R1-500R2.

5. This means 375R2-500R1 = 1250R1-500R2, which resolves to give R2 = 2R1. Putting this relationship into either of the equations of steps 3 or 4 will give the values of R1 (125Ω) and R2 (250Ω).

That is, a 47k resistor should be in series with a normally closed sensor, and a 47k resistor should be connected across a normally open sensor. Note that these resistors should be mounted at the sensor for best security, not at the PCB.

The entry delay is governed by RV3 and C6. Unfortunately, the tolerance and leakage of electrolytics make them unsuitable for timing applications. Therefore, C6, C7, C9 and C13 should be either tantalum or low-leakage types.

RV4 should have a 10k resistor fitted in series. This gives a minimum alarm time, otherwise there is no alarm with RV4 set to zero. Resistors R20, R21 and R26 should be changed from 2.2k to 10k, to limit the gate output current.

There is no reason why IC1 should get hot when the panic button is held down, as the logic is correct. In regard to the kit, the piezo siren is not included, and future kits will incorporate the changes described.

NOTES & ERRATA

TELETEXT TUNER MODULE

(August 1989): Due to large increases in the import cost of components used in this module, with the second shipment received, Dick Smith Electronics has been reluctantly forced to increase the cost of the kit (K-6361) from the previous $69.95.

Although the new price would normally be around $150, the company has decided to absorb much of the increased cost and offer the kit at a more reasonable $99. DSE apologises for the need to implement the rise, which is due to factors beyond its control.

TELETEXT DECODER TUNER MODULE

(August 1989): The PC board for this module (code ZA-1667) contains a small error. The junction of ZD-2, C1 and C2, a 'D'-shaped copper area, is currently not grounded. It should be connected via a link to a suitably grounded point, such as the case of the tuner module. (File: 6/MS/25)

PC-BASED FRAME GRABBER

(August 1989): In Fig.6, U24 is wrongly marked as U10; also the PIXCLK signal is wrongly marked /PIXCLK. In Fig.9, the /COMID signal is wrongly marked as /COMIDO; also pin 9 of U3 needs to be labelled /ACTIVE LINE. In Fig.8, U17 is wrongly marked as U6; U6 is wrongly marked as U18; U18 is wrongly marked as U5 and U5 is wrongly marked as U17; also PIXCLK is missing from pin 2 of U5, U17 and U18. In Fig.12, /INC should connect to /EN245. In the Interface Specification panel, /CLEAR should relate to bit 4; similarly /OE (A to D) should relate to bit 5; also Free Run Mode should read 33H instead of 53H. In the parts list, U30 (a 74LS368) was omitted.

RGBI-PAL ENCODER

(August 1989): There is an error in the PCB pattern (89rgb8). Pin 3 of IC1, which is shown connected to pin 4, should be connected to pin 5 as shown in the circuit schematic. Pin 4 should be connected to the 5V supply rail, again as shown in the schematic.

PLAYMASTER 30-30 AMPLIFIER

(August 1988): Contrary to the previous erratum suggesting that the PCB contained 11 wire links rather than the published figure of 10, there are in fact 13 links to be installed. (File: 1/SA/81)

IMPROVED FM MICROPHONE

(June 1989): To prevent possible instability, each end of RFC1 should be bypassed to the ground plane with a 10nF ceramic capacitor, fitted as close to RFC1 as possible. (File: 3/MS/142)

50 and 25 years ago..

"Electronics Australia" is one of the longest running technical publications in the world. We started as "Wireless Weekly" in August 1922 and became "Radio and Hobbies in Australia" in April 1939. The title was changed to "Radio, Television and Hobbies" in February 1955 and finally, to "Electronics Australia" in April 1965. Below we feature some items from past issues.

RADIO AND HOBBIES IN AUSTRALIA

November 1939

Experimental Television in Natural Colours: On July 27 a very great advance in television technique was demonstrated by Mr J.L. Baird at his laboratories in Sydenham (UK). Here for the first time was shown television in natural colours, using at the receiver a cathode-ray tube.

The apparatus used by Mr Baird is of a totally different type from that employed by the BBC, and at present can only be considered as a very successful experiment which may in the near future be used for cine-television, but will certainly not be introduced into the normal television service for many years.

The system used a spotlight with a rotating colour filter disc and mirror drum to scan the subject before a bank of photocells, with a rotating colour filter in front of the cathode-ray tube of the receiver.

RADIO, TELEVISION and HOBBIES

November 1964

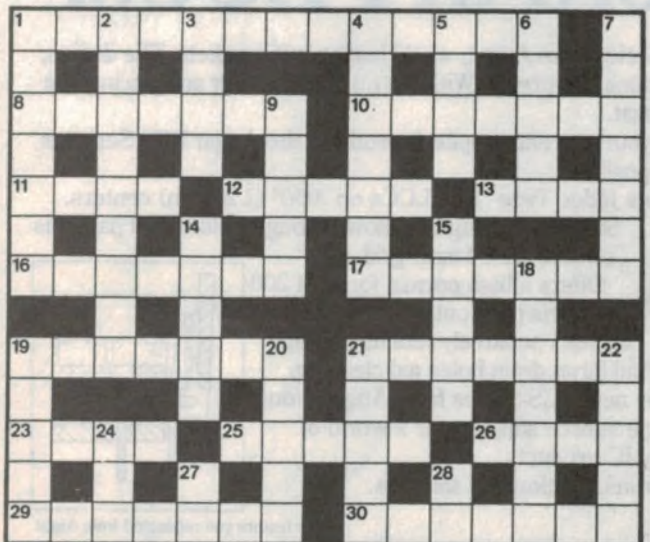
Commonwealth Interferometer Measures the Stars: Professor R. Hanbury Brown and his research team have designed and built a large stellar interferometer at the Observatory in Narrabri. Two 22-foot composite mirrors, each made up of some 250 separate hexagonal mirrors with spherical surfaces, run on trucks around a circular railway track 618 feet in diameter. The mirrors are kept trained on a particular star by an automatic control system, and the electrical signals from the photomultiplier sensors are carried by cables to an electronic correlator in a laboratory at the centre of the track.

The new instrument is not yet working at full sensitivity, but when it does Professor Hanbury Brown hopes to measure down to less than one thousandth (0.001) of a second of arc. This will bring approximately 200 of the brightest stars within the compass of the instrument's performance. The data gained from them will all be completely new and may have considerable importance in stellar theory. EA

EA CROSSWORD

ACROSS

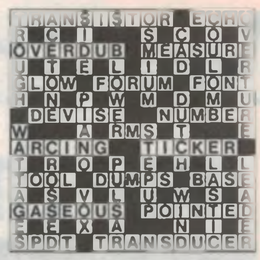
1. Said of light with many component colours. (13)
8. Element used as donor impurity. (7)
10. Maintenance of equipment. (7)
11. Electric traction vehicle. (4)
12. Section of TV circuitry. (5)
13. Property of electron giving magnetic effect. (4)
16. Function of heat sink. (7)
17. Sets of displayed frequencies. (7)
19. Having greatest speed. (7)
21. Said of certain simple cells. (7)
23. For some, this eliminates a step function! (4)
25. Auricle of an organ. (5)
26. Well-known electrical goods manufacturer. (4)
29. An oxide, or a positive cable? (3,4)
30. Hardware items providing clearance. (7)
31. Said of light of a single wavelength. (13)



DOWN

1. Insulating substance. (7)
2. Physicist noted for his study of harmonic patterns. (9)
3. Kids' telephone: string and two ————. (4)
4. Primary recordings. (7)
5. Metric prefix bigger than giga. (4)
6. Crush as a means of securing. (5)
7. The ANZCAN cable runs under this. (7)
9. What some charged clothes do. (5)
14. Connected with conductors. (5)
15. Kerr, Daniell, Weston, are names of ————. (5)
18. Temporary waveform. (9)
19. High-level language. (7)
20. Said of systems in groups of three. (7)
21. First planet beyond Earth to be investigated by spacecraft. (5)
22. Said of things having historical renown. (6)
24. Device serving as an adaptive go-between. (5)
27. Elemental gas. (4)
28. Condition in which an anemometer has zero output. (4)

OCTOBER SOLUTION



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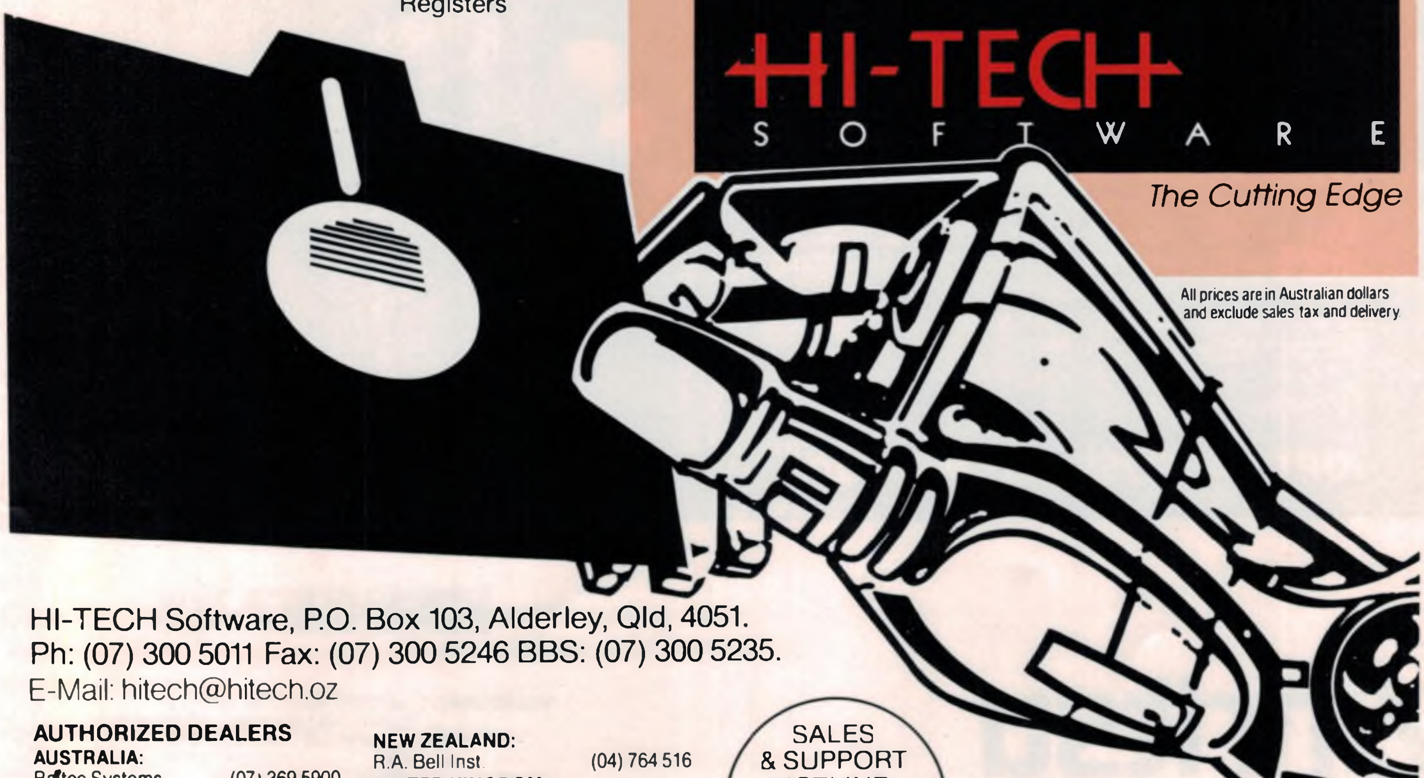

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