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Last Chance: Win a $7500 Pioneer Hifi!

Australia's Top Selling Electronics Magazine

Electronics Australia

MARCH 1988

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HOW HI-FI AMPLIFIERS DEVELOPED
explained by Neville Williams

CD VIDEO: SNEAK PREVIEW OF THE FIRST PLAYERS!

4 GREAT PROJECTS TO BUILD:

SIMPLE ROBOT, HANDY TIMER, "REFLEX" RADIO, COMPUTER INTERFACE

This Fantastic PIONEER® HI-FI

could be yours . . . over $10,000 in Hi-Fi Prizes to be won.

CONDITIONS OF ENTRY

1. The competition is open only to Australian Residents authorising a new/renewal subscription before last mail March 31, 1988. Entries received after closing date will not be included. Employees of the Federal Publishing Company, Pioneer Australia and their families are not eligible to enter. To be valid for drawing, subscription must be signed against a nominated valid credit card, or, if paid by cheque, cleared for payment.
2. South Australian residents need not purchase a subscription to enter, but may enter only once by submitting their name, address, and a hand-drawn facsimile of the subscription to The Federal Publishing Company, PO Box 227, Waterloo, NSW 2017.
3. Prizes are not transferrable or exchangeable and may not be converted to cash.
4. The judges decision is final and no correspondence will be entered into.
5. Description of the competition and instructions on how to enter form a part of the competition conditions.
6. The competition commences on January 1, 1988 and closes with last mail on March 31, 1988. The draw will take place in Sydney on April 4, 1988 and the winner will be notified by telephone, and letter. The winner will also be announced in The Australian on April 6, 1988 and a later issue of this magazine.
7. The prize is: (1st) A Pioneer stereo hi-fi system; (2nd) a Pioneer car stereo system; and (3rd) a Pioneer programmable 6-disc compact disc player. Total value $10,099.
8. The promoter is The Federal Publishing Company, 180 Bourke Road, Alexandria, NSW 2015. Permit No. TC/87/3356 issued under the Lotteries and Art Unions Act 1901. Raffles and Bingo permits Board Permit No. 87/2149 issued on 18/11/87. ACT Permit No. TP87/978 issued under the Lotteries Ordinance, 1964.

1ST PRIZE

A Pioneer home stereo hi-fi system, including an A717 "Reference Series" amplifier and twin power transformers; an F717L "Reference Series" digital quartz AM/FM stereo tuner, with 16-station preset frequency synthesis tuning; a top-of-the-range CT1380WR twin programmable stereo cassette deck, with cordless remote control; a PD-M60 Compact Disc player, with 6-disc multiple play and cordless remote control; a PL-L70 programmable linear tracking turntable, with quartz PLL direct drive motor; two S-701 "Digital Realism" 3-way speakers with 32" woofers and beryllium ribbon tweeters; a pair of matching CP-500 speaker stands; and a CB-C900 deluxe system cabinet. A complete ready-to-go system, valued at $7,762!

2ND PRIZE

A powerful Pioneer car stereo system, comprising a top-of-the-line KEH8080B quick-release AM/FM radio cassette player, with quartz-PLL synthesiser tuning, music search and automatic "best station memory", bass and treble controls, Dolby-B noise reduction and twin 20W outputs; a GM203 add-on booster amplifier; a pair of TS1609 160mm 3-way speakers; and a pair of TS1080 100mm 2-way car, van, boat or recreational vehicle, this top-quality system is valued at $1,532!

3RD PRIZE

A Pioneer PD-M60 multiplay Compact Disc player, with 6-disc magazine, cordless remote control, random programming for up to 32 tracks, digital filtering, 2-speed manual search and built-in headphone amplifier. An excellent addition to any hi-fi system, and valued at $899!

Subscribe Now to Electronics Australia for only $42.00 and you could be the lucky winner of this superb Pioneer stereo hi-fi system worth over **$7,700.**

OR

the second prize winner, of a Pioneer car stereo system worth over **$1,500.**

OR

the third prize winner of a Pioneer programmable 6-disc compact disc player with cordless remote control, worth **$899**

WOW

Regular readers of Electronics Australia know it's the one that gives you best value for money. We already give you the best news, the best construction projects, the best feature stories to keep you abreast of the latest developments — in short, the most interesting and valuable electronics reading every month.

By subscribing, you make sure of getting Electronics Australia every month — delivered right to your mail box. And automatically enter the draw to win one of the 3 Pioneer hi-fi prizes!

BUT THAT'S NOT ALL!

As well as entering the competition you'll also receive a free pair of high quality ARISTA lightweight stereo headphones — ideal for a portable cassette player, radio, CD player or even your home stereo or TV. **Valued at over $10.**

Simply fill out the enclosed self-sealing, postage-paid envelope/coupon and mail or if missing send name, address, telephone no. and cheque/money order to: Pioneer Hi-Fi Competition, Freepost No. 4, P.O. Box 227, Waterloo, NSW 2017. No stamp required
For any enquiries Ph: (02) 693-9515 or (02) 693-9517.

Volume 50, No.3

Electronics Australia

March 1988

AUSTRALIA'S LARGEST SELLING ELECTRONICS MAGAZINE — ESTABLISHED IN 1922

Sneak previews of the new CD Video players

Just hitting the consumer electronics market are the new CD Video players, which play video discs as well as existing audio CDs. Here's a good rundown on what they're like and what they do, starting on page 12.

Four great construction projects

Ever heard of Braitenberg vehicles? They're cute little robots, with adjustable "behaviour". They're also surprisingly easy to build, and low in cost — see page 60. Also to build this month are a handy timer, a two-transistor reflex radio (which works like a 4-transistor circuit), and a simple interface to connect your PC to the outside world.

ON THE COVER

Philips is confident that its new CDV 475 compact disc video player will appeal greatly to young people. Here it's shown with the company's new KH 3674R 15" colour TV. See story page 16.
(Photo by Peter Beattie)

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Entertainment Electronics

Projects and Technical

News and Comment

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Letters to the editor

Colour bar generator

I offer a note which may be of help to those, like me, who have built the EA 87/tv/10 Colour Bar and Pattern Generator from a kit.

Included with my kit was a note to the effect that the modulator, not the unit originally specified by G.W. Black but an "equivalent" (?) would not operate satisfactorily on Channel 0, and Channel 1 was recommended.

What they should truthfully have said was that the modulator would not operate (on colour) to specification but, "good luck to you out there anyway".

In the original *EA* article of October 1987, author G.W. Black correctly points out that the modulator is sensitive to the level of video (page 142) and specifies the operating input voltage as 6.2V DC (page 89).

The so-called equivalent modulator has a zener diode limiting the bias levels to a nominal 5V (in my case 4.8V), so that there is little hope of obtaining colour unless the ratio of resistors R13 and R14, so carefully chosen by G.W. Black, are experimented with. To say the least, this is messy.

I solved the problem by replacing the 5V zener with a 6.4V unit (not having a 6.2V on hand) and after adjustment of C7 was rewarded with operation to specification on both channels 0 and 1.

I also felt that the zener current could be reduced and increased R12 from 180 ohms to 220 ohms.

The "mod" would have the least effect on the original PCB should the constructor decide to replace the substitute modulator with the originally specified LVM 2AU01, at a later date.

E. Williams-Wynn,
Keilor, Vic.

Comment: Thanks for sharing your experience with other readers, Mr Wiliams-Wynn.

Who began Elmeasco?

I refer to *Electronics Australia* for January 1988 page 67, the announcement regarding Len Altman in News Briefs.

Len was not a co-founder of Elmeasco. That company was founded by my wife and myself in June 1967, and at that time Len Altman was employed by Neutronics Pty Ltd., located then at Alexandra Street, Crows Nest.

Len joined Elmeasco as sales engineer later in 1967. original documents which will confirm the above are available.

It would be appreciated if you would publish a correction on this point.

Ted Baker,
Bathurst, NSW.

Australian School of Electronics

Re Robert Brownlie's letter of November 1987, I took the "Practical Electronics Course" offered by the Australian School of Electronics, and was delighted with the literature, tuition and equipment, the building of which was part of the course.

I always felt that I was being undercharged, and would willingly have paid more.

I will be giving Mr Brownlie all the assistance I can, to at least complete the oscilloscope — which is a delightful and very useful little instrument.

F.M. Bongers,
Alice Springs, NT

Comment: Thanks for your advice and assistance to Mr Brownlie, Mr Bongers.

ACS failure: DITAC comments

Senator Button has asked me to reply to your "Editorial Viewpoint" and article on the closure and subsequent sale of manufacturing plant by Appliance Control Systems, in the September issue of *Electronics Australia.*

After reading the editorial and article, the chief fact that strikes me is that ACS suffered from a litany of problems and mismanagement: poor and misleading financial advice; over confidence resulting in attempting to run before walking; and poor business management.

The Government was unaware of the difficulties being experienced by ACS until receipt of the September issue of *Electronics Australia.* On reading the article it would seem that ACS is very much the type of firm that the Government is trying to encourage in Australia.

In fact the Government has introduced a number of initiatives to nurture the development of small to medium sized firms, particularly those which are innovative, technology based and export oriented. Of particular importance has been the establishment of the National Industry Extension Service (NIES) program. This is a joint Commonwealth/-State Government scheme and is part of a whole new approach to industry development. It concentrates on individual enterprises and focusses on raising their internal efficiency. There is even scope within NIES for firms to receive a subsidy to help them develop particular aspects of their business, such as establishing a business plan or improving the quality of their product.

Although NIES has been advertised widely through the media and through industry associations, I understand that ACS did not take advantage of any of the NIES programs. You will be familiar with the old adage, "You can take a horse to water . . . ".

While the Government can do a great deal to foster the type of industry best suited to Australia, and can provide the best possible economic environment to encourage development, it cannot shelter individual firms from the uncertainty of the commercial world. This certainly includes instances where a firm seeks and relies on professional advice which is subsequently perceived as being to its detriment.

Although I am sympathetic with your concern about what has transpired with ACS, and also very conscious of the need to foster fledging enterprises with potential growth prospects, the reality is that there will always be a risk element associated with running a business. At the end of the day, success or otherwise will largely depend on the business acumen and judgement of its owners and no amount of Government intervention can ensure success.

D H Williamson,
Assistant Secretary,
Information Industries,
Dept. of Industry, Technology & Commerce, Canberra, ACT.

Making PCBs

In reply to Doug Rees' comments in your December issue, I disagree with his opinion that scrubbing a PCB with a washing powder is adequate preparation. During my first efforts at making a PCB, I scoured the copper surface up to a dozen times (as per instructions in-

Continued on page 124

Editorial Viewpoint

The importance of home video recording standards

Hello again! In this month's issue you'll find no less than *three* timely articles on the new CD Video players and discs: two special hands-on previews of the first players to hit Australia, plus a rundown on the CD-V launch in the US from our correspondent Ken Pohlmann. I'm sure you'll find them very interesting.

It seems to me ironic that just as CD-V is being launched, Sony has announced it will begin making and selling VHS video recorders. Most of the media have taken this as a final tacit admission by Sony, after 11-odd years of fierce market rivalry, that its own Betamax system has lost the "race".

What makes this so ironic is that technically there has never been anything wrong with Betamax. For a short period in the early days it only provided a 1-hour recording time, compared with the 2 hours of VHS, but this was soon remedied. If anything, Betamax probably was and still is capable of delivering a slightly better picture than VHS.

I'm inclined to think that the only real mistake Sony made with Betamax, way back in 1975 when it was launched (more than a year before VHS) was not to enter into enough strategic alliances with the other major firms working on home video systems. If they'd done this, the industry might well have standardised on a single system rather than split as it did into the two rival VHS and Beta camps.

Which all goes to show how important it is, with any new consumer technology, to ensure that the major market players get together to establish mutually agreed and supported standards. No matter how good your technology may be from a technical point of view, it can still slide into a hole (or worse, be still-born) if you don't establish this market support.

Obviously even innovative market leaders like Sony need to do this, and I feel sure that the premature decline of Betamax made this clear not only to Sony itself, but to many of its competitors as well. Since the 1970's everyone has been paying a lot more attention to establishing industry standards for each new development, and then getting behind them.

The new CD Video players and discs are a good example of this, in fact, with virtually all of the industry involved in establishing and supporting the standard system. And much the same applies with Sony's new Video-8 system, which also has wide industry support.

It looks to me as if the Betamax experience may have taught the whole consumer electronics industry an important lesson. And that's good news for all of us, surely . . .

Jim Rowe

What's New In
Entertainment Electronics

High quality control unit/power amp

The Pioneer C90 Reference Control Amplifier and M90 Reference Power Amplifier are designed for audiophiles seeking the "ultimate" in audio performance.

The C90 Control Amplifier comprises two separate mono amps, each separately servicing the right and left channels to improve stereo separation and eliminate inter-modulation distortion. The C90 has three power transformers that independently supply each channel with its power requirements and the third provides for the operating of switches, relays, microcomputers and displays. This ensures a constant supply of power, free of voltage fluctuations.

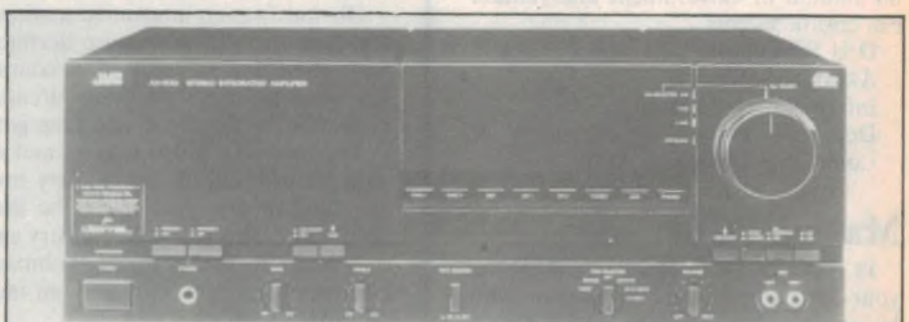
Pioneer's M90 Reference Power Amplifier is equipped with independent power supplies of 200 watts per channel, providing clear, high quality sound reproduction without distortion.

Designers of both amplifiers have gone to great lengths in developing the components and meeting the criteria of perfection. Copper has been used to substantially reduce magnetic distortion and vibration. The amp's copper plated chassis absorbs any leaked signal from the internal wiring and as copper is a soft metal, the screws bond with the chassis giving a more rigid construction.

Each of the main parts are insulated by anti-vibration rubber. To reduce signal loss, internal wire lengths have been kept to a minimum and the amplifiers are equipped with oversize speaker terminals. Also the CD and another quality source, such as DAT, when it becomes available, are directly connected to the M90, bypassing the C90 Control Amplifier, which reduces greatly the amount of circuitry the signal must pass through before amplification.

The C90 and M90 have been attractively finished in black gloss and will retail combined for a recommended retail of $4000 (both).

High quality integrated amp



JVC has developed a new amplifier technology called the Gm circuit in response to the growing popularity of digital audio formats. It is found in the new top-of-the-line A-X900B.

The Gm Circuit is actually three different circuits, Gm Volume, Gm Selector and Gm Driver. Gm Volume provides 100dB or more of signal-to-noise ratio even at the 9 o'clock position of the volume control. Gm Selector reduces the power amp gain by 6dB or 12dB, so that noise is less apparent during low-level listening. Gm Driver reduces the effect of counter electromotive force generated by the speakers.

Other features of the new amplifier include JVC's Dynamic Super-A output stages, a high-gain DC-Servo phono equaliser for MM and MC cartridges, and a low-impedance direct power supply, also provided are a DAD input, monitoring and dubbing for up to three decks and gold-plated PHONO and DAD terminals.

No frills mixer, amp from Shure

Shure Bros Inc. has released a small, no frills, lower priced microphone mixer and companion power amplifier for the sound reinforcement industry, where high power is not required.

The Prologue series 200M microphone mixer and 210A power amplifier are ideal for the non-technical user in such broad mass market applications as churches, clubs, offices, shops, meeting halls, outdoor gatherings, factories, the sound reinforcement rental market or any application for a small paging system.

They are efficient units, with very low power requirements — 12 volts will deliver the full 10 watt output of the amplifier. For outdoor use a car battery can be connected to the DC power input socket.

The Shure Prologue 210A power amplifier has one balanced low impedance 3-pin professional microphone level input, two parallel phono type Auxiliary level signal inputs, two 1/4" phone type loudspeaker jack outputs, a push button circuit breaker reset and the DC power input socket all on the rear. On the front panel is the master volume control and the power on-off switch with pilot light.

The Shure Prologue 200M microphone mixer has four electronically balanced low impedance 3-pin professional microphone inputs with individual level controls. Input number 4 is switchable between microphone input or an Auxiliary input via a phono type jack input.

Power requirements are supplied by the Shure PS21E power transformer delivering 12 volts DC at 12.95A for the amplifier, and the Shure PS20E delivering 12 volts DC at 250mA for the microphone mixer.

For further information contact Australian distributors, Audio Engineers, 342-344 Kent Street, Sydney 2000. Phone (02) 29 6731.

TDK's long life endless cassettes

Based on the experience of the Reverend Martin Boxall of St. Petroc, a small Cornish church in Padstow, England, TDK "EC" series endless audio cassettes offer exceptional life.

One of the oldest standing churches in England, Saint Petroc was built in 1425 and attracts thousands of visitors each year. Rev Boxall hit upon the idea of recording a short historical narrative telling of the history of the church. This could be heard as visitors observed the church's interior.

Operating on a timer, the TDK endless tape has to date run from 11.30 am to 5.50 pm seven days a week, twelve months a year for a total of four years. TDK claims that this would be equivalent to playing an ordinary cassette tape for over ten years, playing for ten to fifteen hours a week, fifty two weeks a

Ken Kihara, general manager of TDK (Australia) says "similar stories of TDK long lasting tape products are not uncommon, and reflect TDK's commitment not only to making the tape formulation superior, but also to manufactured products that will maintain optimum performance for many years to come."

TDK's endless cassettes are available in EC-20S, EC-30S, EC-90S, EC-1M (one minute), EC-3M, EC-6M and EC-12M playing times.

Tannoy launches new loudspeaker

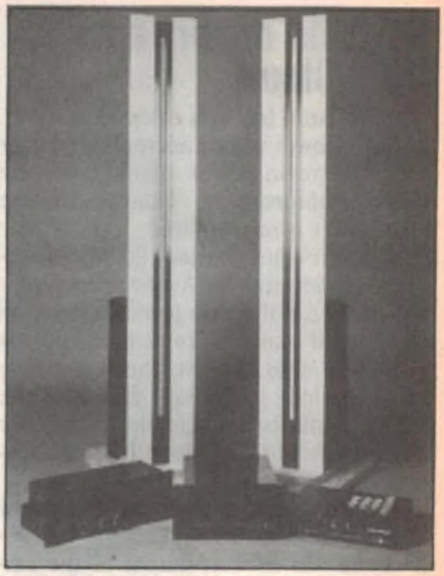
Tannoy UK, for 60 years one of the world's leading manufacturers of high quality studio monitors and loudspeakers has released a new addition to its line up of domestic loudspeakers, the Eclipse. This follows the very successful launch of the Mercury II, which was voted "speaker of the year" by British audio reviewers.

The Eclipse is a two-way loudspeaker and features a ferrofluid cooled polyamide dome tweeter, which is designed to give extremely smooth response and improved dispersion. Additionally a new mid/base unit construction technique for the cone apex configuration combines with the high frequency unit to give a sound quality not normally found in similarly priced speakers.

The enclosure is rigidly constructed from 12/15mm high density particle board. The crossover is hard wired, using low loss components, with heavy duty terminals which will accept the majority of high quality audio cables.

The Eclipse is finished in black ash and is available from Tannoy dealers for $499 per pair.

Australian-made ribbon speaker



Trevor Lees Audio in Melbourne has released a new high performance ribbon speaker system, designed and manufactured in Australia.

The system is said to offer very high efficiency, high output capability and excellent transparency and transient performance. It combines a bass enclosure with an 1800mm-high ribbon unit, to handle the middle and high frequencies (crossover is at around 400Hz). The tall, narrow construction provides wide sound dispersion in both the vertical and horizontal planes.

TLA says the system's high performance is due to a novel design and use of the latest materials, including special high flux magnets and a ribbon only 28 microns thick. This provides minimum mass with very high mechanical strength. The compound enclosure uses a special high strength tubular construction, with solid wood construction used for the bass enclosure.

The speaker system does not require special matching arrangements and is compatible with virtually all amplifiers capable of driving 4-ohm speakers. Price of a twin-speaker full range system is $3500, with the ribbon units also available separately for those with existing bass speakers.

Further details are available from Trevor Lees Audio, 114 High Street, Kew 3101 or (03) 862 2315.

New automatic turntable

JVC has introduced a new fully automatic turntable, the AL-F350BK. According to the company, its design emphasises higher stability and lower resonance to improve tracking accuracy and sound.

The straight tonearm of the turntable is rigid and low-mass to resist resonance and vibration. Moreover, it has a low-centre-of-gravity support to improve stability. This results in lower intermodulation distortion and effectively lower wow and flutter.

The AL-F350BK is fully automatic; even record size is automatically selected to permit accurate stylus cueing. The tonearm features a plug-in cartridge connector for snap-on "T4P" cartridges, a format that has ended wiring errors and simplified cartridge replacement. Operation controls are on the front and outside the closed dust cover, to make operation easier. Finally, the AL-F350BK is a JVC "Compu Link" component for interactive and coordinated operation with other components in the series.

RITRONICS WHOLESALE ARE COMPETITIVE!

75 OHM COAX CABLE IN 100M ROLLS

Cat No.	Descript	1-4	5+	10+
W11222	3C2V	25.00	24.00	23.00
W11224	5C2V	30.00	29.00	28.00

(5C2V WHITE OR BLACK)
LINE LOSS PER 100 FEET (33M 200MHz)
W11222 3C2V 6.2dB (Approx.)
W11224 5C2V 3.9dB (Approx.)
Plus 20% tax where applicable

COMPUTER CONNECTORS

Cat No	Description	1-99	100-	1000+
P10900	DB25 Plug	0.80	0.70	0.50
P10901	DB25 Skt	0.90	0.75	0.60
P10902	DB25 Cover	0.80	0.65	0.55
P12210	Cent. Solder	3.50	3.15	2.50
P12200	Cent Crimp	4.50	4.00	3.50
P10880	DB9 Plug	0.80	0.70	0.50
P10881	DB9 Skt	0.90	0.75	0.60
P10882	DB9 Cover	0.60	0.55	0.50
P10890	DB15 Plug	0.80	0.70	0.50
P10891	DB15 Skt	0.90	0.75	0.60
P10892	DB15 Cover	0.65	0.55	0.50

Plus 20% tax where applicable

NICADS

Cat No	Description	1-99	100	250
S15020	AA .5AH	$2.20	$2.00	$1.95
S15021	C 1.2AH	$6.75	$6.50	$6.20
S15022	D 1.2AH	$7.55	$7.25	$6.90

Plus 20% tax where applicable

HORN SPEAKERS

Cat No		1-9	10
C12010	5" Plastic 10W Max	6.00	5.80
C12015	5" Metal 10W Max	6.00	5.80
C12012	12V Siren	9.90	9.60

Plus 20% tax where applicable

VERBATIM DATA LIFE DISKETTES

Cat No	10 - boxes	100 - boxes
3 1/2" SS/DD	$35.00	$33.00
3 1/2" DS/DD	$37.00	$35.00
5 1/4" SS/DD	$22.00	$20.00
5 1/4" DS/DD	$24.00	$22.00
5 1/4" H/Density	$35.00	$33.00

Plus 20% tax where applicable

DIODES

Cat No	Descript	10-	100-	1000-	10K
Z10135	IN4148	0.03	0.02	0.015	.015
Z10105	IN4002	0.04	0.03	0.03	.025
Z10107	IN4004	0.05	0.04	0.03	.025
Z10110	IN4007	0.10	0.06	0.05	0.04
Z10115	IN5404	0.18	0.14	0.09	0.08
Z10119	IN5408	0.20	0.16	0.10	0.09

Plus 20% tax where applicable

IC's SPECIALS

"Check for the latest memory prices!"

	10-99	100+	1000+	10K+
2532	$12.00	$11.00	$10.00	$9.50
2716	$9.50	$9.00	$8.50	$8.00
2732	$9.00	$8.75	$8.50	$8.00
2764	$7.95	$7.50	$7.00	$6.75
27128	$9.00	$8.50	$8.00	$7.75
27256	$11.50	$11.00	$10.50	$10.00
27512	$20.00	$19.00	$18.00	$17.00
4164-15P	$1.95	$1.80	$1.70	$1.65
41256	$7.00	$6.50	$6.00	$5.75
6116P-3	$3.60	$3.40	$3.20	$3.00
6264	$6.50	$6.00	$5.75	$5.50
SM141D	$1.80	$1.70	$1.60	$1.55
LM3914	$2.40	$2.30	$2.20	$2.10
LM3915	$2.40	$2.30	$2.20	$2.10

Plus 20% tax where applicable

GREY FLAT RIBBON CABLE IN 100 FOOT ROLLS

Cat.No.	Desc	1-3	4-9	10-99	100-
W12614	14 Way	19.50	18.50	18.00	14.00
W12616	16 Way	21.50	19.50	19.00	16.00
W12620	20 Way	29.50	28.00	26.50	20.00
W12625	25 Way	32.50	29.00	28.50	25.00
W12626	26 Way	34.00	32.00	29.00	26.00
W12634	34 Way	44.00	42.00	39.00	34.00
W12636	36 Way	49.00	47.00	42.50	36.00
W12640	40 Way	55.00	52.50	49.50	40.00
W12650	50 Way	62.00	59.50	58.50	50.00

LARGER QUANTITIES NEGOTIABLE!
Plus 20% tax where applicable

FANS

Cat No	Descript	1-9	10-	100+
T12461	240V 4 1/2"	11.00	10.00	9.00
T12465	240V 3 1/2"	11.00	10.00	9.50
T12463	115V 4 1/2"	11.00	10.00	9.00
T12467	115V 3 1/2"	11.00	10.00	9.50

(Fan guards to suit also available)
Plus 20% tax where applicable

TELEPHONE CABLE (200 METRE ROLLS)

Cat No	Description	1-9	10-
W11302	2 Pair	$24.00	$22.00
W11303	3 Pair	$29.00	$27.00
W11310	10 Pair	$120.00	$115.00

Per 200m Roll
20% Sales tax where applicable

MITSUBISHI DISK DRIVES

Description		1-9	10-	25-
4851	5 1/4" 500K	$195	$185	$175
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PN3563	0.18	0.16	PN3565	0.12	0.11
PN3566	0.15	0.13	PN3567	0.10	0.08
PN3569	0.18	0.16	PN3639	0.18	0.16
PN3640	0.18	0.16	PN3641	0.11	0.09
PN3642	0.11	0.09	PN3643	0.11	0.09
PN3644	0.15	0.13	PN3645	0.15	0.13
PN4250A	0.15	0.13	PN4355	0.18	0.16
PN4356	0.19	0.17	MPSA42	0.20	0.15
MPSA43	0.11	0.09	MPSA55	0.18	0.17
MPSA56	0.19	0.16	MPSA92	0.12	0.11
MPSA93	0.14	0.12	2SD350	3.90	3.75
BC327	0.11	0.10	BC328	0.11	0.10
BC337	0.11	0.10	BC338	0.11	0.10
BC547	0.10	0.09	BC548	0.10	0.09
BC549	0.10	0.09	BC557	0.10	0.09
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18 Pin	0.12	0.11	0.10	0.09
20 Pin	0.13	0.12	0.11	0.10
22 Pin	0.14	0.13	0.12	0.11
24 Pin	0.15	0.14	0.13	0.12
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M12156 2156 240V 6-15V 2A tapped	9.00	8.75	8.50
M12840 2840 240V to 9V C.T. at 150mA	3.50	3.30	3.10
M12860 2860 240V to 15V C.T. at 250mA	3.50	3.30	3.10
M16672 6672 240V 15-30V 1A tapped	8.95	8.75	8.40

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Cat No.	Frequency	Can	10-	100
Y11000	1MHz	HC33	4.75	4.00
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Y11008	2.4576MHz	HC18	1.95	1.70
Y11015	3.57954MHz	HC18	1.20	95
Y11020	4.00MHz	HC18	1.20	95
Y11022	4.194304MHz	HC18	1.20	.95
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Q10504	MU45 0-100uA	10.00	9.50	9.25
Q10505	MU45 0-50uA	10.00	9.50	9.25
Q10510	MU45 0-5A	10.00	9.50	9.25
Q10518	MU45 0-1A	10.00	9.50	9.25
Q10520	MU45 0-20V	10.00	9.50	9.25
Q10535	MU45 VU	11.50	11.00	10.75
Q10530	MU52E 0-1mA	12.00	10.00	
Q10533	MU52E 0-5mA	12.00	10.00	
Q10538	MU65 0-50uA	15.00	13.60	13.00
Q10540	MU65 0-1mA	15.00	13.60	13.00
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Q10560	MU65 0 0-20v	15.00	13.60	13.00

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R15138	.0015uF	0.06	0.04	.03
R15140	.0022uF	0.06	0.04	.03
R15142	.0033uF	0.06	0.04	.03
R15143	.0039uF	0.06	0.04	.03
R15145	.0047uF	0.06	0.04	.03
R15146	.0056uF	0.06	0.04	.03
R15147	.0082uF	0.06	0.04	.03
R15148	.01uF	0.07	0.05	.04
R15150	.015uF	0.07	0.05	.04
R15152	.022uF	0.07	0.05	.04
R15154	.033uF	0.07	0.05	.04
R15155	.039uF	0.07	0.05	.04
R15156	.047uF	0.08	0.06	.05
R15157	.056uF	0.08	0.06	.05
R15158	.068uF	0.08	0.06	.05
R15159	.082uF	0.08	0.07	.05
R15160	.1uF	0.09	0.08	.07
R15162	.15uF	0.11	0.10	.09
R15164	.22uF	0.15	0.14	.13
R15165	.27uF	0.16	0.15	.14
R15172	1uF	0.70	0.55	0.50
R15176	2.2u	1.20	1.10	1.00
R15178	3.3uF	1.50	1.20	

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Cat.No	Description	10-	100-
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R16125	10uF 16V	$0.25	$0.23
R16126	15uF 16V	$0.38	$0.36
R16128	22uF 16V	$0.42	$0.40
R16132	47uF 16V	$1.55	$1.20
R16134	68uF 16V	$1.80	$1.50
R16220	4.7uF 16V	$0.35	$0.33
R16224	10uF 16V	$0.38	$0.37
R16228	22uF 16V	$1.20	$1.00
R16300	0.1uF 35V	$0.13	$0.12
R16302	0.15uF 35V	$0.13	$0.12
R16304	0.22uF 35V	$0.15	$0.12
R16306	0.33uF 35V	$0.15	$0.14
R16308	0.47uF 35V	$0.15	$0.14
R16310	0.68uF 35V	$0.16	$0.15
R16311	0.82uF 35V	$0.18	$0.15
R16312	1uF 35V	$0.15	$0.12
R16314	1.5uF 35V	$0.24	$0.20
R16316	2.2uF 35V	$0.24	$0.23
R16318	3.3uF 35V	$0.29	$0.27
R16320	4.7uF 35V	$0.35	$0.33

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R15725	2.2uF 63V	$0.15	$0.13	$0.11
R15742	4.7uF 25V	$0.14	$0.11	$0.10
R15745	4.7uF 63V	$0.14	$0.11	$0.10
R15761	10uF 16V	$0.15	$0.13	$0.11
R15762	10uF 25V	$0.16	$0.15	$0.13
R15765	10uF 63V	$0.18	$0.16	$0.15
R15792	22uF 25V	$0.16	$0.15	$0.13
R15794	22uF 50V	$0.20	$0.18	$0.16
R15812	25uF 25V	$0.16	$0.15	$0.13
R15815	25uF 63V	$0.20	$0.18	$0.16
R15831	47uF 16V	$0.19	$0.16	$0.15
R15832	47uF 25V	$0.19	$0.16	$0.15
R15835	47uF 63V	$0.26	$0.24	$0.22
R15841	100uF 16V	$0.21	$0.19	$0.18
R15842	100uF 25V	$0.21	$0.19	$0.18
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Compact disc video: seeing the light

The companies behind CD-Video are pushing it hard, as the "next generation" of home audio/video entertainment. But will consumers go for it? Here's a look at the situation in America.

by KEN POHLMANN*

**Professor of Music Engineering, University of Miami*

Compact Disc Video (CD-V) is an amalgamation of audio and video technology. The brainchild of Philips NV, Dutch co-inventor of the Compact Disc, CD-Video is an optical disc format designed to create a new retail market, using a bridge between a new media (Compact Disc) and a not-so-new media (LaserVision).

From that merger comes a new medium, the CDV-Single, and a new hardware product, the CD-V player. The result is a playback system of very high fidelity, both in terms of audio and video.

With CD-Video will music lovers need to move their televisions between their loudspeakers (thus creating a "media room") to make for a new kind of listening, and must videophiles append a stereo system to their viewing screen? Is CD-V primarily a music format, or a video format? Moreover, exactly who will enjoy such a product: teenagers dancing to Madonna, Yuppies de-stressing with New Age, or the cultured reviewing Verdi?

Let's take a look at the technology behind CD-V, and try to decide whether it's an innovative media with potential to open new markets, or a reworking of old media destined to die on the crowded battlefield of audio electronics war.

Television incompatibility

CD-Video merges both CD and LV formats; the latter presents a double problem because of the incompatibility of worldwide television standards. The audio portion of a CD-Video player is identical to that of a CD player; audio quality of the CD-V duplicates that of an audio CD player. CD-V thus retains full compatibility with existing CD-Audio standards. However because of incompatible analog television standards, different players and discs must be manufactured for NTSC and PAL.

CD-V thus violates the universality of the Compact Disc, losing the unique advantage of playability and interchangeability between any discs and any players worldwide.

When the CD was standardised, designers were free to design universality into the product. Thus any CD disc may be played on any CD player. With CD-Interactive, because video is stored digitally, compatibility also exists. Not so with CD-V.

Because CD-V video information is stored and reproduced in analog form, a CD-V player must be configured for one standard or another, as are CD-V

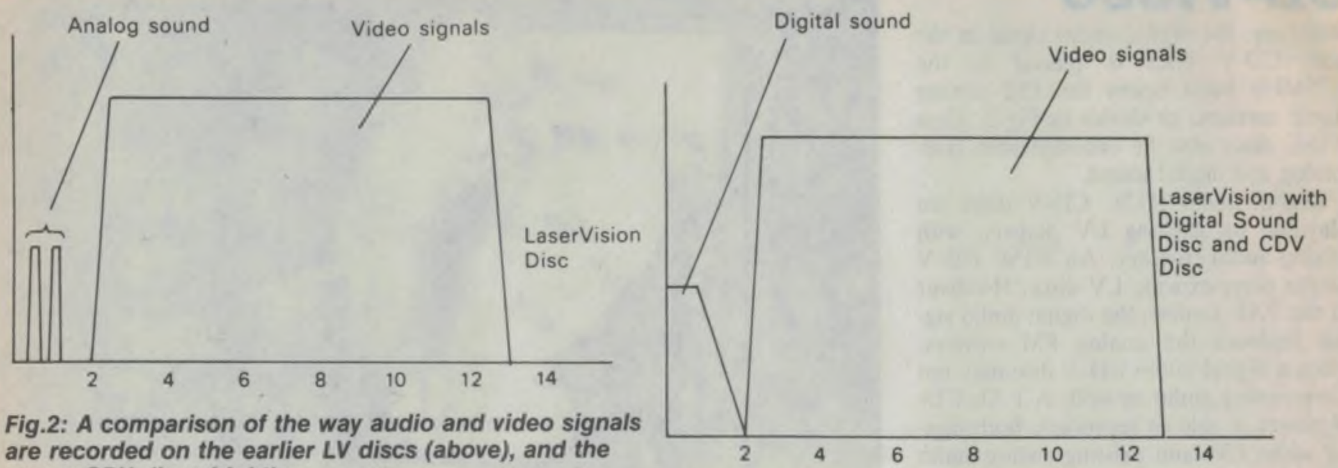


Fig.2: A comparison of the way audio and video signals are recorded on the earlier LV discs (above), and the newer CDV discs (right).

discs. In other words, the video portion of a PAL CD-V disc is unplayable on a NTSC player and vice versa. Also, the analog audio portion of the video program is incompatible because it is integrated into the video signal. The audio-only CD tracks will be playable on any PAL or NTSC, or CD-Audio player.

CDV-Single

CD-Video also introduces an entirely new software format, the 120mm CDV-Single. The CDV-Single appears similar to an audio CD, however the substrate and top lacquer are gold-tinted to distinguish it visually.

The disc is the size of an audio CD, but contains approximately five minutes of full motion NTSC video (encoded as an analog signal) with CD digital audio soundtrack, as well as an extra twenty minutes of CD digital audio only. A PAL standard disc encodes approximately six minutes of video material, along with CD soundtrack, and an extra twenty minutes of CD audio. CD-Audio standards are used for the digital audio, including scanning velocity of 1.2 to 1.4 metres/second, and track pitch of 1.6 micrometres.

Because the audio portion of the CDV-Single disc is placed on the innermost diameter (from 50 to 74 millimetres), as shown in Fig.1, the audio portion may be played on a regular CD player. Likewise the CD-V player may play any audio CD. The video portion, on the outer diameter (from 78 to 116 millimetres) is read only by the CD-V player.

Video information is contained on the outer diameter, encoded as an FM-modulated analog signal according to the LaserVision format. In the NTSC standard, disc speed ranges from 2700 to 1815rpm, to yield a scanning velocity of 11 to 12 metres/second. Track pitch is 1.7 micrometres. In the PAL standard, disc speed varies from 2250 to 1512rpm, with a scanning velocity of 9.2 to 10.2 metres/second. Track pitch is also 1.7 micrometres.

The player must sense the presence of either digital audio-only or video signal, and adjust its operating parameters accordingly. Typically, the player's laser pick-up would read the audio lead-in area, skip to the video portion, then return to the audio-only portion.

CD-V/LV

The 20 and 30 centimetre diameter CD-Video discs are denoted as CDV-EP and CDV-LP respectively. They contain audio conforming to the CD standard and video conforming to the LV standard. Analog audio may be used in addition to digital audio, in the NTSC format. The CDV-EP plays two 20-minute sides, the CDV-LP plays two 60-minute sides. Obviously these discs cannot be played on a standard audio CD player because of their larger diameters. Scanning speed in the NTSC format is 10.1 to 11.4 metres/second. In the PAL format it is 8.4 to 9.5 metres/-second.

In the NTSC format, the audio portion of LV discs was formerly encoded with two FM carriers placed at 2.3 and 2.8MHz, below the FM picture signal. In the PAL format, the FM carriers were placed at 648 and 1066kHz. In ei-

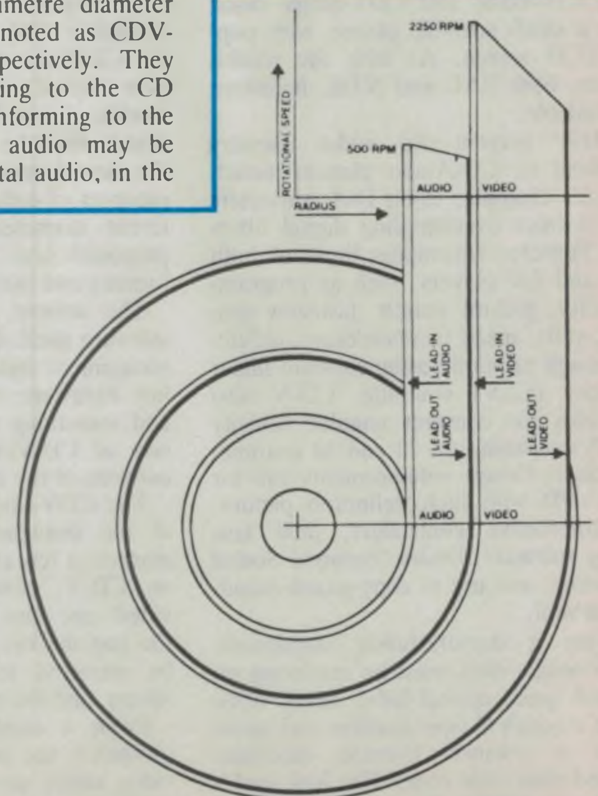


Fig.1: On a CDV-Single, the outer video+audio track plays at between 2250 and 1512rpm, while the inner audio-only tracks play at the normal 500rpm-down speeds.

ther case, the digital audio signal in the new CD-V discs is placed in the 1.75MHz band below the FM picture signal carriers, as shown in Fig.2. Thus NTSC discs may be encoded with both analog and digital sound.

Digital audio NTSC CD-V discs are playable on existing LV players, with analog audio circuitry. An NTSC CD-V player plays existing LV discs. However in the PAL format, the digital audio signal replaces the analog FM carriers. Thus a digital audio CD-V disc may not have analog audio as well. A PAL CD-V player is able to reproduce both digital audio LVs and existing analog audio LVs, however existing PAL LV players cannot reproduce the audio portion of new digital audio CD-V discs.

Player design

The first CD-Video player to hit the market is a combination CD and LV player. It plays 12 centimetre video CDV-Singles, along with conventional full-length audio-only CDs, and all 20 and 30 centimetre LV video discs as well. Hence the name, "combi-player". The loading drawer offers concentric rings for three disc sizes.

In addition to the CD-V combi player playing all four optical disc formats, manufacturers have prototyped a CD-Single dedicated player, able to play only CD-Audio and CDV-Single discs; it is a small portable player, with pop-up LCD screen. As with the combi-player, both PAL and NTSC hardware is available.

CD-V players use audio circuitry identical to CD-Audio players including, for example, 16-bit D/A converters and 4-times oversampling digital filtering. Features encompass those of both CD and LV players, such as programmability, picture search, fast/slow motion, stills, speed increase/decrease, etc. Although primarily using constant linear velocity (CLV) scanning, CD-V also provides for constant angular velocity (CAV) scanning on 20 and 30 centimetre discs. Future enhancements call for CDV-HD with high definition picture, CD-Interactive controllers, dual language software, Dolby Surround Sound encoding, and use of copy-guard encoding as well.

From a manufacturing standpoint, CDV-Single discs must be mastering on a dual speed optical lathe, using video from a 1-inch C-type machine and audio from a 3/4-inch U-matic machine, synced with time code. The high bandwidth of 10MHz (versus 1.5MHz for CD-Audio) necessitates manufacturing procedures closer to those of video discs as opposed to audio CDs, however CDV-Single discs are manufactured at CD audio plants. As discussed, both PAL and NTSC versions are encoded.

CDV marketers believe the new discs will revolutionise home video.

Will it Fly?

Although reflecting some peculiarities caused by the joining of two somewhat dissimilar technologies and mediums, the CD-Video format provides a workable way of enjoying the best of both worlds. Beyond technology, the question is what the consumer is to make of the new format. Will they accept the prospect of collecting discs of three different diameters (four, counting the proposed new 3-1/2" CD-Single audio format) and two colours?

The answer, of course, lies in the software itself. It is a maxim of the entertainment industry that people don't buy hardware; they buy only software and something to play it on. The success of CD-Video thus hinges on the contents of the discs themselves.

The CDV-Single is targeted precisely at the dwindling audio 45rpm single market; a few cuts of music will be put on CD-V, along with a full motion video cut. One immediately thinks of the pop market, and buyers who would be attracted to single cuts from an album, and the music video as well.

From a marketing standpoint, the product is too good to be true. First, a video single promotes album sales, in much the same way that audio singles and music videos do. In addition, for the first time, record labels are given the opportunity to sell music videos to the mass market; a unique situation of the consumer lining up to pay for promotional material. In short, the CDV-Single transforms music video from a promotional tool into a popularly-priced, saleable product.

Of course, the format supports 8" and 12" video discs as well. Because of their long playing times, and CD-quality soundtracks, these discs will be well-suited for material such as concert videos, classical music videos, and feature films.

Philips and partner Warner Communications hopes that the collectibility and ownership aspects of CD will carry over to features on CDV. The growing sales figures of prerecorded video tapes supports the conjecture. CD-Video is thus particularly attractive to its inventor, Philips. After considerable investment, its LaserVision system has never achieved market potential.

With the combi-player, LV is given a second chance, and a considerable advantage from association with the highly successful CD format. If LaserVision cannot succeed on CD's coat tails, it never will.

If the consumer is offered a CD player which also happens to play LaserVision discs, it is certainly possible that this latent market could take off.

So, is CD-Video the next mega-product? The marriage of video and digital audio is being enacted in many product areas, and the CD/LV union would appear to make sense as well. There is no question that video is a major influence on the audio market. Not only does CD-V serve to strengthen LV, it could also strengthen CD as well.

The introduction of CD-V is also a smart move in terms of insurance, against R-DAT. CD-V heightens awareness of the CD format, bringing new market applications to it, and frankly does something that R-DAT could probably never do very well — namely reproduce extremely high quality video.

Of course, such an ambitious merger must have a certain downside to it. In this case, it appears to be limited. First, the introduction of CD-V may create confusion in the minds of the consumer. The idea of the once-simple compact disc is now clouded with CD-DA, CD-ROM, CD-I and CD-V. CD-V makes matters slightly worse, by throwing in two new disc diameters. Worse still, because CD-V violates the universality of the Compact Disc, the unique advantage of interchangeability is lost.

Finally, on the debit side, there is the risk of consumer nonacceptance of the format. That failure may diminish the lustre of CD itself, lending a marketing advantage to competing formats such as R-DAT.

However on balance, CD-V appears to be a gamble well worth taking. Certainly Philips is convinced of that; a major marketing push is now underway, albeit delayed due to shortages of CDV-Single software. Success, of course, will be decided in the months and years to come, by the consumer.

CD-Video thus takes it place in the growing CD family line-up. The good old CD first introduced digital audio, now called CD-DA to avoid confusion. Then subcode was promoted (but not commercialised, as yet). The CD-ROM brought the shiny disc to data storage applications. Now the CD-V player adds video playback to CD-Audio.

The next step will be the CD-Interactive player with backward compatibility with CD-Audio, but adding audio/visual interactivity. Finally, the so-called "CD-VI omniplayer" will be introduced, able to play the complete family of entertainment discs: CD-DA, CD-V and CD-I.

In very direct terms, the Compact Disc thus carries the audio market into the very diverse markets of video and computer applications. Whether the consumer needs or wants such products, which in reality are a considerable departure from existing entertainment products, will provide interesting watching in itself. EA

CD-Video Preview:

Philips' CDV 475 CD-V disc player

We've just had the opportunity to check out one of the first two samples of the Philips CDV 475 compact disc video players to reach Australia. Here's what we found . . .

by JIM ROWE

As I wrote in the magazine last month, Philips effectively kicked off the CD-Video era in Australia with its recent demos to the technical press and selected dealers. Philips spokespeople stressed that they weren't actually *launching* the product here, you understand — just giving us all a preview, on your behalf. The real launch was slated to come later in 1988, when they could guarantee a good supply of both hardware and software.

When I asked whether there'd be the opportunity for us to check out one of the advance pre-production samples, to give our readers a preview, things didn't look too promising at the time. The only two samples in the country seemed to be booked up for interstate demos and internal company training, for months ahead. However a couple of weeks later we struck it lucky — one did become available, although only for two days. Needless to say we jumped at the chance, and this story is the result.

The sample player we were sent was a CDV 475, which is apparently at the top of the initial range. It is a multi-format player, which plays not only the new 120mm CD-Video discs and standard audio-only CDs, but a new double sided CD-Video "extended play" disc 200mm in diameter, and an even larger CD-Video "long play" disc 300mm in diameter (and also double sided). For good measure, it will also play the 300mm LaserVision discs which have been around for a few years now.

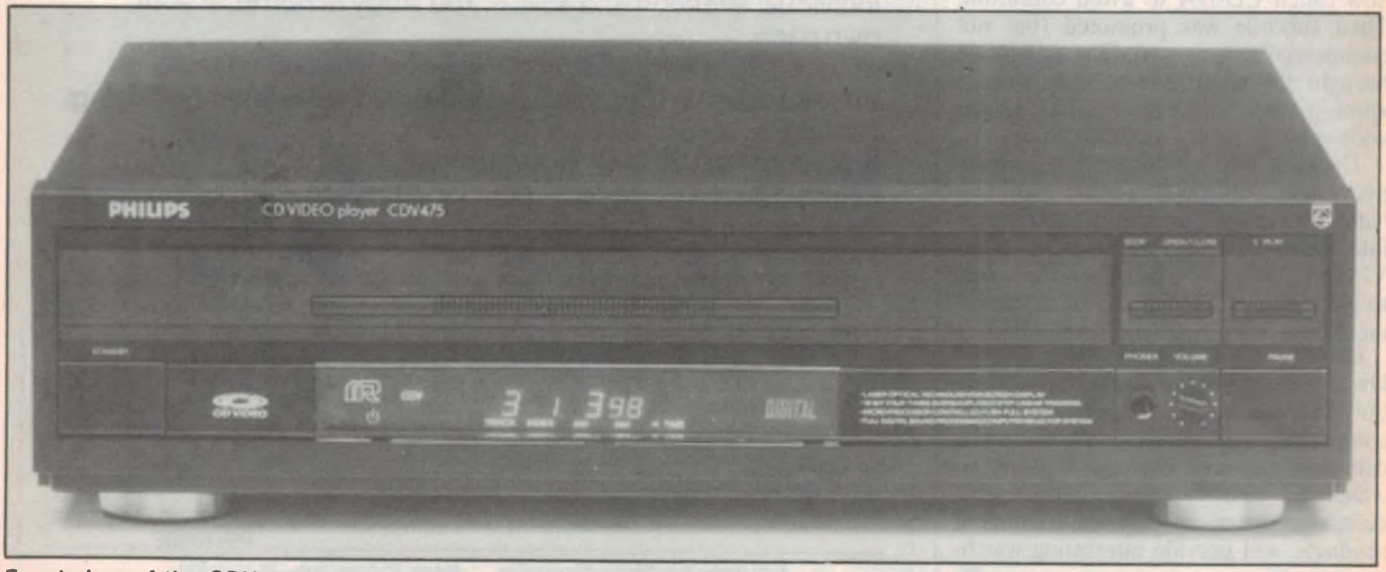
The latter point is quite interesting, because it means that the range of potential software for CD-Video players like the CDV 475 will be wider than the new CD-V discs themselves. There has been quite a range of software released on the original LaserVision discs, including many movies (although not as many as on video cassettes, particularly VHS).

The two systems are actually rather different, although they both use laser playback of an optical recording. The original LaserVision discs use analog sound recording, and are recorded at constant *angular* velocity (CAV). This means they are played back at a fixed rotational speed, with one revolution per complete video picture (two fields) or 1500rpm. The resulting maximum playing time is about 36 minutes per side, for a 300mm disc.

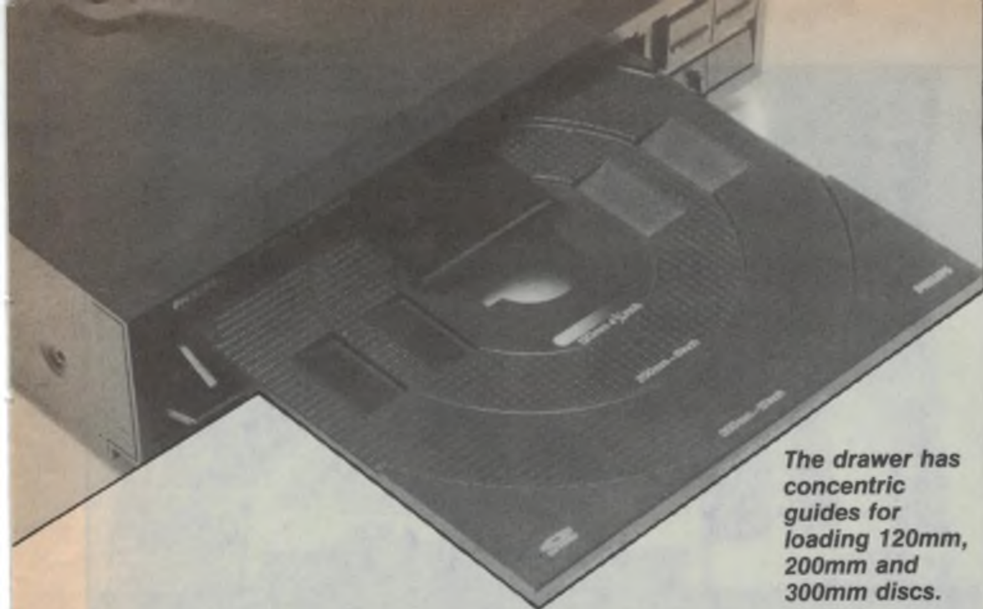
In contrast the new CD-V discs use digital PCM sound recording like audio compact discs, and are recorded at constant *linear* track velocity (CLV). This means that they're played back at a varying rotational speed, faster in the centre than at the outside. As a result they use the disc surface more efficiently, and provide a longer playing time: up to 60 minutes per side for a 300mm disc. But there's a penalty: they can't be stopped for a still picture.

One thing that the new CD-Video discs and the original LaserVision discs have in common is that there are actually two versions of each: one for the NTSC colour TV system used in the USA and Japan, and the other for the PAL and Secam systems used in Europe, the UK, Australia and New Zealand. So unlike audio-only compact discs, CD-Video discs are not truly universal (at least for their video tracks); NTSC discs won't play in a PAL or Secam player, and vice-versa. It's a shame they didn't find a way around this one, but there you are.

Along with the sample CDV 475 player we also received one of the new Philips KH 3674R compact colour TV



Front view of the CDV 475. It looks like a conventional CD player — until the drawer opens!



The drawer has concentric guides for loading 120mm, 200mm and 300mm discs.

receivers, with a square-corner 15" screen. This is shown with the player in this month's cover picture.

We didn't have a great deal of software to try the player out: a couple of the new 120mm CD-V "video clip plus audio-only tracks" discs, plus a 300mm LaserVision disc. There isn't all that much video disc software available in Australia yet, especially during the holiday period and at short notice! Still, it was enough to put the player through its paces.

The CDV 475 is somewhat larger and heavier than most regular audio CD players, as you'd perhaps expect. It measures 420mm wide by 395mm deep, by 100mm high, and weighs in at 8kg.

Needless to say the front-loading disc drawer is rather larger too, to accommodate discs up to 300mm. When the drawer slides out, it's pretty impressive — a bit like a cash register!

The drawer itself is dished, with moulded rings to guide you in loading each standard size of disc.

From the front, the player looks very similar to a normal audio-only CD player — apart from the larger disc drawer. There's an open/close button, play and pause buttons, a headphone socket with volume control, and the usual fluorescent display panel to show the disc track you're playing and the playing time, etc.

Instead of a power on/off switch there's an "on/standby" switch. This seems to switch the CDV 475 into a low-power mode where it draws only 8W, instead of entirely off. I couldn't find any explanation in the manual as to why this is done; perhaps it might have something to do with preventing moisture condensation, although I'm not aware that this poses the same potential problem with optical discs as it does with VCRs.

It's at the back of the CDV 475 that you start to notice more differences, compared with an audio CD player. Along with the normal stereo audio analog outputs, there's now quite a collection of other connectors as well.

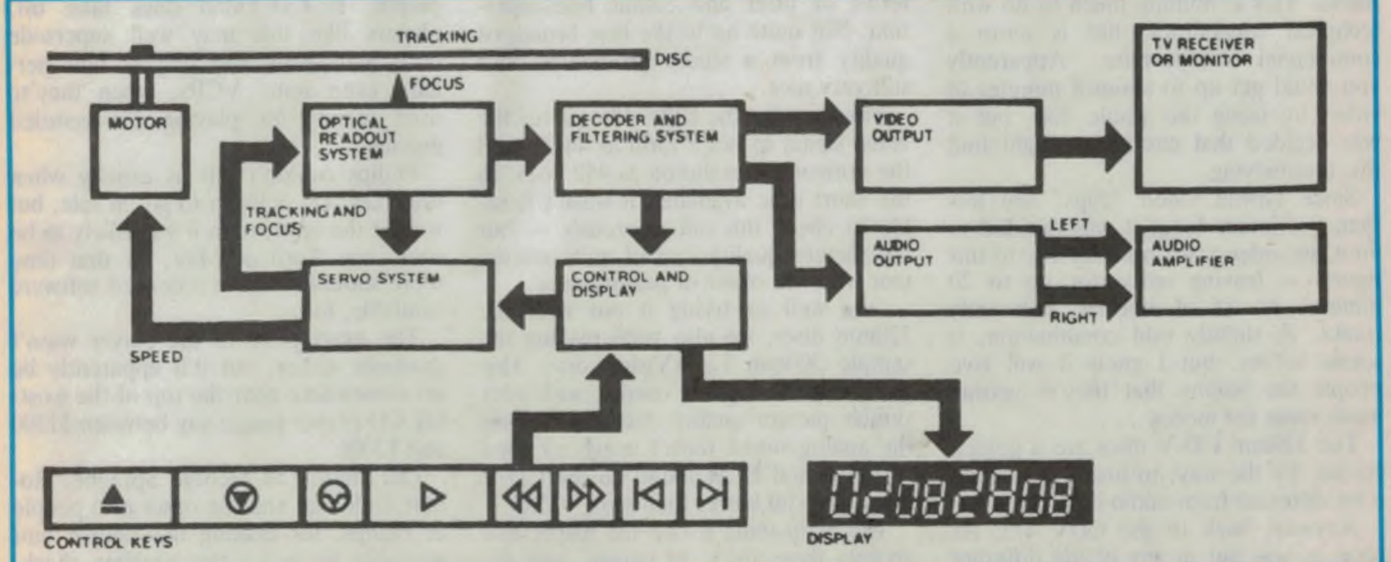
On the audio side, there's a direct digital output. This delivers 500mV p-p at 75 ohms, for feeding to an external D-to-A converter or other digital equipment.

On the video side, there's a modulated RF output for feeding to a standard PAL TV receiver on UHF channel 38. There's also a matching Antenna In socket, so you can connect the CDV 475 permanently into the normal antenna line. Like a VCR, it automatically switches the antenna signals through to the TV when you switch it to "Standby".

For those with a TV or colour monitor accepting composite video input, the CDV 475 also provides a direct video output. And just for good measure, there's also a 21-way Euroconnector/-Scart socket, providing stereo audio, composite and RGB video signals. A matching cable comes with the player to connect it to receivers provided with this type of connector.

So there's a great deal of flexibility possible, in the way you can connect the CDV 475 to your stereo system and TV set/monitor.

Oh — by the way, the player comes with its own cordless remote control unit, complete with a rather bewildering



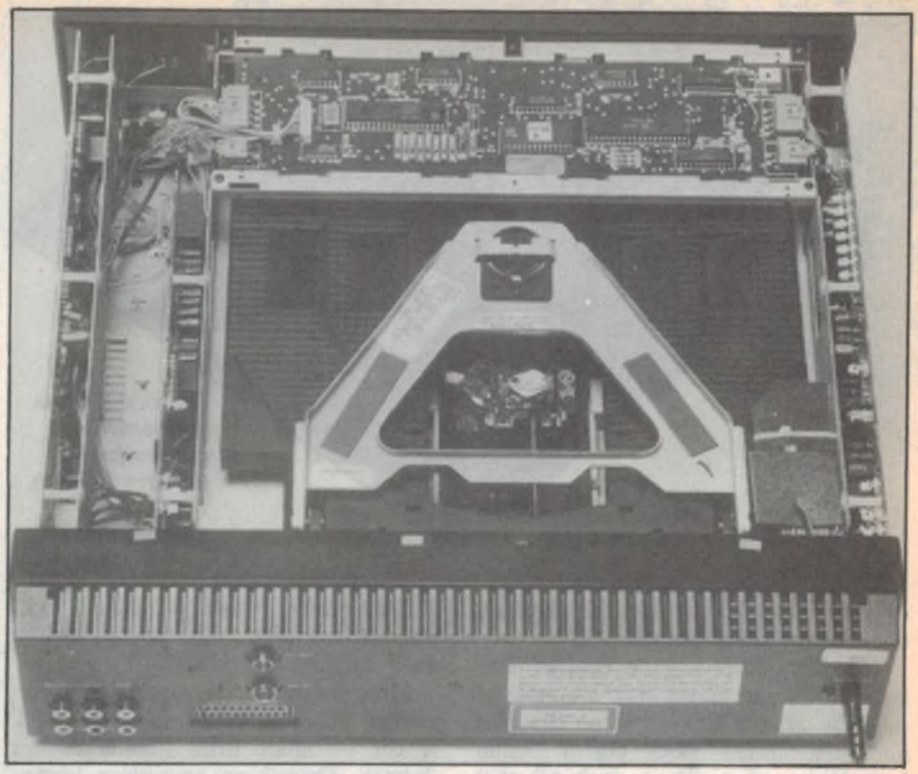
A simplified block diagram of the circuitry inside the CDV 475, showing the way it works. As with many modern appliances, a microprocessor controls most of the functions.

CDV 475

array of control buttons. The range of control functions available here is very wide, much wider than is provided by the main front panel. Fairly obviously the CDV 475 is intended to be driven mainly from the remote control.

It's only when you connect up the player for use and turn everything on, that you notice another important feature of the CDV 475: as well as using its own little fluorescent panel for status indication, it also uses the TV screen. Very smart!

In fact you soon find yourself ignoring the player's own display, and looking at the TV screen to see what's going on — even when you're playing only a normal audio CD.



Inside the player. A single drive spindle is used for all size discs.

Checking it out

The first thing I tried with the CDV 475 was playing a few ordinary CDs, familiar and high-quality ones from my small collection. Predictably, they sounded as you'd expect — excellent. The player uses 4 times oversampling with digital filtering, and has dual 16-bit converters, with a quoted signal to noise ratio of better than 100dB. A few quick measurements with the test disc suggested that everything on the audio side was well and truly up with the latest CD-player standards.

Next I tried the sample 120mm CD-V discs, which have a single video "clip" plus a number of audio-only tracks.

By the way, the standard for these 120mm CD-V discs is for them to have up to 6 minutes of video (with its own digital PCM audio, of course), plus up to 20 minutes of normal audio-only tracks. This is nothing much to do with technical capabilities, but is more a commercial compromise. Apparently you could get up to about 8 minutes of video by using the whole disc, but it was decided that customers might find this unsatisfying.

Since typical video "clips" are less than 6 minutes long, it was decided to limit the video track on each disc to this figure — leaving space for up to 20 minutes or so of normal audio-only tracks. A slightly odd combination, it seems to me, but I guess it will give people the feeling that they're getting more value for money . . .

The 120mm CD-V discs are a golden colour, by the way, to make them look a bit different from audio-only discs.

Anyway, back to the CDV 475. As soon as you put in any of the different kinds or size of disc, it automatically senses both the size, type and recording system. These are indicated on both the front-panel display and the TV screen (if you have the TV turned on and tuned to channel 38, of course!).

With a 120mm CD-V disc the player also automatically finds the video track, and starts playing it unless you direct it otherwise.

The picture quality produced from the sample discs that came with the player was very good indeed — with resolution and noise level both noticeably better than from most VCRs. The picture was also very stable, both in terms of jitter and colour hue/saturation. Not quite up to the best broadcast quality from a studio production, but still very nice.

The spec for the CDV 475 quotes the video signal to noise ratio as 44dB, and the horizontal resolution as 450 lines. In the short time available, it wasn't feasible to check this out rigorously — but the picture quality looked quite consistent with this order of performance.

As well as trying it out with the 120mm discs, we also tried playing the sample 300mm LaserVision disc. This gave almost as good results, with very similar picture quality. Needless to say the analog sound wasn't nearly as good as the digital PCM sound on the CD-V discs, but still better than most VCRs.

The main thing is that the player also accepts these discs, of course, and delivers the kind of results they're capable of providing. It certainly seems to. The sample disc was actually rather scratched, but it tracked and played faultlessly.

By the way the CDV 475 features a new linear tracking mechanism, which includes an additional "tilt" servo to ensure that the laser pickup beam is always kept at the correct tracking angle. Judging by the performance of the sample, it certainly seems to work.

So there it is. The new Philips CDV 475 certainly seems a nicely made unit, with the potential to become a true multi-medium home entertainment player. If CD-Video does take off, players like this may well supersede both audio-only CD players and perhaps even some VCRs, when they're used mainly for playing pre-recorded movies.

Philips couldn't tell us exactly when the CDV 475 is likely to go on sale, but we got the impression it was likely to be soon: say April or May. By that time there should be quite a deal of software available, too.

The exact price of the player wasn't available either, but it'll apparently be set somewhere near the top of the existing CD player range: say between $1500 and $2000.

Our thanks to George Sprague, Robert Goldman and the other nice people at Philips, for making the sample unit available to us for this preview checkout.

CD-Video Preview — 2:

Pioneer's CLD-1050 CD-V/LD/CD player

Before we'd even finished our first CD-V player checkout, there came the chance to test another — this time from Pioneer. Needless to say we were just as interested to try out this one too, especially as it's a full production model and already available in Australia via Pioneer outlets.

by JIM ROWE

Sometimes new technology seems a bit like the traditional tomato sauce bottle — first none'll come, and then a lot'll. So it was that just as we were taking this month's cover photo, before sending back our first sample CD-Video player, another player arrived on our doorstep from Pioneer. It was very interesting to put it through its paces as well, with the other one still fresh in our minds.

Like the other unit already discussed, the Pioneer CLD-1050 is a combination or multi-format player. It will play not only the new CD-Video discs and conventional audio CDs, but existing LaserVision video discs as well. And in the three standard sizes: 120mm, 200mm and 300mm. It automatically detects disc size, and also the recording format used, as soon as you slip the disc into its front-loading drawer and press the Open/Close button.

In fact like the other unit, the only kinds of optical video disc it won't play are those recorded in NTSC format, for use in Japan and the USA. But that's a limitation of the CD-V and LaserVision systems, of course — not the players as such. The video is recorded on the discs in composite form (using frequency modulation), so different *video*discs must be used for each system as well as different players (although audio-only CDs will play perfectly on either). Sad, but true.

Unlike the other unit, which was actually a pre-production sample, the CLD-1050 is actually a full production model. Paul Clarke of Pioneer assures me that they have good stocks, and if any of our readers want to be first on the block to buy one, they're available "right now" via Pioneer dealers.

You may not have a great deal to play on them for a little while, except normal audio CDs and of course existing LaserVision discs, but at least the players themselves are available. So in that sense, Pioneer certainly seems to have stolen a march on its competitors, and given CD-V its real "over the counter" Australian launching.

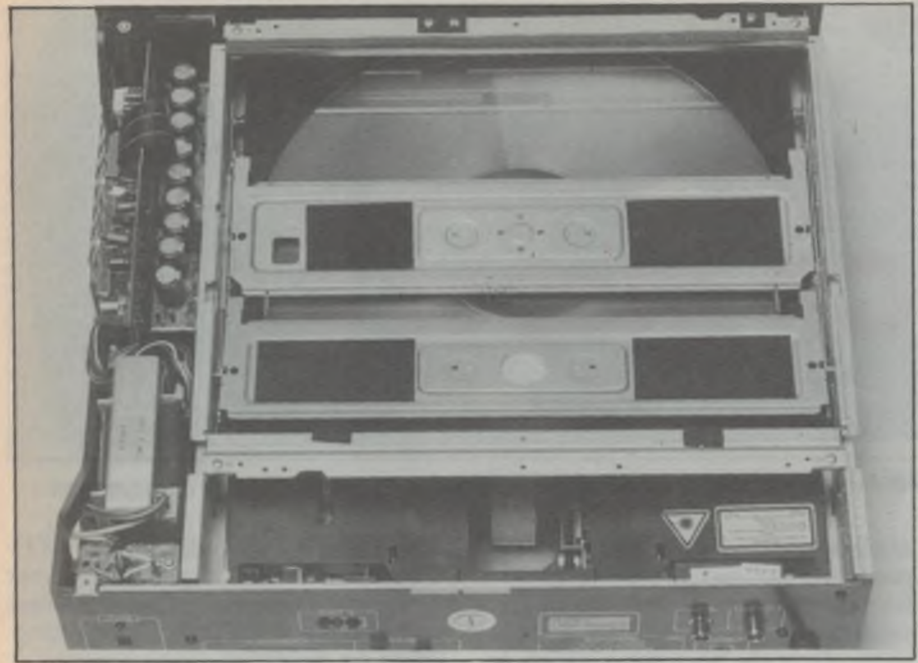
No doubt the rest of the market won't be far behind now, especially once the first releases of CD-V discs take place. That may even have happened by the time you read this.

But back to the CLD-1050 player itself. It's a little deeper and higher than the other unit, measuring 420mm wide by 411mm deep by 120mm high. It's also a little heavier, at 11.5kg. However this is hardly very important, as you're not likely to want to lug it around much — it's the kind of gear you plant permanently on a shelf with the rest of your video/hifi system.

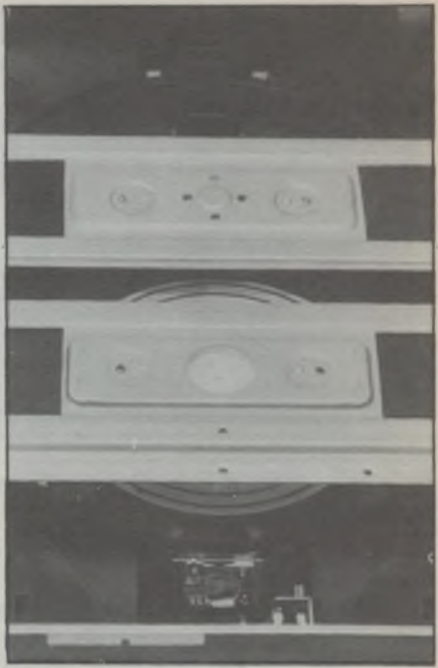
The main thing you tend to notice on the front panel is again the large front-loading disc drawer, big enough to take the largest 300mm discs. Apart from that there's much the same control buttons as you'd find on a standard CD player: scanning and search buttons, Play/Pause, drawer Open/Close, and Power On/Off. Plus the usual fluorescent display panel to show the track information and playing time, etc.

There's also a fairly standard IR-linked cordless remote control unit, although with a few extra keys to cope with the additional functions: a TV/video button for video program source switching, a key to select audio channels (in the case of video discs with bi-lingual audio, rather than stereo), a key to enable or disable display of track/frame information on the TV screen, and so on. Apart from these, it's much the same as you'd find with most modern audio-only CD players.

As before, it's at the rear of the CLD-1050 that you notice more differences from a typical audio CD player. As well as the usual audio outputs to hook up to your stereo amp, there's a pair of RF connectors marked Antenna In and TV — just as you'd find on the back of a VCR. There's also a small



Inside the CLD 1050, when it's playing a 300mm LV disc. These play on the main spindle, nearer the front.



Closeup of the insides when playing a 120mm CD-V disc. These and normal audio CDs play on the rear spindle, which swings down out of the way to play the larger discs.

screwdriver control to fine tune the player's RF output, anywhere between channels 32 and 40 in the UHF band.

But if your TV set has a direct video input, you can also hook up the CLD-1050 this way too, and this will give rather better picture quality. The player provides both a BNC-type video output and a European/SCART type combination connector, for those whose TV set provides this kind of socket.

The player also provides a pair of miniature jacks marked Control In and Out. These are presumably for use with Pioneer's proprietary system for overall remote control.

About the only kind of connectors the CLD-1050 doesn't seem to be provided with are digital audio outputs. The other CD-V player we tested did have these, although at this stage they do seem rather redundant.

What we found

We tried out the CLD-1050 with the same sample CD-V and LaserVision discs used with the other player, together with some known good standard audio CDs. We also gave it a checkout with a CD test disc, to get a good idea of its audio performance.

On the audio side, it turned out to be fine. As far as we could tell, it easily met its specs, which are fairly typical for current CD players: 98dB S/N ratio, 95dB dynamic range, 92dB channel separation, THD below .005% and virtually unmeasurable wow and flutter. The player uses double frequency oversampling for simpler filtering, and has a quoted frequency response of 4Hz — 20kHz within 1dB. It delivers 200mV RMS per channel, for both digital audio from CDs and CD-Vs, and analog audio from LV discs.

Incidentally it also provides a decoder for the CX noise reduction system, as used on some of the later LaserVision discs. We didn't have a CX-encoded disc to try this out, but apparently it does give quite an improvement over discs with unencoded analog audio.

The CLD-1050 manual gives very little information on the video performance of the player. However from our checkout with the sample CD-V and LV discs, it appeared to perform at least as well as the other player we tried, with its quoted 450 lines of horizontal resolution and 44dB of video S/N ratio.

Ideally we'd like to have a video test disc to explore this further, or at least some more program discs with higher quality picture material. However neither of these were available, so you'll have to bear with us when we're a little guarded in our report on picture quality.

The best way to summarise is that like the other player, CLD-1050 picture quality was very clean and stable. The pictures were steady, sharp and with good good colour stability. Resolution seems better than from VCRs, but not quite up to the standard of the best broadcast material.

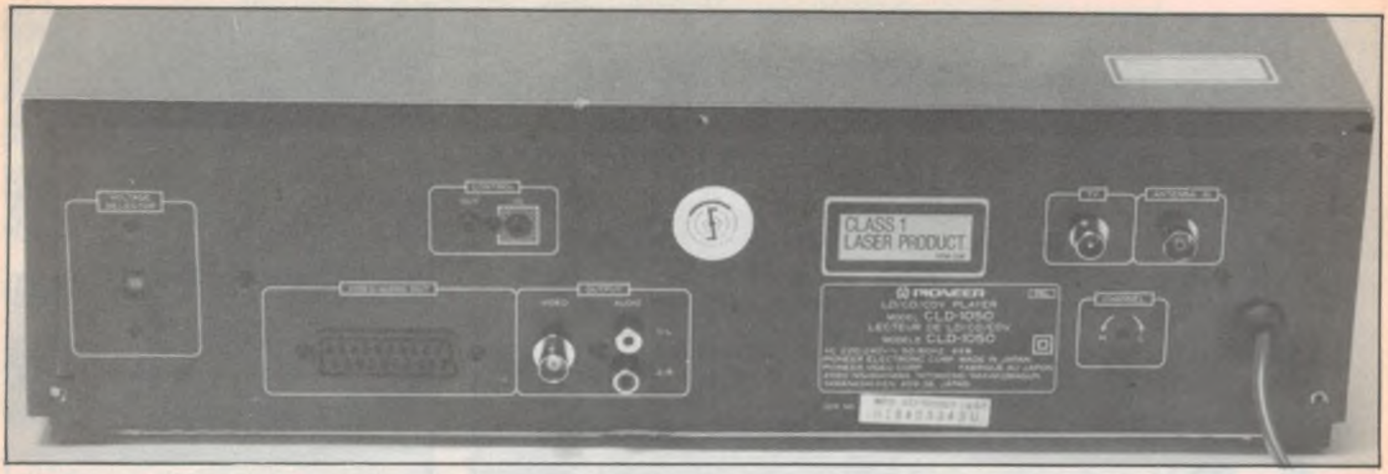
Out of curiosity, we carefully took off the CLD-1050's top cover, to see how its works looked in comparison with the other player. It was rather more complicated mechanically, as you may be able to see from the photos.

Unlike the other player, which played all discs on a single drive spindle, the CLD-1050 has two separate spindles: one for the larger 200mm and 300mm discs, and the other for 120mm CD and CD-V discs. The latter spindle and its associated drive motor actually swing down underneath, when a larger disc is being played, and only swing up into playing position when they're needed.

In fact we couldn't resist watching the player mechanism doing its thing, with the cover off. It's pretty straightforward with a large disc, which is simply lowered onto the main drive spindle as soon as the drawer closes. The disc is then wound up to its running speed (1500rpm), and play begins.

But with the 120mm discs, all sorts of things seem to happen. First the laser pickup sled zots back towards the rear, then the second drive motor and spindle swing up into position, and the sled moves back just behind them. Then part of the main disc drawer moves back, carrying the disc itself back to a position over the correct spindle. Then finally it's lowered, and starts spinning so that the laser can read the ID information. If the disc is a CD-V type, the sled then whips out to the start of the video track, to play it first. Fascinating!

Of course from the user's point of view, all of this is quite transparent. All



Rear view of the Pioneer CLD 1050. Note the direct video and audio outputs, also the European/SCART combination connector.

you've had to do is plunk the disc in the drawer and press the button . . .

By the way, the CLD-1050 also provides much the same fancy track selection, video frame selection, replay speed range and freeze frame facilities provided by the other player. I suspect most CD-V players will provide pretty well all of these features as standard — although I also suspect that most people will rarely use them.

All in all, then, Pioneer's first CD-Video player certainly seems to be nicely made, and to deliver the CD-V goods. At the quoted price of $2499 it isn't exactly cheap, but considering it's a videodisc player as well as a digital audio player the price doesn't seem unreasonable — particularly for the first model to actually hit the market.

If you still haven't bought an audio CD player, or are thinking of upgrading from your existing player, the CLD-1050 might well be worth considering. Not just so you can be first on the block to have a CD-V player — but because it's so flexible. The odds are the CLD-1050 could become the centre of your home entertainment system, if Pioneer and Philips and the other CD-V protagonists are successful.

No doubt this will depend on the availability and price of CD-Video discs, so it'll be interesting to watch developments.

For information on your nearest dealer able to supply the CLD-1050, contact Pioneer Electronics Australia at 178-184 Boundary Road, Braeside 3195.

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The Vifa/EA 60+60 loudspeaker kit has been designed to completely out perform any similarly priced speakers. This is a 2-way design incorporating drivers which give a deeper, more natural bass response and 19mm soft-dome ferro fluid cooled tweeters which provide clear, uncoloured sound reproduction.

These Vifa drivers are identical to the ones used in such fine speakers as Mission, Rogers, Bang & Olufsen, Monitor Audio and Haybrook just to name a few. Some of which cost well over $1,000 a pair!

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The fully enclosed acoustic suspension cabinets are easily assembled. All you need are normal household tools and a couple of hours and you've built yourself the finest pair of speakers in their class!

D19 TWEETER SPECIFICATIONS:
Nominal Impedance: 8 ohms
Frequency Range: 2.5 - 20KHz
Free Air Resonance: 1.700Hz
Sensitivity 1W at 1m: 89dB
Nominal Power: 80 Watts (to 5,000Hz, 12dB/oct)
Voice Coil Diameter: 19mm
Voice Coil Resistance: 6.2 ohms
Moving Mass: 0.2 grams
Weight: 0.28kg
Cat. C10301 **$38**

C20 WOOFER SPECIFICATIONS:
Nominal Impedance: 8 ohms
Frequency Range: 35 - 6,000Hz
Resonance Frequency: 39Hz
Sensitivity 1W at 1m: 90dB
Nominal Power: 50 Watts (12dB/oct)
Voice Coil Diameter: 25mm
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Mount your speakers at ear level on your wall!!
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MICROPHONE SPECIFICATIONS:
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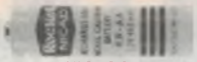
Transmitting System: crystal oscillation
Microphone: Electret condenser
Power Supply: 9V battery
Range: 300 feet in open field
Dimensions: 185 x 27 x 38mm
Weight: 160 grams

RECIEVER SPECIFICATIONS:
Recieving Freq: 37.1MHz
Output Level: 30mV (maximum)
Recieving System: Super heterodyne crystal oscillation
Power Supply: 9V Battery or 9V DC power adapter
Volume control
Tuning LED
Dimensions: 115 x 32 x 44mm
Weight: 220 grams

Cat. A10452 .... R.R.P. $113
Our price, $99



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1/4" shaft.
Equiv (Bourns 3540S. Beckman 7256)
Dials to suit 16-1-11, 18-1-11, 21-1-11

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R14055	100R	R14110	10K
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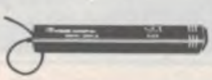

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Tuneable: 92 - 104MHz
Freq. Response: 50 - 15kHz
Range: Over 300 feet in open field
Modulation: FM
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P10904	DB25P R.A. Plug	$4.50
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Sound Pressure Level 10V RMS: 110dB min.
Sensitivity (dB/v/ubar) min.: -65 min.
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Transmit: 4.0 (at 100dB)
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Cat. L19990 (Transmitter) **$4.75**
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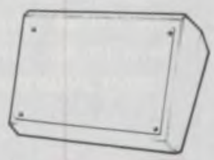

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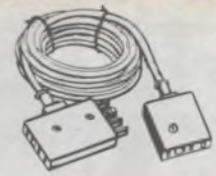

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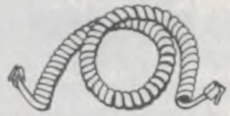

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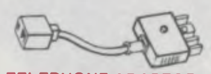

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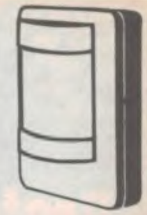

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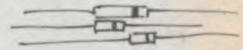

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SPECIFICATIONS
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- Size 72 x 38 x 21mm

A16100 .... **$69.95**

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A16150 .... **$69.95**

Pubs & clubs getting direct satellite broadcasts

Entertainment and news programs broadcast from private TV stations are being received in pubs and hotels directly via a satellite, in addition to conventional broadcasts. What are the pubs and hotels receiving and who is providing it?

by PAUL GRAD

Those fairly large antenna dishes you may have noticed at the back or on the roof of a hotel or pub in the city are to receive TV transmissions coming directly via a satellite.

These transmissions are beamed down directly from one of the three Aussats now sitting in space above us and acting as relay stations for TV and other signals.

What are these satellite transmissions and who is sending them?

They are special transmissions such as sports, news and entertainment programs. Completed and edited before being sent up to a satellite, they are self-contained and may or may not have commercial content.

These transmissions are broadcast by one of two privately-owned TV stations, both based in Sydney: Sky Channel and Sportsplay.

Sky Channel transmits directly up to a satellite using Aussat's earth station at Sydney's outer suburb of Belrose. Sportsplay's finished programs are directly sent up to a satellite by AAP-Reuters in the nearby suburb of Glebe.

Sky Channel, which is incorporated in Western Australia and is owned by the Bond media group, has the exclusive right to broadcast horse racing events. While the Government-operated Australian Broadcasting Corporation (ABC) presents only some of the horse racing highlights, Sky Channel broadcasts extensive coverage on them, making this a very popular program.

According to several Sky Channel subscribers, the comprehensive transmission of horse racing events is the main attraction of the Channel's programs. The Channel has recently also acquired the exclusive right to broadcast greyhound racing events.

The Channel also has access to the American ESPN cable sporting network, permitting worldwide coverage of all kinds of sporting events.

Besides sports events, Sky Channel presents the National Nine Morning News each morning at 11.30am and the National Nine News at 6pm, drawing on satellite resources from News bureaux and studios throughout the world.

It also transmits music programs, both popular and classical, concerts, star profiles and a variety of entertainment programs.

The Channel is on air seven days a week, from 11.30am to 1.00am (Eastern times). It carries a limited commercial content of up to eight minutes per hour.

Sky Channel's licence agreement with the parties receiving its transmissions is for an initial period of five years. The Channel agrees to provide a decoding device and a receiver dish, and to be responsible for all equipment maintenance.

The weekly rental for Sky Channel programs and receiving equipment is $185, which includes the maintenance of the receiving equipment.

Sportsplay uses the facilities of Broadcom House, in Sydney's inner suburb of Ultimo to prepare and edit its programs.

It is an all-sports station, transmitting events such as boxing, basketball, football, but not horse racing for which Sky Channel has exclusive rights. It has recently lost to its rival, Sky Channel, its right to broadcast greyhound races.

Its subscribers also include any private but non-domestic users such as hotels, pubs and clubs.

It offers various types of agreement with prospective subscribers, including or not the supply of receiving equipment.

The great advantage of satellite, compared with conventional, transmissions is they are much simpler, less prone to fault and of higher quality than conventional, terrestrial, long-distance transmissions. They require only one repeater (the satellite itself) instead of the large number of conventional repeaters required for conventional transmissions.

It is possible, via a satellite, to trans-

Outside the Sky Channel studio/administrative complex in Frenchs Forest, a northern suburb of Sydney.

Above: Some of Sky Channel's bank of VTRs, used for program recording and editing.

Below: The control console for one of the two studios at the Frenchs Forest Sky Channel complex.

mit simultaneously to any point throughout the country at a much lower cost than by conventional means. This, then, becomes an economically feasible approach to small, privately-owned TV stations.

Conversely, a satellite can send a signal down in a concentrated (spot) beam, resulting in a higher power arriving at the receiver. A spot beam can be concentrated on a small region such as a city, for example.

The more powerful the arriving beam, the smaller and cheaper is the necessary receiving equipment, and the more economically accessible to private parties is the signal reception.

A complicating factor is that in Australia the signal sent up to, and down from, a satellite must be encoded to prevent its unauthorised use. Thus signal decoding equipment is also required for reception.

But signal coding and decoding techniques have become extremely sophisticated and the "privacy" of the transmissions is virtually assured, thus opening the way to special transmissions paid for by the user.

It is the transponders on the Aussat satellites — the devices which receive, frequency-convert, amplify and retransmit the incoming signals — that constitute the communications resource of the satellite system.

Each satellite has 15 transponders, each of which is leased to one user. Four are high-powered transponders of

Pubs & hotels getting direct satellite broadcasts

30W each and 11 are standard-power transponders of 12W each.

These transponders, each with a bandwidth of 45MHz, can be switched in various ways to a number of transmitting antennas, providing either spot or broad (national) coverage beams. Each satellite can transmit six beams, two broad and four spot.

Both the 12W and the 30W transponders can be used to transmit either broad or spot beams. The power from each transponder can be divided in various ways among the satellite antennas, resulting in beams of various widths. For a given transmitted power, the broader the beam is, the lower will be the signal power per unit area on arrival at the Earth's surface, and the larger and costlier will be the required receiving equipment.

Provided the signals come from a high-powered spot beam, the equipment required by a private user to receive these broadcasts is relatively simple and inexpensive. It was described in detail in an article in our June 1987 issue.

Basically it consists of a parabolic reflector (the dish) between 1.2m and 1.8m diameter, a head amplifier, and a down-converter (which has to include a signal decoder if the arriving signal is encoded) from which signals can be fed to a conventional colour TV set.

The retail cost of a receive-only earth station for reception from a high-powered spot beam averages about $2500, which includes a dish of between 1.2m and 1.8m diameter and the down conversion equipment.

Sky Channel uses a 30W transponder for broad beam, national coverage. Here the necessary receiving equipment is much more expensive and includes an antenna dish of 2.5m diameter.

Sportsplay uses a 12W transponder from which a main, south-eastern beam, covers most of the country (except the far north), and a second spot beam is concentrated on Perth and its environs.

Both stations' transponders are on Aussat 2. They will soon switch to a transponder on the recently-launched Aussat 3.

Privately-owned TV stations, whether commercial or not, are not allowed, at least for the time being, to provide direct broadcast via satellite to domestic users. The only exception at the moment is a privately-owned TV station, GWN (Golden West Network) of Western Australia, which is allowed broadcasts to homesteads directly from a satellite. It provides a service called remote commercial TV service (RCTS).

GWN provides normal commercial services via satellite to homesteads all over Western Australia except Perth.

Its services are entirely free to anyone with suitable receiving equipment. Its only revenue comes from commercial advertisements. About 1400 homesteads throughout Western Australia receive transmissions originating from GWN.

GWN uses a spot beam from a 30W transponder, also on Aussat 2.

The second generation of Australian communications satellites, to be launched in 1991 and 1992, will have a larger number of transponders, including a few of 40W.

But to give an idea of what the future could hold in store, 100W transponders would make it possible to receive signals from a satellite with an antenna dish of only about 45cm diameter. The required ancillary equipment and electronics would also be simpler and cheaper.

This would make the reception of transmissions directly via satellite easily affordable to any private home throughout the country. EA

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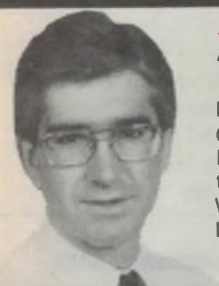

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Compact Disc Reviews

by RON COOPER

BEETHOVEN VIOLIN SONATAS

No.9 "Kreutzer" No.5 "Spring" — "Le Printemps" Itzhak Perlman — violin
Vladimir Ashkenazy — piano
Decca 410-554-2
Playing Time: 61 min 50 sec

PERFORMANCE
1 2 3 4 5 6 7 8 9 10

SOUND QUALITY
1 2 3 4 5 6 7 8 9 10

Beethoven's ten violin sonatas were written in the comparatively short time of 15 years between 1797 and 1812. There are two sets of three and four single works. By the time he came to compose the Kreutzer he had enlarged them to almost concerto proportions. Curiously, these violin sonatas are the only ones with names.

The Kreutzer is probably the greatest sonata ever written for violin and piano, and with it Beethoven brought the sonata from the private salon to the concert hall. This was at the time when public concerts were becoming established in Vienna. The brilliance of this work is shown by the fact that the two outer movements are marked "Presto". The work as a whole is one of dazzling virtuosity with its dashing tarantella finale.

The Spring sonata contains four movements, and the famous lyrical melody from the beginning is where the nickname arises. This relaxed lyricism conjure up other middle period works such as his "Pastoral Symphony", and has a delightful "Mozartian Rondo" finale.

Again this disc is recommended for anyone wishing to expand his library to violin chamber music, but not knowing what to select. This is not a disc for someone just becoming acquainted with classical music.

Soundwise the recording leaves little room for criticism. Excellent balance, almost zero noise, (you do hear artistic breathing!) and a bright but clean top end. If you over amplify the violin will sound edgy but remember, this is a recording of just two artists and the playback volume should be set accordingly. A first rate disc.

CHOPIN

Sonata No.2 B flat minor Op.35
Preludes Nos.1-24 Op.28
Howard Shelley — soloist
IMP PCD 862 DDD
Playing Time: 62 min 43 sec

PERFORMANCE
1 2 3 4 5 6 7 8 9 10

SOUND QUALITY
1 2 3 4 5 6 7 8 9 10

Here is a very new recording (1987) of Chopin's works, which although composed during his mid and late twenties show a great maturity of style, varying from tender and quiet to bold and forceful.

The Sonata No.2 in Bb minor was written during 1839, when Chopin was living with the novelist George Sand and her children at her country home. Here he enjoyed a time of good health and stability in his life.

Like the Preludes, this Sonata was expanding ideas from earlier years. The famous Funeral March was written two years earlier during a period of depression from a failed previous relationship. This state of mind was lifted though, as the relationship with Sand deepened.

The Preludes were begun in 1836 and completed during 1839. The 24 Preludes cover all of the major and minor keys.

Howard Shelley is indeed a very masterful pianist and his skillful handling of these works is a delight.

His interpretations are inclined to be more forceful than others but overall quite excellent. He was the first-ever pianist to perform the complete solo piano works of Rachmaninov and has recorded these on seven discs.

And this recording, — well, I must admit to being a little sceptical with new budget labels, but this recording has an overall very full sound which can only be described as stunning. I can only rate it virtually tops in all respects especially in playing time and price ($19.99).

MAHLER

Two discs
Symphony No.7
Frankfurt Radio Symphony Orchestra
Conducted by Eliahu Inbal
Denon 60CO-1553-54 DDD
Playing Time: (Disc 1) 37 min 27 sec (Disc 2) 40 min 29 sec

PERFORMANCE
1 2 3 4 5 6 7 8 9 10

SOUND QUALITY
1 2 3 4 5 6 7 8 9 10

The Mahler 7th Symphony is linked in similarity to the 5th and 6th, and form his middle writing. They have no vocal parts and could be said to be based on musical impulses.

It is interesting that in earlier writing Mahler had a polyphonic conception of

the music and considered a work finished when the final draft was playable on the piano. However, in these symphonies orchestral sonorities played an important part and required Mahler to hear the works played before the instrumentation was finalised.

For the first performance of this symphony Mahler demanded some 20 rehearsals and tried to improve the orchestration step-by-step. According to his wife Alma, it was not until his 8th symphony that he was completely certain of himself.

This new recording is one of those rare events which seems from the very first note to take your breath away. I almost could not believe the difference in the musical experience that I heard between this recording and an older vinyl version. The tempos are not hurried and the sound just pours out from the beginning, with this tremendous orchestral sound right from the thunderous bass drum rolls in the first movement to all the subtle sonorities throughout the work.

My only criticism is the time, which would possibly just make it on one disc. The quiet ambient atmosphere is awe inspiring and the natural acoustics make you wonder how the engineers have achieved such a result. The answer was in the notes. Always I feel the most important part in any recording is the microphone technique. At some concerts recently in the Sydney Opera House I have counted over 20 microphones throughout and around the Sydney Symphony Orchestra.

Here in this recording they have used predominantly just two mikes — and B and K 4006's at that! Nothing like simplicity to reproduce complex music such as this.

This is a rare event and my first where I feel the disc deserves a 10/10 rating. I say no more! EA

Singapore's electronics industry is surging ahead

One of Australia's closest neighbours, Singapore is rapidly building up a strong and vigorous electronics manufacturing industry. Many of the well-known US and Japanese firms have transferred production facilities to the republic, to take advantage of its resources.

by ZAKARIA BUANG

Five-hundred thousand portable stereo tape recorders a month. That's the target Matsushita has set for its newly renovated manufacturing plant in Singapore. The Japanese consumer electronics giant now has seven subsidiaries in the republic, employing more than 7,000 workers.

American disk drive maker Micropolis is also gearing up its operations. Just over a year old, its plant is to produce a more powerful 170-megabyte Winchester disk drive this year. Production of high performance 85-megabyte disk drives is not in full swing.

Micropolis is growing so fast that it has increased its total workforce from 300 in August 1986 to 1050 at present. The company is still recruiting more people. It added another 1200 square meters to its present three floors, of a flatted factory in July.

Similarly, for SGS Semiconductor, 1987 will be its busiest year. As one of the world's leading electronic components companies, the Italian multinational corporation enjoys an increasing market for its semiconductors, with the Asia-Pacific market growth estimated about 30% a year over the next few years.

Matsushita, Micropolis and SGS are part of Singapore's thriving electronics industry. Representing the consumer, industrial parts and components of the industry, they are experiencing a healthy growth amid Singapore's economic recovery. After a six per cent decline in business in 1985, the electronics industry emerged as the number one industry last year, recording the highest growth of 28%.

With an output of almost $US6 billion, it eclipsed the oil-refining industry which had dominated the economy in the 1970s and early 1980s. It has been one of the top three industries for the last five years.

The Economic Survey of Singapore 1986 disclosed that the improved performance was the result of cost-cutting measures taken at the beginning of 1986 to reduce labour costs and other operation costs, hold down wage increases to restore Singapore's competitiveness.

Coupled with the appreciation of the Yen and European currencies against Singapore dollars, the industry saw new investments and expanded production by multinational corporations already in Singapore. This further boosted the export of non-oil products.

The main impetus to growth in non-oil domestic exports, which rose by 20%

Although barely a year old, the Singapore plant of US firm Micropolis Inc is exporting large numbers of 85 and 170MB hard disk drives.

Singapore's electronics industry has come along way from making simple transistors and assembling low-tech equipment. Its electronics industry now has the latest hi-tech production plant, and with an annual output of $US6 billion became the country's largest industry in 1986.

to $US10 billion last year, came from strong external demand for disk drives, integrated circuits, printed circuits, radio and television sets, and garments.

The export of disk drives increased significantly as a result of a pickup in the global demand for personal computers. Export of integrated circuits grew sharply by 9%, compared with a drop of 8% in 1985.

Export of radio and television sets increased by 14% after more Japanese multinationals moved production of consumer electronic products to Singapore and expansion of production by European manufacturers, Thomson and Philips.

Heavy investments by the industry in R&D have also enabled it to forge ahead of its competitors.

Furthermore, the electronics industry has upgraded from a labour-intensive to a highly capital-intensive industry. The semiconductor industry, for example, has a fixed asset level per worker of $US33,000. This is approximately 20% higher than that of the traditionally capital-intensive machine tool industry. There are 240 electronics companies employing about 70,000 to 80,000 people.

The growth of Singapore's electronics industry has also seen a diversification of its exports. From almost a complete domination by consumer electronics, exports of electronics have now shifted to a balanced combination of 20% consumer electronics, 40% electronic components and 40% industrial electronics.

The development of the electronics industry is as old as the history of independent Singapore. It was about 20 years ago that Singapore's first electronic product, a black and white television set, was assembled. Almost all the parts had to be imported in kit form. Today, most of the components required for the manufacture of colour television sets, stereo audio products, computers and computer peripherals are sourced directly from Singapore-based manufacturers. The industry now runs the whole gamut of electronics production, from sophisticated silicon wafer fabrication to run-of-the-mill assembly of audio equipment and television.

In fact, Singapore has now become the largest manufacturer of disk drives, with Seagate Technology, world leader in micro disk drives, producing 11,000 units a day.

Production in other disk drive companies such as Miniscribe and Micropolis is also in full swing, though most of them have been here for less than a year.

Micropolis, a computer peripheral company, started production in April 1986 and three months later, the 85-megabyte Winchester disk drives passed all the extensive tests conducted in Singapore and the US. Since then the company, which had invested $US10 million, has been shipping the disk drives to customers in America and Europe. The company supplies disk drives to manufacturers of mini-computer and micro-computer systems which are used for CAD/CAM (computer-aided-design / computer -aided manufacturing, engineering work stations and multi-user business systems.

"Our consistently good quality has enabled the company to have ship-to-stock status with several of our customers, that is, these customers do not inspect our drives before installing them into their computer systems," said Mr Wong Lin Hong, the company's managing director.

Mr Wong disclosed that its corporate strategy is for the parent company in the US to concentrate on R & D work and pilot production, and to transfer products to Singapore for volume production. The production of 170-megabyte disk drives in 1987 is a case in point. "It makes sense because production costs are lower here. Furthermore, Singaporean workers can manufacture high technology, high quality production at a very competitive cost," said Mr Wong.

The Singapore plant will account for more than 75% of the group's total revenue this year. Last year, the group registered $US225 million sales worldwide.

Said Mr Wong, "The prospects are good because the computer market is continuing to grow. Software packages are getting more powerful and user-friendly, hardware costs continue to decrease and computer users are now more realistic and have greater understanding of what computer can and cannot do."

"All these contribute to the growing computer market and our company will enjoy and be part of this growth."

The electronic components industry is also growing rapidly. SGS Semiconductor, one of the oldest semiconductor companies in Singapore, has pumped about $US108 million in capital investments into its operations here.

Mr Paul Nicklinson, SGS Public Relations Manager-Asia Pacific, disclosed that the investment has resulted in a four-fold jump in output and a five-fold increase in productivity, while its operations workforce remains at around 1550.

Set up in 1969, the company's Singapore plant has been upgraded into a class-10,000 clean room environment and from producing simple power transistors to an assembly and test plant for high technology integrated circuits and EPROM devices. The plant supplies 65% of the company's Asia-Pacific market.

SGS Semiconductor's confidence in Singapore is reflected in its decision to set up another plant in Ang Mo Kio Industrial Park. Opened in late 1984, it houses the Microchip Design Centre and wafer diffusion modules, bipolar linear and power transistors. The plant also serves as SGS headquarters for the Asia-Pacific region.

Said Mr Nicklinson, "In terms of cost, productivity and quality, the Singapore plant is equal to, if not better than other SGS plants."

"1987 has been our busiest year. To date, the Asia-Pacific is increasing its business by 82% over the last year. This is because more Japanese companies are expanding their operations in Asia-Pacific and new companies are starting operations in this region."

SGS at the end of 1986 was ranked number 16 in market share of integrated circuits and ranked number five in market share of power transistors worldwide.

SGS Asia-Pacific will contribute 20% of the company's worldwide revenues this year. It is supported by 3264 employees and three plants with a current total investment of $US163 million.

While multinationals are enjoying better times, the business pickup has also benefited local electronics companies. Venture Manufacturing (Singapore) Pte Ltd is one of them. From a mere $US2.5 million annual turnover in 1985, a year after operations started, the company chalked up a $US9 million turnover in 1986. The company, which does contract manufacturing for products like modems, power supplies and display typewriters, expects 1987 sales to go up further to $US13 million.

Venture's strategy is to convince its American clients what Singapore can offer in terms of cost-saving. "Don't talk to us if we can't save at least 15 to 20% in materials, labour and related costs," boasts the company's brochure.

"Our strategy," explained Miss Sharon Tay, Venture's finance and administration manager, "is to offer competitive costs in labour and materials, and high quality products, in addition to Singapore's political stability and its location in a region where growth is fastest."

She said that the Americans find these very attractive because the recession has pushed them to trim their costs and look at the Far East for cheaper sources.

Aggressive marketing and the ability to satisfy customers' requirements play an important part in building up Venture's reputation. Last year the company received a grant from the Singapore Trade Development Board (TDB) to set up a marketing office in the US.

"In our kind of business, we have to be where our clients are," said Miss Tay, adding that the presence of TDB and EDB (Economic Development Board) offices in the US also helps to boost exports.

However, Miss Tay stressed that for the industry to sustain high growth, Singapore must continue to keep its costs low and strive for a quality and productive workforce. This is because the industry is competing not only with the other developing countries, such as South Korea and Taiwan, but also the developed countries like Japan, the US and Europe.

Said Singapore's Minister for Trade and Industry, Brigadier-General (Reservist) Lee Hsien Loong, "A key factor of success is cost competitiveness. During a recession, the highest cost producer will be the first to leave the market. Therefore our industry places a high priority on keeping our costs down, and manufacturers should capitalise on this."

For Venture, cost effectiveness is the main consideration for future expansion. As Miss Tay put it, "Our philosophy is to be prudent. Even if we were to expand, we would do it with cost in mind."

Matsushita, a consumer electronic company, is also expanding. It is pumping another $US75 million over the next two years into its seven subsidiaries in Singapore.

Mr S. Yashiki, Senior Manager of Matsushita Electronics (S) Pte Ltd, one of the seven subsidiaries, said that the rising value of the Yen is one of the major factors for the company's expansion in Singapore.

Furthermore, labour and material costs are more competitive in Singapore than in Japan. About 50% of the design work is now performed locally, because it is cheaper to do it here.

Said Mr Yashiki, "Cost effectiveness is very important to us because customers want quality products at very competitive prices. If we can save costs and maintain the quality of our products, then we will be in a better position to compete."

The company's main market is the US, which consumers half the production 20% is exported to Europe and 30% to Southeast Asia and the Middle East. Annual output is expected to increase to $US150 million in 1987 up from $US125 million in 1986.

Although the future looks bright, Mr Yashiki was quick to point out that the company needs to stay competitive and to continue searching for new suppliers which offer low cost, high quality materials.

In the area of R & D, the company is gradually transferring its know-how to Singaporeans to enable them to produce more locally designed, high quality but cheaper products.

Having proven its resilience during the recession, the Singaporean electronics industry seems poised to grow further in tandem with the recovery of the economy.

Silicon Valley NEWSLETTER . . .

Chip makers fight rising costs

When Seeq Technology was churning out chips faster than it could test them this summer, the San Jose company's test-area manager was 3,000 miles away, groping in the dark for a light switch and a quick solution. Frank Zamora was scavenging in a big chip maker's shuttered-up plant, in search of used test equipment that his company couldn't afford to buy new. He found the machines after peering under dozens of dust covers and warmed them back to life for a test.

But his mission was far from over. Despite hopes for a rapid deal, negotiations turned tortuous, and he aborted a hastily arranged plan for high school football players to crate the sensitive equipment. Finally, Zamora acquired the equipment for a bargain price, and quickly shipped it home.

Zamora's odyssey through layers of large chip maker's bureaucracy and through its East Coast plant is just one example of the creative manoeuvering that keeps little chip makers like Seeq above water. Throughout Silicon Valley, scores of small firms are bucking the odds by finding clever ways of doing more with less.

Cost-cutting is a critical issue in the chip industry. At an industry conference recently Gordon Moore chairman of Intel of Santa Clara said the average price of a piece of chip-making equipment has grown 100-fold since his company opened its doors 19 years ago. The cost of research also has mushroomed.

For example, Moore said a lithography machine — a common piece of chip-making equipment — cost about $US12,000 in 1968. Today, the price is closer to $US1 million.

Some industry officials believe the costs of competing have skyrocketed to such a point that only heavyweight chip makers can survive. That's a minority viewpoint, but rising costs certainly have been a factor in the recent mergers of such industry heavyweights as Advanced Micro Device and Monolithic Memories and National Semiconductor and Fairchild Semiconductor.

However it's the newer, smaller firms that must really scrape to get by. A decade ago, startups found it comparatively easy to live off their ideas for new technology. Today, they must watch every penny and duck in and out of markets too small for revenue-hungry giants to stick their hands into.

Cypress Semi's CEO T.J. Rodgers

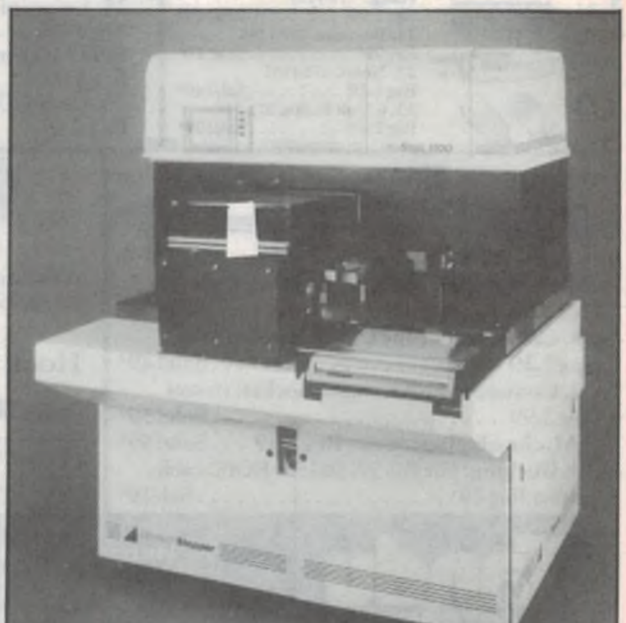
T.J. Rodgers, chief executive and president of Cypress Semiconductor, whose sales reached $US51 million last year, said his technicians know the firm's only wafer stepper must never fail. "I'm not going to buy a $1 million insurance policy," Rodgers said, "We'll be well over a $100 million company before we buy a second machine".

At Sensym in Sunnyvale, engineers with no laser expertise designed their own laser trimmers — machines used to fine-tune a chip's circuitry — with readily-accessible parts. The cost was under $US150,000, compared with $US300,000 for a new machine, said Saeed Nasiri a Sensym vice president.

Technicians at Seeq found a way to recycle the tiny probes that are used to test individual circuits on a chip. Each year, Silicon Valley companies throw away hundreds of thousands of the $5 probes. Thanks to the invention, Seeq can re-use much of its stockpile.

Seeq learned the hard way how to watch its costs. A few years ago, deluded by its own success, the company spent exorbitantly on additional office space, furniture and expensive equipment, Seeq's sales soared, but the company lost millions. Larger firms spotted its growing market for EPROM memory chips. Seeq was quickly squeezed out of the market, because its larger competitors were better suited for high-volume production and because Seeq's unneeded expenses weighed down the company.

"We just couldn't play with the big boys," said Daniel McCranie, Seeq's chief executive and president. McCranie became president in March 1986, shortly before the company reached the end of its rope. In late May that year, Seeq had $US30,000 in the bank just a



Illustrating the type of IC production equipment that chip makers must invest in, this model 1100 wafer stepper comes from Ultratech Stepper in Santa Clara. Steppers like this cost up to a million US dollars each.

few days before it needed to issue $US300,000 in paychecks.

Teetering on the brink of bankruptcy, Seeq learned to think like a start-up again and staged an impressive turnaround. Top executives toiled to find money, shed some of the firm's weighty debt and realigned its market strategy. Below deck, employees logged countless hours — and sometimes spent the night in conference rooms and corners — to meet customer orders, production and design goals.

Seeq which has sales of $US45 million and about 400 employees, recently announced its first profit for a fiscal year. But its workers aren't letting up. "It's sort of hard to slow down when you see your co-workers working so hard," said Roland Garcia, a Seeq technician. "When there's work to do, it's good for the company. The company is getting healthy".

Today, Garcia and other test and maintenance technicians work every other weekend, so they routinely log 12 consecutive days in the shop. "You could spend seven days a week 12 hours a day here sometimes", said David Laughlin, a test engineer. "Nobody I know has a problem with that."

McCranie added "We still have the mentality of saving every nickel. I don't know what's going to happen in the future. But I know that the people feel this company is worth saving. I've seen it".

Seagate working on laptop drive

Seagate is readying a 3.5" Winchester hard disk drive aimed at the market of powerful compact lap-top computers. The company has given key customers a look at the product, developed under the code-name "Omni". Company president Al Shugart said no pricing or shipment dates have been set, as Seagate is still retooling one of its facilities to handle production of the drive.

The Omni drive will contain up to 20 megabytes of data and measures just 1" in height, one third the height of any current Winchester drive on the market. The drive has a single platter and a 3 watt power consumption. The drive is designed to have enough room for a second platter, which would increase the storage capacity to 40 megabytes.

Industry analysts say a drive that small may finally convince Apple Computer to release a lap-top version of its Macintosh system, which has reportedly been under development at Apple for some time.

Tandon sells disk drive business to Western Digital

Tandon, which made a big name for itself in the personal computer industry by growing into one of the industry's leading suppliers of floppy and Winchester disk drives, announced it has agreed to sell most of its disk drive operations to Western Digital in a deal worth about $US80 million.

In recent years, Tandon has branched out into the personal computer business and has apparently decided it wants to put all of its effort and resources into this highly competitive field.

Western Digital of Irvine said it has agreed to pay $US40 million in cash for Tandon's disk drive business, and also will acquire $US34 million worth of Tandon's corporate debts related to the disk drive business.

Tandon president Sirjang Lal Tandon acknowledged that the radical move was intended to ease the financial strains the company has been under, as it is trying to rapidly expand its position in the personal computer market.

Memorex buys Telex

Telex has accepted the $US900 million take-over bid from Memorex, in an effort to avoid a hostile take-over by corporate raider Asher Edelman.

Memorex said the company will be known as Memorex-Telex NV, and will be headquartered in The Netherlands, where Memorex is based.

The combined Memorex-Telex operation will have annual sales of some $US2 billion and will instantly become the single largest independent supplier of IBM-compatible mainframe terminals, mass storage devices and printers.

IBM starting production of 4-megabit DRAM

IBM has announced it will begin volume production of the company's new 4-megabit DRAM chip in early 1988. Currently, IBM is already making the chip in small quantities.

With the announcement, IBM reaffirms its lead over Japanese memory chip makers, although the giant only produces memory chips for in-house purposes.

In Japan NEC, Hitachi, NTT, Toshiba, Matsushita, and Mitsubishi all are working on 4-megabit DRAMs, but have not announced volume production dates.

FORUM

Conducted by Jim Rowe

Is the nanofarad really necessary – or even handy?

Sometimes I'm surprised how much controversy can be generated by things that superficially seem quite small and unimportant. Take the nanofarad, for example: it may be small, but it certainly seems capable of producing strong reactions.

When I was a kid at primary school, one of my teachers drummed into us the rule that the words "got" and "get" should never be used. They were apparently too vulgar, or too gutteral, or too direct, or something. Anyway there were lots of other words that had similar meanings, and well educated people were always supposed to use one of these instead.

I can remember thinking at the time that this was rather interesting: presumably "got" and "get" were special words that had been put into the English language as kind of black sheep, never to be used. They must have been naughty at some time in the past, and had to be punished by no-one ever using them.

Certainly if that teacher ever heard you using them, *you* got punished by having to write out "I must never use GOT" 500 times, or whatever.

It wasn't until later that I discovered other people used these words quite freely, and didn't seem to think they were *verboten* at all. In fact I discovered that many people (and very well educated people at that) took a much more flexible view of language than had my old primary school teacher. They regarded language as a growing and dynamic thing, which was constantly changing and being adapted to suit the needs of its users as a means of communication.

Sure, I also found out there were a few people like my old teacher, who had a very rigid view of language. In fact I even worked with one for quite a few years, who believed that English was absolutely immutable and forever defined by *his* old school dictionary. But by and large, most people seemed to be more flexible and open minded.

All of which is of course preamble, to this month's opening topic: the *nanofarad*. I'm beginning to think that at least some of our readers regard this in much the same way as my old primary teacher viewed "got" and "get".

But let's start at the beginning. As many readers will already be aware, "nano" is one of the standard quantifier prefixes in the metric/SI system. It means a billionth or thousand-millionth, or if you prefer, the base unit multiplied by 10^{-9}.

So a nanometre is a thousand-millionth of a metre, for example, or 10^{-9} metres.

This means that "nano" is kind of midway, in a logarithmic sense, between "micro" (meaning millionth, or 10^{-6}), and "pico" (meaning trillionth or million-millionth, or 10^{-12}). Hence 1000 picometres make one nanometre, and 1000 nanometres make one micrometre (or micron).

Now there aren't all that many SI units where we need to measure and talk much about billionths, but like the metre itself, one unit where we *do* need to do this is the unit of capacitance: the farad (for which the contraction is F).

In practice, one farad is an awful lot of capacitance. Most of the time in electronic circuits we use much smaller values. In fact most discrete capacitors have values falling in the range between a picofarad (10^{-12}F, or 1pF) and a microfarad (10^{-6}F, or 1uF).

By the way, capacitances inside integrated circuit chips are measured in *femtofarads*, where a femtofarad is a thousand-billionth of a farad, or 10^{-15}F. So 1000 femtofarads make one picofarad, for example. Which all goes to show how far away the farad itself is from practical values of capacitance, at least in modern electronics.

But with commonly used discrete capacitor values ranging from around 1pF to the 1uF level, over a range of about a million to one, it's not surprising that this is one of those situations where the "nano" prefix has been applied (at least in some parts of the world). In fact it would be pretty surprising if it hadn't been.

From a logical point of view the situation is very similar to that with resistance, and the prefix "kilo". Most commonly used values for discrete resistors range from about one ohm to around one megohm (a million ohms, or 10^6 ohms). This is again a range of about a million to one, and as a result many years ago people began using the "kilo" prefix for convenience. It saved using so many zeroes . . .

So it's always been very common, all over the electronics world, to talk of a resistor with a value of 4.7 kilohms, for example, or of 68 kilohms. Instead of describing them as 4700 ohms or .068 megohms, respectively.

It's interesting, though, that use of the term nanofarad as a unit in electronics is still almost unknown in countries like Japan and the USA. And it's probably quite significant that these are the countries which are still not fully "convinced" about the metric/SI system of measurement.

Not surprisingly, it was electronics people in continental Europe who first started using the nanofarad, and its use has gradually spread from there as the metric/SI system itself has achieved more "converts". Although electronics people in places like Japan and the USA are happy using parts of the SI system like kilohms and megohms, kilohertz and megahertz (even gigahertz) and microfarads and picofarads, they draw the line at the nanofarad.

No, it's all a wicked plot by those

Europeans, they seem to believe. If we start using the nanofarad, we'll be surrendering to the onslaught of international European imperialism in electronic measurement. For the sake of Mom and Apple Pie, we must hold out.

Besides, who needs the nanofarad? It's perfectly easy to write 2200pF or .0047uF, and everyone knows what we mean . . .

As you can probably sense from the above, I'm personally fairly happy with the nanofarad. It seems to me a pretty logical and convenient part of the overall SI system, like the kilohm and the gigahertz. But I don't think I'm fanatical about it; I don't go around madly crossing out all the 2200pF's or .0068uF's I come across in American circuits, and replacing them with 2.2nF's and 6.8nF's.

In fact by now I seem to have become fairly fluent in both the "nanofarad" and "no-nanofarad" dialects, and can convert from one to the other without any conscious hassle. And I suspect that many of our readers are the same way. But not all of them, obviously.

A few months ago, as you probably noticed, we changed to a new draftsperson for our circuit diagrams. Karen Rowlands, the lady concerned, is an experienced drafter who has been quite used to labelling her circuits according to SI standards — including the use of nF.

Before she started to do our circuits, we had a discussion about the style and standards to be used. She pointed out that there were quite a number of areas in which *EA* was still not conforming to established SI practice, and we considered each of these in turn.

Some I decided not to change, on the grounds that clarity had to remain our prime consideration. For example, we haven't adopted the practice of using the unit or multiplier symbol instead of the decimal point, like "4R7" instead of 4.7 ohms, or "6n8" instead of 6.8nF. Frankly I don't think these are either particularly clear or self-evident, and I decided against 'em.

But when we discussed the pro's and con's of using labels like 6.8nF instead of .0068uF, I finally had to admit that both logic and clarity seemed to support a change.

No sooner had the first few circuits including nanofarad labels been published, though, before the calls and letters started to arrive. Not many of them, to be sure, but enough to notice.

One reader from Tasmania, an experienced service technician, really took us to task:

Capacitors are rated and sold in Australia in microfarads and picofarads, and nanofarads have to be converted to one or the other before use. I have lost track of the number of appliances with performance degraded by the application of the wrong conversion factor. This is particularly so with Philips TV's, where nF is used extensively in their circuit diagrams. My colleagues in the industry abhor nF, preferring uF and pF in all diagrams and calculations. I would suggest that you do the same.

Among 19 colleagues spoken to on this subject, only one (a German born technician) would admit to confidence in using nF, and even he had to convert to uF or pF before buying capacitors here in Australia.

Another writer from Victoria, a tech college teacher, noted that not only did his students find the nanofarad confusing, but most of his fellow teachers found it so as well. In fact an impromptu check among both students and teachers found them all quite clumsy at converting from pF and uF to nF and back, and prone to make a lot of mistakes.

Still another unhappy reader 'phoned to complain that when he asked for capacitors at his local supplier, they wouldn't serve him if he gave the value in nanofarads. He had to convert them into pF and uF, before they knew what he wanted!

Oh dear. All this about a unit related to the uF and the pF by simple ratios of 1000? Some people just don't like change, do they — even if it's a change which makes things easier, once you get used to it . . .

I seem to recall that there were similar reactions when magazines like *EA* started to use picofarads. Sometime back in the 1950s, I think it was. I'm sure there were people who wrote in all upset, to ask why we were confusing

Nanofarads? Capacitors? True-blue Aussie condensers come only in microfarads, mate!

them with this strange and totally unnecessary new unit.

What was wrong with good old microfarads, they asked. After all, everyone knew what was meant by a .0001uF mica capacitor, or a .00002-.00005uF trimmer. Why change?

You'll probably find there was the same sort of fuss when the kilohm was brought in, sometime in the thirties or forties. What's wrong with labelling voltage dividers as 20,000 ohms, or 47,000 ohms for a plate resistor?

Sorry for the sarcasm, but there do seem to be quite a few parallels here.

Perhaps you think I'm being too hard on the anti-nanofarad brigade. If so, write in and tell me what you think. But please give sensible reasons *why* we shouldn't use the nanofarad — and reasons that wouldn't logically force us to stop using the kilohm and gigahertz as well. Just don't come up with arguments like the chooks will give bigger eggs and the cows creamier milk, if only we go back to feet and inches.

I really would like to hear from you, if you can give me a good logical argument — honest!

But for the present, let's leave the subject and turn to an amazing little item I came across a couple of days ago.

Perpetual motion?

One of the publications sent to me regularly (at least up until now, but perhaps not any more, after this) is *Electric Vehicle News*, a monthly newsletter produced by the Australian Electric Vehicle Association of Victoria.

It's an interesting little publication, and I enjoy looking through it each month when it arrives. The people in the AEVA are real enthusiasts when it comes to electric vehicles, and they put a lot of effort into promoting their hobbyhorse. And that's great, especially when you believe as I do that electric vehicles do have a lot of potential.

They'll have even more potential, when or if the R&D people can come up with the necessary breakthrough in battery technology — one that finally does provide an energy density somewhere within coo-ee of the ubiquitous tank of petrol. The only problem is there have been so many "breakthroughs" in this area that have turned into phurphys, I guess like many people I'm getting a little cynical.

Not surprisingly the AEVA people are not the least cynical, and good for them. We need more enthusiasts and positive thinkers, because it's from them that the breakthroughs tend to come.

FORUM

But sometimes their enthusiasm runs away with them, and they lose contact with reality — and the laws of nature.

There was an amazing example of this in the latest issue of *EVN* to reach me. It was in a section called "Novel Ideas From The Road", and seemed to be extracts from a book called *The Consumer's Electric Car*, credited to one Earnest H. Wakefield, PhD.

I can only assume that Mr Wakefield's PhD was in a subject far removed from electronics or physics, like dancing. Either that, or he somehow acquired it from a rather dubious correspondence college, or by saving up the necessary number of breakfast cereal tokens. Because the "novel idea" concerned is a real doozey:

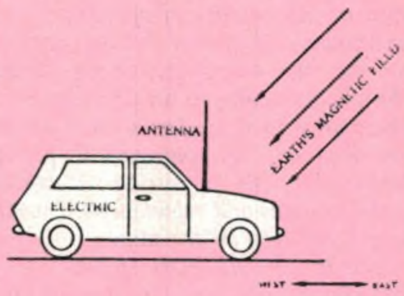
Since electricity can be generated by a wire cutting a magnetic field, equip the electric car with an antenna for cutting the earth's magnetic field. Feed the electricity generated to the motor which, in turn, drives the wheels. The earth's magnetic field runs from the North Magnetic Pole to the South Magnetic Pole, and power from the motor comes from the battery when the vehicle travels either north or south.

Well — why didn't we all think of that before? All those old codgers like Otto, Daimler, Royce, and Ford didn't need to fool around with petrol engines — there was unlimited energy there all along in the earth's magnetic field, free for the taking!

The idea's so incredibly crazy it's hard to know where to start, in explaining why. But here goes.

For a start, an EMF isn't generated in a wire/conductor in a magnetic field unless it's *moving* with respect to that field. When it's stopped, nothing is generated. So there would be no electricity produced by Mr Wakefield's proposed car (I refuse to call him Dr Wakefield), until it was moving. Yet if it was powered from the earth's field, as he proposes, it presumably wouldn't be able to start moving until there was some power generated. Sounds like a stalemate to me, already.

But that's only one part of Mr Wakefield's clanger. Another reason why it couldn't work is that when a wire moves through a magnetic field, and generates an EMF, *no energy whatever* comes from the magnetic field. ALL of the electrical energy produced comes from the mechanical energy used to move the wire, just as in any other kind of electrical generator.



Here's the illustration that accompanied the item on using the earth's field to provide power for electric cars . . .

The magnetic field itself only provides the right environment — rather like the "catalyst" needed for some kinds of chemical reaction.

In fact it's precisely *because* no energy is drawn from the field in either electric motors or generators, that we can use permanent magnets to produce their fields. Many modern motors use permanent magnet fields (including those used in electric cars), while most of the small alternators traditionally used on push-bikes to power the lights also use a permanent magnet for the field.

Electrical generators and motors are simply energy transducers, converting mechanical energy into electrical energy or vice-versa. And like all such devices, they're all imperfect in terms of efficiency. So with a generator, for example, you never get out as much electrical energy as the mechanical energy you put in. A proportion gets turned into heat, due to things like friction, resistance in the wires and so on.

With Mr Wakefield's proposed system, then, any electrical energy produced by his antenna cutting the earth's field wouldn't be coming from the field, but from the mechanical energy needed to move the car along. And more mechanical energy would be needed than you'd get as electrical energy — so he's invented a pretty wasteful way to generate power, by pushing your car along!

Actually I shouldn't be too hard on him here, because you might get some help from an unexpected source.

Because the earth's field is actually very, very weak — typically less than 0.1 of a millitesla (remember? a tesla is a weber per square metre) — you would need rather more of an aerial than the little diagram in *EVN* suggests. In fact with such a weak field you'd need an enormous multi-turn coil, umpteen square metres in area, in order to produce any significant EMF. And with that kind of area, it would almost certainly make a better sail than an electrical generator. So if the wind was blowing in the direction you wanted to go, you mightn't have to push at all.

You might have the opposite kind of problem, though — stopping the car from taking off!

Even this is ignoring the fairly fancy electronic commutation circuitry you'd need to extract the electrical energy from that large multi-turn "antenna coil", of course. This would be necessary, because with all sides of the coil moving in the same direction through the field, their induced EMF's would otherwise cancel out, and you'd get nothing.

I suppose I've been too hard on Mr Wakefield's Folly, by really rubbing his nose in it. But I just couldn't resist, when he'd come up with such patent nonsense. I can only hope that his original book was published tongue in cheek, and that the AEVA people had theirs firmly tucked in too, when they reprinted it.

I have a suspicion that this is the case, because the other "Novel Ideas" in the same section look pretty crazy too . . .

The only problem is that many of the readers of *Electric Vehicle News* may not be capable of recognising these kinds of item as a joke, and might take them seriously. I'm half expecting a crop of letters soon, asking if we've ever described an electronic commutator suitable for a large multi-turn car antenna!

Seriously though, *EVN* is normally quite a good little newsletter. Most of their stuff is much more sensible, and quite interesting if you're into electric vehicles. You can contact the AEVA at PO Box 273, Mitcham 3132. Perhaps if I give them this plug, they mightn't stop sending me their newsletter after all . . .

Well, I've run out of space again without dealing with an interesting letter on double insulation and earthing, which turned up just after last month's column had gone to press. So I'll kick off with that one next month, all going well. I hope you'll join me again then.

Don't forget, if there's anything you'd like discussed here, please write in and let me know. I want to write about topics that interest you, but I'm no mind reader.

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John Logie Baird & the early days of TV

How many people sitting in comfort and watching a program on their modern high definition, brightly coloured television screen, ever think about the pioneers like John Logie Baird who made it possible?

by DOUG THWAITES

Working with little money and primitive equipment, the early television pioneers all had the same dream: that one day they would be able to send a picture from one place to another, even if it was only the next room.

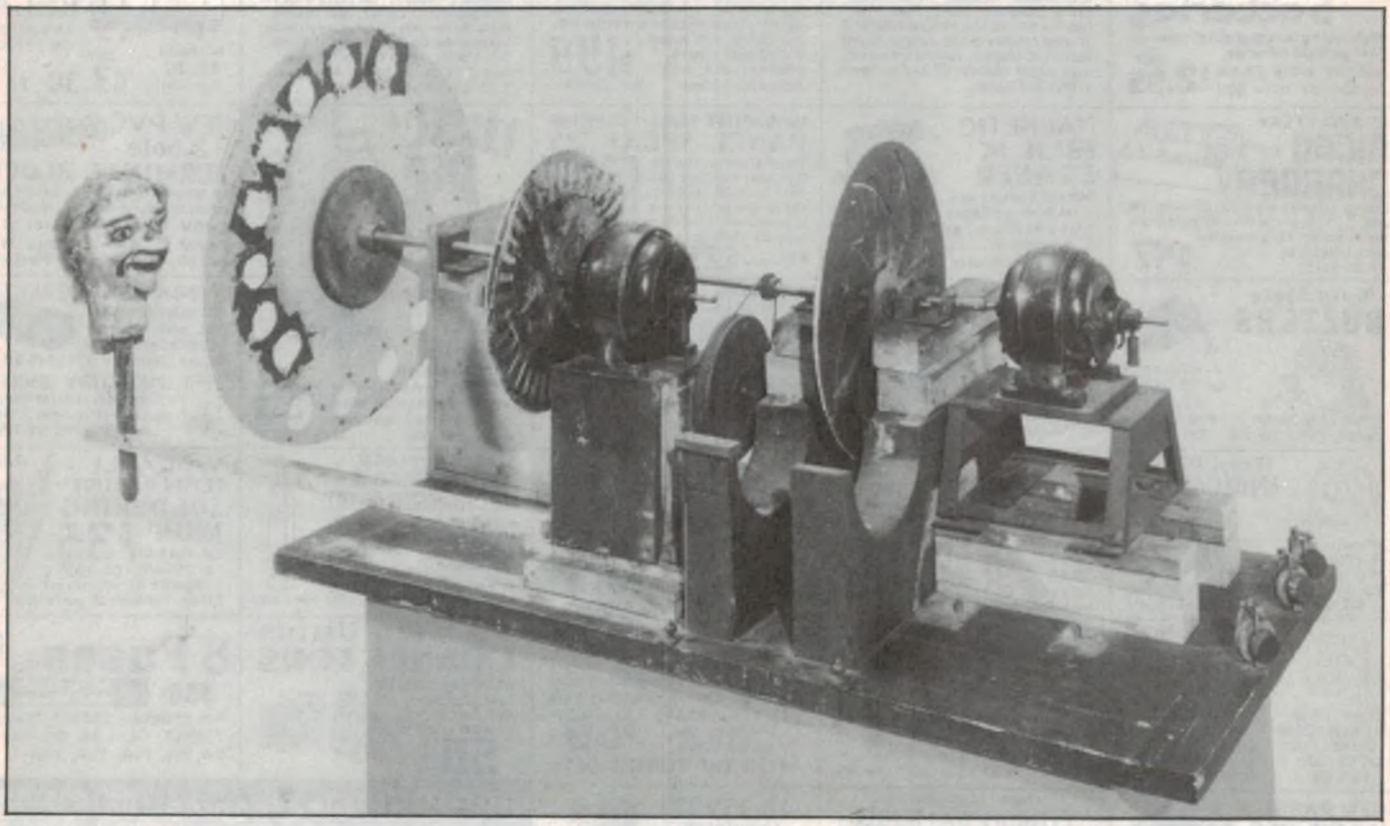
In 1876, Alexander Graham Bell perfected the Telephone and the human voice could travel from one place to another, so the search was on to send the picture as well.

Research to do this commenced in many countries, including Britain, Germany, France and the USA. What was needed was a method of converting light variations into electric current.

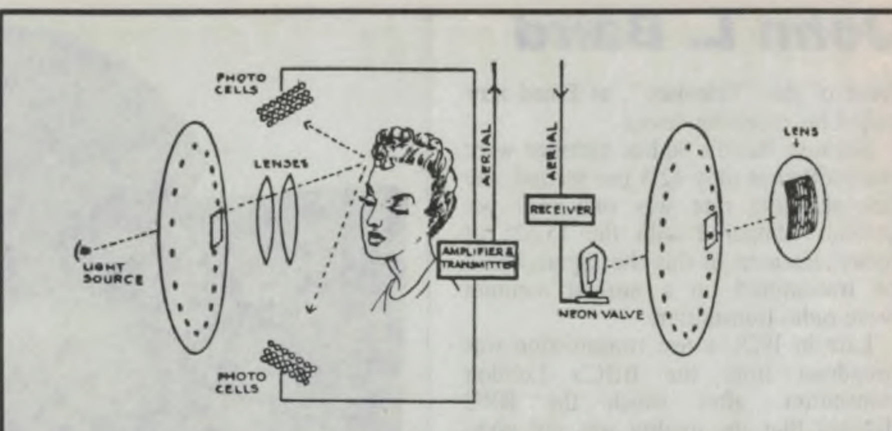
By chance towards the end of the last century, it was found that the element selenium changed its resistance when light fell on it. Selenium is a non-metallic element discovered in 1817, by Berzelius; it became widely used in resistors, and also in rectifiers. However it was not until 1873 that English telegraph engineer Willoughby Smith discovered that its resistance varied with light.

Once its light sensitive properties became known, methods were tried to use it to reproduce the different values of light and dark of a picture. To do this, the picture must be broken up into many separate areas each with its own value of light.

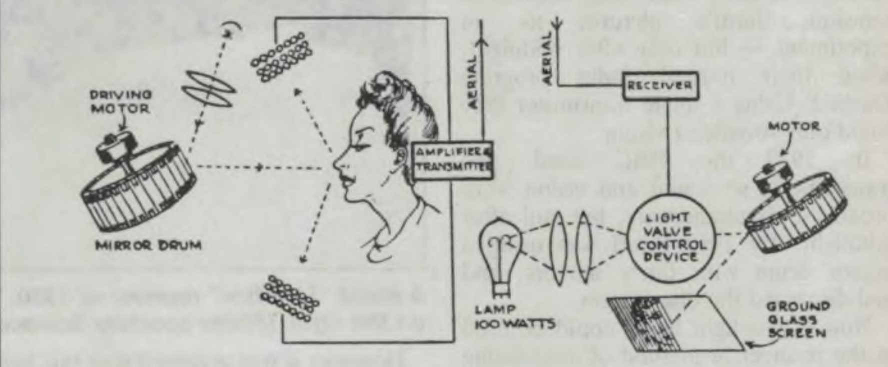
One method tried was to focus an image on to a mosaic of small selenium cells, each one of which was connected by wires to a tiny bulb, arranged in a



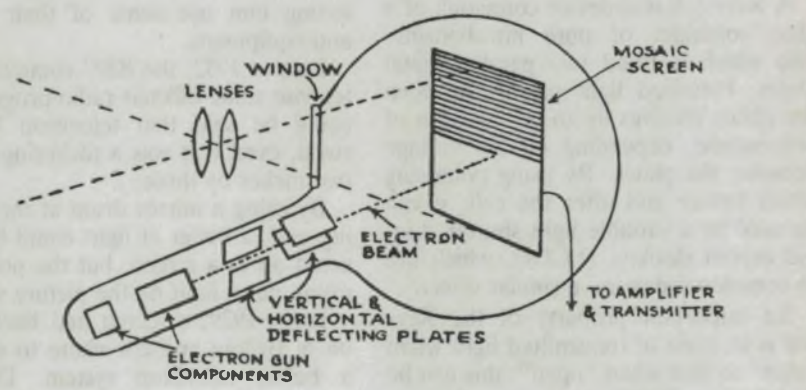
Baird's original television apparatus of 1925. It used a single drive shaft for "transmitter" and "receiver", to simplify synchronising. Note the makeshift construction, and the test subject: a head from a ventriloquist's dummy. (Photo courtesy Science Museum, London)



The basic operation of Baird's first television system, using spinning discs for picture scanning.



Later the mechanical television system used rotating drums with sequentially tilted strips of mirror for the scanning.



The Emitron tube had no moving parts, but used an electron beam to scan the image focussed on a photosensitive mosaic of tiny cells.

similar mosaic. However the difference in the current drawn by the selenium cells for light and dark of the image, was not sufficient to produce a recognisable picture.

In 1887-8 Heinrich Hertz discovered the principle of photo-electric emission: that electrons tend to be emitted from the surface of metals when light falls on them. Shortly afterwards, Elster and Geitel developed the photo-electric cell. This gave better variations in current, but the output was too weak to use. The thermionic valve had not yet been invented, and even when it was in 1904 by Fleming, the early ones were not capable of producing the enormous gain required.

It was not until 1923 that experiments had reached the stage that very blurred images could be sent by wire from one room to another.

John Logie Baird, born in Scotland in 1888 and the son of a minister, was the man who was going to lead the world with his work on television. In 1925 he demonstrated the first working model. It was very crude, made of mostly secondhand materials, but it did produce flickering images.

He was dogged all his life by ill health, and it was due to this that he developed television when he did. He worked mainly for himself, selling some of the things that he invented, and had money trouble most of the time.

In 1922 his health broke down, and he went to a seaside town to recover. Having nothing to do, he set up a bench in his room, and tried to solve the problem that had occupied his thoughts for some time, how to convert a picture into a varying electric current.

In order to transmit the details of a picture through a single pair of wires, it would have to be broken up into small pieces, and the light value of each piece sent in sequence, and presented at the receiving end in the same way.

Baird's apparatus consisted of a rotating disc pierced by 30 holes, oblong in shape. As this rotated the object being viewed was scanned vertically by a bright spot of light, which because of the holes in the disc, moved right until 30 parallel scans had occurred. The studio was in semi-darkness, and the reflected light from the object being scanned was picked up by two or more banks of photo-electric cells. This was the birth of "video".

At this time no method had been found to modulate a beam of light, so the receiver display consisted of a neon lamp with an oblong electrode. When the video signals were fed to it, the intensity of the red glow varied in sympathy, and by viewing the lamp through a revolving disc with 30 holes synchronised with the transmitter disc, an image of the original object could be seen.

Because the human eye can detect changes that take place slower than 24 times a second, and Baird was scanning at 12.5 per second, there was bad flicker.

Once a working model had been produced, continuous improvements took place.

By 1928 Baird had formed a company, which operated a studio and transmitter. It was a remarkable year for Baird — in February pictures were received in New York from London, using a frequency of about seven megahertz. The next week pictures were received aboard a liner in mid-ocean.

In June, a picture was produced using daylight instead of the bright artificial lights. In July, he demonstrated colour television using three colour filters — red, blue and green — set into a disc. Two discs were used, and synchronised, one in front of the camera, and one in

John L. Baird

front of the "Televisor", as Baird now called his receiving device.

Because Baird's 30-line pictures were transmitted at only 12.5 per second, the line scanning rate was only 375 per second, compared with the 15,625 of today. Because of this the signals could be transmitted on a normal medium wave radio transmitter.

Late in 1928, a test transmission was broadcast from the BBC's London transmitter, after which the BBC decided that the quality was not good enough for a regular transmission. However in early 1929, they decided to transmit Baird's pictures as an experiment — but only after midnight, when their normal radio program finished. Using a single transmitter they could only broadcast vision.

In 1930 the BBC used two transmitters, so sound and vision were broadcast simultaneously, but still after midnight. By 1930 Baird was using a mirror drum with thirty mirrors, and had discarded the disc system.

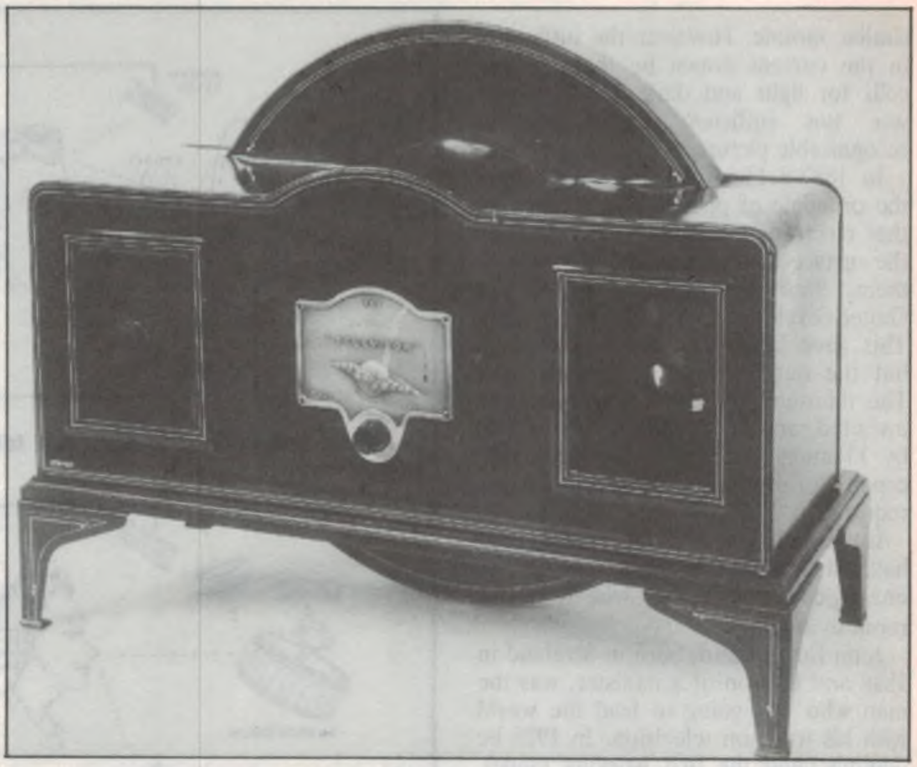
Now that a light beam could be used in the receiver, a method of modulating it had to be found, and a Kerr cell was used.

A Kerr cell is a device consisting of a glass container of pure nitrobenzine, into which is fitted two parallel metal plates. Polarised light passing between the plates receives up to 90° rotation of polarisation, depending on the voltage between the plates. By using polarising filters before and after the cell, it can be used as a variable light shutter. Liquid crystal displays (LCDs), which are so common today use a similar effect.

An important property of the Kerr cell is its ratio of transmitted light when "shut" to that when "open": this can be as large as .000001 to 1 (a million to one). The frequencies at which it can operate are as high as 10MHz, making it quite suitable for television.

Pictures from a mirror drum camera were still viewable on a disc receiver. Baird fitted a mirror drum camera into a van, and transmitted the first pictures from outside a studio, but only from the street in front of his building.

In 1932 the van was taken to Epsom for the famous 'Derby' horse race, and the pictures from it were sent by normal telephone line to a theatre in London. Five thousand people watched the event on a screen measuring nine feet by seven. Newspaper reports were varied, from "A marvel" to "Needs some imagination to visualise the scene".



A Baird "Televisor" receiver of 1930. The picture was viewed through the lens on the right. (Photo courtesy Science Museum, London)

However it was accepted that this had been a clever achievement, and the BBC decided to assist Baird more, by letting him use some of their studios and equipment.

Late in 1932, the BBC commenced to televise some of their radio programs. It could be said that television had arrived, even if it was a flickering picture two inches by three.

By using a mirror drum at the receiving end, a beam of light could be projected on to a screen, but the poor definition put a limit on the picture size.

From 1929, research had been going on in Britain and elsewhere to discover a better television system. Different scanning rates were tried, but it was found that there was a limit of about 200 lines for a mirror drum.

There were rumours of new non-mechanical methods being developed in Germany and the USA, while in Britain, EMI were working on an electronic camera using their patented 'Emitron' tube. In 1934 the British Government set up a committee to investigate what systems were available, and whether a public television service should be started.

In 1935 they produced their report. They had decided that the low definition system in use was not suitable for a public service, and that any future service should have a minimum of 240 lines and not less than 25 pictures a second.

In September 1935 the first stage of television came to an end, and transmissions ceased.

An old Victorian eyesore, Alexandria Palace was chosen as the home for Britain's first official television service. A 300" tower was erected, and both Baird and EMI were asked to supply their equipment, so that a test could be done to find the best system. Programs from both systems were shown on alternative weeks. Transmissions were for two hours a day, one in the afternoon and one at night, six days a week.

BBC Television started in 1936, and used VHF because of the broader bandwidth required for the higher definition.

Baird had two systems. One used a movie camera, from which the film went through a developing process, and then was scanned by a disc while still wet. The trouble with this was that it took 65 seconds to develop the film, and so the sound had to be delayed for this length of time. His other method was using a camera with an electronic device patented in the USA, with a scanning rate of 240 lines.

EMI however used all electronic equipment. Their cameras were fitted with the 'Emitron' tube, using a scanning rate of 405 lines and 25 pictures a second.

They also introduced the technique of *interlacing*, in which the 202.5 "odd"

lines of the picture were scanned first, followed by the 202.5 "even" ones. This meant that although there were only 25 complete pictures a second, any changes in the picture took place 50 times a second, reducing flicker even more.

The new electronic cameras used a cathode-ray camera tube, in which there was fitted a target screen comprising a mosaic of tiny light cells. The picture was focused on to this screen through a window of optical glass in the side of the tube.

Each light cell acquired an electrical charge proportional to the amount of light falling upon it. An electron beam was used to scan the screen and 'read' the variations in charge.

The current from the final anode contained these variations and therefore provided the 'video' signal.

Using higher line frequencies meant that the existing mechanical receiving devices could no longer be used to display the picture. The cathode ray tube now entered the television industry as the replacement.

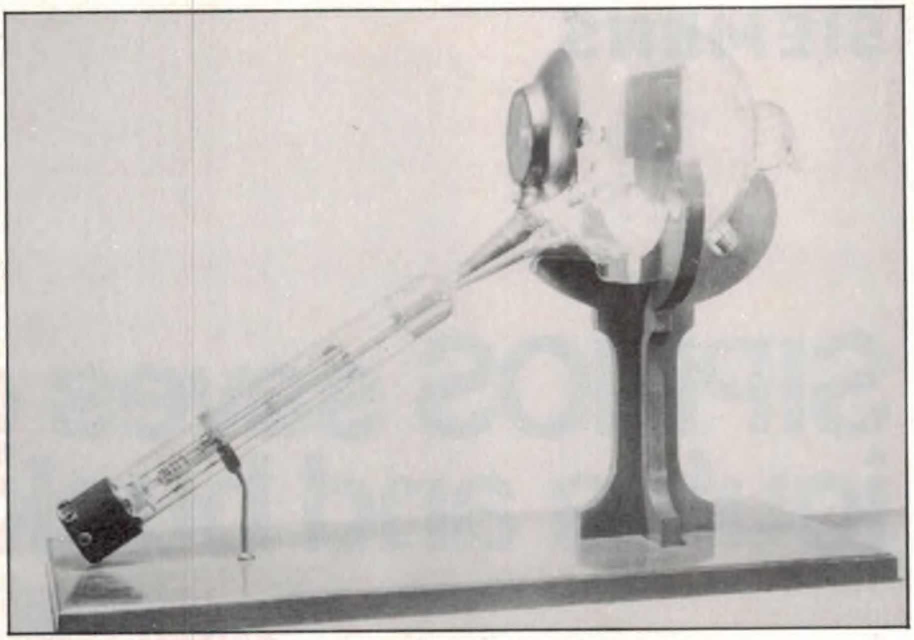
Not however the 'picture tube' as we know it today, with its flat face and short neck with 110° magnetic deflection, but a round faced tube with a long neck, used to obtain the deflection sensitivity needed for electrostatic deflection.

One radio receiver was fitted with a small 3" tube, and became a television receiver by switching to the TV band. After all with only a few hours transmissions a day, television was still only a novelty, and had yet to become so entertaining that it would change our lifestyles.

After three months of the two system trial, it was decided that EMI had the best standards, and Baird backed out, very disappointed. His company continued to manufacture television receivers, and he went back to research.

The technical standards had been set, and now it was the production side that continued to develop, with many new 'firsts'. Slowly television became accepted as a form of entertainment, with its own individual type of programs, outside broadcasts, panel games, plays etc. — and most important, the 'news'. Now, instead of waiting for tomorrow's newspaper, the pictures and the details could be seen today.

Unfortunately for this rapidly growing field of entertainment, war was declared in September 1939. So just four years after the official television service had started, it had to be stopped for security reasons. The exciting first era of television came to an end.

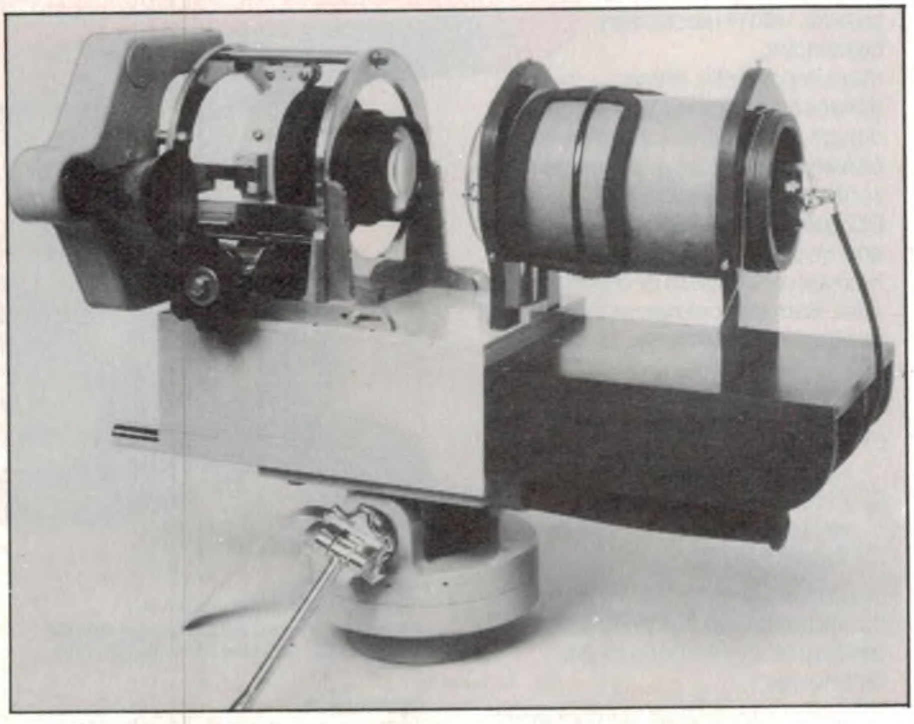


One of the first Emitron electronic camera tubes, of 1935. These soon replaced Baird's system. (Photo courtesy Science Museum, London)

I myself began working in the radio industry in Britain some years before World War 2. I not only met Baird, but also worked on some of his television sets. One used three TSP4 valves in cascade as RF amplifiers, and after detection the video signal was passed back through them for amplification, in "reflex" fashion. The stages needed very high linearity, otherwise cross modulation would occur.

When I arrived in Australia in 1956, it was to set up Myer's TV service department in Melbourne, for the commencement of Victoria's first TV broadcasts.

As Australia's television system was based largely on that of Britain, I believe it's fair to say that if it were not for the efforts of people like John Logie Baird, you might not be watching your nice colour TV set here today.



The 240-line electronic camera developed by Baird for the British Government's 1935 television tests. (Photo courtesy Science Museum, London)

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Geoff Wood bows out

(— well, sort of . . .)

One of the best-known and universally admired people in Sydney's components retailing business has semi-retired, due to health problems. He's still going to be associated with the business that bears his name, but not on a full-time basis.

by JIM ROWE

Geoff Wood seems to have been around on the Sydney electronics scene since long before it was even called "electronics". Almost everyone in the industry seems to know him, and to admire him — not just for his encyclopaedic knowledge of electronic components, but for his positive "can-do" philosophy (especially when it comes to tracking down esoteric and hard to get parts).

I remember when I first came across him myself. It was back in the mid-1950's, and I was still a kid at high school. I'd just started to get really keen on electronics as a hobby, and found it very frustrating trying to obtain components. Most of the stores didn't seem to keep much stock at all, and you'd get a "sorry, we don't have any of those" response to requests for every second part (or so it seemed). This was for quite common-garden components, mind you, and from places that professed to be "trade suppliers".

Then I discovered this funny little shop in a rather rundown old building called Wembley House, just off Railway Square. The building's still there, I think (although I haven't been past it lately).

The shop itself was tiny — no larger than the bathroom in a typical Victorian terrace house. Its counter was about two metres long, with barely enough space behind for two people to squeeze past each other. On the customer side there was just enough space for about three people, before the shop was "full"; if there were any more customers waiting, they had to do so outside in the rather draughty arcade.

The shop had the rather quaint and olde-worlde name *Radio Despatch Service*, but everyone simply called it

"RDS" for short. And despite its tiny space and funny name, it turned out to be a bit like Aladdin's cave.

Whatever you needed, they either had some tucked away under the counter, or up in the "loft", or next door in an equally tiny store room. Or if by some unlikely quirk of fate they *didn't* have any, they'd undertake to get some for you within a day or two. And they would!

I never did find out how good RDS was at despatching radios, but I do know that for supplying components, its service was pretty outstanding.

All of the people there behind the counter were very helpful, but the one who really stood out was Geoff Wood. This bloke seemed to know almost everything there was to know about electronic components — in fact if he didn't know about them, odds were they didn't exist (at least in Australia).

It was from Geoff that the RDS motto "if we don't have it, we'll get it for you" seemed to emanate. Nothing was too much trouble — quite a change from most of the other places, especially when the customer was a hobbyist and a high-school kid at that.

Needless to say, I kept on going back. In fact, RDS became my main (almost only) supplier from then on, as I progressed from schoolkid to engineering trainee and part-time uni student. And when I joined *EA*, or *Radio, TV and Hobbies* as it was then called, it was not surprising to discover that the magazine had an account with RDS, and bought many of its components there too. Where else?

But back to Geoff Wood. He tells me that he had joined RDS in 1950. This was about 11 years after he'd first moved to Sydney as a young lad, from the NSW country town of Cudal (near Orange).

When he'd first come to the city, the war had just started. Too young at the time to enlist, he obtained a job at Kreisler Radio in the manufacturing store. This was obviously where he began to gain his knowledge of components, and where you sourced them.

As soon as he turned 18 in 1943, he enlisted in the RAAF and served through the rest of the war as a fitter. Then in 1946 after the war had ended, he returned to Sydney and got a job at W.Thornley and Sons, a woodworking machinery manufacturer. Again he gravitated into materials buying and sourcing, although he also picked up a lot of experience in woodworking.

By this time RDS itself had been started. It was actually owned by two brothers called Norm and Alan Edge, of whom the latter worked as Chief Engineer for the Sydney County Council. It was Norm who ran the business.

Geoff got to know the Edge brothers via a mutual friend, and they were soon keen for him to join RDS because of his knowledge of electronic parts and buying. He worked there casually on Saturday mornings for a while, but was unsure about making a permanent change. Then in 1950 he had an argument with the boss at Thornley's, and got himself fired. He started behind the counter at RDS the next day.

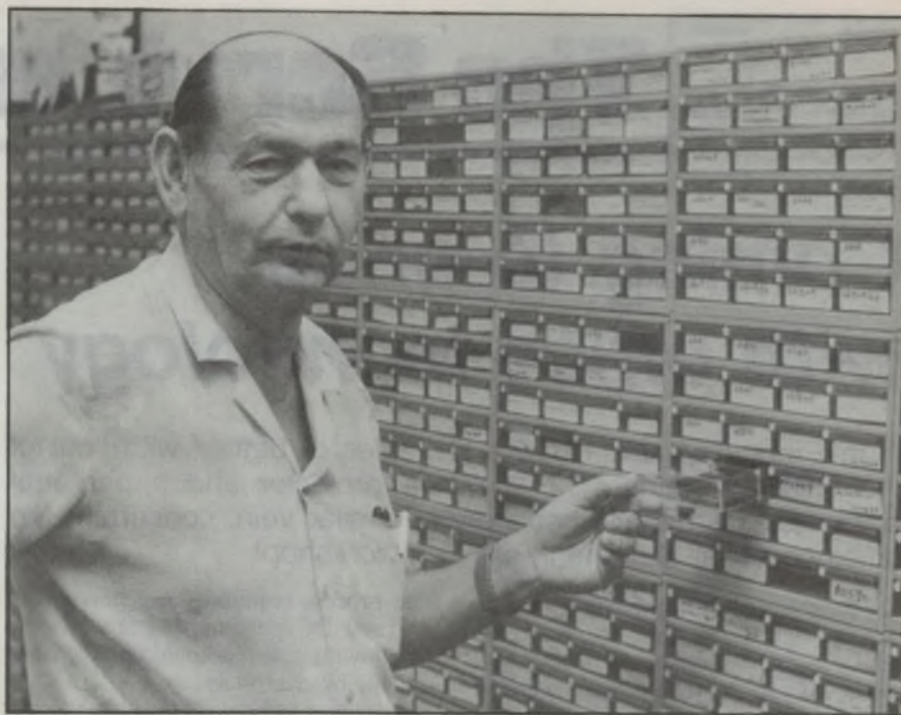
Not long after that, he got to know Merle Edge, Norm and Alan's sister. Before long they were married, and Geoff was part of the family.

Around 1966, RDS moved from its tiny shop in Wembley House to a larger one a few doors down George Street, next to the pub on the corner of Harris Street. The new shop was originally a shoe shop that had been burnt out, and they rebuilt it. Compared with the Wembley House shop it was positively palatial, with a cellar and upstairs floor providing about 12 times the previous space.

Always a very capable woodworker, Geoff Wood himself built rack upon rack of shelving, with umpteen drawers — all tailored to fit each different kind of electronic component. I suspect he also built the counters, too. So with much more space and storage, RDS became even more of an electronic parts cornucopia than ever before.

With its excellent service and good location, RDS prospered over the next 15-odd years. In fact it became widely known throughout Australia, as one of the very best sources of hard-to-get components. Geoff became manager, while Norm Edge left to join his son Bill, in a separate business.

But then in 1981 Alan Edge passed away, and things at RDS changed. Geoff was forced to leave the firm, but STC-Cannon Components immediately snapped him up to take advantage of his enormous component knowledge, in its importing and distribution business. It worked out well, but he missed the bustle of retailing.



Geoff Wood pictured in front of his impressive range of ICs.

In 1983 there came the chance to start his own business, with backing from Peter Moon of semiconductor distributor Semtech. So Geoff Wood Electronics came into being, first of all housed at a shop in Rozelle, just off Victoria Road, and then at its present location in Lane Cove.

Needless to say with Geoff at the helm and doing the buying, business has flourished over the last four years. Like RDS before it, GWE has become widely known as a very dependable broad-range supplier of electronic parts, instruments, tools and materials. Which is a little ironic, since RDS itself no longer exists — it seemed to go downhill fairly rapidly once Geoff had gone.

Now Geoff is reluctantly retiring from the business he's worked so hard to build up, forced to take it easy as a result of health problems. There'll be no more coming in at 6AM and working 12 and 13-hour days, 6 and 7 days a week.

Mind you, wild horses probably wouldn't keep him away completely. Electronic components are in his blood. He tells me that he'll still be helping out with the buying, and popping in from time to time to see how things are going.

Despite the scaling-down of Geoff's own involvement, Geoff Wood Electronics will be continuing in business. In fact Peter Moon tells me they're planning to expand it; a computerised stock control system has now been installed, to help replace Geoff's incredible mental encyclopaedia.

So things look set for GWE to continue Geoff's tradition as the electronics supplier that always delivers the goods, and stocks the bits that others don't.

And as for Geoff himself, he's now officially retired. Well, sort of semi-retired, anyway. You can't keep a good man down.

I'm sure all of his many long-time friends and customers will join me in wishing him a long and happy semi-retirement. All the best mate, and thanks for all your help over the years!

Outside view of Geoff Wood Electronics, in Sydney's Lane Cove.

The Serviceman

Coming to grips with office technology

A few months back, I had a few tales of battles with "out of the ordinary" things like a movie projector and a personal computer. Here's another story in similar vein, concerning an office copier — the one in my own workshop!

Younger readers might find it hard to believe, but at one time there was no such thing as an office "Copying Machine". If you wanted one copy you had a typist retype it for you. If you wanted more, you had her type a "stencil" and ran off the required number of copies on a duplicator.

Exact copies of hand written documents could be made only by photographing the original and printing from the resulting negative. A big advance in document copying came when high speed photographic copiers were developed by firms such as Kodak and Agfa. Even so, each copy took about a minute to produce and came out of the machine all wet and soggy.

The Xerox company developed the electrostatic copying process back in the 1960's and their "dry" copies ensured the success of the process. Dozens of other companies tried to emulate the Xerox machine, with varying success. Although the electrostatic image was easy to achieve, the dry transfer was not and most of the early machines used a liquid toner and developer. These were hydrocarbon based and though they evaporated quickly, the copies were still damp as they emerged from the machine.

More recently still, true "dry" toners and iron powder developers have become available, so that today's copying machines produce dry copies at rates of twenty or more per minute.

The earliest, photographic copiers were almost entirely mechanical. Even the timer had to be wound up by hand! The only concession to automation was the provision of an electric motor to drive the paper transfer mechanism. The Xerox machine, on the other hand, relied heavily on primitive electronics. The process required the generation of AC and DC potentials of around 8 to 10 kilovolts and this could only be done reliably by electronics.

As copier technology developed, electronics became more deeply entrenched in the machines, to the point where today's machines are microprocessor controlled and even the control panel display is either LCD or vacuum fluorescent. One machine even has a self-diagnosis display which shows a little man with a spanner, when the machine suffers a breakdown requiring professional service!

All of this has been a preamble, to a story about electronic servicing that is a bit out of the ordinary. It is about servicing copying machines and in particular the electronics that control them.

It so happens that I have in my workshop a Toshiba BD 4511 copying machine, belonging to the state branch of TETIA. We use it for producing our regular Newsletter, and for occasional copying of circuit diagrams. The machine gets regular, though not heavy use and has given us good service over the several months we've had it.

However last month the machine went mad, and several functions either refused to work or refused to stop working. The few copies it did manage to complete had quite dirty edges, suggesting that the image drum was not being cleaned properly. Then to cap off the exhibition, the machine began misfeeding the paper, piling it up into a jumbled heap inside the works.

If a television set or a radio misbehaved like this I would have little difficulty in sorting out the problems. But I knew nothing about copying machines and had no idea how to go about fixing this one. With the covers off, the machine presented a confusing mass of motors, gears, chains, bowden cables — all interspersed with circuit boards and microswitches. It was an unbelievable mess and I had never seen anything like it.

I had no option but to call for help from the machine distributors. Rather than try to explain my troubles over the phone, I visited the Company's workshop and had an interesting yarn with their chief technician.

Now there must be something special about business machine technicians. Every one I have ever met has been friendly and open, and ready, even anxious to give away his trade secrets. I like to think that I am friendly etc, but I would hesitate to give technical advice to a total stranger, even if I did think he could use it without endangering himself. So the Toshiba man was not unusual among his ilk and was very welcome to me in my hour of need.

As I explained the symptoms, he nodded wisely and hu-hummed and yeahed as though he had seen it all before. When I had finished he began by asking me how much I knew about copying machines. All I could say was that I knew the image was generated on a photosensitive drum, and that toner was picked up and transferred by electrostatic charges. Otherwise, I knew nothing.

So then began a rapid but quite thorough lecture about copying machine technology, particularly as it relates to modern, microprocessor controlled machines.

Like video recorders, early copying machines used mechanical interlocks to prevent misuse. Many of the interlocks were coupled to microswitches so that they could initiate appropriate action only when the door was closed or the paper was in the right position.

With the advent of cheap microprocessors, manufacturers were able to dispense with most of the mechanical interlocks, and simply use sensors to determine the position of vital parts of the mechanism. The micro would scan all of the sensors whenever a function was selected and, if all was in order, would initiate the required action.

Even the copy counter was moved to a dedicated register in the micro, and operation was inhibited if the user had not set the required number of copies. In short, everything relied on the micro getting the right signals from the many sensors located around the machine. So in the case of the TETIA machine malfunctions, we had to determine which sensors were "telling lies". This is where a knowledge of machine theory comes in handy.

The sensors are arranged in a kind of hierarchy. Some are more important and are scanned first; others less vital and are looked at last. Any wrong signal will stop the machine, but apparently wrong signals from the higher order sensors can also upset the operation of the display panel. This seemed to be what was happening to our machine.

The first and most important part of the machine is the high voltage generators and their associated electrodes. In copying machine parlance, they are called "coronas" and the first of these is the "Cleaner corona" that removes any traces of toner from the last image and charges the drum ready to take the next one. Then comes the "Transfer corona", which transfers the toner from the image on the drum to the paper. These two coronas are supplied from separate DC generators at about 10kV.

The second generator also supplies the "Stripper corona", with about 8kV AC. This AC voltage removes the electrostatic charge from the paper and peels it off the drum after the image has been transferred. So, before anything else can happen, these coronas must be working at the correct level. This is the first thing that the microprocessor looks at.

In our case, it seems that it was getting the wrong messages. It would have been better if there were no messages at all. The wrong ones confused the poor micro out of its tiny mind, and it signalled all kinds of non existant problems, such as "No paper" when the paper tray was full, and "Paper Jammed" when the machine was not even running.

According to my friendly copier mechanic, a common reason for this kind of problem is fouling on the corona insulators, from stray toner. Although the machine is designed to keep the toner out of the places it shouldn't be in, some does escape and is attracted to the coronas where it provides leakage paths to ground. So the first thing is to clean, or preferably replace the insulators.

I was shown how to remove the coronas and check them for damage. In the event I got a new set of insulators, to be on the safe side. It was a wise move, because the old ones were badly grimed with used toner and it is unlikely I could ever have cleaned them properly.

This procedure must have been just the right one because the status display stopped sending silly messages and the machine would work, albeit still with dirty copies and frequent paper jams.

It seemed that the next problem to be tackled was the jamming, and this needed a bit of ingenuity to sort out. What I wanted to know was where the jam was occurring. I could see where the paper was finishing up, but that wasn't where it started!

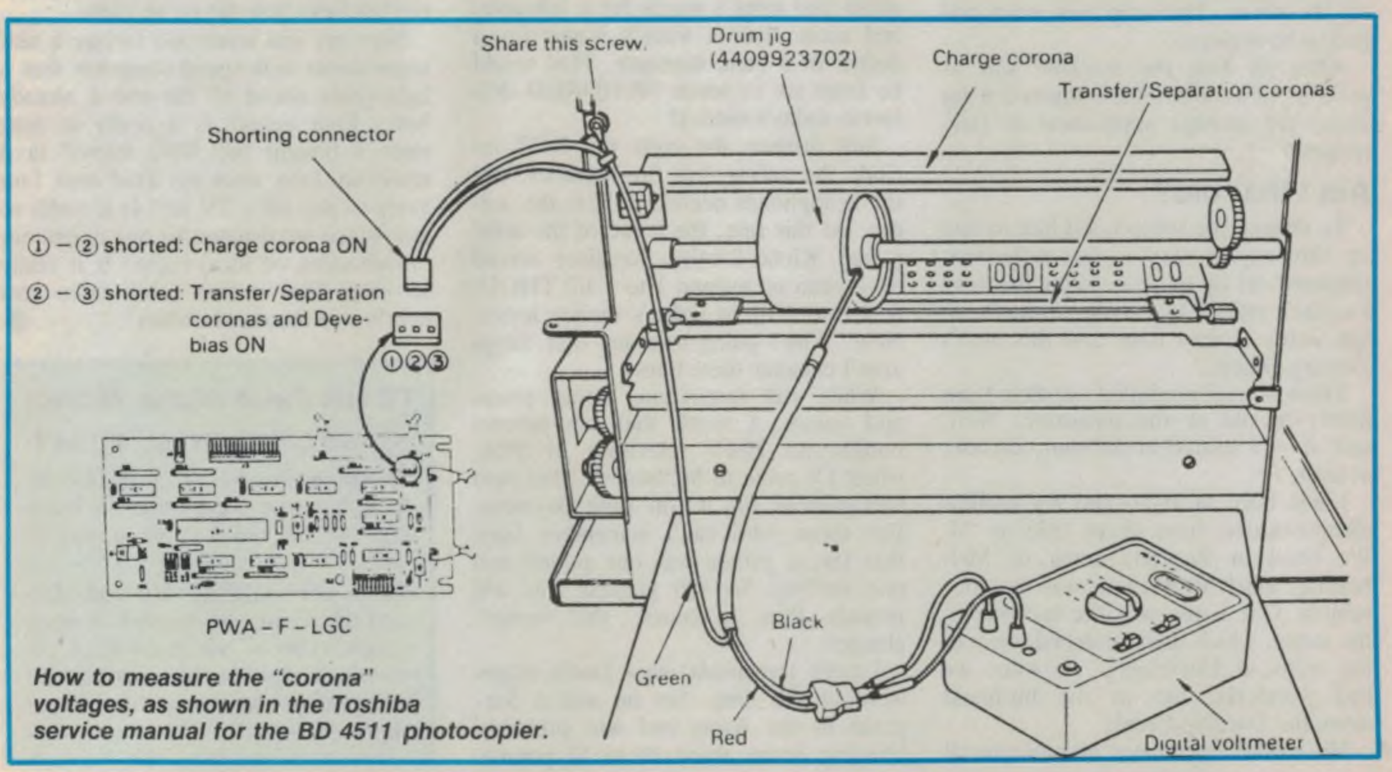
In the end, I removed the front cover and jammed its interlock switch with a suitable piece of wood. This allowed me to run the machine normally and by directing a light into the works, I could watch the paper as it emerged from under the image drum.

This showed me that the paper was adhering to the drum after it passed the transfer corona. Either the stripper corona was weak, or it wasn't working at all.

Now, none of my TV tools are suitable for measuring 8kV AC and this is where my new friend had shown his true worth. He'd not only shown me how to measure the corona, but had loaned me the special jig needed to do the job. He also showed me how to dismantle the machine to fit the jig, and even gave me a copy of the relevant pages from the service manual. See what I mean about copier technicians being a special breed?

Back at the ranch, I lost no time in stripping the machine down ready for the test. It requires that the image drum be removed and the jig put in its place. This is not a difficult task, but it looks most spectacular when the top flies up and all the bits fall out.

The jig is a short length of aluminium



How to measure the "corona" voltages, as shown in the Toshiba service manual for the BD 4511 photocopier.

Serviceman

tube, the same diameter as the image drum. It is fitted with a thick nylon bearing, on which it is mounted in the machine, in place of the normal drum. The jig doesn't rotate, but sits close to the corona wires and picks up an induced voltage from them via the mutual capacitance. This voltage is taken to ground through a high resistance, across which a relative measure of the corona voltage can be taken.

A few minutes later I knew that both bottom coronas were very low in output. The measurement is taken in millivolts with a digital multimeter and does not read the high voltage directly. So I can only estimate that the coronas were down to about 5kV, much too low to do their jobs properly.

The high voltage generator for these two coronas is provided with adjustments, and there was plenty of range left to get the voltages up to the required figures. After this there was no more trouble with the paper jamming, and the copy in the centre of the page was first class. Only the dirty edges problem remained to be solved.

The third corona, the one used to clean the drum, proved to be spot-on as far as voltage was concerned, so there had to be another reason for the dirty copies. This turned out to be non-electrical anti-climax. It was a plastic strip that physically wipes the surplus toner off the drum. The strip was worn and had to be replaced.

After all that the machine was as good as new, and I have learned a lot about yet another application of electronics.

Am I that old?

To change the subject, I'd like to end up this month with a few reflections triggered off by the EA "65th Birthday Feature" articles by Neville Williams, in last year's August issue and this year's January Digest.

These stories reminded me that I am nearly as old as the magazine! Well, sort of — I started in the same decade, at least.

I was born in 1929, and my earliest memories date from about 1933 or '34. We lived in Preston, north of Melbourne, which at that time was an outer suburb. Our house was the last one in the street, which then stretched away to the wilds of Heidelberg. As kids, we had wonderful fun in the bushland along the Darebin Creek.

My earliest memories of radio recall the old two-valve console that stood under the window in the dining room. I spent many magical hours aloft with the flyer Jimmy Allen, and later with "Howie Wing, a saga of Aviation!".

On Sunday, before the professional stations came on the air, we listened to an amateur broadcaster who operated from an address close to my Aunty's place in West Preston. It's hard to believe that we were once so ingenuous as to look forward each week to the music and chat presented over the air by one of our neighbours.

Eventually, one of the valves in the old set failed and Dad gave it to me to play with. Can you imagine anything more dangerous for a 5 or 6 year old? But it didn't seem to matter in those days. We even wrapped fish and chips in newspaper, and never ever worried about the health risks.

Eventually, the valve was dropped and I can still smell the strange odour that came off the broken pieces. I imagine it was the "getter" vapourising, but it is a smell that has remained with me for fifty years.

But back to Neville's August article.

On page 27 there was reproduced a panel from a 1927 edition of *Wireless Weekly*. It costed the parts for the "Klotz 2-valve Receiver". The caption under the panel said "the kits of parts could be bought for only six pounds and thrippence (about $12).

What the caption *didn't* say was that six pounds and thrippence in 1927 was about two week's wages for a labourer, and more than a week's wages for a doctor or a bank manager. That would be from six to seven HUNDRED dollars in today's money!

Still further, the costs did NOT include the valves, nor the batteries, nor the headphones needed to hear the output. At this rate, the value of the completed Klotz 2-valve Receiver would have been up around 1 to 1 1/2 THOUSAND dollars in today's money terms. Now! Who's going to argue that things aren't cheaper these days?

While still reminiscing about prices and values, I recall that my parents bought an HMV television in 1956, when TV came to Melbourne. Dad paid 440 guineas for it, on time payment. For those who can't remember back that far, a guinea was one pound and one shilling. So 440 guineas was 462 pounds. Plus, of course, the "terms" charges.

I can't remember what Dad's wages were at the time, but he was a Sargeant in the Army and was probably bringing home about 10 to 12 pounds per week. I do remember that it was FOUR years before my parents owned that TV set . . .

I do wish I wouldn't keep wandering off like that! I started out about the Klotz 2-valve Receiver. I still have some comments to make about that old time technology.

The Klotz was powered by an "A", and a "B" and a "C" battery. (Can you believe it?). The "A" battery powered the valve heaters and was the hardest working battery in the system. As I recall, much effort was expended in building stronger and longer lasting "A" batteries. It would seem that little thought was given to reducing the drain instead.

If you look back to page 27 in the August issue, you will see in the circuit diagram for the Klotz receiver that both valves have a series resistor in the valve heater circuit. One is a rheostat to adjust the set's volume, and the other is a fixed current limiter. So much for efficiency!

Finally, I was greatly amused by some of the items in the Klotz parts list. The "Wetless" Reinartz Coil is acceptable, and so is the Crescent Audio Transformer. But what about "1 dozen Square Buswire — price ten pence". What a picture that lot must have made behind the "Radion Panel"!

This story has been written on a word processor in a four-year-old BBC microcomputer. The machine is so far in advance of the old Remington typewriter that I used until recently that I simply can't believe how far we've come.

Now my son wants me to buy a new super-duper high speed computer that is light-years ahead of the one I already have. Four years? Is it really so long since I bought the BBC micro? Is it really so long since my Dad took four years to pay off a TV set? Is it really so long since we listened to our neighbour broadcasting on local radio? Is it really so long since a two valve radio cost nearly two thousand dollars? EA

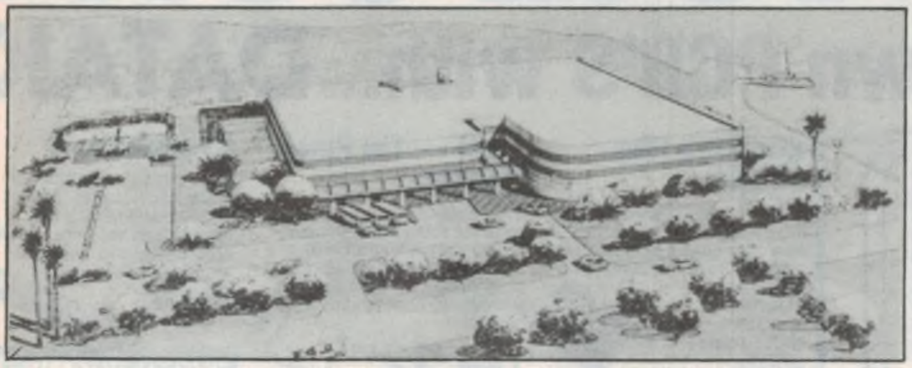
TETIA Fault of the Month

National CP2000, TC86A, TC20AV

Symptom: No sound or picture although power transformer is buzzing. 115 volt rail is down to only 58 volts.

Cure: C583 (1200uF 160 volt electro) dried out, dry jointed or open circuit. This is the main filter capacitor and its failure injects unmanageable ripple into the power supply.

News Highlights



Motorola building "Silicon Harbour"

Motorola Semiconductors is to build a new three-storey electronics plant of over 29,000 square metres and costing several hundred million Hong Kong Dollars, on a 7.2 acres site in the high technology zone of the Tai Po Industrial Estate on the waterfront next to Tolo Harbour, in Hong Kong.

Already dubbed "Silicon Harbour", the new facility will be designing and making semiconductors using CAD/-CAM/CIM technologies. The company says that by 1990 when the building is completed these technologies will not only represent the "state of the art" in the Hong Kong semiconductor industry, but will also be one generation ahead of similar facilities now in USA and Europe.

The emphasis will be on producing high quality semiconductors of increasing complexity at the shortest possible cycle time to serve the electronic industry to move into the current generation of modern circuitry and product miniaturisation.

The plant will accommodate Motorola's Asia Pacific Division Headquarters, regional computer centre and design and manufacturing centre for ASIC, and Bipolar/MOS LSI semiconductors.

In explaining why the company had named the project "Silicon Harbour", Mr C.D. Tam, Vice-President and General Manager of Motorola's Asia Pacific Division, said that the company felt that it could generate a phenomenon for the Hong Kong electronics industry similar to Silicon Valley in California.

Over 100 million colour TV tubes

The world's largest manufacturer of TV picture tubes, Philips, has announced that its production of colour picture tubes has now exceeded 100 million. The company did not start large-scale production of colour tubes until shortly before the introduction of colour broadcasting in Europe in the mid-sixties.

The 100-millionth tube ceremony took place at the Philips factory in Aachen, one of the eight international picture tube production centres.

Philips has also begun full production of high-resolution colour monitor tubes at its tube factory in Durham, England. An investment of approximately 50 million guilders makes the factory (alongside its sister factory at Simonstone) the largest production centre for high-resolution colour monitor tubes in Europe, and one of the most advanced production centres in the world. Production will initially concentrate on 90 degree, 14" high-resolution tubes, with a target of about a quarter of a million tubes per year by the end of 1988.

The market for colour monitor tubes is growing fast, from six million produced world-wide in 1986 to an estimated 13 million by 1990 — a growth of about 25% per year.

The new tubes will have screens displaying 800 by 600 pixels or more, and are destined for monitors used mainly for office automation being produced by the world's top computer hardware manufacturers. The Durham factory will produce these colour monitor tubes in parallel with the current 1.6 million flat-and square television tubes being made annually on the site.

Non-invasive IC probe measures sub-picosecond pulses

AT&T designers aiming to optimise integrated circuit speeds are taking their first direct look inside microelectronic devices at electrical pulses that last less than a picosecond. This is made possible by an electro-optic technique invented and recently perfected by AT&T Bell Laboratories researcher Janis Valdmanis, who has just received the 1988 Adolph Lomb Medal from the Optical Society of America for this work.

The new system permits designers to measure signals with a resolution of less than 0.3 picoseconds — two orders of magnitude faster than conventional electronic measurement systems. Measurements can be taken on any kind of circuit material — silicon, gallium arsenide, ceramic or hybrids — without requiring a specialised circuit design to accommodate testing.

The system can measure electrical signals 100 times faster than those in the

Setec making power supplies for NEC

Melbourne power supply designer and manufacturer Setec, has begun production of a power supply for NEC Australia's D3VS PABX. The power supply was designed and is being manufactured at Setec's Bayswater facility.

Setec's managing director Peter Lloyd commented "We had to design to two international safety standards, two international EMI standards and a mixed bag of nine Australian and Telecom standards. Our design group is used to dealing with a diversity of international and local standards so this task was not a problem."

Peter Marmach, Setec's Production Manager, is proud of the fact that his production line came up trumps. "NEC sent a team of people to audit our production processes. They were entirely happy with our process control and production methods. This was a pleasing result. We believe one of the biggest assets of our production is high quality manufacture."

Warning on cordless telephone imports

Overseas travellers who bring back cordless telephones in their baggage will

10-gigahertz range seen by sampling oscilloscopes, the most common technique for measuring fast electrical pulses today.

"The key element in this new technique is a tiny electro-optic crystal made of lithium tantalate that we've honed at the tip to a point just 40 microns across," said Valdmanis.

Attached to the end of a quartz support rod below a high-resolution microscope, the crystal can be brought down near any point on an integrated circuit to sense local electric fields around the conductors and on-chip connections. These fields, which correspond to voltage variations on the conducting lines of the circuit, change the optical properties of the crystal. This change, in turn, is measured by shining subpicosecond laser pulses through the crystal and measuring their change in intensity.

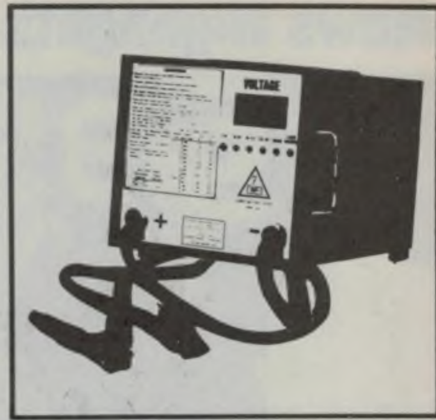
A scientist looking through the microscope can train the electro-optic tip and the micron-sized spot of laser light onto virtually any point of the circuit desired, gaining an electrical "window" into a world of features just microns wide.

Locally developed "world first" solid-state battery tester

KTV Electronics of Melbourne has developed in collaboration with the CSIRO Division of Manufacturing Technology a high-current battery tester, to test motor vehicle batteries. The Harris Model 02 Tester allows the testing of lead acid batteries of capacities in the range 30 — 200aH, at high discharge currents to determine their ability to crank an engine.

The tester is totally solid-state and uses modern thyristor switching technology together with custom-made electronic circuitry. The instrument is completely powered by the battery under test and is fully protected against reversed polarity and over voltage. The tester can be used for testing 6V or 12V batteries.

When the tester is connected to the battery, it loads the battery initially to a small load current, to remove the influence of "surface charge" and indicates the open-circuit voltage of the battery which is a measure of "state of charge".



The high current test, which is then initiated, lasts for five seconds and loads the battery to a current of 330-850A. From a comparison of the terminal voltage of the battery at the end of the test with the values quoted on the front panel of the tester, the condition of the battery can be determined.

The tester is claimed to be particularly suitable for "point of sale" testing, and the only way to test and evaluate sealed low-maintenance batteries.

Further information is available from KTV Electronics, PO Box 618, Sunshine 3020. Telephone (03) 312 1164.

Peter Lloyd sees this power supply as the first step in a long term relationship with NEC. "NEC has plans to export to Canada, South East Asia and China from their Mulgrave plant. We will be striving to provide NEC's power supply needs for these products."

Setec has also begun an expansion program that will provide increased administrative, design and production space. The commission of two HP CAD systems along with new dedicated process assembly lines allow the company to efficiently design and produce export volume or product.

Logan City ITeC seeking help

Logan City Council in Queensland is seeking sponsors and help to establish an Information Technology Centre to provide vocational training for unemployed young people, support local electronics clubs, encourage the establishment of technology-related small businesses and benefit the community as a whole. The proposed centre needs items such as soldering irons, dual trace CROs, signal generators, digital multimeters, tools and toolboxes, multimeter kits and electronic breadboards. It also needs materials for etching PCBs, and a PCB drilling machine.

Organisations able to assist are asked to contact Edward Seabrook at PO Box 226, Woolridge Qld 4114, or on (07) 209 0209 during office hours.

Sony accepts VHS

Sony Corporation has announced that it will make and market VHS system video cassette recorders, effectively conceding what has been evident to industry observers for some time: that its own competing Betamax system has lost the 12-year marketing war between the two.

Betamax was actually the first 1/2" VCR system to be marketed, in 1975. The rival VHS system was launched some 18 months later in September 1976, by its developer JVC and other firms. However VHS gained greater support world wide, and by 1985 it claimed 80% of total VCR sales. A recent report claimed that by the end of 1987, Betamax accounted for only 20 million of the estimated 170 million VCRs sold to date.

Sony spokesmen have stressed that the company will not be abandoning existing Betamax users. It seems likely that both blank and pre-recorded tapes will continue to be available, while demand remains from those 20 million users.

probably never get a chance to use them, warns the Minister for Land Transport and Infrastructure, Mr Peter Duncan.

"Cordless telephones are prohibited imports," he said. "Cordless telephones available overseas often operate on frequencies which are used in Australia by television Channel O, aeronautical, emergency and other radiocommunications services. To prevent interference with essential services, all cordless telephones coming into Australia are impounded by Customs."

News Highlights

George Brown Group opens Brisbane office

The George Brown electronic components distribution group has opened a new branch located in Brisbane, giving it a seven office representation including all mainland capitals plus Canberra and Newcastle.

Mrs Jan Spronk has been appointed Queensland sales manager of the Brisbane office, which is located at 290 Waters Street, Spring Hill.

Speaking at a function to mark the new opening, the principal of the George Brown group George Falkiner said that the company was now approaching its 60th year in the electronic components and equipment distribution field.

"In recent years the George Brown group has developed strongly, including moves to new or expanded premises in several states. We have also increased our committment to high technology and have a world wide product sourcing facility. Close connections are maintained with suppliers including Fairchild, NEC, Zilog, IDTR, Weller, Xcelite, EDI, Thomas & Betts, Augat and others".

Australian car phone wins Canadians

The Canadian government's Department of Communications has given type approval to the cellular radio (car phone) made in Clayton, Victoria by Philips.

The approval opens the way for the Australian product — the FM9010 — to be marketed into Canada.

Samples of the Australian cellular phone have been shipped to Philips Electronics in Canada, to enable its introduction to major dealers and distributors. Carl Alcorn, manager for mobile radio with Philips Canada, says he is very impressed with the performance of the unit and expects wide and favourable distributor acceptance.

General manager of Philips Radio Communication Systems, Mike Tester, says "With the FM9010 — designed to the AMPS standard — we have a truly international product which will compete with all the Japanese and Taiwanese units currently being offered on the North American market."

The FM9010 was launched onto the Australian market only six months ago. The first export orders were from New Zealand.

CAD bureau installs hi-tech scanner

Computer Plot (Australia), one of the leading CAD bureaux, has recently installed the first Optigraphics 300 scanner system in Australia.

The Optigraphics 3000 is an AO-sized drawing scanner and CD conversion system which facilitates the scanning, editing and conversion of existing hard copy drawing into CAD digital drawings, which the end user can then display and manipulate on their own CAD system.

"The Optigraphics 300 provides the best combination of scanning, editing and conversion facilities available, such that we can offer organisations a high degree of flexibility in organising their drawing maintenance and storage/-retrieval functions," said John Cusack, CPA's managing director.

The scanner provides both raster and vector displays which can be edited, archived or output as plots or tapes. Output formats include Intergraph, AutoCAD, ARC, Palette, Computervision and CADAM.

The conversion process involves scanning the document in raster format, editing the image to remove unwanted marks on the drawing.

Character recognition on the Optigraphics 3000 allows hand written characters drawn by draughtsmen and cartographers to be recognised and stored with the associated drawing or map.

Precision Circuits opens Sydney plant

Victorian manufacturer of printed circuit boards, Precision Circuits has opened a new, automated manufacturing plant in Sydney.

The expansion took place despite the claimed downturn in demand that recently forced a Sydney based PCB manufacturer to close its Melbourne plant and lay off 40 people.

Mr Roger Delen, chairman of Delen Corporation says "that the new plant will offer the electronics industry the latest technology in printed circuit board manufacture, so badly needed in this country."

"Six years ago, very few PCBs were imported, however now because of the inability of most Australian manufacturers to deliver consistent good quality boards, and on time, a large percentage of boards are purchased from overseas manufacturers. We are determined to bring this business back to Australia."

"To tackle this problem we have installed sophisticated equipment, and invested heavily in training and motivating our staff to meet the needs of our customers."

The new facility based in the Sydney suburb of Rydalmere, is called Nu-Tech Circuits and will be able to supply both Multi-layer and standard plated-thru boards.

Mr Delen founded Printronics in 1972 and built the company into the largest PCB manufacturer in Australia before selling to Enacon Ltd in 1981.

AEIA sponsoring seminars

The Australian Electronics Industry Association (AEIA) Components Division is sponsoring five key technical sessions in Sydney during 1988, covering practical applications in the area of electronics manufacturing and testing.

The aim of the technical sessions is to provide a forum for the interchange of technical information, by having three selected speakers from the electronics manufacturing industry at each session to cover each topic. Each of the speakers will give a talk on their experiences and their associated problems along with ideas and solutions to solve them.

The first session in March 1988 is titled "Surface Mount Technology — The State of the (Assembly) Art". This is followed in May by "CAD/CAM is Here! Who's using it"; in July by "Quality Technology — The Essentials"; in September "In Circuit Testing v Functional Testing"; and in November, "The Australian Electronics Industry — where to from here".

All sessions will be of around three hours duration. Sessions are planned to start at 6.00pm finishing up with dinner at around 8.00pm. Venue will be the State Sports Centre at Homebush. The fee for each person is $25.00 including dinner.

Further details and registration forms are available from the Secretariat of the AEIA, Components Division, GPO Box 1966, Canberra ACT or member companies of the AEIA Components Division.

New car alarm uses laser "keys"

A new car burglar alarm now available in Australia is claimed to be the most technically advanced anti-theft system currently available.

The Laser Remote car alarm uses an opto-electronic "key", using twin ultra-low power lasers in a compact case which clips to a normal key ring. An inbuilt microchip separately encodes the two beams, to provide some 134 million code combinations.

The alarm is also claimed to be fully protected against RF interference, wind gusts, changes in air pressure and virtually all other causes of false alarms. As no RF link is used, the unit is also claimed to be invulnerable to RF "cracking" by professional thieves.

The new alarm is distributed by Auto Security, 718 Parramatta Road, Croydon 2132.

News Briefs

• Lilydale, Victoria based data communications equipment maker ***Dataplex*** has been awarded a "triple A" award by Telecom Australia, one for its DTE equipment and the other two for its DCE gear. This allows the firm to "self certify" its products for connection to Telecom lines.

• Electronics distributor ***George Brown Group*** achieved top sales for Weller soldering and desoldering equipment in 1987, according to Weller manufacturer ***Cooper Tools***.

• Local car radio manufacturer ***Philips*** has signed agreements with Toyota and General Motors, to secure a dominant share of the Australian business for 1988-91. The agreements are said to cover product worth $60 million.

• Melbourne-based ***Scientific Devices*** has been appointed exclusive Australian distributor for Datron Instruments, of Norwich UK. Datron, recently acquired by US firm Wavetek, makes precision AC/DC calibrators and digital multimeters.

• Test equipment renter ***Tech Rentals*** has moved into larger Sydney premises, at 18 Hilly Street Mortlake 2137. The 'phone number is (02) 736 2066, and the fax number 736 3005.

• Kim Ryrie and Peter Vogel from ***Fairlight Instruments***, along with Tony Furse of ***Creative Strategies***, have been awarded CSIRO medals for their joint development of the CMI computer music instrument.

• TDK (Australia) has appointed ***Monaco Corporation*** as exclusive New Zealand distributor of its tapes and accessories. Monaco has offices in Auckland, Palmerston North, Wellington, Christchurch and Dunedin.

• The winner of the Federal Publishing 1987 Christmas Catalog promotion, and happy new owner of an Achilles Fun Boat is Mr B.D. Maclean, of Sylvania Waters NSW.

• Equipment manufacturer/parts distributor ***Rifa*** is concentrating its sales and marketing in Melbourne, and also pruning its key imported product lines from 15 to four. RIFA semiconductors, Bulgin hardware, Eddystone cases and Dale passive components. MD Neil McCormick says the moves will help the company provide better support and specialised service.

Experiment with "Synthetic Psychology"!

Build a Braitenberg vehicle

These fascinating little devices can behave like simple living creatures, exhibiting traits similar to aggression, fear or love — yet they require surprisingly little circuitry (and no fancy microprocessors) to achieve this.

by MARK CHEESEMAN

Braitenberg vehicles were first brought to our attention by an astute reader, Mr. W. K. Henderson of Balwyn, Victoria, who discovered them in the March 1987 issue of *Scientific American*. They are claimed to be able to express 'feelings' such as fear or aggression, depending upon how they are 'programmed'. They are even more fascinating to watch when it is realized how little circuitry is actually required to make them perform these feats.

The vehicles were originally described in Valentino Braitenberg's book, *Vehicles: Experiments in Synthetic Psychology*. They consist of a base, with two independent drive-wheels and motors, and a third undriven castor. This allows the two main wheels to determine the direction in which the vehicle travels, by varying the speed of one motor with respect to the other.

The motors are driven by a signal derived from photo sensors and processed by some simple circuitry. As the circuitry connecting the sensors to the motors is analogous to neurons in a living organism, they are known as *neurodes*. There are different types of neurodes, which produce varied behaviour from the vehicle.

The light sensors in the original design produce a pulse train, the frequency of which depends on the intensity of light falling on the photocell. The neurodes then act on this pulse train in different ways and derive a drive signal for the motors. The simplest form of neurode is a simple piece of wire, which does nothing to the pulse train fed to the motor. Thus as the pulse rate increases due to increasing light intensity, so does the speed of the motor.

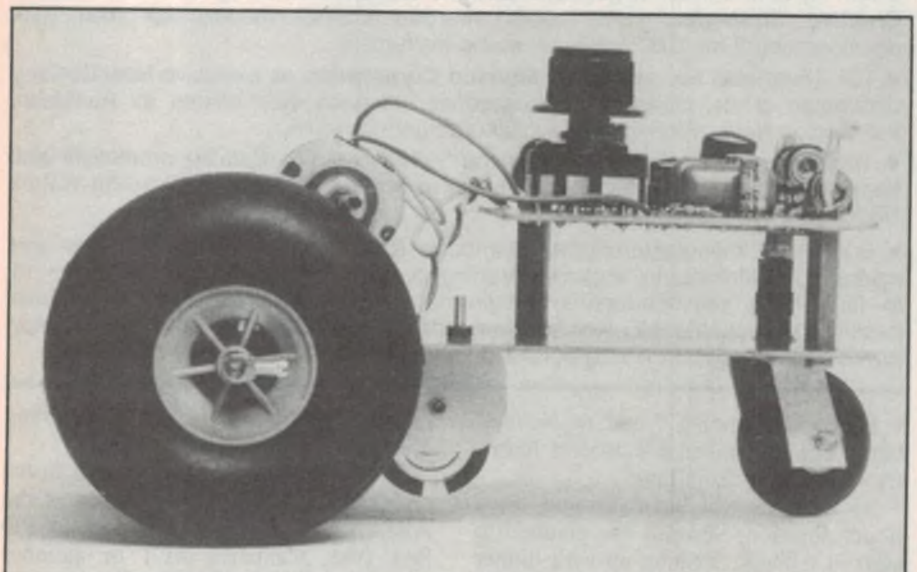
A neurode may connect a motor to the sensor on the same side of the vehicle as the motor, or the sensor on the opposite side. In the former case, the motor on the side of the vehicle will tend to increase speed, steering the vehicle away from the light source. As the vehicle withdraws further from the light source, it slows down, and eventually stops, waiting for another light source to appear so that it can "run away" from that one also.

If the wires are crossed, however, the behaviour changes from the timid sort of behaviour exhibited above, and becomes quite aggressive. As the light intensity falling on a particular sensor increases, it drives the opposite motor faster, steering the machine towards the light source, at an ever-increasing speed. This continues until the vehicle smashes into the light source.

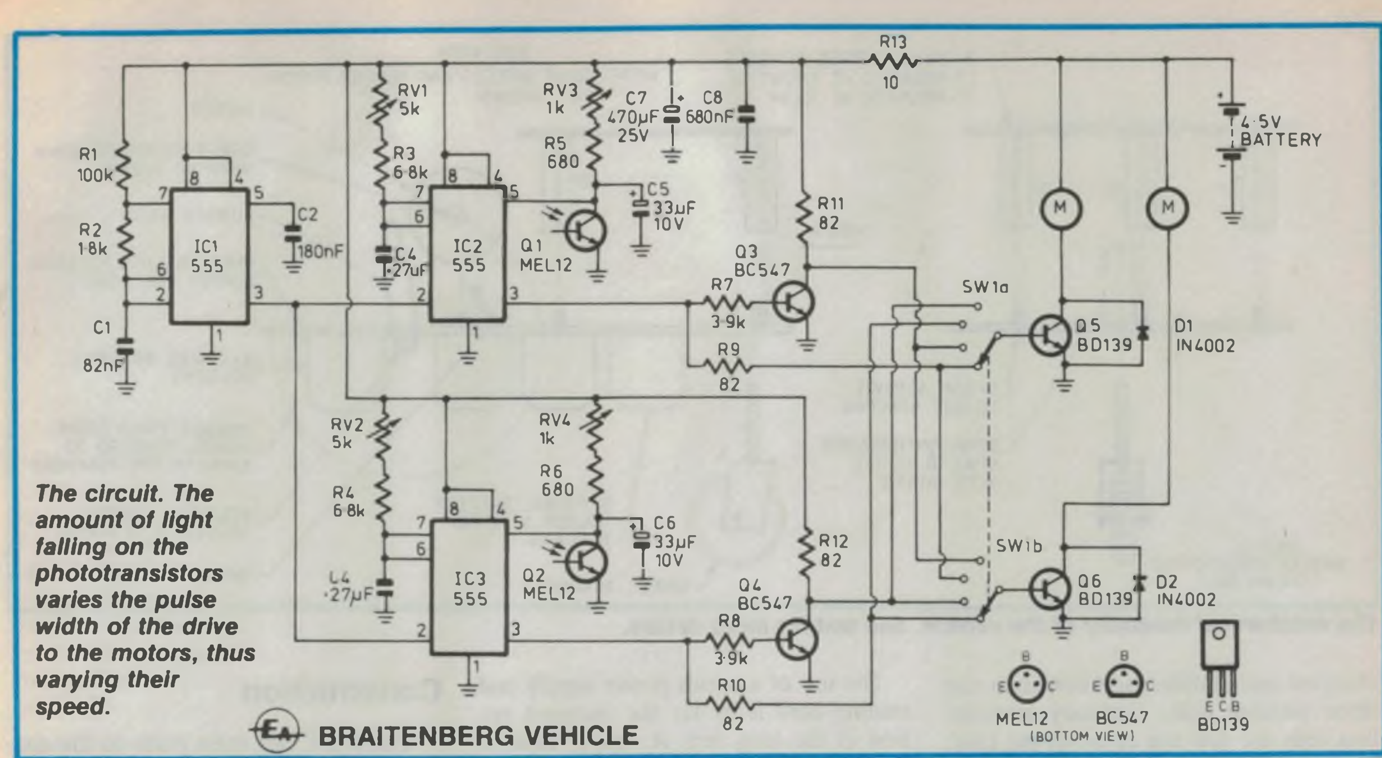
The other type of neurode tends to invert the action of the light source, so that an *increase* in light intensity causes the motor speed to drop. As in the previous example, the motors may be controlled by the sensor on the same side of the vehicle, or the one on the opposite side.

In the first of these latter configurations, an increase in light intensity on one sensor will reduce the speed of the corresponding motor, tending to align the direction of travel towards the light source. The vehicle will eventually reach a point where all forward motion ceases, leaving it gazing at the light source in something closely resembling admiration.

If, however, the sensors control the speed of the motor on the opposite side



The finished prototype looks a little like a 'bug-eyed monster'.



The circuit. The amount of light falling on the phototransistors varies the pulse width of the drive to the motors, thus varying their speed.

of the vehicle, the motor on the side of the vehicle opposite to the sensor receiving most light will tend to slow down, turning the machine away from the light. Unlike the other case when this happens, the vehicle will speed up as it disappears into the darkness, probably crashing into any dark object which gets in its way.

The original design called for stepper motors, as their speed is dependent upon the pulse rate fed to them. Unfortunately, stepper motors aren't cheap, so we have re-hashed the control circuitry to allow the use of ordinary DC model motors.

Instead of varying the pulse rate according to the amount of light falling on the sensors, the pulse rate is kept constant while the pulse width is varied. Varying the pulse width has the same effect on the motor speed as varying the voltage. The advantage of pulse-width modulation, or PWM as it is known, is that the driving transistor is either off or on, and not somewhere in between. This results in greatly reduced power loss, and eliminates the need for heatsinks on the transistors, in addition to prolonging battery life.

It is amazing to see how such a simple and inexpensive "toy" can provide such an interesting display, especially in the eyes of the uninitiated. Its reactions to its environment seem to provide a fascinating insight into human emotions, making the workings of the living brain not seem as complicated as they really should.

Circuit Details

The circuit itself is quite simple, consisting of three 555 timers, four transistors and a few other bits and pieces. One 555 operates in astable mode, producing a train of narrow pulses at a rate of about 150Hz. These pulses trigger the other two 555s, each operating as a monostable, with a pulse width which can be varied by the amount of light falling on the associated phototransistor. This is achieved using the *Control Voltage* or *Modulation* pin (pin 5) on IC2 and IC3.

IC2 and IC3 are configured as monostables. When they receive a negative going trigger pulse, the capacitor connected to pin 7, which was being held discharged by a transistor in the 555, is allowed to charge up toward the positive rail through the resistor connected between the capacitor and the supply rail. When the voltage on pin 6 (in this case connected to pin 7) exceeds the voltage on the control voltage pin of the 555, the timing cycle ends, discharging the capacitor, and the 555 awaits the arrival of the next trigger pulse.

The control voltage pin is usually held at two-thirds of the supply voltage by 5k resistors built into the 555. However it is quite a simple matter to "pull" the voltage on this pin either up or down using external components. In this circuit, the series combination of RV3 and R5 serves to pull the pin towards the positive rail, while the phototransistor Q1 will pull it down harder as more light falls on it.

The higher the voltage on pin 5, the longer the time required for the capacitor to charge up to the threshold voltage, and the longer the pulse on the output. As a continuous train of pulses is being fed to the trigger input of the 555, the output is a pulse-width modulated square wave, the duty cycle of which is dependent upon the intensity of light falling on the relevant phototransistor.

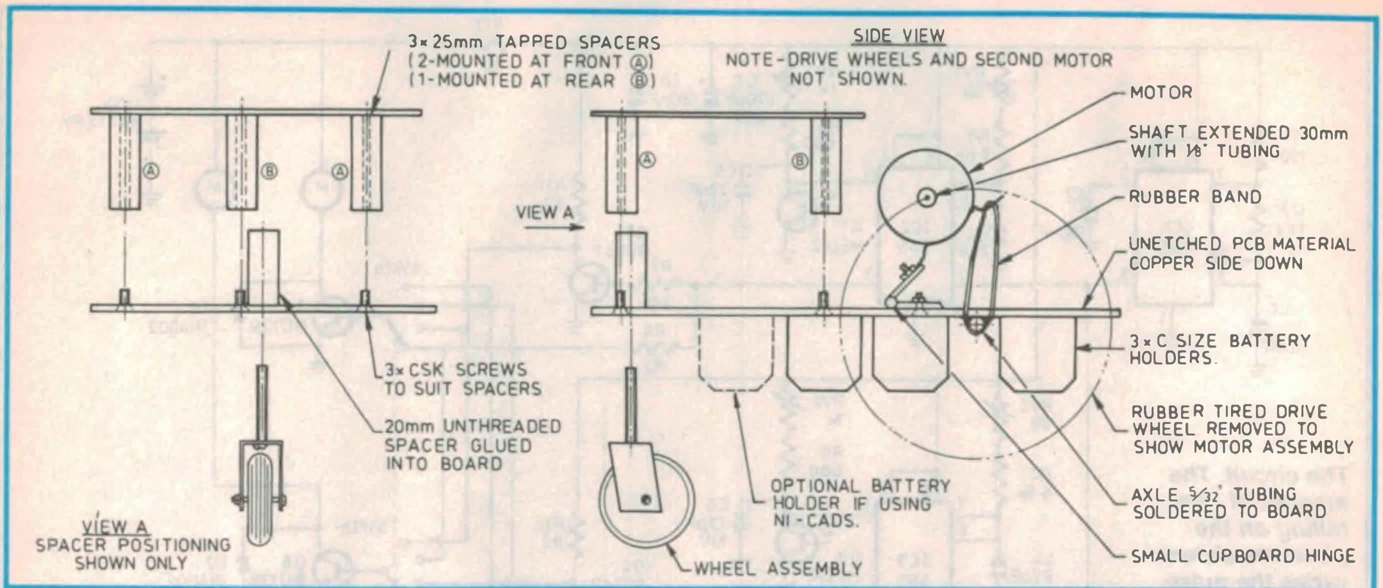
The outputs of IC2 and IC3, and their inverted outputs from Q3 and Q4 are fed to a four-position rotary switch, SW1, which then determines which signal is fed to the two power transistors. In position 1, the motor drive increases with increasing light intensity, with each phototransistor acting on the motor on the opposite side of the vehicle.

The second switch position is the same as the first, except that as the light intensity falling on the phototransistor increases, the motor drive is reduced. The third and fourth positions have the motors controlled by the sensor on the same side of the vehicle as the respective motor. In the third position, an increase in light intensity increases the motor speed, while the opposite happens in position 4.

So SW1 becomes the selector of your Braitenberg vehicle's behaviour.

The RC network formed by R13, C7 and C8 serve to isolate the electronics from the noise generated by the motors, which can be quite severe.

There are several options for the power source for your vehicle. The



The mechanical assembly of the vehicle. See text for more details.

cheapest and simplest solution is to use three alkaline cells. Ordinary zinc-carbon cells are just not equal to the task, as the motors are rather thirsty little beasties. Even with alkaline cells, battery life is rather short, and can become rather expensive in not too short a time.

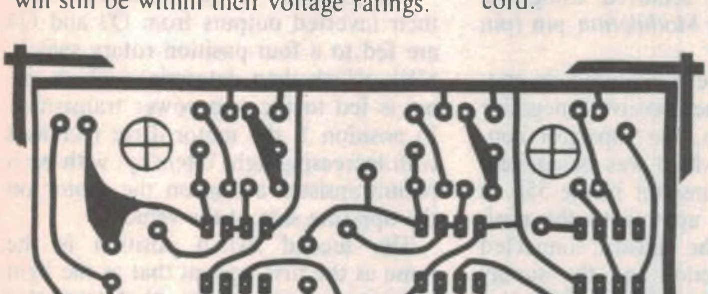
Ni-Cads are probably a more viable option, as they have a lower internal resistance and of course the ability to be recharged. Since NiCads have a lower terminal voltage than their alkaline counterparts, it is recommended that four cells be used. With the voltage drop across the transistors, the motors will still be within their voltage ratings.

The use of a mains power supply and trailing cord is by far the cheapest option in the long run. A supply capable of producing 4.5V at an amp or so should be suitable. One point to watch here is supplies with fast-acting current limiting at about 1 amp. Although the average current seldom exceeds 1 amp, because of the pulse-width modulation the peaks can be higher than this, causing the current-limiting to throttle back the supply to the circuit. The other problem associated with the use of a mains power supply is the problem of the vehicle tripping over its power cord.

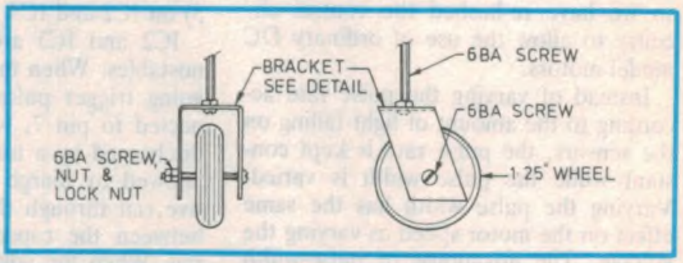
Construction

There are two main parts to the construction process of one of these vehicles: the mechanical building of the vehicle itself, and the assembly of the electronics on the PCB. The latter part is the easiest, so you might as well do this first and get it out of the way.

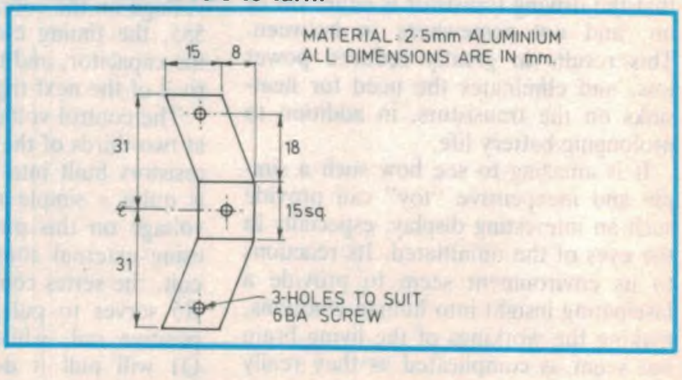
Begin with the printed circuit board, coded 88ro2, by checking it carefully for any bridges between tracks, or breaks in them. There are no static-sensitive components on the board, so the order of assembly is not particularly critical. It is suggested that you mount the lower



The printed circuit board artwork, reproduced actual size.



Front wheel assembly. This must be able to pivot freely to allow the vehicle to turn.



Detail for the front wheel support bracket.

profile components first, as you may experience difficulty in doing so later when the larger components are mounted.

Be careful with the orientation of the ICs, diodes and transistors. The two BD139 flat-pack transistors are orientated with their front (the side with the printing on it) towards the centre of the PCB. The holes for the switch need to be larger than the rest, to allow for the larger pins, and also to help locate it on the board.

The two phototransistors are mounted about 15mm above the board on long 'legs', insulated by spaghetti or heatshrink tubing. They should not protrude beyond the edge of the base, to ensure that they are not prone to damage if an errant vehicle crashes into a nearby chair leg. The base connection (the middle leg) of the phototransistors is not used, and may be cut off.

The 'chassis' of the vehicle itself consists of a piece of unetched single-sided PCB material, measuring 134 x 80mm. The main axle consists of a piece of 5/32" copper tubing, soldered to the copper side of the board as shown in the diagram. This size of tubing was chosen to suit the diameter of the holes in the wheels. If your wheels have different sized holes, you should select the axle material to suit this.

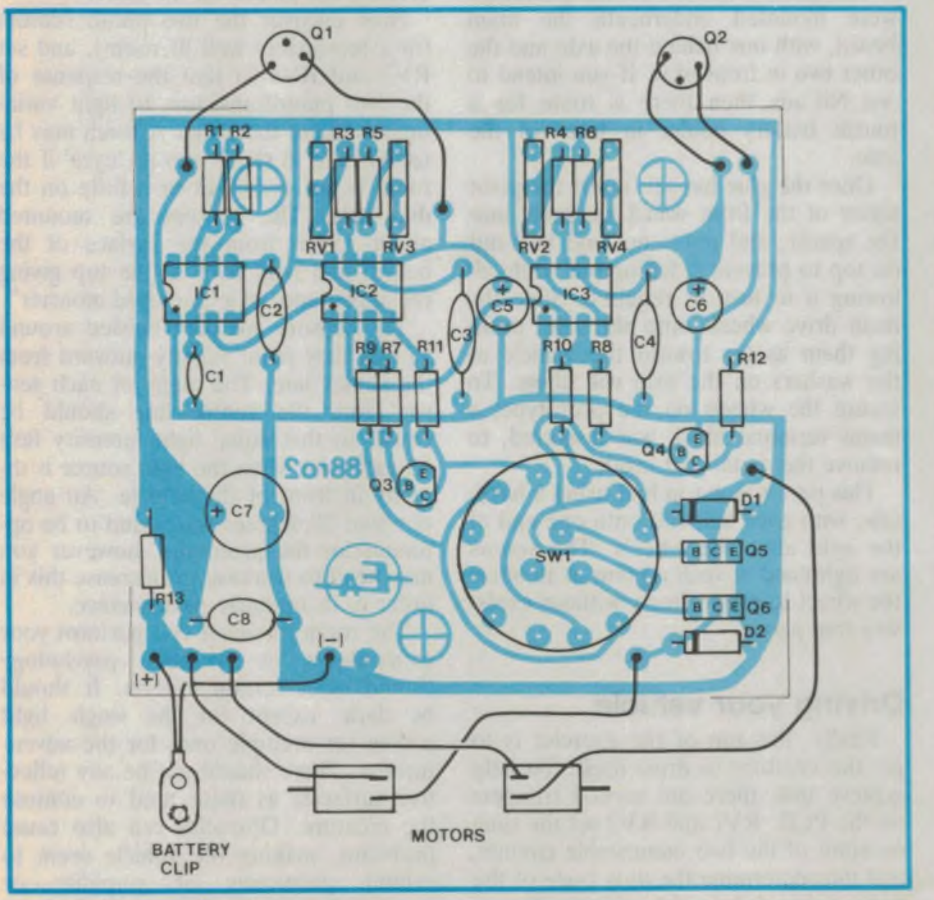
The axle for the main wheels on the prototype consists of a 160mm length of 5/32" copper tubing. This should be soldered to the copper side of the base PCB, about 35mm from the rear end. Use a high-wattage soldering iron for this, as most of the irons designed for electronics work are not capable of delivering the sheer amount of heat required for the job. I used a *Superscope* iron, which proved entirely satisfactory.

Now, find a couple of small brass washers which are a neat fit on the axle. If you can't find washers with the correct sized hole, use ones with a slightly undersized hole. This can easily be enlarged with a reamer while holding the washer tightly with a pair of pliers. To determine the final position of the washers, slide them onto the axle, followed by the wheels.

The washers should be fixed in such a position as to prevent the wheels from sliding along the axle into the body of the vehicle. Now solder the washers to the axle using a high-powered iron, removing the wheels beforehand so that you don't melt them.

The motors used in our prototypes were "Johnson" brand devices, rated at 4.5V, and were obtained from Hobbyco in Sydney. However similar units should be available from virtually any hobby retailer. They measure 25mm in diameter, and 30mm long, with a small shaft extending a further 6mm from one end. They also sport an integral mounting plate, which makes attaching them to the vehicle a breeze.

A pair of small cupboard hinges is used to support the motors, to allow them to be tensioned by elastic bands to hold the shafts against the wheels. The hinges used on the prototype were 35mm long, and their holes conveniently lined up with the mounting holes on the bases of the motors. The placement of the hinges on the base will depend on the size of the wheels which are used. They should be placed so that the motors have a reasonable amount of room to move.



The printed circuit board overlay.

PARTS LIST

1 PCB, 86 x 78mm, coded 88ro2
1 Fibreglass PCB 170 x 90mm, unetched
2 3" model aeroplane wheels
1 1.25" model aeroplane wheel
2 4.5V DC electric motors
2 35mm hinges
3 25mm spacers
1 20mm spacer
1 60mm long piece of 1/8" copper or brass tubing
1 160mm long piece of 5/32" copper or brass tubing
1 3 pole, 4 position PCB mount rotary switch
1 knob for above
3 or 4 single C-cell holders (see text)

Resistors

1 x 1.8k, 1 x 100k, 2 x 6.8k, 2 x 680Ω, 2 x 3.3k, 4 x 82Ω, 1 x 10Ω
2 1k trimpots
2 5k trimpots

Capacitors

1 82nF metallised polyester
1 680nF metallised polyester
1 82nF metallised polyester
1 180nF metallised polyester
2 270nF metallised polyester
2 33uF 10VW PCB electrolytics
1 470uF 25VW PCB electrolytic

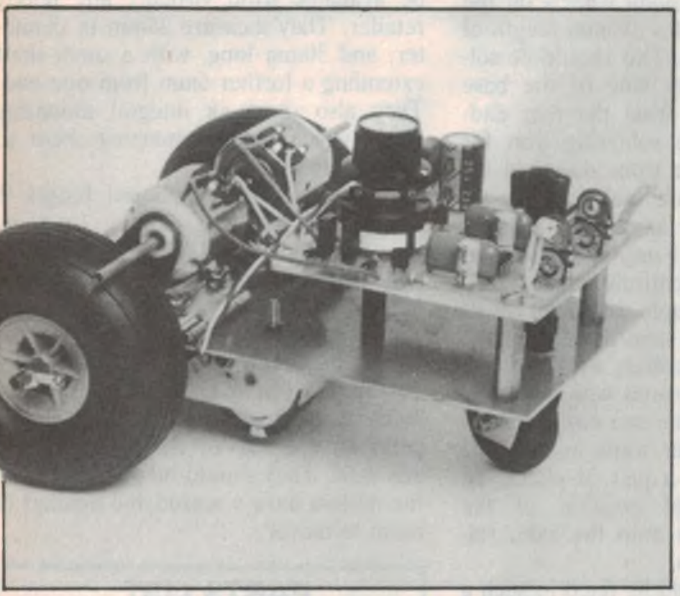
Semiconductors

3 555 timers
2 MEL12 phototransistors
2 BC547 npn transistors
2 BD139 npn power transistors

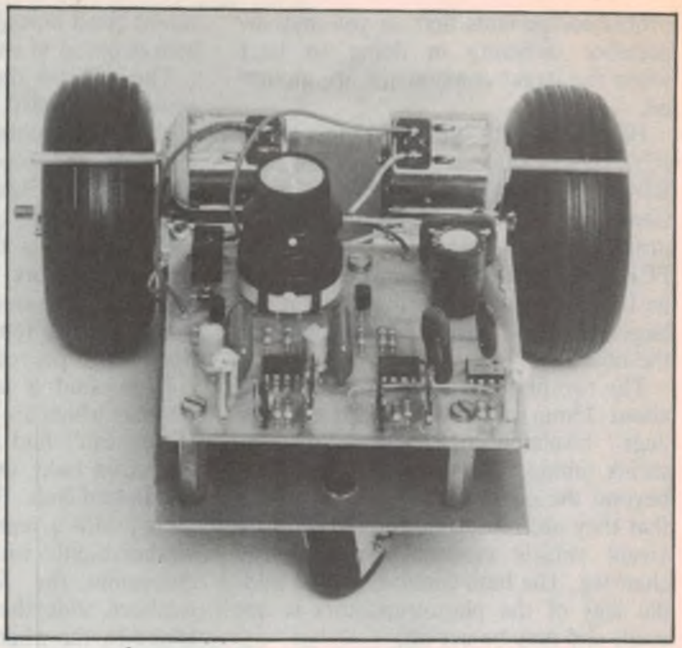
Miscellaneous

Nuts, bolts and washers, super-glue, mains terminal block, hookup wire, sheet aluminium

“Synthetic Psychology”



Side view, showing the overall assembly detail.



Head-on view. note how the ‘eyes’ are mounted above the PCB, which in turn is mounted on the base board.

As supplied, the shaft on the motors will probably not be long enough to ensure reliable contact with the wheels. Therefore, you should extend the shafts using short lengths (about 30mm) of brass tubing. Is is important that the inside diameter of the tubing is as tight a fit on the motor shaft as possible, otherwise the tubing will tend to get off-centre at the end, making the motors wobble about rather violently, and hindering the transfer of power to the wheels.

At this point it is a good idea to mark out and drill the mounting holes for the printed circuit board. The board should be mounted with two supports toward the front of the vehicle, and the single one toward the rear. However, do not mount the PCB yet, as the preparation of the base is not yet complete.

The small (1.25”) wheel acts as a castor to allow the vehicle to turn easily. To achieve this, a small bracket is bent up from a piece of 0.5mm aluminium, with a 25mm long 6BA screw forming the pivot about the whole assembly rotates. Finally, another screw attaches the wheel to the bracket. The wheel must be free to rotate, so a lock-nut is suggested to prevent the nut from coming undone. A couple of washers may help to prevent the wheel from rubbing against the bracket.

Drill a hole in the centre of the base PCB, 15mm from the front. A round 20mm long PCB spacer is used to support the front wheel assembly, and should be a tight fit in the hole. Also make sure that the inside diameter of the spacer is large enough to allow the vertical pivot to rotate freely, but not so large as to give rise to excessive free play in it. Before inserting the spacer into the hole, apply some adhesive, such as super-glue, and also make sure that the spacer is vertical.

The battery holders on the prototype were mounted underneath the main board, with one behind the axle and the other two in front of it. If you intend to use NiCads, then there is room for a fourth battery holder in front of the axle.

Once the glue has set, insert the pivot screw of the front wheel assembly into the spacer, and put a nut and lock-nut on top to prevent it falling out while allowing it to turn as required. Slide the main drive wheels onto the axle, pushing them as far toward the vehicle as the washers on the axle will allow. To secure the wheels on the prototype, a mains terminal block was dissected, to remove the metal part inside.

This part was cut in half using a hacksaw, with each half slid onto one end of the axle after the wheels. The screws are tightened at such a point as to allow the wheel to rotate freely without excessive free play.

Driving your vehicle

Really, the aim of the exercise is to get the creature to drive itself. To help achieve this, there are several trimpots on the PCB. RV1 and RV2 set the time constant of the two monostable circuits, and thus determine the duty cycle of the pulse trains fed to the motors. To set these, cover both of the light sensors so that little or no light falls on them. Turn the switch to position 4, so that the motors will run at maximum speed, and adjust these two trimpots so that the motors both run at about the same speed when placed on the floor.

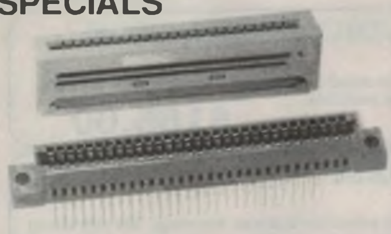
Now uncover the two photo sensors (in a reasonably well lit room), and set RV3 and RV4 so that the response of the two phototransistors to light variations is about the same. A torch may be useful here to shine into its ‘eyes’ if the room is not evenly lit or a little on the dim side. The sensors are mounted about 15mm from the surface of the board, and bent over at the top giving the appearance of a ‘bug-eyed monster’.

The sensors are then twisted around so that they point slightly outward from the center line. The angle of each sensor from the centre line should be equal, so that equal light intensity falls on each one when the light source is directly in front of the vehicle. An angle of about 20 degrees was found to be optimum for the prototype, however you may need to increase or decrease this in order to its optimize performance.

The room in which you perform your experiments in synthetic psychology should meet certain criteria. It should be dark, except for the single light source (or multiple ones for the adventurous). There should not be any reflective surfaces, as these tend to confuse the creature. Obstacles can also cause problems, making the vehicle seem to exhibit properties of stupidity or drunkeness instead of the desired ones.

WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR CHIPS ... WOOD FOR C

CARD EDGE CONNECTOR SPECIALS



Take your pick of these three 0.1" pitch connectors-
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An unrepeatable bargain at only **$13.95** each.

ONLY $1.00

KEYBOARD SWITCHES

Building your own keyboard? Then here's the ideal switch. Single momentary make contact. Complete with ivory keycap.
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Miniature circular type only 6mm diameter and 5mm high. 8 types to choose from - 2 to 16pF, 3 to 11pF, 3 to 22.5pF, 4.2 to 20pF, 5.2 to 30pF, 6.8 to 45pF, 10 to 120pF, 60 to 160pF. All **$1.50.**

THUMBWHEEL SWITCHES

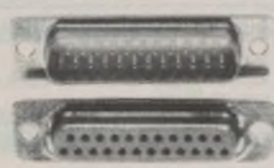
These are genuine C&K high quality. Available in decimal or BCD format. PCB edge connector or solder leads on directly. Both types are **$6.85** each. End plates are **$3.80** a pair and screws are **$1.40** a pair. They come in sizes depending on number of wafers 1- 3 or 3 to 7. Please specify when ordering.

TRIMPOT COVERS

Wouldn't it be handy if you could mount a rectangular multi-turn trimpot on a front panel? Well you can with a trimpot cover. Only **$2.00** and you'll need a ***trimpot tool*** to adjust it with. This handy little gadget is just like a pen and has a blade at each end. One end is specially designed so it can't slip. Well worth **$2.00**.

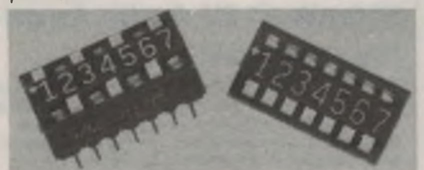
SHORTING LINKS

Ideal for programming and test linking on circuit boards, these links have a standard 0.1" spacing. Contact is partially exposed for touching a probe on. Packet of ten **$2.95.**



23 PIN 'D' CONNECTORS

No it's not a misprint - there are now 23pin D-connectors on some of the newer PC's. So if you're finding it hard to get plugs and sockets to match, Geoff of course has 'em.
Male, Female and Backshell all the same price **$3.50.**



DIP SWITCHES

Geoff carries a wide range of DIP switches including a rotary type. Check your requirements:
Conventional - 2way **60c**, 4 way **$1.75**, 6 way **$2.30**, 7 way **$2.40**, 8 way **$2.50**
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IBM PRINTER CABLES

Available in two lengths - 1.8m and 4m. Both have quality connectors each end. You couldn't make one for the price!
1.8m **$19.95** 4m **$36.00**

NATIONAL 32000 DESIGNER'S KIT

Geoff has had to order two consignments of these kits in since we advertised them. They are only suitable for advanced computer hobbyists and professionals.
Two versions - one with 32016, the other with a 32032. Both have a 32082 Memory Management Unit, a 32201 Timing Control Unit, a 32081 Floating Point Unit, 1 32202 Interrupt Control Unit and two "Tiny Development Systems" (TDS) PROMs. That's seven chips altogether.
There's a massive pack of literature including a databook 40mm thick, a 20mm thick instruction set reference manual, a TDS user guide, a programming reference guide, application notes on UNIX, 32 bit architecture and even a PASCAL listing to aid development of 32000 code using a PC. To top it all off there's an article reprint from the US on a UNIX co-processor for under $US400!!
These are definitely not for beginners but what a great buy - 32016 kit is just **$132.** The 32032 costs **$180.** (P&P $6.00 local or $15.00 airmail - it's a big pack!)

Contact Geoff for all your semiconductor and IC requirements. Our range is constantly expanding. Always remember to call "Wood for Chips!"

MULTI-TURN DIALS

If you use multi-turn potentiometers you need these beaut Dials
10 turn Digital Multi-Dial has three digit readout. One turn of the knob gives a count of 100. Resolution to one fifth of a digit graduations! Measures approx 45x25x25mm (inc knob). Incorporates lever action locking mechanism. **$36.50.**
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JAYCAR CATALOGUE

LOW COST UTILITY TIMER
Ref: EA Feb 1988
Whether you wish your egg soft, but not too soft, or whether you want to add the time factor to a game of Trivial Pursuit, this utility timer is ideal.
Complete kit
Cat. KA-1697
$21.95

TRANSISTOR, FET AND ZENER TESTER **$55.00**
Ref: EA Feb 1988
Revamped version of an oldie. Checks transistors, fets and zeners as well as checking transistor breakdown voltages. Great for the workbench, and also for showing how semiconductor devices operate. Complete kit includes box, meter, transformer and all parts.
Cat. KA-1698

TELEPHONE INTERCOM
Ref: ETI Feb 1988
Use 2 old telephones to make an intercom. Kit includes power supply, filter capacitors, box and all parts.
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$59.95

DOOR MINDER **$37.50**
Ref: Silicon Chip Feb '88
New generation door opener alarm.
Cat. KC-5020
9V power supply
Cat. MP-3010 $18.50

LOW DISTORTION AUDIO OSCILLATOR
Ref: EA Dec 1986
At last it's available, the metered version of our auudio oscillator. Compares with the very best laboratory standard sine wave equipment available.
Cat. KA-1677
$165.00

SUPER SIMPLE MODEM
Ref: AEM Sept 1986
Due to customer demand, we have decided to introduce this into our range. It's very cheap and it works well. Kit is supplied with RS232 female connector and all other parts except power pack, which is extra $13.95 (Cat. MP-3020)
Cat. KM-3046
$85.00

LOW OHMS ADAPTOR FOR DMM's
Ref: Silicon Chip Feb 1988
Another handy kit from SC which utilises your digital multimeter. **$29.95**
Cat. KC-5023

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Ref: Silicon Chip Feb 1988
PC board and all parts supplied including switch. **$9.95**
Cat. KC-5024

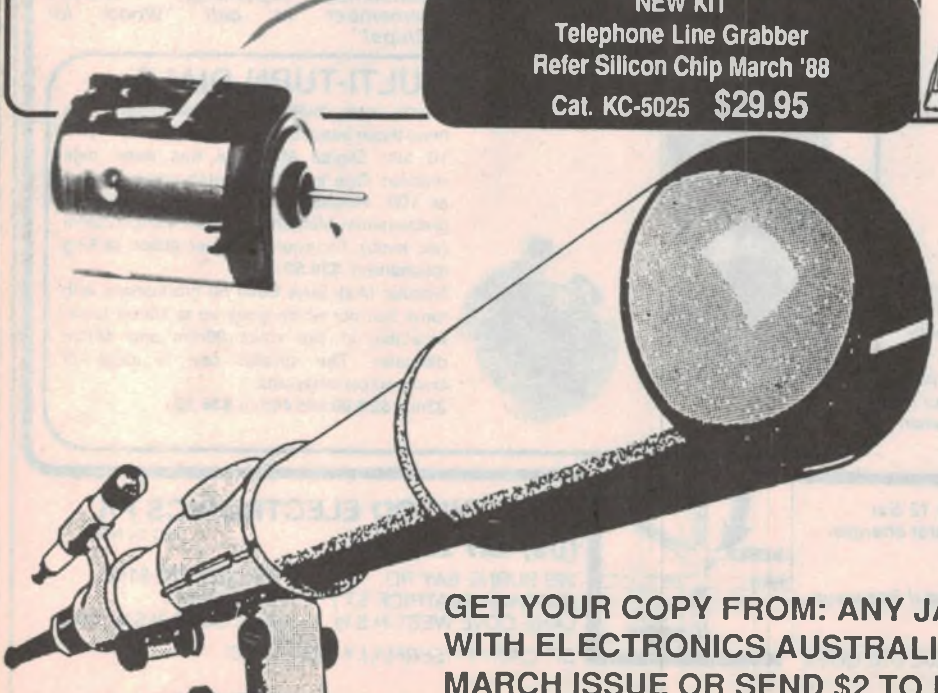
ULTIMATE CAR BURGLAR ALARM
Ref: Silcon Chip Feb '88
Includes flashing light switch, back-up battery and ignition killer. **$79.50**
Cat. KC-5021 Extras - Siren Horn Cat. LA-5700 $26.50Screamer Piezo Cat. LA-5255 $17.95

6V 2400 rpm Cassette Player Motor SCOOP BUY!
This motor measuring 38 dia and 35mm long (plus shaft 10mm long) has high torque, modest current consumption. It is ideal as a cassette deck replacement motor. It is very high in quality - the motor itself is rubber mounted into an outer case, with screened power leads.
Ideal also for toys, robotics, etc.
Cat. YM-2702
ONLY $1.00 ea
10+ 95¢ ea

500mW @ 6V Audio Amplifier under $4!
That's right! A SIX TRANSISTOR 1/2 watt amp for the cost of two hamburgers! It has a two transistor tape preamp which is NAB equalised and a 4 transistor power amp. It has facilities to take line level inputs. The (irregularly shaped) board measures roughly 110(L) x 48(W)mm. Each amp comes with complete schematic and connection diagram. (2 required for stereo).
Cat. AA-0290
$3.95 ea
10+ $3.50 ea

Push Button Wall Mount Phone with AM/FM Radio!
Scoop purchase price! An AM/FM radio with good tone that mounts on the wall (kitchen or garage ideal). When the phone is answered the music mutes out. You can even put the music on the line if you need to put the caller on hold! (Requires 3 x AAA batteries not supplied).
Cat. YT-7072
STAGGERING VALUE
$39.95

NEW KIT
Telephone Line Grabber
Refer Silicon Chip March '88
Cat. KC-5025 $29.95



HAS THE JAYCAR CATALOGUE
(that was inserted in this magazine)
GONE MISSING?

GET YOUR COPY FROM: ANY JAYCAR STORE • FREE WITH ELECTRONICS AUSTRALIA AND SILICON CHIP MARCH ISSUE OR SEND $2 TO PO BOX 185 CONCORD 2137 AND WE'LL POST ONE TO YOU.

CELEBRATION SPECIALS

INTELLIGENT MODEM PRICE SLASHED!!

A very well-known Australian manufacturer of modems came to us with a problem. They had a smallish number of their No.1 selling Intelligent Modems left from their final production run. (The product was being discontinued because their upgraded 1988 model Intelligent modem is fitted in a smaller more attractive case.

They were anxious to clear the old stock to make way for the new. To be frank, however, there is a snag even though it is in reality a very small snag. What is it?

HAYES COMPATIBILITY. 'Hayes' command protocol is used by the intelligent modems to communicate with each other. The problem is that this intelligent modem only uses a subset of the Hayes command protocol. (This can be likened to IBM 'Clone'-type computers. Most are not 100% IBM software compatible. They work well anyway).

Mind you, the above is only a problem if you were, say a bank or large corporation trying to use this modem to receive information at high speed from their intelligent modems!

BUT if you use it as an ORIGINATE modem i.e. as a house user/hobbyist etc., it is perfect! WE GUARANTEE THAT.

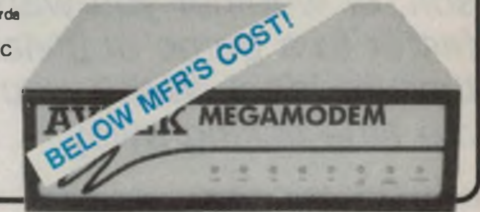
This is a wonderful opportunity to buy a high speed (1200 baud FULL DUPLEX) modem with auto dial/auto answer FOR THE PRICE OF A LOW SPEED DUMB MODEM!

REMEMBER the only drawback is that it will not ALWAYS work with 'smart' software but will always work in the terminal/Viatel mode.

We have purchased this product FAR BELOW manufacturers factory cost. Massive savings are being passed on. This price is 1/2 the price shown in our 1987 catalogue! A condition of purchase was that we did not reveal the manufacturer's name, but you can always make an AVerage guess!

SPECIFICATIONS: • Speeds 300 baud full duplex 1200/75 limited full duplex 1200 baud full duplex (option) • Data Standards CCITT V21, CCITT V23, Bell 103, CCITT V22 (option) Bell 212 (option) • Interface CCITT V24 (RS232) • Data Format Asynchronous • Diagnostics Analogue and digital loopback • Filtering Digital, no adjustment crystal locked • Power 240V AC 12 watts • Transmit Level -10dBM/600 ohms • Receive Sensitivity -40dBM • Receiver Tolerance ±16Hz • Modulation Frequency shift keying Phase shift keying (with V22 option) • V21/V22/V23 (1200/1200 option fitted)

Cat. XC-4834



SAVE OVER 50% WAS $699 NOW ONLY $349

LEDS 10mm

DIRECT IMPORT SAVES YOU MONEY

10mm LEDs - NOW AT AFFORDABLE PRICES

Red Cat. ZD-1956
Green Cat. ZD-1957
Yellow Cat. ZD-1958
Orange Cat. ZD-1959 (NEW)

WAS $1.95 ea
NOW $1.50 ea

10 up $1.30 ea

LED and HOLDER FOR PCB MOUNTING

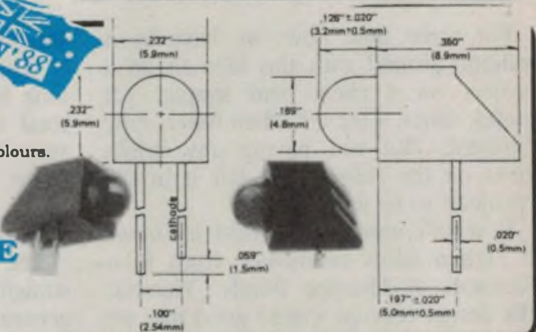
NEW '88

These are basically a 5mm LED mounted in a plastic housing specifically designed for PCB mounting. Available in the 4 standard colours.

Red Cat. ZD-1780
Green Cat. ZD-1781
Yellow Cat. ZD-1782
Orange Cat. ZD-1783

ALL THE SAME PRICE

48¢ ea
10 up 42¢

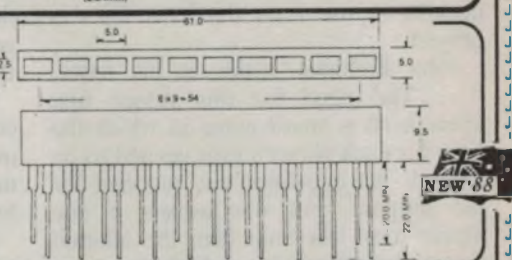


LED BAR GRAPH

Jaycar has introduced this great LED array for our 1988 new product line-up. It has 7 green and 3 red rectangular 5mm x 2.5mm LEDs mounted in a black housing. Ideal for VU metres or where any easy visual clipping level is required.

Cat. ZD-1702

$4.25
10 up $4.00 ea

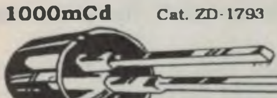


LOWER PRICES ON ULTRA BRIGHT LEDS

DIRECT IMPORT SAVES YOU MONEY

DIRT CHEAP!!

(ALL RED)		WAS	NOW
200mCd	Cat. ZD-1790	99¢	79¢
		10 up 90¢	10 up 70¢
500mCd	Cat. ZD-1792	$3.75	$2.50
		10 up $3.50	10 up $2.30
1000mCd	Cat. ZD-1793	$7.95	$4.95
		10 up $7.50	10 up $4.50



STD BAR - FINALLY RELEASED

NEW '88

The STD Bar for your telephone will be available sometime in January. It appeared in our catalogue but we were afraid to release it due to to the safety aspect of 000 emergency number. We have solved this problem, and the new model will allow emergency calls through on the 000 number, but will stop standard STD calls (except Tasmania). Cat. YT-6540

$34.95

Jaycar ELECTRONICS

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OVER $100		$10.00

ROAD FREIGHT ANYWHERE IN AUSTRALIA $13.50

MAIL ORDER VIA YOUR PHONE

Construction project:

Low cost utility timer

Whether you wish your egg soft, but not too soft, or whether you want to add the time factor to a game of trivial pursuit, this utility timer is ideal. With it you can see and hear the time ticking away!

by HENK MULDER

For some time now, we have been walking around with this idea to do a project on a cheap and simple, yet useful, timer. Like a kitchen timer, only different. But not having any bright ideas on the subject, we left it in the "projects to be done" tray.

It wasn't until we received a *Circuit & Design Ideas* submission from John Freeman of Moonee Ponds, Victoria. His design concept was so good that we decided to use it as the basis for this project.

John Freeman wrote in his letter: "... The need for this device first arose from a board game in which the time for each player's turn needed to be limited. An egg-timer was supplied for the purpose, but was useless if one player took less time than the allotted time — because it couldn't be reset quickly. Subsequently, the device has served as a STD-call timer and as a crude chess clock".

As it happened, the idea looked very much like what we were looking for, hence the decision to turn it into a project.

We didn't take the circuit exactly as it was, but modified it a little to make it a little more suitable for other applications. The functional principle is the same, though.

The resulting timer can be set for a total period ranging from 10 seconds to 15 minutes. This range could be changed, if required, by changing the values of certain components.

When the timer is turned on, or the reset button is pushed, the timer starts counting. First the lowest LED is lit, then the following and so on. Every time the timer moves up one LED, a short beep sounds.

When the tenth LED finally glows, a long beep sounds, to indicate that the total time has elapsed. The LED will stay on until the reset button is hit again.

The circuit

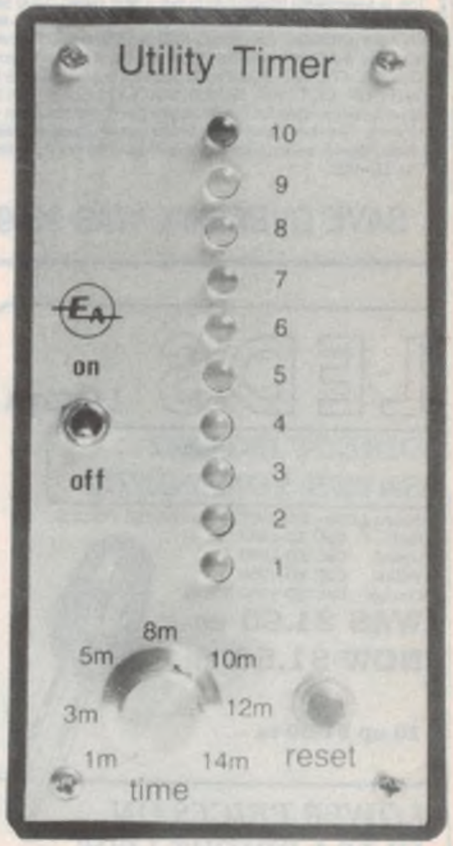
The circuit of the timer is fairly straightforward. There is a main pulse generator (IC1a), a decade counter with decoded outputs (IC2) and a beep generator (IC1b). The two transistors Q1 and Q2 both act as logic inverters.

The main pulse generator (IC1a) consists of half a 556 timer in astable mode. The 556 is a dual "555" type timer. The astable operation of these timers is as follows.

Let's suppose that the timing capacitor (C1) is entirely discharged. This capacitor will be charged via R1, RV1 and R2. When C1 is charged up to 2/3 of the supply voltage, a Schmitt-trigger in the timer chip toggles an output flipflop. The flipflop also drives a transistor which discharges C1 via R2. When C1 is discharged below 1/3 of the supply voltage, the output flipflop toggles again and the whole cycle repeats itself.

Looking at the main pulse generator again, the charge time of C1 can be varied with the potentiometer. The discharge time, on the other hand, is fixed and is determined by R2. In practice this means that the output of IC1a will be successively low for about 100ms and high for anything between 1s and 1.5min, the latter depending on the adjustment of RV1.

Pin 4 of this ICa is a reset input. When the reset input is held high, the

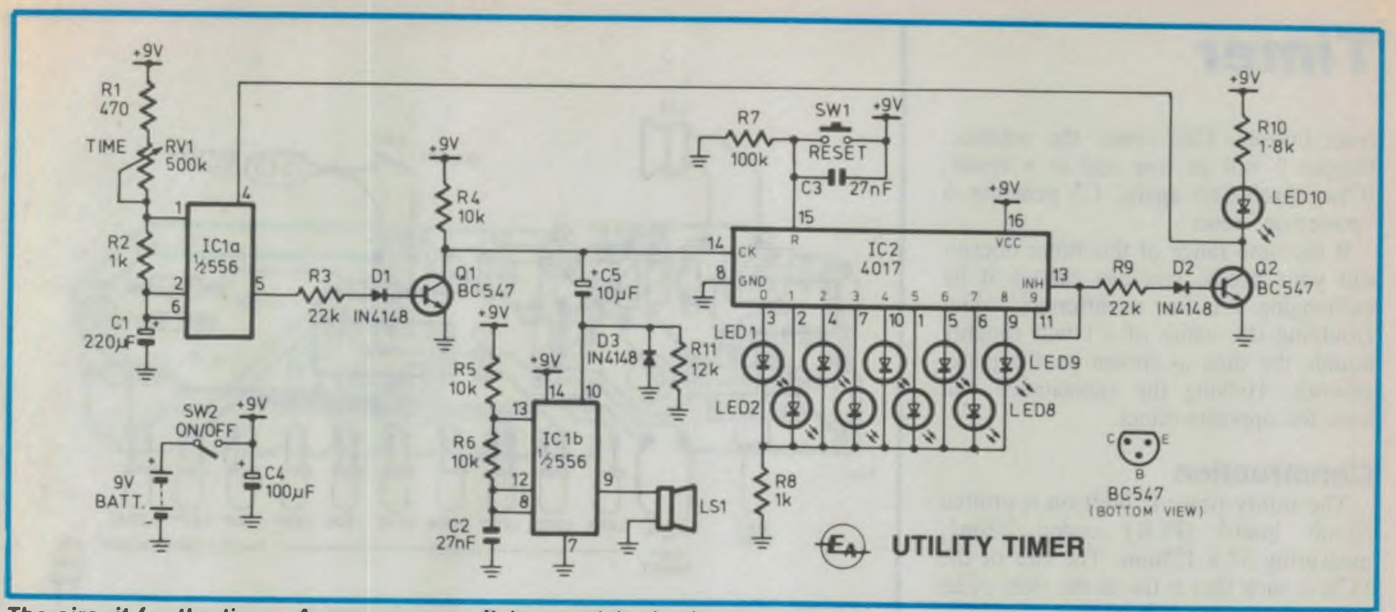


Front view of the completed timer. Fully adjustable between about 10 seconds and 15 minutes, it also shows you how the time is passing . . .

output generates pulses. When this reset input is put to low, the output goes low and stays there until the reset is released.

Let's suppose that IC1a is not reset and still generating pulses. These pulses are inverted by Q1. Diode D1, with its 0.7V forward voltage drop, increases the threshold of this "inverter" to a level of 1.4V.

The inverted pulses are fed to both the decade counter (IC2) and the beep generator (IC1b). The latter is very similar to the main pulse generator. The only difference is that IC1b is geared for a much higher output frequency, being about 2000Hz. A piezo electric



The circuit for the timer. As you can see, it is surprisingly simple.

transducer is connected to the output of IC1b.

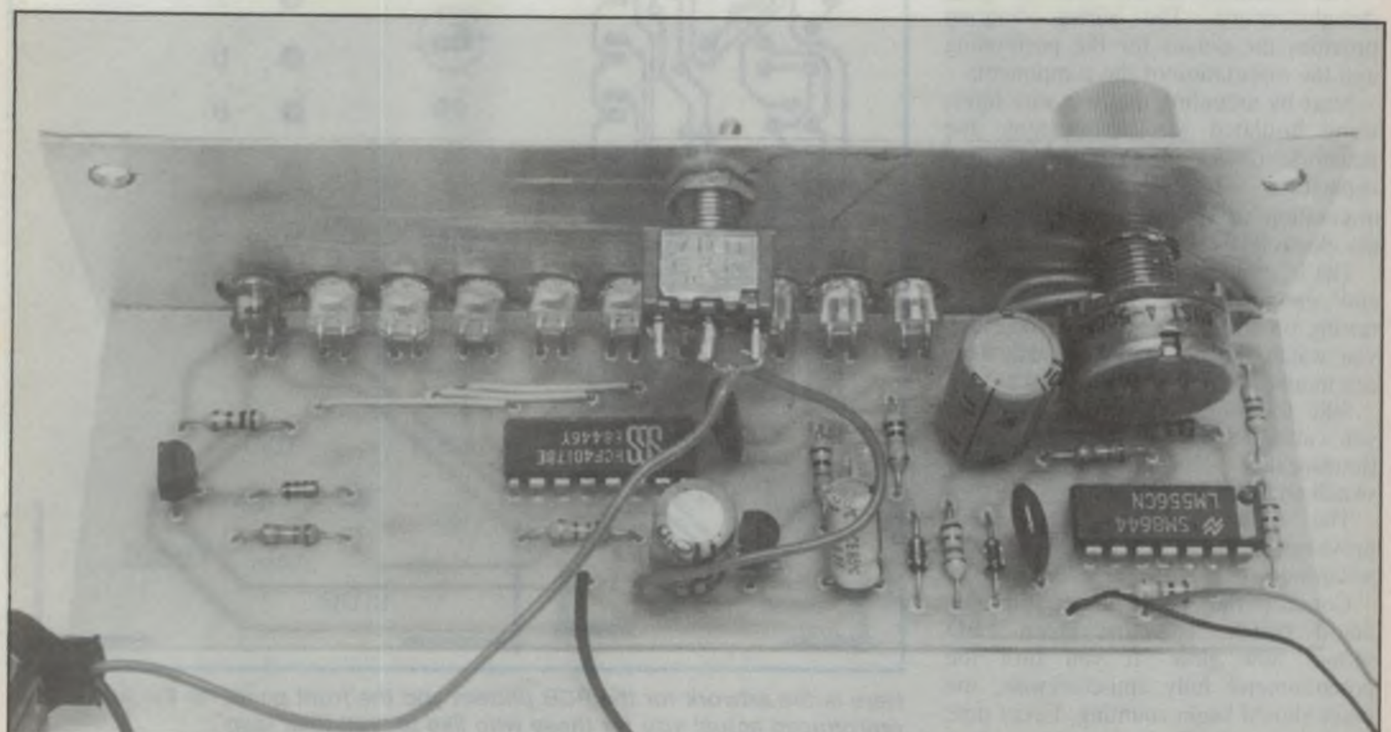
The output of Q1 is connected to the reset input of IC1b via a 10uF capacitor (C5). The pulses, originating from the main pulse generator, hold IC1b in the reset position for the preset period, only to release the beep generator for about 100ms. This results in a short beep. Note that the response time of the high-pass filter C5/R11 is more than 100ms so that for these short pulses, the filter will appear transparent.

As said, the pulses are also fed into the decade counter. Every time a pulse appears at the clock input, the counter increments. The counter has decoded outputs, which means that a high level on outputs 0 to 9 directly corresponds to the number of input pulses counted. Every time the counter increments, the particular output that is high goes low and the next one goes high.

This counting is monitored with the 10 LEDs. When the tenth output (that is output 9) goes high, the clock input to IC2 is inhibited via pin 13. In this state, output 9 will stay high. As this output drives the tenth LED, this LED will therefore stay on.

Transistor Q2 also acts as an inverter. When output 9 is high, the collector of Q2 will be low. This signal is fed to the reset input of the main pulse generator. As the collector of Q2 is low, IC1a stays reset, which means that its output is low. This low signal in turn is inverted by Q1 into a high signal. The high collector of Q1 pulls C5 along and releases IC2b, the beep generator. IC2b will stay released until C5 is charged via R11. With the given values, the beep will sound for about 3 seconds.

The only way to get the timer out of this blocked condition is to push the



Inside the case, showing the construction. Most parts mount on the small PC board.

Timer

reset button. This resets the counter. Output 9 will go low and as a result, IC1a is released again. C3 provides a "power-on" reset.

If the time range of this timer doesn't suit your needs, you can change it by exchanging C1 for a different value. Doubling the value of C1 will roughly double the time as shown on the panel artwork. Halving the capacitance will have the opposite effect.

Construction

The utility timer is built on a printed circuit board (PCB) coded 88tm1, measuring 37 x 125mm. The size of the PCB is such that it fits in the slots of an ordinary low cost Jiffy box.

The LEDs are mounted on the edge of the PCB and together with the PCB mount potentiometer they protrude through the front panel. The potentiometer isn't actually attached to the front panel. The on/off switch and the reset button are the only components mounted to the front panel.

Before assembling the PCB, it is advisable to check that the PCB fits easily in the slot of the box. By the way, some of the boxes with the specified dimensions don't have these slots. Ensure that the one you buy does have them.

The assembly of the PCB is quite straightforward. The wiring diagram provides the details for the positioning and the orientation of the components.

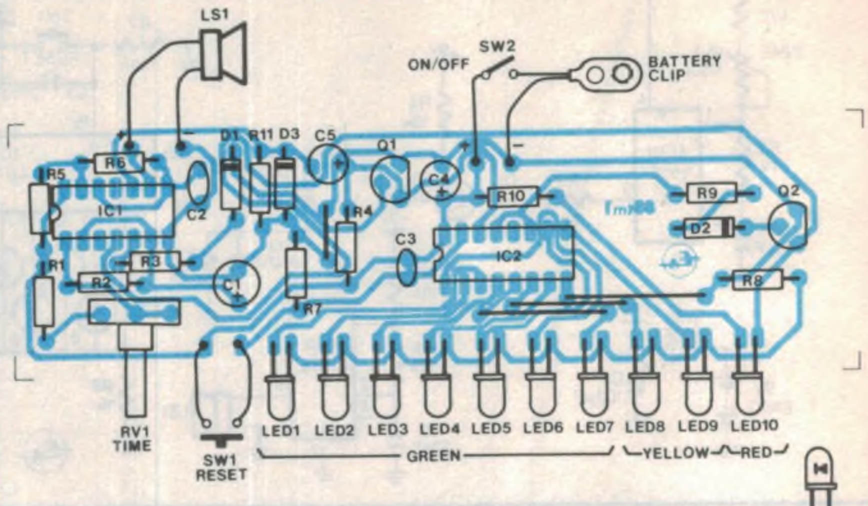
Start by mounting the four wire links, using insulated wire. Next come the resistors, diodes, ICs, transistors and capacitors. Take care with the orientation of the semiconductors and the electrolytics.

The legs of the LEDs should be bent and mounted with the plastic case resting on the PCB. Again, make sure you watch the orientation. Finally you can mount the potentiometer.

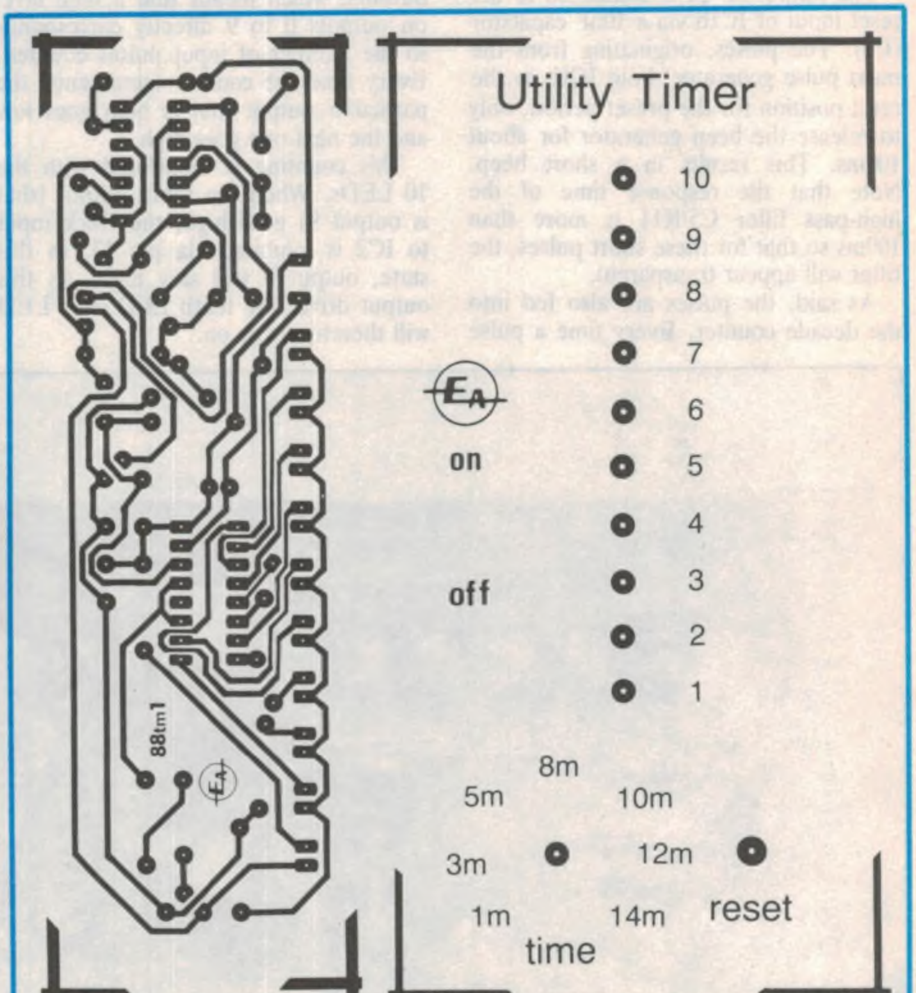
Still following the wiring diagram, you can wire up the piezo transducer (loudspeaker), the pushbutton, on/off switch and battery clip.

The timer can now be tested, provided you have visually checked the soldering.

Connect the battery and flip the on/off switch. The first green LED should now glow. If you turn the potentiometer fully anti-clockwise, the timer should begin counting. Every time the glowing LED moves on, a short beep sounds. The last beep should



Use this overlay and wiring diagram as a guide to assembly. Note the position of the different coloured LEDS.



Here is the artwork for the PCB pattern and the front panel for the timer, both reproduced actual size for those who like to "roll their own".

PARTS LIST

1 PCB coded 88tm1, 37 x 125mm
1 Jiffy box 41 x 68 x 130mm
1 SPST On/Off switch
1 panel mount pushbutton switch
1 piezo transducer
1 Dynamark front panel (62 x 125mm)
1 9V battery clip and battery
1 500k linear pot
1 small instrument knob

Semiconductors

1 556 dual timer
1 4017 decade counter
2 BC547 NPN transistors
3 1N4148 diodes
7 LEDs, 5mm green
2 LEDs, 5mm yellow
1 LED, 5mm red

Capacitors

1 10uF, 16VW electrolytic
1 100uF, 16VW electrolytic
1 220uF, 16VW electrolytic
2 27nF, metallised polyester

Resistors (5%, 0.25W)

1 x 470, 2 x 1k, 1 x 1.8k, 3 x 10k, 1 x 12k, 2 x 22k, 1 x 100k

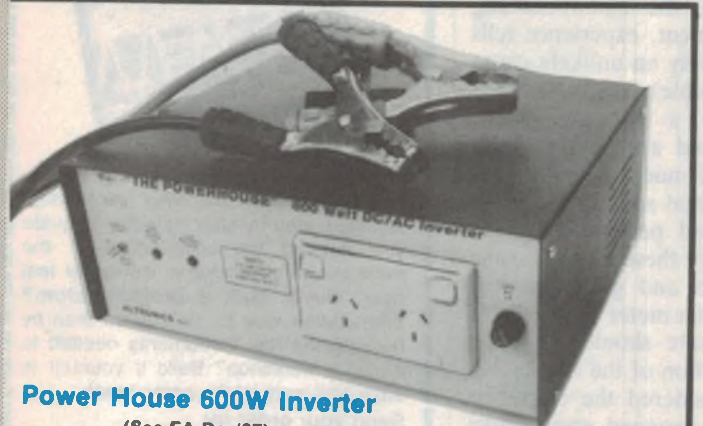
sound longer. On hitting the reset button the cycle should start off again. Turning the potentiometer to the right increases the interval between the beeps.

If any of this doesn't happen, it is wise to switch the timer off and look for the cause of the problem. Although it is tempting to blame the malfunctioning on a faulty component, experience tells us that this is actually an unlikely cause (though not impossible).

In many cases a wrongly placed component can hold up the lot. Even more frequent and much more difficult to spot are accidental solder bridges or cracks in the board pattern. Probably the best way to spot these faults is using a magnifying glass and good lighting. Sometimes an ohm-meter can clarify things, although care should be taken with the interpretation of the results.

Finally, we considered the cosmetics of the timer and designed some panel artwork. This artwork, as shown, is reproduced on Dynamark (Scotchcal). This self-adhesive label material is available in various colours. The holes for the LEDs etc., have to be cut out with a sharp hobby knife. EA

Great Kit Projects To Build Many Just Released For 1988



Power House 600W Inverter

(See EA Dec'87)

Go Anywhere 240V Mains Power from your car or truck battery with these fantastic DC to AC Inverters

A must for farming, camping, mining, boating, remote settlements and wherever else 240W power isn't available.

Features: Strong custom steel chassis • Industrial grade power coat finish • Can be configured to operate off either 12V and 24V DC • Very little internal wiring • Manual or Auto start facilities • Low battery cut out • Compact Toroid transformer.

Fully Built & Tested

K 6770 KIT VERSION	K 6774 12V INPUT	K 6775 24V INPUT
$425	$525	$525

New Easy To Build Model for '88

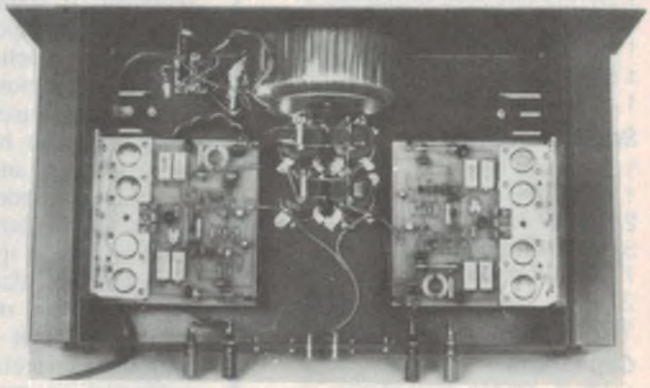
300 Watt Inverter With Auto Start

Operates From 12V Car Battery

Features: Auto start draws power from your battery only when appliance is plugged in and "turned on" i.e. battery can be left permanently connected if required. • **Voltage regulated** • **Current Regulated** • **Current Overload** unit self limits — Single PC Board construction — easy to build as there is very little internal wiring.

Complete Kit — **K 6750 $279.00**

Fully Built & Tested — **K 6755 $379.00**



Calling All Audio Purists
This Great New Amp From Silicon Chip Is For You

Studio 200 Series 100 Watts Per Channel Power Amplifier

K 5010 $399

Features: • In-Built speaker protection • Toroidal Transformer (low hum) • Black Satin Finish • Low leakage power supply capacitors • Housed in Rugged Custom Chassis.

Specifications: • **Output Power** 100W into 8 Ohms **Freq. Res.(at 1W) 20Hz-50KHz** + or - 1db **Input Sensitivity** 870mV **Harmonic Distortion (20Hz-20KHz)** 0.1% **Signal To Noise Ratio** 100db or Better **Protection** 5A fuses plus RDE245A Polyswitch **Damping Factor** (without Polyswitches) 100 (with Polyswitches) 100. **Stability** Unconditional.

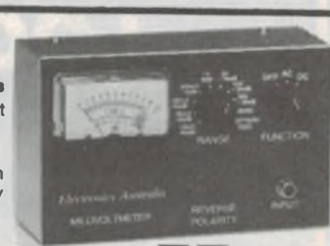
AC/DC Millivolt Meter

(See EA Dec'87)

Precision measure critical circuits

Designed to cause minimal circuit loading whilst reading very low level voltages.

Features: AC/DC range • 7M Ohm input impedance • Reverse polarity indicator • Operates off 1 9V battery (not included) • 10mV to 30V ranges in 8 steps • Zero position • Battery Test position.



K 2670 $55.00

Transistor FET Zener Tester

(See EA Feb/Mar'88)

New updated circuit incorporates facilities for testing transistor FETs and Zeners etc.

Features: • Gain • Leakage • Breakdown Voltages • Zener Voltage • Polarity — NPN/PNP

K 2527 $49.95

Temperature Controlled Soldering Station

Controls the temperature of your standard soldering iron. Suitable for irons rated from 20W—75W Standard soldering iron plugs straight in, no need for modifications.

(See EA Sept'86)

K 6400 $39.00

Car Alarm

(See EA Aug'86)

Ear Splitting 110db Modulated Tone

Now our top selling Car Alarm. Two Sensor inputs—Normally open and normally closed enable simple connection to door, bonnet, Boot light, switches etc.

K 4360 $39.95

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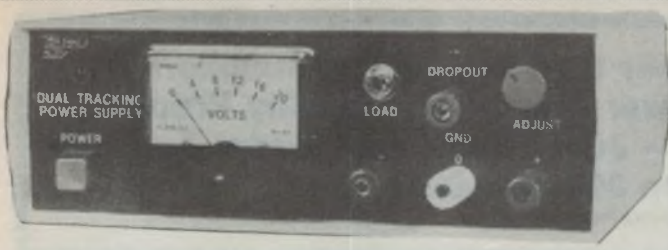


Low Cost Dual Tracking Supply

(See SC Jan'88)

Ideal For Experimenting & Prototyping with Memory, Logic & Op Amp.

Features: Adjustable + or - 18.5V at 1.7A • Volt Meter • Floating Ground • Doorout Indicator • Load Switch • Compact Sturdy "ABS" Instrument Case.

K 3325 $99.00

K 2570

$21.95

Low Cost Temperature Probe

Here's an easy to build probe design which adapts a multimeter or electronic voltmeter into a general purpose thermometer. It's just the shot for measuring heatsink temperatures, how hot it gets inside your car, or whether little Johnny has a fever!

Measures accurately from -20 deg.C to +120 deg.C.

Congratulations To The Design Team At Silicon Chip Magazine for this Excellent Design

K 2515 $299.00

1GHz Digital Frequency Meter

(See SC Nov'87 Jan'88)

This superb 1GHz Frequency Meter will out perform many other instruments twice its price.

Features: Professional machined and screen printed red perspex front panel • Easy to asemble and construct • No special tools required • Bright Hewlett Packard 8 digit display • Electronic switch latching • High performance IC's • High Quality Components.

T.V. Colour Bar and Pattern Generator

(See EA Oct'87)

Service Your Own TV & Save Dollars

Ideally suited to T.V. repairs and amateur television production.

Features: 8 patterns to choose from
- PAL or NTSC compatible
- Operates on Channel 1
- Horizontal sync output • Vertical sync output • RF Output.

Housed in rugged "ABS" instrument case.

K 2700 $179.00

Digital Photo Timer

(See EA Aug'88)

Precision time your Processing with this Low Cost Project

This classy digital timer allows precision timing for photographic processing from 1 second up to 9 minutes 59 seconds in 1 second increments.

GREAT VALUE

K 1850 $85.00

Capacitance Meter Adaptor

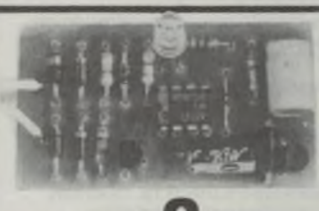
(See SC Nov'87)

Great for hand selecting exact values e.g. exact values for timer circuits etc.

It allows measurements up to 2.2uF Plugs directly into your meter via. in-built banana plugs.

Suits Labtech Q 1075

K 2520 $24.99



K 1400 $9.95

Telephone Off Hook Indication

(See SC Nov'87)

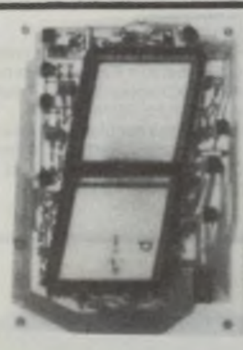
Use where 2 or 3 phones are connected on the one line. If one extension is in use a LED will flash in each of the other extensions. Requires no external supply. Runs off the telephone line. One module required for each phone.

Regenerative Radio

(See EA Jan'88)

Step back in time and build this simple regenerative radio receiver. Using only 3 transistors, its not only fun to build, but uses Varicap tuning.

K 1150 $55.25



Low Ohms Adaptor For Your DMM

(See SC Feb'88)

Measure Accurately Down To 50 Milli Ohms!

Door Minder

(See SC Feb'88)

This project will sense a door opening in a large or small room and will sound a two-tone chime. It does not have to be anywhere near the doorway as it uses an ingenious sensor to detect the pressure change caused when the door opens. Ideal for use in shops, offices, doctors surgeries, Chemists etc.

K 1915 $45.00

Large 7 Segment Display

This large 153mm high seven segment display can be configured for use as either common anode or common cathode. Multiplexed on DC driver and arranged to have a decimal point on either the left or right handside.

It can be used to interface equipment with existing displays for large elapsed times & digital clocks.

K 1225 $59.95

As we all know it's difficult to obtain accurate resistance measurements below 50 Ohms or so with conventional multimeters. This natty little adaptor plugs directly into your DMM via. in-built banana plugs enabling quite accurate measurements to 50 Milli Ohms and less. Full instructions provided.

K 2518 $24.99

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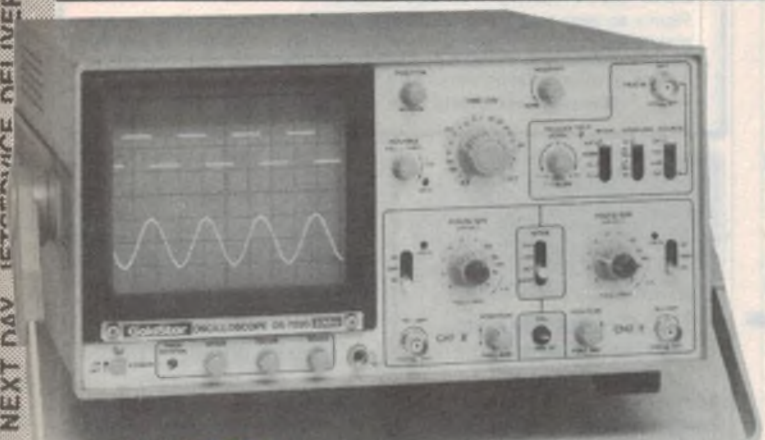

Q 0120 $899

"Australia's Finest Dual Beam 20MHz CRO Is Under a Thousand Dollars"

Dual Trace 20MHz Oscilloscope

This all new CRO must be the best valued quality Oscilloscope in Australia!

This new model is a 20MHz dual-trace Oscilloscope using a high brightness CRT with an illuminated scale. The vertical amplifiers have high sensitivity 1mV-5V/Div. The unit has LED's to indicate when the controls are in the 'uncal' postion, and to indicate if the trace has been triggered. The brilliant triggering circuit will trigger on just about any waveform applied. The highest triggering sweep is 0.2uSec/Div. The Q 0120 also features a 'Hold Off' control for seeing the front end of the input wave form.

Features: Large 6" rectangular CRT with internal graticule. • High sensitivity: 1mV/Div. • High accuracy: + or -3% • Stable, low-drift design • 8 divisions of displayed dynamic range and accurate distortion-free waveform measurements • This instrument has a special TV sync separation circuit for quick measurements of video signals • A convenient X-Y operation mode allows phase difference measurements between two waveforms.

Full 12 Months Warranty

CRO Probe Sets

Q 0175 $49.95

High quality LABTECH Oscilloscope probes. Ideal for use with the Q0120 Oscilloscope. Suits all other brands: 1:1 or 10:1 Attenuation.

1 GHz Frequency Counter

This new addition to the LABTECH range will astound you with its high accuracy and stability. A truely Professional Instrument that will perform brilliantly in the workshop, laboratory, university etc.

Specifications: The pertinent specifications for the Model Q 1530 are listed as follows:-

1. **Measuring Mode - Frequency Measurements - Channel A** • Range: 10Hz to 10MHz direct counter 10MHz to 100MHz prescaled by 10 • Resolution: Direct counter: 1, 10, 100Hz switch selectable - Prescaled: 10, 100, 1000Hz switch selectable. • Gate time: 0.01S, 0.1S, 1S switch selectable • Accuracy: +/- 1 count +- time base error x frequency. **Channel B -** • Range: 100MHz to 1 GHz • Resolution: 100Hz, 1KHz, 10KHz switch selectale • Gate time: 0.027S, 0.27S, 2.7S switch selectable • Accuracy: +/- 1 count +/- time base error x frequency. **Period Measurements (Channel 4) -** • Range: 10Hz to 2.5MHz • Resolution: 10-7S, 10-S switch selectable • Accuracy: +/- 1 count +/- time base error x period. **Totalize measrements (Channel A)** • Range: 10Hz to 10HMz • Resolution: +/- 1 count of input. **General -** • Display: 8 digits, 7mm red LED display with decimal point, gate, overlow, KHz, MHz and uS indication. • Check: Counts internal 10MHz time base oscillator • Power requirement: Line: 115/230V +/-15%, 45Hz-70Hz Internal Battery: Option • Temperature: Rated range of use: -5 deg. C - +50 deg. C — Storage and Transport: -40 deg. C - +60 deg. C • Humidity: Operating: 10-90% RH. Storage: 5 - 95% RH.

Superbly Engineered

Q 1530 $499.00

Audio Frequency Generator

Often in testing audio circuitry it is necessary to have an accurate and adjustable audio signal source available. This little generator even allows you to test 455KHz IF stages

Specifications: Freq.Range 10Hz - 1MHz **Accuracy** +/-3% +2Hz **Output Waveforms** Sine/Square **Output Level** Sine : 8V RMS Square : 10V P-P **Output Attenuator** -20db, -40db and fine adjust.

New Model For '88

Q 1550 $229.00

RF Signal Generator

An RF signal generator is an absolute necessity when it comes to radio servicing. With provision for both internal and external modulation, this generator is a winner.

Specifications: Freq.Range 100Kz - 150MHz in 6 Ranges **RF Output Level** 100mV RMS **Accuracy** +/-3% **Modulation:-** Internal (30% depth) 1KHz • External - 50Hz - 20KHz • Crystal Locked Oscillator

New Model For '88

Q 1540 $249.00

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Digital Multimeter With Built-In Capacitance Meter

Not only do you get all the normal ranges of current, resistance and voltage - but also a convenient and simple to use capacitance meter in five ranges. And as if that's not enough, you also get a transistor tester. Check the features of this top quality new addition to the labtech range.

General:

Display: 3½ digit LCD, 0.5" height, with polarity & L0-BAT indication. **Overrange Indication:** 3 least significant digits blanked. **Maximum common Mode Voltage:** 500V peak. **Operating Environment** 0 deg to 50 deg. C; less than relative humidity from 35 deg C to 50 deg. C **Power:** 9V alkaline or carbon-zinc battery. **Battery Indicator:** Display indicates "L0-BAT" when less than 20% of life remains. **Dimensions, Weight** 170mm x 87mm x 42mm, 350grams.

Q 1085 $139.00

Free Carry Case This Month

Normally $12.50

Look! Check These Great Bargains

UV Eprom Eraser

erase your EPROMS quickly and safely. It will erase up to 9 x 24 pin devices in about 40 mins. for 9 chips (less for less chips) • Erase up to 9 chips a time • Chip drawer has conductive foam pad • Mains powered • High UV intensity ensures thorough erase • Engineered to prevent UV exposure • Long Life UV Tube.

This Month $80.00

Save 20%

Normally $139

Save $40 This Month

Fantastic Woofer Bargain

100W Continuous Power rated 150W Max. Intermittent. Massive 1.4Kg Magnet. 8 Ohm.

C 3070 $99

Micron Electronic Temperature Controlled Temperature Selectable Soldering Station

T 2440 $139

The MICRON T 2440 soldering station offers the ultimate in controlled temperature hand soldering 320 deg.C 350 deg. C 380 deg.C, 410 deg. C. (608 deg. F. 662 deg.F, 716 deg.F, 770 deg. F and 824 deg.F) Fixed temperatures are selectable by rotating the detained rotary switch freely without changing heater or tip.

Temperature Readout via lead baragraph instantly visable.
Patented Heating Element. The specially insulated NICHROME wire heating element is compressed between two layers of stainless steel for ruggednes and is located at the end of the barrel to insure instant heat.

Temperature Readout via lead bargraph instantly visable.
Patented Heating Element. Heat Capacity. Full 48 watts of het energy available for heavy duty work. **Zero Voltage Switching** The revolutionary electronic "Zero Voltage" switching, protects voltage and current sensitive devices such as CMOS against transient voltage spikes caused in stations. **Grounded Tip.** The soldering tip is grounded through the power unit to ensure the tip leakage is less than 0.4 millivolt or 0.03 microampere. **Low Voltage Element.**24V. **Chrome Plated Iron Plated Tip.**

AMAZING PRICE $149 OFF!

A 1510

Normally $399

Microprocessor Controlled Detector Clips On To Sunvisor

World Famous Microeye Detector

This super compact "Sunvisor Clip On" Microeye Detector is virtually invisible from the outside of most vehicles at normal eye height hence its very unlikely yours would attract the attention of a thief (or the Gendarmes for that matter) However, please remember that use of Radar Detectors is not permitted in some states.

This Month $250 — Be Quick

Professional Temperature Fixed Soldering Iron

• 370 deg. Fixed Temperature • High efficiency patented heating element. • Iron clad, chrome plated, long life interchangeable tip. This iron uses high grade iron clad, chrome plated and pretinned tips. Tip life expectancy is many times that of conventional plated tips.

Excellent Professional Iron

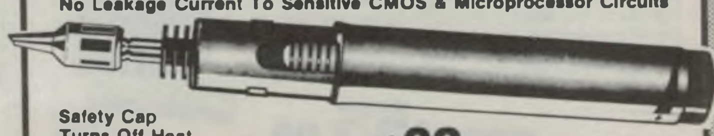
T 2420 $27.50

Great When You're Working On The Boat, Car, Farm, Or Anywhere In The Field

Introducing Portasol The Nifty Go Anywhere Butane Soldering Iron

• No Cords, Batteries or Gas Bottles • Heavy Duty tip Temperature Up To 400 deg.C • Adjustable Temperature equivalent to 10-60 watts • Up to 60 minutes continuous use • Powered by Standard Butane Gas Lighter Fluid.

No Leakage Current To Sensitive CMOS & Microprocessor Circuits



Safety Cap Turns Off Heat & Gas When Replaced

T 2460 $39.95

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Just Imagine a Security/Alarm System you can install in about an hour — Uses no Wiring or Cables and Costs Less than $1 for the Mounting Hardware

UHF 305MHz Microprocessor Controlled Wireless Security System

Commercial grade, quality alarm systems are expensive - Just phone one of the "Name" security firms and get a quote for your home - our estimate is that it will be anything up to $1,000 just for the equipment - **then there is the installation** - countless holes punched through walls, miles of wiring and a day or two of installers labour and **that's around $35 per hour these days. Hardly worth the effort is it? After all what have you got to loose? - Only the Video Player CD Player, Camera, Hi Fi, TV, Jewellery and so on!!**

Well all that is now changed - with our brilliantly engineered Home Guard Wireless Security System Read On —

Take It With You If You Move

Apart from the flawless operation of the Home Guard System—One of the great features is its application with rented or leased premises—Lets face it, money spent on installing a wired system in your Home or Office, Factory etc. is irrevocably lost when you move on. With the Home Guard you simply take it with you.

This alarm system is a brand new design that features completely wireless connection to all accessories, even the reed switches. Think of how easy it is to install a "Wireless" alarm system. The benefits are endless, e.g. arming your Flat or Townhouse with an alarm you don't need to run wires through the roof or drill great holes through your walls. When moving house the alarm is simple to dismantle and re-install elsewhere.

The system divides protected areas into either perimeter zone or internal zone, programmable by dip switches in each transmitter/detector. **Pocket remote control** can simply arm or disarm your house perimeter from your bedside when retiring etc. this allows essential protection while cancelling internal zone as desired. Each transmitter/detector unit can be programmed into interior or perimeter zone. Zones can be programmed for instant or delayed trip. The system has a built-in ear piercing siren for intrusion and panic alarm signals.

System Is Comprised Of :

Main Control Receiver

S 5265 $349

Features:

- Wireless reception of external or internal sensors or detectors.
- Selectable home or away modes for selecting internal and external arming or just external to allow movement inside the building.
- Built in Piezo electric siren gives different signals to indicate different functions.
- Sends signal down power line to activate one or more remote sirens.
- Programmable Arm/Disarm switch buttons.

The main control receiver runs on 240V AC with a 12V 1.2AH battery for emergency backup. All other units with the exception of the line carrier, run on a 9V battery each. The average life expectancy is approximately one year. System works around the 305MHz frequency where there is less chance of false alarm. The range of the unit is normally 80 metres in open space.

Alarm and Indication Sounds

Intrusion Alarm — Panic Alarm — Arm Tone — Disarm Tone — Exit Click Tone — Monitor Tone — Tampering Alarm.

Detector/Transmitter Unit (Reed Switch)

Suitable For Windows and Doors

This consists of an enclosed reed switch and compact UHF transmitter and a removable enclosed magnet. The unit is at rest when magnet and reed are side by side (within 25mm or 1 inch). When the magnet is moved away more than approximately 1 inch the alarm signals to the Main Control Receiver and the alarm is sounded. In practise the Reed/Transmitter is mounted on the door or window frame with the magnet on the moving door or window.

S 5270 $55.00

Passive Infra Red Movement Detector

Ideal for the lounge room, family room or hallways e.g. anywhere where an intruder is likely to pass through. Mounts up on the wall or on top of bookshelves etc. Detects movement within an area of 9M by 9M by sensing intruder body heat movement through the protected area. Should not false trigger with the family cat or curtain movement etc. — as is the case with the cheaper Ultrasonic alarms.

S 5280 $129.00

Remote Piezo Siren

This unit is an optional line carrier receiver. Receives signal through 'AC' line i.e. it would ideally be located in, say, the roof space and plugged into mains power.

S 5290 $125.00

Complete System Special Package Price

One	S 5265	Main Controller
One	S 5270	Reed Switch
One	S 5280	Passive I/R Detector
One	S 5285	Wall control unit.

Including Batteries

This Month $499

S 5260 Normally $570

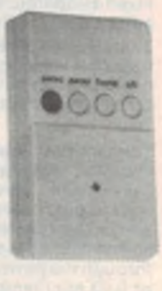
Accessories

Note: For larger installations your system may well require several Reed switches, movement detectors and 2 or more sirens. Also the remote door controller and or pocket remote controls could be very worth while accessories. The fantastic thing about the Altronic system is you simply add more detectors as you discover the need — no wiring, no expensive technicians, no modifications to equipment.

Hand Held Control Transmitter Unit

A real joy to use — keep it at the bedside table — allows you to, say, arm the house perimeters when retiring or you can take it with you when you go out, arming your system after you lock the door. Unit is a function control transmitter — to send 4 different signals.

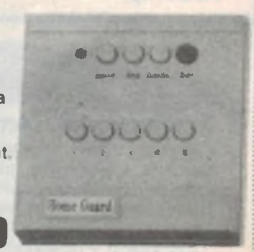
Off — To disarm the system before entering.
Home — To instantly arm the system with 'Perimeter' detection only. **Away** — To arm complete system after a given exit delay time of about 40 seconds. **Panic** — To start an emergency signal whenever needed, in any mode.



S 5275 $59.00

Front Door Keypad Control Unit

This handy accessory virtually duplicates the function of the Master Controller unit but at a more convenient location i.e. just inside your entry door etc. System can thus be armed or disarmed without the need to go to Master unit. Especially handy for larger homes or offices.



S 5285 $99.00

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Nifty Little Chassis Maker & Pan Brake Bender

T 2400 ~~$99.95~~

NOW $80

Handles up to 16 gauge metal up to 445mm wide

Please Note: This product is a genuinePan Brake Bender allowing you to make quite complex chassis, boxes, lids, trays etc. — it is made from solid steel and is not to be confused with inferior Non Pan Brake simple benders currently sold by our competitors.

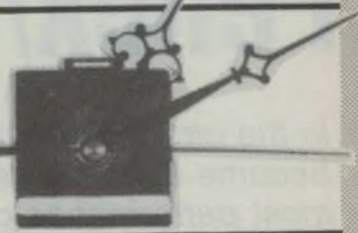
Make Your Own Chassis Boxes, brackets,etc. Unique slotted upper clamping bar allows complex corner bends

Save Over 30%

Sealed Lead Acid Batteries

These rugged high performance batteries are ideally suited for systems where uninterrupted DC Power is required i.e. Security Systems, Computers, Solar Power Systems etc.

		Normally	Now
S 5065	12V/1.2AH	$22.95	$15.00
S 5067	12V/2.7AH	$34.50	$25.00
S 5069	12V/4.5AH	$45.00	$35.00



Clock Movement

Fit your own custom clock face. Great for novel applications such as fitting to pictures etc. Very accurate, runs for approx. 1 year on one AA battery.

X 1010 $18.50

Portable Multimeter With Bench Stand

Includes Continuity Buzzer

20,000 Ohms/Volt DC • 8,000 Ohms/Volts AC, Mirror backed scale • Overload protected, 10 amp DC current range. Unique carry handle doubles as a bench stand.

Includes Battery Tester

Free Carry Case This Month Normally $4.95

Q 1080 $39.95

Economy Pocket Tester

High 2000 Ohms/Volt sensitivity • Overload protected • Dimensions 90 x 60 x 30mm • Mirror back scale helps prevent parallax error • Complete with test leads and instructions • Uses 1 x AA Battery.

Q 1013

Free Carry Case This Month
Normally $4.95

$19.50

New Model IRD Has Fantastic Range

Infra Red Movement Detector

With Two Mode Lens
Why Pay $150 or More

This Month

$79.00

Features: • Lens simply 'snaps' to either **wide angle** (range 40 ft.) for normal use or **Normal angle** (range 80 ft. plus) for corridor applictions. • Snazzy integral mounting brackets allows corner 90 deg. mounting as well as normal surface mount. (This is a fantastic feature as these work best in corners & are visually unobtrusive) • 12V DC Powered • Built-in test lamp • Alarm output SPDT 30V 1a.

S 5301

N.B. These professional detectors use state of the art circuitry to achieve ultra reliability in operation. They are currently specified by several "Name" commercial Security Companies.

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Experimenters' Corner:

A two transistor reflex/regen receiver

In the old days of valve receivers, set designers became expert at techniques aimed at coaxing the most performance out of the smallest number of parts. Here's a design using modern transistors, which employs the same tricks. Just for a change the author also shows how to build it up cheaply using parts from a "junk-box", or salvaged from old sets.

by JOHN RATCLIFFE

The little receiver described in this article was developed some three and a half years ago as an emergency set for use during blackouts. In 1984 there were several occasions when we had prolonged power cuts in Queensland, due to tropical cyclones and industrial disputes.

There being no power, some form of battery set was required. But both commercial battery sets and batteries became almost unobtainable after one or two days, so I had to come up with a home-brew set — and one which required a minimum of battery current.

Of necessity, the design I came up with used parts from my own "junk box". The basic circuit uses only two transistors, and by careful design I was able to keep the battery consumption down to only 1.5mA. Even adding an optional emitter follower stage to drive low impedance headphones only raises the consumption to 2.5mA, so that it will happily run from a small 216-type battery and give many hours of operation.

Despite the low current drain, I have managed to get quite surprising performance, by adopting some of the tricks used in the early days of valve receivers — such as regeneration and reflexing. Those early set designers certainly worked out effective ways of achieving the most performance from the least number of parts, and the same techniques work surprisingly well with today's transistors.

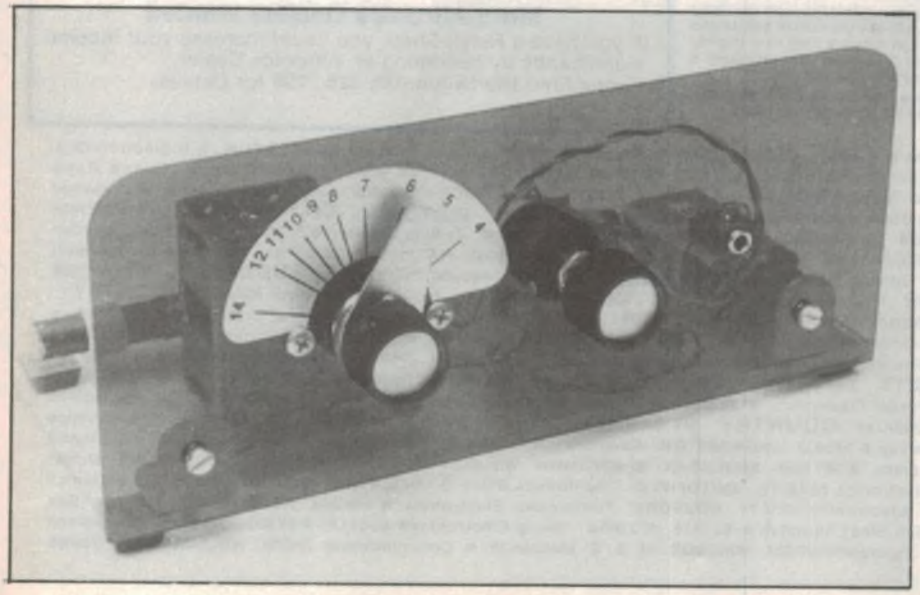
In fact the original receiver gives ear shattering volume on local station reception during the day, at my home in Southport, and very good interstate reception at night. Late at night it even pulls in easily readable signals from overseas stations like 2YA Wellington, WVEV Samoa, and Radio Tahiti (although the last mentioned is heterodyned by another transmitter).

The ability of the receiver to receive signals from overseas transmitters was mentioned in a letter to Mr Brian Oddy, who presents a DX column in the UK magazine "Practical Wireless". He in turn mentioned the receiver in his column. Within a few weeks dozens of requests were received for details of the circuit, and construction information. Later, the readers who had constructed the reflex sets sent in reports of their success, and they're still coming in. Several tropical band and shortwave variations have been made successfully.

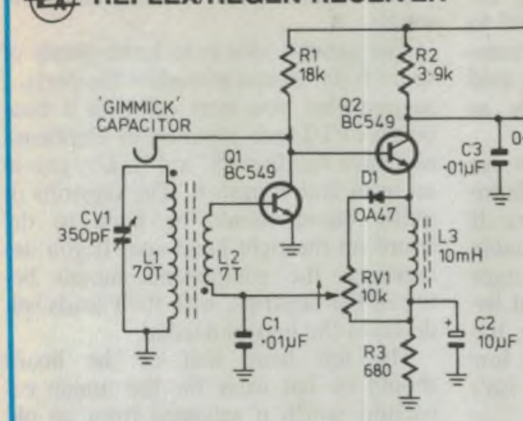
Lately, requests have been received from Australia and New Zealand. With this in mind the writer decided to offer the circuit and constructional details to *EA*, to give a wider group of enthusiasts the opportunity to try it out.

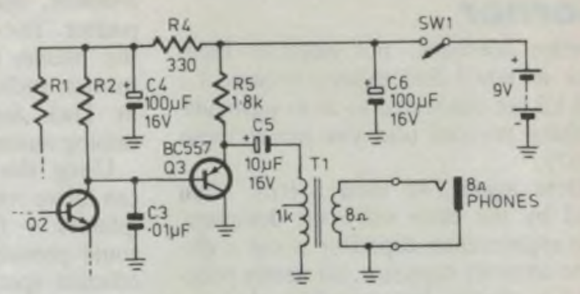
The design is not critical, and it can readily be adapted to use a variety of parts from the junk box or salvaged from old valve or transistor receivers. No external antenna is needed, and the battery supply can be anything from 4.5V to 12V. For example two discarded 6V lantern batteries connected in series will deliver 8 or 9 volts and run the set indefinitely, with normal usage.

It could also be expanded, for exam-



REFLEX/REGEN RECEIVER





At left is the circuit for the basic receiver, which uses reflexing to make two transistors do the work of four. The diagram above shows how to add a third transistor for driving low impedance headphones.

ple by adding a small audio amplifier to run a loudspeaker.

Circuit description

As mentioned earlier, the basic set uses only two transistors, and takes advantage of two long-established techniques for improving circuit efficiency: *regeneration* and *reflexing*. Regeneration is the use of RF positive feedback, to improve both gain and selectivity, while reflexing is the technique of amplifying the incoming RF signals, then detecting them, and then passing them back through the RF stages again, to provide further audio amplification.

Let's look at the circuit itself to see how this is all done. Transistor Q1 operates as a high gain RF amplifier. In many reflex (and many non-reflexed) receivers the output of Q1 would be used to feed the detector directly. However the load impedance presented by such a detector to low level RF signals is usually about 1.5k ohms. This low impedance greatly limits the gain of Q1.

To avoid the problem in this receiver, Q1 does not feed the diode directly. Instead it feeds Q2, which operates for RF signals as an emitter follower. Capacitor C3 ties its collector to ground at radio frequencies, so the transistor provides a unity gain impedance buffer, with high RF input impedance. Its base can be directly coupled to the collector of Q1, without any loading of the high value (18k) collector load resistor. Q1 therefore produces high gain.

The RF signal for the detector diode D1 is taken from the emitter circuit of Q2, which provides a suitably low impedance source. This emitter circuit is composed of an RF choke (L3) in series with a 680 ohm resistor. The resistor is bypassed with a 10uF capacitor, which ensures that the bottom end of the RF choke is at ground potential for the RF signals.

The full RF signal is therefore developed across L3. The 680 ohm resistor is added for the purpose of supplying forward bias for the diode, and base bias for Q1 via the diode, volume control and the 7-turn secondary winding L2 on the aerial coil.

After detection by the diode, the signal is now audio, and is passed back to the base of Q1 via L2. Transistors Q1 and Q2 then operate as a high gain two stage audio amplifier. This time the output is taken from the collector of Q2, via a 0.47uF capacitor — which is the only coupling capacitor in the receiver. For audio signals Q2 acts as a normal common-emitter stage, as L3 has negligible impedance at audio frequencies.

At this point it is relevant to mention the tuning coil, and talk a bit more about the RF choke.

In all small receivers, using only one tuning circuit, selectivity is relatively poor. To improve the selectivity we must reduce the coil's RF resistance, which is a major factor in this poor selectivity.

The main reason for the coil's relatively high RF resistance is a phenomenon known as "skin effect". At radio frequencies the signal current tends to travel on the surface of the wire in the coil, and therefore very little current tends to flow in the main bulk of the wire. This means that the wire tends to behave as a tube rather than a solid wire, with a correspondingly higher resistance. The effect increases with increasing frequency, producing poorer and poorer results.

As a first step in reducing the tuned circuit's RF resistance, we must increase the surface area of the wire by using wire of a larger diameter. Most receiver designers specify 30G (SWG) wire for tuning coils, mainly because it makes for a smaller sized coil, and is easy to wind on the former. But 24G wire has approximately 4 times the surface area of 30G and therefore only 25% of the RF resistance. So simply by using 24G wire instead of 30G, we get an immediate bonus of much more gain, plus a significant improvement in selectivity.

On trial, using the reflex receiver, the 24G coil was compared with a similar 30G coil. The difference was so dramatic that the 30G coil was immediately consigned to the scrap bin.

For the RF choke L3, you may have noticed that a value of 10mH has been chosen instead of the commonly used 1 or 2mH type. But take another look at the circuit, and it will be seen that the RF choke is actually an untuned L/C current.

In all simple receivers gain drops off with a decrease in frequency. For instance, in a MW receiver, gain at 1500kHz is always higher than it is at 600kHz. To counteract this, the value of the RF choke is adjusted here so it resonates at the low frequency end of the MW band. In so doing it boosts the gain at this end of the band, while that at the HF end of the band is relatively unaffected.

In this way the RF gain of the circuit is made very close to constant, over the band. Again this system is not new, as it was used in receivers back in the 1920s when all RF chokes in MW receivers had values of 10 to 15mH.

Apart from boosting the gain at the low end of the band, another big advantage here is that it allows us to add RF regeneration or "reaction", without needing the usual variable feedback control. In fact the required positive feedback is simply provided by a preset capacitor between the collector of Q1 and the top of the tuned winding of the aerial coil, L1. Note that this produces

Experimenters' Corner

positive feedback, not negative feedback as you'd first expect, because L1 and L2 are connected so as to introduce a phase reversal (did you notice those dots?).

Here again I've used a trick often used by the early valve set designers. The regeneration capacitor is not a discrete trimmer capacitor, all neatly packaged in plastic, but something that the old-timers called a "gimmick" capacitor — simply two wires loosely twisted around each other. By varying the degree that they're twisted together, you vary the capacitance between them and hence the regeneration.

In this case it's simply a wire from the collector of Q1, brought over and twisted around the wire from L1 to the top of the tuning capacitor. It's about as simple and as cheap as you can get — but it also demonstrates very well the basic principle involved. I guess the same applies to the overall design.

The original design for the set was made to suit a pair of high-impedance (2000 ohm) headphones. However as these are in rather short supply nowadays, I've also provided details of an additional transistor stage which can be used to drive low impedance 'phones. As you can see, this uses a third PNP transistor Q3 connected as an emitter follower, again to save a coupling capacitor. The output of Q3 is coupled to the 'phones via a small stepdown transformer, such as the 1k:8 ohms type sold by Dick Smith Electronics stores as catalog number M 0216.

Using this additional stage, the set can drive virtually any low-impedance 'phones — from 8 to 60-odd ohms. It could probably also drive a reasonably efficient speaker (say one of the larger diameter types), for (very) personal listening in a quiet room. But since the circuit is deliberately designed for low current consumption, there really isn't much power available.

Construction and layout

No hard and fast method is required for construction. Most required parts can be salvaged from spare parts boxes. In fact I'm assuming you'll probably have to get at least the tuning capacitor CV1 from the junk box or an old radio, because they're quite hard to get nowadays — and expensive even if you can.

Rather than rely upon a modern printed circuit board, I suggest you wire up the parts yourself using tagstrips, or perhaps a piece of utility board like "Veroboard". This will take little longer, but the experience is worthwhile. The tagstrips or utility board can be mounted on a simple L-shaped chassis made from scraps of wood or other material.

The general idea is to leave plenty of spare room to accommodate the parts. I suggest that you start off with a base board of 1/2 inch plywood or chipboard say 20cm by 10cm (8" x 4"). Dry this in an oven and varnish it. The tagstrips or utility board should be fixed to the board on the right hand end. If you use tagstrips, the components mount between the tagstrips, with their leads soldered to the lugs as needed.

The left hand half of the board should be left clear for the tuning capacitor, which if salvaged from an old receiver, can be of any size, and have a total capacity anywhere from about 350 to 500pF. It is not necessary for it to be a single gang type — it can be a two or three gang type if that's all you can find, but only use one section of the gang, by wiring just to its stator (fixed) plates.

By the way, for newcomers who haven't actually used a mechanical tuning capacitor before, the rotor (moving) plates and frame are usually connected to the "earthy" side of the tuned circuit, and the insulated stator plates to the "hot" side. So in this case, connect the stator plates to the dotted end of L1.

Whatever kind of construction is

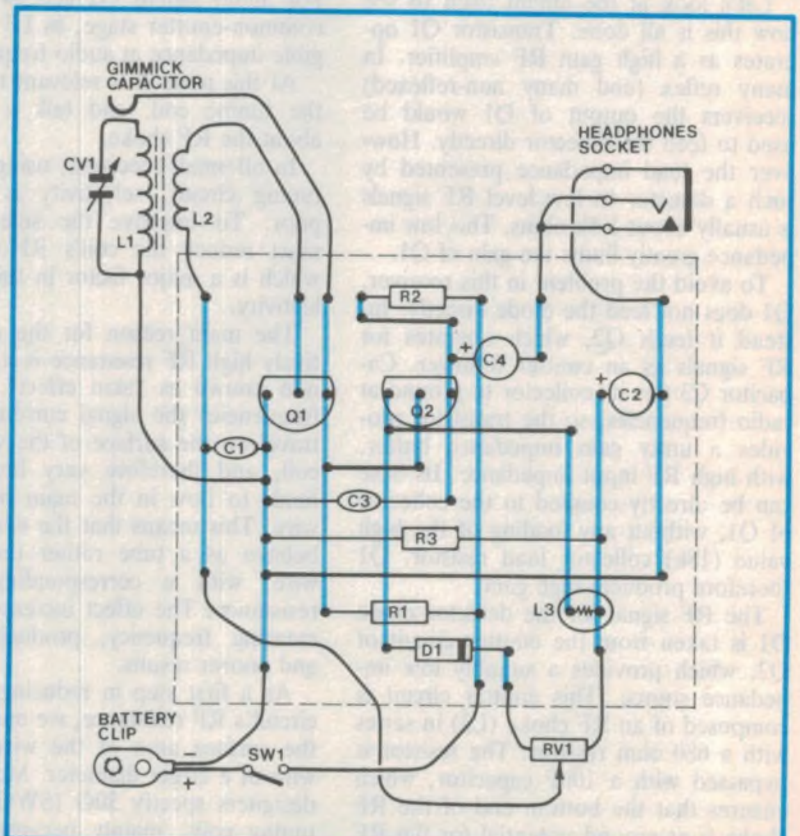
PARTS LIST

1 tuning capacitor (350pF if possible, up to 500pF would do)
1 planetary reduction drive
1 6.5mm phone socket, mono
1 10mH radio frequency choke
Tag strips
2 off 7 way
2 off 3 way
Mounting clips for ferrite rod
Ferrite rod 3"/8 dia. x 15cm (6") long
1 coil as per instruction
2 control knobs
24swg wire for coils (0.56mm)

Semiconductors
2 BC549 transistors or similar
1 OA47 or similar germanium diode

Capacitors
2 0.01uF polyester
1 0.47uF
1 10uF electrolytic

Resistors
R1 18kΩ
R2 3.9kΩ
R3 680Ω
VR1 10kΩ potentiometer, with switch



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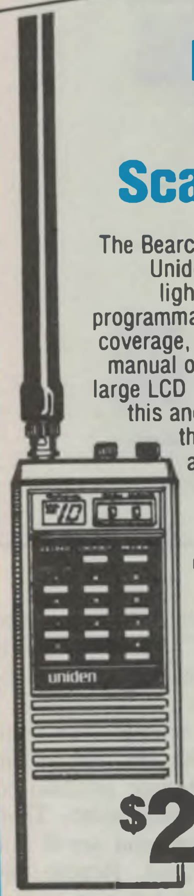

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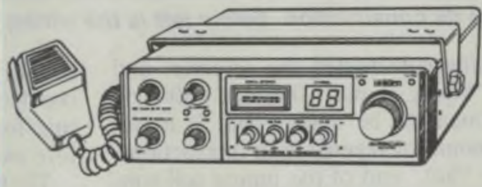

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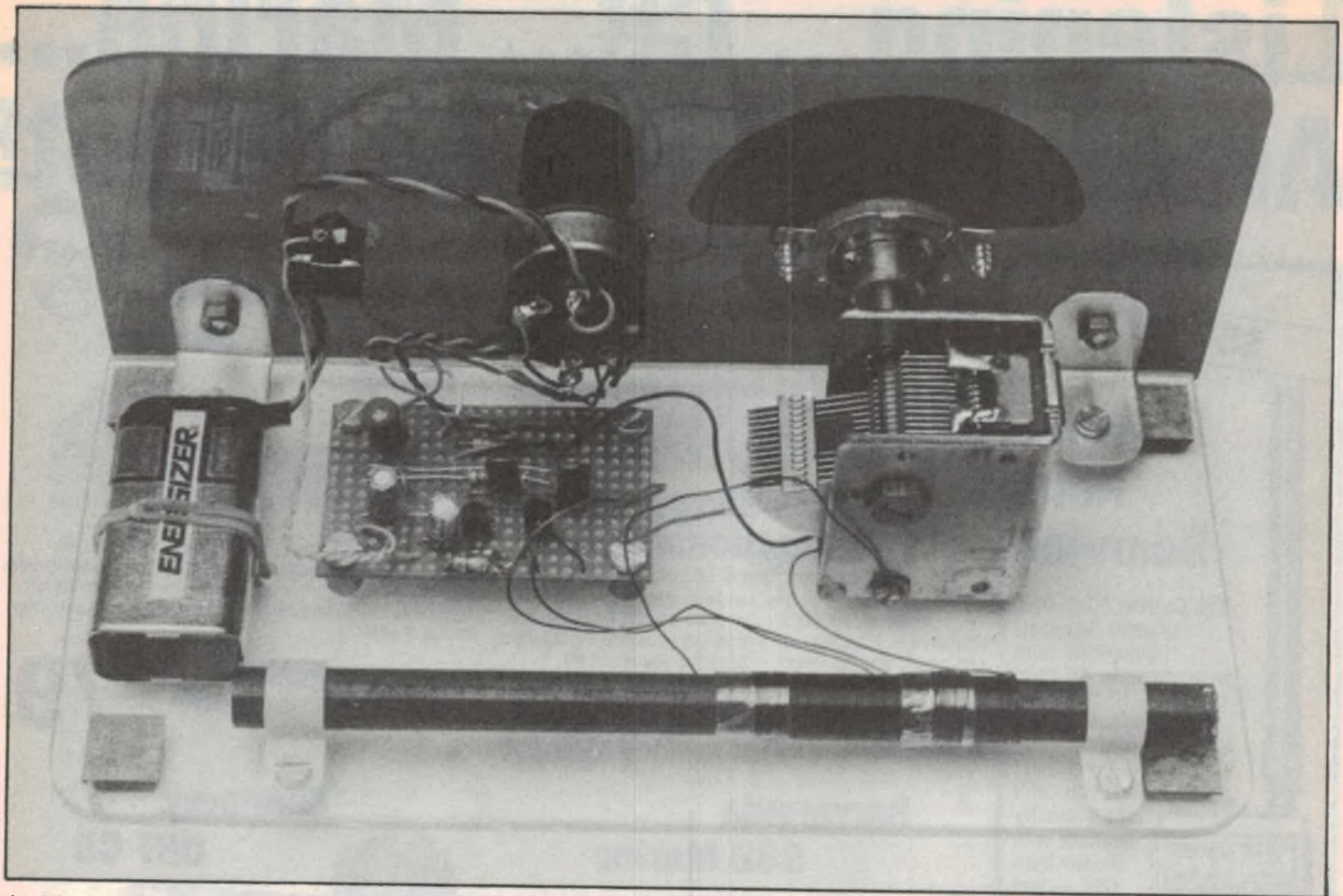


Inside our version of Mr Ratcliffe's set, showing its construction. Below left is the wiring diagram.

adopted, room must be left at the back of the board to accommodate the tuning coil and rod. This is fitted along the length of the base board with suitable clips.

Virtually all of the parts used in the receiver, if not available from the "junk box" can be bought quite cheaply. The resistors, capacitors and transistors are readily available, all being of standard values.

BC549 transistors were used in the prototype receiver. However almost any NPN silicon small signal transistors can be used, even going as far back as BC108 types, without any change in resistor values.

The detector diode can be any germanium one such as OA90-91, or even the old OA70. The best results were obtained by using an OA47 gold bonded computer diode. But do not try using a silicon diode, as results would be disappointing apart from local station reception.

There is just one precaution when wiring up the set as a whole: make sure you mount the RF choke L3 as far away from the tuning coil as possible. If placed near the aerial coil it will cause uncontrollable oscillation.

Having constructed the receiver, and after "trying it out" there is only one adjustment to be made. That is to set the amount of regeneration or reaction.

The "hot" end of the tuning coil connects to the fixed plates of the tuning capacitor, as already noted. Arrange this so the wire from the coil to the capacitor passes over the circuit near to Q1. Then connect a small length of insulated wire to the collector of Q1, so it is "near" the wire connecting the coil and capacitor. It will be these two wires that form your "gimmick" capacitor, to provide the regeneration feedback.

Tune to a weak signal at the low frequency end of the band, with the two wires spaced apart. Then move them closer together, and note whether the signal strength increases or decreases. If it decreases, you've connected the coil's 7-turn secondary winding L2 the wrong way around. So before going any further, turn off and swap L2's connections.

The correct coil connections are those which produce an increase in signal strength when you move the two wires making up the "gimmick" capacitor closer together. In fact if you move them too close to each other, this should cause the receiver to break into oscillation and "howl". The correct setting for the wires is at a point just before oscillation occurs.

To find the right setting, move the tuning capacitor to the HF end of the band, and adjust the wire position to just before the oscillating point. Then go back to the low end and see if this still gives the right result. Repeat this procedure a couple of times if necessary, until you get it right at both ends of the band. While you are doing this have the volume control at maximum, or nearly so. With use it is possible to adjust the receiver so the gain control also acts as a regeneration/reaction control, at the top end of the gain range.

As noted earlier, the basic two-transistor receiver is suitable for the use of high resistance headphones (2000 ohms). For those who have no high resistance phones, and wish to use the more commonly available 8 ohm headphones, the additional impedance matching stage shown can be added. The additional parts involved can be added quite easily.

That's about it. I hope you have fun building up my little radio, and seeing just how much you can get out of a sim-

Experimenters' Corner

ple circuit using the right techniques. Projects like this can be very rewarding — and of course they help you get a good feeling for the basic principles.

Editor's Footnote: We were so impressed with the novel nature of Mr. Ratcliffe's design, and its educational value, that we decided to build up one of his receivers for ourselves. It's actually our version shown in the pictures, and as you can see we built it up using a small piece of Veroboard to mount the minor parts. We also used a couple of Perspex sheet offcuts to make the "chassis" — partly because we happened to have them, and partly because it displayed the parts a little more interestingly.

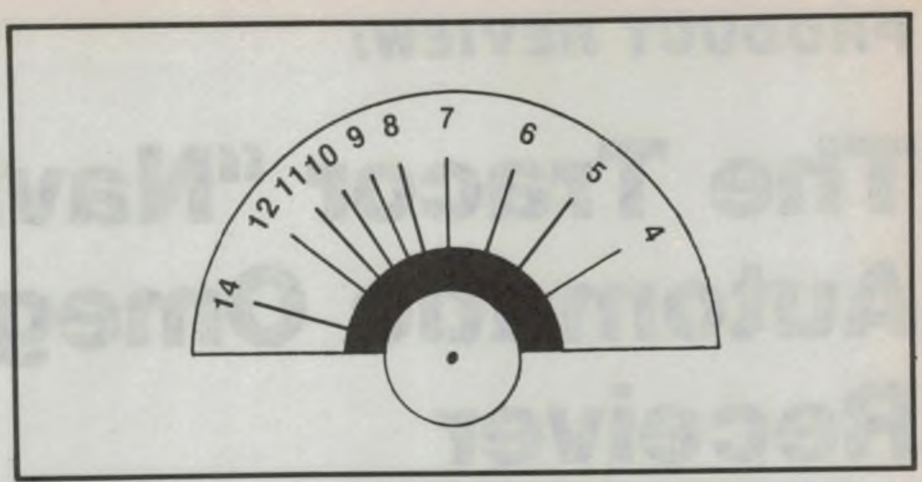
As you can see, we also used a not-too-old single gang 415pF variable capacitor for CV1, with a small planetary-action reduction drive in front to make tuning easier.

We've produced a wiring diagram showing the way we hooked things up on the piece of Veroboard, so you can duplicate this approach if you wish. The board in our unit measures 55 x 35mm, with the conductor strips running parallel to the shorter sides.

We've also produced the artwork for a small dial scale, to suit a 415pF tuning gang like the one we used. We hope these things help.

A further tip: make sure you don't use metal clips to mount the aerial rod — or if you do, make sure that the ends don't touch, to form "shorted turns" around the rod. This would really ruin the performance. It's probably safer to use nylon clips, as shown in our picture.

Our version of the set works very well indeed, pulling in all the local stations at good volume even in our steel-frame office building. At night in a better location, it pulls in lots of others from further afield — so we can back up Mr. Ratcliffe's claims. It's a good little performer, as well as providing a good opportunity for newcomers to get "hands on" experience with some important concepts.



The tuning dial artwork for our version of the set, made to suit the 415pF tuning capacitor shown in the pictures.

PRODUCT REVIEW:

The Tracor "Navigator" Automatic Omega Receiver

Quick — how much do you know about Omega, the world-wide navigation system using ultra low frequencies? OK, we didn't know much either, until we had the opportunity a few weeks ago to try out one of the latest breed of automatic Omega receivers.

When we were preparing our Marine Electronics feature a few months ago, we were sent some interesting information on the latest generation of automatic Omega navigation receivers. The information came originally from Tracor Instruments in Texas, one of the leading companies making Omega gear, but was sent to us by its Australian distributor, Melbourne-based Associated Calibration Laboratories.

Reading through the material, we were so impressed with the level of performance and claimed ease of use of these new receivers, that we asked ACL managing director Peter Williams if we could try one for ourselves sometime. Happy to oblige, he agreed to send one up when he could spare it for a few days. So it was that a few weeks ago, we had our opportunity.

Now we have to admit that our knowledge of Omega was initially pretty sketchy. We knew it was a navigation system using a world-wide network of radio stations, all operating on very low frequencies (VLF), and based on comparing the phase of the signals received from these stations. We also knew that at least in the early days, it had something of a reputation for being quite tricky to use, and prone to errors.

That was about all we knew, at least before we read the Tracor information. That gave us quite a bit of useful background information and technical detail. For the benefit of readers in much the same position as we were, let's summarise what we learned:

First of all, Omega was developed originally by the US Navy in the 1940s. It was based on a system developed by Professor J.A.Pierce and his colleagues at Harvard University, who first tried the idea of a navigation system using phase measurements of the signals from a network of VLF stations.

The present Omega system commenced operation in early 1966, with only two stations: one in Hawaii and the other in New York state. By the end of 1966 two other stations were added, in Aldra (Norway) and Trinidad. Gradually other stations were added as well, including one in Australia at Sale, in eastern Victoria. In 1971 the New York station was shifted to La Moure, North Dakota.

Nowadays there are eight stations in the world-wide Omega network, as shown in Table 1. The Reunion station is on a small island in the Indian Ocean, near Mauritius.

All Omega stations transmit in the VLF region, on frequencies between 10 and 14kHz. In fact there are three standard frequencies that they all use: 10.2kHz, 11.33kHz and 13.6kHz. Other special frequencies in the same band are used to help identify the individual stations.

As part of the Omega system, the eight stations all transmit approximately one second bursts of the three standard frequencies, in the same order of 10.2kHz, 13.6kHz and 11.33kHz. However the timing of the bursts from each of the stations is staggered, so that no two stations are ever transmitting the same frequency at the same time.

Fig.1 shows the complete sequence, which repeats every 10 seconds. As you can see, it is divided into 10 segments labelled A-H, with each station's three-frequency sequence beginning on one of the segments. Although all of the segments are around one second long, the exact lengths vary to make it easier to identify the start and finish of the sequence (and the stations). Short silent periods 0.2 second long are used to separate each of the frequency bursts

from all stations, as indicated in Fig.1 by the small cross-hatched areas at the top.

All of the standard frequencies, and the timing of the bursts are derived from highly accurate caesium-beam frequency standards. In fact each Omega transmitting station has three such standards, whose outputs are averaged to ensure the highest possible accuracy. (As a result, Omega signals can also be used for frequency and time measurements — see Ian Pogson's articles in *EA* for May 1987 and January 1988.)

The idea of all this is to provide a set of easily identified VLF signals, so that hopefully wherever you are in the world, you'll be able to receive and identify at least three of them. Then by comparing the phase of their carrier signals, on one or more of the three standard frequencies, you can determine where you are.

You have to be able to receive three Omega stations to make a navigational "fix", because comparison of the phase difference between the signals from only two stations can only give your position as being on a hyperbolic "line of position" (LOP), between the two. To identify where you are along that particular LOP, you need to compare the phase of at least one of the two stations with that of a third (see Fig.2).

Unfortunately it isn't even as simple as that, because for a given phase difference between say the 10.2kHz signal from two stations, there are actually many different hyperbolic "lanes" you can be in. This is because the same phase difference will occur at regular intervals, a half wave apart on the direct "great circle" line between the two stations, and further apart as you move away from that line.

At 10.2kHz, for example, a half wave is 14.7km long, or just under 8 nautical miles (nm). So the Omega "lanes" of constant phase difference between any two stations will be that distance apart at their closest.

Obviously this is a potential source of considerable ambiguity and/or error. To get around it, you have to perform phase comparisons not just between the 10.2kHz signals, but between the 11.33kHz and 13.6kHz signals as well.

The Omega "lanes" for the 11.33kHz and 13.6kHz signals are closer together than for the 10.2kHz signals, being spaced at 13.23km and 11.02km on the great circle lines. But because the same phase differences occur at different points for the three frequencies, they can be used for cross checking. In fact it turns out that by using all three frequencies, you are able to effectively *widen* the Omega lane ambiguity by a factor of nine times — to 132.3km or 72nm minimum spacing.

This means that providing you know your approximate initial position with an error of not more than 66km, or 36nm (not too difficult), you can use the Omega three-frequency check to locate yourself without ambiguity, and as accurately as Omega allows.

The actual accuracy provided depends largely on the propagation of VLF signals, which is very stable during the day but more variable at night. This gives Omega an accuracy of within about 3km during the day, and double that figure at night.

By the way, it isn't necessary to perform a full three-frequency Omega check every time you take a fix. However it is apparently wise for ships and other moving users to make the full positional check at least daily, to make sure they haven't accidentally "skipped a lane" since last checking. In between the full check they normally only perform measurements using the 10.2kHz signals.

Does all this sound terribly complex? That's probably because it is. In fact with the early Omega receivers you had to do all of the hard work yourself, correcting the phase measurements using tables of "phase propagation corrections" and then working out your position from maps showing the Omega hyperbolic lane lines for each pair of sta-

STATION LETTER DESIGNATION	LOCATION	LATITUDE	LONGITUDE
A	Aldra, Norway	66°25'N	13°08'E
B	Monrovia, Liberia	6°18'N	10°40'W
C	Haiku, Hawaii	21°24'N	157°50'W
D	La Moure, North Dakota	46°21'N	98°20'W
E	La Reunion	20°58'S	55°17'E
F	Golfo Nuevo, Argentina	43°03'S	65°11'W
G	Sale Australia	38°29'S	146°56'E
H	Tsushima, Japan	34°37'N	129°27'E

Table 1: Details of the eight world-wide Omega stations, showing their designation, location, latitude and longitude.

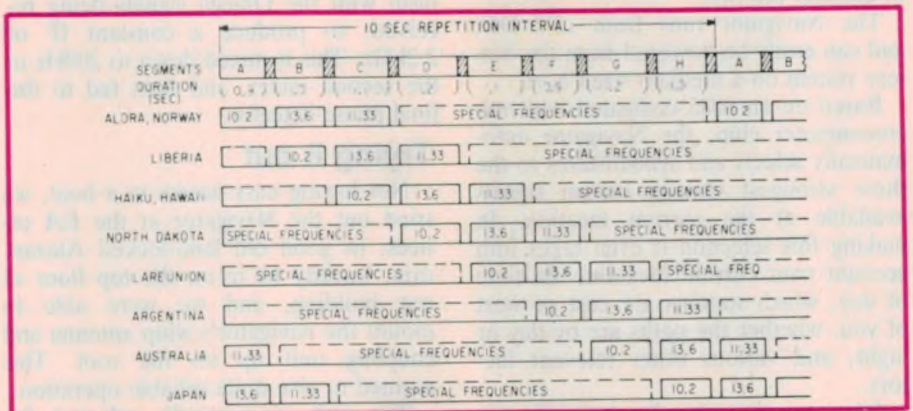


Fig.1: The complete 10-second sequence of Omega transmissions.

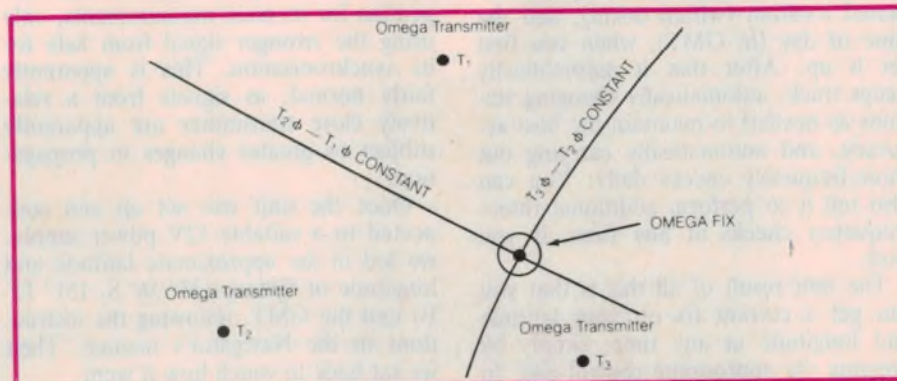


Fig.2: How a point is located on the intersecton of two LOP's.

tions. You almost needed a degree in navigation!

Needless to say in those days Omega receivers were not exactly selling by the container load. In fact the main users were the world's navies, and commercial shipping lines.

But all that changed with the coming of the microprocessor, which revolutionised things for Omega navigation just as it did in many other areas. With a microprocessor to do all the hard work, an Omega receiver finally became almost as easy to use as a compass.

Hopefully all of this background information has given you a reasonable understanding of Omega, and how it works. So let's now get back to the real subject of this story.

At last the Navigator

As you can see from the picture, the Tracor Navigator is a fairly compact little unit which looks more like a digital test instrument than a radio receiver. It has a two-line display panel on the front panel, along with a row of control pads and a 16-key keypad for feeding in commands and other information. Along with the main unit comes a whip antenna about 3m long, plus an antenna coupling/mounting unit and a long cable to connect the two.

The Navigator runs from 12V DC, and can easily be powered from the battery system on a medium sized boat.

Based on an 8085 dedicated 8-bit microcomputer chip, the Navigator automatically selects and synchronises to the three strongest Omega station signals available at the current location. In making this selection it even takes into account your current location, the time of day, which stations are east or west of you, whether the paths are by day or night, and various other relevant factors.

Of course, in order that it can do this initially, you have to feed in your estimated location (within 66km), and the time of day (in GMT), when you first set it up. After that it automatically keeps track, automatically changing stations as needed to maintain the best accuracy, and automatically carrying out three-frequency checks daily. You can also tell it to perform additional three-frequency checks at any time, if you wish.

The nett result of all this is that you can get a current fix on your latitude and longitude at any time, simply by pressing the appropriate control pad. In addition, by pressing another pad you can get a readout of time in GMT, and the day and month.

An optional interface allows it to hook up to a compass and speed log, and then display both speed and heading. There's also an interface to connect it to a satellite navigation unit, so each unit can be arranged to compensate for the other's shortcomings. This provides the continuous reading ability of Omega, with the higher absolute accuracy of satnav.

In addition to the basic functions, the Navigator can also be made to perform various special functions. For example you can command it to perform additional three-frequency checks, as noted above. You can also ask it to display the three Omega stations it's currently using, and if desired command it to change to a different combination. You can also feed in the latitude and longitude of your destination and the waypoints, and it will indicate the correct current bearing and distance.

The Navigator is a double-conversion superhet receiver, with all local oscillator frequencies derived by frequency synthesis from an internal temperature controlled 4MHz crystal oscillator. In operation, the inbuilt microprocessor phase-locks the master oscillator frequency and switches the local oscillator signal used in the first mixer in synchronism with the Omega signals being received, to produce a constant IF of 2.2kHz. This is mixed down to 200Hz in the second mixer, and then fed to the final phase detector.

Trying it out

Not having easy access to a boat, we tried out the Navigator at the *EA* offices, in good old land-locked Alexandria. Luckily we're on the top floor of our building, and we were able to mount the navigator's whip antenna and coupling unit up on the roof. This seemed to give quite reliable operation.

The unit automatically selected the signals from Japan, Reunion and Argentina for its main measurements, only using the stronger signal from Sale for its synchronisation. This is apparently fairly normal, as signals from a relatively close transmitter are apparently subject to greater changes in propagation.

Once the unit was set up and connected to a suitable 12V power supply, we fed in the approximate latitude and longitude of Sydney (33° 56' S, 151° 12' E) and the GMT, following the instructions in the Navigator's manual. Then we sat back to watch how it went.

Well to be absolutely honest we didn't exactly sit back and watch continuously. After all, there were articles to write. But we left it going for a couple of days, taking regular note of the latitude and longitude readings produced, so we could get an idea of Omega's stability and accuracy (at least in Sydney). We also got it to do some extra three-frequency lane checks, just to get the hang of it.

On the whole we were very impressed. In particular by the way the Navigator's microprocessor takes all the hard work and hassle out of Omega — it was magic! No charts, no correction tables, no multiple checks to ensure that you hadn't skipped lanes; just press the button and watch the display . . .

Of course we weren't on a boat, and there wasn't much chance that Alexandria was likely to drift out of its Omega lane! So in that sense, it was a pretty easy test.

But on the other hand, since Alexandria was indeed fixed, any variations in the readings would indicate drift or some other kind of error in either the Navigator, or Omega itself.

As it happened, the readings did vary, but by quite small amounts and certainly within the ball-park of Omega's rated accuracy.

In the first hour or so after turn-on, the latitude readings changed by about 0.7 minutes and the longitude readings by about 3.8 minutes. According to our calculations, these correspond to errors of about 1.3km and 7km respectively. Possibly they're due to a small warmup drift in the Navigator's master oscillator, because after that the readings only varied by 0.3 minutes for latitude and 1.9 minutes for longitude — giving 0.56km and 3.5km respectively.

This is over a couple of days and nights, so it's not bad at all, for the Omega system. Rated resolution for the Navigator receiver itself is 1/100th of an Omega lane or 146 metres, but this is far better than Omega itself can achieve.

In short, the automatic Tracor Navigator is certainly very easy to drive, and it shows just how far Omega receivers have come in the last few years. From our modest little test, it seems easily capable of achieving the full accuracy potential that Omega can provide — and automatically.

The Navigator will cost you around $6000, if you'd like one for your cruiser. Further details are available from Associated Calibration Laboratories at 27 Rosella Street, East Doncaster 3109, or by 'phoning them on (03) 842 8822. (J.R.)

Principles of Logic Analysis — 4

In this fourth and final article in the series, the author discusses how the data acquired by the logic analyser from the system under test is evaluated, to analyse operation.

by WOLFGANG SCHUBERT

As already mentioned, the last data reduction step carried out during logic analysis can take place in two ways during evaluation:

- The data are displayed in such a way that the user can easily see whether the device-under test is operating correctly, or
- The data are interpreted by the logic analyser, which states whether the device-under-test is OK.

Display of recorded data

The **timing display** basically corresponds to a multi-channel oscillogram with the difference that the recorded signals are displayed time-discrete and level-discrete. This type of display is particularly suitable for determining immediately whether signals change their level or whether two signals are identical. This means that the previously mentioned stuck-at errors and undesired links between two signals can be easily found in such a display.

This type of display is the most common one with timing analysers because it can be used to directly obtain the intervals between signal edges as required with hardware measurements.

The disadvantage of a timing display is that values are somewhat difficult to read. This is shown clearly in the example of Fig.39: it appears at first glance that the eight channels Z07 to Z00 represent a correctly operating binary counter, because each channel shows a signal with half the frequency of the channel below it. Only when examined closely is it seen that the polarity of channel Z03 is incorrect, i.e., the counter is not operating correctly.

The timing display shown originates from the 20MHz analyser of the LAS from Rohde & Schwarz, which can display 16 channels. The user can select whether the complete analyser memory is to be shown in one display (as shown) or whether a magnified section is to be displayed. This section (WINDOW) is shown — in relationship to the complete memory — on the scale below the last channel. The section can be shifted throughout the complete memory using the SHIFT WINDOW function.

Two cursor lines (CURSOR 1 and CURSOR 2) are also visible in the display, which can be moved separately through the memory. The time between the two cursors can be read (C1-C2) and the right-hand column indicates the logic level of the 16 channels under the currently active cursor (CURSOR 1 in this case).

The other important type of display for data stored by the analyser is the state display. This display is always very suitable if the information coded in the levels of the recorded data lines is important, because the user can define the notation in which each group of channels is to be displayed. A binary counter has again been analysed in the example shown in Fig.41 (this time with an external clock). It has been recorded by qualification of only a few counter values.

The most common notations for the display are: binary, decimal, octal, hexadecimal and ASCII. A disadvantage of the state display is that the user only gains an insight into a relatively small quantity of data if the screen is not rolled.

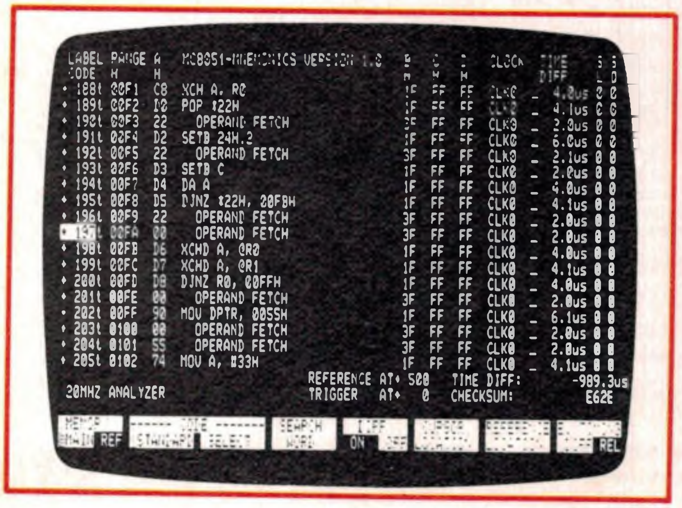


Fig.37: An analyser's disassembler-type display.

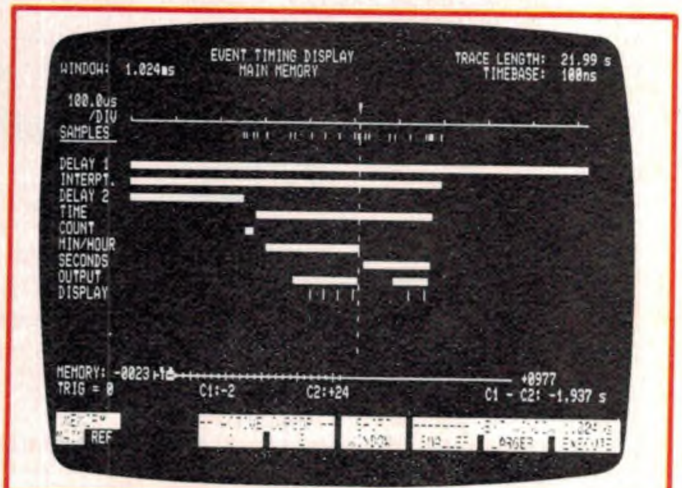


Fig.38: In contrast, an event timing display.

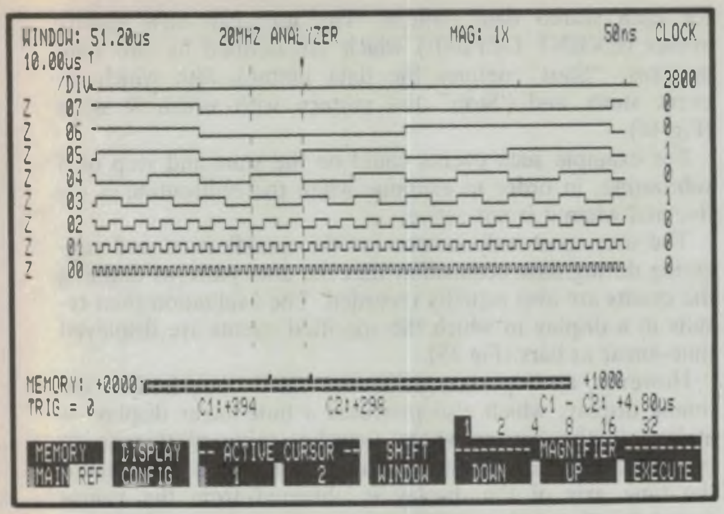


Fig.39: A timing display on the 20MHz LAS analyser.

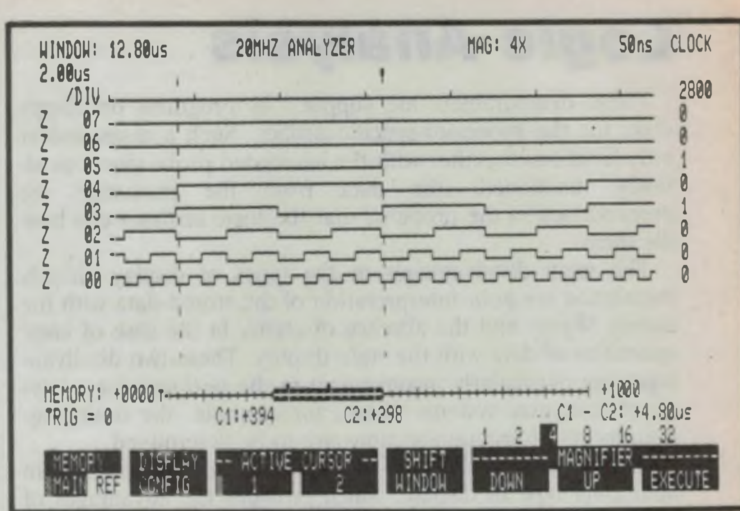


Fig.40: Example of magnified timing display (4X).

The state display of the 20MHz analyser of the LAS contains 18 clocks on one screen; this is only 1.7% of the total memory contents of 1006 clocks.

The state display of Fig.41 has eight columns. The first column contains a line number starting with 0 for the trigger. the second column contains additional information: a "T" identifies the trigger point, a "t" the repeated occurrence of the trigger criterion if triggering has already taken place and an "R" as a reference point. This reference point can be shifted by the user to any position in the memory using the function REFERENCE LOCATION, and is used as a reference for time difference measurements which are briefly described below.

The stored data are displayed in the next column. In this case only two of the eight possible groups were defined, i.e., groups "Z" and "D", both of which comprise eight lines. The stored data are displayed in hexadecimal form (code H) for group Z and in binary form (code B) for group D.

The fifth column with the name CLOCK contains information on which of the external clock was responsible for storage of each individual data word. This feature is particularly useful when analysing multiplexing bus systems where various clocks occur. The user can assign names to the external clocks which are then reproduced in this column. In the example shown, all data have been applied to the analyser memory by external clock CLK0.

The column with the name TIME DIFF only appears if the instrument is equipped with a timing option (LAS-B5) which was mentioned in the last article. This option stores timing information with each clock which enables either the interval from the previous line or the interval from the reference mark to be specified during the evaluation. Furthermore, the time difference (TIME DIFF in the fifth line from the end) can be output between the reference mark and the cursor position identified by an inverted line number.

The last two columns contain the status of the sequential qualifier (selector, column SL) and the sequential triggering (sequencer, column SQ) at the time the corresponding data line was stored. The horizontal lines in the second column and in the last two columns indicate that clocks has occurred between these two data lines which have not lead to storage. This can occur, for example, in START/STOP mode or when using the qualification facility.

An extension of the state display is used for microprocessor program sequence analysis: the disassembled display. In this case the state display is extended by one column which

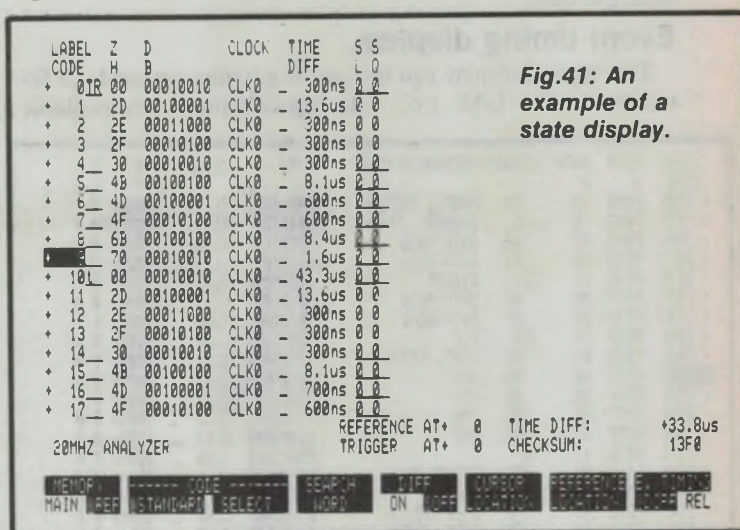


Fig.41: An example of a state display.

specifies in plain text the instruction currently being processed. The disassembler program can determine this instruction from the data stored in this line and in the following lines.

This is illustrated in Figs.42 and 43; compare the displays for the instruction LDD $065F, from lines 202 to 204.

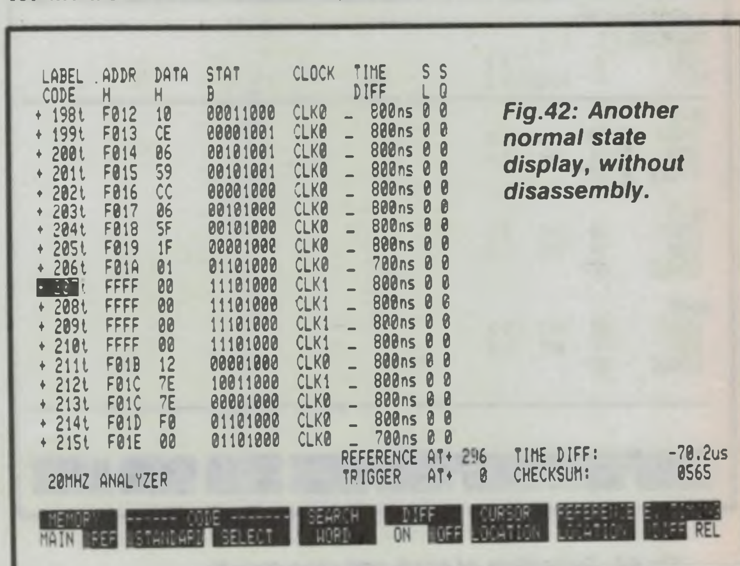


Fig.42: Another normal state display, without disassembly.

These disassemblers are supplied as programs on floppy disks for the processor-specific probes. Such a disassembler only functions together with the associated probe since, as already mentioned, the data from the processor are preprocessed in the probe so that the logic analyser can handle them.

The main disadvantages of the types of display already mentioned are poor interpretation of the stored data with the timing display and the absence of clarity in the case of large quantities of data with the state display. These two disadvantages are particularly inconvenient in the performance analysis of computer systems where, for example, the timing requirements of program sections are to be determined.

For this reason the LAS from Rohde & Schwarz has an additional type of display, which provides the advantages of timing and state displays with such measurements: the event timing display.

Event timing display

This type of display can be used if a timing option LAS-B5 is fitted in the LAS, i.e., if timing information is available for each stored data pattern. The user can now specify events (EVENT DEFINE) which are defined by two data patterns: "Start" defines the data pattern with which an event starts and "Stop" the pattern with which it stops (Fig.44).

For example such events could be the start and stop of a subroutine, in order to examine when this subroutine is active and when it is not active.

The user must only ensure for the qualification and triggering during data acquisition that the data patterns defining the events are also actually recorded. The evaluation then results in a display in which the specified events are displayed time-linear as bars (Fig.45).

However, an important difference exists compared to the timing display, which also produces a time-linear display — at least in those cases where recording takes place with an internal clock and without qualification or start/stop: because the time axis of the display is obtained from the values stored by the timing option, external clocks, qualification and stops of any lengths are permissible during recording without falsifying the correct timing display.

In the event timing display shown in Fig.45 an 8-bit counter has again been analysed. Three events are defined: they correspond to three numeric ranges covered by the counter. The residence of the counter in these ranges appears as a bar in the display; the different lengths of the bars are produced by the various sizes of the individual ranges. Various magnification factors can be selected just as with the timing display; there are also two cursors between which the time interval (C1-C2) can be read.

The event timing display shows the sequence in which the individual events occurred. This sequence is often not particularly important; it is more important to know the total time required by individual events compared to others.

Such information can be easily obtained from the event timing histogram (Fig.46), as an alternative to the event timing display. In this case the total time required by each event while recording is taking place is displayed as a bar. This total time for each event can then be compared with the trace length in the top line on the display to obtain information on the time required by the event expressed as a percentage.

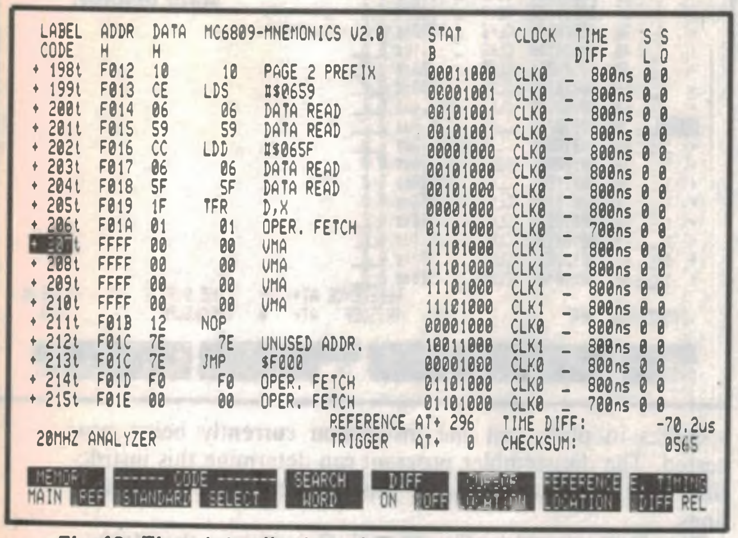


Fig.43: The state display of Fig.42, with disassembly.

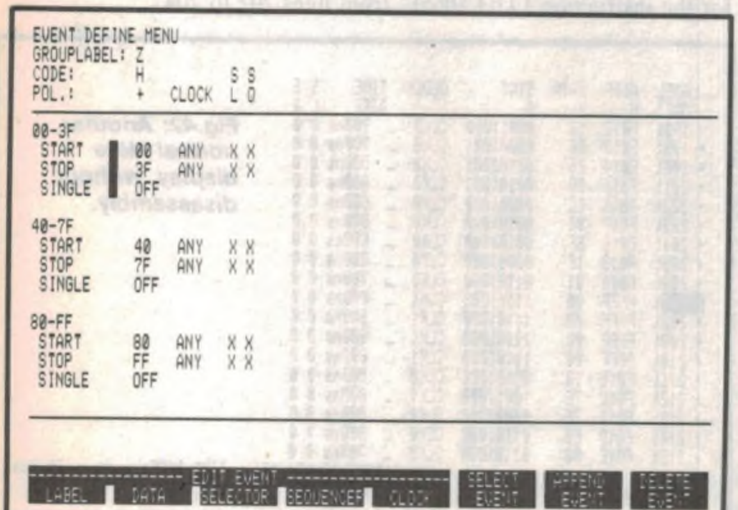


Fig.44: Definition of start and stop events.

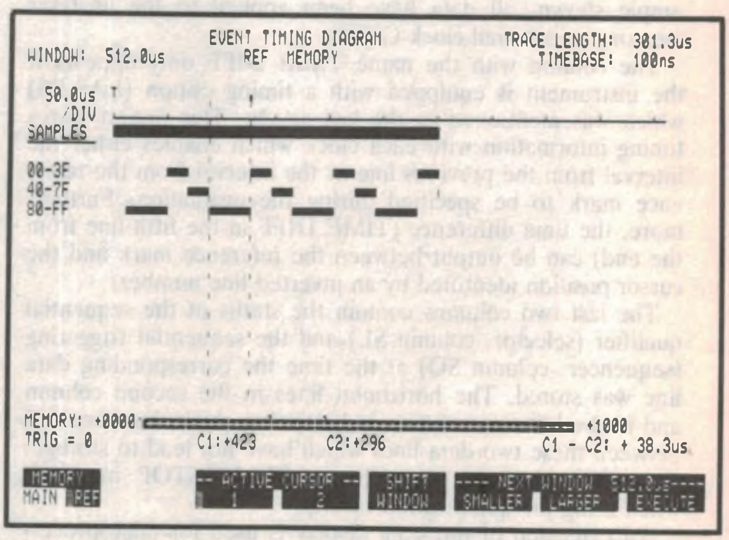


Fig.45: Display of an 8-bit counter, using the event timing diagram format.

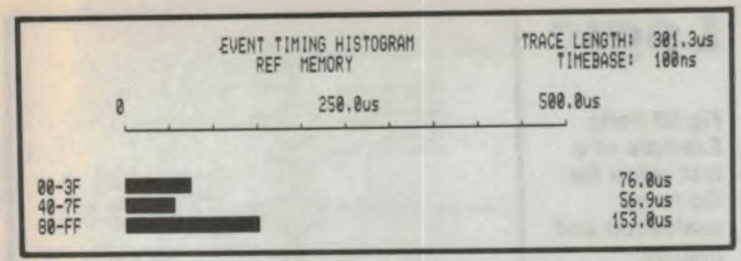


Fig.46: Totals of time spent by the counter in three numeric ranges, defined at lower left.

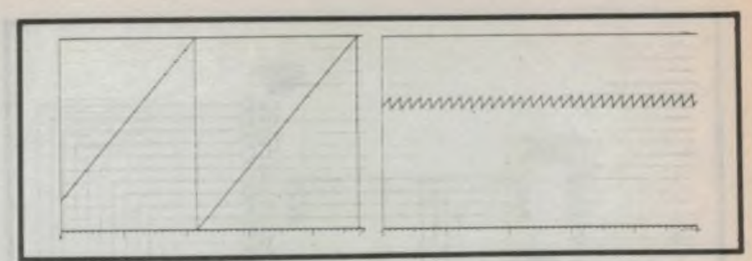


Fig.47: The older type of Y-T display, showing again an 8-bit counter.

The event timing display and event timing histogram nevertheless have one disadvantage: a trace is not obtained if the starts and stops of the individual events are not first defined.

The two evaluation methods described below were already incorporated in the first logic analysers. These logic analysers were auxiliary units for standard oscilloscopes, and converted the digital data into analog voltages using D/A converters which were then displayed on the oscilloscope. These types of display are no longer so important and have therefore only been implemented in the LAS as BASIC programs and not as standard displays.

It can be useful to obtain information for individual channel groups concerning the sequence in which the channel group runs through the numbers in its range. The number of the channel group is displayed as an analog y coordinate, for each clock on a horizontal axis.

For example, if the addresses accessed by the processor are output in a **y-t display** when analysing a program sequence, it is very easy to observe the address ranges in which the program is currently being executed.

For the sake of simplicity, an 8-bit counter has again been analysed in the example of Fig.47. The counter values from 00H to 0FFH appear in this display as a ramp and the overflow from 0FFH to 00H as a vertical line. If counter bit 4 is short-circuited to ground in this asynchronous counter, only the least significant 4 bits of the counter can continue and the other bits remain stationary, thus producing the other display because the counter can now run through only 16 status instead of 256 (which 16 status are run through depends on the random position of the four most significant bits of the counter, at the moment the short-circuit is made).

Problems may occur when using the y-t display to output channel groups with many channels, because the screen resolution is no longer sufficient. For example, if the 16-bit address bus of a microprocessor is to be displayed, the 65, 536 different status possible on this bus are crammed on the y axis, but it is then no longer possible to observe the address range from 0000H to 0FFFFH all at once.

The **x-y display** can be meaningful if the *sequence* in which the processor accesses the various address ranges is unimportant, and it is only necessary to determine whether the processor accesses or not. In this type of display the channel group to be displayed is divided into two halves. The top half provides the y coordinate, the bottom half the x coordinate of a position on the screen which is then marked by a point or a cross.

Channel groups with twice as many lines as in the y-t display can now be output with the same screen resolution, except that the information on the sequence in which the individual items of data occurred on the lines, as well as the frequency with which they occurred, is lost.

An 8-bit counter is again displayed in Fig.48, as a simple example. The most significant four bits of the stored counter data provide the 16 possible y coordinates, the least significant four bits the 16 possible x coordinates. As long as the counter is functioning correctly, it assumes all 256 status at some time; all 256 possible positions are then marked in the display by a cross. It must be noted, however, that no conclusions whatsoever can be made on the sequence in which the individual status were passed. For example, this display would not indicate if the counter has been triggered incorrectly and runs backwards instead of forwards. In the event of a fault (counter bit 4 applied to ground), only 16 status are passed again, as shown on the right of Fig.48.

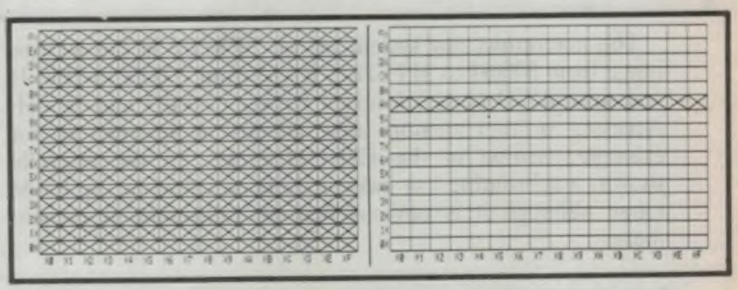


Fig.48: An X-Y display, as before for an 8-bit counter.

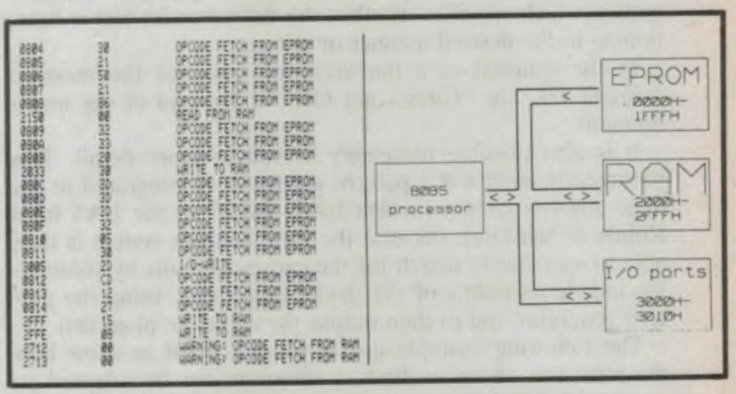


Fig.49: Customising a display for a specific system.

It may be advantageous to define a special display using a BASIC program, especially in the case of continuous measurements or measurements which are repeatedly made. A user-specific display will be used here as an example in which the activities of a microprocessor can be recognised in a manner similar to the state display (Fig.49). The only difference is that this state display has been extended by the user by one column, in which system-specific information is displayed in plain text. This text provides information on which system components exchange data with the processor in the special system, and whether these data transfers are permissible.

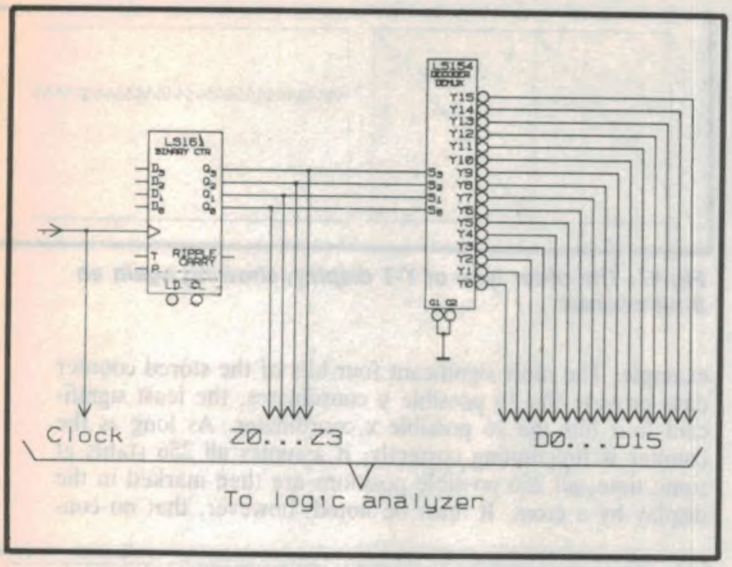


Fig.50 (left): Example of a test setup for Go/Nogo evaluation and display.

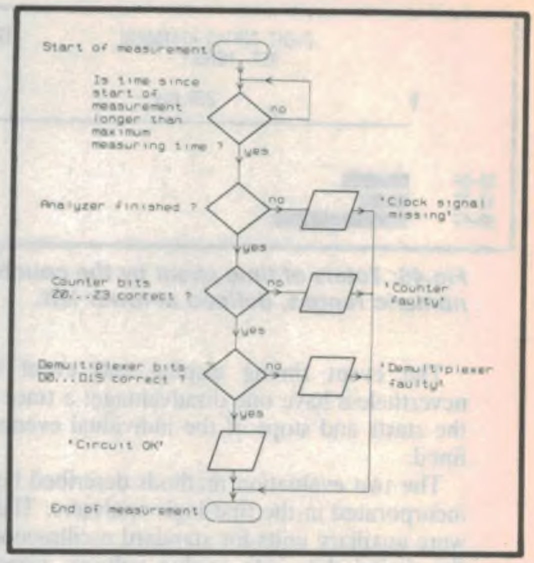


Fig.51 (right): The evaluation routine for a Go/Nogo display for the test circuit at left.

The microprocessor system has an EPROM in the address range from 0000H to 1FFFH, a RAM from 2000H to 2FFFH and several I/O ports addressed between 3000H and 3010H. Accesses to other memory areas are just as incorrect as, for example, writing in the EPROM range. In the example shown, a subroutine has incorrectly been called in the RAM range although it is obvious that no subroutine is present there.

Interpretation of recorded data

If a logic analyser enables the user to write his own programs — for example in BASIC — which then evaluate the data following the measurements, it is possible to write the programs in a manner far more specific to the measurement than the evaluations such as the state display already implemented in the analyser. This means that the logic analyser can be programmed to provide the one single "bit" of information which specifies whether the device-under-test is functioning in the desired manner or not.

In the simplest case the user only receives the message "Circuit OK" or "Circuit not OK" at the end of the measurement.

It is also possible to specify a fault in more detail. This particularly applies if a pattern generator is integrated in the logic analysis system (option LAS -B6/B7 in the LAS from Rohde & Schwarz), because the logic analysis system is then able to specifically search for the causes of faults by stimulating individual points of the device-under-test, using the pattern generator and to then output the causes in plain text.

The following example uses a simple circuit to show how the structure of an evaluation program can be adapted to provide detailed information on the fault (Figs.50-51). Assume that a 4-bit binary counter controls a 1:16 demultiplexer. Counter bits Z0 to Z3 and the demultiplexer outputs D0 to D15 are connected to the logic analyser. The clocks used for the counter are also used for the logic analyser. The logic analyser is to directly trigger following the start of measurement and record everything; in addition, the maximum measuring time required by the analyser to fill its memory is known from the product of the memory size and the clock period.

In this context it is important in such a program — as shown in this example — that the functional dependencies amongst the system components and signals can be defined to enable a statement to be made on the fault: the demultiplexer cannot operate correctly if the counter is not functioning, and the latter does not count if a clock signal does not arrive.

In conclusion, we should mention a further type of interpretation of the data stored by the analyser, which is mainly important when analysing interfaces such as Ethernet: the long-term evaluation. This is a BASIC program which also handles control functions, such as measurement start and definition of trigger conditions, in addition to the data evaluation functions.

The program carries out several measurements within a specified period and then displays which activities took place during these measurements. In the example shown in Fig.52 an Ethernet was examined over a longer period to see which partners communicate on the network. The network participants are displayed by boxes with their Ethernet address and the data flow between the participants by arrows.

Statistical evaluations are also possible over extended periods in the same manner, for example, the maximum and average loadings can be determined in computer networks as can the frequency of transmission errors.

(Published by courtesy Rohde & Schwarz of Munich, West Germany, and Rohde & Schwarz Australia, 13 Wentworth Avenue, Darlinghurst NSW 2010)

Fig.52: Example of a long-term evaluation on an Ethernet.

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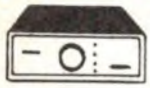

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- LED display for Power, TX, RX, CD
- AC power adaptor included
- DB25 pin connector
- Telecom Approval N° C83/37/1045

Cat. X19120 .... **$295**
(SOFTWARE FOR VIATEL .... $95)

NEC DISK DRIVES

3½" DISK DRIVE

- 1 M/Byte unformatted (640K formatted)
- Double sided, double density
- Access Time 3m/sec

Cat **$255**

5¼" SLIMLINE

- Switchable 1.6 M/Byte to 1 M/Byte unformatted, 1.2 M/Byte to 720K formatted
- Double sided, double density
- AT compatible

Cat. C11906 .... **$269**

8" SLIMLINE

- Double sided, double density
- 1.6 M/Byte unformatted

Cat C11908 .... **$785**

20 M/BYTE HARD DISK

Tandon drive with controller card. IBM* compatible. Warranty.
Cat X20010 .... **ONLY $595**

40 M/BYTE HARD DISK

Seagate drive, IBM* compatible. 12 month warranty.
Cat X20020 .... **ONLY $795**

80 M/BYTE HARD DISK

Seagate drive, IBM* compatible. 12 month warranty.
Cat X20030 .... **ONLY $2,695**

IBM* XT* COMPATIBLE COMPUTERS $695*

- Final assembling in Australia
- AT* style keyboard
- Tested by us for 24 hours prior to delivery!
- 8 Slot motherboard
- 6 months warranty!
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10 MHz Turbo, 256K RAM Single Drive, Graphics and Disk Controller Card. **$695**

256K RAM, 10MHz TURBO COMPATIBLE COMPUTER

2 x 360K Disk Drives, Multifunction Card, Colour Graphics, Disk Controller, 1 Parallel Port (Includes Timer Disk) **$945**

10 MHz TURBO, 640K RAM COMPATIBLE COMPUTER

2 x 360K Disk Drives, Multifunction Card, Colour Graphics, Disk Controller, 1 Serial, 1 Parallel Port (Includes Timer Disk). **$995**

WITH 20 M/BYTE HARD DISK:
& Single 360K Floppy Disk Drive **$1,495**
& Dual 360K Floppy Disk Drives **$1,595**

WITH 40 M/BYTE HARD DISK:
& Single 360K Floppy Disk Drive **$1,945**
& Dual 360K Floppy Disk Drives **$2,045**

WITH 80 M/BYTE HARD DISK:
& Single 360K Floppy Disk Drive **$3,795**
& Dual 360K Floppy Disk Drives **$3,950**

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RS232 DATA SWITCH WITH TESTER

- No power required
- Ideal for 1 computer to 2 peripherals or 2 computers to one peripheral
- 25 pin RS232 "D" connectors
- Six dual coloured LED indicators showing certain flow status

T.D. Transmit Data
R.D. Receive Data
R.T.S. Request To Send
C.T.S. Clear To Send
D.S.R. Data Set Ready
D.T.R. Data Terminal Ready

- Size: 200(W) x 68(H) x 150(D)mm

Cat X19110 .... R.R.P. $169
Our Price $149

PANASONIC KX-P1081 DOT MATRIX PRINTER

- 120 C.P.S.
- Pica or Elite character set
- Print Modes: NLQ, Dot Graphics, Proportional Font, Draft
- Proportional Printing
- Reliable and Compact
- Proportional Printing
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Cat. C20035 .... **only $595**

CANON A-50 PRINTER

- Serial Impact Dot Matrix
- 180 C.P.S.
- Near Letter Quality Mode
- 1.4K Buffer

Cat. C20045 .... **$595**

3½" EXTERNAL DRIVE

- 720K formatted capacity
- 37 way D type connector fits directly onto drive controller card
- Compatible with IBM* PC/XT
- Requires DOS 3.2 or greater
- Size: 266(D) x 104(W) x 75(H)mm

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- Manual
- 6 Months Warranty
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WITH 20 M/BYTE HARD DISK **$2,295**
WITH 40 M/BYTE HARD DISK **$2,795**
WITH 80 M/BYTE HARD DISK **$4,295**

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- 25 pin "D" plug (computer end) to Centronics 36 pin plug

Cat P19029 1.8 metres **$14.95**
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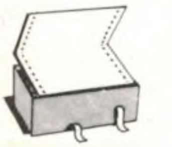
RS232 BREAK OUT BOX

A simple way of monitoring RS232 interface lead activity. Interface powered, pocket size for circuit testing, monitoring and patching. 10 signal powered LED's and 2 spares. 24 switches enables you to break out circuits or reconfigure and patch any or all the 24 active positions.

SPECIFICATIONS:
Connectors: DB25 plug on 80mm ribbon cable and DB25 socket.
Indicators: Tricolour LED's for TD, RD, RTS, CTS, DSR, CD, TC, RC, DTR, (E)TC
Jumper Wires: 20 tinned end pieces
Power: Interface power
Enclosure: Black, high impact plastic
Dimensions: 85 x 95 x 30mm

X15700 .... **$94.95**



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Quality paper at a low price! 2,000 sheets of 70 gsm bond paper.
Cat C21003 11 x 9½" **$39.95**
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- Restores order to your work area without occupying extra space
- Feeds and refolds paper under the printer automatically
- Adjustable paper deflectors ensure smooth flow of paper
- Made of moulded plastic
- Suitable for most printers

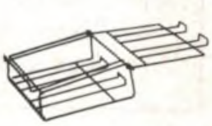
C21058 (80 column) **$69.95**

JOYSTICK FOR IBM

Features Selectable "Spring centering" or "free floating". Electrical trim adjustments on both axis. 360 degree cursor control.
Cat. C14205 .... **$39.95**

PRINTER RIBBONS TO SUIT:

CP80, SX80, DP80, BX100, MB100	(C22036)	
1-9 $8.95		10+ $7.95
MX70, MX80, FX70, FX80, RX70, RX80	(C22031)	
1-9 $8.95		10+ $7.95
MX100, FX100, RX100	(C22002)	
1-9 $19.95		10+ $18.95
LX80	(C22003)	
1-9 $19.95		10+ $18.95
LQ1000	(C22012)	
1-9 $27.60		10+ $25.00



PRINTER STANDS

- Restores order to your work area
- Conveniently stacks paper printout in document tray automatically
- Made of black plastic coated steel
- Suitable for most printers
- Excellent value at these prices!

C21054 (80 column) **$26.95**
C21056 (132 column) **$36.95**

3½" DISK STORAGE (DD80-L)

- Holds up to 80 x 3½" diskettes
- Smoked plastic hinged lid
- Lockable (2 keys supplied)
- High impact plastic base
- Contemporary design

Cat. C16038 .... **only $19.95**

APPLE* COMPATIBLE SLIMLINE DISK DRIVE

Compatible with Apple 2+
Cat. X19901 .... Normally $225
SPECIAL $179

APPLE* IIC COMPATIBLE DISK DRIVE

(including cable .... **only $199**

IBM* AT* COMPATIBLE $2,795

- Final assembling & testing in Australia!
- 6 MHz
- 80286 CPU
- 1 M/Byte Main Board
- 1.2 M/B Floppy Disk Drive
- Colour Graphics Display Card
- Floppy & Hard Disk Controller
- Printer Card and RS232
- 20 M/Byte Hard Disk
- 8 Slots
- 200W Power Supply
- Keyboard
- 6 Months Warranty

SAMSUNG 12" FLAT SCREEN COMPOSITE MONITOR ONLY $149

FEATURES:
- Flat, high contrast, non-glare screen
- High resolution, 80 or 40 character display
- Tilt/swivel base
- Compatible with Apple* and IBM* colour composite signal

SPECIFICATIONS:
Picture tube: 12" diagonal and 90° deflection
Phosphor: Available in Green or Amber
Video input signal: Composite Signal
Polarity: Negative Sync
Level: 0.5-2.0Vp-p
Impedance: 75ohm
Scanning frequency:
Horizontal: 15.734 KHz + - 0.1%
Vertical: 50-60Hz
Video bandwidth: 20MHz
Active display area: 216(H) x 160(V)mm
Display character: 80 character x 24 rows
Input terminal: RCA Phono Jack
Controls:
Outside: Power Switch, Contrast, Brightness, H-Shift, V-Size
Inside: H-Width, H/V hold, H/V linearity, Focus
Power supply: 110/120V 60Hz, 220/240V 50Hz
Dimensions: 310(W) x 307(H) x 300(L)mm
Weight: 8.1 Kg
Shipping weight: 9.6 Kg

Cat No.	Description	Price
X14510	GREEN	only $149
X14512	AMBER	only $149

RITRON 2 MONITORS

Stylish monitors available in green or amber displays and featuring swivel base that tilts forward and back 30 degrees and swivels right to left 60 degrees!

SPECIFICATIONS:
CRT DISPLAY SIZE: 12 inches non-glare 90 degree deflection
INPUT SIGNAL: 1.0 - 2.5V p-p composite video signal
INPUT INPEDANCE: Normal 75 ohm, high approx. 50K ohm
INPUT TERMINALS: RCA phone jack
RISE AND FALL TIME: Less than 25 us
VIDEO BANDWIDTH: 20MHz
Corner: 800 lines
Geometric distortion: 2% or less
Linearity: less than 2%
CONTROLS: Front: Power On/Off, brightness, contrast
Rear: Vertical hold, Horizontal hold, Vertical line, Vertical size.

Green Cat. X14506 **Normally $235**
Amber Cat. X14508 **Normally $239**
NOW ONLY $169

THOMSON EGA MONITOR

Top quality high resolution EGA monitors with a space-age design.

SPECIFICATIONS:
CRT: 14 inch (360mm) diagonal, 90 degree deflection
Display Size: 245(H) x 180(V)mm
Phosphor: P22, non glare, tinted screen
Dot Pitch: 0.31mm
Video Bandwidth: 18 MHz
Resolution: 15.75KHz - 640 x 200, 21.85KHz 640 x 350
Input Signals:
1. RGBI - positive, H(+), V(+)
2. RrGgBbI - positive, H(+), V(-)
Input Impedance: TTL Level (330 ohms)
Dual Scanning Frequency:
Horizontal: 15.75 KHz or 21.85 KHz + - 10Hz
Vertical: 50 - 60 Hz
Connector: 9 pin, D-type
Size: 312(H) x 363(L) x 380(W)mm
Weight: 10.8 Kg (Net)

X14525 .... **$895**

CHEAP DISKS

5¼" DISK STORAGE (DD50-L)

Efficient and practical. Protect your disks from being damaged or lost!

Features:
- 50 x 5¼" disk capacity
- Smoked plastic hinged lid
- Lockable (2 keys supplied)
- Contemporary Design

Cat. C16025 .... **only $14.95**

5¼" DISK STORAGE (DD100-L)

Efficient and practical. Protect your disks from being damaged or lost!

Features:
- 100 x 5¼" disk capacity
- Smoked plastic hinged lid
- Lockable (2 keys supplied)
- High impact ABS plastic base
- Contemporary design

C16020 .... **only $17.95**

MONITORS $129

VERBATIM DISK SPECIALS!

All prices 10 disk boxes!

Description	1-9 boxes	10+boxes
3½" 1S/2D	$44.95	$42.95
3½" 2S/2D	$46.95	$43.95
5¼" 1S/2D	$22.00	$21.00
5¼" 2S/2D	$26.00	$24.00
5¼" 2S/4D	$75.00	$70.00
5¼" 2S/HD	$42.95	$41.00

JUMBO 5¼" DISK STORAGE (DD120-L)

If you have lots of disks you'll appreciate the extra capacity of this disk storage unit when it comes to locating a particular disk.

Features:
- 120 x 5¼" disk capacity
- Smoked plastic hinged lid
- Lockable (2 keys supplied)
- High impact plastic base

C16028 .... **only $22.95**

SAMSUNG TTL 12" MONITOR

- High contrast, non-glare screen
- Excellent value for money!

SPECIFICATIONS:
Picture tube: 12" diagonal 90° deflection
Mode: TTL
TTL input signal:
Polarity: TTL Positive
Level: 4V p-p + - 1.5V
Impedance: 75ohm
Video bandwidth: 16MHz (- 3dB)
Scanning frequency:
Horizontal: 18.432 + - 0.1KHz
Vertical: 50HZ + - 0.5%
Active display area: 216(H) x 160(V)mm
Display characters: 80 characters x 25 lines
Input connector: 9 pin connector
Controls:
Front: Power ON/OFF, Contrast
Rear: V-Hold, V-Size, Brightness
Internal: Vertical Linearity, Horizontal Linearity, Horizontal Width, Focus
Power supply: 110/120V 60Hz, 220/240V 50 Hz
Dimensions: 308(W) x 297(H) x 307(L)mm
Weight: 7.3Kg
Shipping weight: 8.3Kg

Cat.No.	Description	Price
X14500	(GREEN)	$189
X14502	(AMBER)	$189

SAMSUNG 12" 20MHz COMPOSITE MONITOR ONLY $129

FEATURES:
- High contrast, non-glare screen
- High resolution, 80 or 40 character display

SPECIFICATIONS:
Picture tube: 12" diagonal and 90° deflection
Phosphor: Available in Green (P39) or Amber
Video input signal: Composite Signal
Polarity: Negative Sync
Level: 0.5V-2.0Vp-p
Scanning frequency:
Horizontal: 15.734 KHz + - 0.1%
Vertical: 60Hz
Video bandwidth 20MHz
Active display area: 216(H) x 160(V)mm
Display character: 80 characters x 25 rows
Input terminal: RCA Phono Jack
Controls:
Outside: Power Switch, Contrast, Brightness, H-Shift, V-Size
Inside: H-Width, H/V hold, H/V linearity, Focus
Power supply: 110/120V 60Hz, 220/240V 50Hz
Dimensions: 308(W) x 307(H) x 297(L)mm
Weight: 7.3Kg
Shipping weight: 8.3 Kg

Cat.No.	Description	Price
X14514	(GREEN)	$129
X14516	(AMBER)	$129

10 OR MORE ONLY $119ea

SAMSUNG 12" TTL/COMPOSITE MONITOR ONLY $179

FEATURES:
- At last a monitor with both TTL and Composite modes!
- High contrast, non-glare screen
- High resolution, 80 or 40 character display
- Swivel/Tilt base

SPECIFICATIONS:
Picture tube: 12" diagonal and 90° deflection
Phosphor: Green (P42)
Video input signal: Composite/TTL Switchable
Polarity: Negative/Positive
Level: 0.5 - 2.0Vp-p/4.0 - 1.5Vp-p
Impedance: 75ohm, more than 6.8K ohm
Scanning frequency:
Horizontal: 15.75 KHz + - 0.1%/18.432KHz + - 0.1%
Vertical: 47-63Hz
Video bandwidth: 20MHz
Active display area:
Composite: 206(H) x 160(V)mm
TTL: 216(H) x 160(V)mm
Display character: 80 characters x 25 rows
Input terminal: Phono Pin Jack, 9 pin D-Sub Connector
Controls:
Outside: Power Switch, Contrast, Brightness, Signal Select, V-Hold, V-Size
Inside: H-Width, H/V linearity, Focus, H/V-Shift
Power supply: 110/120V 60Hz, 220/240V 50Hz
Dimensions: 308(W) x 297(H) x 307(L)mm
Weight: 7.3 Kg
Shipping weight: 8.3 Kg

Cat.No.	Description	Price
X14509	(GREEN)	$179

"NO BRAND" DISKS!!

Now you can buy absolute top quality disks that are also the cheapest in Australia! They even come with a 5 year guarantee, 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 white paper jacket, and index labels. (5¼" disks includes write protects)

5¼" D/S "NO BRAND" DISKS FROM $0.80 EACH!!

10+DISKS	100+DISKS	1,000+DISKS
$9.00ea	$8.50ea	$8.00ea

(ALL PRICES PER 10 DISKS. TAX EXEMPT PRICES LESS $1)

3½" D/S D/D "NO BRAND" DISKS!

10+DISKS	100+DISKS	1,000+DISKS
$27	$26	$24

(ALL PRICES PER 10 DISKS. TAX EXEMPT PRICES LESS $4)

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$1 - $9.99	$2.00
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$50 - $99.99	$5.00
$100 - $199	$7.50
$200 - $499	$10.00
$500 plus	$12.50

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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MasterCard VISA

HEAD CLEANER DISKS

It only takes a minute amount of dust dirt or magnetic oxide particles on your drive heads to cause problems, errors, downtime or an expensive service call. Regular use of a head cleaner will keep your drive free of trouble causing dirt and help keep your system up and running. These disk cleaners are simple to use, and include cleaning solution and instructions.

CAT.No.	SIZE	PRICE
C12560	3½"	$6.95
C12555	5¼"	$6.95
C12851	8"	$24.95

SAKATA 13" RGB COLOUR MONITOR

High quality IBM* compatible monitors, great with VCR's too!

SPECIFICATIONS:
CRT: 13" 90° deflection colour
Input Signal:
Video Signal: Separate video signal
Video: Positive
Sync.: Positive
Input Level: TTL Level
Scanning Frequency:
Horizontal: 15.7KHz
Vertical: 60Hz
Display Size: 245(H) x 182(V)mm
Resolution:
Horizontal: 640 dots
Vertical: 200 lines
Size: 343(H) x 362(W) x 421(D)mm
Weight: 11.6kg

Cat. X14530 .... **$695**

ANTI GLARE SCREEN

Half the price of other brands!!
Relieve eye strain and headaches and increase productivity with these Anti Glare Screens. Suitable for 12" monochrome.

Cat. X99995 .... **$24.95**

MICRODOT DISKS!

DESCRIPTION	1-9 BOXES	10+ BOXES
3½" 2S/2D	$29.95	$28.95
5¼" 1S/2D	$12.95	$11.95
5¼" 2S/2D	$13.95	$12.95

(SEND $2 FOR SAMPLE DISK!)

Computer project plus special offer:

Connecting your PC to the outside world

Don't confine your personal computer to processing a few words, crunching a few numbers or playing games. Using it to monitor and control things in the "outside world" can be easier than you'd think, as the author of this article explains. Right now it can also be surprisingly cheap, thanks to a special offer his firm is offering EA readers . . .

by PETER KING, B.E.

I'm sure that many readers of *Electronics Australia* will be aware that almost any personal computer can be used to form the heart of a "computer control centre", keeping track of events happening in the "outside world" via suitable signals fed to its inputs, and controlling either these or other events via output signals. A PC may therefore be used to replace complicated and inflexible relay logic, for example, controlling all sorts of systems such as industrial processes, building security and air conditioning systems, irrigation and stock feed controllers, and so on.

The big advantage of a computer-controlled system of this kind is that virtually any aspect of its behaviour can be changed at will, simply by modifying the control program.

But don't you need fairly complicated and expensive interfacing circuits to use a computer for this kind of thing? And fancy programming? No, not at all. In fact providing your computer has a Centronics-type parallel printer port, or a similar TTL-compatible parallel interface (which means just about all PCs), it can be surprisingly simple and inexpensive. The programming can be quite straightforward too, using standard BASIC.

Using the techniques I describe in this article, you can easily provide most small computers with at least 8, and frequently up to 12, digital outputs capable of being used to perform on/off control. You can also provide up to 5 isolated digital inputs, capable of accepting either AC or DC signals from 12V to 24V — easily provided by relays, microswitches, sensors or transducers.

In short, your computer can be given enough "real world" inputs and outputs to make it capable of quite sophisticated control functions. And all at very low cost — so it's now quite feasible to use your PC to control mundane things like a lawn or garden watering system, or the house lights while you're away, or for things like programming your model train layout.

Providing control outputs

It's really very easy to provide almost any computer with digital control outputs, by taking advantage of modern component technology.

Many readers may not be aware of the quiet revolution that has occurred in relay technology in recent years. With miniaturisation occurring, very significant improvements have been made in speed, lessening power requirements and, of course, quieter operation.

The National brand relays ND-HD-5V, for example, operate on as little as 3.5 volts at 20 milliamps. This makes them capable of being driven directly from any high current TTL output! They can be mounted on Vero Boards or PCBs, and operate in less than 1ms.

That means that if they were driven from a 50Hz AC supply, they would indeed switch on and off 50 times per second. In fact, they can cycle on and off at up to 500 times per second!

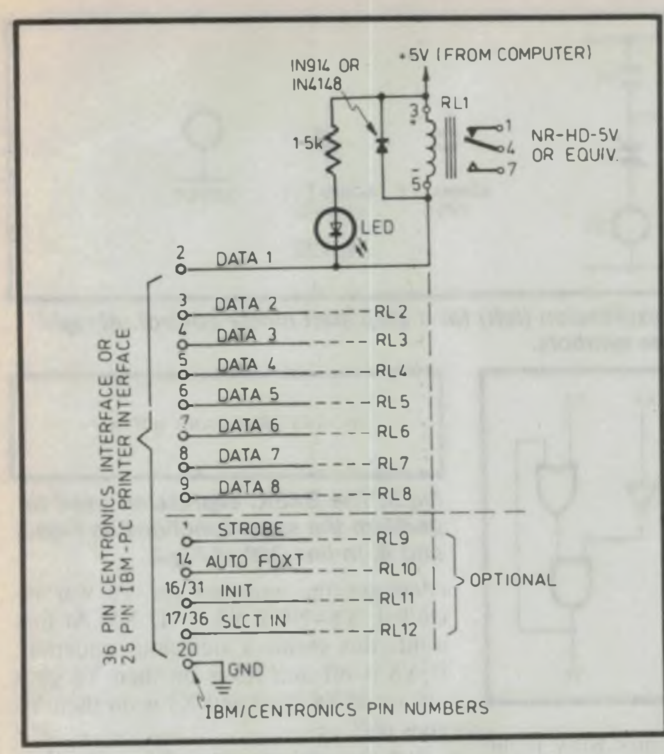
It is not practical to run them continually at such speeds, as being an electro-mechanical device they have a limited operational lifetime. I.e., one million operations at maximum switching power and 1000 million operations, mechanical life. They may sound like a lot, but a quick calculation indicates that operating at 500 cycles per second it's a mechanical life of only 23 days! However, operating once per second the rate lifetime is extended to 32 years — truly amazing!

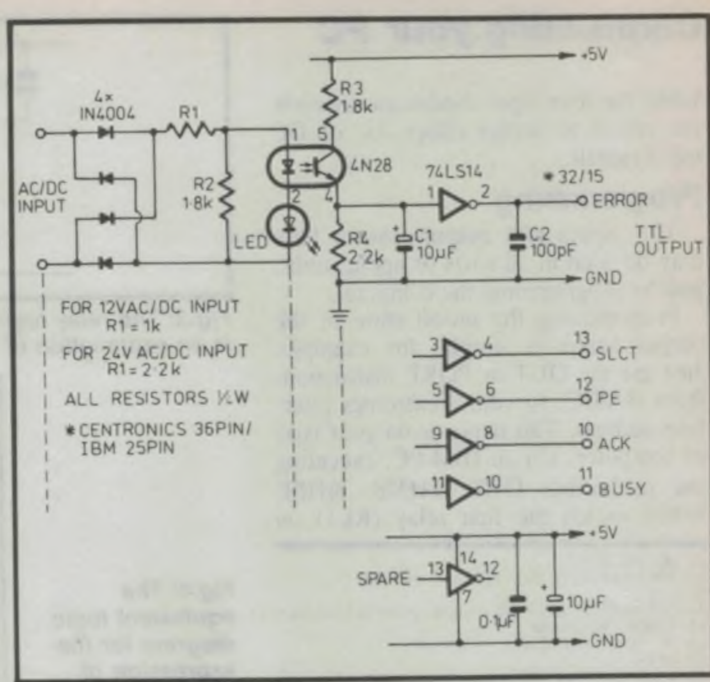
One thing to watch out for, with these relays, is the polarisation (+/-) of the coil. This is due to the use of a tiny internal magnet to aid pull-in and, indeed, the reason for the low drop-out voltage of only 0.5 volts. This however, can be used to advantage by installing a simple RC network: the hold-in current can be reduced to less than 5 milliamps, providing even greater power savings!

Because of their small current requirements, these relays can be *directly* connected to the Centronics port outputs of many PCs. The circuit diagram shows the possible pin connections. Eight relays may be connected to the data lines, while additional relays (up to 4) can be connected to the output control lines.

If indication of the output state is required then low current LEDs may be connected from each output to +5 volts, with a suitable series resistor. You should keep the LED current small to insure that the outputs, when in the low state, provide maximum drive current to the relays.

The +5 volt supply should be obtained from the computer (around





Details of the author's simple output control circuits (left) and input sensing circuits (right).

200mA for 8 relays), where possible. If using an IBM-PC, as I was, then the 5 volts can be obtained from pin 1 of the games port or, alternatively, from pin 5 of the keyboard connector.

Note that the SPDT contacts on these relays are rated at up to 30V and 1A DC, but not at the same time. Maximum switching power into resistive loads is 20W. For switching 240V or higher currents, you'll need to use booster relays.

The applications for these computer controlled outputs is limited only by your imagination. They could be used for model control, including train or robot control. They could be used to switch a radio on and off or stop and start a tape recorder, operate a photoflash or rotate your antenna! Further, it could control a sprinkler system, switching them on, at a particular time of day by making use of the computer systems clock (if you have one). To reduce the trail of wiring, the relay contacts could even be used to replace the pushbuttons in the remote control unit described in the June 1987 issue of *EA*, thus providing remote control of devices on the other side of the room from your computer!

Many will need to disconnect their printer in order to make use of this interface. However, those with IBM-PCs or compatibles can simply add up to three additional printer cards to their system (for around $35 each). The IBM-PC uses a 25 pin D-connector but the pin numbers remain the same as for the Centronics interface except for the "Init" and "Slct in" pins. The port addresses for your IBM may be one of the following: 0278, 0378, 03BC in Hexadecimal.

Here are a few hints to ensure correct operation. The cable to the relays should be shielded and not too long. Also, to help reduce any voltage spikes or noise being introduced onto the computer systems 5 volt supply, a 10uF electrolytic cap and .01uF ceramic cap should be placed between the +5 volt supply and ground, preferably at the computer end.

If the on-off state of the relays needs to be inverted (perhaps to guarantee that the relays remain off on power-up) then simply use a 7404, 7405 or 7406. Alternatively a device such as the Motorola MC1413 or equivalent can be used, which eliminates the need for the protection diodes across the relays. These are incorporated in the IC itself.

Providing sensing inputs

The second circuit diagram illustrates how up to five 12-24 volt AC or DC inputs may be provided, again via the computer's Centronics port — or indeed, any similar TTL input port. Here we take advantage of the Error, Slct, PE, Ack and Busy control inputs on the Centronics port.

Fully isolated inputs are provided by the use of the popular 4N28 opto-coupler, which provides almost complete separation (+/− 500 volts!) between the higher voltage inputs and the computer's TTL logic inputs. Such isolation not only allows long leads to be used on the inputs, but protects the computer should someone inadvertently apply too high a voltage.

The input circuit works as follows. When sufficient AC or DC voltage is applied to the input terminals, then approximately 10 milliamps of current flows through the opto-coupler's infrared LED. As a result, the NPN phototransistor at its output begins to conduct current, between pins 5 and 4. The voltage across the 4N28 output drops to 0.25 volts, and capacitor C1 begins charging. When the upper threshold voltage (1.6 volts) of the Schmitt trigger inverter (74LS14) input is reached, then the output switches to the LOW state. When voltage is removed from the input, then the opto-coupler's LED goes OFF and its photo-transistor stops conducting. C1 then discharges through R4. At the lower threshold voltage (0.8 volts) the Schmitt trigger TTL output switches to the HIGH state.

R1 can be altered for different input voltages and limits the current through the opto-couplers input. R2 determines the threshold voltage at which the output switches. C1 controls the turn-on and turn-off delay time and so provides contact debouncing of the inputs. It also eliminates the pulses produced by an AC input. C2 is provided to eliminate any noise spikes that may occur on the TTL output. The LED in series with the opto-coupler shows the current ON/OFF state of the input concerned.

Connecting your PC

while the four input diodes are to allow the circuit to accept either AC or DC input signals.

Programming

The inputs and outputs shown here may be used in all sorts of applications, just by programming the computer.

Programming the on-off state of the output relays is simple, for example. Just use the OUT or POKE instruction, from BASIC, to your Centronics interface address. This depends on your type of computer. On an IBM-PC, executing the instruction OUT &H378, &HFE would switch the first relay (RL1) on

```
10 DEFINT A-Z
20 PORT=&H0378:' Set to port address
30 A=1
40 OUT PORT,A XOR &HFF:' XOR inverts the output
50 TIME$="00:00:00"
60 IF TIME$<"00:00:01" THEN 60
70 A=A*2
80 IF A<256 THEN 40
90 GOTO 30:' Start again
```

Fig.1: A simple BASIC program to activate each output relay in turn, at second intervals.

and all other (RL2-RL8) off. The program of Fig. 1 would allow you to activate each output in turn (shift register style) with a time interval of one second.

Shown in Fig.2 is a program illustrating just how easy it is to control both the inputs and outputs, using again the BASIC programming language.

The IBM PC was used again here, but any computer could be used provided that you know the computer's input and output port addresses. On the IBM the input address for the printer port is one more than the printer's base address (i.e., if your data outputs are at 378 hexadecimal then the inputs will be at 379). The exact base address depends on whether you're using the primary printer port, or an additional card.

The program first sets all variables A-Z to integers (for speed). Then the output and input port addresses are set and all outputs are turned OFF (line 200).

At the line 240 the input state is read into variable X. On some computers a PEEK instruction may need to be used here, instead of INP (X). Then each bit of the input byte is translated into individual logic variables X1 through to X5.

If the input is in the low state, then the corresponding variable will be set to TRUE (-1). If the input is high, then it will be set to FALSE (0). Note that X5's equation is different to the others (X1-X4), this is necessary because on the IBM-PC the Centronics Busy input is inverted.

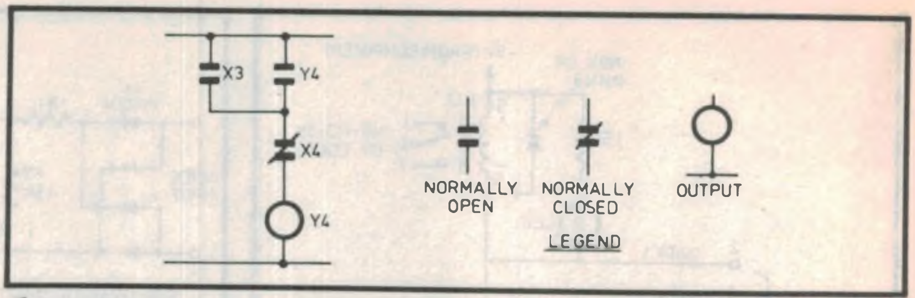


Fig.3: The relay logic expression (left) for a stop/start motor control. At right is an explanation of the symbols.

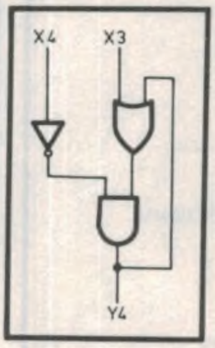


Fig.4: The equivalent logic diagram for the expression of Fig.3.

Y4 = (X3 OR Y4) AND NOT X4

Fig.5: The BASIC expression used to perform the same functions as Figs.3 and 4, in line 360 of Fig.2.

Note that X1 will correspond to the input connected to the printer port's Error line, X2 to that connected to the Slct line, X3 the PE line and X4 the Ack line.

From the lines 330 through to 400 we perform the necessary logic operations, whatever these may be for your application. Here the output Y1 will go on only when both X1 and X2 are on. Y2 shows an OR condition and Y3 an Exclusive OR (XOR).

Y4 may be a bit of a puzzle to some, until we show the equivalent relay logic function in Fig.3. Yes! It's a simple Stop/Start motor control. Activate X3, and Y4 goes on and stays on until X4 is activated. Fig.4 shows the equivalent in digital logic gates, and Fig. 5 our programmed equations.

This should illustrate just how easy it is to translate either relay or digital logic into the computer's control equations.

Finally, at line 440 the individual logic output variables (Y1 to Y8) are reassembled bit by bit back into a single output byte, and sent to the relay control output port (line 450). Some computers may need to use the POKE instruction here.

To give the "illusion" that everything is occurring instantaneously, the whole process is repeated without end (line 490). So as the inputs change, so too will the output conditions change. Programmable control is at your fingertips.

To show the speed limitation of your computer the equation for Y8 was included: Y8=NOT Y8 AND X5. At first sight, this seems a ridiculous equation. If Y8 is off *and* X5 is on then Y8 goes on, yet if Y8 is on and X5 is on then Y8 goes off?

Let me explain, when X5 is on, then the output Y8 behaves in an unstable manner (i.e., its output changes state on each output update). The equivalent in relay logic or digital logic would produce an oscillating output, and that's exactly what happens here!

The rate of oscillation depends on the on/off relay times through the device.

```
100 REM *** LOGIC CONTROL PROGRAM ***
110 REM *                            *
120 REM *   By Peter E. King         *
130 REM ******************************
140 DEFINT A-Z
150 REM
160 REM Initialize port addresses
170 REM
180 YPORT=&H378
190 XPORT=&H379
200 OUT YPORT,255
210 REM
220 REM start/ scan inputs X1-X5
230 REM
240 X=INP(XPORT)
250 X1=(X AND 8)=0
260 X2=(X AND 16)=0
270 X3=(X AND 32)=0
280 X4=(X AND 64)=0
290 X5=(X AND 128)<>0
300 REM
310 REM perform logic functions
320 REM
330 Y1=X1 AND X2
340 Y2=X1 OR X2
350 Y3=X1 XOR X2
360 Y4=(Y4 OR X3) AND NOT X4
370 Y5=X5 AND Y1
380 Y6=0
390 Y7=-1
400 Y8=NOT Y8 AND X5
410 REM
420 REM update outputs Y1-Y8
430 REM
440 Y=(Y1 AND 1)+(Y2 AND 2)+(Y3 AND 4)+(
Y4 AND 8)+(Y5 AND 16)+(Y6 AND 32)+(Y7 AN
D 64)+(Y8 AND 128)
450 OUT YPORT,Y XOR 255
460 REM
470 REM finished  go back and scan again
480 REM
490 GOTO 240
```

Fig.2: A longer program, again in BASIC, to scan the five input lines and then perform logic functions in order to control the various outputs.

But what is the delay time for the computer? It will be *variable*, because it depends on the speed at which your computer can execute the instructions shown in the program. Use a faster computer, and it will oscillate faster. Compile the BASIC program and it will oscillate faster again — up to *ten times* faster!

If you have understood how this simple program works and how logic functions are programmed into the computer, then you will be able to control almost anything. You will also begin to understand how PLCs (Programmable Logic Controllers) or PCs (Programmable Controllers) operate, and the significant advantage they offer over conventional logic, in that functional changes may be made quickly and easily without any re-wiring.

Special offer

Now for details of the special offer, to *EA* readers who are interested in building a low-cost interface for their computer.

My business, ProCon Software, normally operates in the field of computer or PLC industrial control. But due to an industrial project which fell through, I have 1000's of the National NR-HD-5V relays to dispose of. I am prepared to make a special offer to all EA readers. These relays normally sell for around $6.50 to $7.50 plus tax; however I will provide them to readers at $5.95 each — tax included!

In addition, for those that purchase 8 relays or more, ProCon Software will provide a free IBM-PC 5.25 inch disk with the following programs on it:

(1) A memory resident program called CONTROL, which allows each of the eight relays to be toggled ON and OFF from the keyboard whilst running other programs. (Yes — you can now turn devices ON and OFF from the keyboard whilst still running your favourite program, be it wordprocessing, a game or programming language!)

(2) A BASIC program called STICK, which demonstrates how to control the relay outputs from the computer's joystick — ideal for robot or model car control etc.

(3) A BASIC program called REMOTE, which controls the relay outputs by the systems clock, turning each ON or OFF at a particular TIME and DATE. Could be used as the basis for a sprinkler control system, or as a burglar deterrent by switching a radio or TV on and off at different times of the night and day.

Because of the circumstances, this is a "one off" deal and can only be provided whilst stocks last. As I said, I have thousands of these relays in stock and they must be cleared as-soon-as-possible. But when they're gone, the offer must end.

The disk containing the programs can also be purchased separately, if you wish, at $10 plus $2 post and pack. This is extremely reasonable, I'm sure you will agree.

As an additional service to *EA* readers I will also offer the 4N28 opto-couplers, at a much discounted price of $1 including tax (normal retail is $1.50).

The relays opto-couplers and software may be purchased by sending a cheque or money order for the number required, plus $2 post and pack (any quantity) to:

ProCon Software,
P.O. Box 43,
Essendon, Victoria 3040.

Telephone enquiries can be made on (03) 336 4956. Quantity breaks occur at units of 50 and 500 — telephone for prices on this.

By the way ProCon Software is located at 49 Combermere Street, Essendon 3040. Personal callers will also be welcomed.

Circuit & Design Ideas

Interesting circuit ideas from readers and technical literature. While this material has been checked as far as possible, the circuits have not been built and tested by us. As a consequence, we cannot accept responsibility, enter into correspondence or provide constructional details.

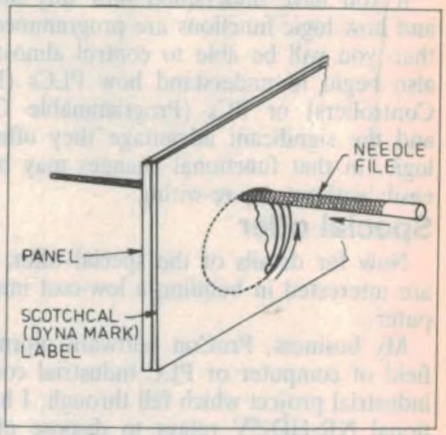
Cutting holes in Scotchcal/Dynamark labels

Assuming all holes are drilled, punched or cut in the front panel of a project, the time comes to stick the "Scotchcal" label to it, and cut its holes to match.

Up to now the suggestion has been to use a scalpel (ouch!!) from the back and cut the label through the hole. Well, this stresses the label round the hole leaving an undesirable finish.

I have discovered a very easy way of obtaining a near-perfect finish around any shaped hole in a stick-on label. The technique is as follows:

1. Finish front panel with all holes cut out.
2. Produce and stick label to front panel.
3. Using a *round* needle file from the front (label side), push point of file through label just inside cutout. The point of entry can be marked from rear in all holes, by using point of needle file to produce a very slight indent, which can easily be seen from the front.
4. Once the file has penetrated it should contact the edge of the main hole, then the cutting action between the file and the edge of the hole continues for the full stroke of the file.
5. Withdraw the file (without touching label) until point of file nearly comes out and start another plunge and cutting action, working around the side of the hole. Continue until all label material is removed from hole.

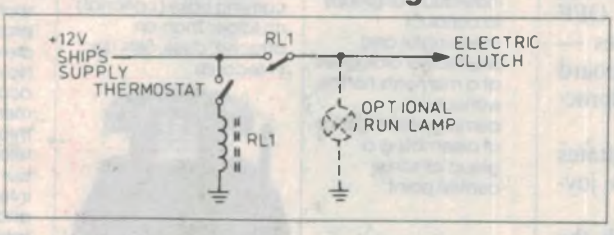


6. Use a *square* needle file to finish corners of rectangular holes.

Eric Rodda,
Marion, SA.

$25

Simple auto-run circuit for fridges



Here is a somewhat simpler circuit for a "refrigerator auto-run unit" for boats, as featured in the *Circuit & Design Ideas* section of November 1987.

A particular feature of this design is that it resets automatically!

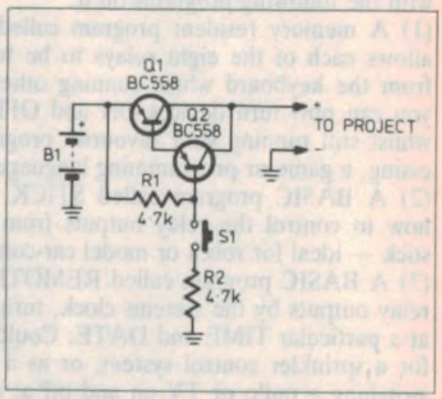
To carry out the modifications, discard all but the relay, RL1. Then connect up the fridge's thermostat, as shown in the drawing. The green run-lamp may be retained as an extra option, at increased expense, if required.

Don Fraser,
Mt. Gravatt, Qld.

$15

Editor's Note: This will obviously be a simpler and cheaper approach where the refrigerator's thermostat is easily accessible, and it is being built into the boat permanently. But the original design may still be preferable, where the thermostat isn't accessible, or the fridge is a portable unit, and/or you don't want to modify it.

Darlington assisted switch



When momentary power switches are used with battery powered projects, the contact resistance of cheap switches often interferes with circuit operation. This is because the voltage applied to the project varies with the contact resistance of the switch.

This circuit corrects for the contact resistance of the switch, so that even with the noisiest of cheap switches, it supplies an unvarying battery supply to the project.

The switch is now used to turn on the Darlington pair (Q1, Q2) via R2, and off via R1 when the switch opens. The leakage current when off is less than 0.1uA.

Eric Rodda,
Marion, SA.

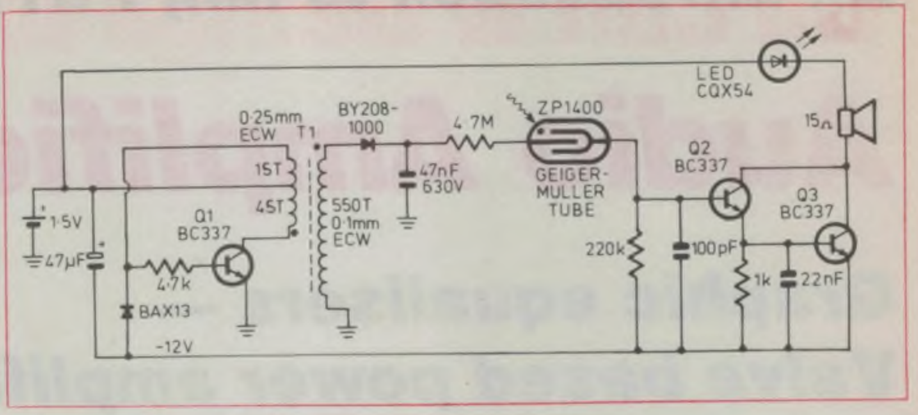
$15

Dreamed up a great idea?

If YOU have developed an interesting circuit or design idea, like those we publish in this column, why not send us in the details? As you can see, we pay for those we publish — not a fortune, perhaps, but surely enough to pay for the effort of drawing out your circuit, jotting down some brief notes and popping the lot in the post (together with your name and address, or course!). Send them to Jim Rowe, Electronics Australia, PO Box 227, Waterloo 2017.

Simple Geiger counter

Here are details of a very elegant and relatively low cost Geiger counter circuit, actually provided by the Elcoma division of Philips to illustrate the use of its G-M tube type ZP1400. This is a fairly sensitive window-type tube, and one that is very suitable for general detection of beta and gamma radiation. However it is also a little expensive, currently costing around $120. Cheaper tubes are available, such as the ZP1310 and ZP1320, both of which sell for around half the price. These will work in this circuit — but they are rather less sensitive and may give disappointing results.



The complete circuit operates from a single 1.5V cell. To produce the 500V DC needed for the tube, transistor Q1 is used in a simple flyback DC/DC converter. This uses a step-up transformer T1, wound on a Philips type RM6S-3E5 ferrite potcore. The Philips catalog numbers for the potcore components are 4322 022 47971, 4322 021 32950 and 4322 021 31780. The last of these is the clip, of which two are needed.

The primary winding of T1 consists of 15 turns plus 45 turns of 0.25mm enamelled copper wire, while the secondary consists of 550 turns of 0.1mm enamelled copper wire. Note that the collector end of the primary winding and the "live" end of the secondary winding must have the same polarity. So if both windings are wound in the same way, these ends should be the at the starts (or the finishes).

By connecting a second diode and capacitor to the base end of the transformer primary, the converter is also made to produce a second –12V output, to power the amplifier section. This uses two further BC337 transistors Q2 and Q3, to amplify the small current pulses produced by the G-M tube.The end result is a "click" in the loudspeaker, and a brief flash of light from the LED, each time the tube discharges.

The higher the click/flash rate, the more intense the radiation incident on the tube.

A switch may be wired in series with the 1.5V cell to turn the counter on and off as desired. The current drain is approximately 7mA, so an AA or C sized cell will provide adequate capacity.

Courtesy Philips Elcoma.

An introduction to hifi, Pt.17

Audio Amplifiers — 2

Graphic equalisers — Valve based power amplifiers.

After passing through the "front end" of an audio amplifier, the incoming signal is then normally fed to the power amplifier section, as depicted in Fig.1 of the preceding chapter. But before looking at power amplifiers, it may be helpful to interpose a segment covering so-called "graphic equalisers".

by NEVILLE WILLIAMS

A discussion of graphic equalisers is appropriate at this point in the series because, in effect, they are supplementary to, or a more elaborate form of, tone control. As such, they are commonly included in the signal path just ahead of the power amplifier section, either as an outboard unit or as an additional feature built into an integrated amplifier or receiver.

As already noted, conventional tone control systems can be set to produce a gradually rising or falling characteristic below about 500Hz and above about 1000Hz (Ch.16, Fig.6), being very useful when it is desired to re-balance a signal which is judged to have too much or too little bass or treble. A touch of one or both knobs and a more acceptable overall sound will hopefully result.

But an optimum balance cannot always be achieved as easily as that.

It may well be that the loudspeaker system exhibits a noticeable response peak in the 70-80Hz region, falling away rapidly below 50Hz. An ordinary bass-end tone control could certainly reduce the 70-80Hz "thump" but, in the process, it would further attenuate the already deficient low-end bass. On the other hand, advancing the control might assist the deep bass but the 80Hz thump would be further accentuated.

Again, the listening room acoustics may create peaks and/or troughs in the response, as heard, while similar problems can be introduced by signal sources or recordings, particularly of the less pretentious kind. (Perhaps the most capricious listening environment of all is the interior of a motor vehicle, by reason of its dimensions and shape, the seating arrangements, absorbent upholstery and panel resonance effects).

Graphic equalisers may provide some recourse with such problems, permitting relatively narrow segments across the frequency spectrum to be selectively boosted or cut, as the circumstances may require.

A comprehensive graphic analyser typically involves a row of up to twenty vertically mounted slide potentiometers — ten each for the respective stereo channels — ranged along the front panel. Each potentiometer is marked with a frequency representing the nominal centre of the segment which it controls.

Typical performance

When all slider control knobs are in the mid position, as normally indicated by a horizontal reference line and/or a detent, a well designed graphic equaliser should ideally be neutral in terms of signal quality and sound. The gain would be unity, the frequency response substantially flat overall (typically within +/-0.25dB), the distortion level very low (typically less than 0.01%), dynamic range and signal/noise ratio 95-105dB, and signal overload rating well above the anticipated operating level — say 5V RMS.

For good measure, many equalisers include a "Defeat", "Bypass" or "Cancel" switch which re-routes the respective L&R stereo signals direct from equaliser input to output, bypassing the intervening components. Such a facility permits instant comparison between an "equalised" setting and "flat", and also allows the system to be cut out of circuit when it is not actually in use. This obviates any lingering apprehension about residual distortion, &c.

Sliding any given knob upwards will

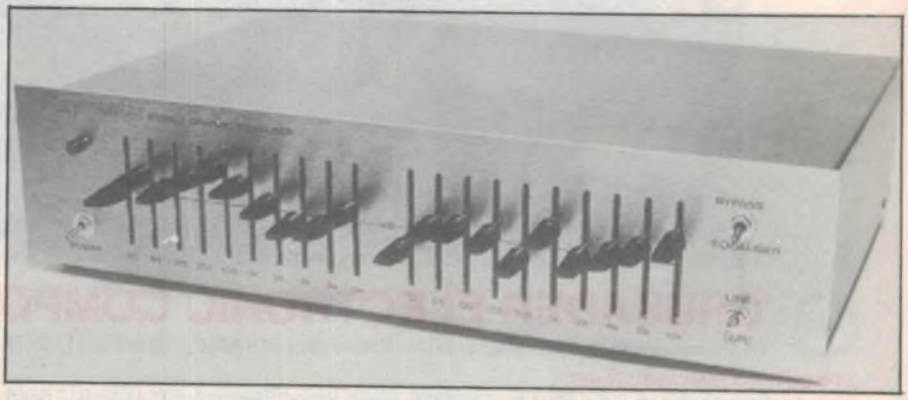


Fig.1: The Playmaster Stereo Graphic Equaliser, as described in the May '79 issue of EA. The potentiometer settings suggest a peak at 125Hz and a roll-off towards 16kHz — a contour more likely to have been selected by the photographer than by a hifi enthusiast!

produce a response peak centred on the designated frequency, and of an amplitude adjustable all the way from flat to about +12dB. Moving it downwards can produce a "trough" ranging in amplitude down to about -12dB.

When a number of potentiometers have been adjusted to secure a desired sonic balance, their sliding control knobs present a visible contour suggestive of a frequency response curve — perhaps a peak or trough here or there, or an upwards or downward slope. Hence the name "graphic" equaliser.

In the case of a 10-band equaliser, using 10 potentiometers per channel, the overlapping frequency segments would typically be centred on the following frequencies: 32, 64, 125, 250, 500, 1000, 2000, 4000, 8000 and 16,000Hz.

The approximate octave relationship between the centre frequencies gives rise to the alternative description "octave" equaliser — further emphasised by the fact that the nominal centre frequencies approximate the C-notes in the musical scale.

(In professional applications, equalisers having rather more potentiometers spaced at centre frequencies only 1/3 of an octave apart may be used. Needless to say, the individual controls are arranged in this case to act upon a correspondingly narrower segment of the spectrum.)

Fig.1 shows the front panel of the 10-band or 10-octave Playmaster Stereo Graphic Equaliser, described for home construction in the May '79 issue of this magazine. Fig.2 shows the effect of moving each of the octave potentiometers between the maximum boost limit (+13dB) and maximum cut (-13dB).

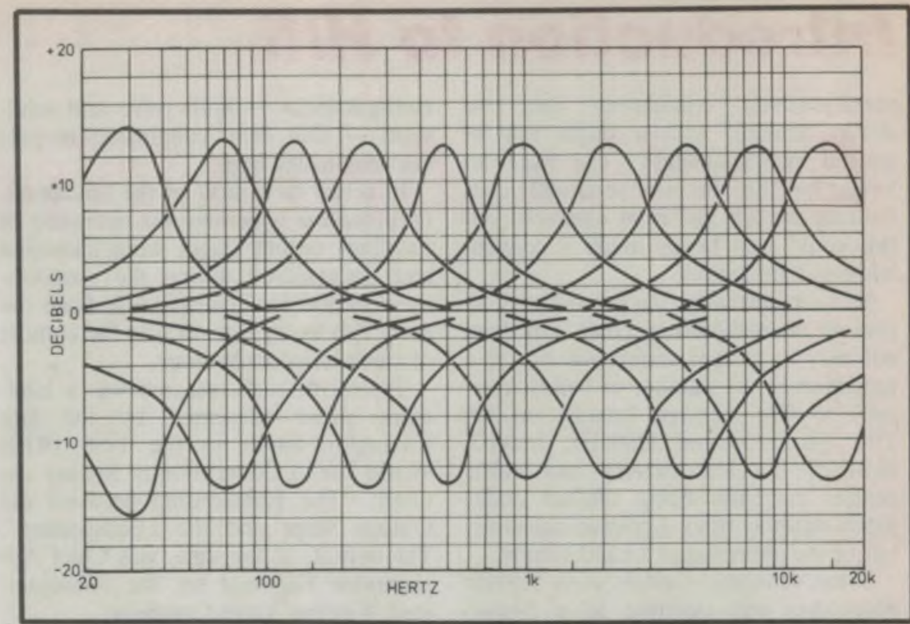


Fig.2: Showing the effect of the separate potentiometers in the Playmaster Equaliser. Each can be adjusted to produce deviations ranging all the way from "flat" to a maximum of about +/-13dB.

Looking at the curves, it is apparent that they would offer a way of dealing with the hypothetical — but not unlikely — loudspeaker problem mentioned earlier: depress the 64Hz pot. to reduce somewhat the response in the 70-80Hz region, and raise the 32Hz pot. to boost the response below 50Hz — as appropriate, but within the power limits of the amplifier and/or loudspeaker system.

Basic circuit

The shape of the response peaks and troughs depicted in Fig.2 are strongly suggestive of resonant circuits and, in fact, the first generation of graphic equalisers did use a suitably configured op-amp (operational amplifier) in conjunction with selected inductors and capacitors connected in series (Fig.3).

In practice, the inductors posed quite a problem by reason of their cost and bulk, and their tendency to pick up hum from nearby power transformers and mains wiring.

The difficulty was overcome by a clever and inexpensive bit of circuitry referred to as a "gyrator" (Fig.4). It involves using an op-amp to reverse the voltage/current relationship in a capacitor, such that the combination behaves like an inductor. By replacing the inductor in Fig.3 with a gyrator having apparently equivalent characteristics, the same end result can be achieved more cheaply, more conveniently and without the inordinate sensitivity to hum fields.

(For a complete schematic circuit and a more detailed explanation of its operation, see *EA* for May '79, p.58).

The interconnection of an outboard graphic equaliser to an existing integrated amplifier or receiver could pose a problem, were it not for the fact that many modern units carry input and output connections for one or more cassette recorders. It is frequently possible to patch an equaliser into this so-called "tape loop", and to plug the cassette deck into duplicate sockets provided on the back of many equalisers.

Perhaps it is sufficient to note here that, before investing in an add-on equaliser, it is wise first to establish how readily, or otherwise, it can be connected to your existing hifi system. At best, it may involve no more than suitable cabling; at worst, it may necessitate breaking into the internal wiring of the receiver or amplifier — a job for an expert.

Built-in equalisers

When a graphic equaliser is incorporated into an integrated amplifier or receiver, it is common practice to economise in the number of panel controls by

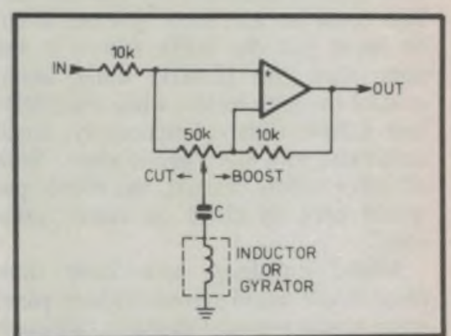


Fig.3: The basic control circuit used in graphic equalisers — a feedback op-amp with a slide pot, strung between its two inputs. It operates over a frequency band determined by the series resonance of C and L.

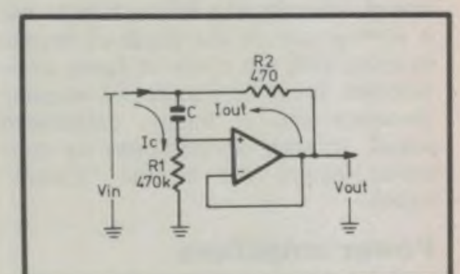


Fig.4: One of the actual gyrator circuits used in the Playmaster Graphic Equaliser. The value of the inductor simulated is determined by the choice of capacitor "C".

simultaneously configuring the two stereo channels with a single row of ganged potentiometers. The user no longer has the option of separately configuring the left and right channels, but this could well be as much a convenience as a limitation!

More importantly, the present urge to contain manufacturing costs can lead not only to ganged slider pots but to a reduction in the number of bands, typically to five, centred broadly on 60, 220, 800, 3200 and 12800Hz. Indeed, most of the hifi systems and music centres currently being offered under $1500 dutifully offer a graphic equaliser, but of the abbreviated 5-band variety.

Some economy models even feature what they still describe as a 3-band graphic equaliser, but which can offer little more than group control over the low, middle and high frequencies. Although they might look the part, it is doubtful whether a 3-band equaliser could achieve much more, in practice, than conventional bass/treble boost/cut tone controls.

A 5-band equaliser would certainly offer greater flexibility, in that the low bass could be selectively boosted or cut by using just the 60Hz slider. In the same way, the 12.8kHz slider would control the high treble, while the 220Hz and 3.2kHz sliders, respectively, could contribute to a more gentle slope. With all other sliders centred, the 800Hz pot would have an effect on voice "presence".

5-band equalisers also have their place in car sound systems, where panel space poses a special problem, although some automotive models still manage to accommodate 7-band, 9-band and even 10-band systems.

For a top quality in-home system, a 10-band equaliser is much to be preferred — but only if it is under the control of someone who knows how to use it intelligently. In the hands of anyone to whom it is just a row of knobs to be twiddled, it can be a source of on-going confusion and of lumpy, unbalanced sound. In such circumstances its most useful feature will be the "Cancel" switch!

Power amplifiers

The development of the power output section of domestic hifi amplifiers adds up to a quite intriguing study, although not one that can be pursued at length in this present series. It should be helpful, however, to mention certain notable configurations — both valve and solid-state — that have culminated in present-day technology.

In actual fact, most of the fundamental principles governing the operation of amplifier output stages were identified and documented during the establishment period for domestic hifi, from the early 30's to the late 40's, in the context of valve-based technology.

Typical of such research was a landmark paper presented by the late F.Langford-Smith to the 1938 IREE World Radio Convention in Sydney entitled: "The Relationship between the Output Stage and the Loudspeaker". The author, at the time, was Chief Applications Engineer for the Amalgamated Wireless Valve Company.

When solid-state technology took over in the '60s and '70s, it brought radical changes in methodology, but the critical design parameters that had been identified by Langford-Smith and others, 30 years previously, still applied: source impedance, load impedance, distortion, frequency response, damping, feedback, stability, etc.

The inclusion of a segment on valve type power amplifiers therefore offers more than mere historic or nostalgic interest. It should serve to highlight considerations which apply with equal force to modern solid-state designs, while also bringing a touch of reality to those who choose to regard valve-based amplifiers as a race apart.

From the seemingly endless — and often misguided — arguments in the '30s about triodes, tetrodes and pentodes, about operating conditions, biasing arrangements, direct coupling, negative feedback, and so on, a basic configuration that earned early and unfailing respect from the then-hifi fraternity is shown in Fig.5.

Reproduced from the June 1937 issue of *Radiotronics*, the particular example shows a pentode voltage amplifier, followed by a triode-connected pentode as a phase splitter, driving a pair of push-pull 2A3 power triodes — a valve broadly equivalent to two old-time 45s in parallel. The available power output is quoted as 7W RMS with the distortion, mainly second harmonic, ranging from 0.25% at low output levels to 2.5% at full volume — said to be substantially below that of then available program sources.

Measured across a resistive load at voice coil impedance, and dependent on the particular output transformer, the frequency response was shown as –2dB at 35Hz, virtually on reference from 42-1000Hz, a gentle rise to +3dB at 4kHz, falling back again through reference just above 10kHz — again, an acceptable result for the period.

(A contemporary alternative approach was to use a pair of triodes as a

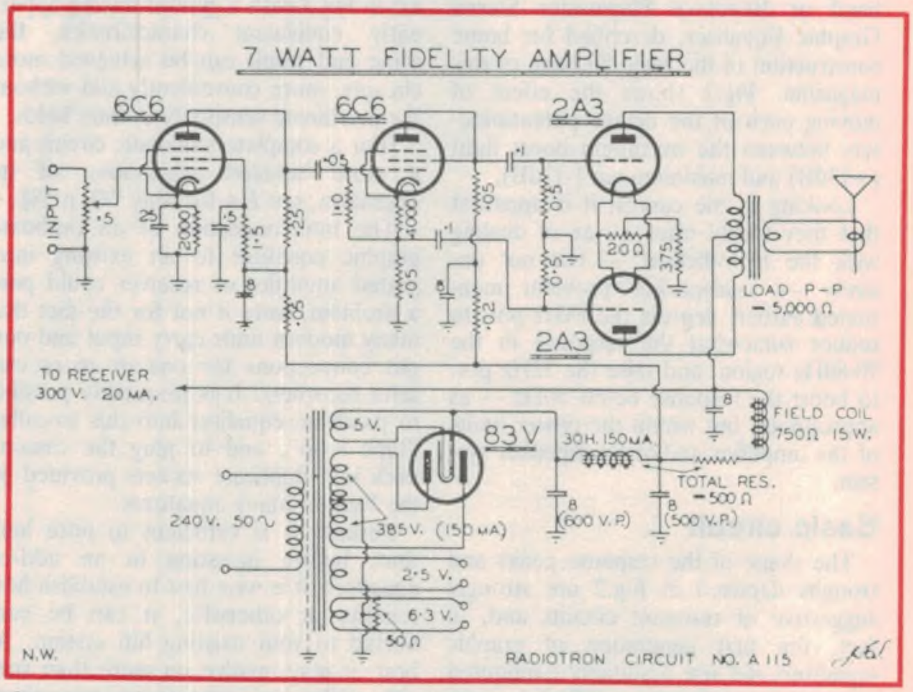


Fig.5: The circuit for a 7-watt pure class-A push-pull 2A3 amplifier comes from the A.W.Valve Co technical bulletin "Radiotronics" for June, 1937. A class-AB version delivering 13.5W was described in "Radiotronics" for August 1939.

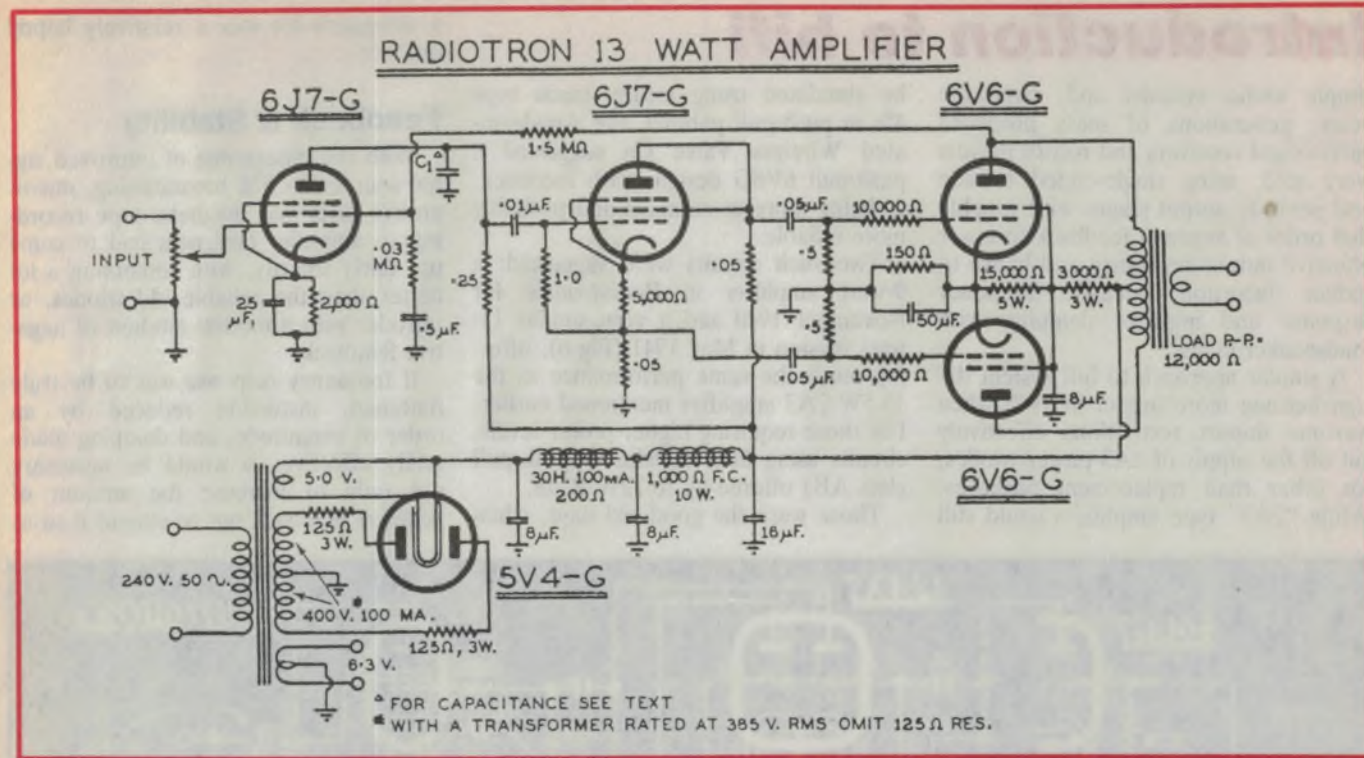


Fig.6: When the importation of 2A3 triodes was restricted on 1940, attention turned to the use of 6V6-G tetrodes using, initially, a simple system of negative voltage feedback — from one side of the output transformer to the screen of the pentode voltage amplifier.

phase inverter ahead of the output valves, preceded by a triode voltage amplifier).

Either way, the merit of the overall approach rested, very largely, on three basic performance criteria:

(1) All stages operated under class-A conditions — near the centre of their dynamic characteristic — thus minimising harmonic distortion.

(2) Because of their intrinsically low output resistance (e.g. 800 ohms) 2A3 output triodes could operate into typical reactive loudspeaker loads, without exhibiting unduly increased harmonic distortion or non-linear frequency response.

(3) When stepped down by the output transformer, the valve output resistance assumed a value well below the nominal loudspeaker voice coil impedance, thereby ensuring good loudspeaker damping, particularly at the bass resonant frequency.

Admittedly, the 7W RMS power output available from a pair of 2A3s was modest by present standards but, in those days, such amplifiers were commonly used with large and expensive mono hifi loudspeaker systems, designed with a special emphasis on acoustic efficiency. The sound pressure level available could be much the same as from a less sensitive modern system driven by a 20-30W amplifier.

Push-pull 2A3 amplifiers were still being used — by choice — right up into the mono LP era although, well before then, designers had managed to obtain increased power by pushing them to their dissipation limits and even adding a few dB of negative feedback to keep the measured performance abreast of other evolving technology.

For example, *Radiotronics* for August 1939 carried details of an amplifier broadly similar to Fig.5 but using the 2A3s under maximum class-AB conditions, driven by a triode-connected 6V6G phase splitter. No provision was made for negative feedback, but the design offered an output of 13.5W RMS at a distortion figure ranging from very small at low signal levels to about 3% at full output.

Tetrodes and pentodes

In terms of published characteristics, power output tetrodes and pentodes invariably appeared to have a marked advantage over contemporary power triodes, in terms of both gain and power output; hence the urge to use them. In the early '30s, for example, a single 47 offered 2.7W output against 1.5W from the 45 triode, for a comparable DC power input and distortion level and about one-third of the grid drive signal.

The 47 was followed by a whole string of pentodes and beam-power tetrodes, from the 59 to the 6V6 and 6L6, offering progressively higher gain and improved input/output efficiency for a distortion level ostensibly similar to that of power triodes.

The catch was/is that, in practice, with their high intrinsic output resistance (30,000-60,000 ohms) tetrodes and pentodes perform very poorly into complex reactive loudspeaker loads. The distortion level rises way above the published figure for a resistive load, while the acoustic output also varies widely with load impedance, and therefore frequency. In addition, the output stage imposes little in the way of damping on the voice coil.

As a result, from the very outset, tetrode and pentode output stages gained a reputation for louder signals (higher sensitivity and output), a harsh sound (increased distortion), a strident quality (rising treble response), and "boomy" bass (poor loudspeaker damping).

To reduce the effective output resistance and thereby counteract these inadequacies, it was/is essential to use negative (voltage) feedback around the output stage. In broad terms, around 10-12dB of feedback or a gain reduction of 3-4 times is necessary to achieve performance parameters comparable to those of a triode power stage *without* feedback.

This presents no special problem in

Introduction to hifi

simple audio systems and, over the years, generations of mass produced valve-based receivers and record players were sold, using single-ended tetrode and pentode output stages with roughly that order of negative feedback to lower effective output resistance and hence to reduce distortion, linearise frequency response and improve damping with loudspeaker loads.

A similar approach to hifi system design became more urgent in 1940 when wartime import restrictions effectively cut off the supply of 2A3 power triodes, for other than replacement purposes. While "2A3" type amplifiers could still be simulated using locally made type 45s in push-pull parallel, the Amalgamated Wireless Valve Co suggested a push-pull 6V6G design, with feedback, as being more economical and probably more reliable.

Two such circuits were suggested: a 9-watt amplifier in *Radiotronics* for November 1940 and a very similar 13-watt version in May 1941 (Fig.6), offering much the same performance as the 13.5W 2A3 amplifier mentioned earlier. For those requiring higher power levels, circuits using 6L6 tetrodes in push-pull class AB1 offered up to 32W RMS.

Those were the good old days, when a designer's lot was a relatively happy one but . . .

Feedback & Stability

With the emergence of improved signal sources — FM broadcasting, microgroove discs and magnetic tape recording — amplifier designers had to come up, fairly smartly, with something a lot better than the reliable old triodes, or tetrodes with a modest amount of negative feedback.

If frequency response was to be truly flattened, distortion reduced by an order of magnitude, and damping made really effective, it would be necessary not only to increase the amount of negative feedback but to extend it so as

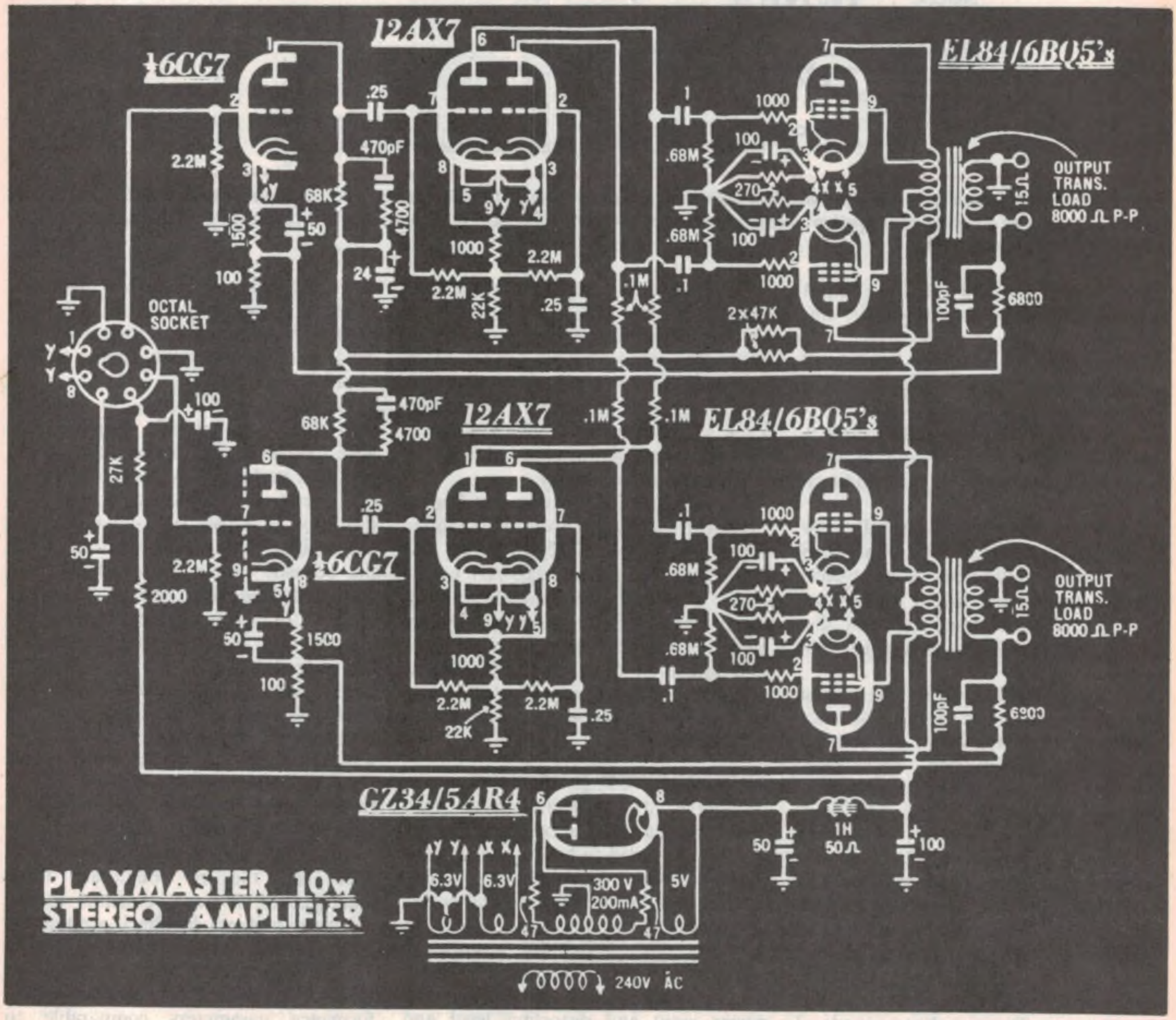


Fig.7: Combining economy with performance: the first of the stereo ultra linear valve Playmasters. Note the 100pF capacitor across the 6800Ω feedback resistors and the 470pF/4700Ω "step components" across the 6CG7 anode loads, all serving to tweak the phase.

to include the voltage amplifier, the phase inverter stage and the output transformer as well.

This would typically involve grounding one side of the transformer secondary winding and taking a feed from the other side back to a suitable early point in the signal chain as, for example, the cathode circuit of the voltage amplifier. Needless to say, the connections would be so arranged that the feedback would be negative, rather than positive.

It sounds simple enough but, unfortunately, the likely presence of coupling capacitors within the feedback loop, along with bypass and stray shunt capacitance and the complex reactive qualities of the output transformer, all conspire to rotate the phase of the original and the feedback signal at subsonic and supersonic frequencies.

Even the reactive qualities of the loudspeaker system can have an effect, as also can the capacitance and inductance of the loudspeaker cable.

Given sufficient feedback and negative-to-positive phase rotation, an amplifier can all too easily become marginally or completely unstable. At best, the sound quality may suffer; at worst, the amplifier may "motorboat" at a very low frequency, or oscillate so violently at a supersonic frequency as to endanger the tweeter loudspeaker.

The practical outcome of this is that, in designing a high performance tetrode or pentode power amplifier, extreme care is necessary with the circuitry and layout — and especially the choice of output transformer. It may also be necessary to tweak the phase shift with supplementary resistors and capacitors, in the interests of stability.

A well designed high-feedback, high-performance amplifier can be mass produced quite successfully, or duplicated in the case of a do-it-yourself project. Problems can arise, however, if a given circuit is built up using other components, and particularly a different output transformer. Variants really need to be checked with a CRO and a sine/-square wave audio generator, to determine whether or not they are intrinsically stable.

The "ultralinear" circuit

The climax to the audio valve era came with a development credited to Hafler and Keroes, reported in the Feb.'52 issue of this magazine (then *Radio & Hobbies*). They discovered that pentode and tetrode valves could be made to assume triode-like characteristics, by feeding the screens from a tapping part way up the respective halves of the output transformer primary winding.

For example, their work with an amplifier using push-pull 6L6s showed a clear optimum tapping position at 80% of the plate load impedance — about 10% down the winding from the respective anodes, expressed in turns.

At this point, the available power output was the same as for tetrode operation (20W RMS) but the effective anode resistance, referred to the 16 ohm secondary winding, had dropped from 145 ohms to less than 20 ohms. Low level distortion, even into a resistive load, had also fallen markedly.

It took a while for the message to get through, the more so because the authors' choice of the term "ultra linear" tended to suggest just another gimmick. In fact, the mode very effectively combined the sensitivity and efficiency of pentodes or tetrodes with a vitally important low output resistance, not too far removed from that of a triode.

It also took a while to verify optimum tapping points for other output valves, and for manufacturers to produce transformers with suitably interwound sections. This done, however, an ultra linear amplifier could be produced at virtually the same cost as its pentode/tetrode equivalent. It could use a similar order of feedback, but with the advantage that it would be operating around a much better basic amplifier — with a much better end result.

The mode really came into its own in the late '50s, with stereo demanding a new generation of compact, efficient, high performance, two-channel amplifiers. The first of this new breed was the Playmaster 10+10W stereo amplifier, described in the January 1959 issue (See Fig.7) using a specially designed kit of A&R transformers. It set the style for others which carried through to the end of the valve era, a few years later.

According to the accompanying article, written by the late John Moyle, the negative feedback was checked out up to 32dB but finally set at about 20-22dB — this around an already impressive basic amplifier. No figure is quoted for distortion, although this would inevitably have been very low compared with earlier tetrode/pentode designs using less feedback.

The response, however, is shown as dead flat from 10Hz to 100kHz, falling away above that in a relatively smooth, controlled fashion. Photographed off a CRO screen, the square wave response was totally free of overshoot or ripple.

Derivatives of this circuit, and of the larger version using EL34s did a good job in their day, driving the large and efficient Rola, Goodmans and Wharfedale loudspeakers. They ran into problems, however, when loudspeaker manufacturers found it necessary to trade off acoustic efficiency in an effort to produce smaller, wide-range systems.

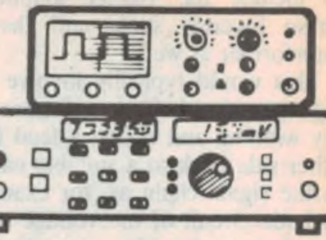
It became necessary to produce amplifiers capable of much higher power output and, in the ultimate, transistors offered the most practical means to meet that requirement.

There are still those who credit valves with the ability to produce a more "musical" sound than transistors but, having in mind the limited sensitivity of modern loudspeakers and the extended dynamic range of compact discs, something much more pretentious is necessary than even the best ultra linear designs of the '60s.

Currently, more pretentious designs certainly are available at the top end of the marketplace — similar basic thinking but scaled up in size, weight, complexity and specifications, with cost almost an afterthought. Whether the end result is better than, equal to, or even as good as the best solid-state equivalent is something that hifi enthusiasts argue about with considerable spirit.

(To be continued)

Know your Test Instruments



BASIC PRINCIPLES OF THEIR OPERATION AND USE

2. Ammeters, voltmeters, ohmmeters and multimeters

Testing and measurement of currents, voltages and resistances is a constant necessity in any electronics project. It is essential for anybody working in electronics to have a basic understanding of how testing and measuring instruments work and to know how to use them.

by PAUL GRAD

In any electronics project it is often necessary to test and measure electrical quantities — most commonly currents, voltages and resistances. This is done with instruments called meters, which are independent of the circuits from which the measurements are to be taken. Ideally the meters should not themselves affect the quantities to be measured.

There are instruments to measure only one quantity such as current — usually called ammeters; voltage — voltmeters; and resistance — ohmmeters. There are also instruments called multimeters, with which several different quantities can be measured.

The instruments can be suitable for measuring either DC or AC quantities, or both.

There are meters designed for installation in an instrument panel, as for example in a powerstation control room. These usually measure only one quantity. For electronics work, portable meters are normally used.

Most of the meters commonly used contain moving parts set in motion by a current flowing through a coil in the meter. These are of two basic types, moving-coil and moving-iron meters.

The moving-coil meter has a coil of very fine wire wound on a light aluminium frame. The coil is surrounded by a permanent magnet. The frame is mounted on pivots to allow it and the coil to rotate freely between the poles of the magnet. When a current flows through the coil it produces a magnetic field causing the coil to be repelled by the permanent magnet. The coil's polarity is deliberately made to repel, rather than attract, the permanent magnet.

The current thus causes the coil frame to rotate on its pivots. An indicator needle or pointer attached to the coil moves along a scale calibrated for the quantity to be measured, from which the quantity's value is read directly. This mechanism is similar to that of an electric (DC) motor, except that in the meter the deflection produced by the current is in one direction only and stops, after a short while, due to the effect of two delicate spiral springs, each attached to one of the pivots. The springs counter the needle's movement, supplying a restoring torque to the coil's rotation. The springs are a crucial part of the moving-coil/needle assembly, because they ensure the assembly's deflection is proportional to the current flowing through the coil.

In moving-iron meters the coil is fixed. The magnetic field created by a current in the coil induces a magnetic field of the same polarity in two soft iron blades or vanes, causing them to repel each other. One of the vanes is fixed and the other can rotate by an angle proportional to the current flowing through the coil. A meter pointer attached to the rotating vane moves across a scale.

This may all sound quite simple. However, supplying a versatile, accurate and low-cost meter, which must also withstand extensive use and abuse, may pose daunting technical and manufacturing problems.

When manufacturing a meter it is necessary to decide what sensitivity (the maximum current a meter can measure, or the amount of current necessary to cause the meter pointer to deflect full scale) the meter's moving parts should have. It is also necessary to know the magnitude of the current that the moving parts can withstand without deformation due to heating or worse.

The sensitivity of the meter is important, not only for accuracy of measurement, but because the meter should draw as low a current as possible from

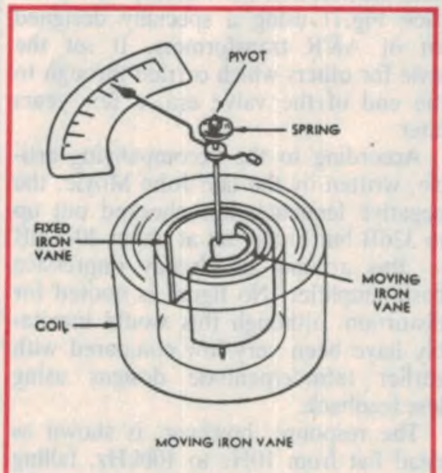


Fig.1: Basic construction of a moving iron meter movement. Coil current causes the fixed and moving vanes to repel each other.

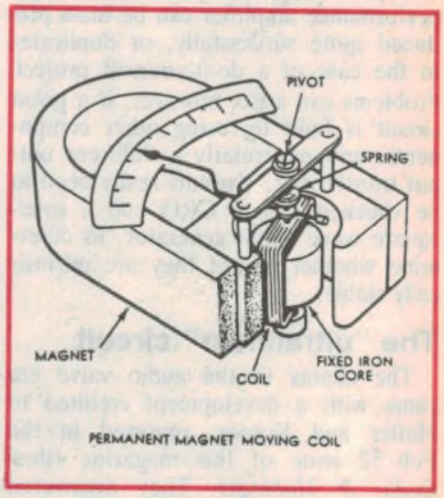
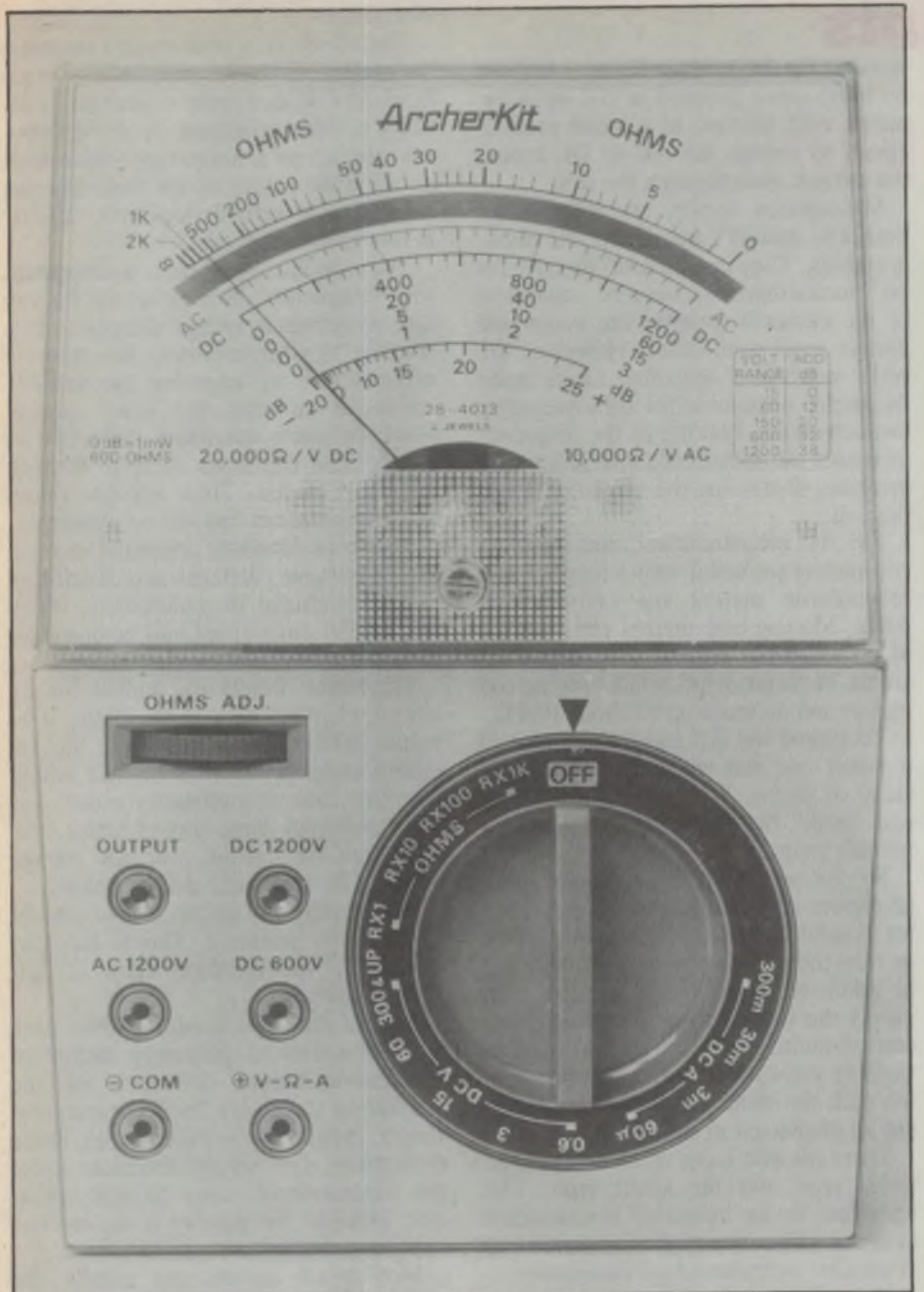


Fig.2: A basic moving coil meter. Current in the coil causes it to rotate, against the torque of the spiral spring.



Not the very latest model, perhaps, but a typical analog multimeter with voltage, current and resistance ranges. (Courtesy Intertan Electronics)

the circuit from which measurements are being taken. The larger the current drawn by the meter, the more the meter will "load" the circuit and affect — even "falsify" the quantities measured. This can be a critical factor in many measurements and it is often necessary to make a fair guess of the magnitudes of the quantities to be measured, before connecting a meter to the circuit. By knowing the internal resistance of the meter it is then possible to judge whether it can be safely connected and to what extent its connection will affect the measured values.

In the meters available, currents of at the most 10mA are drawn by the coil, and modern sensitive meters draw only 10uA or 20uA.

An ammeter, which measures current directly, usually contains one or more internal resistances, called shunts, connected in *parallel* with the coil. The current is thus divided between the shunt and the coil, reducing the current through the coil itself. A switch on the meter allows including one or more shunts into the path of the current, changing the range of current values that can be measured with the meter.

A meter movement giving full-scale deflection of the pointer with only 1mA through its coil can be made to give full deflection with 1A flowing in a circuit, for example, by wiring the coil in parallel with a shunt which takes 999/1000ths of the total current. (To do this, it would need to have a resistance 1/999th that of the meter's coil.)

It is also possible to connect suitable shunts externally to an ammeter, to extend its measurement range in the same way.

In a voltmeter it is again a current flowing through its coil that causes the needle to move, but instead of measuring current the meter measures current x resistance, or the voltage drop across its internal resistance. Again, the meter's coil can take only a small current, and therefore only a small voltage.

However, ammeters and voltmeters have to be connected into a circuit in different ways, and this has to be taken into account when we want to extend their range. An ammeter has to be connected always in series with a circuit component, because it is designed to measure the current flowing through it.

Voltmeters, on the other hand, must be connected in parallel with the circuit component being measured, since with them you want to measure the voltage difference between two points. Therefore they must have a higher internal resistance than an ammeter. To increase their internal resistance and to extend their range, resistances, also called multiplier resistances, are connected in *series* with the coil.

An important characteristic of a voltmeter is its impedance, or ohms/volt rating. For example, a meter with a 1000 ohm internal resistance with a full-scale deflection at 1V has a 1000 ohms/-volt rating.

The ohms/volt rating is an inherent characteristic of the meter movement and remains the same for all ranges of a multirange voltmeter. This is because the current required for full-scale deflection is the same for any measurement range and the resistance/voltage ratio for full-scale deflection is constant because it obeys Ohm's law.

The total resistance of a voltmeter is the ohm/volt rating multiplied by the voltage value corresponding to full-scale deflection. Although the ohm/volt rating is the same for a given voltmeter, its total internal resistance increases or decreases as the range increases or decreases. Also, for different voltmeters, the lower their ohm/volt rating, the lower their total internal resistance must be to measure a given voltage.

Needless to say, the lower the meter's

internal resistance, the more current it will draw from the circuit to which it is connected. As a result it will load the circuit and "falsify" the measurements more, leading to a larger measurement error. With a modern voltmeter based on say a 50uA meter movement, the resulting impedance ratio of 20,000 ohms/-volt generally gives accurate measurements in most circuits.

The moving-coil meter is basically suitable for DC measurements, but can be fairly easily adapted to AC measurements with the aid of a small rectifier circuit to change the AC to DC before the current goes through the coil.

Moving-iron meters are suitable for both DC and low-frequency AC measurements. They can be used directly for AC measurements, because regardless of the current's polarity the vanes will always repel each other. However, the coil's inductance and other losses make the meter unsuitable for high-frequency measurements, because as the frequency increases the inductance and losses also increase, decreasing the current through the coil.

For AC measurements, both moving-coil meters provided with a rectifier and moving-iron meters are calibrated at 60Hz. Moving-iron meters can be used at up to 100Hz without a significant increase in meter error, while moving-coil meters can measure up to about 10kHz.

To extend the AC measuring range of a meter one can use a transformer instead of shunts. With a transformer one can both increase and decrease a meter's range.

So far we have talked only about ammeters and voltmeters. Meters used for resistance measurements are similar in that they contain a moving coil, but in addition they contain a battery to supply the current to move the coil, and current-limiting resistances including a variable resistance. In the simplest case the coil, the battery and the resistances are all connected in series.

There are two types of ohmmeter, the series type and the shunt type. The resistance to be measured is connected in series with series-type ohmmeters and in parallel with shunt-type ohmmeters.

In a series-type ohmmeter the test leads are between the battery and the variable resistance. When the test leads are shorted together, a current flows through the coil and, by adjusting the variable resistance, the pointer is set for maximum deflection on the scale, corresponding to zero test resistance.

In a shunt-type ohmmeter the test leads are connected directly across the meter coil. The current supplied by the battery flows through the coil when the test leads are open, and when no test resistance is connected across the leads there will be full-scale deflection of the pointer on the scale. When the test leads are shorted all current bypasses the coil and the pointer is at zero deflection on the scale, which is the opposite of what happens with series-type ohmmeters.

Therefore, in a series-type ohmmeter the values shown on the scale increase from zero at maximum deflection to infinity at zero deflection. And the opposite applies to a shunt-type ohmmeter, in which the values on the scale increase from zero at zero deflection to infinity at maximum deflection.

The variable resistance is important with ohmmeters, because as the battery ages its terminal voltage decreases. It is possible to continue using the meter a while longer by adjusting the variable resistance so that the same current which produces maximum deflection of the pointer continues to flow through the meter circuit. Thus accurate values of test resistances can still be obtained.

The three functions described — measuring currents, voltages and resistances — are combined in multimeters, which are usually quite small and compact for easy and convenient transportation.

The meter circuits in a multimeter are almost identical with those of the individual meters described, with the required components all contained within the same case. A multimeter usually has three scales or three sets of scales, one calibrated for current, one for voltage and one for resistance measurements.

When using any meter, it is important to know its accuracy. This is the percentage of measurement error at full-scale deflection.

Meters are most accurate when used for measurements producing maximum or near-maximum deflection of the pointer on the scale. Their accuracy becomes progressively poorer with lower deflections. One should therefore select the measurement range so that whenever possible the pointer is at, or near maximum deflection.

Moving-coil meters are usually the most accurate meters with moving parts. Those designed for general use have an accuracy of + or — 2% (maximum error of 2% of the value measured at maximum deflection). Those designed for laboratory use have a greater accuracy, of at least + or — 0.5%.

Meters of + or — 0.2% or + or — 0.1% are much more expensive than those of + or — 0.5% accuracy, because extremely delicate balancing and calibrating work has to be done during their manufacture. It is also important to take great care with these high-accuracy instruments during packaging and transportation. If carelessly packaged and knocked about during transportation, they will probably no longer have their high accuracy when arriving at their destination.

Rod Irving TOP 40 Kits

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The best thing about stereo is that it sounds good! The greatest stereo hi-fi system loses its magnificence if the effect is so narrow you can't hear it. This project lets you cheat on being cheated and creates an 'enhanced stereo effect' with a small unit which attaches to your amp.
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Most microcomputers worth owning have an 'RS232' connector, or port, through which serial communications (input/output) is conducted. It is a convention that for listing on a printer, the BASIC LLIST or LPRINT command assumes a printer is connected to the RS232 port. Problem is: serial interface printers are more expensive than parallel 'Centronics' interface printers. Save money by building this interface. (ETI Jan. 84) ETI 675
Cat K46750 Normally $49.50
SPECIAL, $29.50

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The Microbee, among other home computers, has a 'sort of' RS232 port in that it doesn't implement negative-going portion of its ouput signal (TxD). Most peripherals with an RS232 input can cope with that but inevitably, there are those that can't. This project fixes that!
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This project was developed to take some guess work out of testing or checking an electric fence. Many factors can influence the operation of an electric fence energiser and fence, reducing its effectiveness. This tester indicates the presence of each pulse from the energiser and shows when the pulse voltage exceeds an amplitude of 2kV, 3kV and 5kV, once calibrated. If used in an uncalibrated mode, the unit will indicate pulse amplitudes on the fence of 40%, 60% and 100% of energiser output.
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How many times have you cursed your Multimeter when you had to measure a low-value resistance? Well with the "Low Ohms Meter" you can solve those old problems and in fact measure resistance from 100 Ohms down to 0.005 Ohms.
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(ETI455.)
Cat. K44550 **$44.95**

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This project is specifically designed for modellers and photographers who make heavy demands on Nicad batteries quite routinely. Theres nothing more frustrating than having your remote control model run out of juice as it runs/flies out of sight, or your flash run out of flash at an inappropriate moment. If you use Nicads and need a quick charge then this project is a must for you.
(ETI 274, July 80)
Cat. K45630 **$79.95**

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The ultimate kit modem featuring 1200/300 baud, case and prepunched front panel.
Exceptional value for money!
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Normally $169
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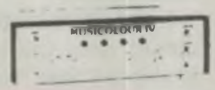

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Bothered by smeary colours, signal beats and RF interference on your computer display? Throw away that cheap and nasty RF modulator and use a direct video connection instead, it's much better! The Video Amplifier features adjustable gain and provides both normal and inverted outputs. Power is derived from a 12V DC plugback supply.
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Want to put on really professional slide show? This slide cross-fader can provide smooth dissolves from one projector to another, initiate slide changing automatically from an in-built variable timer, and synchronise slide changes to pre-recorded commentary or music on a tape recorder. All this at a cost far less than comparable commercial units. (EA Nov. 81) 81SS11
Cat. K81110 Normally $99.00
SPECIAL, $89.00

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Protect your home and possessions from burglars with this up to the minute burglar alarm system. It's easy to build, costs less than equivalent commercial units, and features eight seperate inputs, individual sector control, battery back up and self-test facility.

Specifications:

- Eight sectors with LED status indication
- Two delayed entry sectors
- Variable exit, entry and alarm time settings: entry delay variable between 10 and 75 seconds; exit delay variable between 5 and 45 seconds; alarm time variable between 1 and 15 minutes
- Resistive loop sensing: suits both normally open and normally closed alarm sensors
- Battery back-up with in-built charger circuit
- Built-in siren driver

The RIE kit includes a superb printed and prepunched metal case and inside metal work, plus a gell battery! Unbeatable VALUE!
K85901 without battery backup **$134**
SPECIAL, $115
K85900 complete kit **only $159**
SPECIAL, $129

AUDIO TEST UNIT

Just about everyone these days who has a stereo system also has a good cassette deck, but not many people are able to get the best performance from it. Our Audio Test Unit allows you to set your cassette recorder's bias for optimum frequency response for a given tape or alternatively, it allows you to find out which tape is best for your recorder.
(81AO10) (EA Oct. 81)
Cat. K81101 **$59.50**

FUNCTION GENERATOR

This Function Generator with digital readout produces Sine, Triangle and Square waves over a frequency range from below 20Hz to above 160Hz with low distortion and good envelope stability. It has an inbuilt four-digit frequency counter for ease and accuracy of frequency setting.
(EA April. 82 82AO3A/B)
Note: The RIE Function Generator has a high quality screen printed and prepunched front panel!
Cat. K82040 **$109**

PARABOLIC MICROPHONE

Build a low cost parabola, along with a high gain headphone amplifier to help when listening to those natural activities such as babbling brooks, singing birds or perhaps even more sinister noises. The current cost of componenets for this project is around $15 including sales tax, but not the cost of batteries or headphones. (EA Nov. 83) 83MA11
Cat. K83110 **$14.95**

50/500MHz 7 DIGIT FREQUENCY METER

Want a high performance digital frequency meter that's easy to to build? This unit uses just five IC's, measures period and frequencies up to 500MHz, and features a bright seven digit display. Save a small fortune over comparable commercail units.
Note: The RIE Frequency Meter Kit includes high quality prepunched and silk screened front panel!
(EA December 81)
(50MHz 81fm10a, 500MHz 81fm10b)
50MHz Cat. K81120 **$149**
500MHz option Cat. K81121
add $29.95

ELECTRIC FENCE CONTROLLER

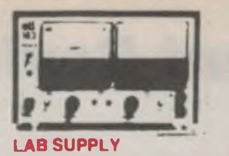
Restore discipline to the farm or allotment with this new electric fence controller. It features higher output power and lower current drain than the previous design for use in rural areas.
(EA Dec. 85, 85el11)
Cat.K85110 Normally $49.95
SPECIAL, $45.95

TRANSISTOR TESTER

Have you ever desoldered a suspect transistor, only to find that it checks OK? Trouble-shooting exercises are often hindered by this type of false alarm, but many of them could be avoided with an "in-circuit" component tester, such as the EA Handy Tester. (EA Sept. 83) 83TT8
Cat. K83080 Normally $18.95
SPECIAL, $15.95

VIDEO FADER CIRCUIT

Add a touch of professionalism to your video movies with this simple Video Fader Circuit. It enables you to fade a scene to black (and back again) without loss of picture lock (sync) or colour.
(EA Jan. 86, 85ff10)
Cat.K86010 Normally $24.95
Special, only $19.95



LAB SUPPLY

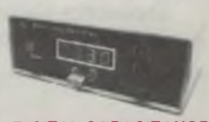
Fully variable 0-40V current limited 0-5A supply with both voltage and current metering (two ranges: 0-0.5A/0-5A). This employs a conventional series-pass regulator, not a switchmode type with its attendant problems, but dissipation is reduced by unique relay switching system switching between taps on the transformer secondary.
(ETI May 83) ETI 163
Cat. K41630 **$249**

1W AUDIO AMPLIFIER

A low-cost general-purpose, 1 watt audio amplifier, suitable for increasing your computers audio level, etc. (EA Nov '84)
Cat. **$9.95**

HEADPHONE AMPLIFIER

PRACTICE WITHOUT ANNOYING THE FAMILY!
If you play any type of electronic instrument,this headphone amplifier will surely interest you. It will let you practice for hours without upsetting the household,or you can use it to monitor your own instrument in the midst of a rowdy jam session. (EA Feb. 84) 83MA11
Cat. K84111 **$39.95**



DIGITAL CAPACITANCE METER Mk.2

Updated from the EA March '80 issue, this Digital Capacitance Meter checks capacitor values from 1pF to 99.99uF over three ranges. Its main features include a nulling circuit and a bright 4 digit LED display.
***Note:** The RIE kit contains quality silk screen printed and prepunched front panel AND an exclusive High Intensity Display!
(85cm9a, EA August '85)
Cat. K85090 **$99.95**

THE SCREECHER CAR BUGLAR ALARM

Here is a low cost car alarm designed with a new deterrent strategy. Instead of using the alarm to try to draw the attention of passers-by to the felony in progress, this alarm sounds inside the car, to deafen the thief and make it too uncomfortable to proceed with pinching the vechile!
(86a19, EA August '86)
Cat. K86081 **$29.95**

CAR IGNITION KILLER

Most car burgular alarms are easily circumvented, but not this cunning "Ignition Killer". This sneaky antitheft device uses a 555 timer to place an intermittent short circuit across the points. Until disabled by its hidden switch the circuit effectively makes the car undriveable - a sure deterent to thieves! (EA Feb. 84) 84AU1
Cat. K84010 **$24.95**
(Our kit includes the box!)

30 V/1 A FULLY PROTECTED POWER SUPPLY

The last power supply we did was the phenomenally popular ETI-131. This low cost supply features full protection, output variation from 0V to 30V and selectable current limit. Both volatage and current metering is provided. (ETI Dec. 83) ETI 162
Cat. K41620 Normally $73.50
SPECIAL, $63.50

VIDEO ENHANCER

100's SOLD
Like tone controls in a hi-fi amplifier, touch up the signal with this Video Enhancer. (EA Oct. '83) 83VE10
Cat. K83100 **$39.50**

ZENER TESTER

A simple low cost add-on for your multimeter. This checks zeners and reads out the zener voltage directly on your multimeter. It can also check LEDs and ordinary diodes.
(ETI May 83) ETI 164
Cat. K41640 **$11.95**

50 W AMPLIFIER MODULE (ETI 480)

Cat. K44880 Normally $31.80
SPECIAL, $21.95
(Heatsink optional extra)

100 W AMPLIFIER MODULE (ETI 480)

Cat. K44801 Normally $34.80
SPECIAL, $28.95
(Heatsink optional extra)

POWER SUPPLY TO SUIT
Without transformer **$22.95**

CRYSTAL MARKER GENERATOR FOR RECIEVER AND CRO CALIBRATION

A simple but very useful piece of test equipment for calibrating and aligning recievers, transceivers and oscilloscopes. It is portable, battery operated and inexpensive to build.
(ETI 157, October 81)
Cat. K41570 **$37.50**

FREQUENCY STANDARD

Get the equivalent of a rubidium frequency standard by draping a piece of wire over the back of your TV set!! Believe it or not your humble television can provide an extremely stable and accurate reference frequency. The wire acts as a transducer to pick up electromagnetic radiaton from the back of the set. Normally you would need to spend thousands of dollars to achieve accuracy beyond the "parts per thousand" you expect from ordinary meters. With this simple project, an extremely accurate 1MHz signal can be derived for very little outlay.
(ETI 174, July 86)
Cat. K41740 **$24.95**

SUPERB VIFA/EA 60 + 60 SPEAKER KIT!

The Vifa/EA 60 + 60 loudspeaker kit has been designed to completely out perform any similarly priced speakers. This is a 2-way design incorporating drivers which give a deeper, more natural bass response and 19mm soft-dome ferro fluid cooled tweeters which provide clear, uncoloured sound reproduction.

These Vifa drivers are identical to the ones used in such fine speakers as Mission, Rogers, Bang & Olufsen, Monitor Audio and Haybrook just to name a few. Some of which cost well over $1,000 a pair!

The dividing network is of the highest quality and produce no inherent sound characteristics of their own, they simply act as passive devices which accurately distribute the frequency range between both drivers in each speaker.

The fully enclosed acoustic suspension cabinets are easily assembled. All you need are normal household tools and a couple of hours and you've built yourself the finest pair of speakers in their class!

D19 TWEETER SPECIFICATIONS:
Nominal Impedance: 8 ohms
Frequency Range: 2.5 - 20KHz
Free Air Resonance: 1,700Hz
Sensitivity 1W at 1m: 89dB
Nominal Power: 80 Watts (fo: 5,000Hz, 12dB/oct)
Voice Coil Diameter: 19mm
Voice Coil Resistance: 6.2 ohms
Moving Mass: 0.2 grams
Weight: 0.28kg
Cat. C10301 **$38**

C20 WOOFER SPECIFICATIONS:
Nominal Impedance: 8 ohms
Frequency Range: 35 - 6,000Hz
Resonance Frequency: 39Hz
Sensitivity 1W at 1m: 90dB
Nominal Power: 50 Watts (12dB/oct)
Voice Coil Diameter: 25mm
Voice Coil Resistance: 5.5 ohms
Moving Mass: 15 grams
Cat. C10322 **$89**

Cat. K86092 (speakers only) **$379**
Cat. K86091 (complete kit) **$449**

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Test Instrument Review:

Goodwill's new 13MHz function generator

Function generators are very handy instruments, offering a variety of test signal waveforms and operating modes. The new Goodwill model GFG-813 offers operation up to 13MHz, together with considerable flexibility. Here's a rundown on its capabilities:

Test instruments made by the Taiwan company Goodwill Instruments (or GW Instruments, as it now seems to prefer being called) have been popular for quite a few years now, ever since they became available here in the late 1970s. No doubt this is because they offer good value for money, combining a high level of performance and features with a generally very reasonable price tag. The company's small single-beam CRO has become almost the unchallenged market leader for home and schools use, for example, either in its original form or in its various alternative disguises.

One of the very latest additions to the GW range is the new GFG-813 Function Generator, a wide range and very versatile unit which features both a main generator and a second generator, used for modulation or sweeping.

The main generator has a very wide frequency range, spanning from 0.1Hz to 13MHz in eight ranges. There's also the ability to produce single shots and bursts, either internally or externally gated.

It provides a choice of sine, square or triangular output waveforms, with symmetry adjustable over a range between 80:20 to 20:80. The output can also be adjusted for DC offset, over a range from –10V to +10V with no loading or –5V to +5V with a 50 ohm load. This allows the generator to effectively produce sawtooth waveforms and either a positive or negative ramp.

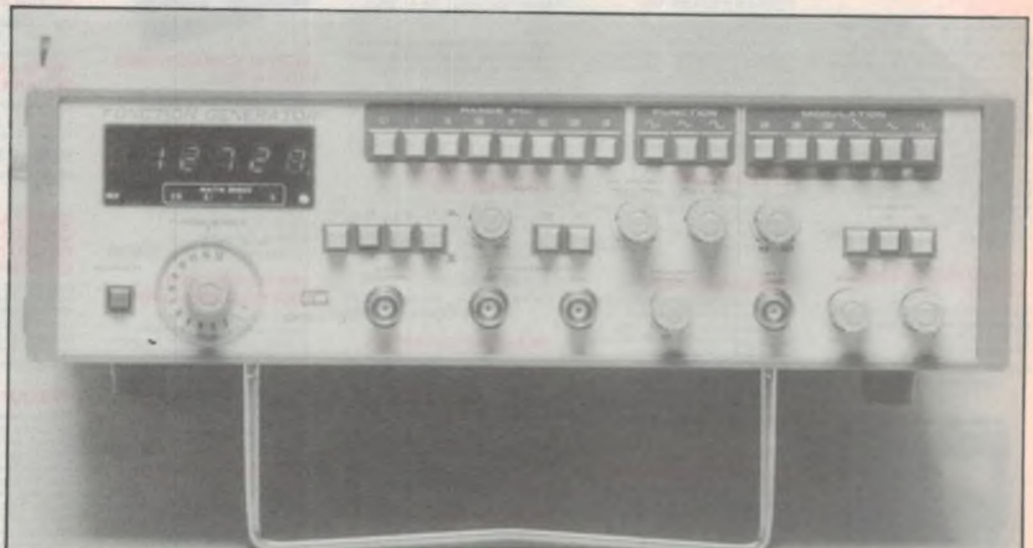
The nominal maximum output amplitude is 20V peak to peak with no loading, or 10V p-p into a rated load of 50 ohms. Hence the output impedance is 50 ohms. A combination of fixed and variable output attenuators allows the output level to be reduced by up to 80dB — i.e., down to a level of 1mV p-p.

Frequency adjustment is also via a combination of switched ranges and a continuously variable control. To allow accurate frequency setting, the GFG-813 features a built-in six digit frequency counter. This has two basic ranges (10MHz and 30MHz) combined with a choice of four gating times (10s, 1s, 0.1s and 10ms), to give resolutions ranging from 0.1Hz to 1kHz. The counter may also be used to measure external signals, a handy feature. It has an input sensitivity of less than 20mV RMS.

For sinewave output, the main generator has a rated total harmonic distortion (THD) of less than 0.5% (-46dB) from 10Hz to 50kHz, and less than 3% (-30dB) from 50kHz to 13MHz. Output amplitude is flat within 3% from 10Hz to 100kHz, and within 10% from 100kHz to 10MHz.

Triangle wave linearity is rated at within 1% at 100Hz, while square wave symmetry with the control in the "Cal" position is rated at within 2% from 0.1Hz to 100kHz. Rise and fall times for square wave output are less than 18 nanoseconds.

In addition to the primary adjustable output from the main generator, there is also a "Sync" output for triggering a CRO or driving external counters. This



The new GFG-813 function generator from GW Instruments offers operation to 13MHz, an inbuilt digital frequency counter and many operating modes.

provides a fixed amplitude square wave output 180° out of phase with the main output. The sync output signal is rated at better than 1V p-p into no load, with an output impedance of 50 ohms.

Like the main generator, the second generator inside the GFG-813 produces sine, square and triangular waves — but over a smaller frequency range: from .01Hz to 10kHz. As before the symmetry can be adjusted, but again over a smaller range (and only in one direction, from 1:1 to 9:1).

The main use for the second generator is to modulate the main generator, of course, although its output is also available for external use. For this purpose it has an output level of greater than 1V p-p into 10k. The sinewave output has less than 2% THD between 10Hz and 10kHz.

When used to modulate the main generator, it can be used to produce AM, FM, gating/bursts and sweeping. For AM, the modulation depth is fully adjustable between 0 and 100%. For FM, the deviation can be adjusted between 0 and 5%.

For gating, the start/stop phase range is from +90° to –80°, with a useful range to 1MHz. With gating set for single pulse and the main generator set for square wave output and a suitable symmetry, the GFG-813 becomes quite a useful pulse generator.

Sweeping is adjustable from zero to a maximum/minimum frequency ratio of over 100:1. As with the other types of modulation, the second generator's symmetry control may be used to adjust the sweeping envelope, while the sweeping rate is adjustable over the range .01Hz — 10kHz.

As an alternative to using the inbuilt second generator for modulation or sweeping, the GFG-813 also has provision for external modulation and frequency control. The external modulation bandwidth for AM is DC — 1MHz, while that for FM is DC — 50kHz. An external DC signal varying between 0 and –2V may be used to vary the main generator output frequency over a 1000:1 range, with a linearity of better than 0.5% to 1MHz and 5% to 10MHz.

All inputs and outputs on the GFG-813 are via BNC connectors, and the instrument comes complete with three cables having a BNC plug at one end, and crocodile clips at the other. It also comes with an instruction manual, an IEC type power cable and some spare mains fuses.

Thanks to Emona Instruments, the Australian distributors for GW, we had the opportunity to try out a sample GFG-813 and put it through its paces. We found it very nicely made, and its performance met or exceeded the specs in virtually every respect.

In fact we could only find a couple of fairly minor things about it to criticise. One is that the frequency counter doesn't have period or inverse frequency measurement, which would make it somewhat easier to measure the generator's exact output frequency on the very lowest ranges. The other is that the symmetry control on the secondary/modulation generator also changes the frequency. When combined with the fact that the symmetry is only adjustable one way from the 1:1 position, this limits flexibility a bit.

All in all, though, the GFG-813 seems to offer a great deal in terms of both performance and features, and as a result we believe it offers excellent value for money at the quoted price of $1615 plus tax if applicable.

For further information on this and other instruments in the GW Instruments range, contact Emona Instruments at 86 Parramatta Road, Camperdown 2050, or their dealers in each state.(J.R.)

Books & Literature

Switching technology

HIGH POWER SWITCHING, by Ihor M. Vitkovitsky. Published by Van Nostrand Reinhold, 1987. Hard covers, 235 x 158mm, 304 pages. ISBN 0 442 29067 5. Recommended retail price $110.

This is not just a book on switching circuits to cope with a few tens or hundreds of volts and amps. When author Vitkovitsky talks about high power, he means *high power* — like a *terawatts* of pulsed power. That's right, power levels of a million megawatts or more. The kinds of power levels that need to be switched for things like thermonuclear power generation and Mr Reagan's famous SDI pulse weapons. Anything that uses extremely brief but very high energy pulses.

The author is a researcher in this area, currently assistant superintendent of the Plasma Physics division of the US Naval Research Laboratory in Washington. In this book he has produced what is claimed in the sleeve notes to be the most up-to-date work available on this esoteric subject, and I can quite believe it.

It covers switches for both opening and closing circuits. Two introductory chapters lead things off, and discuss basic concepts of switching at high power levels. Then the following chapters discuss in detail the various switching technologies available: gas spark gaps, vacuum and low pressure discharges, solid dielectric breakdown, liquid dielectrics, arcs for opening circuits, fuses, opening plasma switches and solid state opening switches. Finally an appendix deals with shielding and safety procedures.

Overall it's pretty deep stuff, as well as being quite specialised. There's quite a deal of maths, although nothing that the average engineering undergraduate couldn't wade through.

I can't see it becoming a best seller, particularly at the price. But if you're into high-powered pulse technology, I'm sure it would make a valuable reference.

The review copy came from distributors Nelson Wadsworth, of 480 La Trobe Street, Melbourne. (J.R.)

Radar update

MODERN RADAR TECHNIQUES, edited by M.J.B. Scanlan. Published by Collins, 1987. Hard covers, 240 x 160mm, 291 pages. ISBN 0 003 83190 6. Recommended retail price $115.00.

Not an introductory text on radar — more of an update, to help those with a good basic understanding of the principles bring their knowledge reasonably up to date. It seems to be intended primarily for engineers and technicians working in the field, but my impressions is that it would also be of interest to the general reader — providing they're not fazed by a bit of reasonably high-powered maths here and there.

The book is actually a collection of six papers by acknowledged experts in the field, from both the USA and the UK. In turn the papers cover the subjects of:

- Computers and Data Processing in Radar
- Phased Arrays
- Target Characteristics
- Radar ECM and ECCM
- Over-the-horizon Radar
- Secondary Surveillance Radar Techniques

By the way, "ECM" means electronic countermeasures (i.e., jamming), and "ECCM" means electronic counter-countermeasures. I didn't know these either, but the editor of the book has thoughtfully provided a glossary at the back explaining the various acronyms . . .

Overall the papers seem well written, and should be found quite readable and worthwhile by those for whom they're intended. But this won't be a very broad group, because of both the technical level and the not-insignificant price.

The review copy came from Blackwell Scientific Publications, of 107 Barry Street, Carlton 3052. (J.R.)

Text on EM waves

TRANSMISSION AND PROPAGATION OF ELECTROMAGNETIC WAVES, by K.F.Sander and G.A.L.Reed. Second edition, published by Cambridge University Press, 1986. Soft covers, 153 x 230mm, 458 pages. ISBN 0 521 31192 6. Recommended retail price $46.50.

The second edition of an established textbook on electromagnetic waves. Like the first edition, it is intended mainly for undergraduate students in electronics engineering and applied physics; quite a high level of maths is assumed.

For the second edition, the authors (both academics at Bristol University in the UK) have added a chapter on optical wave transmission, to bring it up to date. As with the rest of the book, this section deals with wave propagation and transmission, not with the details of applying the phenomena for communications.

There are now nine chapters in all, dealing in turn with Plane Electromagnetic Waves, Energy Flow in the Electromagnetic Field, Guided Waves, Radiation, Transmission Line Theory, Propagation in Line Systems, Waveguide Systems, Microwave Radio Systems and Optical Transmission. A set of mathematical appendices is provided at the rear.

My impression is that it's a comprehensive and thorough treatment of this very basic and important subject, and should be of great value for engineering and science students. But radio amateurs, enthusiasts and others looking for an understandable explanation of wave propagation will almost certainly find it too mathematical. Keep looking, folks . . .

The review copy came from the local office of Cambridge University Press, at 10 Stamford Road, Oakleigh 3166. (J.R.)

Special Publications from Electronics Australia

FUNDAMENTALS OF SOLID STATE. Now in its second reprinting — which shows how popular it has been! It provides a wealth of information on semiconductor theory and operation, delving much deeper than very elementary works but without the maths and abstract theory which make many of the more specialised texts heavy going. Starting with a background chapter on atomic theory, the book moves easily through discussions on crystals and conduction, diode types, unijunction, field effect and bipolar transistors, thyristor devices, device fabrication and microcircuits. A revised glossary of terms and index complete the book. *Fundamentals of Solid State* has also been widely adopted in colleges as recommended reading — but it's not just for the student. It's for anyone who wants to know just a bit more about the operation of semiconductor devices. **$4.50**

DIGITAL ELECTRONICS. Electronic equipment plays an important role in almost every field of human endeavour and every day, more and more electronic equipment is 'going digital'. Even professional engineers and technicians find it hard to keep pace. In order to understand new developments, you need a good grounding in basic digital concepts and *Introduction to Digital Electronics* can give you that grounding. Tens of thousands of engineers, technicians, students and hobbyists have used this book to find out what the digital revolution is all about. This new fourth edition has been updated and expanded to make it of even greater value. No previous knowledge of digital electronics is necessary — The book includes an excellent coverage of basic concepts. **$4.50**

BASIC ELECTRONICS. This popular text has now been re-issued. *Basic Electronics* is almost certainly the mosty widely used reference manual on electronics fundamentals in Australia. Written as a basic text for the electronics enthusiast, it is also being used by radio clubs, secondary schools and colleges, and WIA youth radio clubs. It begins with the electron, introduces and explains components and circuit concepts and progresses through radio, audio techniques, servicing instruments, television, etc. If you've always wanted to know more about electronics, but have been scared off by the mysteries involved, let *Basic Electronics* explain them to you. Easily understood diagrams and text make this the perfect introduction to the growing and exciting world of electronics. We've even included five electronic projects for the beginner. **$4.50**

SOLD OUT

PROJECTS & CIRCUITS. If you like building electronic projects in your spare time, you can't afford to miss out on this exciting book of popular projects from *Electronics Australia*. Just look what's inside! **Audio and Video Projects:** Video Amplifier for Computers and VCRs, Video Enhancer, Vocal Canceller, Stereo Simulator for Tuners and VCRs, Guitar Booster for Stereo Amplifiers. **Automotive Projects:** Transistor-assisted Ingition System, Breath Tester, Low Fuel Indicator, Speed Sentry, Audible Turn Indicator. **Mains Power Control Projects:** Musicolor, Photographic Timer, Driveway Sentry, Touch-lamp Dimmer. **Power Supplies and Test Equipment:** Battery Saver for Personal Portables, Dual Tracking ±22V Power Supply, 3 1/2-Digit LCD Capacitance Meter, In-Circuit Transistor Tester. **Plus EA's 10-year project index.** **$4.50**

WIRELESS WEEKLY. Our own time machine! It may look like a book, but don't let it's appearance fool you. There are no whirling dials and control levers; but once you open the cover, it'll take you on an incredible journey backwards in time. You'll find yourself back in the 1920's, when Australia's first few radio stations were just getting established and a typical radio set cost ten weeks' wages. We've chosen a collection of highlights from the 1927 issues of 'Wireless Weekly': You'll find some front covers, a few editorials, the best new items, a collection of typical do-it-yourself radio set designs, and some selected pages from the programme listing. Plus a sprinkling of the original advertisements, of course. These are particularly fascinating because they show prices and put everything into proper context. Send today for ***The Best of Australia's Wireless Weekly in 1927*** . . . A fascinating and nostalgic trip into our radio past. **$3.95**

ELECTRONIC PROJECTS FOR YOUR CAR. How can you extend the performance of your car without it costing an arm and a leg? With these selected projects from *Electronics Australia* you can add all of the gadgets you've dreamed of: Cruise Control, Courtesy Light Delay, Deluxe Burglar Alarm, Headlight Reminder, Audible Reversing Alarm, Transistor-assisted Ignition with Optoelectronic Trigger, Driveway Sentry, Speed Sentry, Tacho/Dwell Meter, Breakerless Ignition, Audible Turn Signal and more easy-to-build projects to add value, interest and safety to your pride and joy! PLUS Feedback from those who have built the projects themselves and Bright Ideas for you to develop yourself: Automatic Antennae Retraction, 6V Car Adaptor, Fuse-Failure Indicator and more . . . **$3.95**

ELECTRONIC TEST GEAR TO BUILD. Why buy it? These valuable projects from *Electronics Australia* will add a new dimension to your workshop! Detailed, step-by-step instructions guide you through the construction of the most useful of electronic workshop test gear: 500 MHz 7-digit Frequency meter, Wheatstone Bridge and Resistance Box, AC Millivoltmeter, DC Voltmeter, LCR Bridge, Modulated Signal Injector, Audio Prescaler. PLUS Feedback from those who have built the projects themselves and Bright Ideas for you to develop yourself: Linear Frequency Controller, Dummy Loads, General Purpose Counter Timer and more . . . **Never built a project before?** What better way to get started than by building the test instruments needed to begin a workshop? **Build it yourself to save and learn at the same time!** **$3.95**

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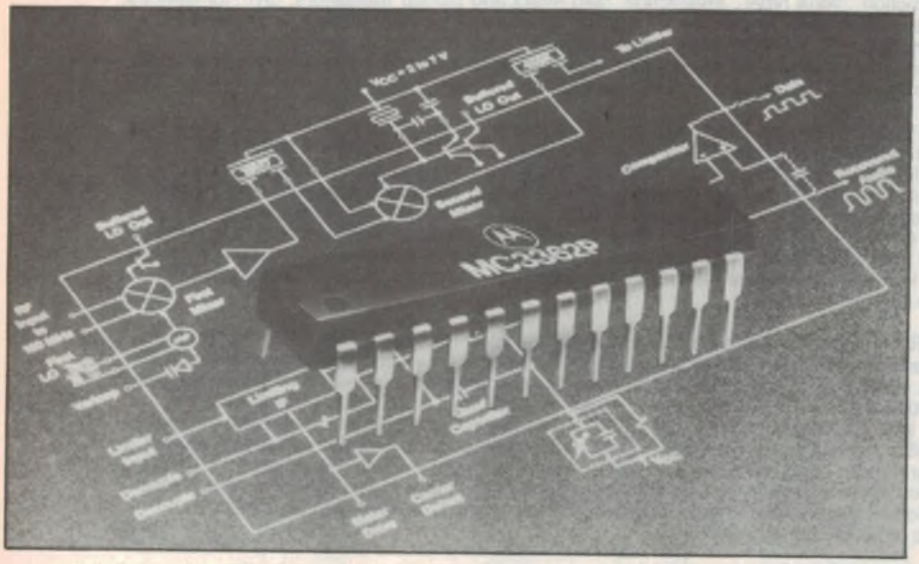
Solid State Update

KEEPING YOU INFORMED ON THE LATEST DEVELOPMENTS IN SEMICONDUCTOR TECHNOLOGY



Dual conversion FM receiver chip

A highly integrated low voltage (2V) dual-conversion FM, narrowband receiver IC has been introduced by Motorola. The MC3362 FM Narrowband Receiver can fill many applications as a complete VHF receiver, incorporating all essential functions from the antenna input to audio preamp output.

The MC3362 is very suitable for use as a utility receiver for voice and data communication including cordless phones, VHF two-way radios, remote control receivers, home security systems and unlicensed peripheral data links.

The device is manufactured by the patented MOSAIC process, resulting in excellent performance for RF inputs up to 180MHz. If the first LO signal is provided externally, the device can be used at over 400MHz. Design features include dual conversion circuitry for excellent image rejection; received signal strength indicator (RSSI) output; low power consumption (6-35mW); and data slicing comparator for FSK data recovery up to 30kbps (15kHz).

Package options include a 24-pin DIP or a 24-lead wide-body SOIC for surface mount applications.

16K CMOS static RAM

The IDT6116SA/LA is a 16,384-bit high-speed static RAM organised as 2K x 8. It is fabricated using IDT's high-performance, high-reliability technology, CEMOS. This combined with innovative circuit design techniques, provides a cost-effective alternative to bipolar and fast NMOS memories.

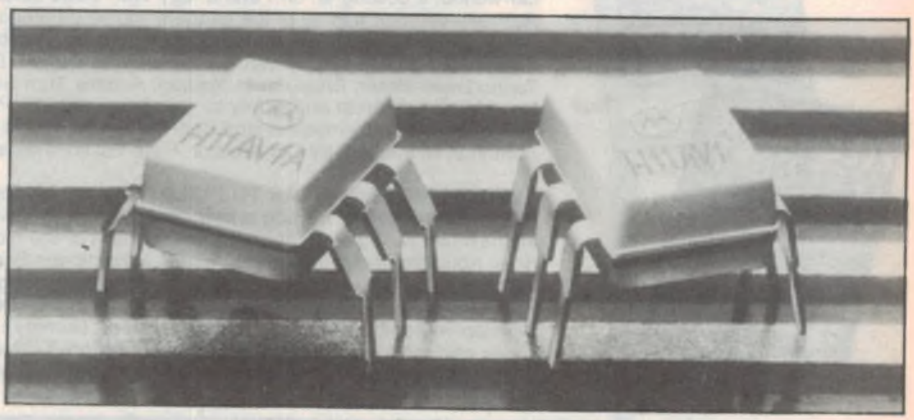
Access times as fast as 30ns are available with maximum power consumption of only 495mW. The circuit also offers a reduced power standby mode. When CS goes high, the circuit will automatically go to, and remain in a standby power mode as long as CS remains high. In the standby mode, the device consumes less than 20uW typically. This capability provides significant system level power and cooling savings. The low-power (L) version also offers a battery backup data retention capability where the circuit typically consumes only 1uW to 4uW operating from a 2V battery.

All inputs and outputs of the IDT6116SA/LA are TTL-compatible and operation is from a single 5V supply, simplifying system designs. Fully static asynchronous circuitry is used requiring no clocks or refreshing for operation, providing equal access and cycle time for ease of use.

For further information contact George Brown Group outlets or George Brown Group, Marketing Division, 456 Spencer Street, West Melbourne 3003.

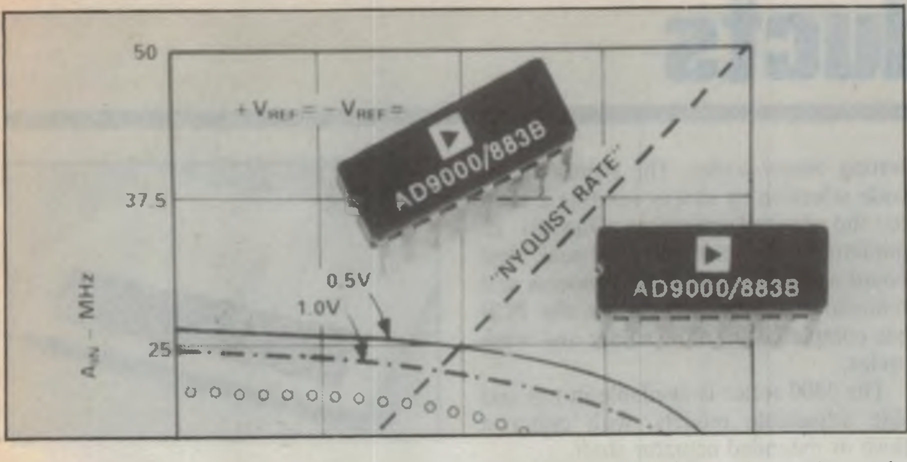
7500V opto isolators

Motorola now offers the H11AV1/A series of transistor output optoisolators for use in switchmode power supplies. Motorola's H11AV1/A optoisolators, an alternate source to General Electric, give customers the benefit of "dome" construction and the highest isolation voltage in the industry (V_{ISO} = 7500-VAC pk min).



The optoisolators are available in the 6-pin dual-in-line package which results in both UL recognition and VDE approval, required in many industrial applications.

The H11AVV1/A optoisolators have a transistor output with DC current transfer ratios ranging from 20% to 100%. Other features include extremely low coupling capacitance (0.2pF typ.) and a high efficiency, low degradation liquid-phase epitaxial grown emitter. The "A" suffix part numbers permit circuit board mounting on .400 inch centres, which satisfies VDE requirements for minimum creepage distance between input and output solder pads.



6-bit A/D converter works at 75Msps

Analog Devices AD9000 analog-to-digital "flash" converter is available processed to MIL-STD-883B Rev. C. The device guarantees a minimum 75Msps (million samples per second) encode rate with no missing codes. Applications for the converter include telecommunications, electronic warfare systems, and radar guidance.

Maximum DC specifications for the AD9000 are: ±1lsb differential nonlinearity, ±1lsb integral nonlinearity and ±1.5lsb initial offset error. Dynamic linearity — measured with a 15MHz input signal — is typically ±0.5lsb. Other dynamic specifications include: 44dB in-band harmonics, 42dB signal-to-noise ratio, 46dB two-tone intermodulation rejection, 2ns aperture delay and 25ps aperture uncertainty (jitter).

An overflow bit facilitates cascading converters to achieve higher resolution without reducing the sampling rate. The AD9000 accepts reference voltages up to ±2.048V and unipolar or bipolar input signals ranging from ±0.5V to ±2.0V. Typical power dissipation is 675mW.

Further information from Parameters, 25-27 Paul Street North, North Ryde 2113.

ISDN 2-wire interface

Siemens has supplemented its existing ISDN 4-wire (S-bus) IC PEB2080 with a 2-wire U-bus IC, PEB2095.

The device is a monolithic interface (CMOS, 2um) which handles Basic Rate ISDN flow (144kbit/s). It is claimed to introduce a further level of cost-effectiveness into the design of ISDN Basic Rate interfaces.

All ISDN-ICs from Siemens, including the PEB2095 U-bus device, have an "IOM" interface (ISDN Oriented Modular Architecture) enabling them to be freely used in subscriber terminals as well as in switching units such as the Siemens Hicom PABX.

For further information contact the Siemens Communications Products Department, 544 Church Street, Richmond 3121.

CMOS 8-bit A/D converter

Precision Monolithics has introduced the PM-7574, an 8-bit CMOS successive approximation analog-to-digital converter. The PM-7574 is a direct second-source to the industry standard AD7574.

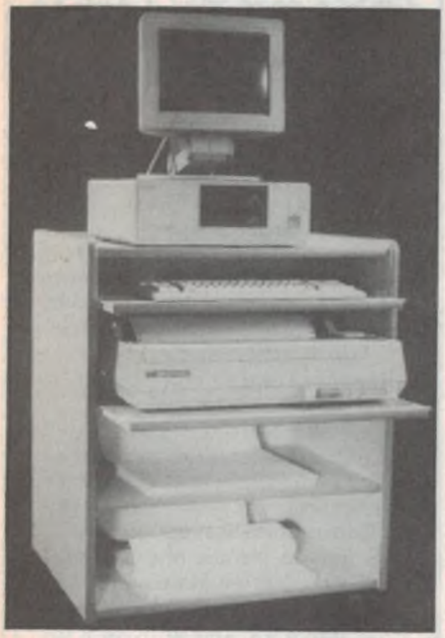
PMI's PM-7574 offers microprocessor compatibility and a 15us conversion time. Additionally, ESD protection circuitry has been incorporated into all digital inputs. This protective circuitry greatly increases the ruggedness of the device. Careful circuit design has resulted in reduced transition noise during conversion, ensuring greater conversion accuracy, especially as the limits of analog input bandwidth are approached.

The PM-7475 is easily interfaced to microprocessors and may be interfaced as a static RAM, using a WRITE command and start data conversion and a READ command to read the results. Alternatively, the PM-7574 can be interfaced as a ROM so that a new data conversion is automatically started at the conclusion of each data READ. The PM-7574's BUSY output may be used to generate microprocessor WAIT states in systems where software economy is essential.

Data conversion is performed using successive approximation. "No missing codes" is guaranteed over the full temperature range. The PM-7574 has an internal clock whose frequency is set with the addition of a resistor and a capacitor. When maximum speed is required, an external 550kHz clock may be used to obtain a 15us conversion time.

For further information contact VSI Electronics, 16 Dickson Avenue, Artarmon 2064.

New Products



PC workstation

The latest release from Omega Data Furniture is the Omega "PC Pal" designed to provide an economical and functional workstation which houses both the personal computer and the printer. This product is new to the Australian market and is targeted at the small PC user, home user and the space conscious corporate computer operator.

Space saving is achieved by the use of independent roll out shelves of the computer keyboard and the printer. Paper management shelves are built in beneath the printer shelf.

Overall measurements of the unit are width 665mm, depth 510mm and height 815mm. It sits on castors, providing full mobility. The construction material is double sided melamine in a stylish light grey colour (one colour only).

The "PC Pal" is shipped in a flat pack and its knock-down design allows for easy assembly with Allen key provided.

For further information contact Omega Data Furniture, 20 Peachtree Road, Penrith 2750.

Low profile DIP switch

Eeco's 3300 series sealed subminiature Micro-Dip Switch was designed to eliminate problems presently experienced with the use of DIL Switches in setting binary codes. The switch allows code selection by simply rotating a shaft to the desired position. Due to its miniature size and internal seal, less board space is required and process seal removal is not necessary once the PCB has completed the flow solder and wash cycles.

The 3300 series is available in top and side adjustable models, with either a flush or extended actuator shaft.

For further details contact Tecnico Electronics, 11 Waltham Street, Artarmon 2064.

New logic analyser family

Hewlett-Packard Australia has introduced a new family of logic analysers: the HP 1650A and HP 1651A logic analysers, and the modular HP 16500 logic analysis system.

The new logic analysers are targeted at the general-purpose, low-priced and high-performance markets, respectively. Each provides a range of features that benefit engineers involved with digital hardware design and debug, software development and systems integration.

The HP 1650A logic analyser provides 80 channels of 100MHz transitional timing and 25MHz state analysis.

The HP 1651A has all of the features of the HP 1650A, except it provides 32 channels of state/timing analysis.

The HP 16500A logic analysis system is a modular, user-configurable instrument that can provide from 80 to 400 channels of 100MHz transitional timing and 25MHz state analysis, a 1GHz timing analysis, 50Mbit/sec pattern generation, as well as a 100MHz digitising oscilloscope.

A major contribution to the cost-effectiveness of all three analysers is a logic-analyser-on-a-chip, developed with HP's NMOS III process. Each chip contains 140,000 discrete devices to make up a complete, 16-channel state-and-timing analyser and acquisition memory in a single package.

The HP 1651A uses two logic-analyser-on-a-chip ICs, the HP 1650A uses five, and the HP 16500A can use from five to 25.

Further information is available from Steve Hitchings, Hewlett-Packard Australia Limited, PO Box 221, Blackburn 3130.

Printer switch

The new Switchmate II permits the connection of a mix of up to six IBM PC or Digital systems sharing access to one or two printers. This effectively doubles the original Switchmate's printer capability.

The dual printer sharing capability of the Switchmate II makes it ideally suited to multiple system environments requiring a combination of printer alternatives, such as laser and impact printing, continuous forms and cut sheet stationery, and printing and plotting.

Like its predecessors, the Switchmate II is totally automatic and transparent to both user and system. The operators send documents to the printer in exactly the same way they would with a dedicated printer. When two printers are attached, an individual system's printer selection remains in effect until changed by that system's operator. Each system maintains a printer selection independent from the selection of others.

Virtually all printers found in the DEC environment are supported, as well as many printers from other vendors. At the computer end, all DEC computers, including DECmates, and IBM PC compatibles are supported.

For further information contact: Logo Computer Centre, Suite 303, Henry Lawson Business Centre, Birkenhead Point, Drummoyne 2047.

Specialised capacitors

Three new lines of specialised capacitors have been added to the range stocked by All Electronic Components. The new types are specifically suited for applications such as motor starting, motor running, lighting and power factor correction.

The range of capacitors designed for motor starting runs from 3.75uF to 240uF; those for motor running, from

2uF to 30uF; and those for lighting from 3uF to 30uF, all with appropriate ratings. If a required item or value is not in stock, the firm is happy to quote on buying it in.

Further details from All Electronic Components at 118-122 Lonsdale Street, Melbourne 3000, or (03) 662 3506.

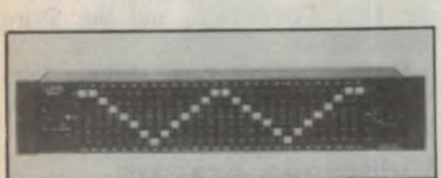
Digital multimeters

Advantest has introduced a series of four new benchtop DMMs with a maximum display of 32999 and sampling at 100 times per second. The multimeters are all capable of measuring AC and DC voltages and currents as well as resistance and low power in-circuit resistance. A temperature range is also incorporated within two of the models.

Other features of the Advantest TR6845 series include panel setting memory function, built in beeper for continuity testing, auto or manual ranging, selectable integration times, and true RMS or average AC voltage and current measurements.

A wide range of accessories is also available, including battery pack, GPIB adapter unit, BCD output unit, analog output unit, comparator output unit and a high voltage probe.

Further information is available from Measurement and Control Division, AWA Technology Group, Unit C, 8 Lyon Park Road, North Ryde 2113.



1/3 Octave graphic equaliser

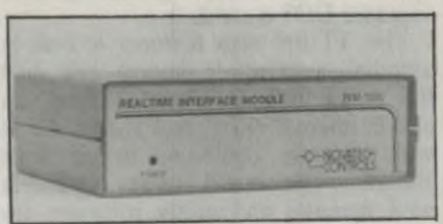
White Instruments has introduced the Model 4650 one-third octave, RC active graphic equaliser with slider faders, now available in Australia from Rebel Audio.

A tool for audio professionals, the 4650 features 28 one-third octave filters which sum together without ripple. That is, their individual bandwidth is sufficiently wide, so that when two adjacent filters are adjusted to cause a boost or cut response with an amplitude of 12dB, its frequency will be centred between the two adjacent filters.

Low noise is a major feature of the 4650. White specifies noise on a worst-case basis (in the case of the 4650, it is 80dB) — unlike other manufacturers which specify on best case, with all filter controls set flat.

The Model 4650 is equipped with fixed, 12dB/octave band limiting filters. The high-pass (low-cut) filter is set at 16Hz; the low-pass (high-cut) filter is set at 35kHz. The benefit of these is a linear roll-off of subsonic and ultrasonic components in the signal which, if present, can rob the amplifiers of a substantial amount of power and cause distortion.

For further information contact Rebel Audio, 104-106 Hampden Road, Five Dock 2046.



Realtime interface module

Novatech Controls has released a Realtime Interface Module, the RIM-100, which connects any computer with an RS 232-C serial port to the real world at a low cost.

RIM-100 boxes can be connected together in a network to provide hundreds of inputs and outputs at low cost. Each box has 17 analog inputs, 2 analog outputs and 14 digital inputs or outputs. Eight of the digital inputs can be used as counters or accumulators.

Inputs can be from temperature sensors, load cells, pH meters, power meters, position transducers, shaft encoders, proximity detectors, limit switches, relays and many others.

For further information contact Novatech Controls, 429 Graham Street, Port Melbourne 3207.

Solar power controller

Philips engineers at Hendon, South Australia have developed a circuit module that will provide the control functions necessary for charging lead acid batteries from solar modules. The OM1602 thick film hybrid modules measure only 53 x 28 x 5 mm and can control systems of 12 volts to 48 volts.

Charge current flows from the solar array via an external series switching element, to the battery. The series switching element can be a relay or a FET, as the OM1602 has been designed to drive either device. When the voltage across the battery exceeds a level corresponding to full charge, the series switching element is open circuited, allowing the battery voltage to discharge. The voltage will fall until it falls below another preset level, at which the series switching element is closed.

The switching levels are factory-preset and require no field adjustment, however provision has been made to allow for slight adjustment if desired.

The only extra components required to make a complete regulator are the isolating diodes for each panel, and the switching element. Having all the control circuitry contained in one module, it is suitable for both large and small installations.

Technical data including application details is available on request, from Philips Elcoma, 11 Waltham Street, Artarmon 2064.

Power line disturbance analyser

Tech-Rentals now has available the Dranetz 646 power line disturbance analyser, designed to detect aberrations in the AC mains supply of a kind likely to cause unreliable operation in computers and other microprocessor based equipment.

The instrument classifies disturbances into long, medium and short term and prints their value and duration when they exceed predetermined values. The most potentially troublesome are impulses, and periods as short as a microsecond can be detected.

The 646 will operate with both single and three phase supplies, measuring phase to neutral and neutral to earth disturbances. It also provides a DC monitoring channel having a range of 1-100V. The initial set up of the instrument is simplified using menu driven instructions. A non-volatile memory retains both the set-up and measurements. The output is via an internal thermal printer and RS 232C interface.

For further information contact Tech-Rentals offices in each state, or ring its Melbourne head office on (03) 879 2266.

New Products

Card adds speech, DTMF capability to PCs.

The Tone-Talker TT-100 is a full length PC compatible board which provides speech synthesis as well as digitised voice recording and playback, coupled with DTMF (dual tone multi-frequency) transmission and reception. It is therefore capable of allowing a computer to be remotely accessed via a telephone line, with the computer responding vocally to DTMF tone code commands.

Other applications include voice mail and call forwarding, high-speed DTMF data communications and voice analysis for security systems. Programming is via standard DOS commands.

The TT-100 also features a built-in autodial, autoanswer modem with dual line capability. It operates from an 8MHz internal clock, and is compatible with systems operating to at least 10MHz. The board comes complete with manuals and utility software, including a "voice library".

Further details are available from Dacos Pty Ltd, 538 Mountain Highway, Bayswater 3153, or (03) 729 0044.

60Mb, 125Mb tape storage

The Cipher Data PC60Bi and PC125Fi are 60 megabyte and 125 megabyte 1/4" tape systems for IBM PC/XT, AT, PS/2 and compatible computers. The tape systems are half-height internal drives and include mounting hardware, controller card, cable, software and user documentation.

The systems provide backup, restore and data archiving for computers using hard disks. In addition, they offer data interchange in desktop publishing, CAD/CAM, page imaging and other large database applications that require high capacity disk storage.

The systems support PCs using MS-DOS, PC-DOS and XENIX operating systems, as well as major PC network packages such as Novell, IBM Token Ring, PC Network and others. A QIC-24 recording format with SYTOS Tape Operating System provides full compatibility with the IBM 6157 tape drive.

Further information from Elmeasco Instruments, 18 Hilly Street, Mortlake 2137.

10Mb hard disk for Toshiba T1100

The LiteDrive hard disk subsystem is designed to add 10 megabytes of hard disk storage to the popular Toshiba T1100 laptop computer. It weighs only 180 grams (6 ounces), and fits neatly into the machine's second floppy disk drive slot.

The manufacturer claims that the disk will give up to six hours operation on battery power with normal use, or over two hours with constant use. The drive automatically parks the head after six seconds without an access, providing protection against crashes.

Easily set up, the LiteDrive can be installed by a dealer in as little as 15 minutes.

10Mb LiteDrives are also available fro the Zenith Z-171 and NEC Multispeed, while 20Mb units are available for the IBM Convertible, and the Sharp 4501/4502.

Further information from John Waugh Components, 27 Raglan Street, South Melbourne 3205 or (03) 699 9111.

Videotape erasers

Amber Technology has introduced two new high-energy video tape erasers for the professional video market, from the UK company Amos of Exeter.

Model BET 90 is ideal for high energy reel to reel erasure in professional studio environments. Surpassing industry standards which require audio erasure to an order of better than -70dB, the BTE 90 achieves levels of better than -90dB. Working in continuous operation, the BTE 90 is capable of erasing more than 100 tapes per hour, with a cycle time of 22 seconds.

Model BET 1905 is designed to erase the new series of MII Beta SP cassettes. This low-cost unit has an operation cycle time of 12 seconds, and can process more than 40 tapes per hour.

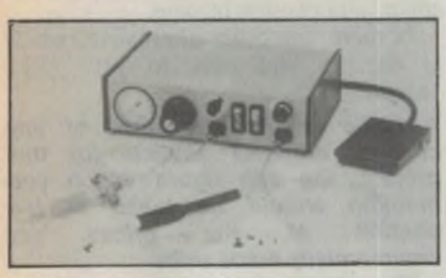
Full information is available from Amber Technology, Cnr Skyline Place and Frenchs Forest Road, Frenchs Forest 2086.

High density I/O modules

TI's new high density I/O modules feature 32 discrete I/O points packaged in a single-width module which allows them to each fit in one slot of a 500-Series I/O base. Designed for PC applications, they are compatible with the 560, 565, 520C, or 530C CPUs. They can also be used with the 5TI, PM550 or PM550C provided the 500-2161 6MT/500 interface is used.

Currently four models are available: 24V DC IN, 110V AC IN, 24V DC OUT, and 24/110V AC OUT. To limit the unit's footprint the 32 channel inputs are broken into two groups of 16.

Further information from Texas Instruments Australia, Industrial Systems Division, 6-10 Talavera Road, North Ryde 2113.



Manual pick & place for surface mount

Scope Laboratories of Melbourne has announced a combined adhesive and solder paste dispenser with vacuum pick up pen for miniature SM components. The new unit is designed to help smaller to medium sized electronic manufacturers tackle the dual problems of improving labour efficiency and lifting quality.

Labour efficiency should come from the speed and precision of the slim vacuum pick and replacement pen. The high accuracy of the dispensing head (down to 0.001mL) is combined with extremely fast cycling times of 600 per minute maximum.

The Model 602 is supplied complete with all hoses and fittings plus over 250 disposable dispensing syringes and nozzles. The unit requires a 240V 5A power point and normal factory compressed air.

Other applications within electronics could include the accurate dispensing of solder mask, anti-vibration mastic, solvent based silicone sealant, acrylate adhesives and potting resins.

Trade enquiries and interested distributors can get further data by contacting Scope on (03) 338 1566, or Fax (03) 338 5675.

Arbitrary/function generator

An arbitrary/function generator capable of simulating virtually any signal is being introduced by Tektronix, for use in electronics design, research and development, mechanical engineering, test and measurement, and materials testing.

Tektronix' AFG 5101 Arbitrary/Function Generator combines the functions of an arbitrary waveform generator with those of an analog function generator.

As an analog function generator, the AFG 5101 will generate standard sine, square, and triangle waveforms, as well as DC, with frequencies from .012Hz to 12MHz (0.2% accuracy from 120Hz to 12MHz) and amplitudes of 10mV to 9.99V p-p into 50 ohms. For greater frequency, accuracy (.005%) and stability, a synthesiser option is available (option 2).

For arbitrary waveform generation, the AFG 5101's two independent, selectable 12-bit by 8K waveform memories allow virtually any imaginable waveform to be created. The 8,192 horizontal addresses and 4,096 vertical addresses combine in an array of over 33 million points for building signals. This includes waveforms that can be manually entered from front panel programming keys, or transferred to the AFG 5101 from computer data which has been generated via discrete inputs, mathematical equations, graphic programs, or by digitisers.

In addition to the point-by-point waveform generation, the user can select one of five predefined, 1000-point waveforms, including sine, square, triangle, ramp-up and ramp-down. These predefined waveforms can be placed and edited at user-specified locations in arbitrary memory.

The AFG 5101 features an internal 10MHz clock for selecting a point-by-point digital-analog conversion rate between 100 nanoseconds and 999.9 seconds for waveform frequencies of 21uHz to 5MHz.

Further information from Tektronix Australia, 80 Waterloo Road, North Ryde 2113.

Information centre

TV antenna

I am writing with a couple of queries regarding the Yagi 4 element TV aerial featured in the November 1983 issue. I wish to build the aerial for Channel 8, and would like to know whether the dipole should be electrically insulated or mounted directly onto the boom, in the centre at the top. I have seen commercial aerials made both ways and the article does not indicate either way.

The other thing I wish to know is, as the aerial will be operating on a fringe area signal the more gain I can get the better. Could its performance be improved by building two aerials and stacking them, or by adding extra directors at the front. Which of these alternatives would be the most practical, if it is the latter could you please state the length of the directors. I would assume that the spacings would remain the same. (D.W., East Gresford NSW)

• ***The aerial to which you refer has a driven element of the folded dipole type. This type of driven element is best connected to a balanced line (such as 300 ohm ribbon). The points where the feedline connects to the element must be insulated from the boom. However, as the centre of the folded dipole is electrically neutral, it does not really matter whether it is insulated or not — except perhaps for discharge of static electricity.***

It is possible to stack two antennas, however you may experience some difficulty in arranging a suitable impedance matching system. Adding extra directors would also help increase gain, but a single 8-element antenna would not have as much gain as two 4-element antennas. However either of these options will reduce the bandwidth of the antenna, which may result in the picture becoming "blurry". We suggest that you try the original antenna as published first, and if the results are not satisfactory, perhaps consider the use of a masthead amplifier as an alternative to a more elaborate antenna system. An amplifier will not reduce the bandwidth of the antenna, but may suffer interference from any strong local signals, if there are any.

Wind direction indicator

I am indebted to *Electronics Australia* and its staff for the knowledge and enjoyment I have derived as a reader of your magazine for more than 35 years.

My son is now "following in my footsteps" and is keen to construct the Wind Direction Indicator project published in January 1982. After checking with your local advertisers I am unable to obtain one item — a UAA170 dot display driver.

Could you recommend a source of supply or alternatively an equivalent integrated circuit. (K.M., East Malvern, Vic)

• ***The UAA170 dot display driver is made by Siemens. We suggest that you try Geoff Wood Electronics in Sydney, as this firm stocks a very wide range of ICs.***

However it may also be possible to use a LM3914, operating in dot mode, to do the same job. The only complication is that this would require a completely new PC board, as the LM3914 does not have the same pinouts as the UAA170.

UHF converter cost

I am keen to build the UHF Converter of January 1987, as I am a deaf person. But I was disappointed with one part, which costs a lot to buy: the varicap-tuned UHF converter. This costs about $40, a bit expensive for me with my invalid pension income.

Is there any other alternative, which is cheaper and easy to get? (J.J., Doverton Vic)

• ***While we do not know of any cheaper modules suitable for this project, the $40 figure which you mention should be taken in the context of the prices for commercially made units.***

The module in question contains virtually a complete UHF/VHF down-converter, requiring very few external components in order to make it operational. It's very unlikely that this job could be done more cheaply.

Inverter hum

I have recently constructed the 15 watt 12V — 240V Inverter described in the April 1987 issue. The unit works well, but there is a noticeable hum in the output of my Technics SLP-X7 CD player. The hum isn't present when the player is running on NiCads.

Could you please suggest a remedy for the problem? (M.B., Cronulla NSW)

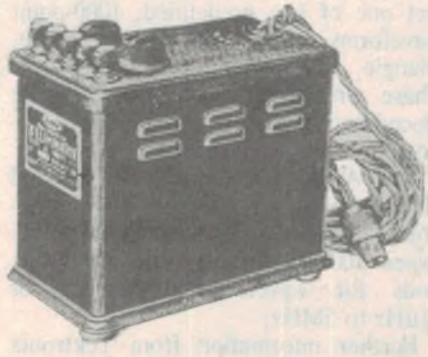
• ***A few tests may be necessary to track down the source of the hum in your CD player/inverter set-up. The first test is to eliminate the CD player itself as the source of trouble. The simplest method is to plug the power pack into the house-hold mains supply and check the CD output for a clean signal.***

Next, run the system from the inverter whilst monitoring the output with headphones, rather than any other equipment it may normally be connected to (e.g., car power amplifier).

What was it?

Starting this month, we're going to publish in each issue the picture of an electronic "mystery item" from the past. It'll be up to you to guess what the item concerned was, and the function it performed. We hope you find the feature interesting and amusing.

Can you guess what this item was? It dates from 1927, where you'd find it in many home loungerooms. It cost 10 guineas — about two weeks' wages!



(Answer next month).

If the hum is still present, it is time to look at the inverter itself. An oscilloscope may be necessary at this point, to check for excessive harmonics on the output, or incorrect operation of the output stage.

Simple FM sets

I enjoy building electronic projects that are not too complicated.

While there has been plenty of circuits printed for simple radios covering the AM broadcast band, I am unable to find designs that will cover the FM band — 88 to 108MHz.

With there being so much activity on this band now, would it be possible for you to print some circuits in this line? (T.W., Albany WA)

• Simple sets for FM reception at these frequencies are not easy to come up with, unfortunately. Still, we'll look into it and see what can be done.

Combination lock

In your August 1987 edition you had a project called the "4-digit combination lock". I purchased all the parts from Dick Smith Electronics and made the PCB myself (probably not the best thing to do, as it was my first one). I have constructed it now, but am having problems with its working.

On the dual 555 timer (556) one of the timers works (the first one), but the other does not. It seems that the output at pin 9 is already high, although not enough to power the diode. When the switch is pressed, the output straight away drops down low. I don't know if what I just told you helps but I would be much obliged if you could help. (R.R., Yeppoon, Qld)

• The problem you have encountered may be due to inadequate power supply voltage. The 556 will not behave as intended unless pin 14 is around 12 volts. This 12 volt supply is controlled by the action of Q1 and Q2, as explained in the text of this project.

If the power supply is OK, it's time for a thorough check of all the PCB tracks, solder joints, and components around IC1. It is also possible that IC1 itself is damaged, and may need to be replaced.

Using VOX for CB

I enclose a copy of a typical Cybernet chassis used for many CB radios, including American Electronics, Apollo, General Electric, Electrophone, Super Panther and others. These are still in common use today. As you can see they use a single pole double throw (SPDT) switch for transmit/receive mode switchings.

Could you please advise your if your VOX as described on page 64 of the November 1987 issue is suitable for this type of circuit? (P.S., Yagoona, NSW)

• The Voice Operated Relay can be used to switch this particular transceiver from receive to transmit. However, you will need to use a Double Pole relay, and this cannot be mounted on the PCB. Simply wire the contacts in place of the contacts on the Microphone switch, and use the "mox" position of the switch on the vox if you want to use manual transmit switching.

Telelink modem

Over a period of many years the only projects from EA which have beaten me have been modems — the first was the acoustic model from some years ago, and now the current Telelink, described in November 1987.

Having built the modem and checked (?) everything, and established that it wouldn't work, I found that due to some permutation of Murphy's Law or just plain stupidity electro C6 was upside down. This was replaced but still no joy. The only sign of life is the transmit LED flashing on keystrokes, and a single flash from the carrier detect LED when the remote bulletin board gets sick of waiting and switches the line out.

My usual method of substitution to find defective components is not practical in this instance due to the costs involved, so I'm hoping you can help with some testing data or any suggestions which may help me to get the unit working.

My I also point out that the parts list omits two diodes 1N4148, a 22/25 electro (C32) and shows a 47nF cap which I think might be shown on the circuit diagram as 27nF (C12).

Being an optimist, do you have any plans to design a baud rate converter to add to this modem?

As this is the first time I have had occasion to write, may I say how much I have appreciated your magazine over the years. The time is rapidly approaching when structural alterations will be necessary to house my heaps of EA. (L.D., Ballarat, Vic)

• The first thing to check is that the computer or terminal is operating at the same baud rate as you have selected on the modem, that is either 300 baud or 1200/75 baud split. 300 baud is probably the best place to start, as you don't have to worry about which direction is carrying data at which rate.

To troubleshoot the modem, the first thing to do is to determine if all the supply voltages to the circuit are correct. Obviously, some power is present in the circuit in order to power the LEDs. Check that –5V appears on the output of IC7, and on pin 4 of the '7910.

Assuming that all this checks out, the next thing to do is to follow the test procedure outlined on page 76 of the October issue. This involves jumpering the pad labelled "TEST" on the PCB overlay to +5V. Then select 300 baud originate and the "Carrier Detect" LED should light, and all characters typed on the keyboard appear on the screen. The same should happen with the selector switched to the 300 baud answer and 1200 baud transmit positions.

These tests will determine whether the modem chip itself and the interface to the computer are working correctly. When dialling up a bulletin board, you should use the 300 baud rate at first until you are sure that the modem is working correctly. You should also remember that most bulletin boards support many different baud rates, and it can take up to 30 seconds before the board system switches to the rate which you are using.

Before dialling up a bulletin board however, it would help if you could get hold of another modem which is known to work, and connect the phone line cords together via a phone double-adaptor (but not connected to a phone line). Select 300 baud originate on one modem, and answer mode on the other. If you have access to two computers or terminals, then connect one of these to each modem, and the characters typed on one keyboard will appear on the screen of the other.

Alternatively, if you can't get hold of a second terminal, connect your computer to the Tele-link, and jumper pins 2 and 3 on the DB-25 connector of the other modem. This will create a loop which will test the complete transmit and receive sides of the modem. If all these tests are successful, then you will have to look more closely at the compatibility of the bulletin board to the baud rate which you have selected.

We hope the above helps. Thanks for your note about the errors. At present we don't have any plans to describe a baud rate converter, but we'll give it some thought.

Letters

Continued from page 7

cluded with the CCPR12 (?) photo resist) and never did I obtain a surface to which the resist adhered evenly — hence my use of MEK.

As to this particular solvent being dangerous, no more so than petrol. We are not talking about a gallon of the stuff sloshed around in a small unventilated space. A small wad of paper towel dipped in half a teaspoon or so of the solvent is all that is necessary.

As to caustic soda being dangerous, of course it is — like crossing the road. Its very name suggests that the user should be careful. If Doug Rees were my age, he would well remember caustic soda being used in quite large amounts by farmers' wives, making their annual requirement of laundry soap. So far as I am aware, no injuries resulted from this widespread use of sodium hydroxide. The fact is that my article is about low cost techniques, and Doug Rees may like to respond by giving the cost per gram of caustic soda against the comparative cost of his CPD developer.

Finally, re mutilation of the catalogue reference, this of course was caused by "gremlins". However, I did mention that the resist was obtainable from DSE, so that little confusion should arise in the minds of prospective users who should, hopefully, be put right by the stockists.

Ian Page,
Mangawhai, NZ.

Battery sulphation

As much of my work is concerned with the production and use of electricity away from mains supply, I was most interested in Paul Grad's article concerning the discovery of the vanadium redox cell (EA November 1987).

In reference to lead acid batteries Paul makes the following reference to "sulphation": "Also, even when the batteries are carefully recharged, some of the water is usually lost in the form of hydrogen and oxygen gases and the acid content becomes high enough to cause sulphation. This is a process by which areas of the electrode become hard and brittle and do not react properly with the electrolyte."

From this description sulphation occurs on recharge and could be prevented by ensuring that the electrolyte level was maintained correctly. Furthermore it implies that sulphation occurs most at full charge when the electrolyte is most concentrated with acid.

My understanding of sulphation was that it occurred when the battery was in a discharged condition. A discussion with some of my colleagues arrived at the conclusion that "sulphation" was caused by the crystalline regrowth of lead sulphate on the positive plate. In this state the normal charging reaction is unable to proceed at its usual rate. If a badly sulphated battery is subjected to a heavy charging current, then the electrolytic would penetrate into fissures in the plate eventually causing the sulphated material to fall from the plate as sediment. This effect would be worst in a fully discharged battery left standing for an extended period.

No matter what the state of charge of a battery left standing, any sulphate on the positive plate will crystalise. The longer it is left the more time is available to form larger crystals, which are slow to react. To prevent sulphation the battery should be mildly overcharged on a regular basis. This ensures that all sulphate is removed from the plates of every cell. (Some cells are naturally less efficient than others and lag behind on recharge). This is the basis of "equalisation charge".

Sulphation usually manifests as excessive sediment, cracked or swollen positive plates and inability to reach full charge as determined by a hydrometer. This last condition makes it unlikely that sulphation is a product of excess acid.

Additives are available which claim to prevent sulphation. These proprietary liquids give little clue to their composition, except that one claims to contain cadmium. I can only guess that this somehow inhibits crystallisation by displacing lead in the lattice.

I feel that sulphation is poorly understood by most of us and my own contribution is purely conjecture. This is unfortunate as sulphation is probably the single most common cause of battery failure. Perhaps we could discuss the topic in Forum. Maybe someone out there knows the answer.

Thank for a great magazine. I find the new style and emphasis of the new editorial staff very refreshing.

Greg Clitheroe,
via Uki, NSW.

Comment: We'll see what the reaction from others is, Greg. If there's enough interest we could perhaps explore it in Forum.

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.

Wireless Weekly 3d

March 1938

Baird Television Announcement: Within a few weeks a modern television transmitter will be right here in Sydney! On board the Strathaird, which is at present plowing its way through the North Atlantic Ocean on its way to Australia, is John Logie Baird, well-known as the originator of the Baird television system, who, according to cables just received, is coming to Australia with two and half tons of television transmitting and receiving equipment with the object of establishing a television station here.

Much speculation has been done in the past by people who have wondered who would be the first to introduce modern television into Australia on a large scale, and this latest report of Baird's activity appears to show how the first words in Australian television history are to be written.

RADIO, TELEVISION and HOBBIES

March 1963

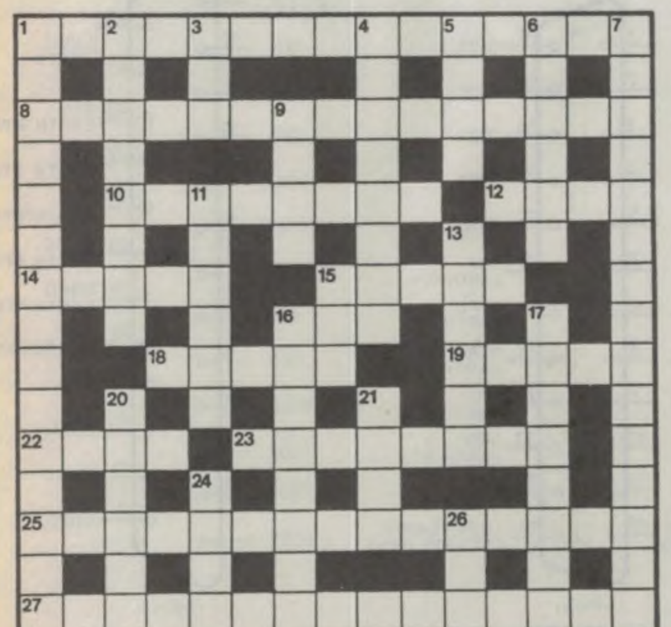
NTSC or SECAM?: While the rest of the world — and Europe in particular — watches, British television tackles its biggest job since its inception over 25 years ago; the conversion to the 625 line standard, UHF, and colour. The selection of a suitable colour system alone is a major decision, and one which Australia may well have to face up to in the next few years.

The recent series of NTSC tests and the forthcoming SECAM tests — almost certainly starting late in February — from the BBC's UHF transmitter at Crystal Palace seem likely to determine the characteristic of British and European colour television for many years

Will European television adopt a 625-line form of NTSC? Will it plump for SECAM? Or will the final choice be a modified system — such as that of Telefunken — combining some techniques from both of the main systems?

Australian TV Transmitters: Transmitter for ABC3, Canberra now in operation, is the first to be made in Australia for the Postmaster-General's Department for national television. It is the sixth locally made transmitter to come into operation and the first of seven to be made here for which the Postmaster-General's Department placed an order with Amalgamated Wireless (Australasia) Ltd. The remaining six ABC stations will service Launceston, Ballarat, Shepparton, Rockhampton, Toowoomba and Townsville districts.

MARCH CROSSWORD



ACROSS

1. Industrial heater. (8,7)
8. Such are the particles attracted to negative poles. (15)
10. Common display state of many modern appliances. (4,4)
12. Coated with gold. (4)
14. Gas generated by electric spark. (5)
15. Part of an alarm system. (5)
16. Don't argue, it's a logic element. (3)
18. These are in all overseas cables. (5)
19. Common name for an old-type insulator. (5)
22. Strips to tidy wiring. (4)
23. Said of sound of protest-marcher's loudhailer? (8)
25. Warmer for winter. (8,7)
27. Output of synthesiser. (10,5)

DOWN

1. Topically, what all EA crosswords have, possibly as exemplified by 27 across. (10,5)
2. Constituent of beta rays. (8)
3. Hobart TV Channel 6. (1,1,1)
4. Having huge pools of light! ? (8)
5. Supply path for model train. (4)
6. State of car battery's electrolyte. (6)
7. Radio is an example of such radiation. (15)
9. Units of impedance. (4)
11. Insulating sheath of nerve fibres. (6)
13. Effect successful response to a Mayday call. (6)
15. Alternative to Mayday. (1,1,1
16. Elementary particle having no charge. (8)
17. Obviously, errors in recording. (8)
20. A homing missile using heat radiation. (6)
21. Extra core of a transformer (not connected with 26 down). (4)
24. Prefix used in electrostatic system of units. (4)
26. Switch an alarm "on". (3)

SOLUTION FOR FEBRUARY

THE IEEE 488/GPIB OR IEC 625 INTERFACE BUS

The standard interface bus now used for interconnecting measuring instruments, exchanging data between them and controlling them via computers is the IEEE 488 bus or GPIB (general purpose interface bus). The European IEC 625 bus is very similar, and basically compatible.

Historically the IEEE 488 bus developed from a proprietary bus system developed by Hewlett-Packard, for connecting their instruments and computers. The original bus was called the HPIB (Hewlett-Packard Interface Bus).

Basically the IEEE 488 bus is a parallel interface, with a total of 24 signal and earth lines. It uses standardised 24-way Amphenol 57N24 connectors (a shorter version of the connector used for the Centronics printer interface).

The European IEC 625 bus is electrically and logically almost identical, but uses 25-pin DB connectors with slightly differing connections. Conversion cables or adaptors can be used to interconnect equipment made for the two bus systems.

The signals used in the IEEE 488/IEC 625 bus system are shown in Fig.1, with the connector wiring shown in Fig.2.

In both versions of the interface, all devices are connected to the bus in parallel, in "daisy chain" fashion. Each device is provided with a single interface socket, while the cabling uses "piggyback" connectors having a socket mounted at the rear of the plug to allow an additional connection.

Up to 31 different devices may be connected to the bus, each having its own unique bus "address". At any particular time, only one device can place data on the bus for transmission to others; the device doing so is called the *talker*. The device or devices accepting the data are known as *listeners*; up to 30 devices can be connected simultaneously to act as listeners.

One device connected to the bus is permanently designated the *controller*, and it determines the overall operation of the bus. Usually the computer itself is the controller.

Some devices are only capable of acting as listeners (for example a programmable power supply or signal generator), but most are able to function as either a listener or a talker as required.

All signal lines on the bus use wired-OR negative logic, with basically TTL logic levels (Logic 0 = +2.0 — 5V, Logic 1 = 0 — 0.8V). In other words the bus lines float high in the false state, but are pulled low for true. Line drivers are generally open-collector or tri-state gates or inverters.

There are three main groups of signals, for data itself, data transfer handshaking, and bus management.

The *data bus group* comprises lines DIO1-8, which are bi-directional. The *data transfer control bus group* comprises the three lines NRFD (Not Ready For Data), DAV (Data Available) and NDAC (Not Data Accept). The *management bus group* comprises the five lines ATN (Attention), IFC (Interface Clear), SRQ (Service Request), EOI (End or Identify) and REN (Remote Enable).

Dealing with bus management first, the ATN line is used by the controller device to identify *command* bytes, and distinguish these from normal data bytes (both are sent on the Data lines DIO1-8). IFC directs all devices on the bus to revert to their default state (usually passive listening). SRQ is used by any device on the bus to request attention from the controller. EOI is used by any device that has been functioning as a talker, to indicate when it has finished, and also by the controller to invite a "parallel poll" (more about this in a moment). REN is used to switch a device into its active state, or to enable one of its functions.

Bus Line	IEEE488 Pin No.	IEC 625 Pin No.
Data bus group		
DI01 Data line 1	1	1
DI02 Data line 2	2	2
DI03 Data line 3	3	3
DI04 Data line 4	4	4
DI05 Data line 5	13	14
DI06 Data line 6	14	15
DI07 Data line 7	15	16
DI08 Data line 8	16	17
Data Transfer Group		
NRFD Not ready for data	7	8
DAV Data available	6	7
NDAC Not data accepted	8	9
Bus Management Group		
ATN Attention	11	12
IFC Interface clear	9	10
SRQ Service request	10	11
EOI End or Identify	5	6
REN Remote Enable	17	5
(All other lines earthed)		

Fig.1: Bus signals used for IEEE 488 and IEC 625.

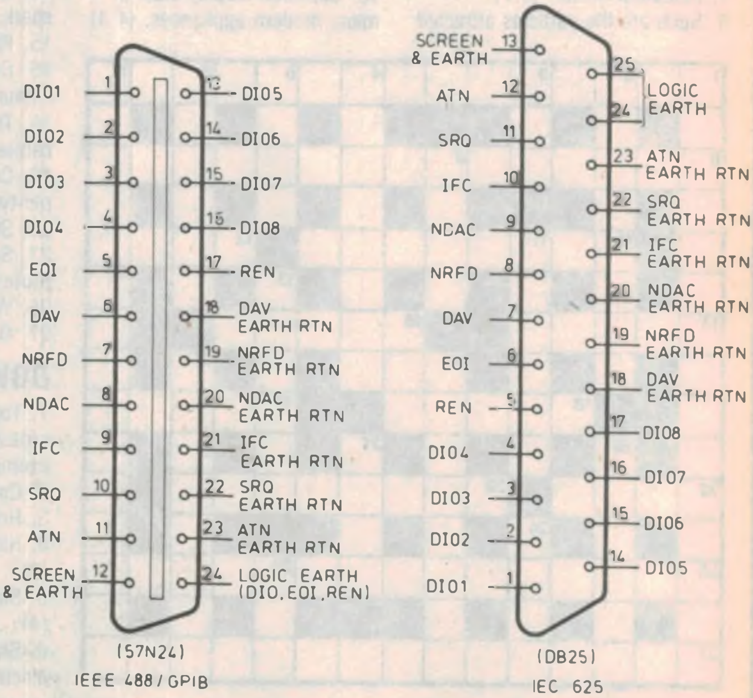


Fig.2: Standard connector wiring for the two compatible buses.

THE IEEE 488/GPIB OR IEC 625 INTERFACE BUS

For handshaking, the NRFD line is essentially rather like the Busy/Ready-bar line of a Centronics-type parallel printer interface, only with the opposite logic polarity. When a device is busy, it holds this line down at logic 1 level; when it is ready to accept data, it releases the line so that it returns to logic 0. The DAV line is used by a talker device to provide what is virtually a data strobe pulse, to indicate when there is stable data on the data bus lines. Finally the NDAC line is used as a "data accepted" acknowledge line, being allowed by a listener to go high when it has read a data byte.

Note that because of the wired-OR logic used, a number of listener devices can be arranged to receive data simultaneously. The NRFD and NDAC lines will only rise to their "Ready for more" levels when all devices have finished processing the data.

The IEEE 488 data bus lines DIO1-8 are used to pass standard 8-bit parallel bytes, which are either data or device commands. For command bytes, the five least significant bits are used for device addressing while the three most significant bits are used to indicate whether the device addressed is to act as a talker or a listener. Addresses 0 to 30 inclusive are used for actual devices, while address 31 is used as a "disable" code. If it is specified as a talker, the existing talker is disabled, and if it is specified as a listener, all current listeners are disabled.

Apart from commands to enable or disable addressed devices as listeners or talkers, there are a variety of commands to set up various kinds of polling configuration, and to direct devices to perform various functions like enabling or disabling their front-panel controls.

Two different kinds of "polling" are available on the IEEE 488 bus: serial and parallel. These are alternative ways for the controller to respond to the SRQ line being pulled low, by one or more other devices.

For serial polling, the controller responds by sending out a "Serial Poll Enable" (SPE) command. It then addresses each device in turn, directing it to act as a talker and transmit its status. Each device is directed to return to listener mode, after being polled, and its request for "service" completed.

For parallel polling, the controller sends out a "Parallel Poll Configure" (PPC) command. This is used to allocate each bit of a status byte, to 8 different devices. Then each time a "Parallel Poll Enable" (PPE) command is sent, all eight devices respond together, via their allocated data bit line. The controller is thus able to check their status quickly, by examining the resulting data byte.

A wide variety of test and measuring instruments are now available for use on the IEEE 488 bus, including counters, voltmeters, spectrum analysers, power supplies, signal generators and logic analysers.

- Jim Rowe

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Next month in

Electronics Australia

New 300W Inverter

Work done during development of the 600W "Powerhouse" inverter described in our December issue has allowed a worthwhile revamp of its 300W little brother. This is now even easier to build, and performs better as well.

Low cost 50MHz frequency counter

For many people, a fancy 1GHz counter is overkill — and a bit too expensive. Here's a design for a 50MHz model that still lets you measure most signals, but will cost you less than $100. Very easy to build, too!

Bench Amp/Signal Tracer

A utility amplifier that can double as a signal tracer is really a "must" for the experimenter's workbench. Here's a new design that's low in cost and easy to build . . .

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