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Australia's Top Selling Electronics Magazine

Electronics Australia

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SEPTEMBER 1985

* TACHO/DWELL METER FOR CARS

SATELLITE TV: What it means *

* HOW MULTI-LAYER BOARDS ARE MADE

*

MORDAUNT-SHORT LOUDSPEAKERS REVIEWED

POWER MAINS APPLIANCES FROM A CAR BATTERY

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Input Frequencies: VHF Ch.0 - 11 (46.25 - 273.25MHz)
UHF Ch.28 - 63 (471.25MHz - 855.25MHz)
Intermediate Frequencies: Picture - 36.875MHz
Sound #1 - 31.375MHz
Sound #2 - 31.133MHz
2nd IF Frequencies: Sound #1 5.5MHz
Sound #2 5.742MHz
Outputs: Composite Video - 1V p-p into 75 ohms
RF output - Ch0/1 preselectable 1.5mV
Speaker outputs - 1.0 watt RMS max
Audio line outputs - 300mV p-p into 4.7K
Distortion: Line outputs - 3% THD max typically 1%, Speaker outputs - 3% THD max

SAVE $50!

WAS $249 . . . NOW

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Cat K-6325

DICK SMITH ELECTRONICS PTY LTD

B022

Volume 47, No. 9

Electronics Australia

September 1985

THIS MONTH'S COVER

Making multi-layer PC boards is a fascinating and complicated process. At the forefront of this technology is a Sydney-based company known as Printronics. Our report on how their boards are produced begins on page 12.

Features

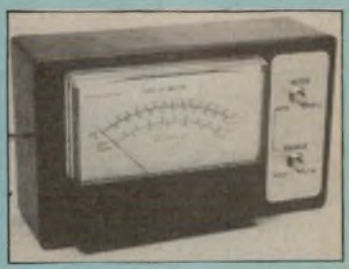
Hifi, Video and Reviews

Projects and Circuits

Columns

Departments

Tacho-dwell meter for cars

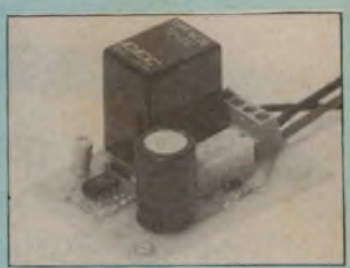


Build this tacho-dwell meter and save money on engine tune-ups. It can be used on four, six and 8-cylinder engines and should cost you less than $20. Details page 54.

What's coming

Next month we intend to describe a HF transceiver for the amateur bands and a high-powered Mosfet amplifier module. See page 129 for further details.

Special offer: free PC boards



As a special offer for this month only, we've arranged for the supply of 1000 free PC boards for our popular Ignition Killer project. It's first come, first served — see page 82.

NOW WITHIN YOUR SCOPE

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$835
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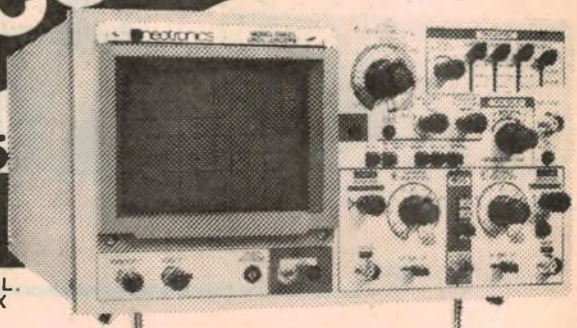
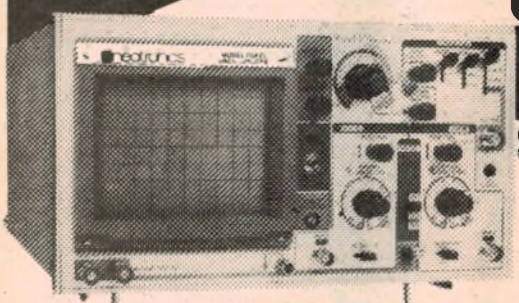


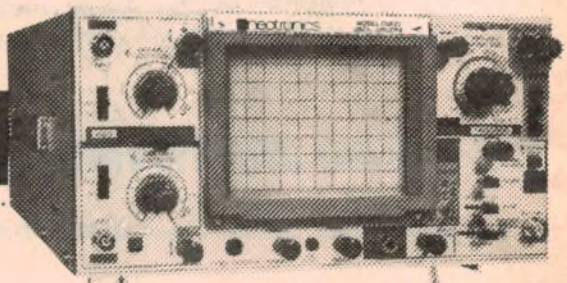
● Bandwidth 35MHz ● Rise time to 10 n sec. ● Sensitivity to 1mV/DIV ● 6KV acceleration ● Delayed sweep ● Trigger hold off ● Alt. trigger ● Single sweep

OS-620
$595
$682 INCL. TAX



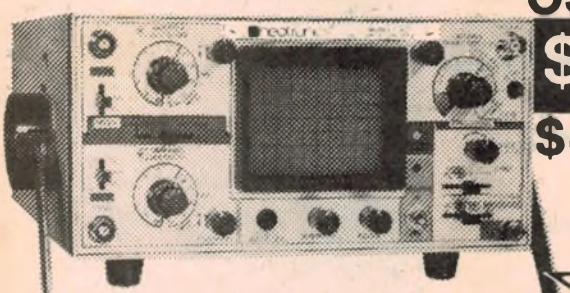
● Bandwidth 20MHz ● Rise time less than 17 n sec. ● 5mV/DIV sensitivity ● Channel A, channel B, dual, add, subtract ● Component tester ● X-Y mode ● TV video synch filter.

OS-645
$1285
$1475 INCL. TAX



● Top of the range ● 45 MHz bandwidth (usuable to 70MHz) ● Signal delay ● Trigger delay ● 15KV acceleration ● 5mV/DIV sensitivity (1mV at reduced bandwidth)

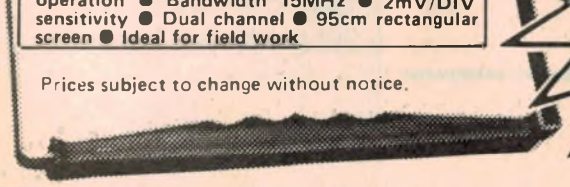
OS-615S
$785
$896 INCL. TAX



● Rechargeable battery operated 6 hrs. operation ● Bandwidth 15MHz ● 2mV/DIV sensitivity ● Dual channel ● 95cm rectangular screen ● Ideal for field work

Prices subject to change without notice.

PROBES INCLUDED IN PRICE



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Editorial Viewpoint

by Leo Simpson

Yet another contender in the video war

It's official. The 8mm video format has been released in Australia. Just as this issue was about to go to press, Sony released their 8mm camera-recorder, the CCD-V8. This incorporates so much that is new that it is dazzling. And as you might expect, it will take some time for it to be objectively assessed.

The size of the 8mm tape cassette is the first mind-boggling aspect. It is about the same size as the normal audio cassette except that it is a little thicker — yet it can record 90 minutes in standard play mode and three hours in long play mode. The standard play mode gives a picture quality which is at least the equal of current VCRs and certainly better than those of just a few years ago.

Sound quality is good too, since the recording method is the same as for current hifi VCRs. In addition, there is a PCM capability which will give stereo recordings, together with the picture, that will rival the compact disc standard.

When you consider the much greater size of the current VHS and Beta tapes, this is a phenomenal achievement. If they can do all this today, what will the 8mm format be capable of several years on?

Together with the size and weight advantages of the 8mm format, Sony's new camera-recorder also incorporates a CCD image sensor instead of the conventional pick-up tube. The CCD sensor is not only smaller and lighter but is more insensitive to shock and vibration and has little tendency to picture flare from highlights.

It all added up to a pretty impressive debut for the 8mm format but just to make things interesting, National Panasonic introduced their own camera-recorder which uses a full size VHS cassette. While this is much more bulky and more expensive, incidentally, than the brand-new 8mm contender, it has the enormous number of existing VHS video recorders to give it considerable initial momentum.

8mm video, on the other hand, is starting from scratch. The one thing it has going for it, which Philips V2000 and Betamax did not have, is that it is the new standard, agreed upon by 127 electronics companies. And the 8mm camera-recorder from Sony can be used with existing VHS or Beta VCRs.

It remains to be seen how much headway 8mm makes against VHS in the next few years but either way, the intense competition in the marketplace, now from Korea as well as Japan, is going to be good for the consumer.

The really crucial question, as far as the suppliers of all this wonderful technology are concerned, is whether the consumer will want it all. In the last few years we have seen the full technological might of the electronics companies unleashed upon the consumer. More often than not, the reaction has been either confusion or cynicism. We have reached saturation in the advanced countries at least. There is now virtually no free time remaining for the average person to enjoy any more fruits of technology.

This is a big problem for Japan as it cannot continue to grow inexorably by just catering for the consumer electronics markets of the world. It will have to look elsewhere if it is to stay ahead in the race for technological supremacy.

News Highlights

Fifth wheel heading for retrenchment

The famous "fifth wheel", the means by which vehicle manufacturers have for decades tested the performance and safety of their designs, is on the road to retrenchment.

Basically, the technique involved trailing a mechanical fifth wheel behind the test vehicle. This wheel was linked to measuring instruments and provided data which then had to be analysed.

Taking the place of this outmoded method of testing performance is the Correvit, a device which is computer-based and can be attached to any land moving vehicle. It measures braking, sway, petrol consumption, speed, tyre performance and handling ability, to name just a few.

The Correvit is fitted to the outside of the vehicle and uses optical speed and distance sensors to obtain data directly from the optical image of the track over which the vehicle is moving. This information is fed directly into a compact portable computer inside the test vehicle. At the end of the test run, a printer can provide an instant set of performance figures in a variety of formats.

In Australia, Mitsubishi and Nissan have been quick to adopt the technology. Other local users include the Melbourne Tramways Authority, tyre specialist Bob Jane, the Royal Auto Club of Victoria and Modern Motor magazine.

Manufacturers shy away from digital TV

Semiconductor houses and TV set manufacturers who were hoping to supply digital integrated circuitry for production of a broad range of TV models have been disappointed to find that the market is not yet willing to try the new technology. It seems that increasingly integrated analog circuits will dominate the market for at least the next three years.

However by the end of the decade everything points to the fact that a digital approach will dominate production. With cable and satellite distribution and interactive services such as videotext the TV will be more like a visual communication system than the program receiver it is now.

One of the problems stopping progress is the high cost of the frame stores that are available. At present, suitable charge-coupled-device (CCD) frame memories are unavailable. A frame store based on RAM would require six 256K circuits at a cost higher than the cost of the rest of the components put together.

The importance of the frame memory lies in its ability to add such features to the set as freeze-frame and zoom-in, and to act as a buffer which manufacturers can use to double the bandwidth of a demodulated TV signal. They can remove the cross colour, cross luminance and large-area flicker that plague standard TV pictures.

For many of the set producers the transformation from the decades-old analog-receiver production line to digital devices is too big a step to take in the short term, so they will wait and gauge its impact before conversion.

Two major TV networks sign up for AUSSAT

Mr Graham Gosewinckel, General Manager of AUSSAT, announced recently that Heads of Agreement had been initialled with two of the major television networks (9 and 10) for the use of the satellite system.

The agreements relate to the lease of one high powered transponder by each of the two networks on the second AUSSAT satellite. They are for an initial period of three years with options for renewal. The service will commence in July 1986.

VDUs linked to miscarriages

Japanese statisticians believe they have found a link between VDUs and miscarriages. According to the survey published by Japan's General Council of Trade Unions, over one-third of pregnant women working at video display units experienced problems during pregnancy or at delivery.

Using a sample of some 13,000 VDU workers, of whom 4500 were women and 250 were pregnant, they found that 91 of these had experienced problems. Eight had miscarriages, eight had premature births, and five had still-births.

Other figures showed that among pregnant women who worked on the terminals for longer than six hours a day, two thirds had problems with pregnancy or labour. As time in front of the terminals decreased the proportion of pregnant women suffering problems also dropped.

A major recommendation of the survey was to keep pregnant women away from the terminals until this correlation could be checked more thoroughly.

In Britain, the reaction is guarded. The government has declared that science has not found evidence yet that display terminals affect pregnancy but has recommended special care for mothers who may be worried about the effects of VDUs. They believe that the rate of miscarriages among Japanese women working the terminals could probably be the result of statistical anomalies. Eyestrain and backache are the worst hazards of VDUs.

Personal problems for computer dealers

Computer dealers have everything but the customers. The slump in the personal computer market began the minute IBM started to make as many PCs as it could sell. Prices dropped to keep sales soaring, but this proved to have other effects as well.

To maintain cash flow, retailers over-ordered so that they could qualify for the best factory discounts, dumping what they couldn't sell on the unauthorised dealers market. The price war which this exacerbated left retailers reeling.

The solution, according to market researchers, is simple — tap the large reservoir of potential demand that still exists. It seems that as little as 15% of the potential market of more than 20 million customers in the US own personal computers.

But tapping this area is easier said than done. Retailers must now convince customers that they really do need a computer, but it doesn't stop there. They must then provide expensive service and support for it.

The situation is the classic Catch 22: how do you sell at discount prices and yet still supply a comprehensive service and support team for your clients? Many companies have dropped the bargain attitude and are aiming at the untapped market with a strategy of full-price with full-service.

For companies with the capital behind them to go on with this strategy things look set to get better, but only time will tell.

8mm video launched in Australia

Several manufacturers are scrambling to get their 8mm video camera recorders onto the domestic market before the Sony Corporation's accelerated entry corners it.

The Sony product, released in Australia in August, is the CCD-V8, an 8mm video camera-recorder with a 1-inch black and white viewfinder-playback unit. According to the Japanese trade journal JEI, Sony's decision to introduce the unit so early was brought about by the decline in their Beta-format VCR sales during the last financial year.

To help make the product that much more attractive on the domestic market, Sony has released three 8mm videocassettes with 30, 60 and 90-minute playing times. Sony has also used an improved charge-coupled device (CCD) image sensor to keep the total weight of the product to 1.97kg, or 2.3kg with battery pack and tape.

The 0.67-inch CCD image sensor has 250,000 picture elements for impressive horizontal resolution. Improvements to the metal recording tape and to the recording heads also contribute to the output quality.

The recorder has been released with a range of optional accessories, including an AC power pack, battery charger and adapter, two rechargeable battery packs, two sets of antenna connector cables and an antenna selector.

News Highlights

New universal demodulation ICs

Two new automatic audio processors have been developed by the Sony Corporation. Both feature a universal demodulation IC that is compatible with the four contending AM stereo broadcast systems in use in the US and Canada.

The CX20177 device indicates stereo reception and which method is being used. The second device indicates stereo, but not format. The processors have PLL and malfunction-preventing circuits that introduce no co-channel interference or parasitic phase-shift modulation.

The universal demodulation IC also includes an envelope detector, PLL synchronous AM detector, mute circuit and an FM detector to name just a few, and comes packed into a 20-pin mini flat package.

Video print system hides scanning lines

The demand for photographic quality copies of colour video images has, in the last few years, increased dramatically. Three Japanese organisations have developed prototype systems that produce photographic prints with no visible scanning lines.

The main problem encountered in producing such prints is that the photographic material must be exposed for a much longer time than one TV frame period. To cope with this, all the systems use a semiconductor video frame memory to store a complete picture. This memory also allows for interpolation of additional scanning lines so that a line structure is not visible in the finished product.

The film is exposed by light emitted from a flattened cathode-ray tube with three stripes — one for each primary colour, on its faceplate. One of the organisations, Konishiroku, bases its system on enlarging paper, which reduces the overall cost. The technology uses an optical-fibre CRT with which the paper is almost in contact. The paper is swept past the tube vertically and the full phosphor light output is concentrated onto the enlarging paper to produce a print free of scanning lines.

Ham Radio at the Power House Museum . . . After years of planning, Amateur Radio Station VK2BQK has been opened at the Power House Museum in the Sydney suburb of Ultimo. The idea is to demonstrate the activities of amateur radio. Visitors can use the equipment to communicate by voice, Morse code and radio teletype with other amateur radio stations in Australia and overseas. The station is operational from 12-4pm on weekends and public holidays, and from 11-1pm and 2-4pm on Tuesdays. Above: station custodian Pierce Healy VK2APQ at the controls.

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R15138	.0015uF	0.06	0.04	.036
R15140	.0022uF	0.06	0.04	.036
R15142	.0033uF	0.06	0.04	.036
R15143	.0039uF	0.06	0.04	.036
R15145	.0047uF	0.06	0.04	.036
R15146	.0056uF	0.06	0.04	.036
R15147	.0082uF	0.06	0.04	.036
R15148	.01uF	0.07	0.05	.045
R15150	.015uF	0.07	0.05	.045
R15152	.022uF	0.07	0.05	.045
R15154	.033uF	0.07	0.05	.048
R15155	.039uF	0.07	0.05	.045
R15156	.047uF	0.08	0.06	.055
R15157	.056uF	0.08	0.06	.055
R15158	.068uF	0.08	0.06	.055
R15159	.082uF	0.08	0.07	.055
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
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M12155	2155	4.80	4.10	3.70
240V 6-15V 1A tapped				
M12156	2156	6.35	6.15	5.95
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M16672	6672	6.35	6.15	5.95
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Q10505	MU45 0-50uA	5.95	5.75	5.50
Q10510	MU45 0-5A	5.95	5.75	5.50
Q10518	MU45 0-1A	5.95	5.75	5.50
Q10520	MU45 0-20V	5.95	5.75	5.50
Q10535	MU45 VU	6.95	6.75	6.50
Q10530	MU52E 0-1mA	7.95	7.35	
Q10533	MU52E 0-5mA	7.95	7.35	
Q10538	MU65 0-50uA	9.35	8.95	8.75
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PN3566	.15	.13	PN3567	.10	.08
PN3569	.18	.16	PN3639	.18	.16
PN3640	.18	.16	PN3641	.10	.08
PN3642	.10	.08	PN3643	.10	.08
PN3644	.15	.13	PN3645	.15	.13
PN4250A	.15	.13	PN4355	.16	.14
PN4356	.16	.14	MPSA42	.23	.20
MPSA43	.23	.20	MPSA55	.15	.14
MPSA56	.15	.14	MPSA92	.22	.20
MPSA93	.22	.20	SC1410	.85	.75
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BU208	2.50	2.20	2SD350	2.50	2.20

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Cat. T12463	115V 4½"	10.50	10.00	8.00
Cat. T12467	115V 3½"	10.50	10.00	8.00

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S13404 4 Way	.80	.75	.70
S13405 5 Way	.90	.85	.80
S13407 7 Way	1.10	1.00	.95
S13408 8 Way	1.20	1.10	1.00

20% Sales tax where applicable

COMPUTER CONNECTORS

Cat No	Description	1-99	100+	1000+
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P10901	DB25 Socket	1.40	1.30	1.20
P12210	Centronics Solder	3.50	3.15	2.50
P12200	Centronics Crimp	6.00	5.50	5.00
P10880	DB9 Plug	1.30	1.20	0.90
P10881	DB9 Socket	1.40	1.30	1.00
P10890	DB15 Plug	1.30	1.20	0.90
P10891	DB15 Socket	1.40	1.30	1.00
P10902	DB25 Cover	80	75	70

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SIP RESISTORS

Standard values.

	1-9	10+
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8 Pin	0.60	0.50
10 Pin	0.65	0.60

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3 Pin Chas FMle Cat. P10966	2.50	1.90

Plus 20% Sales Tax where applicable

RELAYS

Massive 3A connectors

	1-9	10+	100+
S.P.D.T Cat. S14060	$1.20	$1.10	$0.90
D.P.D.T Cat. S14061	$1.50	$1.40	$1.20

75OHM COAX CABLE

Cat No	100M	500M	1000M
W11222 3C2V	18.00	17.00	16.00
W11224 5C2V	27.00	25.00	24.00

(5C2V WHITE OR BLACK)

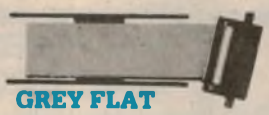
100M ROLLS

LINE LOSS PER 100' (33M 200MHz)

W11222 6.2dB (Approx)

W11224 3.9dB (Approx)

Plus 20% tax where applicable



GREY FLAT RIBBON CABLE

			PER 100 FT ROLL			
Cat No	Desc.	Per Mtr	1-3	4-9	10-99	100+
W12614	14 Way	1.29	19.50	18.50	18.00	14.00
W12616	16 Way	1.90	21.50	19.50	19.00	16.00
W12620	20 Way	2.20	29.50	28.00	26.50	20.00
W12625	25 Way	2.50	32.50	29.00	28.50	25.00
W12626	26 Way	2.60	34.00	32.00	29.00	26.00
W12634	34 Way	2.80	44.00	42.00	39.00	34.00
W12636	36 Way	3.00	49.00	47.00	42.50	36.00
W12640	40 Way	3.20	55.00	52.50	49.50	40.00
W12650	50 Way	3.75	62.00	59.50	58.50	50.00

EX STOCK

LARGER QUANTITIES NEGOTIABLE

Plus 20% tax where applicable

CRYSTALS

Cat No.	Frequency	Can	10+	100+	500-	1000+
Y11000	1MHz	HC33	5.50	4.75	4.50	4.00
Y11005	2MHz	HC33	2.25	1.95	1.85	1.70
Y11008	2.4576MHz	HC33	2.25	1.95	1.85	1.70
Y11015	3.57954MHz	HC18	1.20	.90	.65	.60
Y11020	4.00MHz	HC18	1.30	.90	.75	.60
Y11022	4.194304MHz	HC18	1.40	.90	.75	.60
Y11025	4.75MHz	HC18	1.40	.90	.75	.60
Y11026	4.9152MHz	HC18	1.40	.90	.75	.60
Y11042	6.144MHz	HC18	1.40	.90	.75	.60
Y11050	8.00MHz	HC18	1.40	.90	.75	.60
Y11055	8.867238MHz	HC18	1.40	.90	.75	.60
Y11070	12.00MHz	HC18	1.40	.90	.75	.60
Y11072	14.318MHz	HC18	1.40	.90	.75	.60
Y11080	16.00MHz	HC18	1.40	.90	.75	.60
Y11085	18.432MHz	HC18	1.40	.90	.75	.60
Y11090	20.00MHz	HC18	1.40	.90	.75	.60

FULL RANGE OF CRYSTALS AVAILABLE ON INDENT

Plus 20% tax where applicable

MEMORY

"Check for the latest memory prices!"

	10-99	100+	1000+	10K+
4164-15P	$2.00	$1.90	$1.60	$1.40
41256	$9.00	$8.00	$7.50	$6.00
6116P-3	$3.00	$2.90	$2.00	$1.80
2716	$4.90	$4.50	$4.25	$4.00
27128	$9.00	$8.00	$6.00	$5.00
2532	$7.50	$6.50	$6.40	$6.30
2732	$6.50	$6.10	$5.90	$5.50
27256	$29.00	$27.00	$22.00	19.00

Plus 20% tax where applicable

VERBATIM DATA LIFE DISKETTES

		10-99	100+	1000+
SS/DD	MD525-01	2.50	2.35	2.25
DS/DD	MD550-01	3.20	3.00	2.80

XIDEX DISKETTES

SS/DD	2.50	2.50	2.25
DS/DD	3.40	3.05	2.85

Plus 20% tax where applicable

RITRON II

Swivel base monitor in stylish case

	1-9	10+
Green Cat. X14506	$165	$159
Amber Cat. X14508	$165	$159

Plus 20% tax where applicable

MONITORS

Cat No		1-3	4+
X14500	Ritron 1 Green	$140.00	$135.00
X14502	Ritron 1 Amber	$145.00	$140.00

WHILE STOCKS LAST

Plus 20% tax where applicable

UNPROTECTED HEADERS STRIP HEADERS

Dual in Line 2.54mm

		1-9	10+
P12240	10 Way Unprot Header	1.25	1.10
P12246	16 Way Unprot Header	1.35	1.20
P12250	20 Way Unprot Header	1.45	1.25
P12256	26 Way Unprot Header	1.50	1.40
P12260	30 Way Unprot Header	1.75	1.65
P12264	34 Way Unprot Header	1.95	1.75
P12270	40 Way Unprot Header	2.25	1.95
P12275	50 Way Unprot Header	2.75	2.50
P12280	60 Way Unprot Header	2.95	2.75

Plus 20% Sales Tax where applicable

MITSUBISHI DISK DRIVES

		1-9	10+	25+
4851	5¼"	$160	$150	$140
4853	5¼"	$220	$205	$175
4854	5¼"	$250	$220	$195
2896	8"	$450	$420	$400

Plus 20% tax where applicable

ADD ON DISK DRIVES FOR 6502 SYSTEM

1-9	10-24	25+
$180	$160	$150

RITRONICS WHOLESALE

Incorporated in Victoria Pty. Ltd.

56 Renver Road, CLAYTON, 3168, VICTORIA, AUSTRALIA. Phone (03) 543 2166 (3 lines) Telex: AA151938

Minimum account order is $50, minimum cash sale is $25. Minimum post/pack $3.00. Minimum account post/pack $5.00. Comet Road Freight, bulky items and/or over 10Kg is extra.

Bankcard, Visa and Mastercard welcome.

KIKUSUI 20MHz DUAL TRACE SCOPE

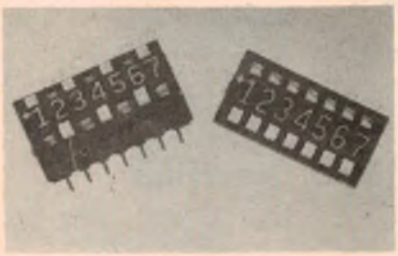
$697.00 EX TAX INC PROBES

$808.00 INC TAX

Compact and easy to operate for hobbyists and professionals

- 5mV/div sensitivity
- Hold-Off function
- CH1, CH2, Dual, Add, X-Y modes
- Intensity modulation
- 0.2uS to 0.5S/div sweep range

GOLD PLATED DIP SWITCHES



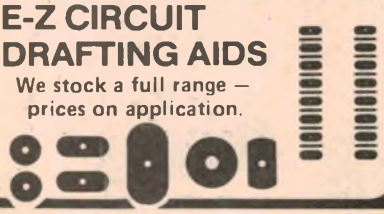
A cancelled order means distributor had to dispose of quality gold-plated DIP switches. We grabbed 'em and pass the low prices on to you. Stock up because this is a once-off offer. Rocker type action. Sealed contacts. Seven section fits normal 14-pin DIL outline. **$1.20** each but buy ten and they're only **$1.00** each.

ASK US ABOUT RAINBOW CABLE

In an attempt to meet the needs of professionals and advanced hobbyists we are now stocking a comprehensive range of flat cables in both rainbow colours and plain grey up to 60 way. Contact us for further details. We also stock a wide selection of IDC connectors to suit.

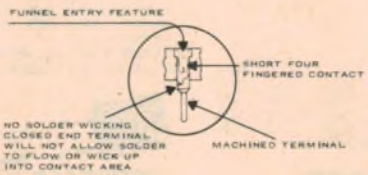
E-Z CIRCUIT DRAFTING AIDS

We stock a full range — prices on application.

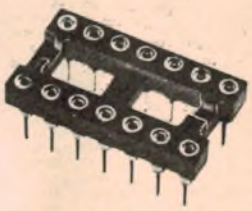


MACHINED PIN WIRE WRAP SOCKETS

Due to the enormous popularity of our GOLD PLATED low profile IC sockets we have now added Wire Wrap types – again at ridiculously low prices. Remember these aren't the cheap tin plated variety these are GOLD PLATED 8 pin **82¢**, 14 pin **$1.50**, 16 pin **$1.72**, 18 pin **$1.95**, 20 pin **$2.15**, 24 pin **$2.58**, 28 pin **$3.00**, 40 pin **$4.50**

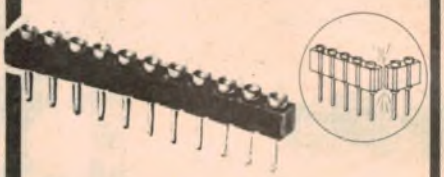


OPEN FRAME LOW PROFILE IC SOCKETS



Highest quality glass filled polyester with MACHINED contacts. Four finger GOLD PLATED contact. Terminals are tin plated for easy soldering. Open frame ensures good cooling, easy cleaning and checking. Available in 8 to 40 pin configurations. 8 pin **56¢**, 14 pin **98¢**, 16 in **$1.12**, 18 pin **$1.26**, 20 pin **$1.40**, 24 pin **$1.68**, 28 pin $1.96, 40 pin **$2.80**.

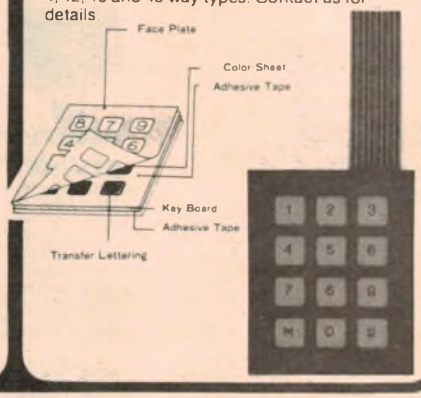
SINGLE IN-LINE SOCKETS & ADAPTORS



SIP sockets feature four finger GOLD PLATED beryllium copper contacts with tin plated brass terminals. 20 pin strip can be easily snapped apart to form shorter lengths. Maintains spacing when mounted end to end or end to side. Socket strip **$2.50**. Adaptor strip **$2.00**.

KEYBOARDS

We are now stocking membrane keyboards which are ideal for digital experimenters. Extremely low profile. Come complete with connector for fitting to your pcb. Faceplate protects your keyboard lettering. Available in 4, 12, 16 and 40 way types. Contact us for details.



8.30 to 5 Monday to Friday. 8.30 to 12 Sat.
Mail Orders add $3.00 to cover postal charges.
Next day delivery in Sydney add $5.00.
All prices INCLUDE sales tax.
Tax exemption certificates accepted if line value exceeds $10.00.

GEOFF WOOD ELECTRONICS PTY LTD
Incorporated in N.S.W.
656A Darling St, Rozelle 2039
(One door from National Street)
Tel: **810 6845**

bankcard
$10.00 minimum

specialising in electronic components for the professional and hobbyist.

News Highlights

Dick Tracy eat your heart out

The creators of the famous Dick Tracy cartoon character must have had Epson in mind every time they had their eagle-nosed hero talking into his suit sleeve.

The Epson RC-20 wrist computer, worn like a watch, provides enough internal memory (8K of ROM and 2K of RAM) to be useful as a scheduler, memo generator, calculator and world time editor.

All the necessary software for those functions comes bundled in the wrist computer. The heart of the RC-20 is a SMC84COM CMOS chip, compatible with the Z-80 used in most of the world's personal and home computers.

What makes this device extremely useful (or so the maker's claim) is that information fed into it can be later downloaded into Epson's PX-8 lap portable computer, or the range of Epson personal computers.

The memo program can store anything that fits on a four-line by seven-character screen. The RC-20 is available for less than $220 (excluding tax) and — would you believe it? — also tells the time.

For further information contact Epson Australia on (02) 452 5222 or (02) 818 4887.

IBM feels pinch of recession

The recession in the US computer industry has been merciful to no-one, not even the IBM Corporation.

Company president John Akers has stated that performance in the first nine months of fiscal 1985 lags behind the corresponding period last year. IBM had previously predicted solid growth during 1985 but is now retreating from that forecast as the market continues its downward trend.

Business Briefs

● Telecommunications manufacturer, **Standard Telephones and Cables Pty Ltd** has posted a record profit of $16,753,000 for the year ending December 31, 1984. The major factor in the company's success, according to STC's Chairman, is the steady flow of new and innovative products.

● **Magna-Techtronics (Aust) Pty Ltd** has moved to new premises in Artarmon. The new address is 7-9 George Place, Artarmon, NSW, 2064. Phone: (02) 427 0666.

● In a move aimed at boosting local software production, **Hewlett-Packard** has launched a software centre in Ringwood, Victoria.

The centre, which will have an annual budget of around $2 million a year, is designed to manufacture products for both the local and export markets. Apart from opening the door to the export market, HP's $1.5 million dollar investment will earn the company valuable offset credits with the government.

● **MPA,** a leading supplier of ASCII terminals in Australia, has moved its Sydney sales and support office from Artarmon to Suite 2, 156 Military Road, Neutral Bay. The new phone number is (02) 908 3666.

● **Barson Computers** has announced the appointment of Mr Robert Padmore to head its new manufacturing plant in NSW. Mr Padmore is to be responsible for the planning, establishment and running of the plant at the company's new complex in Talavera Road, North Ryde, NSW.

● **Arlec Pty Ltd** has appointed The Conwell Trading Co as its new agent for North Queensland. Their address is 21 Mackley Street, Garbutt, Queensland 4814. Telephone (077) 79 4288.

● **Datacraft's Black Box** division has been moved to larger premises at 34-36 Manchester Road, Mooroolbark, Victoria, 3188. Telephone (03) 726 7600. The Black Box range includes pre-assembled cables and connectors from Datacraft's automated assembly line.

SILLY SPEAKER SENSATIONS

PIONEER

UNBELIEVABLE SPEAKER BARGAIN

PIONEER 4" 8 OHM 10 WATT SPEAKER

NORMALLY $5.95 ea

SAVE A MASSIVE $4.95

MINIMUM BUY 4 pcs

Cat. AS-3025

ONLY $1.00 ea

PLEASE NOTE: Due to weight add extra $1 Post & Packing

SILLY PRICES

PIONEER

PIONEER SURPLUS ECONOMY TWEETER

Normally worth about

$4.00 each

Limited Quantity

Cat. CT-2000

ONLY $1.00 ea

PIONEER

We have made a bulk purchase of DISTRESS STOCK SPEAKERS, and can offer you the basics for some speaker kits at ridiculous prices.

GRILLED MIDRANGE AND TWEETER

Two really nice Pioneer matching speakers. Put them with a crossover $12.95 ea Cat. CX-2615 and with one of the woofers on this page for a fabulous system, which would handle up to 50 watts RMS, depending on the woofer chosen.

TWEETER Cat. CT-2005

USUALLY $6.95 ea

MIDRANGE Cat. CM-2078

USUALLY $14.50 ea

BUY 2 OF EACH FOR

ONLY $29.90

SAVING YOU $13.00

Almost the cost of the 2 tweeters

Sorry No PIC available for tweeter

PIONEER

GREY MIDRANGE & TWEETER

Basically the same specs as the grilled ones, except both speakers have square grey frames.

TWEETER Cat. CT-2040

USUALLY $5.95 ea

MIDRANGE Cat. CM-2042

USUALLY $12.50 ea

BUY 2 OF EACH FOR

ONLY $23.90

SAVING YOU $13.00

More than the two tweeters!

NEVER TO BE REPEATED

PIONEER 6" WOOFER 4 OHMS

Another huge scoop once only purchase. Ideal woofer for cars, or a small speaker box, or even two in a tower box.

★ Power Rating 15 watts RMS ★ Nominal Resonant Frequency 40-45Hz ★ Nominal Sensitivity 97dB/W ★ Response Range to 4,000Hz

WE STOCK THIS IN A TWIN CONE VERSION for $17.50

A REALLY SPECIAL PRICE WOULD BE $10. BUT WE HAVE SLASHED THEM TO ONLY $6.00 ea.

THAT'S CRAZY Limited Quantity

Cat. CW-2105

SAVE $11.50

ONLY $6 ea

PIONEER

TOO MUCH MIDRANGE OR HIGHS? If this is your problem put one of each in line with your speakers. They are easy to install and come with wiring instructions. Power handling 80 watts RMS system power.

NORMALLY $7.95 ea

THIS MONTH

1 TWEETER Level Control and 1 MIDRANGE Level Control for

$7.95

THAT'S 2 for 1 or ½ PRICE

Mid Control Cat. AC-1680

High Control Cat. AC-1682

MANUFACTURERS/ WHOLESALERS!!

Turn your surplus stock into cash!!

Jaycar will purchase your surplus stock of components, electronic equipment or traded-in gear in good condition. We are continually on the lookout for sources of prime quality merchandise that can be resold to electronic enthusiasts.

Call Gary Johnston or Bruce Routley NOW (02) 747 2022

PIONEER

PIONEER 12" GUITAR SPEAKER

65W RMS

Strictly limited quantity. Crazy price. They won't last!

USUALLY $59.50

SAVE $20.00

Cat. CG-2381

SAVE $20.00

PIONEER

★ Impedance 8 ohms ★ Power rating 65W RMS ★ Sensitivity 97dB/w ½ metre ★ Frequency range 60-6kHz ★ Resonance frequency 80hz

ONLY $39.50

PIONEER DOME TWEETER

LESS THAN ½ PRICE

A dome tweeter for under $10! Ridiculous! Only 250 available.

USUALLY $18.50

SAVE $9.55

Cat. CT-2020

★ Impedance 8 ohms ★ Power rating 25W RMS - 100W RMS system power ★ Crossover frequency 2000Hz ★ Sensitivity 95dB/w ½ metre ★ Frequency range 2000 - 20,000Hz

PIONEER

SAVE $9.55

ONLY $8.95

PIONEER HORN TWEETER

Great sounding black anodised square metal horn. Two together sound great. Limited quantity.

LESS THAN ½ PRICE

WAS $13.50 SAVE $7.00

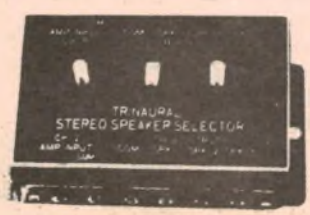
Cat. CT-2014

PIONEER

★ Impedance 8 ohms ★ Power rating 12W RMS - system 60W RMS ★ Crossover frequency 2000Hz ★ Sensitivity 101 dB/w ½ metre ★ Frequency response 2000 - 20,000Hz

SAVE $7.00

ONLY $6.50



MOTOROLA PIEZO TWEETER BARGAIN!

This Hi Fi high power tweeter is a surface mount, cone dispersion line source unit that is fitted with its own grille. The use of high temperature materials in its construction means it can be used in automotive applications. Two piezo units provide a wide (90°) dispersion horizontally with a narrow dispersion vertically. Sensitivity is 98dB @ 2.8V @ ½m. Frequency response easily goes out to 40kHz. The KSN-1071 normally sells for a very reasonable **$24** each (pre-devaluation). While stocks last this unit is available from Jaycar for the ridiculously low price of **$12.95 each!** A high quality, high power Hi Fi Tweeter for a prayer!

Cat. CT-1918

ONLY $12.95 ea

APOLOGY

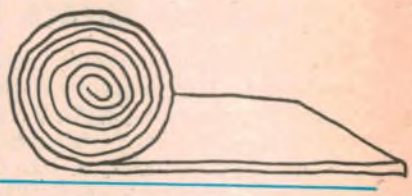
In our July ads we advertised that our Salvage Warehouse was at Concord. By the time the ads hit the streets we had had a change of plan and the stock had been moved to GORE HILL STORE. We apologise for any inconvenience caused.

INNERBOND

Innerbond is the ideal substance for lining the insides of speaker cabinets. It has excellent damping properties and is clean and non-irritating. Comes on a roll approximately 900mm wide. Thickness is 25mm.

Cat. AX-3690

$4.50/metre



GRILLE CLOTH

High quality, acoustically transparent grille cloth is ideal for protecting those expensive drivers - but making sure all the sound gets through. Comes in a 1.5 x 1 metre roll. Black in colour.

Cat. CF-2752

$10.50/metre

7 WAY SPEAKER SWITCH

This stereo speaker switch will enable you to select any combination of three pairs of speakers. Comes complete with wall plate. Has easy to connect screw terminals. Full instructions supplied. Separate switch for each pair of speakers. Not the cheap rotary switch type.

Cat. AC-1676

ONLY $12.95 ea

BUT THIS MONTH

SAVE $4.00

ONLY $8.95 ea

JAYCAR FAVOURITES FOR YOU!

Biotron "Electronic Blood/Alcohol Checker

Simply blow into the mouthpiece to see if you are over the limit. Dual analogue meter and LED go/bordertine/no go readout. Calibrated in Australia. Surprisingly accurate. Can be recalibrated if the law changes. Reads for 0.05.
Cat. YS-5100

NORMALLY $78.00
SAVE $29.00
ONLY $49.00 ea

ULTRASONIC HOUSE ALARM

This alarm is fully self-contained, even includes the siren. Place it on a shelf, (it looks like a speaker) and the ultrasonic waves detect movement. Great for single room protection, or can be used as a master control for a whole house.
You can connect an external on/off switch, external horn siren. It has provision for N/O instant circuit and N/C instant and delay. A battery compartment is there for C cells, but we recommend a 1.2A 12V Gel battery. Cat. SB-2480 $26.50 and 240V power supply Cat. MP-3019 $22.50

WE HAVE A LIMITED NUMBER AVAILABLE FOR
ONLY $69.00
Normally $99.00
SAVE $30.00

Cat. LA-5140

DC CONVERTOR

This unit plugs into your car cigarette lighter socket and will provide up to 300mA at 6 and 9V DC. Ideal to power the Ghetto Blaster in your car! We only have a few left so hurry!
Cat. MP-3015

NORMALLY SELL FOR AROUND $10
This Month $2.95
that's ⅔ OFF!

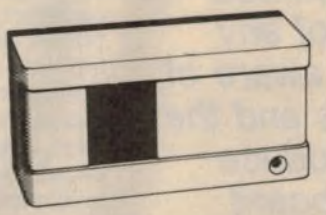
INFRA RED MOVEMENT DETECTOR

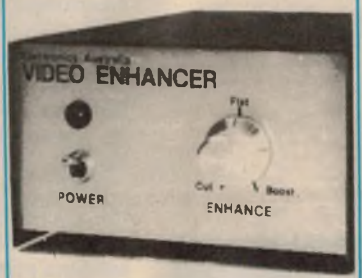
The infra red or IR detector for short, falls into the Black Magic category. It basically is a high gain passive tuned receiver of a particular IR band. The heart of the unit consists of a high gain lens (antenna?) which has a 'Commutated' field of view. Its reception pattern is comb like, but highly tuned to the IR wavelength of human bodies. When a human passes within proximity of the pickup area, the lens will selectively pick up IR radiation and then not. Movement across the pickup area will result in a series of pulses sent to a detector circuit.
IR detectors are very reliable as they do not transmit and will not respond to non heat radiating objects. Curtains, for example, can wave about without tripping the alarm. Even the cat is unlikely to trip the unit.

FEATURES:
- 12V DC powered
- Small 77mm x 62mm x 51mm
- Double sensor
- Computerised OC to lower failure rate
- Built-in test lamp
- Alarm output SPST 30V DC @ 1A
- NO or NC terminations

Cat. LA-5017

SAVE $20.00
ONLY $89.00 ea

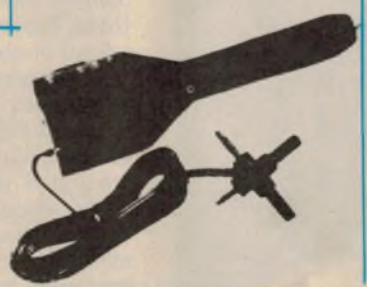




VIDEO ENHANCER

Ref: EA October 1983
A simple but effective kit to help improve copy recordings of video tapes. The Jaycar kit includes the box and Scotchcal label.
Cat. KA-1118

WAS $39.50
SAVE $14.50
ONLY $25.00 ea

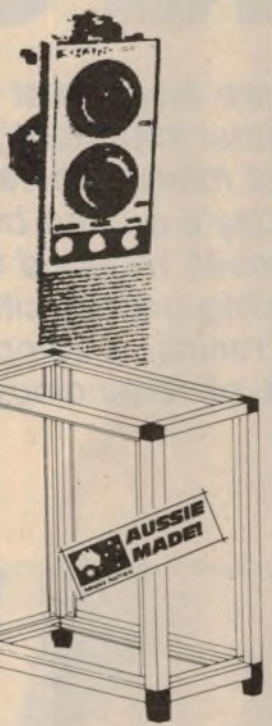


BARGAIN OF THE CENTURY!!

How do we do it? Another
BARGAIN!!

Once again, Jaycar has secured a massive below-cost scoop purchase. This time a nifty combination VHF/UHF television tuner assembly! We dare not mention the name of this famous Japanese brand!!! ★ Brand, spanking new ★ Separate VHF rotary tuner ★ Separate UHF rotary tuner ★ All knobs & wiring INCLUDED! ★ Attractive front panel fascia included! ★ Circuit diagram included!
Be quick to secure one of these bargains.
Cat. DM-9004

LAST FEW!!!!
SAVE $50.00!!!
ONLY $19.95 ea



"ZIP RACK" 19" RACK SYSTEM - NEW LOWER PRICES AND A WIDER RANGE!

The natural finish (silver) rack frames are now cheaper and we now have black frames as well!
THE RACK IS AVAILABLE IN 3 SIZES

6, 12 and 18 rack unit

(One rack unit is 44.5mm or 1¾").
Each kit comprises ★ 12 frame pieces, including 2 pieces with pre-punched holes for front panel mounting. Anodised finish. (You can use the rack back-to-front to mount non-standard racks) ★ 4 top corners (black) ★ 4 bottom corners (black) ★ 4 x clip-in M6 nuts for mounting your equipment) ★ 4 x M6 Phillips head mounting screws ★ Easy to follow instructions.
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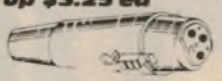

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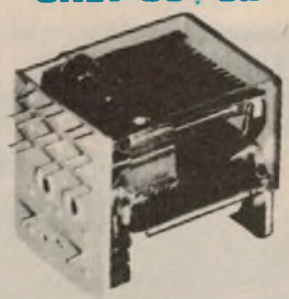

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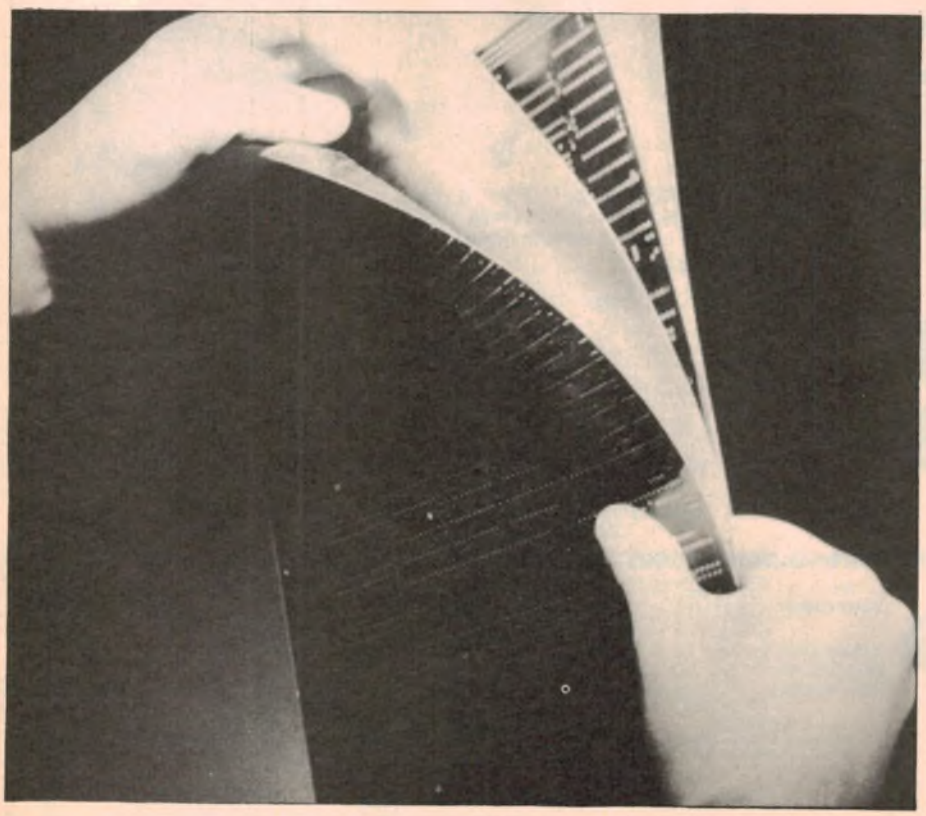
How multi-layer PC boards are made

A visit to Printronics

While most readers are aware that the printed circuit board is the most important part of any electronic device, not many people are aware of the complexity of today's printed boards and the manufacturing processes required to produce them. Australia's leading printed circuit board manufacturer is Printronics, a company which is right at the forefront of technology.

by LEO SIMPSON



For complex electronic circuitry, particularly computers, multi-layer printed circuit boards are now commonly used. They allow ICs to be densely packed.

If you are a manufacturer of equipment which requires a high grade printed circuit board, one company you are sure to think of as a supplier is Printronics Pty Ltd. This company specialises in the manufacture of double-sided, multi-layer and flexible printed circuit boards, for use in computers, telecommunications, miniature medical electronics and defence equipment.

Printronics was formed in June 1972 as a producer of printed circuit artworks. The company quickly progressed to the full manufacture of printed circuit boards and was firmly established in this field by 1974.

Since that time it has concentrated on the professional market and developed the resources and range of services to satisfy a growing demand for the highest quality printed circuit boards. Recently, Printronics Pty Ltd became a wholly owned subsidiary of the Abignano group of companies. Abignano Ltd is a publicly listed company.

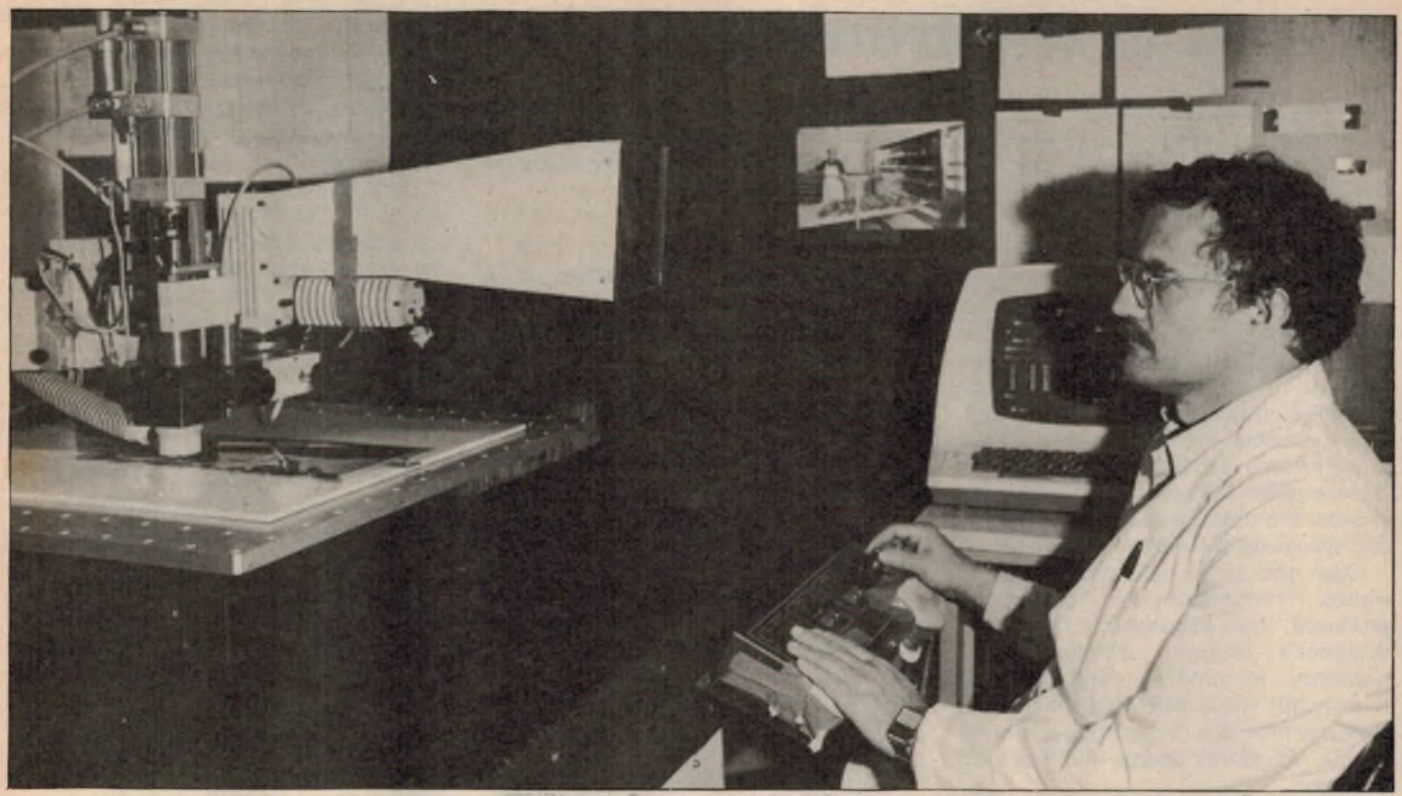
Printronics has two factories, one at 25/33 College Street, Gladesville, in Sydney and the other at 17 Scoresby Road, Bayswater, Victoria. They employ a total of about 180 people.

The typical board produced by Printronics these days is large, perhaps as big as 30 x 40cm or even bigger, and may accommodate a hundred or more integrated circuits. The board will be double-sided with plated-through holes or may be a multi-layer board with as many as eight conductive layers all laminated together.

The price of a board of this calibre will probably lie in the region of $100 to $200 each, depending on the overall complexity, the material specification and the quantity in the production run.

A single production order may easily run into several hundred thousand dollars and will typically take between four to eight weeks from order to delivery.

Producing such a board is no job for a backyard manufacturer. It requires a



Once the actual size transparencies for the PCBs are produced, they have to be digitised. This microscope has cross-hairs which are precisely located over every hole to provide a numerical control tape for drilling.

major investment in manufacturing plant and a staff of highly skilled employees. The story of how such a complex printed board is produced is one of many steps but one which makes very interesting reading.

Double sided PCBs

A major part of Printronics activities is the manufacture of double-sided printed circuit boards with plated-through holes. This is the standard board for a great deal of modern professional electronic equipment and it represents a major part of the initial development cost of any professional product.

The question which must naturally arise when considering large printed circuit boards is "why have double sided boards and why have plated through holes?"

The answers relate to the complexity of today's circuits which use large numbers of multi-pin integrated circuits. By using a board which has a printed circuit pattern on both sides, the integrated circuits can be packed more closely together while still enabling all the connections required between the IC pins to be made.

If the board were restricted to having just one printed circuit pattern, it would be difficult to fit all the needed copper tracks around the ICs and there would inevitably be a lot of jumper leads which add labour and time to the production process. So double-sided boards can be packed more densely and largely eliminate the need for jumpers.

Plated through holes are required to make connections between the copper circuit on one side of the board and the copper pattern on the other side. If the holes are not plated through, it is necessary to make these connections either via pin-throughs which are soldered on both sides of the board, or via the component leads themselves which again must be soldered on both sides.

Soldering pin-throughs on double sided boards may be practical for boards made in very small quantities, but it is clearly impractical for large densely packed circuit boards which have to pass through a wave soldering machine. Hence a most important facet of double-sided board manufacture is the processing required to obtain reliable plated-through holes.

First steps

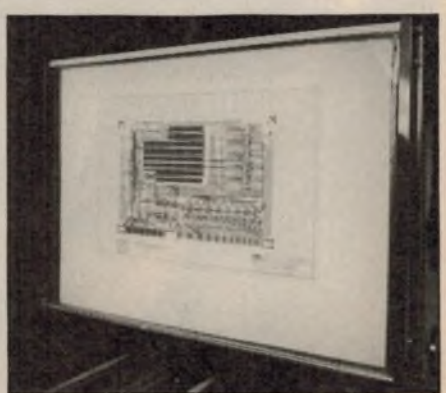
The first steps in the production of any printed circuit board is the design of the artwork. This may be hand-laid using red and blue tapes to indicate the tracks on each side of the board.

Usually the original artwork will be twice full size (ie, 2:1), in order to obtain more precision by the 50% photo reduction.

Alternatively, the artwork may have been produced by CAD (computer-aided design) process and printed by a computer-controlled photo plotter. This has the advantage of being more quickly produced, more consistent in execution, and better in registration between the circuit layers. CAD-generated artwork is usually produced full size rather than twice up.

Normal production boards from Printronics are produced from artwork having a minimum track width and minimum track spacing of 6 thou. That's 0.15mm in metric and is very fine indeed.

For a standard double-sided printed circuit to be manufactured, four photo transparencies need to be produced from the designer's artwork. These are the two printed circuit patterns, the solder mask



This is a typical tape artwork for a double sided board. One side uses red tapes while the other uses green. This artwork must be photographed and reduced by half to produce two actual-size transparencies of the copper patterns.

A visit to Printronics

and the component overlay. As well, there must be mechanical drawings of the board showing the overall shape, cut-outs, material specification, hole sizes and any other necessary details.

Step-and-repeat

Where the boards to be made are physically quite small, several may be made on the one large sheet of copper laminate. For these boards, the artwork is duplicated many times on a step-and-repeat camera, which reproduces the same pattern precisely many times on the one photo transparency. This greatly reduces the physical handling of boards and speeds up the production process.

Once the actual size printed circuit photo transparencies have been produced by Printronics from the designer's original artwork, it is necessary to produce tapes for the numerically controlled drilling machines. This machine can be regarded as a very precise XY plotter except that it is used in reverse.

It is equipped with a microscope which the operator views via a screen rather than an eye-piece. The operator locates the microscope cross-hairs precisely over each hole position in the artwork and presses a button to record the digital information on tape. At the same time, a pen marks each hole on the artwork as it is done, which can be used as a check for completeness.

Production

The first step in production of a double-sided printed board, once the above details have been taken care of, is the drilling of the bare copper laminate. For most of the boards made by Printronics, this is 1.6mm thick fibreglass laminate with copper foil on both sides.

The bare, unetched boards are drilled at least four at a time, in a numerically controlled machine which has four spindles, one for each board (or stack of boards, if they are thin).

The spindles can automatically change drill bits, as and when required, according to their programming. The machines have very large and heavy marble frames, to ensure very good dimensional stability.

The holes are drilled at a rate of several holes a second, so large boards accommodating, say, a hundred ICs, might take 10 to 15 minutes to drill.

Plating through holes

Once the boards have been drilled, the next step is plating through the holes. The boards are first given a brush and scrub, to remove any dirt and detritus from the drilling process, and then placed into racks. These are then placed in a bath of alkaline detergent cleaner/conditioner.

This is mainly intended as a wetting agent for the fibreglass surface exposed after drilling. This surface is hydrophobic, ie, it repels water, and therefore needs a wetting agent before the plating process can proceed. Several rinses are applied to the boards, after which they go into an acid bath to produce a micro-etch of the copper surfaces.

Further rinses follow, and then a dip into an acid-salt solution (sodium chloride plus hydrochloric acid). This coats the bare fibreglass surface in the board holes with an ionic solution prior to the next step — a dip into a tin-palladium colloidal suspension. This deposits a mixture of tin and palladium, mainly the latter, onto the fibreglass surfaces. This step is probably the most important of all, and the most crucial.

Next, the boards are passed to a bath containing a fluoro-boric acid, to remove excess tin deposits.

Copper plating

Finally, we come to the copper plating stage. This is an electro-less process, meaning that it is non-electrolytic, ie, no electricity is used.

The boards are placed in a bath containing the following ingredients: as you might expect, there is a copper salt such as copper sulphate or copper chloride, an alkaline agent, a complexing agent (a large organic molecule compound known as EDTA) and formaldehyde. The copper is deposited onto the hole surface, with the palladium acting as a catalyst to the process.

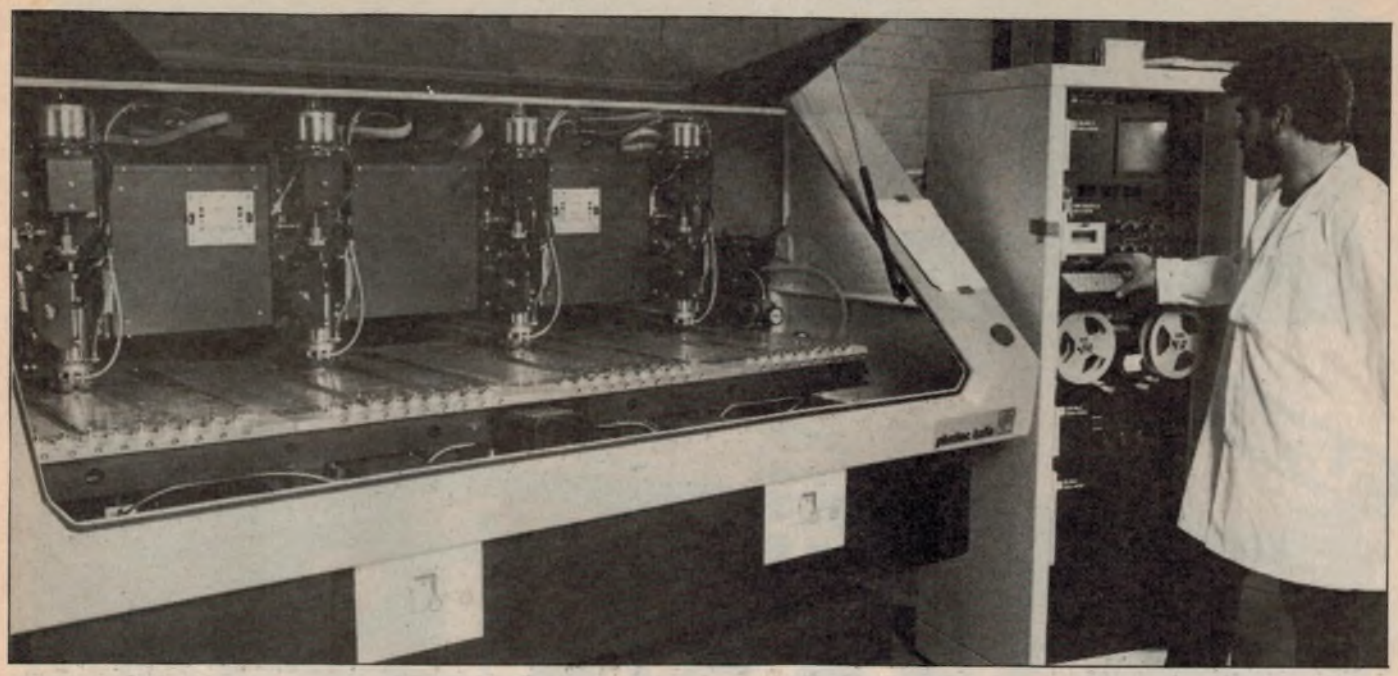
At this stage, we have boards, which have been drilled and their holes plated through with copper. All the normal process steps for a printed board remain: coating with photo resist, exposure, developing and etching, to provide the copper tracks on both sides of the boards. Even then, quite a few steps remain before the boards can be delivered to the customer.

One of these steps is nickel and gold plating for edge connectors. Solder plating can also be done, to provide protection of the copper pattern and easy solderability.

Printronics' preferred process, to protect the copper pattern, is a black oxide coating. The oxide coating is grown onto the copper surfaces in an oxidising solution (this is a similar process to anodising aluminium) of sodium chlorite.

The resulting oxide coating has a number of advantages: (a) it produces a clean conductor surface with better

This is one of the later steps in board production: application of dry film solder resist. The film is exposed and developed and then cured by an ultraviolet light and baking process, after which it is solder dipped and levelled.



Drilling is one of the first stages of double-sided board production and a later stage in multi-layer boards. This large numerically-controlled drilling machine has a very heavy marble frame for dimensional stability. The four drilling heads can change bits at will.

adhesion of the green solder mask; (b) it provides a board which is easier to inspect for defects; and (c) it is less likely to produce puckering of the solder mask due to heating of the copper tracks when the boards go through wave-solder baths.

The green solder mask, to prevent solder being deposited on non-hole areas, is a one or two-part epoxy which is applied by screen-printing and cured by an ultraviolet light and heat process. This produces a very tough and stable coating which is also attractive. There is also an alternative dry film process which gives the same result.

After having the green solder mask applied, the boards are given an acid etch, to remove the oxide coating the exposed pattern and in the plated-through holes. (The gold plated areas are protected during this and the subsequent steps, by a heat-resistant tape.)

The boards are then given a solder dip which coats all areas not covered by the solder resist. The process is in three stages. First, a dip in hot flux, then into the solder bath and then a pass through hot "air knives". These are jets of hot compressed air which blow all the excess solder out of the holes and level the solder off flush with the surface of the solder mask.

The final process is to screen-print the component overlay in white ink onto the top surface of the board. No, it isn't. Several steps remain.

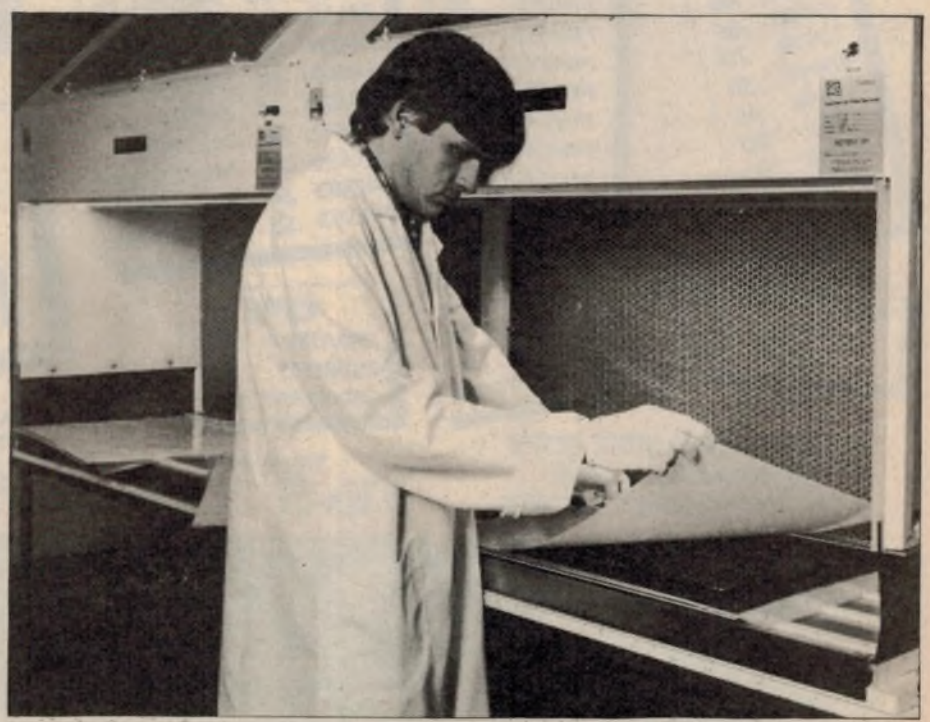
The boards are machined to final shape with diamond-tipped saws, press blanking or, more commonly these days, by numerically controlled high speed routing. The router bits are usually 2.5mm in diameter, to produce a fine radius on all board corners. The NC router machines also produce any odd-shaped cut-outs in the boards.

Finally (finally!) the boards are visually inspected before being packed for delivery. Printronics can also fully test the boards for track continuity, open circuits and shorts using a programmable tester, a Fairchild 4400. This machine has a "bed of nails" at a 2.54mm grid spacing. Printronics charge about $4500 to "hard wire" the bed of nails and otherwise program the machine.

This may seem fairly steep, but on a run of 1000 boards it only adds $4.50 to the board cost — which is cheap for a complex design.

Multi-layer boards

Multi-layer boards are quite another story. These are used to obtain even greater board complexity, better circuit performance and higher packing density. As far as Printronics are concerned, a typical multi-layer board has six



This is the build-up station for multi-layer boards. Processed copper laminates and uncured "pre-preg" epoxy glass mats are laid up prior to being fed to the laminating press.

The machine in the background of this photo is the laminating press for multi-layer boards. The boards are laid up between heavy stainless steel plates and loaded in batches into the three-level press which subjects them to heat and pressure to cure the epoxy.

A visit to Printronics

conductive layers but it might go to eight or even higher.

You may well ask how a multi-layer board can provide higher performance. Apart from more direct conductor runs, it is usual practice to make one conductive layer the positive supply while another is the ground plane or 0V supply. These layers have minimum copper etched away, ie, solely around the IC lead holes.

The resulting large supply conductors (occupying almost the entire board area) have a very low impedance, to ensure excellent high frequency performance which is mandatory in today's high speed computer designs.

How they're made

While conventional boards start out as a relatively thick copper laminate, multi-layer boards start out as fibreglass laminates, 0.1 to 0.8mm thick and with copper film on both sides.

Here, the first steps are to apply photo resist, expose, develop and etch to produce the copper track pattern on the internal layers. These are then laid up with a number of "pre-preg" plain uncured fibreglass mats and outer layers of fibreglass laminates with unprocessed copper foil. These become the top and bottom copper surfaces of the board.

Four of these complete sandwiches are then fed into a laminating press, where the material is subjected to high temperature and pressure. This cures the fibreglass and leaves a board which appears the same as the virgin material for standard double-sided boards. The difference is that it has two or more inner etched conductive layers which are concealed within the board.

The composite boards are then drilled and made ready for the plating through process for the holes. This is similar to that for double-sided boards, but there are a number of wrinkles. When the boards are drilled through, the epoxy in the hole edges tends to be smeared over inner copper conductors. There are a number of processes by which the copper is exposed but the most elegant used by Printronics is an etching method which pares back the epoxy around the copper conductors. This process gives very good "keying" of the copper plating to the internal copper conductors.

From there on, the process steps for multi-layer boards are very similar to those for double-sided boards.

Even in an article of this length it is difficult to do full justice to the range of services which can be provided by Printronics Pty Ltd. They have a full prototyping service and can produce boards on quite a range of materials, including microstrip on Teflon substrates with soft gold finishes, surface mount and flexible boards and boards with carbon tracks.

An inspection of Printronics factory in Sydney (and doubtless their manufacturing facility in Melbourne) is a satisfying experience for two reasons. First, it is good to know that such advanced manufacturing facilities exist in this country. Second, it is good to know that there are sufficient companies here to more than adequately support the facility.

Printronics Pty Ltd is currently engaged in a major expansion program and appears destined to experience strong growth into the foreseeable future.

It looks like a drilling machine but it is a numerically controlled high-speed routing machine for cutting the boards to final shape. Ear protectors are a must!

Acknowledgement

Electronics Australia gratefully acknowledges the assistance of the staff of Printronics in preparing this feature and in supplying all photographs. Particular acknowledgement is accorded to Gary Worth, Sales & Marketing Manager and to Tim Kotlar, the Technical Manager.

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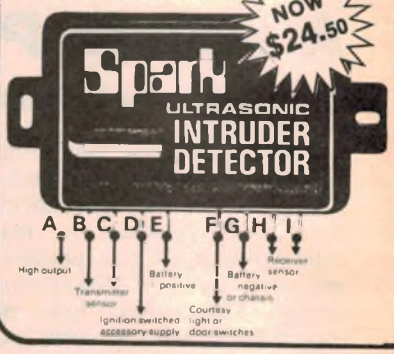

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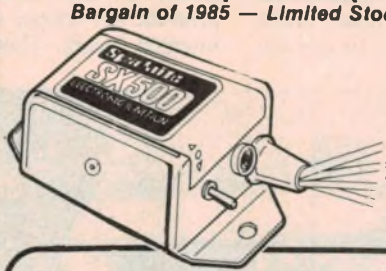

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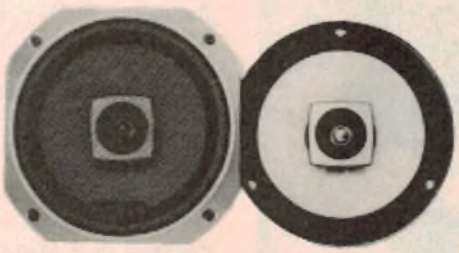

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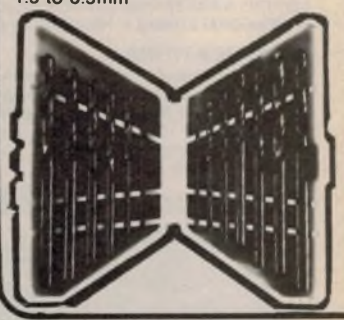

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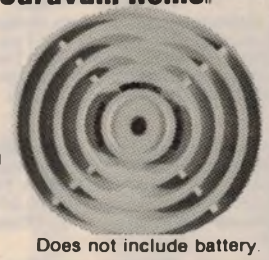

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- Loud, persistent 85db alarm wakes the soundest of sleepers.
- Low cost 9 volt battery lasts approx. 1 year,easily replaced.
- Low battery alarm • Test Switch.
- Dead easy to install-takes less than 10 minutes-all you need is a screw driver. **Protect yourself and your whole family as of today.**

BLOOD PRESSURE & HEART RATE MONITOR

Why Risk Unnecessary Heart Attack?

A simple (take the reading yourself) periodic check of your blood pressure and pulse provides an "inward look" into a vital aspect of your bodily health. Heart disease strikes down many people in their early 40's (or even 30's). The tradgedy remains that had such victims been alerted, remedial medical, physical and dietary action could have been prescribed to avoid illness and in many cases restore full bodily health.

A superb Gift for the dedicated fitness enthusiast **Absolutely essential** for those over 40 and concerned with their health, or on Fitness Therapy. Use this **easy to operate** Monitor, to measure your pulse (or heart rate) and Blood Pressure. Remember high blood pressure is in itself symptomless and the usual forerunner to future chronic heart disease. **Features** include "error" display warning of incorrect use. Handbook supplied will enable anyone in your family to be fully conversant with this monitor in minutes. Easy to read display of Systolic and Diastolic Blood Pressure and Pulse Rate. Cat X 3055

Entertainers Microphone

Dynamic Low Impedance 600 Ohm Fitted with Lead and Jack Plug

A scoop purchase of these surprising quality entertainers Microphone allows us to pass these on to you at an unbelievable price - these recently sold for nearly $40!! - Sturdy construction, frequency response 80-15KHz

$12.50

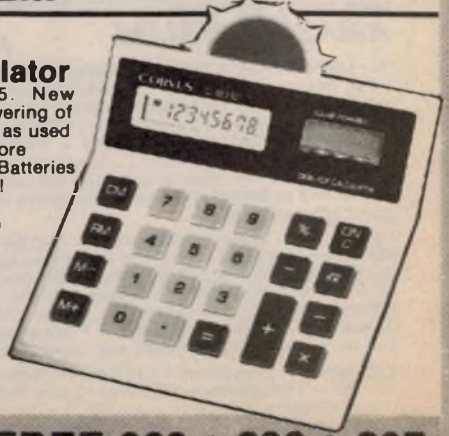
Desk Top Calculator

Just released for 1985. New technology now allows powering of large desk top type display as used with our new X 1050. No more batteries to go flat. No more Batteries to leak! No more Batteries!!! Perfect for Home or Office Fantastic Value. Cat X 1060

Was **$19.95**

Now

$15



● PHONE YOUR ORDER — ALTRONICS TOLL FREE 008 • 999 • 007 ●

ALTRONICS COMPONENTS 9th Birthday Sale

• Hundreds of Quality Electronic

Save up to 50% on

bankcard welcome here · MasterCard · VISA

Credit Cards accepted — You don't pay a

POWERFUL 6000 RPM MINI DRILL
FOR PC WORK

Tons of Torque. Just the shot for PCB work., 12V DC operated from external power pack. 1.2mm chuck capacity. Supplied c/w 1mm drill bit. Cat T 2302

A Top Seller at $14.95
Now an Incredible
$10

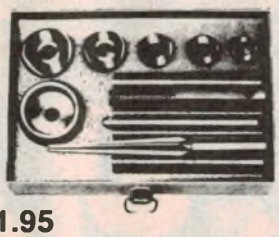
Quality Imported Tools

NEEDLE FILE SET
Use for contacts, points, general electronic work. Very handy! Set of 5 files, round, square, half round, triangular and flat. Cat T 2350

Great Value $11.95

HOLE PUNCH SET
A must for every enthusiast or serviceman. Cuts holes in metal up to 1.6mm (16 gauge). Set of 5 punches and tapered reamer. Cat T 2360

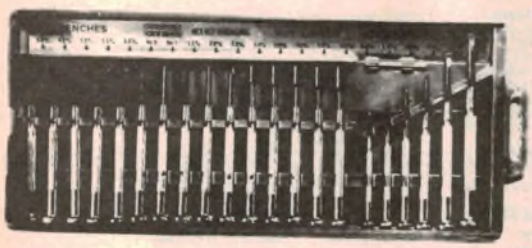
Punch Sizes
16mm
18mm
20mm
25mm
30mm



$21.95

Clearance Sale

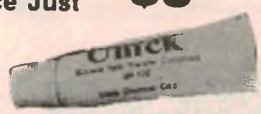
50% Off Niffty Tool Kit Set



This very handy 21 piece tool kit would compliment every home work bench. Set includes socket drivers, Allen key drivers, open ended spanners Philips drivers etc.
All housed in PVC storage box with clear plastic lid.
Cat T 2398
Were selling for $16.95
Altronics Clearance Price Just $8

HEATSINK COMPOUND
Heat conducting paste facilitates heat transfer from semi to Heatsink. One tube good for up to 30 T03 package semiconductors.

H 1600 7.5g Pack **$2.50**



TRADE PACK
H 1610 150g **$11.50**

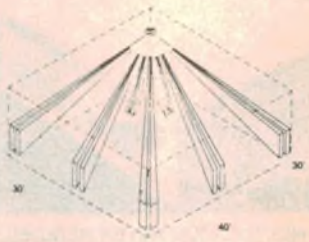
INFRA—RED MOVEMENT DETECTOR

$89

ACTUAL DETECTOR APPROX.
100W x 60H x 90D

The heart of the unit consists of a gain lens (antenna) which has a "Commutated" field of view .
Its reception pattern is comb-like,but highly tuned to the IR wavelength of human bodies. When a human passes within proximity of the pickup area, the lens will selectively pick up IR radiation and then not. Movement across the pickup area will result in a series of pulses sent to a detector circuit. IR detectors are very reliable as they do not transmit and will not respond to non heat radiating objects.

FEATURES:
• 12V DC powered • Small • Double Sensor • Computerised QC to lower failure rate • Built-in test lamp • Tamper switch included • Alarm output SPST 30V DC + 1A
Cat S 5300



DE-SOLDER BRAID

HALF PRICE

T1230 ..... **$1**

LOW COST 25 WATT MICRON

Light-weight • Interchangeable tips • Efficient thermal transfer from element to tip • tip temperture maintains within the limits suitale for electronic work and also small household jobs • fitted with T 2434 tip - and of course, fully S.E.C. tested and approved. Cat T 2415

With Iron Plated Tip Just - $17.50

Solder at 1980 Prices!!!

Be quick 1000 rolls only at this price

Altronics professional grade 1mm solder with tip save additive - Handy 200gm reel. Cat T 1200

1 - 9	$5.00
10 - 19	$4.50
20+	$4.00

Save up to a Massive 35% on our Major Competitors Prices

PROFESSIONAL TEMPERATURE FIXED SOLDERING IRON

- 370° Fixed Temperature
- High Efficiency patented Heating Element
- Iron clad, chrome plated, long life interchangeable tips..

Why pay more for Weller?

IRON CLAD TIPS
This iron used high grade iron clad, chrome plated and pretinned tips. Tip life expectancy is many times that of conventional plated tips.
Cat T 2420

~~$22.50~~ **$19.50**

Super Type Glue

Super Aron Alpha Instant Glue.Utilises patented "no mess" dispenser. Essential for home handyman, technician, laboratory etc. Cat T 3010

1 - 4 **$2.95**
5 up **$2.00** ea

Bulk Buy this Month and Save

Bonanza

Components and Products — our Competitors prices.

cent until you get your statement next month!

These Sale Prices Valid Until 31st October Unless Sold Out Prior

SAVE $$$

ALARM CONTROL MODULE

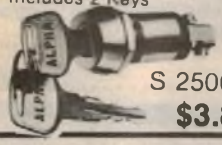
EASY TO INSTALL ★ BUILT IN SIREN DRIVER—DIRECTLY DRIVES LOW COST 8 OHM HORN SPEAKERS, SIREN HORNS AND MECHANICAL BELLS ★ LOW POWER 12V DC OPERATION.

EXIT/ENTRY DELAY
BOTH N/C AND N/O CONTACTS
Ideal for homes, offices, factories, shops, caravans, any area requiring protection.

S 5350
NOW
$39.50

Quality Key Switches 1/3rd Off!!

Standard Type
Includes 2 Keys



S 2500 **$3.80**

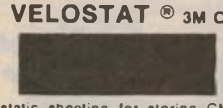
High Security Type
4 Pole
2 Position

S 2510 **$4.75**

IDC CABLE

	Per M	10M +
W 0616 16 way	1.75	1.65
W 0624 26 way	2.75	2.55
W 0634 34 way	3.60	3.35
W 0650 50 way	6.50	6.00

VELOSTAT ® 3M Co.

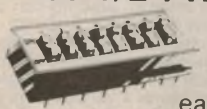


Non-static sheeting for storing CMOS IC'S, LSI'S etc. 1000 times better than aluminium foil. Will store up to 150 IC'S on one 225 x 150mm sheet.

H 0600 ..... ~~$3.50~~ per sheet **$2.00**

DIL SWITCHES

From 80¢
Near 1/2 Price



		ea.	25 Up
S 3050	4 way	90¢	80¢
S 3060	8 way	1.25	1.00
S 3065	10 way	1.50	1.35

2N3055 Super Buy Premium Quality S.G.S. Brand

1 - 9	99¢
10-24	89¢
25-99	79¢
100 up	69¢

ALL PURPOSE TIMER STOPWATCH

Counts up in seconds and minutes to max. 60 mins. Counts down in seconds and minutes to max. 100 mins.

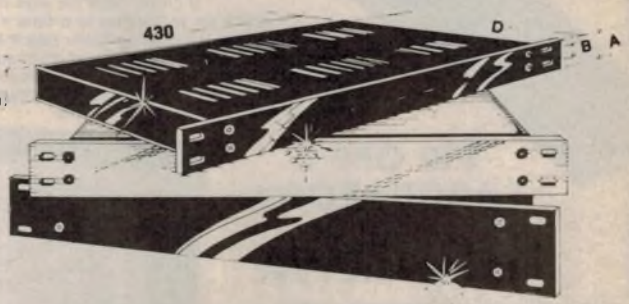
This fantastic little digital timer includes in-built alarm (count down function) Typical applications would be Medical timer, Kitchen timer, time reminder, excercise timer or even Parking Meter reminder.

Don't Pay $25

Altronics Sale Price $15
Cat X 1030

PROFESSIONAL SERIES RACK CABINETS

Now your preamps, Amps, Control Modules Monitor Panels etc. can look every bit as good as Technics Nakamichi and other top manufacturers.



ALL ALUMINIUM CONSTRUCTION

FEATURES: These beautifully crafted rack cabinet boxes will give your equipment a real Ist class appearance with removable top and bottom cover panels • All dimensioning conforms to the International Standard • Natural or Black finish • Ventilated lid • Deluxe finish front panel • Individually cartoned • Supplied in Flat Pack Form - Easily assembled in minutes - **Side Elevations:-** D=254mm C (Internal Chassis Height) • B (mounting Bolt Centres).

SIX NATURAL AND BLACK FINISH MODELS — The Black or Natural finish cabinets are each available in 44mm, 88mm or 132mm high models. Mounting hole centres conform exactly to International Racking Specifications both vertically and horizontally.

Cat. No.	Finish	A	B	C	Were	Now
H 0401	Natural	44	34	38	49.95	47.50
H 0402	Natural	88	57	82	59.50	56.00
H 0403	Natural	132	89	126	69.50	62.95
H 0411	Black	44	34	38	55.00	50.00
H 0412	Black	88	57	82	65.00	59.50
H 0413	Black	132	89	126	75.00	69.50

EGAD! — Popular D Range Computer Connectors Reduced up to 50% *Be Very Quick - This Month Only*

		WERE	NOW
P 3000	DB9 Male 9 Pin	2.75	1.95
P 3010	DB9 Female 9 Pin	3.25	2.25
P 3020	DB9 Male RT/L PCB	3.75	2.50
P 3030	DB9 Female RT/L PCB	4.50	3.00
P 3040	DB9 Male Straight PCB	2.95	2.00
P 3050	DB9 Female Straight PCB	3.95	2.70
P 3090	DB9 Backshell cover	1.98	1.00
P 3100	DB15 Male 15 Pin	3.25	2.00
P 3110	DB15 Female 15 Pin	3.85	2.50
P 3120	DB15 Male RT/L PCB	4.35	3.00
P 3130	DB15 Female RT/L PCB	5.50	3.95
P 3140	DB15 Male Straight PCB	3.85	2.50
P 3150	DB15 Female Straight PCB	4.85	3.10
P 3190	DB15 Backshell cover	2.20	1.10
P 3200	DB25 Male 25 Pin	4.95	3.30
P 3210	DB25 Female 25 Pin	5.50	3.95
P 3220	DB25 Male RT/L PCB	4.95	3.25
P 3230	DB25 Female RT/L PCB	6.95	4.50
P 3240	DB25 Male Straight PCB	4.95	3.20
P 3250	DB25 Female Straight PCB	6.25	4.50
P 3290	DB25 Backshell Cover	2.20	1.10

Less 20% For 10 Up Quantities

ALTRONICS COMPONENTS

9th Birthday Sale

• Hundreds of Quality Electronic

Save up to 50% on

bankcard welcome here · MasterCard · VISA

Credit Cards accepted — You don't pay a

NEW $89

UV EPROM ERASER

Cat D 1450

Erase your EPROMS quickly and safely. This unit is the cost -effective solution to your problems It will erase up to 9 x 24 pin devices in complete safety in about 40 minutes for 9 chips (less for less chips). • **Erase up to 9 chips at a time** • Chip drawer has conductive foam pad • Mains Powered • High UV intensity at chip surface ensures thorough erase • Engineered to prevent UV exposure • Long Life UV tube • Dimensions 217 x 80 x 68mm • Weight 670 grams

$10 OFF !! LABORATORY SERIES MULTIMETER

Superb European styling with quality 'Beckman' style rotary switch. Features mirror backed scale to help eliminate parallax errors. • **Ranges: DC Voltage** 2.5,10,50,250,1000 **DC Current** 5, 50, 500mA and **10A** position. **Battery test** 1.5V 'AA' 1.5V 'C' and 'D'9V **Sensitivity** 20,000 Ohms/Volt D. Also features db scale. Cat Q 1020

10 AMP DC RANGE

NOW $22.50

SOLDERLESS BREADBOARDS

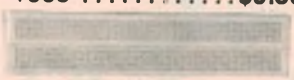
These solderless breadboards enable circuits to be literally thrown together in an instant, yet all components remain reusable. A necessity in all research laboratories to save on expensive development costs. • Standard 0.1 inch spacings • Accepts all LSI's semis, transistors, diodes, leds and passives • 22-30 gauge solid hook up wire for interconnections • Boards are 'Keyed' to enable easy expansion.

MINI 100 HOLES

P 1000 ..... $2.50

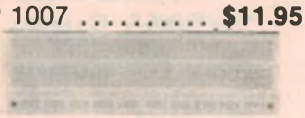
640 HOLES

P 1005 ..... $9.80



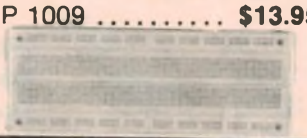
640 + 100 HOLES

P 1007 ..... $11.95



640 + 200 HOLES

P 1009 ..... $13.95



400 + 1280 HOLES

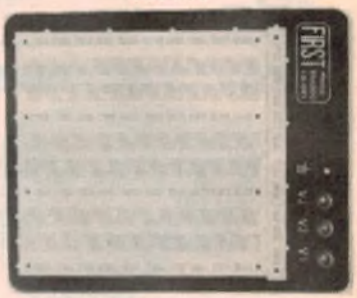
Accepts up to 16 x 16 Pin D.I.L.IC's. Screw Terminals for PS Connections

P 1012 ..... $29.50

500 + 1920 HOLES

Accepts up to 24 x 16 pin D.I.L. IC's Metal Backing Plate for Shielding of sensitive circuitry.

P 1015 ..... $45.00



STATE OF THE ART

PRESSURE SENSITIVE—ETCH RESISTANT PC ART AIDS BY IZUMIYA

Altronics proudly announce the inclusion to our range of the FANTASTIC IZUMIYA PCB ARTWORK AIDS—The incredible feature of IZUMIYA tapes, symbols etc. is, unlike most others, they are etch resistant—that is you can lay artwork direct on to the copper face of the PCB and etch directly with ferric chloride! — Naturally you can use them to prepare finished artwork to paper, film, metal in the normal manner.

SINGLE SHEET PACKS

ALL $1.95ea or 10 Up
SAVE OR MIX $1.60

DOUGHNUTS

2mm	H 8601
3mm	H 8604
4mm	H 8605

OVAL PADS

3 x 2mm	H 8610
4.5 x 3mm	H 8611

DIL IC PADS

Single	H 8641
Triple	H 8642

TRACKS

0.5mm	H 8621
0.8mm	H 8624
1mm	H 8625
2mm	H 8630

T-CONNECTORS 1mm Gauge — H 8635

EDGE CONNECTORS 3.17mm Pitch — H 8646

NUMERIC 2.7mm/H — H 8658

ALPHA

3.2mm/H	H 8673
3.8mm/H	H 8659

CREPE DESIGN TAPES

H 8702	0.5mm x 16M	$2.95
H 8703	1.0mm x 16M	$2.95
H 8704	1.5mm x16M	$2.95
H 8705	2.0mm x16M	$2.95
H 8710	Pack of any 4	$10.00

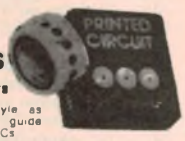
ART TAPE CUTTING KNIFE

SPARE PACK OF 6 BLADES T 2390 $4.95, T 2392 $1.25

ROLL PACKS

Ideal for Trade Users

Contents vary each style as dimensions differ. As a guide doughnuts contents 250 PCs



DOUGHNUTS

2mm H 8802	$3.50	$3.25
3mm H 8803	3.50	3.25
4mm H 8804	3.50	3.25

TEAR DROPS

3mm H 8830	$4.95	$4.50
4mm H 8840	4.95	4.50

T-CONNECTORS

1.6mm H 8816	$5.75	$5.50
2.5mm H 8825	5.75	5.50

IC PADS

4 x 2.8mm H 8841	$3.50	$3.25
4 x 2.5mm H 8842	3.50	3.25

Low Power Design also Works as a Battery Charger

12/240v Inverter for Small Appliances

Cat K 6705

$69.50

The inverter is ideally suited to powering low wattage mains appliances from the car battery while camping. This considerably improves the comfort level of the civilised camper. Similarly, it has uses in boating. Typically, it can be used to power an electric shaver, electric blanket, electric can opener or a 40W light bulb. Alternatively, back in the home (or still on the camp site), frequency sensitive items such as belt or idler driven turntables can be powered at a very precise crystal controlled frequency for accurate sound reproduction. If speed variation over a small range is required, then a switch is provided to change from the crystal based 50Hz signal to a variable oscillator.

● PHONE YOUR ORDER — ALTRONICS TOLL FREE 008 • 999 • 007 ●

ALTRONICS COMPONENTS 9th Birthday Sale

• Hundreds of Quality Electronic

Save up to 50% on

Credit Cards accepted — You don't pay a

5(6.5)MHz Oscilloscope Kit

$249 (See EA Oct '84)

Over the years many people have asked, "Do you have a CRO Kit"? — Our answer - up until now - has been that built and tested units were not dearer than kits, if you could get a kit at all. The Altronic K 2000 Cathode Ray Oscilloscope kit has a guaranteed 5MHz band width but should go to around 6.5MHz. It also features 75mm (3") CRT Blue Phosphor with accurate graticule, separate vertical and horizontal BNC input sockets etc. Remember, a 5MHz scope is usually adequate to troubleshoot most micro processor and other digital circuitry as well! This is a wonderful opportunity to learn electronics and end up with a valuable piece of test equipment as well. The Altronic K 2000 kit is absolutely complete. The chassis is prepunched and every component including nuts and screws are provided, along with instructions. Cat. K 2000

BENCH TOP POWER SUPPLY

Electronics Australia have released this superb new supplykit in **our very attractive H 0480 Instrument case** — thus complementing the Frequency Counter,Function Generator projects etc. Cat K 3210 **$59**

FEATURES:
- Output variable between 3 and 30V
- Short circuit Protection
- Full 1 amp output over entire voltage range
- Load switching
- Current limiting fully variable-twin selectable ranges
- Dual Scale Meter
- Separate earth terminal provided

SPECIFICATIONS:
- Output Voltage—3 to 30 Volts
- Output Current—0 to 1 Amp (fully variable)
- Load Regulation—better than 0.2% from 0 to full load
- Output ripple—less than 2mV RMS

Kits and Bits at Bargain Rates

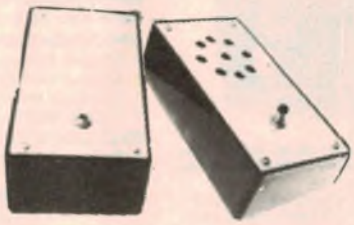
MICROBEE OWNERS

As we no longer sell the Microbee Computer range, we now have these surplus products which we want to quite regardless of cost. Don't let these unbelievable prices put you off — these are all Ist quality products. Naturally Ist come Ist served. So phone order yours right now!

FAX DECODER

(ETI Sept.'83)

Now $15



This project allows you to decode the signals of shortwave stations transmitting radio facsimile weather maps, satelite pictures etc.• complete kit of parts includes DB15, Ribbon cable • Software listing. Cat K 9733

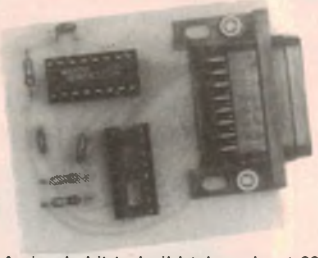
Radioteletype Decoder (ETI April '83)

Display RTTY encoded messages on your Video Monitor. Receive up to date weather information International News before the Papers all sorts of coded military info. Simple circuit uses PLL techniques. Single PCB Construction. Kit includes DB15 Plug and Backshell for connection to microbee. Shielded pretinned PCB. Cat K 9733

Now $20

PARALLEL PRINTER INTERFACE $15

Build your own Interface and Save $$

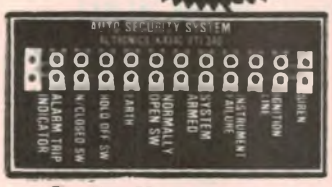


A simple kit to build-takes about 20 minutes. Save on the cost of a built interface and save the cost of a serial printer. Cat K 9671

CAR SECURITY SYSTEM KIT

ETI 340

$10 Off Now **$49**



This New ETI Design represents the ultimate in vehicle protection systems available today.

The Design uses stratigically placed Ceramic Resonance Mics to detect any tampering with your vehicle. **Features** + Automatic arming with entry and exit delays + dash mount led to indicate status of alarm + extra alarm inputs that can be wired to protect your boot, car HiFi etc.

Supplied complete with Two resonance Microphones, security window stickers and exclusive ABS case with drilled and silk screened front panel. We have also included a fully identified terminal block on the case to allow easy installation in your vehicle.

++ADDED BONUS++

This System includes circuitry to monitor your dash warning lights and will inform you of any abnormal condition

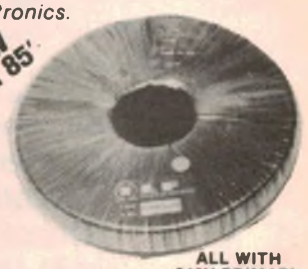
REF ETI APRIL 1984

K 4340 ..... ~~$59.50~~

K 4341 additional sensors . **$8.00**

STATE OF THE ART TOROID POWER TRANSFORMERS

For the same price as your common garden heavy, bulky, buzzing iron (any old iron at that!) transformer you can now design in a superb Toroid Power Transformer from Altronics.



ALL WITH 240V PRIMARY

Why a Toroid?
- Smaller size and weight to meet modern "Slimline" requirements.
- Low electrically induced noise demanded by compact equipment.
- High efficiency enabling conservative rating whilst maintaining size advantages.
- Lower operating temperature.
- Simple, quick single bolt mounting.

Cat No.	Sec	V	VA	Ea.	10Up
M 3050	12V + 12V	160W	45.00	43.50
M 3060	25V + 25V	160W	45.00	43.50
M 3065	30V + 30V	160W	45.00	43.50
M 3070	35V + 35V	160W	45.00	43.50
M 3075	40V + 40V	160W	45.50	43.50
M 3080	45V + 45V	160W	45.50	43.50
M 3085	12V + 12V	300W	55.00	52.50
M 3088	25V + 25V	300W	55.00	52.50
M 3090	30V + 30V	300W	55.00	52.50
M 3092	35V + 35V	300W	55.00	52.50
M 3100	40V + 40V	300W	55.00	52.50
M 3105	45V + 45V	300W	55.00	52.50

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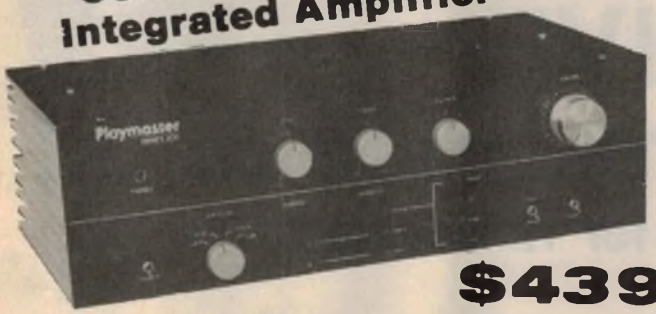

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Letters to the editor

Beat Repetitive Strain Injury

I was pleased to read your story on Repetitive Strain Injury amongst computer users (Forum, EA, June 85), and I strongly agree with your assessment of it as a real rather than an imaginary problem.

The problem is not necessarily confined to the professional keyboard operators in the typing pools of business and government organisations. Indeed, home computer users and hobbyists like myself are likely to be even more at risk due to our tendency to spend many hours without a break at poorly designed equipment while trying to track down the "last" program bug. Recently, I have developed what I believe to be RSI symptoms, and I would like to alert others to the hazards. Fortunately, some improvements can be made at virtually no cost.

Personal computers generally represent good value for money in terms of computing capacity, but little (if any) attention is paid to ergonomics, or the mechanical design of the man-machine interface. Has anyone yet seen a personal computer manual that recommends the correct keyboard and screen height and room lighting conditions?

I am a 40-year-old male who has been working with computers as a hobby since 1976. I am also involved with computers at work and use wordprocessors as a matter of convenience. On balance, the total time spent at the keyboard of my home computer would far exceed that at work.

I learnt to touch-type (after a fashion) on a typewriter and had no difficulty with that except fatigue and the frustration caused by errors due to the apparent random connection between the keys and the typebars!

The mechanism of a manual typewriter seems to absorb much of the shock when the keys are struck. My first problem when changing to an electronic keyboard was soreness of the finger joints after long typing sessions. Some of this was probably due to striking the keys with a similar force to that required for a typewriter. Electronic keyboards have very little "give" at the bottom of the keystroke, and the stroke is relatively short, so that much of the shock must be absorbed in the fingers. This problem was alleviated in my case by sitting the keyboard case on a thin foam rubber pad, and modifying my striking technique.

The desk on which the computer is mounted is a very important factor, and conventional writing desks, kitchen tables, etc, are likely to be much too high. The expensive fully adjustable workstations used in RSI-conscious businesses would be overkill for the hobbyist. A much cheaper solution is to modify an existing desk to suit the user's own dimensions. Remove any reinforcing rails at the front of the desk so that the desk top is as thin as possible. When seated at the correct height, the elbows should form a right angle when the fingers are curved and are resting on the home row keys. If the keyboard is too thick (as most are), the underside of the desk-top will be almost resting on the your legs.

Unless the keyboard is very thin (eg, IBM-PC style), a wrist rest should be used. If your hands curl upwards from the wrists to reach the keys then you may, as I have, develop wrist and forearm problems. Incorrect wrist and arm positioning may not necessarily feel uncomfortable, but believe me, the persistent pains that may subsequently develop as a result certainly are! Imagine not being able to read the latest copy of EA in bed because it is too painful to support it in front of your eyes for more than a few minutes. If holding EA is difficult, "Byte" is well nigh impossible! A wrist rest is perhaps the cheapest preventative or palliative measure that may be added to a workstation.

Get a piece of wood that is the same length as your keyboard, and thick enough to be level with the bottom of the space bar. Sand it smooth and place it in front of your keyboard in such a position that the wrist joints are supported when your fingers are on the keys.

Now check your display screen. Its centre should be about 20 degrees below your line of sight, and angled so that it is at right angles to your line of sight. After lowering your desk, you will probably need to raise the display to avoid neck and shoulder problems. A strong cardboard box of the appropriate size will do. Get rid of your modified TV as soon as you can afford a proper monitor. Position your workstation so as to avoid glare and reflections from windows and room lighting. A monitor with an etched faceplate helps to avoid glare problems.

A good chair is also essential. A modern ergonomic typist chair, with or without a gas-lift, is best. The hobbyist on a limited budget may have to settle for something cheaper; an older style office chair may be OK if modified. Strip off the arm rests, and try to make the seat firmer, perhaps by loading the spring cavity with foam and adding a board underneath. Ergonomic chairs have firm contoured seats with foam padding rather than springs. Since replacing my old office chair with one of these, a persistent back pain that plagued me for many months has disappeared, so I rate it as $200 well spent.

Regular rest breaks away from the keyboard are also important. A 10-minute break in every hour of intensive keyboard work is the norm in

continued on page 31

ID cards will not stop tax evasion

I have followed the ID card debate and have even thought about it myself. In your July editorial you have put the case for adoption of the ID cards very succinctly. I have come to the opposite conclusion.

The sentence "The ordinary person has little to fear from the introduction of personal identity cards" is the precise point of difference. This assumes that the government and its executive officers are benevolent now and will be for ever and ever. My reading of history and my limited experience of people in power would lead me to choose other adjectives before benevolent for their description.

Two other points (minor compared with the fundamental one above) also need mention.

An error in a big computerised system can cause someone a lot of trouble and be difficult to remove. A couple of years ago I had a building society account frozen by the Federal Attorney-General. Building society officer: "are you bankrupt or about to be?" It took a while to sort out but it turned out to be someone with the same surname and first initial, different Christian names and different address (another town).

But near enough was good enough for some bureaucrat and, as far as I know, there may be a computer record somewhere which still contains false information about me.

D. J. Hamilton,
Taringa, Qld.

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Letters to the editor

government departments. If your typing skills are still at the "hunt-and-peck" stage, you may be able to do with less. Warm-up and relaxation exercises of the type shown as "Pause Gymnastics" are also a good idea.

Perhaps in a few years time computers will respond to speech so that the keyboard may be discarded. In the interim, I hope that the above suggestions will help fellow computer enthusiasts to continue to enjoy a stimulating hobby without developing symptoms of RSI.

B. Daniells,
Magill, SA

Reservations about computer banking

Your Forum article in the July issue raises some very important issues.

Although I believe that computer technology is the key to the future (whether we like it or not), I have reservations about some aspects of computer banking. Recently I closed my accounts at the State Bank (of Victoria). The reasons for this move had nothing to do with computers but did result in my receiving a "hard sell" about the wonders of their newly introduced "State Banking System". Like similar accounts offered by other banks, the system is almost totally computer based.

While I feel that security is a problem, despite assurances to the contrary, I am more concerned that the only record of a transaction is the data entered by an operator (either the bank teller or yourself if using the automatic teller). With a conventional passbook account you receive a "hard copy" of each transaction in the form of an entry into the passbook.

Although you are supposed to check the entry before you leave the bank, you can always take the book back if you find an error at a later time. But how do you prove that an error has been made when the only record is in the computer which, after all, only shows which buttons the operator pressed? You may receive a statement at the end of each month, but who can clearly remember every transaction made over that period?

A couple of minor points, mentioned only in passing in the Forum article, raise a more important issue when taken together. I am employed by a large provincial municipality which is presently introducing a computer system. Although my work is not affected by its introduction (yet!), I am involved in my capacity as union shop steward. Most of the problems brought to me are not of relevance here, but one point stands out, as it could affect every ratepayer of the municipality.

Although the council has no qualms about spending the considerable sum of money to purchase and install the hardware and software, they have decided not to have any of the staff properly trained. Formal training is offered by the suppliers but for the council it "costs too much!" This means that employers using the system must learn by trial and error — and the system will eventually contain all the important records of the municipality.

Penny-pinching attitudes like these are by no means confined to this council — it reflects the thinking in many authorities and businesses handling equally important data. Any system is only as strong as its weakest link, and here, I believe, is the real problem with the introduction of the computer. No matter how enthusiastic promoters of the technology may be, if management cannot be convinced to spend money on training the system will never realise its full potential.

R. Woods,
(address witheld by request).

Starwars: it may be feasible

I agreed with your recent editorial comment on "Starwars Weapons" until seeing several recent New Scientist articles. You have probably come across them also by now.

It seems likely that present lasers could damage solar cells and photographic equipment on low flying surveillance satellites. It appears that atmospheric distortion can be overcome and cloud diffusion avoided by setting up lasers widely apart so that one at least will be able to put a spot on a friendly mirror in space which will reflect it onto the target. Developing present equipment could advance it enormously. As you said, its use against missiles is less predictable.

I cannot refer to your editorial because the magazine is so popular it passes through my hands when I've read it, and never returns. Congratulations on a wonderful magazine.

Rev. D. Kinsella (VK2AXK),
Waverly, NSW.

A new look for outback

HACBSS, AUSSAT and B-MAC!

by NEVILLE WILLIAMS

If everything goes according to plan, up to 300,000 radio or TV-deprived residents in remote areas of Australia will be receiving a high technology Christmas present — as per the heading above — some time in November. It's costing the Government a packet but it will usher in a whole new era of entertainment and communications for Australia and its environs.

Above: AUSSAT 1, the first of three satellites to be launched to cater for Australia's growing communications needs.

Right: satellite dish antennas will soon become a familiar sight in Australia's outback.

In case you haven't caught up with them, we should perhaps interpret those three odd looking words or, rather, acronyms in the heading:

HACBSS: Homestead and Community Broadcasting Satellite Service — the Federal Government's name for a system intended to provide high quality radio and television programs, along with telecommunications, for residents beyond the reach of effective land-based services.

AUSSAT: Satellites (AUSSAT 1, 2, 3 etc) contracted and paid for by Australia to meet its own communications requirements and, if sought, those of neighbouring nations.

B-MAC: A completely new signal format for disseminating colour TV plus radio signals, which offers important advantages over the existing PAL format, especially when broadcasting via satellites. More about B-MAC later.

While Australia has had a long involvement with satellites, mainly in collaboration with the USA, our own domestic satellite communications requirements have been met only to the extent that they could be accommodated on somebody else's hardware. The ABC, for example, has broadcast TV programs for years through INTELSAT IV or IVA, meeting a need in some isolated areas, but certainly not achieving nation-wide coverage.

By contrast, the new AUSSAT system, involving three separate satellites, will provide reliable radio, television, telephonic and data services across the entire Australian continent and its off-shore environs, plus centralised air traffic control (see Fig.1).

(For a detailed look at the planning and technology behind AUSSAT, see Philip Watson's article in our March 1984 issue.)

The AUSSAT program, running neatly to schedule as we write, calls for AUSSAT-1 to be launched by the US Space Shuttle on August 24, by which time this issue — and this article — will be beyond recall in the printery. Hopefully, the satellite will be safely in its geostationary position above the equator by the time you get to read it!

AUSSAT-2 is due to be launched toward the end of November and, by then — assuming that all goes well — the nation-wide HACBSS-1 service should have begun through AUSSAT-1, providing: "ABC radio and television programs — news, current affairs, weather information, entertainment, comedy, drama, schools programs and special events". (HACBSS-2, a commercial TV/Radio service for the WA zone is also on the way, using AUSSAT-1.)

South-west Pacific

The third satellite, originally timed for the early 1990s, was seen as initiating a "second generation" in the AUSSAT series, with a supplementary communications role, involving New Zealand and island states in the south-west Pacific area.

It has now been re-scheduled by the Government-owned satellite authority, AUSSAT Pty Ltd, for launch in mid 1986, bringing that phase of the planning forward by several years, according to the Minister for Communications, Mr Michael Duffy.

This follows involvement by Australia in the South Pacific Forum and the setting up of the South Pacific Telecommunications Development Program. Said Mr Duffy:

"Provision of modern telecommunica-

tions networks in the newly developing island countries of the region is a massive task.

"I hope the AUSSAT decision will enable countries in the region to establish services earlier than expected and lead to more effective use of a second generation of AUSSAT satellites, for which planning is already under way."

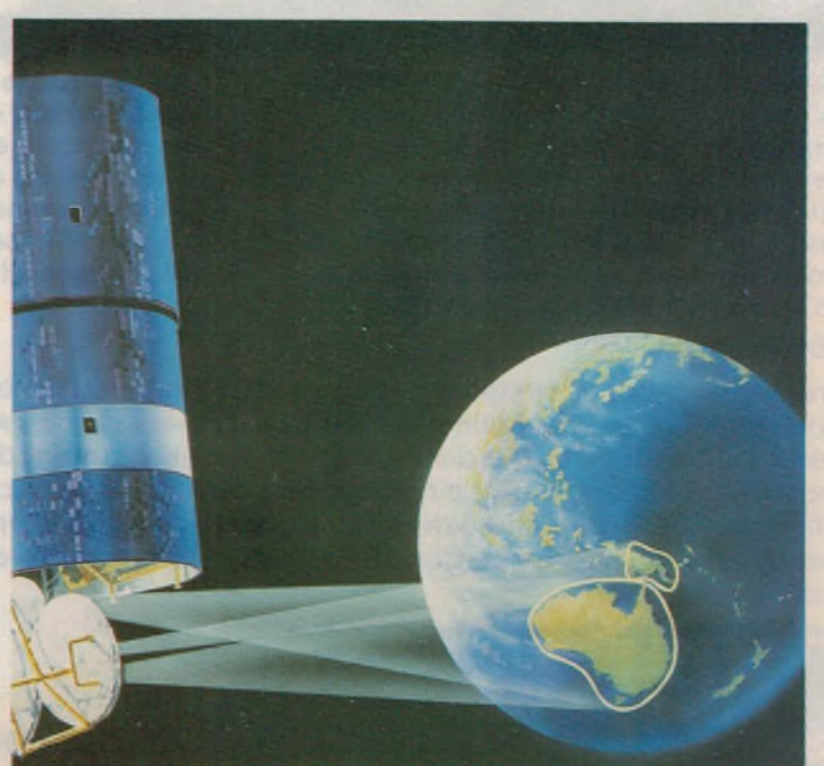
Countries mentioned as having a potential interest in the expanded AUSSAT project include New Zealand, Fiji, Western Samoa, Tonga, Vanuatu, the Solomons, Papua New Guinea, the Cook Islands, Kiribati, Tuvalu, Federated States of Micronesia, Nauru, Tokalau and Niue.

New receivers required

But back to the purely domestic scene and to the HACBSS — that aspect of the AUSSAT project that directly concerns listeners and viewers in poorly served areas:

Mr Duffy has warned that, with the commissioning of the AUSSAT system, TV transmissions through INTELSAT IVA will cease:

"As from the first half of 1986 this



Above: artist's impression of the AUSSAT satellite above Australia.

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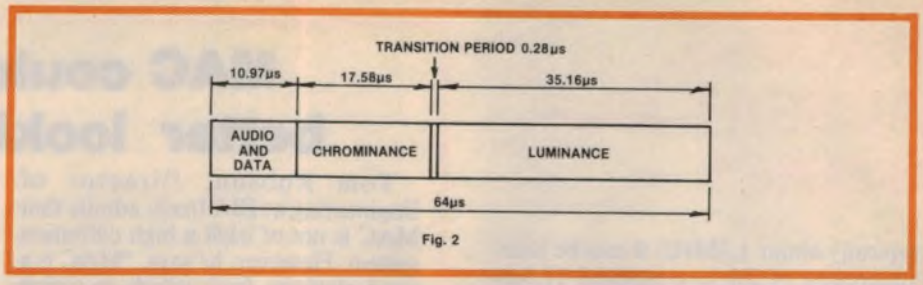


Fig. 2.: How the information is multiplexed in the Australian B-MAC system. The chrominance involves alternating colour difference components, with B-Y and R-Y on successive lines.

service will stop and the ABC will use the AUSSAT satellite system exclusively for its satellite services.

"There will also be commercial services and, possibly, commercial radio available via AUSSAT but none of these services will be able to be picked up by earth stations designed to be operated with INTELSAT.

"The two satellite systems have significantly different operating standards and therefore existing earth stations will need to be converted or replaced to receive the new ABC program signal from the AUSSAT system.

"Conversion from INTELSAT reception to AUSSAT reception is very difficult and, in most cases, it will be more economical to install new equipment."

Behind this warning lies a vital decision about the format for the radio and television signals from AUSSAT — probably the most far-reaching of the many technical decisions that have had to be made on the way to the present position.

The initial assumption was that the TV signals would simply conform to established CCIR/PAL standards, as used by all Australian TV stations. The signals would, of course, be imposed on carrier frequencies appropriate to satellite working but would be capable of direct down-conversion for reception on standard TV receivers, as with INTELSAT.

Limitations of PAL

However, it didn't work out that way. Like SECAM and NTSC, PAL is very much a compromise system, originally devised to achieve mutual compatibility between colour and monochrome transmissions and receivers. All three systems retain the basic luminance signal to suit monochrome receivers but the chrominance (colour) information is superimposed on it, by means of a colour sub-carrier, to be decoded and used by colour receivers.

The accompanying sound is frequency modulated on to a separate sub-carrier, set (in Australia) 5.5MHz above the picture carrier, with a still further sub-carrier required, nowadays, for stereo sound.

Because all this information is transmitted (and received) simultaneously, sundry precautions have to be taken to minimise the risk of interaction between the individual signals.

Even so, let someone appear on the set with a jacket having narrow vertical stripes, and whole areas of the jacket may shimmer with random patches of colour. This happens because a repetitive variation in luminance signal, caused by the stripes, is misinterpreted by the receiver as colour information.

Other possible problems include colour fringeing, patterning or video "noise" in large areas of saturated colour and interaction between picture signals and a heavily modulated sound carrier.

Such problems, barely manageable now, loom much larger when looking to future television needs, which could readily involve a demand for higher effective definition and a lower "noise" content, as for larger screen viewing; this, in the context of DBS (direct broadcasting from satellites) using, of present necessity, low powered (eg 30W and 12W) frequency modulated transmitters, with attendant noise problems.

Considerations like these caused DOC (Department of Communications) engineers to take a much harder look at the routine PAL option and finally to favour a more "rugged" signal format for the AUSSAT service — even if it meant venturing out on a technical limb!

Going for them was the fact that they were planning an essentially new service for which most directly involved viewers would be buying new equipment, covering both radio and TV reception. If Australia was to make a forward move in terms of transmission standards, this was the time to do it!

And so to MAC!

Of the options which DOC engineers had to consider, the one most favoured was a format for disseminating TV signals, devised originally by IBA (Independent Broadcasting Authority) engineers at Crawley Court, Hampshire, UK. It is referred to as "MAC", short for "Multiplexed Analog Components".

As suggested by the title, MAC maintains the video information in analog form but multiplexes it — transmitting luminance and chrominance information in sequence rather than simultaneously — while still conforming to a basic 50/625 (or 60/525) field/line rate.

Basically, the luminance signal for each line is time-compressed in the ratio 3:2 by processing it through a memory store, such that it is reduced in duration to a nominal 35µs. Squeezing the signal increases by about 1.5 times the bandwidth needed for a given order of definition (to 7.5-8MHz) but, more to the point, it allows the luminance information to be concentrated into less than two-thirds of the normal 64µs line scan period.

Because the bandwidth required for the chrominance signal is smaller

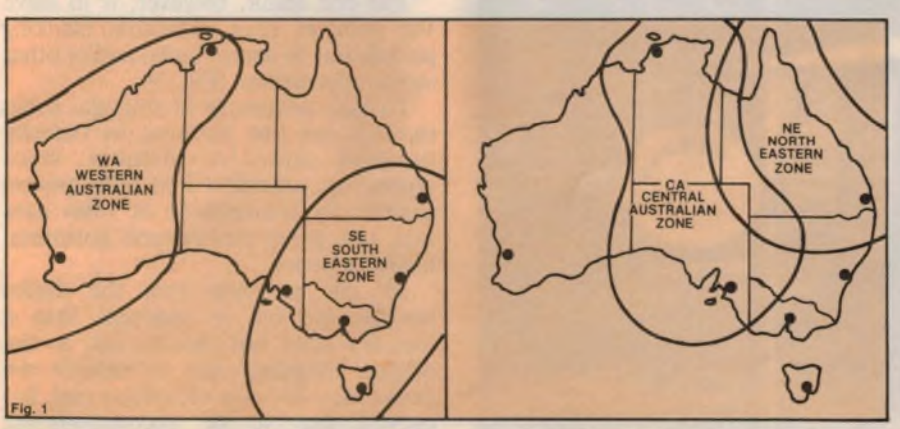


Fig. 1: Based on the data in DOC document 512, these would be the contour limits for the various zones within which design criteria for HACBSS would be satisfied, assuming the use of a 1.8m diameter dish. The signals cover the entire continent and its environs.

HACBSS, AUSSAT and B-MAC!

(typically about 1.3MHz) it can be time-compressed by 3:1 to a nominal 17.5μs, allowing it to be slotted into the remaining signal space — in practice, immediately following the horizontal blanking period, as in Fig. 2.

By so multiplexing the chrominance and luminance signals (or separating them in time) and thus eliminating the need for a potentially troublesome colour sub-carrier, a "MAC" format video signal can be distributed or transmitted with much less risk of cross luminance/colour defects.

Sync, sound and data

But the MAC system doesn't stop there. Having obviated the need for a colour sub-carrier and its associated reference "burst" in the line blanking period, the obvious next step was to eliminate the line sync pulses also, thus clearing the 11μs line blanking period and making it available for something more useful than simply instructing the screen to go black!

Until quite recently, the idea of not transmitting line sync pulses in real time would have been unacceptable but, with the chip technology now available, it is entirely practicable to reconstitute sync pulses at the receiving end, given a reliable reference signal.

Such a reference is provided in the MAC system by special synchronising "codewords" in lines 2 and 315 in the vertical blanking periods, with the interesting further option of "scrambling" the signals, where required, by fiddling with the timing.

The end result, however, is to leave the nominal 11μs horizontal blanking periods free to accept audio and/or other signal information. (Fig. 2)

To take advantage of this, the audio signal(s) can (for instance) be digitally sampled and, by memory store processing, organised into data groups, suitable for transmission at video data rate, one group during each horizontal blanking period.

At the receiving end, the digital samples are fed in sequence into a memory store but clocked out at the original sampling rate to recover the audio signal(s) — a technique that has proved capable of accommodating multiple high quality sound tracks, with space to spare for other data!

Overall, a MAC signal is not only very

MAC could provide better looking pictures

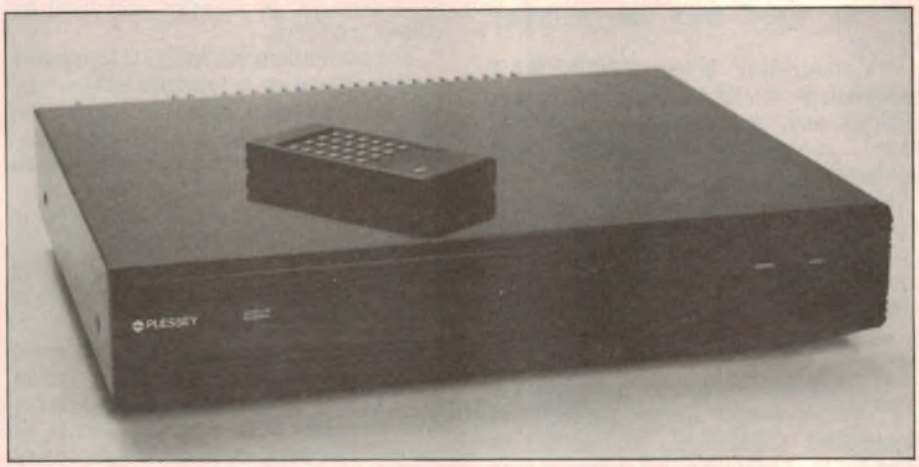
Tom Robson, Director of Engineering at IBA freely admits that MAC is not of itself a high definition system. However, he says, "MAC is a good platform from which to spring off, if contemplating improvements".

With a good quality signal coming into the home, computer processing could convincingly enhance the picture.

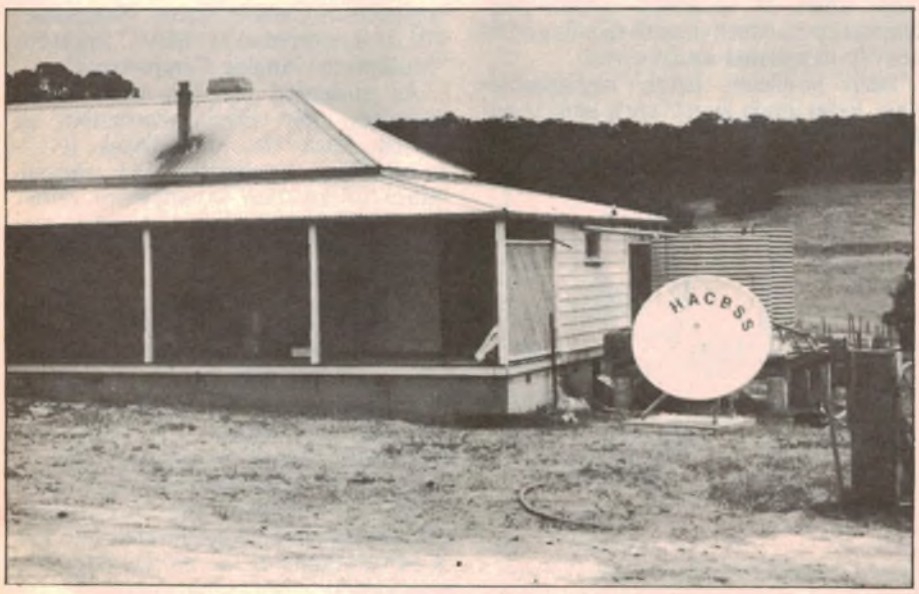
But we will soon have a complete frame store on a chip, Robson explained, and it will then be possible to double artificially the number of scanning lines from 625 to 1250, by simulating the intermediate lines.

"For all practical purposes, this would be equivalent to 35mm definition," he said.

The frame frequency could also be doubled by simulating the intermediate pictures, thereby reducing the perception of frame flicker. While not much of a problem at present, it could become one if and when screens get larger, because the eye is more susceptible to flicker in its peripheral vision.



A Plessey MAC satellite receiver (or IDU) with IR control unit. As indicated in Fig. 3, it contains a channel selector, an FM demodulator and a baseband processor unit (BPU) which decodes and makes available the various outputs, as shown. It also supplies power, through the cable, to the ODU.



The satellite dish will become as familiar on outback stations as the water tank and the sheep dog. This view shows an early version of a HACBSS receiving dish outside a southern NSW homestead.

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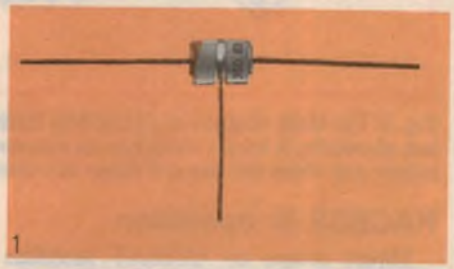
1


4


2


5


3

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HACBSS, AUSSAT and B-MAC!

"rugged" but also very "tidy", with luminance, chrominance and multi-channel hifi sound on one modulated carrier.

It is also incompatible with existing TV equipment in other than field/line frequency but affordable consumer type equipment is now becoming available which will allow it to be re-encoded into the PAL (or other) format.

Those prefixes

That's the basic concept but, along the way, "MAC" has managed to collect a confusing array of prefixes ranging at last count from A– to E–!

Broadcasters generally have welcomed MAC, because it offers a convenient way to exchange high quality program signals, which could subsequently be re-encoded into PAL, SECAM, etc for regional transmission. But some are insisting on greater sound and data capability to meet their own special needs, plus accommodation for other video compression and aspect ratios (eg 5.33:3) against possible future requirements.

Currently, versatility, complexity, cost, bandwidth, uniformity, etc, are all matters for on-going — and mainly hypothetical — debate, with B–, C–, D2– and C/D2 being actively canvassed as "logical" variants of the MAC theme.

Faced with the need to make a firm decision, primarily to suit its own domestic satellite broadcasting service, Australia's Department of Communications opted for B-MAC, developed by Digital Systems in Canada, a subsidiary of Scientific Atlanta (USA). Fifty-percent owned by Plessey of UK, Scientific Atlanta had earlier acquired the North American rights to MAC from IBA, making Plessey (Australia) the natural contact for the technology in this country.

The most advanced of the MAC variants, in terms of available and demonstrable hardware, B-MAC provides video multiplexing, as described, plus provision for six high quality (17kHz) audio channels, a data channel (9600 bits/s), optional scrambling, on-screen text of various kinds, and system test signals. Its use in this country will be a world first, with the prospect that the Australian initiative will confirm it as the world standard for the MAC format.

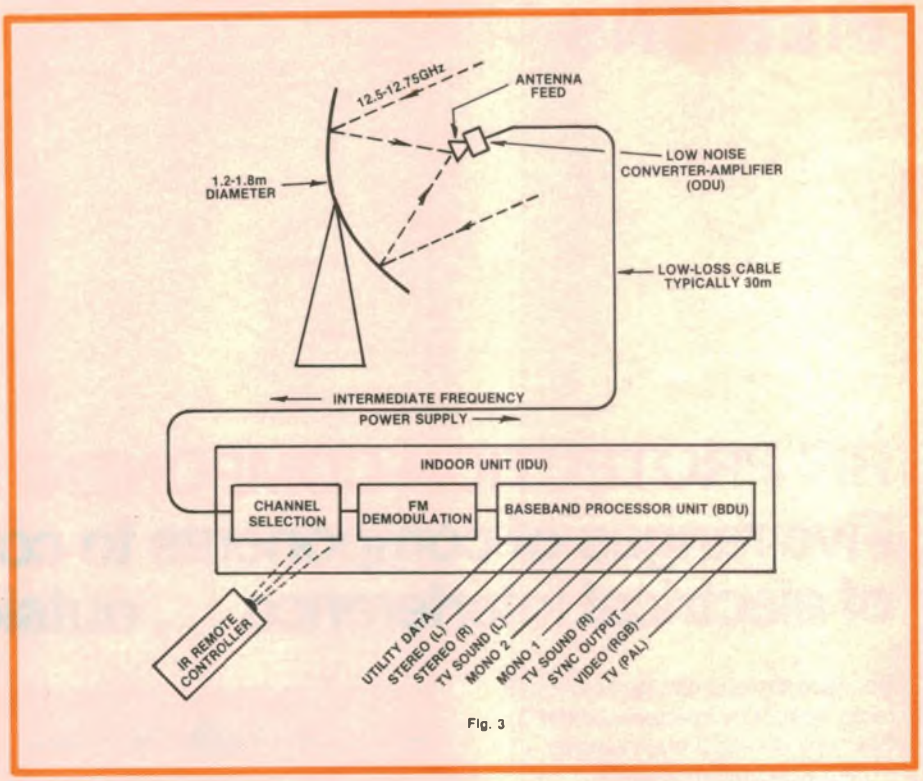


Fig. 3: The block diagram of a HACBSS Earth Station suggests state-of-the-art technology. It is but, physically, it breaks down into an antenna system mounted outside, a length of cable and an indoor unit about the size and shape of a standard VCR.

HACBSS in operation

Direct access to AUSSAT satellites will be provided from all Australian capital cities, but with satellite control and ABC (HACBSS-1) program feed being effected from Sydney, with back-up from Perth, as required.

HACBSS TV and radio signals will be transmitted to the satellite in the B-MAC format, using up-link carriers in the range 14.25-14.5GHz. Re-broadcast B-MAC transmissions will be in the frequency range 12.5-12.75GHz.

As indicated in Fig. 3, HACBSS-1 has provision for a colour television program with its own stereo sound, an entirely separate stereo radio channel, and two mono radio channels — about right for the present resources of the ABC. A seventh channel is available for utility data such as (to quote a DOC release) "emergency warnings, special educational programs and other services".

It is beyond the scope of this article to examine the audio encoding format in detail but it is described as using "adaptive variable slope delta modulation", a technique developed by Dolby Laboratories of San Francisco and London. It includes provision for error concealment and is claimed to be economical in terms of bandwidth requirements, allowing the above-mentioned audio and data channels to be accommodated, without exceeding bandwidth limits as set by the video signal.

More to the point for the user is the undertaking that all sound channels will satisfy modern expectations for a quality system, with a specified frequency response of 20Hz to 17kHz and a dynamic range of 80dB.

Video response to a normal RGB monitor is also excellent at 0–5.5MHz.

Earth stations

Fig.3 illustrates, in block schematic form, the equipment necessary to receive the HACBSS service. In describing it, we deliberately use the jargon that is already emerging around the technology — starting with the term *earth station* to describe the contents of Fig. 3.

It should be noted that all components constituting a HACBSS earth station are currently the subject of provisional DOC (Department of Communication) specifications, which should be observed by manufacturers and vendors and certainly checked out by intending purchasers. (They are much too comprehensive to be spelled out in this article.)

A parabolic dish antenna is mandatory, designed to function efficiently in the 12GHz band. For strong signal areas, well inside the beam limits, a dish diameter of 1.2m should suffice but 1.8m is suggested for where the signals are weaker or likely to be attenuated by frequent rain squalls.

The antenna must be capable of critical "pointing" adjustments on two axes and sufficiently stable to retain the

adjustments long-term, substantially unaffected by wind or extremes of temperature.

The dish structure must also include provision to support an Antenna Feed unit at the point where the 12GHz energy is focused, with the overall array capable of providing discrimination of not less than 25dB between vertically and horizontally polarised signals from the satellite.

Also mounted on the dish, usually integral with the Antenna Feed unit is an ODU (Outdoor Unit) which must convert the 12GHz signal to a lower and more convenient *intermediate* frequency (around 1MHz), and amplify it substantially, with a minimum of added noise, before passing it, by coaxial cable, to the IDU (Indoor Unit).

The coaxial cable, typically about 30m long, must exhibit low loss at the intermediate frequency. In practice, it usually has to fulfil a multiple role, feeding the signal down to the IDU and, for example, passing a DC supply back up to the ODU.

The IDU sounds a rather forbidding title but, in fact, looks just like any other piece of domestic hifi or video equipment (cassette deck, VCR, etc) except that it has fewer knobs and more space to spare inside!

Within the IDU, the incoming signals are fed to a channel selection system activated, typically, by an infrared remote controller similar to those used for a VCR. A basic IDU may have provision to select, demodulate and decode one TV program and one radio program — mono or stereo in either case — on the assumption that a typical household would not require more than two programs at any one time.

More elaborate IDUs can demodulate and decode a greater number of programs simultaneously for wider distribution.

For television viewing, the IDU provides the option of direct video and audio output for a high quality RGB monitor and amplifier system, or a re-encoded PAL type signal on channels 0 or 1, to operate a normal TV receiver. This provision leaves open the further option of distributing the PAL signal by cable, etc, for other TV receivers.

Much more remains to be said about AUSSAT, HACBSS and MAC but this must await another issue.

As I write, it only remains for the Shuttle to deliver AUSSAT-1 safely into orbit, for the Hughes-built satellite to function correctly, for the ground control stations to work, the ABC to supply the programs, and for you to set up your own private earth station — along with the 299,999 others that the ABC hopes will constitute its ultimate HACBSS-1 audience!

New design features automatic starting

Compact 12/230V 300VA inverter

Of compact design, this new 300VA 12/230V inverter features a toroidal transformer and automatic self starting. It is powered from a 12V car battery and boasts voltage regulation, current limiting and thermal overload protection.

by JOHN CLARKE

Power inverters have a unique appeal to many of our readers. They provide a measure of independence from the electricity supply authorities and enable appliances to be operated away from civilisation. The applications of an inverter are many and varied and extend from supplementary mains power to supplying power at a remote site.

An inverter of this rating is particularly useful at building sites and on the farm. It is typically used to power electric drills, soldering irons and sanders in situations where mains power is not readily available. An inverter is often preferred in such cases since a long extension cord from a mains supply can be dangerous or inconvenient.

Where no mains supply is available, such as in the remote outback of Australia and at many campsites, an inverter can be used to power audio and video equipment, lights and power tools. Its 300VA output capability means that it can power a great variety of mains appliances.

This new design has many features which provide high efficiency and user convenience. A relatively small toroidal transformer allows it to be housed in a compact plastic case that is easily carried in one hand. On the front panel are green, orange and red LED indicators and a double general-purpose mains outlet.

The green LED indicates whether or not the output voltage is regulated while the red LED lights if the circuit shuts down due to thermal overload. The orange LED lights if excessive current is drawn from the output. In this case, the inverter automatically reduces its output voltage to limit the output current.

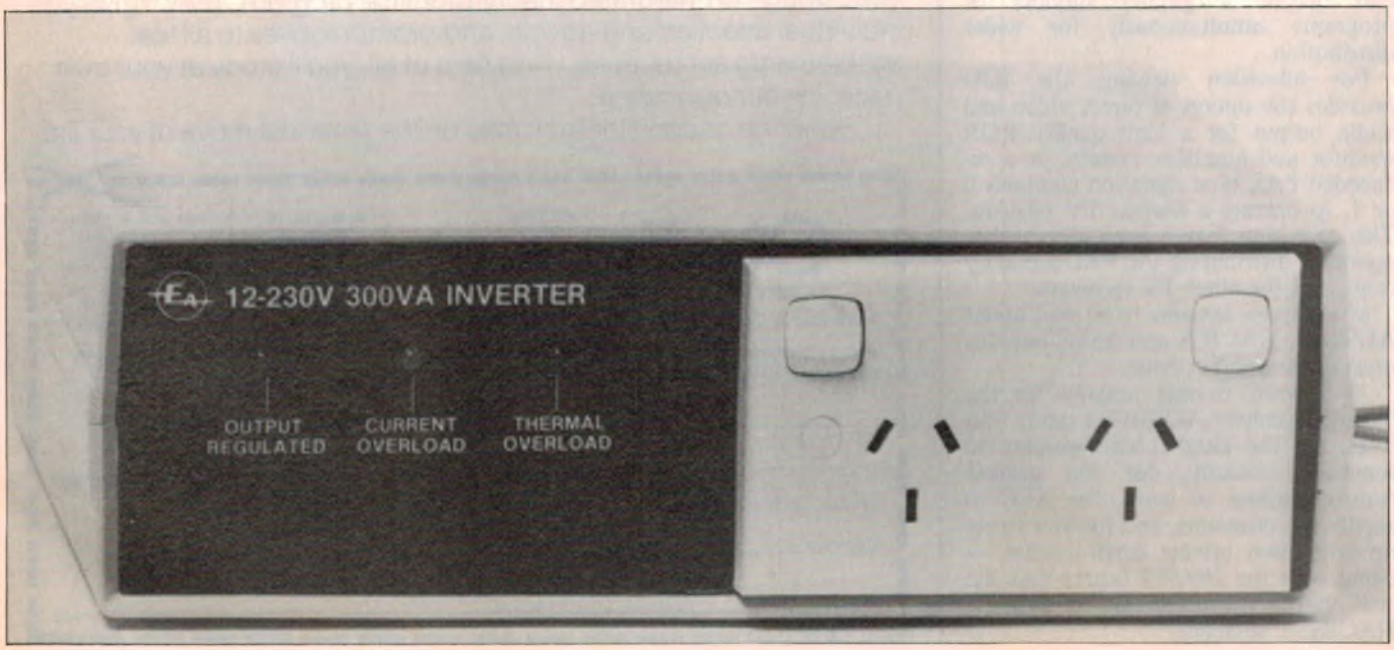
Auto-starting

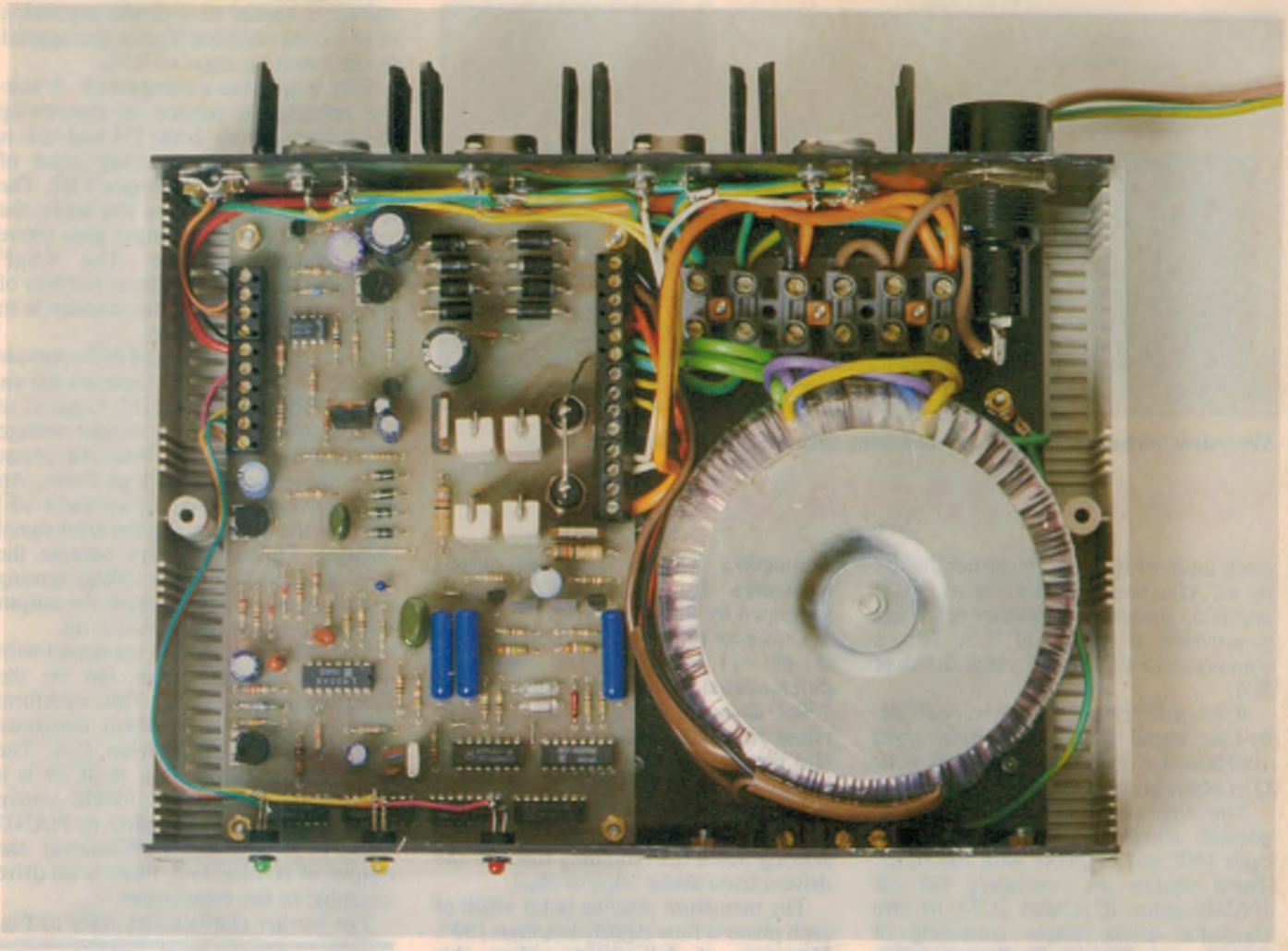
Unlike previous EA inverter designs, this circuit consumes virtually no power until an appliance is switched on. The circuit then starts automatically.

This auto-start feature is far more convenient and efficient than manually switching on the inverter, independent of the appliance. The gains in power savings are mainly realised with appliances that are used intermittently. These include power tools and sewing machines.

During the period that the appliance is

The unit can be purchased either as a kit ($199) or fully assembled ($249) from Altronics Pty Ltd.





View inside the prototype. The transformer and PCB are mounted on a steel baseplate which prevents the case from flexing.

not used, the inverter circuit is powered down and consumes virtually no power.

How it works

General operation of the inverter is relatively simple. A crystal locked 50Hz waveform is buffered with several transistor stages. These drive a transformer in a push pull mode to step the low voltage from the battery up to 230VAC.

As a refinement, the output current and voltage are monitored to provide voltage regulation and current limiting. The output voltage is measured using a separate transformer winding, while current is measured by monitoring the voltage across a very small resistance in the low voltage side of the circuit. By varying the pulse width of the 50Hz waveform applied to the transformer, voltage regulation is achieved.

Similarly, current overload is prevented by reducing the pulse width of the 50Hz waveform.

Thermal overload cutout is achieved by monitoring the temperature of the output transistors and switching off the supply to the 50Hz drive circuitry and the transistor pre-driver stages. This effectively shuts down the inverter which automatically restarts when the output transistors cool down.

The automatic start feature relies on a small standby current flowing through diodes in series with the 230VAC output. When the load is connected, this current flows through the load and switches on a transistor. This transistor then switches on the 50Hz driver stages in the inverter circuit and the inverter becomes operational.

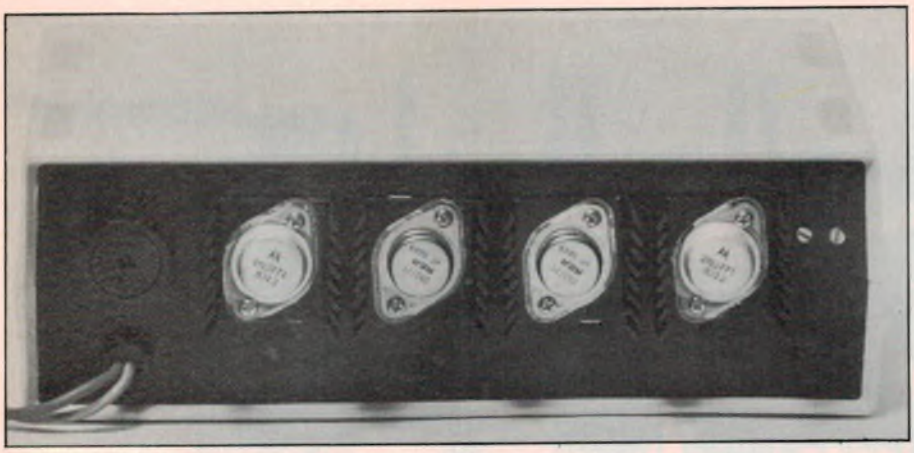
IC1a and its associated 4MHz crystal provide the clock signal for the circuit. Both inputs of the gate are tied together so that it functions as an inverter. A 10MΩ resistor connected between input and output places the inverter in the linear mode so that it behaves as a very high gain amplifier which drives the crystal into oscillation. Correct loading for the crystal is provided by the two 47pF capacitors.

The resulting 4MHz signal is applied to the clock input of a 4017 decade divider (IC2). The divide-by-10 output from IC2 at pin 12 is then applied to the

WARNING!

Equipment to be operated from this inverter must be in a safe condition, since the voltages produced are at mains potential. This means that frayed cords, exposed unearthed metal parts (unless double insulated), and broken or wet insulators must be repaired before the item is used. Note that contact with both output lines could prove fatal!

It is also important to keep the electrolyte level of the battery above the plates. This prolongs battery life and reduces the risk of battery explosion. When charging the battery, do so in a well ventilated area. The hydrogen given off from a charging battery is highly explosive. When connecting the inverter to the battery, make sure that the appliance is not plugged in so that sparks do not occur near the battery.



The output transistors must be mounted using mica washers and insulating bushes.

12/230V 300VA inverter

clock input of IC3, which further divides by 10. After two further divisions in IC4 and IC5, an output frequency of 400Hz is provided at pin 12 of IC5. This is connected to the pin 15 clock input of IC6.

IC6 is a 4-bit binary counter. A divide-by-four signal at its Q2 output gives 100Hz and a divide-by-eight signal at its Q3 output gives 50Hz.

The 50Hz signal is inverted by IC1b to provide complementary 50Hz signals, each 180° out of phase with the other. These signals are separately fed via NAND gates IC1c and IC1d to two transistor driver stages consisting of BC559 and BD140 Darlington pairs. These in turn drive TIP3055 NPN transistors and two pairs of parallel connected 2N3771 power transistors, which drive the primary windings of the transformer.

Note that the NAND gates are capacitively coupled to the bases of the BC559 transistors. This prevents one side of the transistor output stage from permanently conducting if the oscillator fails.

Another point of note is that two output transistors have been used for each phase. This arrangement ensures adequate gain, the typical gain of a 2N3771 being 20 at 15A and only 10 at 30A. The use of a transistor pair also reduces the saturation voltage since the current in each transistor is halved.

We have not used emitter resistors for each of the output transistors, since they are wasteful of energy when high currents are involved. As an alternative, we have used 0.1Ω resistors on the base of each transistor. Although this is not considered the ideal manner of ensuring equal current sharing, it works well enough in practice.

The two MR110 diodes, D1 and D2, conduct the reactive current after their opposite transistor pairs have ceased conduction. This protects the output transistors from inductive kickback generated by the transformer.

Let's now return to the 100Hz output at pin 11 of IC6. This signal is differentiated by the 100kΩ resistor and 150pF capacitor combinations and fed to phase driver transistors Q1 and Q2. The idea here is to prevent both drivers from being on at the same time when switching from one driver to the other. The differentiators achieve this by slowing down the switching times of the drivers from about 10μs to 60μs.

The maximum possible pulse width of each phase is thus slightly less than 180°. However, at full power when this maximum pulse width is applied to the transformer, the loss is only about 0.6W which is negligible.

As mentioned previously, the inverter features voltage regulation and current overload protection. These features rely on error voltages derived from the output voltage and current to control the pulse width of the signal fed to the driver stages.

The output voltage is monitored via secondary winding S1, which reflects the voltage at the 230VAC output winding (S2). This monitored voltage is rectified by diodes D8 to D11, filtered and applied to the inverting input of op amp IC7b via trimpot VR1. The amplifier has a gain of 1M/220 or 4545, and the 1MΩ feedback resistor and 6.8μF capacitor give it a long response time.

The non-inverting input of IC7b is held at 5.6V with zener diode D5. Whenever the voltage at the wiper of VR1 begins to exceed the zener diode voltage, the output of IC7b begins to fall toward ground. This is the error voltage signal.

To obtain the error current signal, the supply current to the output transistors is passed through R1 to develop a small voltage proportional to current. This voltage is applied to a divider consisting of two 220Ω resistors, filtered and applied to the inverting input of IC7c.

IC7c is wired as a comparator. A voltage reference is derived by monitoring the voltage across diode D4 and this is applied to the non-inverting input of IC7c via current limit trimpot VR2. The output of IC7c thus goes low when the voltage at its inverting input goes above the reference voltage. The 6.8μF capacitor across IC7c ensures stability of the comparator when the inverter is in the current limited mode.

The outputs of IC7b and IC7c provide the DC error signals and these are fed via a diode OR gate (D6 and D7) to pin 12 of comparator IC7d. If the output voltage or current goes higher than the preset level, the error signal will go lower. An RC delay circuit (39kΩ, 4.7kΩ and 47μF) controls the rate at which the error signal changes. This is necessary because the long time constant of the voltage sensing circuit would otherwise cause the output voltage to overshoot at switch-on.

The DC error signal is compared with a 100Hz triangle wave fed to the inverting input of IC7d. This waveform is generated by IC7a which integrates the 100Hz waveform from IC6. The result of the comparison in IC7d is a pulse width modulated 100Hz square wave. This signal is applied to NAND gates IC1c and IC1d. Whenever the output of IC7d is low, there is no drive available to the transformer.

For further clarification, refer to Fig.

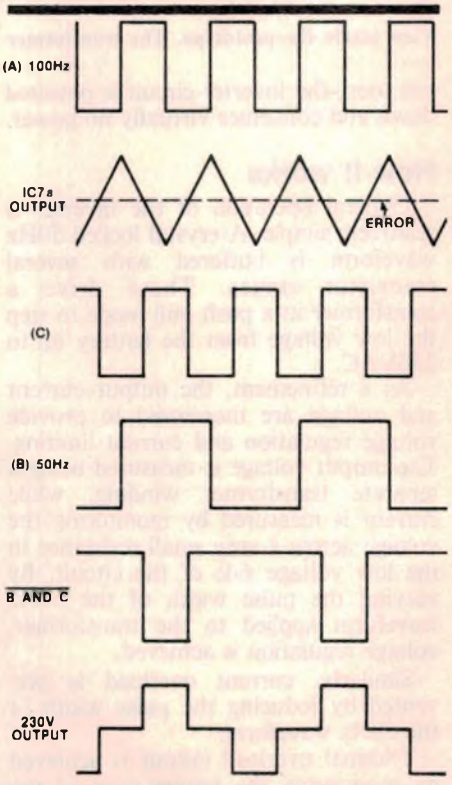
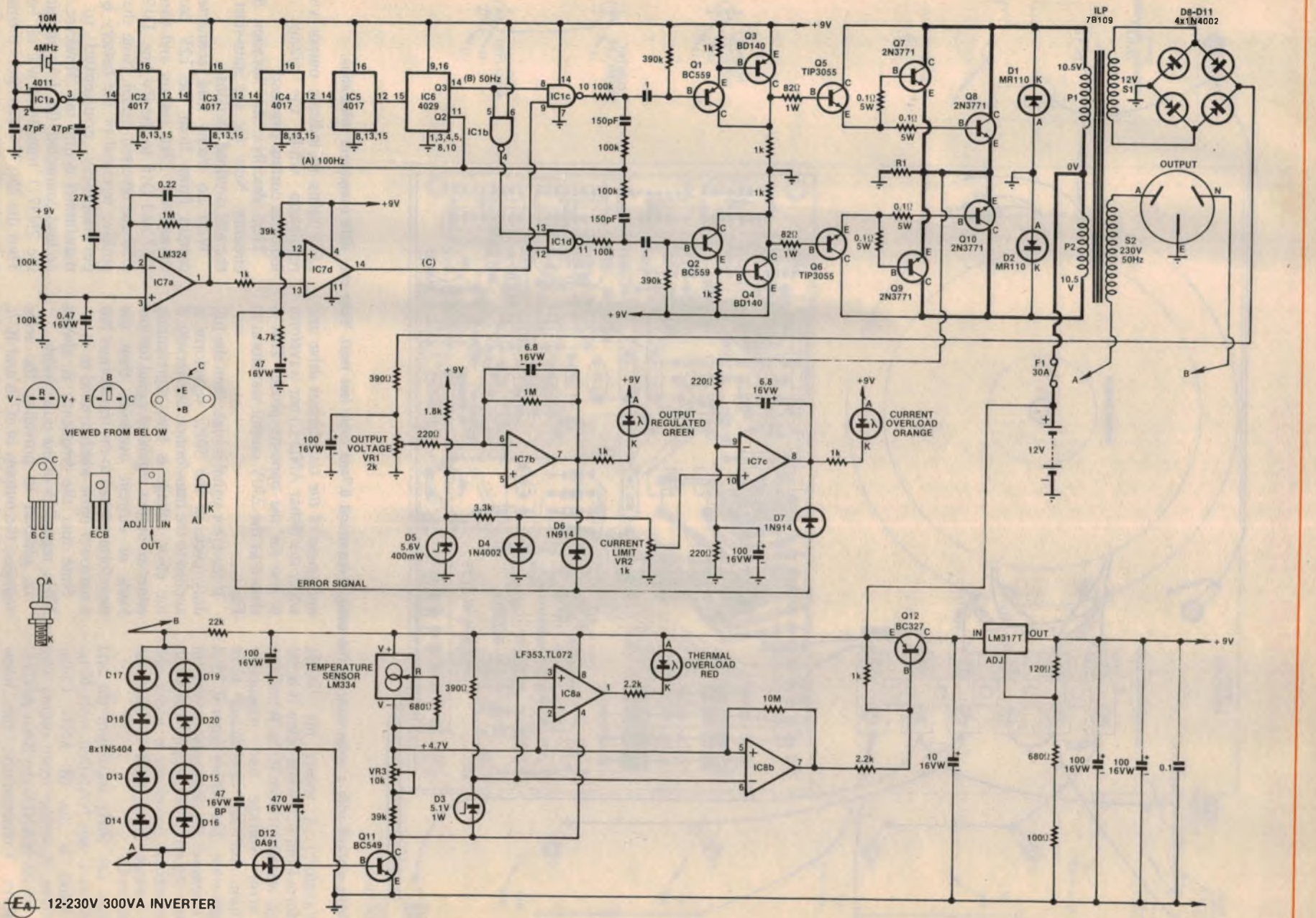
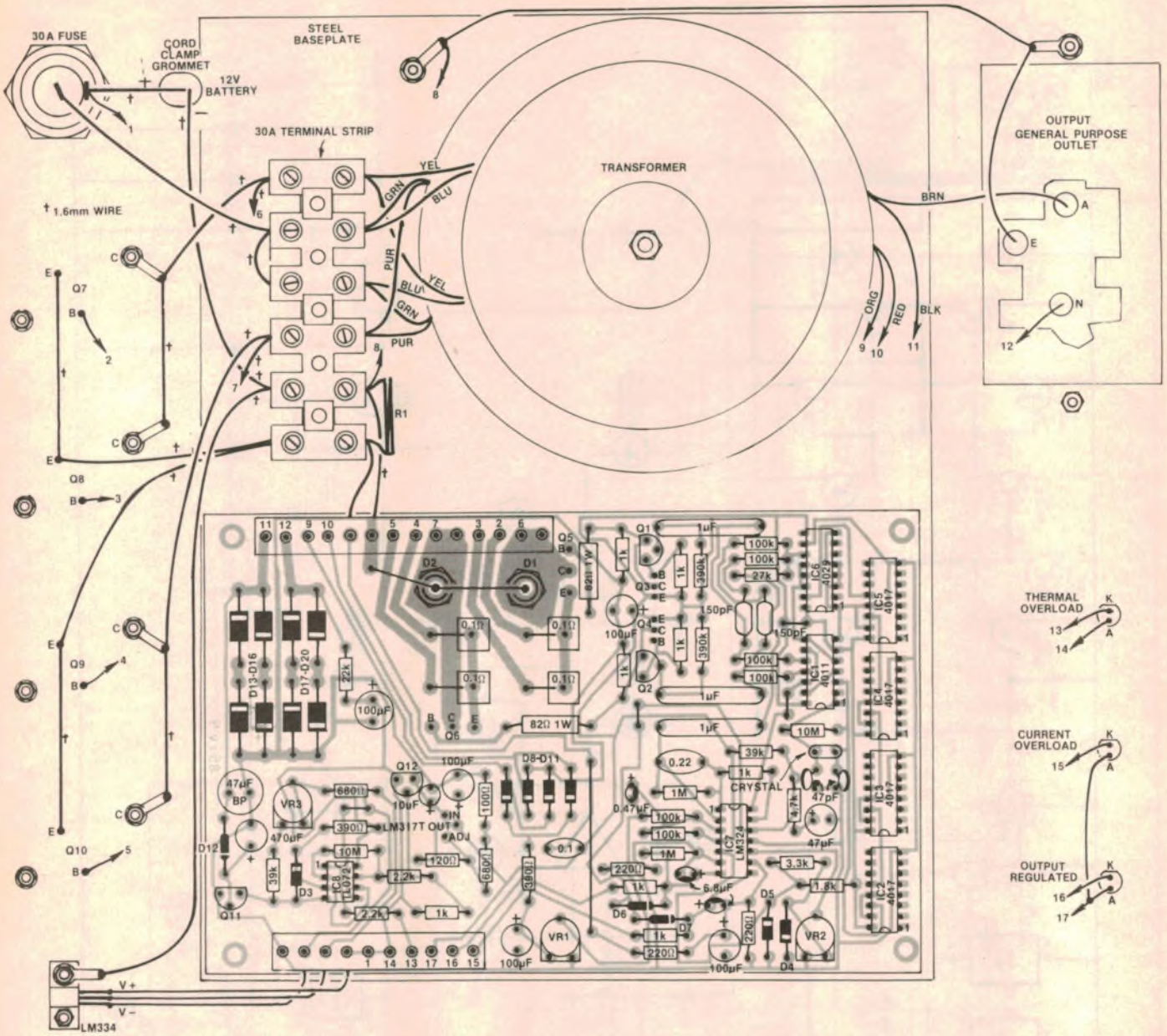


Fig. 1: this diagram shows the waveforms at various points on the circuit.


12-230V 300VA INVERTER
VIEWED FROM BELOW
ERROR SIGNAL
OUTPUT VOLTAGE VR1 2k
OUTPUT REGULATED GREEN
CURRENT OVERLOAD ORANGE
THERMAL OVERLOAD RED
CURRENT LIMIT VR2 1k
TEMPERATURE SENSOR LM334
LF353,TL072
LM317T
ILP 7B109
D8-D11 4x1N4002
8x1N5404
OUTPUT
12V
F1 30A
S1
S2 230V 50Hz
(A) 100Hz
(B) 50Hz
(C)
3/IT/-

12/230V 300VA inverter



All wiring marked with a cross must be run using seven-strand 0.7mm cable (see text). Take care with component orientation.

1. Waveform A shows the 100Hz waveform from IC6 while below it is the triangle waveform from IC7a. Whenever the error voltage and triangular waveform intersect, comparator IC7d changes state. The output from IC7d is high whenever the triangular waveform is below the error voltage and low when the triangular waveform is above the error voltage. This result is shown as waveform C.

When the 50Hz waveform (B) and waveform C are NANDed with IC1c, the result is the (B AND C)-bar waveform. A similar result occurs with IC1d, which NANDs the B-bar AND C waveform. Consequently, the transformer is only driven for the time that the (B AND C)-bar waveform is low for one phase of the transformer drive and when the (B-bar AND C)-bar waveform is low for the opposite phase. This is shown as the 230V output waveform in Fig.1.

If the error signal is high, then the full duty cycle of the 50Hz waveform is applied to the transformer. Conversely, if the error voltage is low, representing either an output regulated signal for low loads or current overload, then the waveform applied to the transformer has a narrower pulse width applied to it.

Note that the frequency is always 50Hz, regardless of the pulse width.

In addition to providing the error voltages, the outputs of IC7b and IC7c are connected to LED indicators via 1kΩ current limiting resistors. The green LED lights to indicate output voltage regulation while the orange LED indicates current overload.

That describes the inverter driver circuitry. Now for the auto-start and thermal overload sections.

With no mains load connected, a current flows from the 12V battery, through the 22kΩ resistor and then via D17 and D18 to the 0V line. D19 and D20 are reversed biased. Note that the positive terminal of the battery is also permanently connected to the transformer centre tap. However, with no load connected, the drive circuitry to the 2N3771 transistors will all be off. Thus the 2N3771 transistors themselves will all be off and so no current flows in this part of the circuit.

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Cat. K82092
WAS $19.50 NOW $14.50

RADIOTELETYPE CONVERTER FOR THE MICROBEE
Have your computer print the latest news from the international shortwave news service. Just hook up this project between your short wave receivers audio output and the MicroBee parallel port. A simple bit of software does the decoding. Can be hooked up to other computers too. (ETI Apr. '83)
WAS $20.00 NOW $14.95

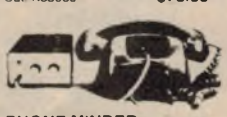
FUNCTION GENERATOR
This Function Generator with digital readout produces Sine, Triangle and Square waves over a frequency range from below 20Hz to above 160Hz with low distortion and good envelope stability. It has an inbuilt four-digit frequency counter for ease and accuracy of frequency setting. (EA April 82 82AO3A/B)
Cat. K82040
Cat. K82041 **$87.50**

EA AM STEREO DECODER
AM stereo is now broadcast in Australia on an experimental basis. This add-on decoder works with the Motorola C-QUAM system. (EA Oct '84) 84MS10
Cat. K84101 **$27.50**

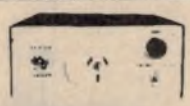
EPROM PROGRAMMER
If you have ever wanted to rewrite or extend the operating system of your microcomputer or if your re interested in dedicated microprocessor applications then this EPROM Programmer is just the thing. It is an inexpensive unit that uses readily available IC s. interfaces directly to the expansion bus on the back of all the popular 8080/Z80 microcopmputers and programs 2708's, 2716's, 2758's and 2732's. (EA July 80) 80PP71
Cat. **$79.50**
(Horwood case supplied)

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 **$15.00**

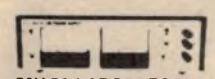
EFFECTS UNIT
An "effects unit" that can create phasing, flanging, echo, reverb and vibrato effects.
(EA June '83) 83GA6
Cat. K83060 **$75.00**



PHONE MINDER
Dubbed the Phone Minder, this handy gadget functions as both a bell extender and paging unit, or it can perform either function separately. (EA Feb. 84) 84TP2
Cat. K84020 **$27.50**

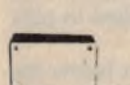


40 W INVERTER
This 12-240 V inverter can be used to power up mains appliances rated up to 40 W, or to vary the speed of a turntable. As a bonus, it will also work backwards as a trickle charger to top up the battery when the power is on. (EA May 82) 82IV5
Cat. K82050 **$54.50**

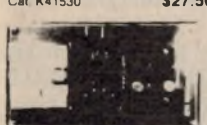


50V 5A LABORATORY POWER SUPPLY
New switchmode supply can deliver anywhere from three to 50V DC and currents of 5A at 35V or lower. Highly efficient design.
(Ea May-June 83) 83PS5
Cat. K83050 **$149**

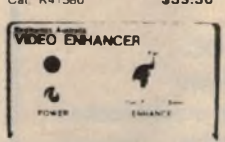
30 V/1 A FULLY PROTECTED POWER SUPPLY
The last power supply we did was the phenomenally popular ETI-131. This low cost supply features full protection, output variation from 0V to 30V and selectable current limit. Both volatage and current metering is provided. (ETI Dec.'83) ETI 162
Cat. K41620 **$52.50**



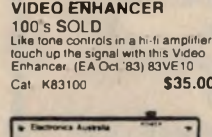
TEMP PROBE
Can measure temperature from -50 to 150-c. It simply plugs into your multimeter - great for digital multimeters. Accuracy of 0.1-c resolution of 0.1-c
(ETI June 83) ETI 153
Cat. K41530 **$27.50**



LOW OHMS METER
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.
(ETI Nov. 81) ETI 158
Cat. K41580 **$39.50**



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 **$35.00**



VIDEO AMPLIFIER
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 plugpack supply.
(EA Aug '83) 83VA8
Cat. K83081 **$17.50**

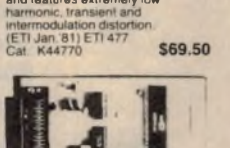
ELECTRONIC MOUSETRAP
This clever electronic mousetrap disposes of mice instantly and mercifully, without fail, and resets itself automatically. They'll never get away with the cheese again!
(ETI Aug. 84) ETI 1524
Cat. K55240 **$32.50**

MUSICOLOR IV
Add excitement to parties, card nights and discos with EAs Musicolor IV light show. This is the latest in the famous line of musicolors and it offers features such as four channel "color organ" plus four channel light chaser, front panel LED display, internal microphone, single sensitivity control plus opto-coupled switching for increased safety.
(EA Aug. 81) 81MC8
Cat. K81080 **$99.00**

1W AUDIO AMPLIFIER
A low-cost general-purpose 1 watt audio amplifier, suitable for increasing your computers audio level, etc. (EA Nov. 84)
Cat. K84111 **$9.95**

VOICE OPPERATED RELAY
EA s great Voice Operated Relay can be used to control a tape recorder, as a VOX circuit for a transmitter or to control a slide projector. (EA Apr. 82) 82VX4
Cat. **$14.95**

MOSFET POWER AMPLIFIER
Employing Hitachi Mosfets, this power amplifier features a "no compromise" design, and is rated to deliver 150 W RMS maximum and features extremely low harmonic, transient and intermodulation distortion.
(ETI Jan. 81) ETI 477
Cat. K44770 **$69.50**



MICROBEE SERIAL-TO-PARALLEL INTERFACE
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 **$59.00**

LATEST KITS!

MULTI SECTOR ALARM STATION
Protect your home from intruders with this up-to-the-minute burgular alarm system, its 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.

Complete kit including deluxe prepunched metal work and electronics for only...
Cat. K85900 **$119**

300 BAUD DIRECT CONNECT MODEM
Modem? What do I want with a modem? Think of these advantages:
- Can t afford a floppy disc? Use your telephone to access one for the cost of a call.
- Bored with your old programs? Download hundreds of free programs.
- Want to get in touch with fellow computer enthusiasts? Use 'electronic mail'.
- Ever used a CP/M system? CP-DOS? UNIX? Well a modem will make a your computer a remote terminal on some of the most exciting systems around.

Save on ready built modems.
Cat **$99**

STEREO ENHANCER
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.
(ETI 1405, ETI MAR 85)
Cat. K54050 **$79.50**

LOW BATTERY VOLTAGE INDICATOR
Knowing your batteries are about to give up on you could save many an embarrassing situation. This simple low cost project will give your early warning of power failure, and makes a handy beginner s project.
(ETI 280, March 85)
Cat. K42800 **$7.95**

PARALLEL PRINTER SWITCH
Tired of plug swapping when ever you want to change from one printer to another? This low-cost project should suit you down to the ground. It lets you have two Centronics-type printers connected up permanently, so that you can select one or the other at the flick of a switch.
(ETI 666, Feb. 85)
Cat. 46660 **$69.95**

ROD IRVING ELECTRONICS
425 High Street, NORTHCOTE, 3070 VICTORIA, AUSTRALIA
Phone (03) 489 8866
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$50-$99.99	$5.00
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$500 plus	$12.50

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Errors and ommisions excepted

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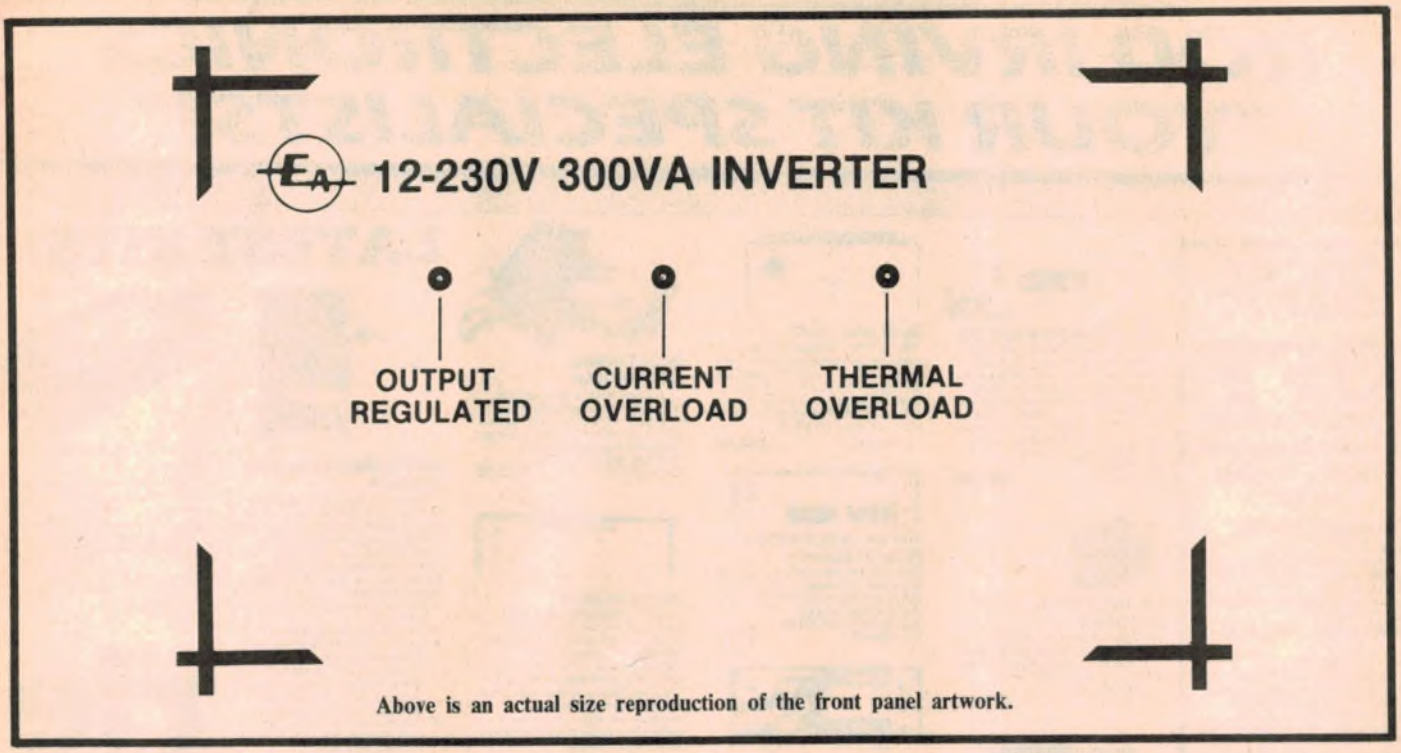


Above is an actual size reproduction of the front panel artwork.

12/230V 300VA inverter

When an appliance is connected and switched on, the forward bias voltage across D17 and D18 (which is applied to the neutral AC output line) is applied via the series resistance of the appliance and the S2 winding to the anode of diode D12. This bias voltage then charges the 47μF and 470μF capacitors and turns on transistor Q11.

Q11, in turn, powers up op amp IC8 and allows current to flow through D3 and the LM334 temperature sensor. D3 sets the reference voltage on pins 3 and 6 of IC8a and IC8b respectively.

The LM334 temperature sensor is a three-terminal device which produces a current that is directly proportional to its absolute temperature. This current flows through VR3 and the series 39kΩ resistor and the resultant voltage applied to pins 2 and 5 of IC8a and IC8b.

Normally, this voltage is set below the zener diode voltage. This means that comparator IC8a will have a high output and comparator IC8b will have a low output. Consequently, the thermal overload LED will be off and Q12 will be on.

With Q12 on, the +12V supply from the battery is applied to an LM317 adjustable three-terminal regulator. This, in turn, supplies a regulated +9V rail to the inverter control circuitry. Thus, the inverter starts.

SPECIFICATIONS

Nominal supply voltage	12V DC
Output voltage	see table
Frequency	50Hz crystal locked
Regulation	see table
Maximum load	300VA
Current limiting	30A (primary)
Standby current	580μA

LOAD (W)	OUTPUT VOLTAGE (RMS)	INPUT CURRENT (A)	BATTERY LIFE 40Ah/20hr (MINUTES)
40	240	4.6	240
100	250	11.9	80
200	240	21.7	50
300	230	30.3	28

Operation of the regulator is as follows: the voltage between the output and adjust terminals is maintained at 1.25V which means that about 10mA flows through the 120Ω resistor. This current also flows through the 680Ω and 100Ω resistors and so the adjust terminal is jacked up to +7.8V. This means that the output is maintained at 1.25V plus 7.8V, or around +9V.

The 10μF capacitor at the input of the regulator ensures stability of the device while the 100μF and 0.1μF capacitors at the output are used for supply decoupling.

Thermal overload protection is achieved by using the LM334 to monitor the heatsink temperature. As the heatsink temperature rises so does the voltage on pins 2 and 5 of IC8. When this voltage reaches the reference voltage set by D3, the output of IC8a goes low and switches on the thermal overload LED. At the same time, the output of IC8b goes high and Q12 turns off.

This switches off the power to the inverter control circuitry and thus Q5-Q10 are also switched off. The circuit automatically re-starts when the heatsink cools down.

The 10MΩ resistor across IC8b provides a small amount of hysteresis. This prevents the inverter from switching on and off in rapid cycles as the output transistors heat and cool.

Incidentally, note that diodes D13-D20 actually provide part of the circuit for the AC load current.

When the load is disconnected, the bias for transistor Q11 is removed. After a short delay determined by the charge

on the 470μF and 47μF capacitors, Q11 switches off and the supply to IC8 is removed.

There are two further points of note regarding the auto-start feature. First, the 47μF bipolar capacitor shunts AC signals to ground when the load is first switched off. This is necessary, since some appliances have a small capacitor permanently connected across the mains switch. The resulting current through this capacitor could otherwise be sufficient to keep Q11 on.

Second, once the inverter starts, base current for Q11 is provided by the AC load current through the appliance. This is because the 545μA through the 22kΩ resistor is easily swamped by the considerably higher load current. Diode D12 is used to prevent reverse current flow in the base of Q11. The 470μF capacitor stores sufficient energy to keep Q11 on during the negative AC cycle when D12 is reverse biased.

Construction

Most of the parts are mounted on a PCB coded 85pi9 and measuring 110 × 171mm. This board is mounted inside a plastic instrument case (supplied by Altronics, Cat No H-0482) measuring 260 x 190 x 80mm. A Scotchcal front-panel artwork indicates the LED functions.

A steel baseplate is used to support the toroidal transformer (also supplied by Altronics, Cat No M-3200), terminal strip and printed circuit board. This is secured to the integral plastic standoffs inside the case using nine self-tapping screws.

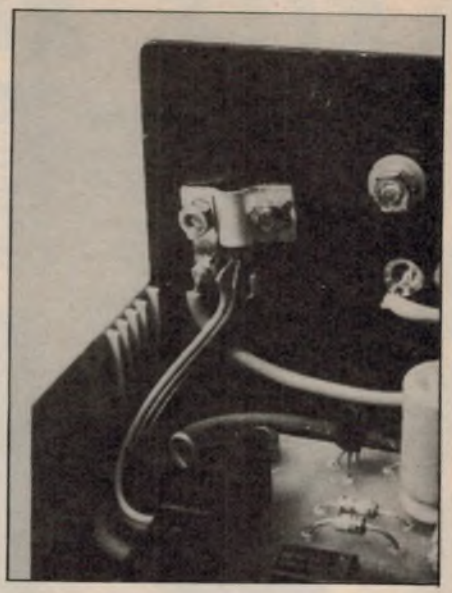
Note that the baseplate should be supplied with 3mm 90° folds along its front and rear edges. These provide extra rigidity and prevent the case from flexing when the baseplate is mounted in position.

Note also that 2.5mm black anodised aluminium panels are substituted for the plastic front and rear panels usually supplied. These provide additional strength and heatsinking for the output transistors.

Begin construction with the PCB assembly. No particular procedure need be followed but we suggest that you solder in the smaller components first. Note carefully the orientation of the semiconductors and electrolytic capacitors when they are being installed.

Refer to the circuit diagram for the transistor pin designations. Note that Q3 and Q4 (BD140) face in opposite directions. The 5W resistors are mounted end on to conserve space on the PCB.

The two 10A diodes are bolted directly to the PCB. Before they are mounted, their cathode studs should be cut, with a hacksaw, to a length of 6mm. This is to ensure clearance between the studs and the baseplate, when the PCB is mounted in position. This done, insert the stud (cathode) end of each diode through the hole provided for it on the PCB and install a star washer between the PCB and nut. Before tightening down the nut, orient the hole in the anode lug so that it faces lengthways along the PCB.



This close-up view shows how the LM334Z temperature sensor is mounted.

KITS, KITS AND MORE KITS

IN-CIRCUIT TRANSISTOR TESTER

Ref: EA September 1983

Have you ever unsoldered a suspect transistor only to find that it checks O.K? Troubleshooting exercises are often hindered by this type of false alarm. You can avoid these hassles with the 'In Circuit' transistor, SCR and diode tester.

The kit does just that, tests devices WITHOUT the need to unsolder from the circuit! VERY handy!

The Jaycar kit includes a Jiffy box and Scotchcal panel showing the truth table for device checking.

Cat. KA-1119

ONLY $17.95

"RAILMASTER" Pulse-Power Train Controller

Ref: EA September 1984

This is a state-of-the-art train controller offering tremendous features

- ★ Variable simulated inertia
- ★ Full short circuit protection including both audible and visual indicators
- ★ Power and track monitor indicators
- ★ Adequate power for double and triple heading locos
- ★ Fixed 12V DC and 15V AC power for lighting and accessories
- ★ Optional walk around throttle

The Jaycar kit includes realistic Scotchcal front panel and the special console case only available from us. The large paddle switches have been specially imported just for this kit. We believe that you will be delighted with this unit.

Cat. KA-1560

$89.95

Optional Walk Around Controller Cat. KA-1559

ONLY $9.95

Diesel Sound Simulator

Ref: Ea November 1984

This project mounts inside a model train (i.e. goods wagon) and produces a noise similar to a diesel locomotive. The 'speed' varies according to the throttle action for added realism. All listed parts provided.

Cat. KA-1561

$19.95

Steam Sound Simulator

Ref: EA December 1984

Build this realistic steam sound simulator for your model train layout. It features an infra-red optical switch to synchronise the "chuffs" to the wheel rotation. Like the KA-1561, it picks up the power from the railway tracks. All specified components supplied including 32 ohm headphone type transducer.

Cat. KA-1562

$17.95

Motorcycle Intercom - Ref: EA Feb 1984

What a great kit! This full duplex unit enables you to talk to your pinion passenger whilst riding with your helmets on! Powered by the bikes battery - you can both talk at the same time if you wish as there are no switches to activate. The Jaycar kit includes the special headphone inserts and all parts.

Cat. KA-1533

ONLY $39.95

DWELL/TACHOMETER

Ref: EA Sept. 1985

Tune up your car quickly and easily with this handy piece of gear. The Jaycar kit includes case, large meter and Scotchcal meterscale.

Cat. KA-1612

ONLY $34.95

Suits 4-6 or 8 cylinder cars

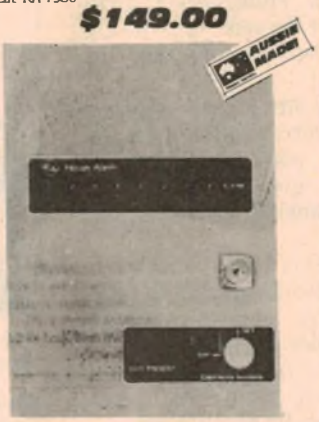
8 SECTOR BURGLAR ALARM - Ref: EA Jan/Feb 1985

Why buy a commercially-made up unit for more when you can buy this kit and SAVE money! A unique feature of this kit is the fact that you can wire N/O and N/C alarm sensors ON THE SAME LINE

- ★ 8 SECTORS
- ★ 2 delayed entry sectors
- ★ Steel box
- ★ Includes battery and siren driver in the price
- ★ Variable exit and entry delays

Cat. KA-1580

$149.00



STEREO AM DECODER (Australian Standard)

Ref: EA October 1984

This unit uses the Australian standard Motorola CQUAM decoder chip. It will decode the new AM stereo transmissions (with suitable AM tuners). The Jaycar kit is supplied with 1% resistors in lieu of the standard ones, for extra precision.

Cat. KA-1555

ONLY $24.95

Digital Bench Type Capacitance Meter

Ref: EA August 1985

- ★ Easy to assemble
- ★ 4 digit LED readout
- ★ Measures from 1pF to 99.9uF
- ★ 3 ranges
- ★ Bench type mains powered

NEW!

Cat. KA-1595

ONLY $79.95

PLAYMASTER SERIES II MOSFET AMP KIT

Ref: EA Jan/Feb/March 1985

"... s stereo amplifier that will equal or better just about any integrated commercial amplifier, regardless of price". Leo Simpson, Editor of EA, February 1985

MAIN FEATURES

- Switchable phono input for MM and MC cartridges
- Electronic signal switching
- Full facilities for dubbing between two cassette decks
- Monitor loop for either of two cassette decks or a signal processor
- Click action pushbutton switches for selection of sources, dubbing and tape monitor with LED status indicators
- Centre detents on bass, treble and balance controls, multiple detents on volume control
- Heavy duty heatsinks
- Power transformer for low hum and noise
- Easy to build - all parts except power supply mount directly on the two printed circuit boards; wiring has been kept to an absolute minimum
- 100 watts RMS per channel into 8 ohm load
- Less than 0.01% total harmonic distortion

Cat. KA-1500

ONLY $429.00

40 WATT DC INVERTER

Ref: EA August 1985

An upgrade of a previous design featuring a smart new ABS case.

Cat. KA-1598

$79.95

NEW!

300 WATT INVERTER

Ref: EA Sept. 1985

This totally new design is a vast improvement over the EA June 1982 project. It features a modern all-plastic case, easier assembly, toroidal type inverter transformer, auto start up and double, switched power outlets.

And it's cheaper than the old model!!

The Jaycar kit contains all specified parts to enable you to complete the project in one go.

Cat. KA-1610

ONLY $199.00

NEW!

Car Booster Amp

Ref: EA August 1985.

This project enables you to have 2 x 50 watts RMS of power for your car sound system. In order to do this, a special high voltage power supply forms part of the system. Absolutely stunning value for money. Around half the price of inferior commercial units.

The Jaycar kit is, as usual, absolutely complete.

Cat. KA-1600

ONLY $179

NEW!

5(6.5)MHz OSCILLOSCOPE KIT

Ref: EA October 1984

Over the years many people have asked, "Do you have a CRO kit?" Our answer - up until nov - has been that built and tested units were no dearer than kits, if you could get a kit at all.

The Jaycar KJ-7050 Cathode Ray Oscilloscope kit has a guaranteed 5MHz bandwidth but should go to around 6.5MHz. It also features 75mm (3") CRT Blue Phosphor with accurate graticule, separate vertical and horizontal BNC type input sockets etc. Remember, a 5MHz 'scope is usually adequate to troubleshoot most microprocessor and other digital circuitry as well!!

This is a wonderful opportunity to learn electronics AND end up with a valuable piece of test equipment as well.

The Jaycar KJ-7050 kit is absolutely complete. The chassis is prepunched and every component including nuts and bolts are provided, along with instructions.

Cat. KJ-7050

ONLY $269.00

LOWEST PRICE EVER! LUCKY LAST!

Lyrebird 73 Note Piano

Ref: EA Oct 1981 — Jan 1982

This fabulous piano kit has an amazingly realistic sound. Many hundreds of happy users enjoy this kit, but all good things come to an end. We have 12 kits'd left and that's it!

This is your absolute last chance to own a 6-octave piano at an unbelievable price. Sorry no deposits, no back orders as no more will be built after these 12 have been sold.

Cat. KA-1350

~~$475~~
~~$325~~
$299
SAVE $176.00

Please add $20 for freight/packing

ETI 1401 DIRECT INJECT BOX

Ref: ETI Sept. 1985

This unit accepts unbalanced audio inputs (line or mic. level) and produces a line level balanced signal to drive mixers or balanced input equipment. The Jaycar kit includes die-cast box, specified push button switch bank and all other parts.

Cat. KE-4708

ONLY $34.95

NEW!

"ELECTRIC FENCE"

Ref: EA Sept. 1982

mains or battery powered, this electric fence controller is both inexpensive and versatile. It should provide an adequate deterrent to all manner of livestock. Additionally, its operation conforms to the relevant clauses of Australian Standard 3129. The kit does not include automotive ignition coil which is required.

Cat. KA-1109

ONLY $18.50

30 VOLT - 1 AMP BENCH TOP POWER SUPPLY

Ref: EA January 1985

This new design features a modern moulded plastic bench top type case, variable output from 3-30V and variable current limiting over 2 ranges. Overload protection and switchable voltage/current metering is also provided.

Cat. KA-1574

ONLY $68.50

FROM JAYCAR NO 1 IN KITS

High Performance SPARK PLUG LEADS

Exclusive individual HT leads Hypalon, GUARANTEED for 100,000km's!!!

Jaycar has sourced the best commercial quality spark plug leads in the world! Jaycar stocks a range of 15 different lengths with combinations of right angles (RH) and straight distribution cap entry (SE). The other end all have identical spark plug covers (except for coil/distributor leads.)

Cat. WA-5404 ..... 30cm (RH)
Cat. WA-5408 ..... 40cm (RH)
Cat. WA-5412 ..... 50cm (RH)

ALL $3.95 each

Cat. WA-5416 ..... 60cm (RH)
Cat. WA-5420 ..... 70cm (RH)

ALL $4.95 each

Cat. WA-5434 ..... 30cm (SE)
Cat. WA-5438 ..... 40cm (SE)
Cat. WA-5442 ..... 50cm (SE)

ALL $3.95 each

Cat. WA-5448 ..... (SE)
Cat. WA-5452 ..... 70cm (SE)
Cat. WA-5456 ..... 80cm (SE)
Cat. WA-5460 ..... 90cm (SE)

ALL $4.95 each

Cat. WA-5474 ..... 30cm coil to dist
Cat. WA-5478 ..... 40cm coil to dist

ALL $3.95 each

Cat. WA-5482 ..... 60cm coil to dist

$4.95 each

★ Guaranteed 100,000km's
★ Fully waterproof plug & coil connections
★ Superior radio interference suppression especially VHF/CB radio
★ The highest spark performance from 'unique' metallic core
★ Constant quality spark for easier starting & better economy
★ Far superior performance to carbon cored leads

UNIQUE CONSTRUCTION

MAIL ORDER HOTLINE (02) 747 1888

TRANSISTOR ASSISTED IGNITION

Ref: EA January 1983

Latest version of this fantastically popular kit! The Jaycar kit comes COMPLETE down to the plastic TO-3 transistor covers, genuine heatsink and DIE CAST BOX - as used in the original EA unit.

Beware of kits that use flimsy sheet metal. This kit is designed to be used with contact breaker points. If you want Hall-Effect breakerless option we suggest the KA-1505.

Cat. KA-1506

ONLY $37.95

TAI HALL-EFFECT "BREAKERLESS"

Ref: EA December 1983

This kit is virtually identical to the KA-1506 except that it contains the interface electronics for the KJ-6655 Hall-Effect Triggerhead.

Cat. KA-1505

ONLY $39.95

The Listening Post

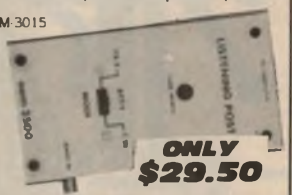
Ref: AEM July 1985

This device attaches between audio output of a short wave receiver and the input port of a computer. It allows decoding and printing of Morse Code, Radio-teletype (RTTY), AND radio facsimile (FAX) pictures! You can, for example, watch weather maps from the Met and dump them on to your printer!

Specific software for the Microbee is in the first article. Programs for other popular computers will be printed in later issues of AEM.

Complete set od specified components (Inc. IDC plug)

Cat. KM-3015



ONLY $29.50

240V NEGATIVE ION GENERATOR

Ref: AEM Sept 1985

The Jaycar kit includes ABS plastic case, special PCB etc. Please note that this kit is the ORIGINAL KJ-6511 around which the AEM project was based.

Cat. KJ-6511

ONLY $45.00

AEM 6500 - 60/120 WATT UTILITY MOSFET AMP MODULES

Ref: AEM July 1985

This is a low cost high performance design using proven MOSFET technology. A single pair of (2SJ49/2SK134) Mosfets will deliver up to 60 watts output. Another pair may be added for 120 watt performance. The module has been designed to fit into a large variety of commonly stocked instrument cases and rack boxes. It features VERY LOW distortion and impeccable transient performance. It is unconditionally stable and virtually blow-up proof. It can be powered from common transformer/rectifier/capacitor combinations. A Winner!

As usual, the Jaycar kit reflects a quality approach. All specified components for each version are included.

60 WATT MODULE Cat. KM-3010
$49.50

120 WATT MODULE Cat. KM-3012
$65.00

AEM 9500 Beat Triggered Strobe

Ref: AEM July 1985

This project provides a very bright stroboscopic effect for parties, discos, etc., but with an ADDITIONAL FEATURE! This strobe will actually flash in synchronisation with the music!

The Jaycar kit includes case, photographic reflector, flash tube etc.

Cat. KM-3018

ONLY $59.00

CONTACTLESS HALL-EFFECT "BREAKER POINTS"

See EA December 1983

A professionally engineered electronic ("breakerless") contact breaker system. Each kit contains the following:

★ Hall Effect Triggerhead
★ Magnetic rotors for both 4 & 6 cylinder cars
★ Over 6 cam lobe adaptors
★ Over 12 different adaptor plates for your particular distributor
★ Other hardware (i.e. screws)
★ Removes from car when you sell it.
★ As easy to install as a set of points
★ Simple instructions included

Cat. KJ-6655

ONLY $32.50

240V AC MICRON PROFESSIONAL IRON 20 WATT

This great iron has all the features of those costing a lot more ● 370° fixed temperature ● High efficiency patented heating element ● Iron clad, chrome plated, long life interchangeable tips

Cat. TS-1550

$22.50

IRON CLAD TIPS

Cat. TS-1552 ..... Micro Chisel 1mm
Cat. TS-1553 ..... Mini Chisel 1.5mm
Cat. TS-1554 ..... Standard Chisel 3mm

All $3.95 each

MICRON 25 WATT LOW COST SOLDERING IRON

Ideal for the hobbyist and handyman. 240V operated with spare tips available. Lightweight. Tip temperature variation within the limits suitable for electronic work. Comes complete with tip.

Cat. TS-1440

ONLY $17.50

SPARE TIPS

Cat. TS-1441 ..... Micro Chisel
Cat. TS-1442 ..... Mini Chisel
Cat. TS-1443 ..... Standard chisel

ALL $2.95 each

30 + 30 WATT STEREO AMP WITH PRE AMP

★ Fully built and tested
★ Separate bass, treble, balance and volume controls
★ Less than 0.1% distortion
★ Mic, phono and aux inputs (line)
★ Power supply components on board

Back at last! No hassles amplifier. Just connect a transformer, speakers, a signal and you're away!

NEW SHIPMENT JUST ARRIVED!

Cat. AA-0300

ONLY $49.95

Transformer to suit MM-2008 $12.50

Electronic Jumper Leads - ETI 341

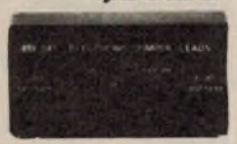
Ref: ETI August 1985. This project enables you to charge up a car battery via the cigarette lighter plugs in each car. A small inverter boosts the battery voltage from car No.1 to charge the flat battery in car No.2 via its cigarette lighter socket.

It's amazing how quickly you can put enough charge in a flat battery to start the car!

Complete set of parts including 2 x cigarette lighter plugs.

Cat. KE-4703

$39.95 NEW!



ETI 699 Modem Kit

Ref: ETI May 1985

This brilliant new design is a price breakthrough. Never has a modem with such SOPHISTICATED FEATURES been offered at such an incredibly low price. Now you can have no excuse to gain the tremendous benefits that a modem will offer viz:

★ Access to huge data banks
★ Networking
★ Telecommunications
★ Electronic shopping
★ Software exchange
★ And much more

This ETI kit is a full modem with facilities similar to units costing hundreds of dollars more. It even includes a Telecom approved push button telephone! Now is your chance to use your electronic skills in your new hobby and save a fortune over ready builts. You can obtain this modem kit (which includes a telephone for us humans) for the incredibly low introductory price of only $139. That's right! $139, inc. case, down to the last nut and bolt. But hurry! Stocks of the critical modem chip are very low and will severely limit kit supply.

Cat. KE-4695

ONLY $139.00

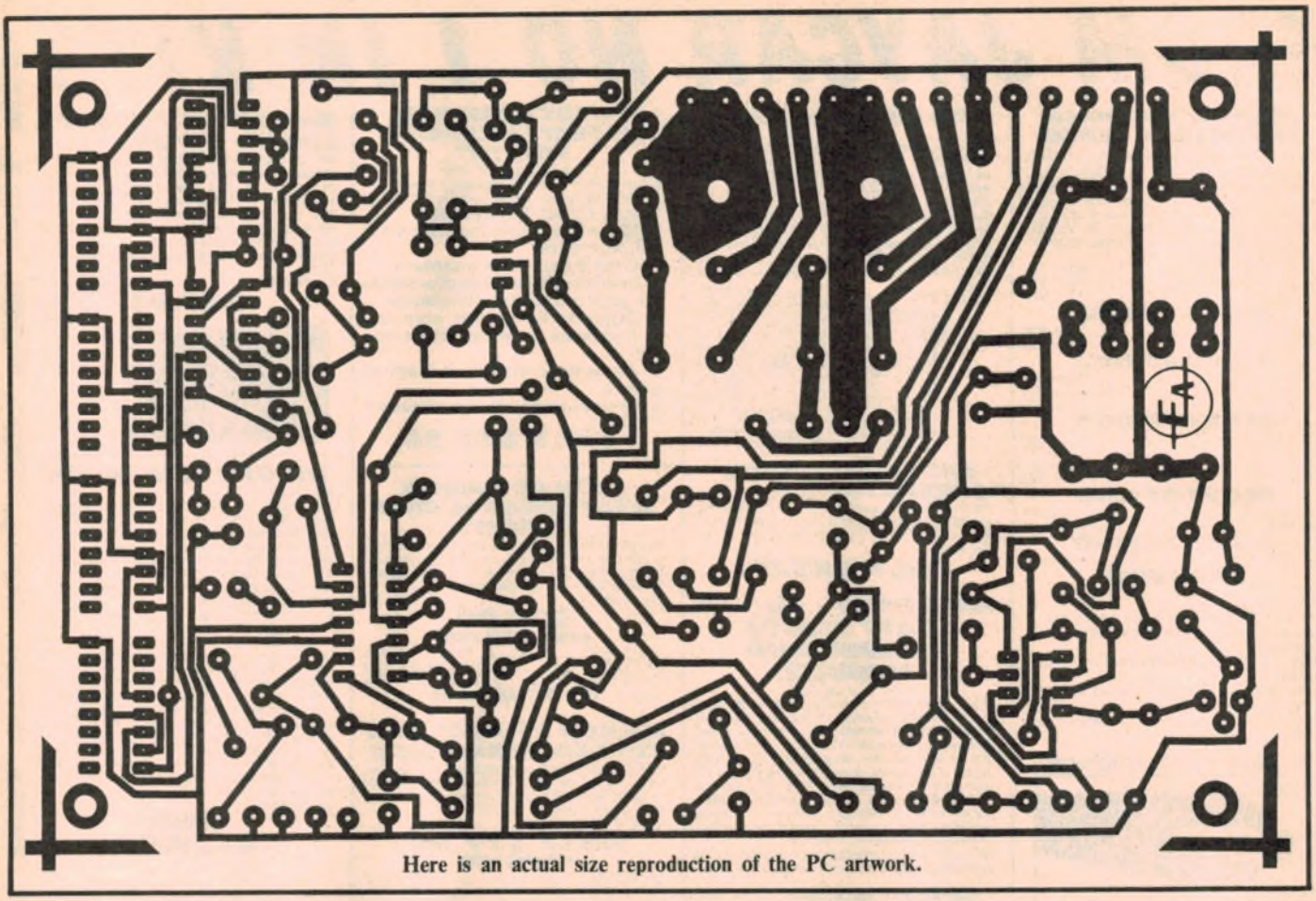
ETI 698 Microbee Dialler - ETI July 1985

Complete set of parts.

Cat. KE-4696

ONLY $19.95

SEE OUR EXTENSIVE RANGE OF KITS IN THE JAYCAR 1985 CATALOGUE



Here is an actual size reproduction of the PC artwork.

12/230V 300VA inverter

The anodes of the two diodes are connected together and soldered to the earth pad of the PCB, as shown on the wiring diagram. Use 1.6mm tinned copper wire for this job.

Work can now begin on the aluminium rear panel. This accommodates the 2N3771 transistors and their associated heatsinks, together with the fuseholder, cable entry grommet and LM334 temperature sensor.

The heatsinks are supplied pre-drilled and these can be used as templates for drilling the mounting holes for the output transistors. This done, drill the mounting holes for the fuseholder and cable clamp grommet. The temperature sensor is secured using a small aluminium bracket and this requires two mounting holes.

The various items of hardware can now be mounted on the rear panel. Note that the 2N3771 output transistors must be electrically isolated from the heatsinks using mica washers and insulating bushes (see Fig.2). Smear all mating surfaces with heatsink compound before assembly and attach a solder lug to one of the mounting screws for each transistor.

Use your multimeter to confirm that the transistor cases have been correctly isolated from the heatsinks.

By comparison, the front panel assembly is quite straightforward. The first job is to mount the general purpose outlet (GPO). This requires two screw mounting holes and a large cutout in the panel to clear the terminal moulding.

The best way to make the cutout is to first drill a series of holes around the inside perimeter of the required area. This done, the centre piece can be removed and the edges filed down. The Scotchcal label can be used as a drilling template for the three LEDs.

Two 12mm 4BA bolts and nuts are used to secure the mains outlet to the front panel. The LEDs are mounted using plastic bezels.

The baseplate requires holes for nine No.4 6mm self-tapping screws, together with mounting holes for the PCB, terminal strip, transformer and an earth terminal lug. Use the accompanying diagram (Fig.2) as a drilling guide.

The hardware can now be mounted on the baseplate according to the wiring diagram. Mount the terminal strip and earth solder lug using 12mm 6BA screws and nuts. The transformer should be bolted down using the hardware

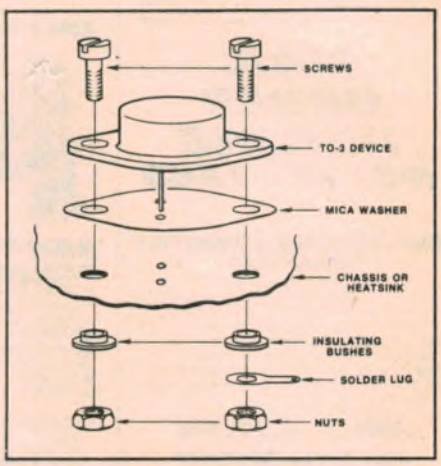


Fig.2: this diagram shows the mounting details for the output transistors.

supplied. One large rubber washer is sandwiched between the transformer and the base, while the other goes between the top of the transformer and the large metal washer.

The PCB is mounted on tapped standoffs. The standoffs are first attached to the baseplate (before it is secured in position) using screws from the underside and then the PCB is secured, also using short screws.

Construction can now be completed by wiring up the unit according to the wiring diagram. Note that all wiring

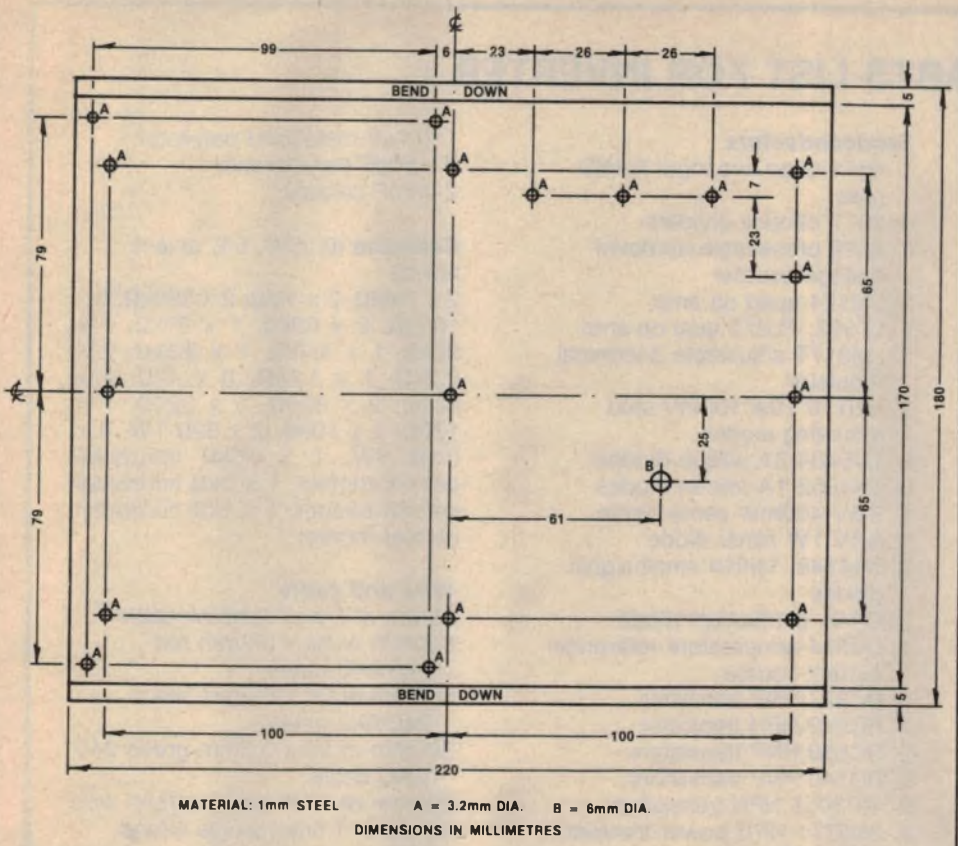


Fig.3: here are the drilling details for the metal baseplate.

marked with a cross must be run using seven-strand 0.7mm cable. This includes the wiring to the fuse, to the battery, and to the collector and emitter terminals of the heatsink transistors.

The wiring between the transistor bases and the PCB should be run using red or black 24-strand 0.2mm wire. Similarly, the earth wiring can be run using green 24-strand 0.2mm wire. Either light-duty hookup wire or rainbow cable can be used for the temperature sensor connections.

R1 is simply a 200mm length of 1mm single-strand wire wound into a coil and connected across the terminal block. A length of plastic sleeving over the wire prevents it from shorting.

Note that both the front and rear panels are earthed to the baseplate, in the latter case via the 30A terminal strip. The battery leads are clamped to the rear panel using an in-line cord grommet and are terminated with large automotive battery clips.

Testing and adjustment

Before switching on, go over your work carefully and check for possible wiring errors. In particular, check that all polarised parts have been correctly installed and check the wiring to the transformer. Check also that there are no shorts between any of the heatsink transistor terminals and ground.

Satisfied that all is well, set trimpot VR1 to mid-position and trimpots VR2 and VR3 fully clockwise.

Now connect a 12V automotive battery to the inverter and plug a 100W lamp into the mains output. The inverter should immediately start operating and light the lamp. Assuming all is well, check the voltages across D3 and D5. You should get readings of 5.1V and 5.6V respectively.

The output of the LM317 regulator should be at +9V. Note that the spare terminal next to the V- input for the LM334 is connected to ground. This can be used for the ground connection to your multimeter when measuring the above voltages.

To set the output voltage, either a true RMS voltmeter will be required or the adjustment will have to be carried out using a comparison method. If an RMS meter is available, lightly load the inverter using a 100W lamp and adjust VR1 for a reading of 250VAC.

To adjust the output using the comparison method, connect a second 100W lamp to the mains and adjust VR1 until both lamps appear to have the same brightness. The output regulated LED should be lit following this adjustment.

Now disconnect the 100W load and check that the inverter automatically switches off. The best way to check this is to monitor the +9V output from the three-terminal regulator.

The next step is to adjust the thermal overload protection. Connect a very large load, such as a 1kW electric

PARTS LIST FOR INVERTER

1 plastic instrument case, 260 x 190 x 80mm (Altronics H-0482)
2 2.5mm black anodised aluminium panels for case
1 PCB, code 85pi9, 110 x 171mm
1 Scotchcal front panel, 130 x 75mm
1 300VA toroidal transformer (Altronics M-3200)
1 double general purpose outlet
4 TO-3 U-shaped heatsinks, 40 x 40 x 25mm, RS Components Cat No 402-967
1 30A panel-mounting 5AG fuse holder
1 30A 5AG fuse
1 steel baseplate, 176 x 220mm
1 10-way PCB terminal block
1 8-way PCB terminal block
1 6-way PCB terminal block
1 6-way 30A mains terminal block
2 automotive battery clips
1 cord clamp grommet for 6.5mm cable
4 6mm untapped PCB standoffs
3 LED mounting bezels
7 solder lugs
4 TO-3 insulating kits plus mounting hardware (mica washers, insulating bushes, screws and nuts)
1 4MHz parallel resonant crystal
9 No.4 x 6mm self tapping screws
10 4BA x 12mm bolts plus nuts and lockwashers
2 6BA x 12mm bolts and nuts
1 strip of aluminium sheet 20 x 6mm

Semiconductors
1 4011 quad two input NAND gate
4 4017 decade dividers
1 4029 presettable up/down 4-stage counter
1 LM324 quad op amp
1 LF353, TL072 dual op amp
1 LM317T adjustable 3-terminal regulator
2 MR110 10A 100PIV stud mounting diodes
8 1N5404 3A silicon diodes
5 1N4002 1A silicon diodes
1 5.6V 400mW zener diode
1 5.1V 1W zener diode
2 1N4148, 1N914 small signal diodes
1 OA91 germanium diode
1 LM334 temperature reference current source
1 BC327 PNP transistor
1 BC549 NPN transistor
2 BC559 PNP transistors
2 BD140 PNP transistors
2 TIP3055 NPN transistors
4 2N3771 NPN power transistors
1 5mm red LED
1 5mm green LED
1 5mm orange LED

Capacitors
1 470μF 16VW PC electrolytic
5 100μF 16VW PC electrolytic
1 47μF 16VW PC electrolytic
1 47μF 16VW PC bipolar electrolytic
1 10μF 16VW PC electrolytic
2 6.8μF 16VW PC electrolytic
3 1μF metallised polyester
1 0.47μF 16VW PC electrolytic
1 0.22μF metallised polyester
1 0.1μF metallised polyester
2 150pF polystyrene
2 47pF ceramic

Resistors (0.25W, 5% unless noted)
2 x 10MΩ, 2 x 1MΩ, 2 x 390kΩ, 6 x 100kΩ, 2 x 39kΩ, 1 x 27kΩ, 1 x 22kΩ, 1 x 4.7kΩ, 1 x 3.3kΩ, 2 x 2.2kΩ, 1 x 1.8kΩ, 8 x 1kΩ, 2 x 680Ω, 2 x 390Ω, 3 x 220Ω, 1 x 120Ω, 1 x 100Ω, 2 x 82Ω 1W, 4 x 0.1Ω 5W, 1 x 10kΩ horizontal cermet trimpot, 1 x 2kΩ horizontal cermet trimpot, 1 x 1kΩ horizontal cermet trimpot.

Wire and cable
25mm of 5-way rainbow cable
500mm of 24 x 0.2mm red 240VAC cable
500mm of 24 x 0.2mm black 240VAC cable
300mm of 24 x 0.2mm green 240 VAC cable
200mm of 1mm single strand wire
60mm of 1.6mm single strand wire
600mm of 7 x 0.7mm orange cable
300mm of 7 x 0.7mm green cable
800mm of 7 x 0.7mm red cable (for battery lead)
800mm of 7 x 0.7mm black or green cable (for battery lead)
200mm of 1.5mm ID plastic tubing

Miscellaneous
Heatsink compound, solder, rainbow cable etc.

radiator, and monitor the heatsink temperature by keeping a finger on one of the output transistors. Rotate VR3 anticlockwise so that the inverter re-starts each time the thermal overload trips, until the output transistors become just too hot to touch.

Alternatively, if a temperature probe is available, set VR3 so that the thermal overload trips when the transistor case temperature reaches 70°C. Check that the thermal overload LED lights each time the circuit trips.

The current limit is adjusted using a 300W load (eg, three 100W light bulbs). All you have to do is adjust VR2 until the lamps just begin to dim. VR2 should then be backed off slightly until the lamps operate at full brightness.

Alternatively, use an RMS voltmeter to monitor when the output voltage begins to drop, then back off until the output voltage is restored to normal. This sets an approximate 30A current limit on the primary side of the transformer.

Performance

The accompanying table summarises the performance of the prototype.

As can be seen the output voltage remains relatively constant with a varying load. At light loads, the output regulated LED is lit and the output waveform is controlled by the voltage regulation circuit. This means that only part of the 50Hz waveform is present on the output.

At much higher loads (around 300W), the full 50Hz waveform is present and the regulation is dependent upon the battery voltage, the saturation voltages of the 2N3771 transistors and the drop across the battery supply leads. Our tests were made using a fully charged battery.

The final column of the table shows the expected discharge time of the battery. These figures assume a fully-charged battery rated at 40Ah. The discharge time for a 40Ah specification is 20 hours which means that the battery can supply 2A for 20 hours.

However, if the battery is discharged over a shorter time, its capacity is decreased and is inversely proportional to the rate of discharge. As a result, we can expect four hours of battery life for a 40W load but only 1.5 hours for a 100W load. This diminishes to just 28 minutes for a 300W load.

Substituting a traction battery or a battery with a higher capacity will provide longer discharge times.

BIG CHOICE ART UNION No. 131

CHOOSE THE BEST RECORDING EQUIPMENT IN AUSSIE AND THEN PICK IT UP AND WE'LL PICK UP THE TAB TO $50,000

Choose this 1st prize and win recording equipment including a multi track tape recorder and a mixing console (value $50,000) plus a Ferrari GTS 308 (value $80,300) plus a North/South American holiday for two (value $34,000) plus NEC Cassette recorder (value $1,700) plus Profeel TV system (value $3,000) plus Beta Hi-Fi (value $1,000) plus 100" Sony TV Screen (value $10,000). **Total value $180,000.**

BIG CHOICE ART UNION NO. 131 DRAWN 4TH OCTOBER, 1985.

Choose this as your $180,000 first prize or select from these alternatives:

A Silver Spirit Rolls Royce ($161,000) **plus** a $19,000 diamond pendant **OR**
A Mack Ultraliner (Model MHR 613R) **or** a Mack Superliner (Model 721RS) both with extras **OR**
A Cuddles "35", **plus** a Cuddles "30" Cruiser with luxurious extras **OR**
A GTS 308 Qualtrovalvole Ferrari ($80,300) **plus** a Haines Hunter 850 FBC Cruiser with dual Volvo 6 cyl. turbo motors ($89,700) **plus** a $10,000 diamond pendant **OR**
A John Deere 8850 Tractor with a John Deere 1610 Chisel Plough or Cultivator ($177,000) **plus** a Honda 4 wheel TRX250 ($3,000) **OR**
A 40' x 13' "Watermaid" steel hulled semi-cruiser houseboat ($59,500) **plus** an XJS Jaguar Saloon ($65,500) **plus** a Nth/Sth American holiday for two ($55,000) **OR**
A "Round Australia" package including a Range Rover, Viscount caravan, 2 trail bikes, camera equipment, $10,000 of Flag Inns accommodation and services, a Ford Fairlane, camping equipment, diamond pendant, and a Haines Hunter Cabin Cruiser.

Each of these prizes valued at

$180,000

Tickets in the Art Union are just $5.00 each.

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$40 Book Choose from: A Ford Fairlane plus a $2,000 diamond pendant **OR** a 19' 6" Haines Hunter Cabin Cruiser with a 185 h.p. Johnson outboard with Roll-Ezy trailer and extras **OR** a 12.2 metre Haulmark tri-axle semi-trailer complete with gate sides, with cap tarp and side curtains and 6-15RX22.5 wide profile tyres

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Permit No. A7390 **A.C.T. Permit No. 85/287**

For Saturday afternoon mechanics:

Tacho-dwell meter for tune-ups

Here's the most basic tune-up meter we've described for a long time. It's easy to build and calibrate and can be used with four, six or eight cylinder engines. Best of all, it should only cost about $20 all up.

by COLIN DAWSON

In recent years, our tune-up meter projects have become increasingly sophisticated. Several even had digital displays and featured complicated switching arrangements to compensate for the number of cylinders. We've decided to take a different approach with this project — minimum complexity and minimum cost.

Despite its simplicity, our new Tune-up Meter is quite versatile. It derives its input from the negative terminal of the ignition coil (or from across the points) and measures both rpm and dwell. A switch is used to select either high (x 2) or low (x 1) rpm ranges.

Rather than switch ranges when changing from one engine type to another, we have used a meter with multiple scales. The tacho scales are calibrated 0-1500rpm and 0-2200rpm for six and 4-cylinder engines respectively. The corresponding dwell scales are 0-60° and 0-90°. For both rpm and dwell, 8-cylinder readings are half the values indicated on the 4-cylinder scales.

One important feature of the unit is that it can be used with almost any type of ignition system. Breakerless, transistor-assisted (TAI) and capacitor discharge (CDI) ignition systems are all compatible.

The unit will prove particularly useful for tuning cars with standard ignition systems. Many cars still fall into this category and, with tune-ups costing around $40 a throw, there is a good case for doing it yourself.

Even modern cars equipped with "set and forget" type breakerless ignition are not immune to ignition system vagaries. While the repair may sometimes be beyond the scope of a weekend mechanic, it is often still worthwhile determining whether rough running is the result of an ignition system fault or some other cause.

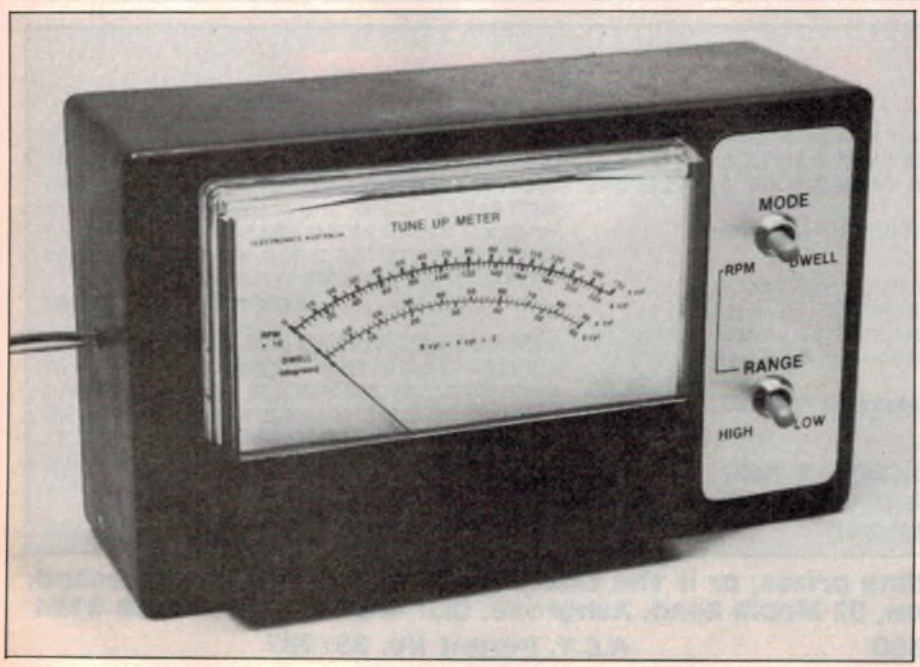
Irrespective of the ignition type, the idle rpm should be periodically adjusted. If the idle speed is set too high, the vehicle will return poor fuel consumption figures. On the other hand, a low idle speed will cause rough idling and erratic low speed response.

Ignition timing adjustments also require the use of a tachometer. Generally, the ignition timing is set at a specified rpm and this can be different from the engine idle speed. The cold (initial) idle speed is also quite important, especially for ADR27a anti-pollution models. A high initial idle burns off contaminants and minimises carbon build up.

Dwell settings are particularly important for standard (Kettering) ignition systems. Dwell is defined as the number of degrees of camshaft rotation for which the points are closed. Correct adjustment ensures minimum points wear and an acceptable spark strength.

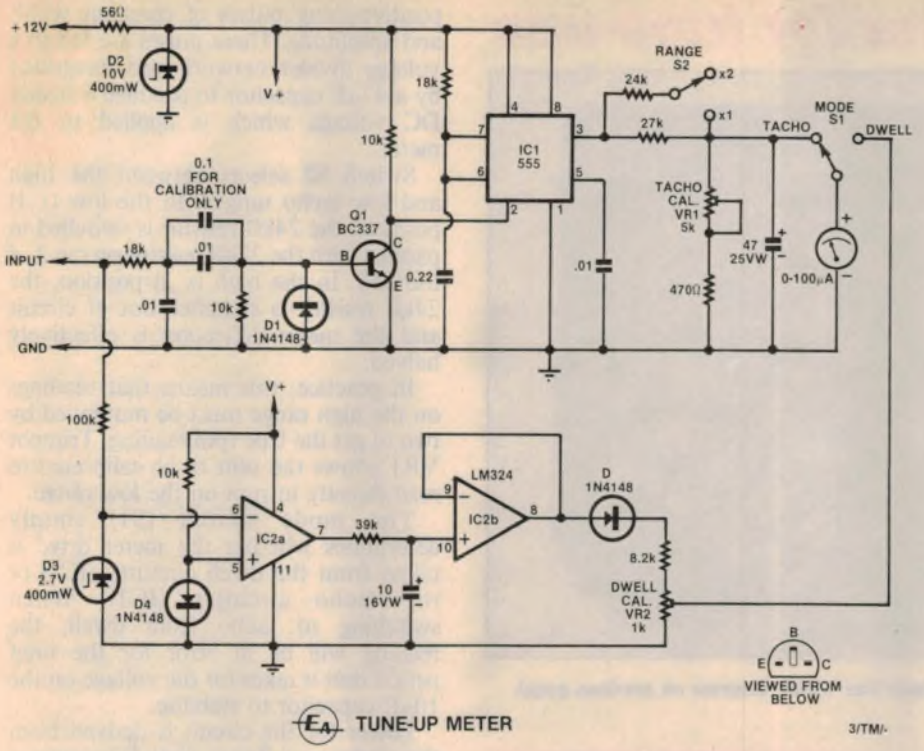
The dwell angle is not quite so critical where TAI or CDI are fitted, but the setting should still be made within specifications. Note, however, that the unit will not read dwell on many cars fitted with breakerless ignition. This is of academic significance only as the dwell angle is not adjustable in these cases.

The circuit is housed in a standard plastic case and features high and low tacho ranges.



How it works

The circuit bears more than a passing resemblance to the Digital Engine Analyser published in EA, July 1983.



Q1 and IC1 form the tacho circuit while IC2 forms the dwell circuit. The input is derived from the negative terminal of the coil

We have substituted a 100μA moving coil meter in place of the digital display and also simplified the switching. In most other respects, the circuit is unchanged.

The input pulses can be processed in two ways, depending on whether the circuit is switched to tacho or dwell mode. Dwell is the simpler of the two — let's look at this first.

The dwell circuitry is centred around IC2, an LM324 quad op amp package. This IC is unusual in that its inputs can be pulled all the way down to the negative supply rail. This makes the LM324 particularly suitable for use with a single supply.

The waveform appearing at the negative terminal of the ignition coil is at the supply potential (plus inductive spikes) when the points are open and ground when the points are closed. Although higher voltages can easily be clipped, the op amp input must be capable of monitoring the ground potential.

In fact, the input is clipped by zener diode D3 and its associated 100kΩ resistor. This limits the input pulses to a maximum of 2.7V. While this may seem rather severe, the explanation is that it prevents the circuit from being triggered by ringing in the ignition system. For about two milliseconds after the points open, there is a considerable amount of ringing superimposed on the positive supply voltage. This effect is eliminated by the clipping circuit.

The clipped input pulses are subsequently fed to the inverting input of IC2a which functions as a comparator. A reference voltage of 0.7V is provided by D4 and this is applied to the non-inverting input (pin 5). IC2a thus compares the clipped input signal and the reference voltage. Whenever the input voltage is lower than the reference voltage, IC2a's output is high, and vice versa.

The output of IC2a (pin 7) is therefore a square wave with the same frequency as the points operation.

This square wave signal is fed into an integrator consisting of a 39kΩ resistor and a 10μF capacitor. The voltage appearing across this capacitor is DC and its level is determined by the input duty cycle. Since the duty cycle depends on the dwell angle, it follows that the voltage on the 10μF capacitor is proportional to the dwell angle.

IC2b is configured as a voltage follower. It monitors the integrator voltage and reproduces this voltage exactly at its output (pin 10). This output is a low impedance and can be used to drive the meter.

Notice that a diode (D5) is included in the output circuit. This does not function as a rectifier — the signal is already DC. Rather, the forward voltage (approximately 0.7V) is used to compensate for the residual output voltage of IC2b. The LM324, in common with most other op amps, can not swing its output to the supply rails, and the diode is needed to prevent a permanent meter offset.

The 8.2kΩ resistor and 1kΩ trimpot connected between D5 and ground provide a means of calibrating the dwell reading.

Tacho circuit

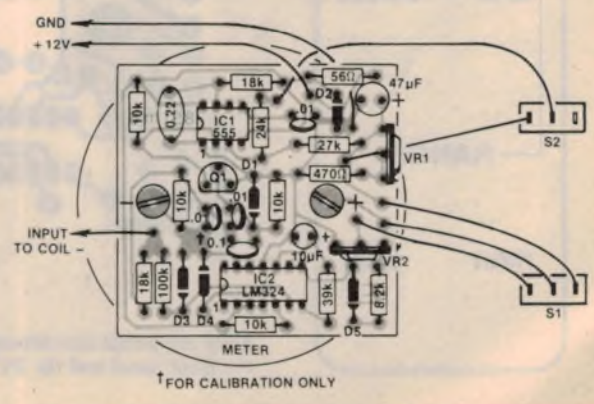
In the tacho mode, the input signal is applied to a voltage divider consisting of 18kΩ and 10kΩ resistors and filtered by a .01μF capacitor. From there, the signal is applied to a differentiating network (.01μF) which produces positive and negative output spikes coinciding with the rising and falling edges of the input waveform. Diode D1 clips the negative-going spikes to prevent damage to the base-emitter junction of transistor Q1.

Transistor Q1 is normally held off by its 10kΩ base-emitter resistor and is briefly turned on each time a positive pulse is applied to its base. Q1 thus functions as a detector. It produces a brief negative-going pulse at its collector each time the points open (or the coil-switching transistor turns off). These pulses are used to trigger IC1, a 555 timer.

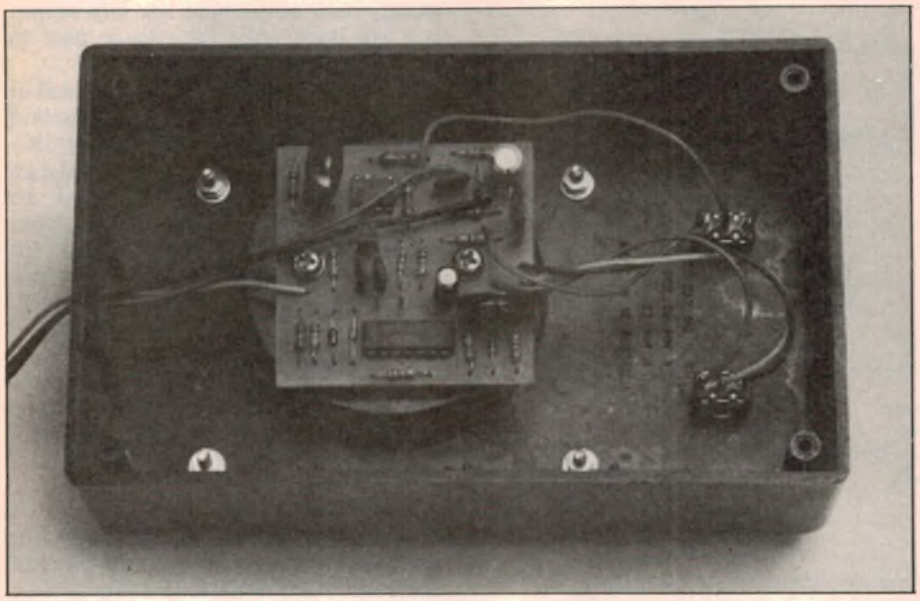
IC1 is configured as a monostable. It produces a brief positive pulse on its pin 3 output whenever a negative-going trigger pulse is applied to pin 2 (ie, each time the points open). The actual monostable period is 1.1 times the RC time constant set by the 18kΩ resistor and 0.22μF timing capacitor, or about 4.4ms.

IC1's output thus consists of a train of

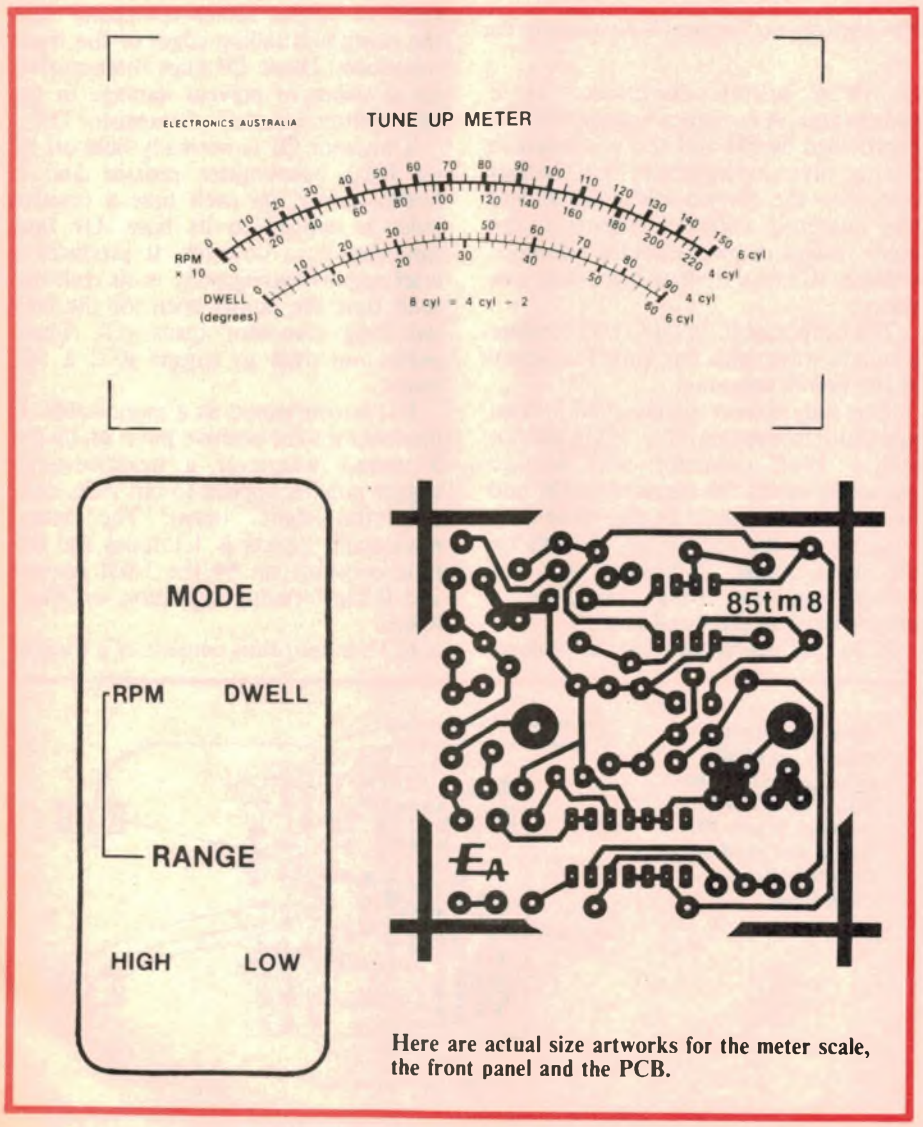
Note carefully the orientation of all polarised parts. The 0.1μF capacitor is soldered to two PC stakes and must be removed after calibration.



Tacho-dwell meter for tune-ups



The PCB is mounted directly on the meter terminals (see wiring diagram on previous page).



Here are actual size artworks for the meter scale, the front panel and the PCB.

positive-going pulses of constant width and amplitude. These pulses are fed to a voltage divider network and integrated by a 47μF capacitor to produce a steady DC voltage which is applied to the meter.

Switch S2 selects between the high and low tacho ranges. In the low (x 1) position, the 24kΩ resistor is switched in parallel with the 27kΩ resistor on pin 3 of the 555. In the high (x 2) position, the 24kΩ resistor is switched out of circuit and the meter deflection is effectively halved.

In practice, this means that readings on the high range must be multiplied by two to get the true rpm reading. Trimpot VR1 allows the unit to be calibrated to read directly in rpm on the low range.

The mode switch (S1) simply determines whether the meter drive is taken from the dwell circuitry (IC2) or the tacho circuitry (IC1). When switching to tacho from dwell, the reading will be in error for the brief period that it takes for the voltage on the 10μF capacitor to stabilise.

Power for the circuit is derived from the car battery. Zener diode D2 regulates the supply rail to +10V DC to make the circuit insensitive to variations in battery voltage. D2 also protects the circuit against reverse battery connection.

Finally, the circuit shows a 0.1μF calibration capacitor in parallel with the .01μF capacitor on the base of Q1. This larger capacitor is necessary because the waveform generated by the calibration circuit (Fig.1) has a much slower risetime than that generated by the ignition system.

Construction

The Tune-up Meter is housed in a plastic utility box measuring 150 x 90 x 50mm. This is fitted with an aluminium lid which, on the prototype, forms the back panel. We expect that kit retailers will supply Scotchcal artworks for the meter scale and the front panel.

The first job is to cut the main mounting hole for the meter. If you don't have a hole saw, this can be done by drilling a series of holes inside the circumference of the cutout area and then filing to a smooth shape.

Note that the cutout is offset to the left of centre on the front panel. Once the cutout has been made, mark out and drill the four screw mounting holes for the meter.

The Scotchcal label can now be affixed to the front panel and mounting holes drilled for the two switches. A hole must also be drilled in one end of the box to allow access for the power and input leads.

Most of the components are accommodated on a small printed circuit board (PCB) coded 85tm8 and measuring

PARTS LIST

1 0-100μA meter, 100 x 80mm panel size
1 plastic utility box, 150 x 90 x 50mm
1 PCB, code 85tm8, 54 x 55mm
2 SPDT toggle switches
1 Scotchcal front panel, 34 x 81mm
1 Scotchcal meter scale, 95 x 52mm
3 2-metre lengths of automotive cable (red, black and blue)
3 alligator clips to suit
2 PC stakes

Semiconductors
1 555 timer IC
1 LM324 quad op amp
1 BC337 NPN transistor
1 10V 400mW zener diode
1 2.7V 400mW zener diode
3 1N4148 diodes

Capacitors
1 47μF 25V electrolytic
1 10μF 25V electrolytic
1 0.22μF metallised polyester (greencap)
1 0.1μF greencap (see text)
3 .01μF ceramic

Resistors (0.25W, 5% unless stated)
1 x 100kΩ, 1 x 39kΩ, 1 x 27kΩ, 1 x 24kΩ, 1 x 18kΩ 0.5W, 1 x 18kΩ, 4 x 10kΩ, 1 x 8.2kΩ, 1 x 470Ω, 1 x 56Ω, 1 x 5kΩ 10mm vertical trimpot, 1 1kΩ 10mm vertical trimpot

Calibration circuit
1 1kΩ 0.25W resistor
1 4.7V 1W zener diode
1 9-18V mains transformer

55 x 54mm. This board is mounted directly on the meter terminals.

No special procedure need be followed when assembling the board but note carefully the orientation of the ICs, transistor, diodes and electrolytic capacitors. Two PC stakes are used to terminate the leads to the 0.1μF calibration capacitor. The 18kΩ input resistor should be a 0.5W type to provide a 250V rating.

The rest of the wiring details can be gleaned from the wiring diagram. Three clip leads are required for the coil and battery connections. These should be run using automotive hookup wire and should be colour coded to avoid confusion (eg, red for positive, black for negative, blue for input).

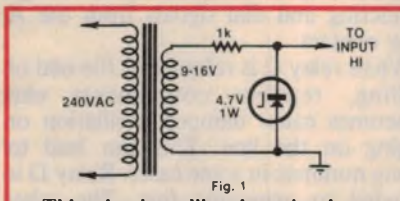


Fig. 1
This simple calibration circuit uses the mains as a frequency reference.

Construction can now be completed by re-calibrating the meter scale. First, undo the two large retaining screws and unclip the front cover. This done, remove the meter scale by undoing the two small retaining screws, then fit the new scale and re-assemble the meter.

Calibration

Despite the number of scales on the meter, the calibration procedure is straightforward.

The tachometer circuit is calibrated by using the mains as a frequency reference. Fig. 1 shows the calibration circuit. This uses a 4.7V zener diode to clip the 9-18V secondary output of a mains transformer to provide a suitable 50Hz input waveform. Most readers will have a suitable transformer on hand.

Note: 50Hz corresponds to 3000 sparks per second which is equivalent to 1000rpm for a 6-cylinder car, 1500rpm for a 4-cylinder car and 750rpm for an 8-cylinder car.

The Tune-up Meter can be powered from a bench power supply or from the car's battery during the calibration procedure.

Connect the calibration circuit to the Tune-up Meter (don't forget the ground connection), select the low (x 1) tacho range, and solder the 0.1μF calibration capacitor to the PC stakes. Trimpot VR1 should now be adjusted so that the meter reads 1000rpm on the 6-cylinder scale.

Now switch to the high range and check that the reading is halved. If all is well, remove the 0.1μF calibration capacitor.

The dwell calibration is even easier. All you have to do is adjust VR2 for a full-scale reading (60° on the 6-cylinder scale) with the input lead open circuit.

Finally, accurate engine tuning requires the use of a timing light. These can be purchased for around $30 and are well worth the investment.

Circuit & Design Ideas

Interesting circuit ideas from readers and technical literature. While this material has been checked as far as possible for feasibility, the circuits have not been built and tested by us. As a consequence, we cannot accept responsibility, enter into correspondence or provide constructional details.

Auto dialling/auto answer attachment for modems

With this circuit attachment, a computer using a modem can answer incoming and dial outgoing calls. It connects between the audio output of the modem and a standard telephone and telephone line. RS232 outputs from the computer control the switching functions within the circuit.

All relay contacts on the circuit are shown in their released state. With relay B released, the telephone line connects to a standard telephone which can be used normally.

When the phone rings the resulting ring current operates relay E and the telephone bell in series. This closes contact E1 and thus sends an RS232 signal to the computer. This is the ring indicator signal. The bell switch short circuits the bell, to allow the computer to answer the call in silence.

A 1μF capacitor between pins 4 and 6 of the telephone socket allows relay E to operate on incoming rings even if the telephone is unplugged. This is because pins 3 and 4 of the telephone socket short together when the plug is removed.

On receiving a ring indicator signal, the computer can answer the call by operating relay B. This switches the line to the modem.

To initiate an outgoing call, the computer must operate relay B to loop the line, operate relay C to short out reactive components in the modem, pulse relay A to dial the number, release relay C and await a Receive Line Signal Detect from the modem.

The timing diagram shows the various relationships between the relays contacting and dial signals from the A relay contact.

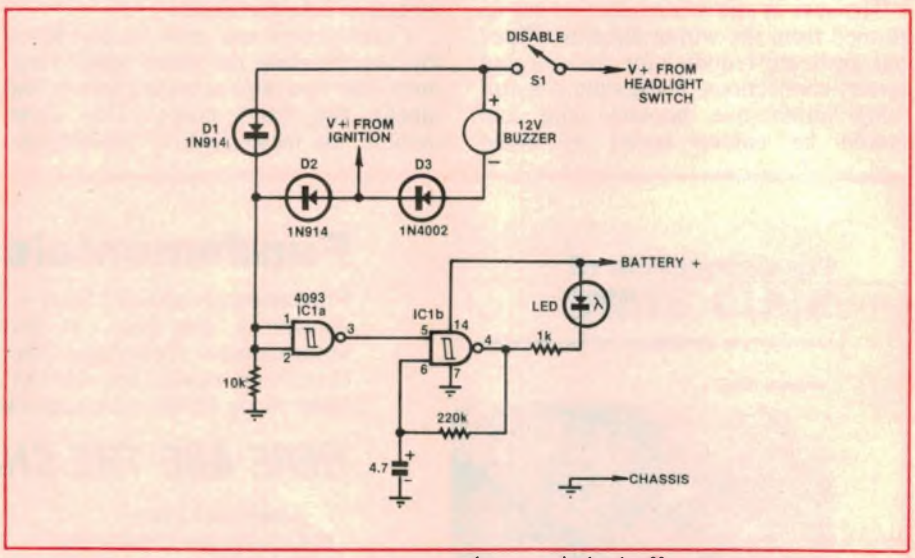
When relay C is released at the end of dialling, reactive components can sometimes cause damped oscillation or ringing on the line. This can lead to wrong numbers in some cases. Relay D is included to overcome this. The relay operates on line current and the contacts remove the 470Ω resistor shunt from across the line. When the line is connected to the modem the 470Ω resistor is directly across the line and heavily damps any impending oscillations.

The bridge rectifier across relay D allows either polarity on the line to energise the coil, while the 1μF capacitor provides an AC transmission path.

All relays with the exception of the 200Ω coil of relay D are 1000Ω types. All diodes are 1N4004 or equivalent.

Readers planning to build this circuit must be aware that certain Telecom standards apply when connecting equipment to the phone line. The standards are mainly concerned with dangerous voltages and correct isolation. For relevant details, see Telecom Australia Specification 1302 "Electrical Safety Requirements for Permitted Attachments".

G. Payday,
Ringwood, Vic. **$50**

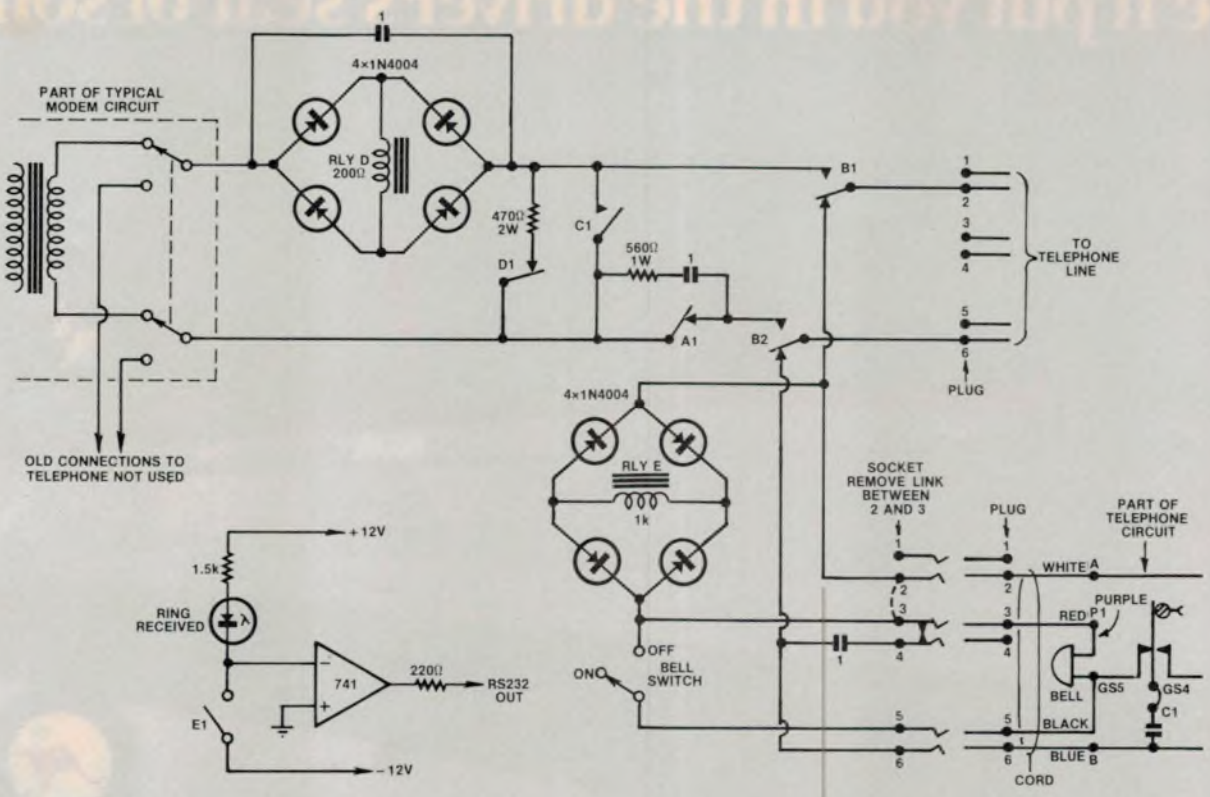


Headlight reminder and burglar deterrent

By adding this simple circuit to your vehicle, a buzzer will sound if the vehicle headlights are left on after the ignition is switched off. In addition, the buzzer can be disabled should it be necessary for the headlights to be left on without the ignition. A flashing LED then indicates that the headlight reminder buzzer has been switched off.

As a bonus, the LED will continue to flash when both ignition and headlights are switched off. This acts as a deterrent to a would-be-burglar by indicating the possibility of an alarm system.

Operation of the circuit is relatively straightforward. When S1 is closed, the buzzer sounds when there is positive battery voltage on the plus side of the buzzer and when the negative side is at ground. The 1N4002 diode conducts and



The circuit connects between the audio output of the modem and a standard telephone and telephone line. Note that additional circuitry is required for the relay drivers (see below).

current flows through the buzzer. This situation only occurs when the headlights are on with the ignition off.

If the ignition is also on, the negative and positive side of the buzzer are both at positive potential and so no current flows through the buzzer. Similarly, with the ignition on and the headlights off, the 1N4002 is reverse biased and no current flows.

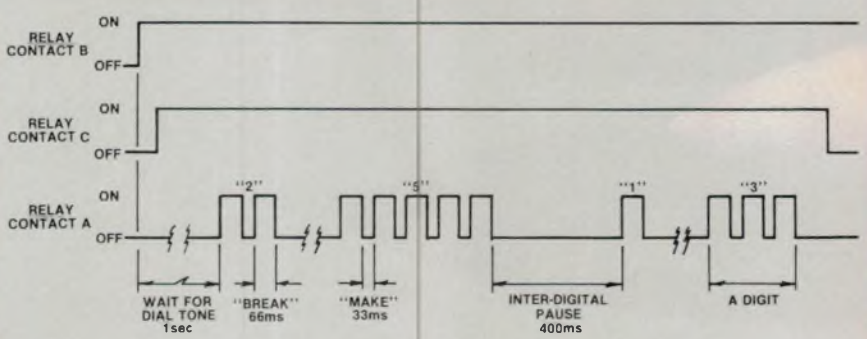
IC1b is a Schmitt NAND gate connected as a gated oscillator. Whenever the pin 5 input is high, the gate oscillates at a one second rate.

IC1a is connected as an inverter. At the input are connected two diodes, one from the headlight side and the other from the ignition side of the buzzer. The input is normally held low with the 10kΩ resistor. If either the ignition or headlight is on then the input of IC1a is pulled high via one of the diodes and consequently, the output is low. This disables the oscillator and the LED is off.

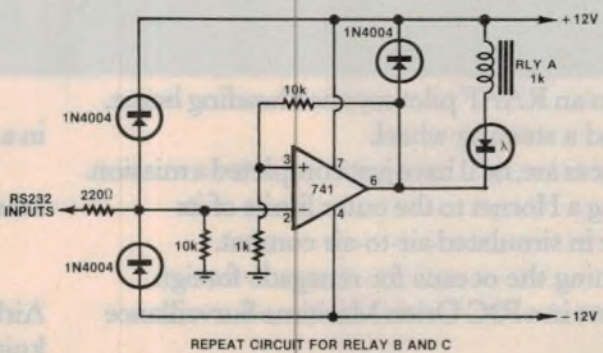
If the ignition and headlights are both off, then the output of IC1a is high and the LED flashes. If switch S1 is opened, the output of IC1a goes high whenever the ignition is off regardless of the headlights. The LED thus flashes to indicate that the buzzer is disabled.

P. Howarth,
Gunnedah, NSW.

$25



This timing diagram shows the relationship between the relays contacting and the dial signals from the A relay contact.



The relay driver circuit is based on a single 741 op amp (repeat for relays B and C).

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PILOT

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The Serviceman

The Achilles (w)heel of Sharp VCRs

Of all the problems encountered with VCRs it is not surprising that a large percentage are mechanical, mainly to do with the tape transport system. These can vary all the way from outright failure to various intermediate conditions, such as failure to search, failure to search in a particular direction, or subtle picture disturbances.

This is the main theme of my notes this month but, before I get onto that, I would like to acknowledge a letter from Mr A.M. of Sunbury, Victoria. This was in response to a story I related in the April 1985 notes concerning a Pye 20A17 colour TV set, which actually used a Philips KT2 chassis. In telling the story I expressed some puzzlement as to exactly where and how the vertical sawtooth signal was generated. I even went so far as to suggest that someone else could explain the circuit.

Well here is A.M.'s explanation and I suggest that those seriously interested should read it in conjunction with the circuit on pages 54 and 55 of the April issue.

After reading the April issue of your article I was amazed that such a glaring, and obvious error, could find its way into what is, after all, a technical magazine.

In the text I was informed that Q188 and Q187 possessed some magical properties whereby somehow they leapt into oscillation and formed a sawtooth generator.

After perhaps as many years in the trade as the serviceman, I have always found a hold control is a good indication as to what does what. As this (R612) is a DC control set up to feed two transistors (Q607,608) in the equivalent setup to a PUT (Programmable Unijunction Transistor), it seems likely that this is the source of the sawtooth. What the serviceman found at Q817/818 was sync pulses being amplified before being fed to a rectified network D606/C606 as a means of control of the PUT. (A.M., Sunbury, Victoria).

Thank you A.M., for your explanation. You are perfectly correct, of course, and I can only plead to being completely misled, partly by the lack of a manual initially and partly by the pressure of the job at the time. Not that that is really any excuse, and I don't present it as such.

However, prompted by your letter I delved into the Philips manual again, in a more leisurely atmosphere, and eventually did find a reference to Q607/608 as the sawtooth generator. Unfortunately, it was some distance from that part of the manual I first referred to, and which seemed the most logical section.

The letter also triggered an address in the memory bank which sent me delving into my Pye manuals. I found it eventually; the manual for the old Pye T29 in which a very much better description of the circuit is given. Any interested readers would be well advised to refer to that if the Philips manual is not available, or as a supplement to it if it is.

So there it is; a spot of confusion which has been successfully resolved. My thanks once again to A.M. for taking the trouble to write and help set the record straight.

And now onto my VCR theme. This was also triggered by a reader's letter, from Mr J.S. of Greenvale, Queensland, and was prompted by the Sharp VCR problems which I described in the December 1984 notes. He writes as follows:

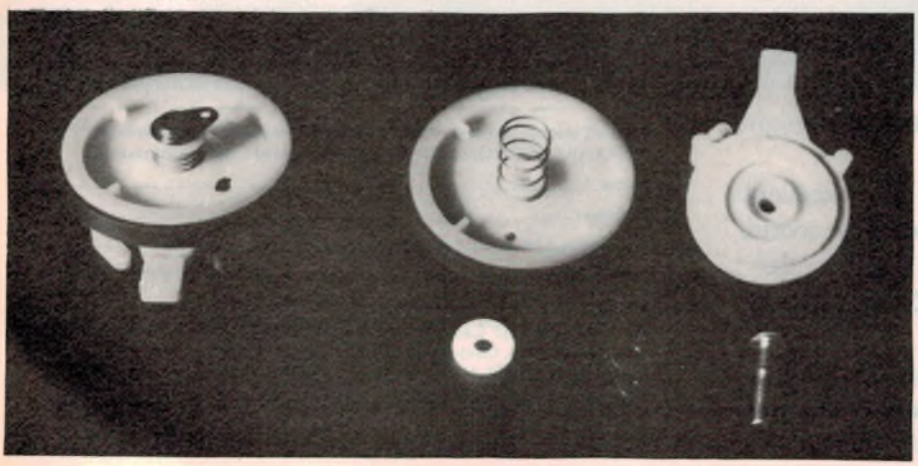
I refer to your article in the December issue, on a VCR. I too had the same problem with the same model. I think you may have missed the real problem.

The idler that drives both take-up and rewind spools has a friction device designed to make it toggle into the required position, depending on the direction of rotation of the associated drive motor. I found that the friction had increased (why I don't know) to the point where the motor was stalling, hence blowing fuses.

The correct solution, no doubt, is to install a new idler assembly. However, I cut off the fabric (felt) friction washer and, after some experimentation with cardboard washers, made it so that there was sufficient friction to allow it to toggle on rotation change, but not so much that it stalled. I am not suggesting this as a permanent solution.

It is an interesting design and has the potential to fail in two ways. Not enough friction and the idler won't toggle into the drive position; too much friction and it won't turn. That's the rub. (J.S., Greenvale, Qld).

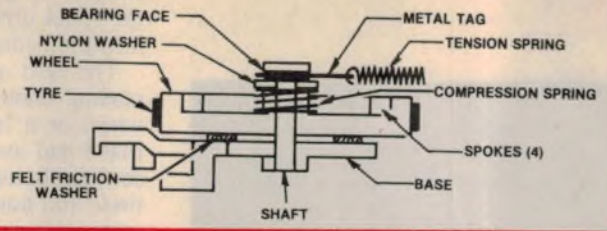
This view shows the complete idler wheel assembly (left) and a disassembled unit at right. The felt friction washer is on the base (see diagram).



Investigation

In fairness to J.S. I should explain that his letter was dated 31/12/84 and was received in the EA office in mid-January 1985, being passed on to me not long after. The reason I have not dealt with it earlier was partly due to lack of space, but mainly because it started a train of thought and investigation extending

This diagram shows how the idler wheel assembly goes together. The felt friction washer is at the heart of the problem.



over many months, the results of which I now feel are worth passing on.

For the benefit of readers not familiar with the Sharp machines, the idler wheel is a nylon wheel some 35mm in diameter and fitted with a black rubber-like tyre. It is supported by a simple nylon base which slips into appropriately shaped slots in the deck. This base is fitted with a felt washer (referred to by J.S.) which bears against the underside of the wheel. The base also supports a shaft on which the wheel turns and forms the basis of a spring loaded bearing system.

There is a compression spring which bears against the wheel at one end and against a nylon washer at the other. This, in turn, bears against a metal tag which anchors a small tension spring used to hold the assembly against the drive spindle. Then there is another washer, and finally a metal face attached to the shaft. The result of this arrangement is that the compression spring forces the wheel downwards against the felt washer on the base, and this provides the friction referred to by J.S.

As J.S. suggests, this friction is critical, but is probably more so than either he or I imagined initially. It can also be responsible for some quite subtle faults as well as the more obvious ones. However, there is one point which I feel deserves comment. J.S. says, "I think you have missed the real problem".

Well, this was only partly true. It is true that I was not aware of this problem when I encountered the trouble described in the December notes, but it is equally true that this was not the problem on that occasion. As I explained at the time, I simply cleaned the tyre of some oily substance (origin unknown) and this cured the trouble. And, as I mentioned at the time, I found the same condition in a second set and treated it in the same way with the same result.

The sequel to those episodes was that both idler wheels continued to function satisfactorily for a significant period thereafter. In the case of the first set, which was serviced in September 1984, the idler functioned until quite recently, a period of some nine months, but then did develop excessive friction and had to be replaced. The second set is still functioning. Both get a lot of use.

I mention this because I feel that it is important to distinguish between two quite distinct faults, even though the simplest solution, in both cases, might be to replace the idler. Many factors would influence the on-the-spot decision.

Back to tin tacks

Since that first episode I have encountered a number of Sharp machines with a variety of transport problems, all of them attributable to increased friction of the idler wheel. And let me acknowledge, right here and now, that I was extremely grateful to J.S. for alerting me to the problem. His warning saved me a lot of effort the first time around.

As for that first set in the December notes, let's look at the sequence of events leading up to its most recent troubles. I think the story is worth telling because it seems to introduce one more factor to the idler wheel behaviour. This set is used daily, the owner being a shift worker who, otherwise, would miss out on a great many evening programs which he likes to follow.

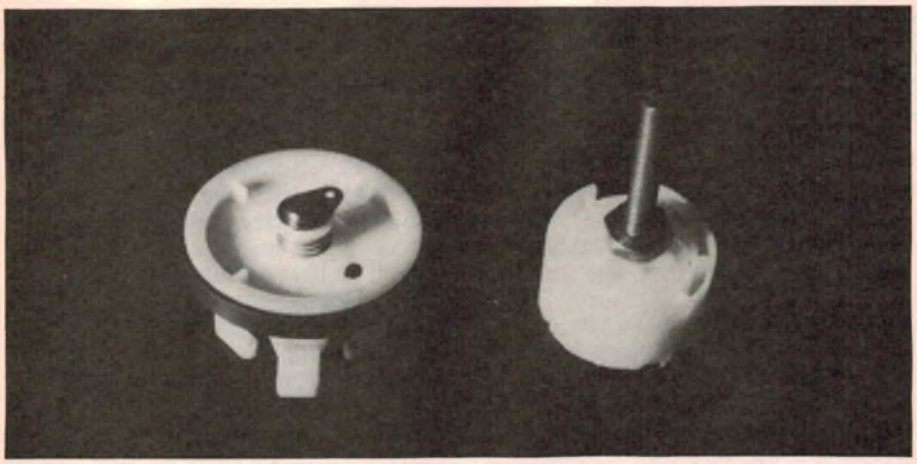
Everything went smoothly until the family went on holiday for a couple of weeks, leaving the VCR behind. On their return they put the system back into operation but, as the customer put it, "it began to gobble up tapes." After the second damaged tape he brought it to me and related the above sequence.

Since the problem was not immediately evident I suggested that he leave it with me. I set it up in a corner of the bench, loaded it with tape, and let it run. It never missed a beat. I ran it again the next day, and it performed perfectly again. In fact I ran it every day, and sometimes several times a day, for the next couple of weeks and not once did it falter.

At the end of that time I decided that there was little point in prolonging the tests; I might just as well give it back to the owner. In the meantime, needing the bench space, I unplugged it and put it to one side. It was a couple of days before the owner could get around to picking it up and, just before he was due to call, I plugged it in again for a final check.

Needless to say, this was when it decided to misbehave. What was more, it was immediately obvious that it was an idler wheel problem. I pulled the idler wheel out, tested it (more about this in a

The Serviceman



This torque gauge coupler (right) uses a blank spool from a discarded cassette.

moment), confirmed that it was faulty, and fitted a new one. That was several weeks ago and so far all is well.

But why did the idler wheel apparently fail on both occasions after it had been lying idle? Does the friction mechanism freeze up if it is not used regularly, particularly on an aging wheel? Frankly, I don't know, but it is one more point to keep in mind when faced with a problem of this kind.

Fault No.2

Another recent fault in a Sharp mechanism involved a failure to search, although it would record and rewind satisfactorily. In this case the trouble was quite consistent and I had no trouble observing it. Initially, more as an exercise than anything else, I tried cleaning the idler wheel, but this made virtually no difference. So I pulled the idler out, checked it, decided it was faulty, and replaced it. This cured the trouble.

These are only two of several cases I have had in recent months, and which varied in minor details only, the common theme being the failure of the idler wheel. However, there was one other case involving the idler wheel, which had quite different symptoms. I will discuss it a little later.

Torque tests

For the moment let's talk about testing the idler wheel, as I have already mentioned briefly. Quite early in the piece it seemed to me that if the friction of these idler wheels was all that critical, then some means of measuring it was highly desirable, if only to clear this component on those occasions when some other fault produced similar symptoms.

The torque gauge seemed the obvious device to use for this, even though there is no mention of such a test in the manual and, therefore, no figures on which to work. I would have to establish these on a suck-it-and-see basis. But first I had to apply the torque gauge. My idea was to couple the gauge to the wheel then, while anchoring the bearing assembly, rotate the wheel by means of the torque gauge and note the torque needed to move the wheel.

The top of the idler wheel is recessed to a depth of about 6mm, for about 30 of its 35mm diameter, and this recess contains four short spokes at 90° intervals. My idea was to make something which would fit into this recess, and engage the spokes, without fouling the spring assembly in the centre.

The solution came from an unexpected, but not inappropriate, source; a blank spool from a discarded video cassette. This consists of a central boss or hub of about 26mm diameter, on which the tape is wound, and a large toothed disc about 90mm in diameter which guides the tape. Or, in simple terms, a one sided spool.

Fortunately the spool I salvaged was made with the boss and disc as two separate pieces, and which were fairly easily separated. The boss is hollow where it is splined to engage the drive shafts, allowing it to fit easily over the spring assembly. Its outside diameter is slightly smaller than the wheel recess and, by cutting four slots to engage the spokes, it makes an ideal coupling device.

The other end of the boss was drilled in the centre — and there is a convenient recess in the moulding to indicate the centre — and a short 3/16 whitworth bolt fitted and secured with a nut and lockwasher (this latter is essential.) This is then fitted into the jaws of the torque gauge. Maybe all that sounds complicated, but it isn't really and anyone should be able to make a similar fitting. (Incidentally, it also provides a convenient means of coupling directly to the spool drives, for appropriate torque measurements).

The next question was, what kind of reading should I expect from a good wheel or a faulty one. It so happened that I had just taken delivery of a set of six wheels for stock, so I went through these and noted the readings. There was some variation from wheel to wheel, but not a great deal, and I struck an average figure. There can also be some variation between successive readings on the same wheel, apparently depending on the speed with which the torque gauge is rotated. I tested each wheel several times and averaged these readings.

Then I checked a couple of faulty wheels I had on hand, noted the readings, and put them aside until more faulty ones could be tested. As the collection grew, and another batch of new wheels was tested, an interesting pattern emerged. As I see it, new wheels should read around 75g-cm, while faulty wheels will read from 100 to 150g-cm, the latter figure indicating extreme cases.

As a result, I now regard any reading of 100g-cm or higher as indicating a faulty wheel. Lesser figures but significantly higher than 75g-cm would be suspect, depending on other symptoms. I may have to revise these figures with experience but, for the moment, they provide a good place to start from.

Unfortunately, these measurements are not easy to make while the idler wheel is in situ. In order to attempt it, the short tension spring which holds the wheel against the motor drive shaft has to be removed and then the whole idler assembly has to be manouevred clear of the drive shaft. All things considered I find it easier and more satisfactory to remove a suspect wheel. Fortunately, this is not difficult in the Sharp machines.

Another point I have noticed about these wheels is that, in at least two cases of seriously faulty wheels, there had been a marked discolouration of the original snowy white nylon, which had turned a dirty yellow. While it is too early to be sure about this symptom, it is worth keeping in mind.

Unusual symptoms

And now for the unusual set of symptoms I mentioned earlier. In this case, the owner complained about a form of picture disturbance. In one sense it was relatively minor and I imagine many viewers may not have been bothered by it or, if they were, would have put it down to outside interference and shrugged it off as one of those things you have to live with. This may be important because it is possible that the same symptoms occurred in other cases, but

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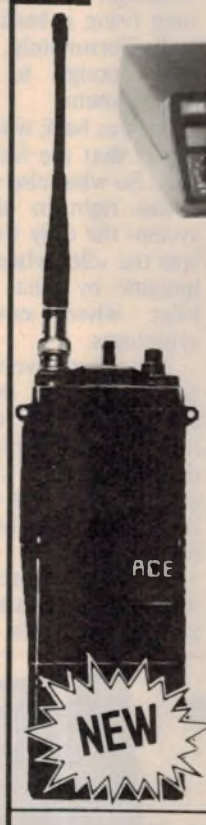

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The Serviceman

no one bothered to mention them.

The symptom might best be described as a very brief "shimmer", somewhat similar to the effect caused by hum in the vertical deflection system. However, the effect was quite fleeting, quite random, and of varying intensity. Sometimes a whole program could be played with only a few brief bursts, or none at all. At other times bursts would come in rapid succession, for quite long periods, completely spoiling enjoyment of the program.

And, even though I have likened it to 50Hz hum, the "frequency" as observed on the screen was much too high to have come from that source. It would have to have been several hundred Hertz. An alternative description of the fault might be to imagine that there had been a momentary loss of horizontal hold, followed by a certain amount of hunting to restore the lock.

The effect could occur either during playback, even on professionally recorded tapes, or during recording. If it was a playback only phenomenon, replaying the tape could produce a satisfactory picture or one which was disturbed in quite different places. When it occurred during recording the disturbance was always in the same place.

Fortunately the owner was astute enough to realise that it was going to be difficult for me to diagnose the fault if I could not see it, so he had put aside a tape on which the fault had been recorded. I was able to play this on a known good machine in the workshop and confirm the owner's description.

My first reaction was to ask myself whether it was a mechanical (ie, transport) problem or an electrical one. For a number of reasons, including the fact that it occurred in both record and playback modes, I concluded that it was more likely to be mechanical. Another reason was that the owner had observed that it was usually worse at the beginning of a tape rather than at the end, and that it was a lot less obvious on 30 minute tapes than on three hour ones.

Both these observations suggested to me that it could be a factor of the amount of leverage being exerted by the take-up spool. If excessive this would be most obvious on a small take-up spool, and least obvious at the end of a reel, or on a 30 minute reel which uses a large hub. In fact, excessive torque in the take-up drive was my first guess.

In fact, the torque gauge proved me wrong, the readings being well within tolerance. At that point I was at something of a loss. I hadn't thought about the idler wheel at that stage, being more used to the far more drastic symptoms this is likely to provide. All I could do was go over the transport system, clean all the guides etc, and hope that I might have cleared the fault. Then I gave it back to the owner, explained the situation, told him to try it for a week, then bring it back to me if all was not well. Fortunately, we know each other well enough to come to such an arrangement.

He was back within the week with the report that the fault was just as bad as ever. So what else could it be? Assuming I was right in blaming the transport system the only thing left for me to try was the idler wheel, though I could not imagine by what mechanism a faulty idler wheel could produce these symptoms.

The alternative was to suspect a major fault in the drum assembly and associated servo drive, and I had no intention of buying into that. So, like a drowning man, I clutched at the nearest straw or, in this case, idler wheel. At least it wouldn't take much effort to try it.

So a new wheel was fitted and the machine given another test. It worked perfectly, but I'm too old a hand to be deceived that easily. I kept it for several days and ran it several times a day, watching it as closely as other duties permitted. As far as I could see it didn't falter once, so I returned it to the owner on another "week's trial" basis.

At the end of the week he reported that it hadn't missed a beat, in spite of quite prolonged use. I had to admit that this seemed promising, particularly as he assured me that it would not have performed for so long before he brought it to me. So he kept on using it and now, several weeks later he reports that it is still performing perfectly.

So it seems I cured the problem, even if I'm not quite sure what caused it. The only suggestion I can make comes from an observation in the original December story. Readers may remember that I noted a tendency for the take-up spool to hesitate, then take up the slack. Could such behaviour be to blame? Is it possible that the sudden taking up of slack could tug the tape sufficiently to override the capstan? If it did it could logically cause the drum to hunt in an effort to correct the error.

Which is a long shot I suppose, but the best I can offer at the moment.

One final observation. I recently had occasion to phone through an order for another batch of wheels. As I was dictating the order to the lass at the other end I suddenly realised that I had neglected to look up the part number. I apologised and suggested she wait on while I found it. "Oh, don't worry about it", she replied, "I know it by heart. We sell hundreds of the things".

So that's my experience with Sharp idler wheels to date. I'm afraid it has forced me to the conclusion that this component is the Achilles heel of an otherwise excellent machine. Let's hope the makers can do something about it.

TETIA Fault of the Month

Blaupunkt 'Cardona' and similar chassis

Symptom: Both mains fuses blown and D1242 & D1243 (BY255) on bridge rectifier board shorted. May happen repeatedly in humid weather.

Cure: Trouble occurs when EHT flashes over to degaussing coil. Move coil as far away from ultor cap as possible then clean picture tube around ultor and pack cap with silastic.

This information is supplied by courtesy of the Tasmanian branch of The Electronic Technician's Institute of Australia. Contributions should be sent to J. Lawler, 16 Adina St, Geilston Bay 7015.

Texas Instruments digital signal processor helps Lear Siegler Inc. make your message loud and clear... from anywhere.

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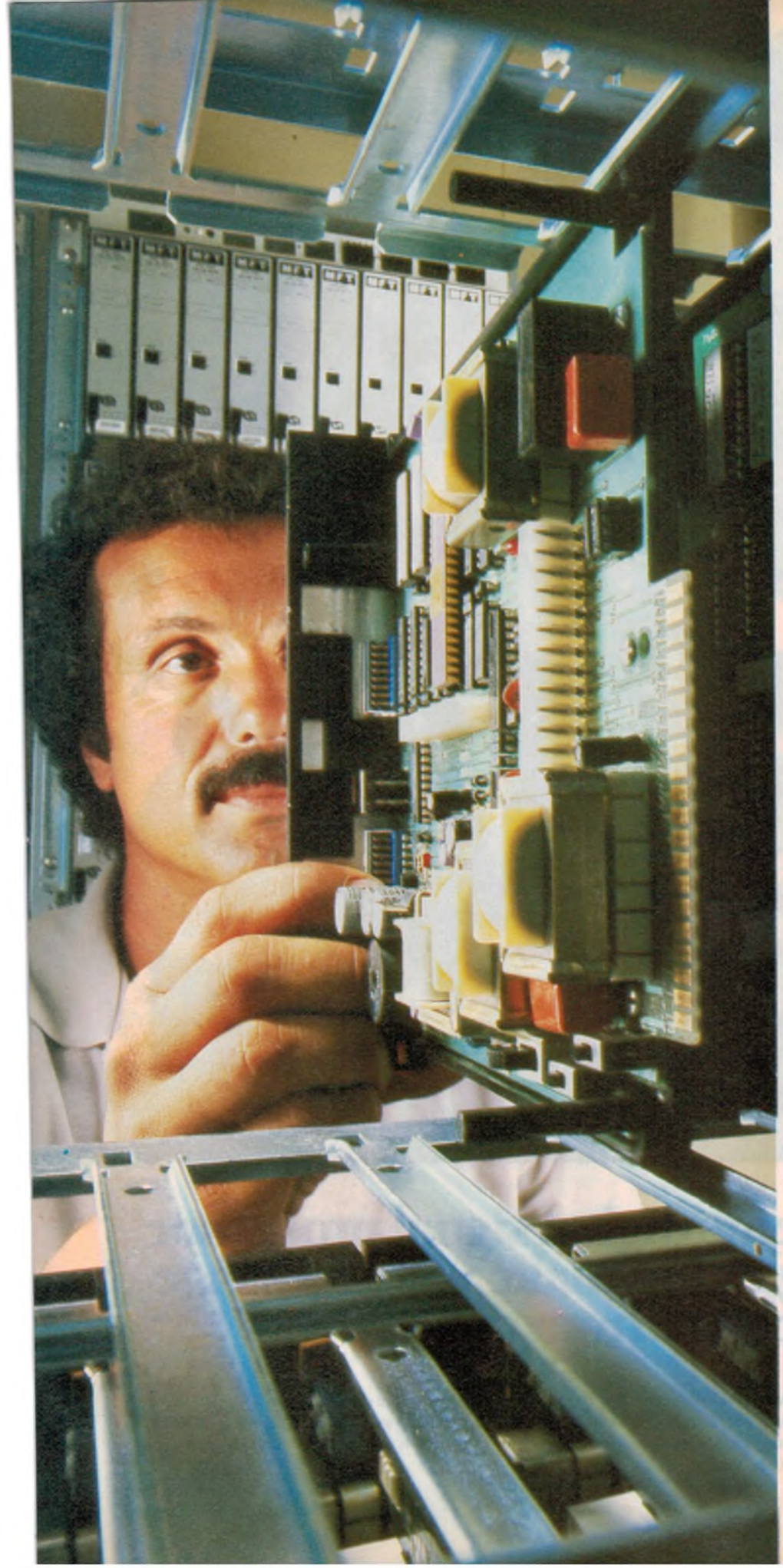

TI digital distortion

When you're depending on the telephone to get your message through, you don't need "singing" on the line. A standard two-wire circuit "sings" when signals travelling in opposite directions are insufficiently isolated in a repeater. To eliminate this problem, Lear Siegler, Inc., manufacturer of repeaters used worldwide, relies on the Texas Instruments TMS32010 digital signal processor (DSP). And cuts setup time for each repeater from hours to minutes.

In the unique VFR-7608 repeater, TI's TMS32010 performs all the functions of analogue equalisers, filters, and amplifiers (see diagram opposite). It compensates automatically for line impedance 8,000 times per second. Completely isolates the opposing signal streams. Puts an end to "singing."

TMS32010 eliminates reflections "by the numbers"

The standard solution to "singing" is an analogue network designed to cancel out reflected signals on the line. But even with expensive "precision" hybrids, the best solution is a compromise that limits usable bandwidth and gain.

Digital signal processing with the TMS32010 balances the circuit across the entire frequency band every 125μs. Because the repeater adapts continuously, the circuit *cannot* "sing" at any frequency, and its gain can be fully utilised.

DSP cuts setup time to minutes

Tuning each analogue repeater is an hours-long, trial-and-error procedure for a highly skilled technician. Using a comprehensive history of each circuit, he must set 68 switches in an analogue repeater. TI's TMS32010 in Lear Siegler's new digital repeater eliminates 65 of those switches. Ends the need to keep detailed circuit histories. And the small, affordable plug-in unit is interchangeable with older repeaters.

So your message can always come through – loud and clear.

◀ **Setup is as simple as 1-2-3** with Lear Siegler's adaptive telephone repeater using TI's TMS32010 DSP. Whereas manual adjustment of an analogue repeater can take many hours, only three simple switch settings are required to assure rock-stable, "sing"-free performance from the digital repeater.

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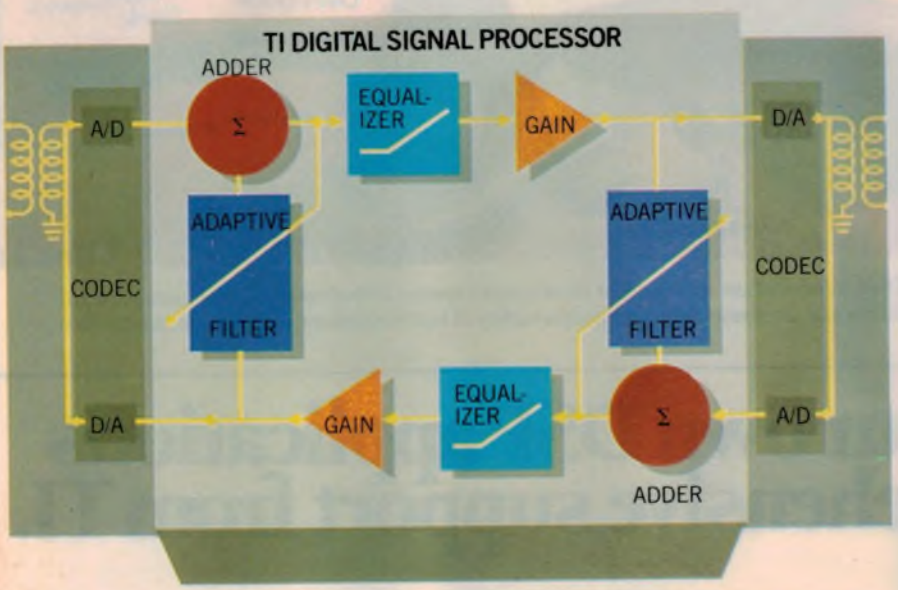


Heart of the adaptive repeater is TI's single-chip, 16/32-bit TMS32010 digital signal processor. All the functions shown are achieved in real time through software operating on signal digitised by conventional single-chip codecs.

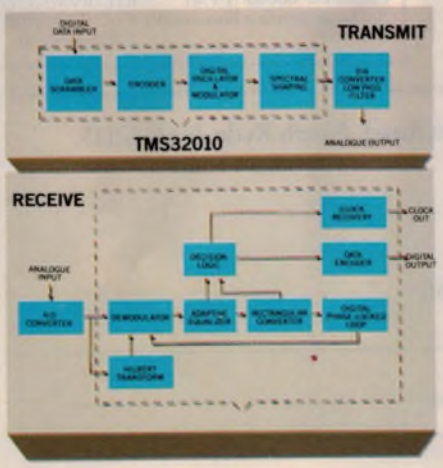
The TMS320 family from Texas Instruments: "Workhorse of digital signal processing."

The TMS32010, first member of the TMS320 DSP family, is TI's trailblazing contribution to an important new technology. A Lear Siegler engineer who has been following the progress of digital signal processing from its inception says, "The TMS32010 is the first device that can reliably do what we need. It's a real workhorse: The '8080' of DSP."

TI's TMS320 DSPs excel at high-speed numeric-intensive applications

High-performance TMS320-family DSPs from Texas Instruments will find widespread use in many fields where large volumes of high-speed computation are required. In telecommunications, they can also be used to build high-speed modems with data-transmission rates up to 9,600 baud. They can make speech recognition, analysis, and synthesis practical. Speed image processing and pattern recognition. Facilitate high-speed process control and instrumentation. Process radar, sonar, and seismic signals. And furnish the multiple functions often required for a single application.

For example, a TMS320 DSP could enable an industrial robot to synthesize and recognise speech, sense objects and their orientation, and perform mechanical operations through digital servo-loop computations.



High-speed modem functions are effectively performed by TI's TMS32010, as well as such expanded functions as auto-dial/answer, dial-tone verification, busy-signal detection, and self-test routines.

The TMS320 family, with its extensive development support *(see page 4)*, can handle all the signal processing for spectrum analysis. Autocorrelation, windowing, fast Fourier transforms – performing a 64-complex-point FFT in only 550 µs. And for seismic processing involving very low frequencies which only a digital system can implement.

Image enhancement, pattern recognition, and data compression are all possible with TMS320 processors. They can extract features and perform template comparisons for optical character recognition.

A one-chip alternative to bit-slice processing

TI's 16/32-bit TMS320 DSPs offer an inexpensive alternative to multichip bit-slice processors. They combine the flexibility of a high-speed controller with the numerical capability of an array processor – on a single chip, in one 40-pin DIP.

Highly pipelined architecture and a comprehensive instruction set give the TMS320 the speed to execute five million instructions per second with 32-bit precision: More than fast enough, for example, to handle the 40 additions and 40 multiplications necessary for realtime voice-frequency processing within the 125-µs sampling interval. A conventional microprocessor, operating a 8 MHz, would require 900 µs, and quickly become bogged down in the signal stream.

Now in three versions

The TMS32010 microprocessor has 288 bytes of on-chip data RAM, and can address up to 8K bytes of off-chip memory at full speed.

The TMS320M10 microcomputer is identical to the TMS32010, but it also includes 3K bytes of on-chip mask-programmed ROM.

The military version, SMJ32010JDS, is processed to the extended temperature range requirements of MIL-STD-883B.

To learn more about the many applications and available development support for TMS320-family DSPs, return the coupon on the following page.

See back page for more information.

In-depth support for the TMS320 family of TI DSPs inludes a host-independent development system, an evaluation module, emulator and analogue interface board, as well as assembler/linkers and simulators that can run on a variety of host computers and PCs. Documentation is extensive and thorough.

Develop your own DSP applications with comprehensive support from TI.

Texas Instruments has assembled an extensive group of development-support packages for the TMS320 family of VLSI digital signal processors *(see table)*. Included are all the hardware, software, and documentation you need to utilize the power and speed of TMS320 DSPs in your designs. A rapidly growing volume of third-party support is also available.

Use your own PC as a TMS320 development station

The latest addition to TI's development-support software is the TMS32010 Digital Filter Design Package developed by Atlanta Signal Processors Inc. It makes your Texas Instruments Professional Computer or IBM PC a cost-effective, easy-to-use, digital-filter design station. With it you can produce the TMS32010 source module. Then you can assemble the code and simulate it in software on the PC. Later you can download the code into the hardware-development system for realtime emulation.

Two versions are now available: **DFDP-T1001** for the Texas Instruments Professional Computer, and **DFDP-IBM001** for the IBM PC.

TMS32010 Software and Hardware Support

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IBM	MVS	TMDS3240310-08
IBM	CMS	TMDS3240320-08
TI/IBM PC	MS-DOS	TMDS3240810-02
Simulators		
DEC VAX	VMS	TMDS3240211-08
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Hardware		
Evaluation Module (EVM)		RTC/EVM320A-03
Analogue Interface Board (AIB)		RTC//EVM320B-06
Emulator		TMDS3262210

STOP PRESS TMS32020 Announced

Earlier this year TI announced the TMS32020 which increases performance of DSP algorithms through innovative additions to the TMS320 family architecture.
TMS32010 source code is upward compatible with TMS32020 source code and can be assembled using the TMS32020 Macro Assembler.

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Combining preferred resistor values

Producing non-preferred resistance values from preferred values can be a lengthy exercise, particularly when it is desired to know all the practical combinations which will give the desired value. The author has solved the problem by evolving a suitable computer program, the print-out of which is reproduced in this article.

by THOMAS HAIN, BSc (Hons) MSc

With the advent of the new generation of general purpose resistors (eg, metal glaze) it is possible to place a much greater demand on their function. In particular, their temperature coefficient and long term stability is such that they may replace high stability or precision resistors in many design circumstances.

The problem then is how to make up those awkward values, between the standard values, with the fewest resistors (presumably two). The practice of "padding" is well known, in which one adds a small resistor in series, or a large resistor in parallel, to the main resistor to trim the overall value up or down until it is correct.

This method is not as efficient as possible, since it does not consider using two resistors of similar value. This is where the appended table comes in.

This table gives, in numerical order, all the values between one and 10 that can be made up with two standard (preferred) value resistors, from the 10% range, connected either in parallel or in series. This does not limit the table to one decade, since the whole table may be multiplied by factors of 10.

To limit the number of combinations to a reasonable and justifiable figure the constraint is applied that the ratio of the two values is no greater than 100:1 or less than 1:100. The table gives combination values which are, on average, 0.36% apart and there are normally several combinations from which to choose.

Assuming that the purpose of creating a non-standard value is also to create a precise value, it may at first appear that these tables are useful only provided all standard resistors have exactly their nominal resistance. This is not true but, in any case, I have found that modern 5% values have a very small spread, typically of the order of 2%, and are centred quite closely on the nominal value.

If it is not possible to select resistors from a batch by measuring them, it will be necessary to use a closer tolerance resistor for at least one of the two in order to achieve the desired accuracy.

Let us consider the way in which the error of the composite resistor depends on the tolerance or error of the two individual resistors. In mathematical terms: eR = eR1 + eR2 for the series resistance case where eR is the error of the composite resistor R, and eR1 and eR2 are the errors of the two series resistors.

Since tolerances (in terms of percentage) rather than actual errors are normally quoted for R1 and R2 the previous expression may be stated more usefully as:

$$T = \frac{T_1R_1 + T_2R_2}{R_1 + R_2}$$

where the T is tolerance, expressed in percent. Note that if one resistor is much larger than the other the accuracy requirements for the larger one are much more stringent.

In a similar way an expression may be derived for the parallel combination:

$$T = \frac{T_1/R_1 + T_2/R_2}{1/R_1 + 1/R_2}$$

Note that here if one resistor is much larger than the other the accuracy requirements of the smaller one are much more stringent.

In the above expressions T may be replaced by temperature coefficient, indicating that the requirements for the temperature coefficients may also be more stringent for some resistors.

If the error of the composite resistor is to be minimised the contribution to the overall accuracy by the individual resistors (in either tolerance or temperature coefficient) should be equal. This implies that the ratio (inverse ratio) of the individual errors in the series case (parallel case) should not be greater than the ratio of the individual resistors.

From these considerations a general procedure can be developed for achieving odd resistance values using the appended tables:

(1) Find a convenient combination from the tables. One in which the resistance ratio is fairly large may be an advantage, since this means that the drift and temperature coefficient requirements are critical for only one of the two resistors.

(2) The larger (smaller) resistor in a series (parallel) configuration is the most critical since it will contribute the greatest part of the overall temperature coefficient and long term drift. The value of this resistor should be fairly close to nominal.

(In most applications a normal metal glaze resistor may be quite adequate but an Electrosyl high stability resistor would be advantageous in more demanding applications.)

(3) For a series (parallel) configuration select the smaller (larger) value such that the measured combination is within acceptable tolerance.

(4) It is possible that the range of values for the resistor mentioned in step (3) is incapable of producing a value within the required tolerance. In this case it will be necessary to go back to step (2) and choose another value.

The above procedure is used when resistors are being selected from a batch. This means that the tolerances are immaterial. What matters is the temperature stability and long term stability.

An example: A resistance of 91kΩ, plus or minus 2%, is required. The table shows that 9.091 can be achieved by paralleling 10 and 100. Thus the resistors required are 100kΩ and 1MΩ in parallel. The tolerances, if selection is not possible, will be 1% and 10% respectively. Naturally, if the second tolerance is better than 10% it can do no harm.

If selection is possible the procedure would be to select 1MΩ resistors (any tolerance) until the combination gives a value between 89kΩ and 93kΩ. In this case the tolerance of the 100kΩ is not of importance, but the temperature stability is still 10 times more important than for the 1MΩ.

Over the page will be found the computer print-out mentioned in the article. In the interest of accuracy it has been reproduced directly, rather than reset.

Resistor combination chart

1.000	S	.000	1.000	1.461	P	1.500	56.000	2.063	P	2.200	33.000	2.941	P	3.300	27.000
1.010	S	.330	.680	1.468	P	1.500	68.000	2.070	S	.270	1.800	2.943	P	3.900	12.000
1.010	S	.010	1.000	1.470	S	.270	1.200	2.076	P	3.300	5.600	2.970	S	.270	2.700
1.012	S	.012	1.000	1.470	S	.470	1.000	2.083	P	2.200	39.000	2.988	P	4.700	8.200
1.015	S	.015	1.000	1.473	P	1.500	82.000	2.102	P	2.200	47.000	3.000	S	1.500	1.500
1.018	S	.018	1.000	1.476	P	1.800	8.200	2.117	P	2.200	56.000	3.000	S	1.200	1.800
1.020	P	1.200	6.800	1.478	P	1.500	100.000	2.126	P	2.700	10.000	3.000	P	3.300	33.000
1.022	S	.022	1.000	1.481	P	1.500	120.000	2.130	S	.330	1.800	3.020	S	.820	2.200
1.027	S	.027	1.000	1.485	P	2.700	3.300	2.131	P	2.200	68.000	3.030	S	.330	2.700
1.030	S	.470	.560	1.485	P	1.500	150.000	2.131	P	3.900	4.700	3.043	P	3.300	39.000
1.031	P	1.500	3.300	1.499	P	2.200	4.700	2.143	P	2.200	82.000	3.071	P	5.600	6.800
1.033	S	.033	1.000	1.500	S	.680	.820	2.153	P	2.200	100.000	3.083	P	3.300	47.000
1.039	S	.039	1.000	1.500	S	.000	1.500	2.160	P	2.200	120.000	3.090	S	.390	2.700
1.040	S	.220	.820	1.515	S	.015	1.500	2.168	P	2.200	150.000	3.095	P	3.900	15.000
1.047	P	1.200	8.200	1.518	S	.018	1.500	2.173	P	2.200	180.000	3.116	P	3.300	56.000
1.047	S	.047	1.000	1.522	S	.022	1.500	2.178	P	2.200	220.000	3.147	P	3.300	68.000
1.056	S	.056	1.000	1.525	P	1.800	10.000	2.180	S	.680	1.500	3.170	S	.470	2.700
1.068	S	.068	1.000	1.527	S	.027	1.500	2.190	S	.390	1.800	3.172	P	3.300	82.000
1.070	S	.390	.680	1.530	S	.330	1.200	2.200	S	.000	2.200	3.195	P	3.300	100.000
1.071	P	1.200	10.000	1.533	S	.033	1.500	2.200	S	1.000	1.200	3.197	P	4.700	10.000
1.080	P	1.800	2.700	1.539	S	.039	1.500	2.204	P	2.700	12.000	3.200	S	1.000	2.200
1.082	S	.082	1.000	1.547	S	.047	1.500	2.222	P	3.300	6.800	3.205	P	3.900	18.000
1.083	P	1.500	3.900	1.556	S	.056	1.500	2.222	S	.022	2.200	3.212	P	3.300	120.000
1.090	S	.270	.820	1.560	S	.560	1.000	2.227	S	.027	2.200	3.229	P	3.300	150.000
1.091	P	1.200	12.000	1.565	P	1.800	12.000	2.233	S	.033	2.200	3.241	P	3.300	180.000
1.100	S	.100	1.000	1.568	S	.068	1.500	2.239	S	.039	2.200	3.251	P	3.300	220.000
1.100	P	2.200	2.200	1.579	P	2.200	5.600	2.247	S	.047	2.200	3.260	S	.560	2.700
1.111	P	1.200	15.000	1.582	S	.082	1.500	2.256	S	.056	2.200	3.260	P	3.300	270.000
1.120	S	.120	1.000	1.590	S	.390	1.200	2.268	S	.068	2.200	3.267	P	3.300	330.000
1.120	S	.560	.560	1.595	P	2.700	3.900	2.270	S	.470	1.800	3.300	S	.000	3.300
1.125	P	1.200	18.000	1.600	S	.100	1.500	2.282	S	.082	2.200	3.300	S	1.500	1.800
1.137	P	1.500	4.700	1.607	P	1.800	15.000	2.288	P	2.700	15.000	3.313	P	3.900	22.000
1.138	P	1.200	22.000	1.620	S	.120	1.500	2.299	P	3.900	5.600	3.328	P	5.600	8.200
1.149	P	1.200	27.000	1.636	P	1.800	18.000	2.300	S	.100	2.200	3.333	S	.033	3.300
1.150	S	.330	.820	1.640	S	.820	.820	2.320	S	.920	1.500	3.339	S	.039	3.300
1.150	S	.150	1.000	1.650	S	.150	1.500	2.320	S	.120	2.200	3.347	S	.047	3.300
1.150	S	.470	.680	1.650	P	3.300	3.300	2.349	P	2.700	18.000	3.356	S	.056	3.300
1.158	P	1.200	33.000	1.662	P	2.200	6.800	2.350	S	.150	2.200	3.368	S	.068	3.300
1.164	P	1.200	39.000	1.664	P	1.800	22.000	2.350	P	4.700	4.700	3.377	P	4.700	12.000
1.165	P	1.900	3.300	1.670	S	.470	1.200	2.353	P	3.300	8.200	3.380	S	.680	2.700
1.170	P	1.200	47.000	1.680	S	.180	1.500	2.350	S	.560	1.800	3.382	S	.082	3.300
1.175	P	1.200	56.000	1.690	S	.680	1.000	2.390	S	.190	2.200	3.400	S	.100	3.300
1.179	P	1.200	68.000	1.688	P	1.800	27.000	2.400	S	1.200	1.200	3.400	S	1.200	2.200
1.180	S	.180	1.000	1.707	P	1.800	33.000	2.405	P	2.700	22.000	3.400	P	6.800	6.800
1.183	P	1.200	82.000	1.715	P	2.700	4.700	2.420	S	.220	2.200	3.408	P	3.900	27.000
1.193	P	1.500	5.600	1.720	S	.220	1.500	2.455	P	2.700	27.000	3.420	S	.120	3.300
1.196	P	1.200	100.000	1.721	P	1.800	39.000	2.470	S	.270	2.200	3.450	S	.150	3.300
1.198	P	1.200	120.000	1.734	P	1.800	47.000	2.479	P	3.900	6.800	3.480	S	.180	3.300
1.200	S	.000	1.200	1.735	P	2.200	8.200	2.480	S	.680	1.800	3.488	P	3.900	33.000
1.210	S	.390	.820	1.744	P	1.800	56.000	2.481	P	3.300	10.000	3.520	S	.820	2.700
1.212	S	.012	1.200	1.754	P	1.800	68.000	2.496	P	2.700	33.000	3.520	S	.220	3.300
1.212	P	2.200	2.700	1.760	S	.560	1.200	2.500	S	1.000	1.500	3.545	P	3.900	39.000
1.215	S	.015	1.200	1.761	P	1.800	82.000	2.525	P	2.700	39.000	3.570	S	.270	3.300
1.218	S	.018	1.200	1.768	P	1.800	100.000	2.530	S	.330	2.200	3.579	P	4.700	15.000
1.220	S	.220	1.000	1.770	S	.270	1.500	2.553	P	2.700	47.000	3.590	P	5.600	10.000
1.222	S	.022	1.200	1.773	P	1.800	120.000	2.555	P	4.700	5.600	3.600	S	1.800	1.800
1.227	S	.027	1.200	1.779	P	1.800	150.000	2.576	P	2.700	56.000	3.601	P	3.900	47.000
1.229	P	1.500	6.800	1.782	P	1.800	180.000	2.588	P	3.300	12.000	3.630	S	.330	3.300
1.232	P	1.800	3.900	1.788	P	3.300	3.900	2.590	S	.390	2.200	3.646	P	3.900	56.000
1.233	S	.033	1.200	1.800	S	.000	1.800	2.597	P	2.700	68.000	3.688	P	3.900	68.000
1.239	S	.039	1.200	1.803	P	2.200	10.000	2.614	P	2.700	82.000	3.690	S	.390	3.300
1.240	S	.560	.680	1.818	S	.018	1.800	2.620	S	.820	1.800	3.700	S	1.000	2.700
1.247	S	.047	1.200	1.820	S	.820	1.000	2.629	P	2.700	100.000	3.700	S	1.500	2.200
1.256	S	.056	1.200	1.822	P	2.700	5.600	2.641	P	2.700	120.000	3.717	P	6.800	8.200
1.268	S	.068	1.200	1.822	S	.022	1.800	2.643	P	3.900	8.200	3.723	P	3.900	82.000
1.268	P	1.500	4.200	1.827	S	.027	1.800	2.652	P	2.700	150.000	3.727	P	4.700	18.000
1.270	S	.270	1.000	1.830	S	.330	1.500	2.660	P	2.700	180.000	3.754	P	3.900	100.000
1.282	S	.082	1.200	1.833	S	.033	1.800	2.667	P	2.700	220.000	3.770	S	.470	3.300
1.290	S	.470	.820	1.839	S	.039	1.800	2.670	S	.470	2.200	3.777	P	3.900	120.000
1.300	S	.100	1.200	1.847	S	.047	1.800	2.673	P	2.700	270.000	3.801	P	3.900	150.000
1.302	P	1.900	4.700	1.856	S	.056	1.800	2.700	S	.000	2.700	3.817	P	3.900	180.000
1.304	P	1.500	10.000	1.859	P	2.200	12.000	2.700	S	1.200	1.500	3.818	P	5.600	12.000
1.320	S	.120	1.200	1.868	S	.068	1.800	2.705	P	3.300	15.000	3.832	P	3.900	220.000
1.320	P	2.200	3.300	1.880	S	.680	1.200	2.727	S	.027	2.700	3.844	P	3.900	270.000
1.330	S	.330	1.000	1.882	S	.082	1.800	2.733	S	.033	2.700	3.854	P	3.900	330.000
1.333	P	1.500	12.000	1.890	S	.390	1.500	2.739	S	.039	2.700	3.860	S	.560	3.300
1.350	S	.150	1.200	1.900	S	.100	1.800	2.747	S	.047	2.700	3.861	P	3.900	390.000
1.350	P	2.700	2.700	1.919	P	2.200	15.000	2.756	S	.056	2.700	3.873	P	4.700	22.000
1.360	S	.690	.690	1.920	S	.120	1.800	2.760	S	.560	2.200	3.900	S	1.200	2.700
1.362	P	1.800	5.600	1.933	P	2.700	6.800	2.768	S	.068	2.700	3.900	S	.000	3.900
1.364	P	1.500	15.000	1.939	P	3.300	4.700	2.779	P	4.700	6.800	3.934	S	.039	3.900
1.380	S	.180	1.200	1.950	S	.150	1.800	2.782	S	.082	2.700	3.947	S	.047	3.900
1.390	S	.560	.820	1.950	P	3.900	3.900	2.789	P	3.300	18.000	3.956	S	.056	3.900
1.385	P	1.500	18.000	1.960	P	2.210	18.000	2.800	S	.100	2.700	3.968	S	.068	3.900
1.390	S	.390	1.000	1.970	S	.470	1.500	2.800	S	1.000	1.800	3.980	S	.680	3.300
1.404	P	1.500	22.000	1.980	S	.180	1.800	2.800	P	5.600	5.600	3.982	S	.082	3.900
1.407	P	2.200	3.900	2.000	P	2.200	22.000	2.806	P	3.900	10.000	4.000	S	.100	3.900
1.420	S	.220	1.200	2.000	S	1.000	1.000	2.820	S	.120	2.700	4.000	S	1.800	2.200
1.421	P	1.500	27.000	2.020	S	.220	1.800	2.850	S	.150	2.700	4.003	P	4.700	27.000
1.423	P	1.900	6.800	2.020	S	.820	1.200	2.870	P	3.300	22.000	4.020	S	.120	3.900
1.435	P	1.500	33.000	2.031	P	2.700	8.200	2.880	S	.180	2.700	4.048	P	6.800	10.000
1.444	P	1.500	33.000	2.034	P	2.200	27.000	2.880	S	.680	2.200	4.050	S	.150	3.900
1.454	P	1.500	47.000	2.060	S	.560	1.500	2.920	S	.220	2.700	4.078	P	5.600	15.000

4.080	S	.180	3.900
4.100	P	8.200	8.200
4.114	P	4.700	33.000
4.120	S	.820	3.300
4.120	S	.220	3.900
4.170	S	.270	3.900
4.195	P	4.700	39.000
4.200	S	1.500	2.700
4.230	S	.330	3.900
4.271	P	5.600	18.000
4.273	P	4.700	47.000
4.290	S	.390	3.900
4.300	S	1.000	3.300
4.336	P	4.700	56.000
4.340	P	6.800	12.000
4.370	S	.470	3.900
4.396	P	4.700	68.000
4.400	S	2.200	2.200
4.445	P	4.700	82.000
4.460	S	.560	3.900
4.464	P	5.600	22.000
4.489	P	4.700	100.000
4.500	S	1.800	2.700
4.500	S	1.200	3.300
4.505	P	8.200	10.000
4.523	P	4.700	120.000
4.557	P	4.700	150.000
4.580	S	.680	3.900
4.580	P	4.700	140.000
4.602	P	4.700	220.000
4.620	P	4.700	270.000
4.634	P	4.700	330.000
4.638	P	5.600	27.000
4.644	P	4.700	330.000
4.653	P	4.700	470.000
4.679	P	6.800	15.000
4.700	S	.000	4.700
4.720	S	.820	3.900
4.747	S	.047	4.700
4.756	S	.056	4.700
4.768	S	.068	4.700
4.782	S	.082	4.700
4.788	P	5.600	33.000
4.800	S	1.500	3.300
4.800	S	.100	4.700
4.820	S	.120	4.700
4.850	S	.150	4.700
4.871	P	8.200	12.000
4.880	S	.180	4.700
4.897	P	5.600	39.000
4.900	S	2.200	2.700
4.900	S	1.000	3.900
4.920	S	.220	4.700
4.935	P	6.800	18.000
4.970	S	.270	4.700
5.000	P	10.000	10.000
5.004	P	5.600	47.000
5.030	S	.330	4.700
5.090	S	.390	4.700
5.091	P	5.600	56.000
5.100	S	1.800	3.300
5.100	S	1.200	3.900
5.170	S	.470	4.700
5.174	P	5.600	68.000
5.194	P	6.800	22.000
5.242	P	5.600	82.000
5.260	S	.560	4.700
5.302	P	8.200	15.000
5.303	P	5.600	100.000
5.350	P	5.600	120.000
5.380	S	.680	4.700
5.398	P	5.600	150.000
5.400	S	1.500	3.900
5.400	S	2.700	2.700
5.431	P	5.600	180.000
5.432	P	6.800	27.000
5.455	P	10.000	12.000
5.461	P	5.600	220.000
5.486	P	5.600	270.000
5.500	S	2.200	3.300
5.507	P	5.600	330.000
5.520	S	.820	4.700
5.521	P	5.600	390.000
5.534	P	5.600	470.000
5.545	P	5.600	560.000
5.600	S	.000	5.600
5.634	P	8.200	18.000
5.638	P	6.800	33.000
5.656	S	.056	5.600
5.668	S	.068	5.600
5.682	S	.082	5.600
5.700	S	1.000	4.700
5.700	S	.100	5.600
5.700	S	1.800	3.900
5.720	S	.120	5.600
5.750	S	.150	5.600
5.780	S	.180	5.600
5.790	P	6.800	39.000
5.820	S	.220	5.600
5.870	S	.270	5.600
5.900	S	1.200	4.700
5.930	S	.330	5.600
5.941	P	6.800	47.000
5.974	P	8.200	22.000
5.990	S	.390	5.600
6.000	S	2.700	3.300
6.000	P	10.000	15.000
6.000	P	12.000	12.000
6.064	P	6.800	56.000
6.070	S	.470	5.600
6.100	S	2.200	3.900
6.160	S	.560	5.600
6.182	P	6.800	68.000
6.200	S	1.500	4.700
6.279	P	6.800	82.000
6.280	S	.680	5.600
6.290	P	8.200	27.000
6.367	P	6.800	100.000
6.420	S	.820	5.600
6.429	P	10.000	18.000
6.435	P	6.800	120.000
6.500	S	1.800	4.700
6.505	P	6.800	150.000
6.552	P	6.800	180.000
6.564	P	8.200	33.000
6.596	P	6.800	220.000
6.600	S	3.300	3.300
6.600	S	2.700	3.900
6.600	S	1.000	5.600
6.633	P	6.800	270.000
6.663	P	6.800	330.000
6.667	P	12.000	15.000
6.683	P	6.800	390.000
6.703	P	6.800	470.000
6.718	P	6.800	560.000
6.733	P	6.800	680.000
6.775	P	8.200	39.000
6.800	S	1.200	5.600
6.800	S	.000	6.800
6.868	S	.068	6.800
6.875	P	10.000	22.000
6.882	S	.082	6.800
6.900	S	.100	6.800
6.900	S	2.200	4.700
6.920	S	.120	6.800
6.950	S	.150	6.800
6.980	S	.180	6.800
6.982	P	8.200	47.000
7.020	S	.220	6.800
7.070	S	.270	6.800
7.100	S	1.500	5.600
7.130	S	.330	6.800
7.153	P	8.200	56.000
7.190	S	.390	6.800
7.200	S	3.300	3.900
7.200	P	12.000	18.000
7.270	S	.470	6.800
7.297	P	10.000	27.000
7.318	P	8.200	68.000
7.360	S	.560	6.800
7.400	S	2.700	4.700
7.400	S	1.800	5.600
7.455	P	8.200	82.000
7.480	S	.680	6.800
7.500	P	15.000	15.000
7.579	P	8.200	100.000
7.620	S	.820	6.800
7.674	P	10.000	33.000
7.676	P	8.200	120.000
7.765	P	12.000	22.000
7.775	P	8.200	150.000
7.800	S	2.200	5.600
7.800	S	3.900	3.900
7.800	S	1.000	6.800
7.843	P	8.200	180.000
7.305	P	8.200	220.000
7.958	P	8.200	270.000
7.959	P	10.000	39.000
8.000	S	3.300	4.700
8.000	S	1.200	6.800
8.001	P	8.200	330.000
8.031	P	8.200	390.000
8.059	P	8.200	470.000
8.082	P	8.200	560.000
8.102	P	8.200	680.000
8.119	P	8.200	820.000
8.182	P	15.000	18.000
8.200	S	.000	8.200
8.246	P	10.000	47.000
8.282	S	.082	8.200
8.300	S	2.700	5.600
8.300	S	.100	8.200
8.300	S	1.500	6.800
8.308	P	12.000	27.000
8.320	S	.120	8.200
8.350	S	.150	8.200
8.380	S	.180	8.200
8.420	S	.220	8.200
8.470	S	.270	8.200
8.485	P	10.000	56.000
8.530	S	.330	8.200
8.590	S	.390	8.200
8.600	S	3.900	4.700
8.600	S	1.800	6.800
8.670	S	.470	8.200
8.718	P	10.000	68.000
8.760	S	.560	8.200
8.800	P	12.000	33.000
8.880	S	.680	8.200
8.900	S	3.300	5.600
8.913	P	10.000	82.000
8.919	P	15.000	22.000
9.000	S	2.200	6.800
9.000	P	18.000	18.000
9.020	S	.820	8.200
9.091	P	10.000	100.000
9.176	P	12.000	39.000
9.200	S	1.000	8.200
9.231	P	10.000	120.000
9.375	P	10.000	150.000
9.400	S	4.700	4.700
9.400	S	1.200	8.200
9.474	P	10.000	180.000
9.500	S	3.900	5.600
9.500	S	2.700	6.800
9.559	P	12.000	47.000
9.565	P	10.000	220.000
9.643	P	15.000	27.000
9.643	P	10.000	270.000
9.700	S	1.500	8.200
9.706	P	10.000	330.000
9.750	P	10.000	390.000
9.792	P	10.000	470.000
9.825	P	10.000	560.000
9.855	P	10.000	680.000
9.880	P	10.000	820.000
9.882	P	12.000	56.000
9.900	P	18.000	22.000
9.901	P	10.000	1000.000
10.000	S	1.800	8.200

S- Series combination, P- Parallel combination, *- Standard value for precision resistors.

Resistor colour code

The coloured bands on a resistor indicate its value in ohms and its tolerance in percent. On most of the resistors you are likely to encounter, three bands are used to indicate the value while a fourth band indicates the tolerance. The tolerance band will be slightly separated from the value bands so it's easy to tell them apart. Some other types of low tolerance resistors have four value bands as well as the tolerance band.

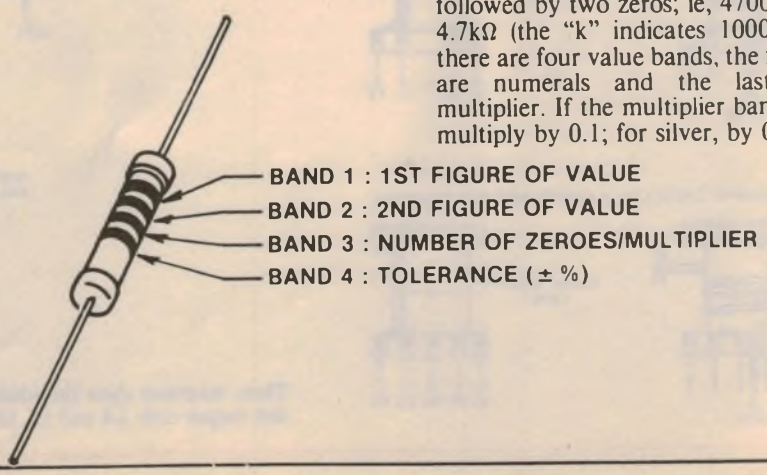
Here's what the colours mean for the value bands:

BLACK	0	GREEN	5
BROWN	1	BLUE	6
RED	2	VIOLET	7
ORANGE	3	GREY	8
YELLOW	4	WHITE	9

For the tolerance band, the colours are:

BROWN 1% RED 2% GOLD 5%
SILVER 10%

When reading the value of a resistor, start with the band furthest away from the tolerance band. The first two bands indicate the first two digits of the value while the third band is the multiplier (ie, it indicates the number of zeros). For example, the bands might be yellow, violet and red. This means the value is 47 followed by two zeros; ie, 4700 ohms or 4.7kΩ (the "k" indicates 1000). Where there are four value bands, the first three are numerals and the last is the multiplier. If the multiplier band is gold, multiply by 0.1; for silver, by 0.01.



Second article completes the construction

High-power car stereo amplifier Pt.2

Last month, we looked at the circuit of our new high power Car Stereo Amplifier and detailed the PCB construction. In Part 2 this month, we describe the final assembly and give the setting up details.

by GREG SWAIN and ANDREW LEVIDO

Once the PCB assemblies have been completed, the metalwork can be tackled. Begin by drilling the mounting holes for the PCBs. These holes must be countersunk so that the screw heads can sit flush with the top of the case (beneath the heatsink).

This done, position the extruded heatsink on the "bottom" of the case, directly above where the amplifier board is to be mounted. The photographs show how the heatsink is mounted. Mark the position of the heatsink and remove it. Mark out and drill four holes in the heatsink and case so that the two can be bolted together.

We positioned these holes 30mm in from the ends of the heatsink and 10mm in from the edges.

The countersunk screws can now be installed in their appropriate holes. The four long screws (35mm) are for the amplifier PCB while the four shorter ones (15mm) are for the inverter board. The 35mm screws are secured using 25mm spacers and nuts while the 15mm screws are each secured using two nuts.

The latter act as spacers which hold the inverter board off the bottom of the case. Use shakeproof washers under all mounting nuts.

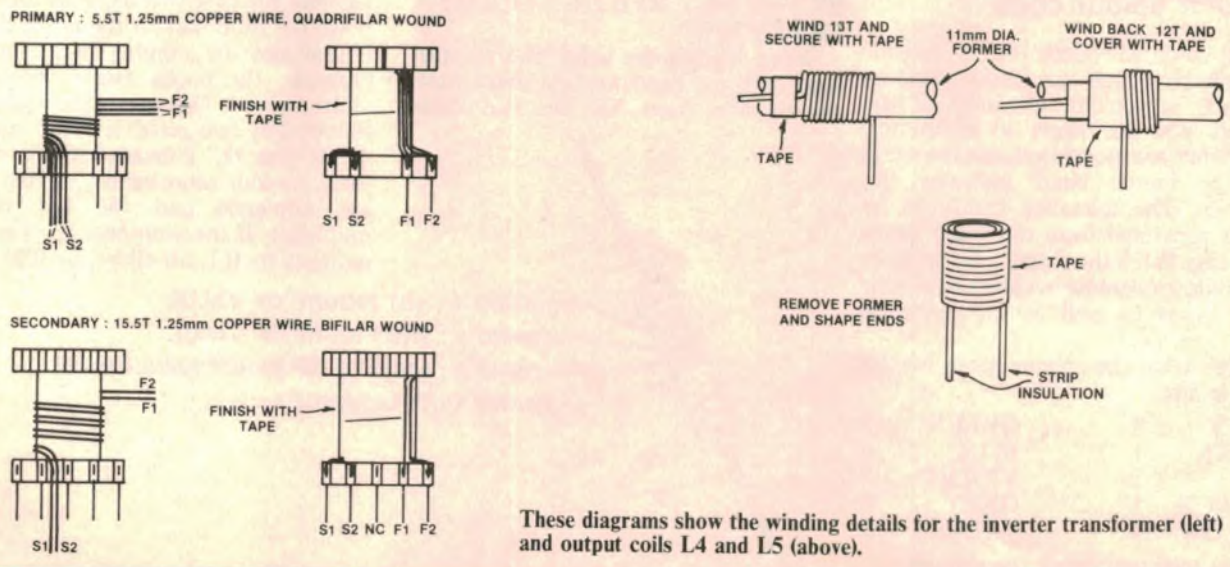
Next, temporarily mount the inverter board in position and mark the mounting holes for the Mosfet transistors. Remove the board and drill these holes. Be sure to remove every trace of sharp metal from the inside of the case since these can pierce the insulating washer under the transistors and cause short circuits.

The accompanying diagram (Fig.1) shows the drilling details for the side of the case. The holes for the cable clamps must be enlarged and shaped using a rat tail file. You will also have to bend up and drill the aluminium shield, as shown in Fig. 2. This is secured using two of the screws that secure the heatsink.

The power transistor mounting holes can now be drilled. To do this, bolt the heatsink in position then, using a mica insulating washer as a template, mark the mounting holes for the four transistors. You can determine the order and orientation of the transistors from the photographs and the parts layout diagram for the amplifier PCB.

Two holes must also be drilled in the heatsink to accommodate the Vbe multiplier transistors (Q13 and Q24). These holes are located between the output pairs and should be drilled slightly undersized so that the transistors are a friction fit in the heatsink. We used a reamer from the inside of the case to give each hole a slight taper.

The output transistors (Q15, Q17, Q26 and Q28) must be isolated from the heatsink using mica washers and insulating bushes, as depicted in Fig.3.



These diagrams show the winding details for the inverter transformer (left) and output coils L4 and L5 (above).

The two arrows indicate the locations of the Vbe multiplier transistors (Q13 and Q24).

Check that the heatsink is free of metal swarf and smear all matching surfaces with heatsink compound before assembly.

Note that a solder lug should be secured to one of the mounting screws for each output transistor. These serve to terminate the collector leads from the amplifier PCB.

As each transistor is mounted, use your multimeter to check that its case is indeed insulated from the heatsink. The Vbe multiplier transistors (Q13 and Q24) can also be installed at this stage. A dab of epoxy resin adhesive can be used to hold Q13 and Q24 in place.

Now for the internal wiring. Prop the amplifier PCB against the metal shield in the chassis and install the wiring to the heatsink transistors (use medium-duty hookup wire). This done, both the amplifier and inverter PCBs can be permanently installed in the chassis and the Mosfet transistors bolted to the side of the case together with mica washers and insulating bushes.

Once again, use your multimeter to confirm that the metal tabs of the transistors are correctly isolated.

The LM334Z temperature sensor is secured in a small aluminium clamp and this is attached to the mounting screw used to secure Q6 (see Fig. 4). The sensor terminals are connected to the V+, V− and R points on the inverter PCB via flying leads.

Note that the aluminium clamp must not touch the metal tab of the Mosfet transistor, otherwise the tab will be shorted to chassis. Plastic sleeving should be pushed over the sensor terminals to avoid the possibility of shorts to the aluminium clamp.

The remaining wiring details can be gleaned from the PCB parts layout diagrams. Note that the power supply wiring between the two PCBs passes through a small grommeted hole in the metal shield. Note also that the input RCA sockets are insulated from the metal case by first fitting rubber grommets to the holes. The input sockets are wired using shielded audio cable.

The speaker leads and other external leads (battery and remote) are clamped to the case using in-line cord clamps. We used 240VAC-rated twin flex for the speaker leads. The 15A fuse should be wired into the positive supply lead to the battery.

Finally, the ground (GND) terminal on the amplifier PCB must be connected to chassis. The best way to do this is to connect the ground terminal to an earth lug via a 60mm flying lead. The solder lug can then be secured to the nearest mounting pillar when the lid is fitted.

Setting up

Having completed construction, the setting up process can begin. First, temporarily disconnect the ±27V leads to the amplifier PCB. This done, set VR1 and VR3 on the inverter board fully clockwise and VR2 fully anticlockwise. VR4 on the amplifier board should initially be set fully clockwise and VR5 fully anticlockwise.

Now power up the inverter using a variable DC power supply capable of delivering a couple of amps at 13.8V. Note that the control line will have to be connected to the positive supply terminal. A car battery can be used if you don't have a variable power supply, although you won't be able to set the under-voltage cutout.

Connect your multimeter across the positive supply and adjust VR1 until the meter reads +27V. Now check that the negative supply is very close to this figure, say within 1V.

If you are unable to set the correct voltages, switch off immediately and check for wiring errors.

Assuming all is well, the under-voltage cutout can now be set. Reduce the power supply voltage to the level you have

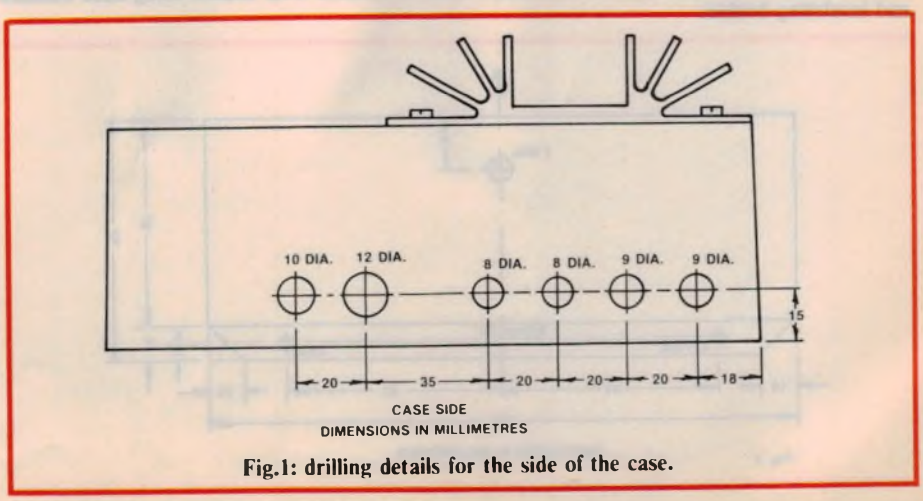
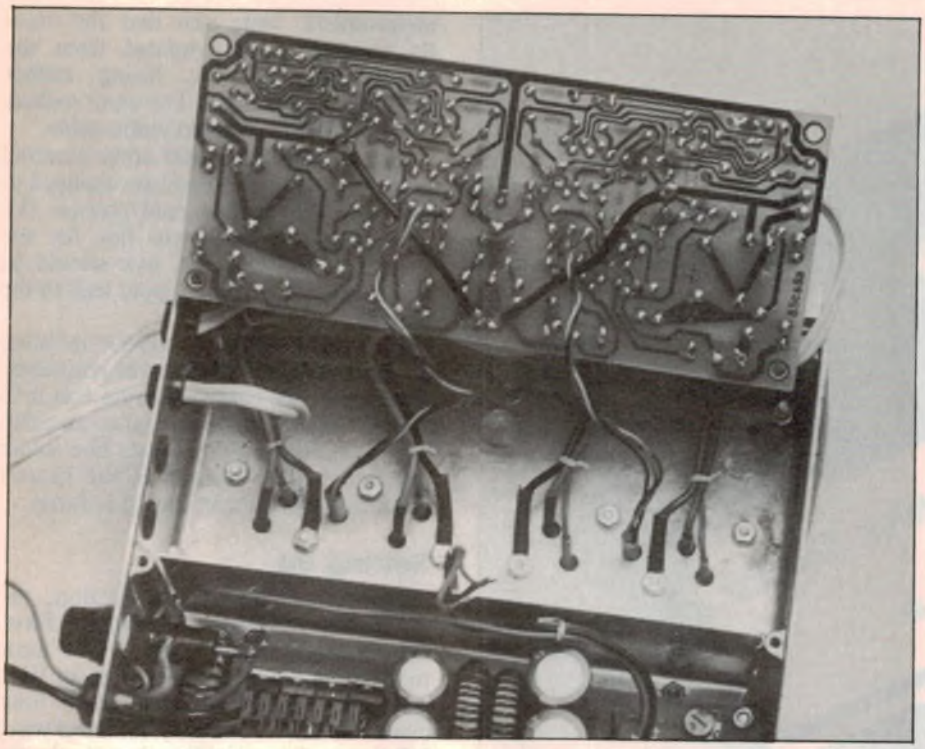


Fig.1: drilling details for the side of the case.



View showing the wiring to the output transistors and Vbe multipliers.

100W Car Stereo Amplifier

selected as the minimum allowable battery voltage (we recommend 11.5V). Now turn VR2 slowly clockwise while monitoring the inverter output voltage. At some point, the output voltage will drop abruptly to near zero. VR2 has now been set.

If you don't have a variable supply and are using the car battery, simply rotate VR2 clockwise until the inverter output voltage drops to 0V, then rotate VR2 anticlockwise one quarter of a turn.

The over-temperature adjustment is set by calculating the voltage across the 12kΩ resistor (pin 3, IC4b) at room temperature from the desired value at 95°C.

The first step is to accurately measure the reference voltage produced by IC1. You can check this at pin 2 of IC4b.

You also need to know the ambient temperature. Add 273 to the ambient temperature to obtain the absolute temperature, then multiply this temperature by the reference voltage and divide by 368 (368°K corresponds to 95°C). The resulting number is the voltage (probably between 4V and 5V) that you want to appear across the 12kΩ resistor at the ambient temperature.

Adjust VR3 until this voltage appears across the 12kΩ resistor. The over-temperature cutout has now been set. Switch off and re-connect the +27V supply rails.

Finally, the quiescent current for the output transistors must be set using VR4 and VR5. To do this, connect a digital multimeter across one of the 0.22Ω resistors in one channel and set the meter to the 200mV range. Install the fuses for that channel only, then switch on and carefully rotate the appropriate bias trimpot (VR5) until the meter reads between 4mV and 5mV (this sets the quiescent current to approximately 20mA).

Alternatively, if you do not have a digital multimeter, you can set the quiescent current by removing the 2A fuses and connecting 100Ω 1W resistors temporarily across the fuseholders. The bias trimpot (VR5) is then adjusted to obtain two volts DC across each 100Ω resistor, which again gives a quiescent current of 20mA.

Repeat the above procedure for the other channel. With that done, check that the output of each power amplifier is very close to 0V (ie, within ±100mV). If not, you have a fault which should be rectified before loudspeakers are connected.

If you are unable to set the quiescent current in any channel correctly, switch off immediately and check for errors. Are all the transistors oriented correctly? Have you inadvertently transposed two of the output transistors or wired them incorrectly?

This completes the setting up procedure. The amplifier can now be given a quick bench test. All you have to do is connect up a pair of loudspeakers and a suitable signal source and try it out.

Fig.2 (below) shows the details of the aluminium shield while at right is a close-up of the BUZ71 Mosfet transistors. Note that the transistors must be isolated from chassis using mica washers and insulating bushes.

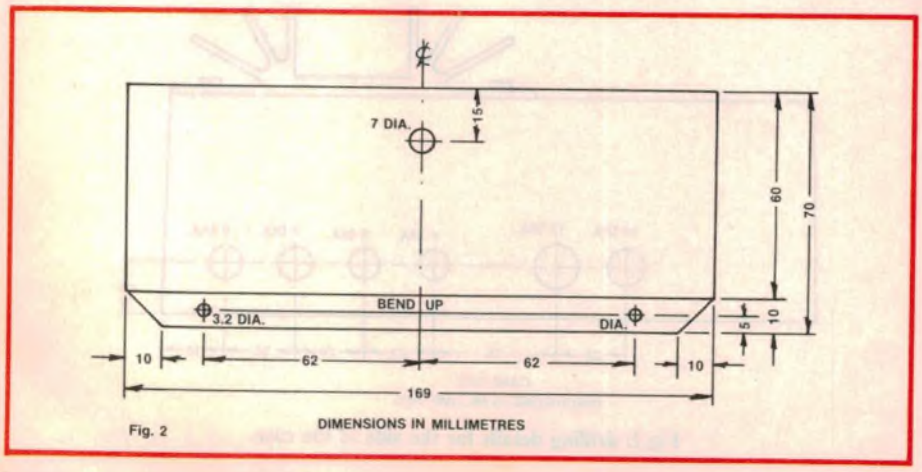
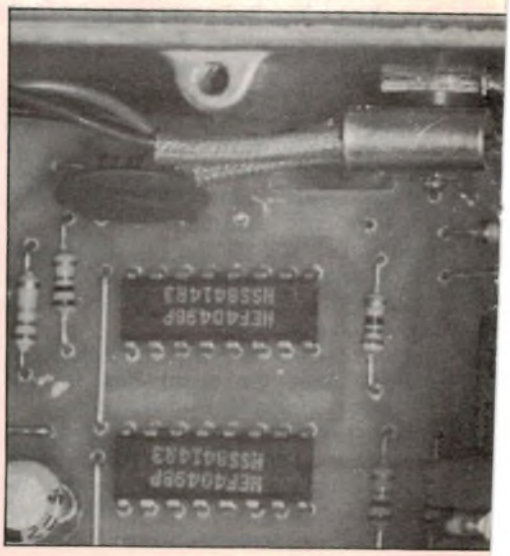


Fig. 2



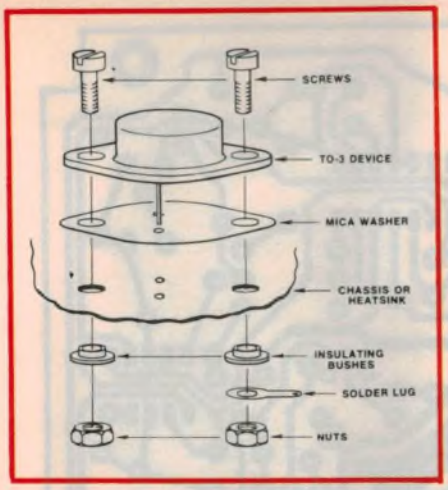


Fig.3: this diagram shows how the power output transistors are mounted.

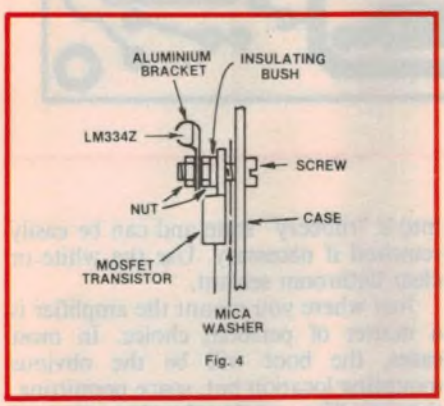
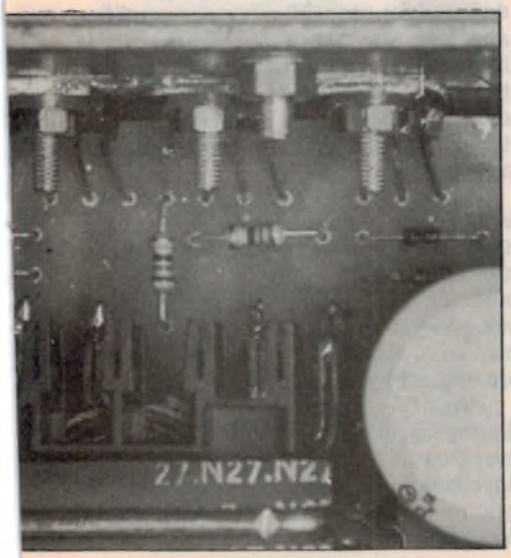
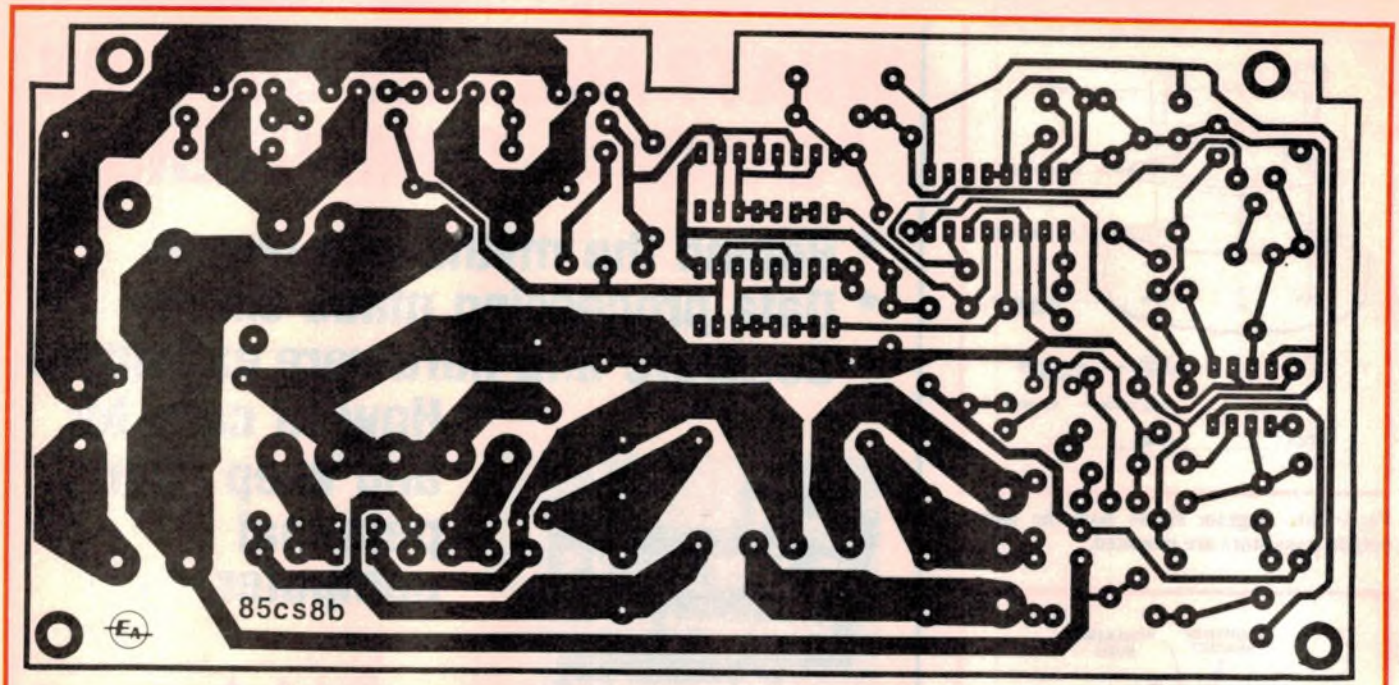


Fig.4: the LM334Z temperature sensor is secured in a small aluminium bracket.

Installation

Before installing the amplifier, it is a good idea to provide shock proofing for the larger components, to prevent damage due to vibration. This can be done by applying *Silastic* (tradename) caulking compound around the bases of the larger components. These include the





Above is an actual size artwork for the inverter PCB (85cs8b).

100W Car Stereo Amplifier

three toroid coils (L1, L2 and L3) on the inverter PCB, the two air-cored coils (L4 and L5) on the amplifier PCB, all the large electrolytic capacitors and the four rectifier diodes (D6-D9).

In particular, apply generous amounts of *Silastic* between coils L2 and L3, and between the coils and their adjacent electrolytic capacitors.

The advantage of *Silastic* is that it sets into a "rubbery" state and can be easily removed if necessary. Use the white or clear bathroom sealant.

Just where you mount the amplifier is a matter of personal choice. In most cases, the boot will be the obvious mounting location but, space permitting, the amplifier could also be mounted under one of the front seats. Power can be derived from any convenient point on the fusebox where +12V is permanently applied; eg, from a horn or headlight terminal.

Note that power should be derived from the battery side of the fusebox. It should not be derived via one of the existing automotive fuses.

Ideally, the remote line should be switched by the radio-cassette player. In fact, many radio-cassette players are designed for use with a booster amplifier and are fitted with a remote output socket which goes to +12V whenever the unit is switched on. In this case, it is only necessary to fit a suitable plug to the remote line so that it can be plugged straight in.

If there is no remote output, the remote line should be connected to the switched side of the +12V supply inside the radio-cassette player. If this is too difficult, a connection can be made to an accessory terminal on the fusebox. In this case, the amplifier will be switched on and off by the ignition switch.

Finally, make sure that the loudspeakers are capable of handling the rated power output. There's no point in investing in a high-power amplifier if you're going to use it with cheap loudspeakers.

Performance of prototype

OUTPUT POWER
50W RMS per channel into 4Ω

HARMONIC DISTORTION
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less than 0.5% for all powers up to 50W into 4Ω loads
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SIGNAL TO NOISE RATIO
65dB referred to 1W; 82dB referred to 50W

FREQUENCY RESPONSE
20Hz – 50kHz (–1dB)

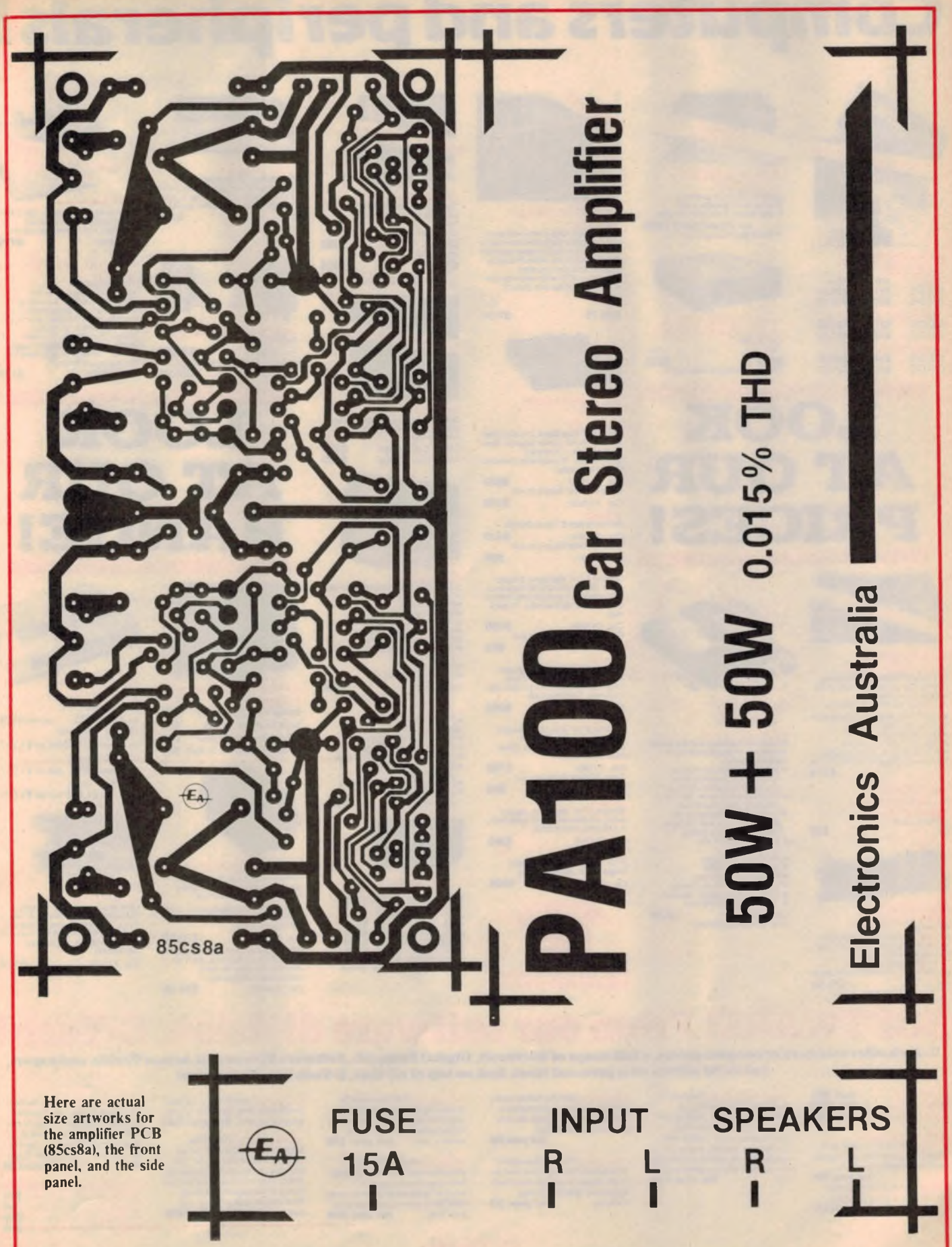
GAIN
24dB (90mV RMS for 50W)

LOAD IMPEDANCE
4Ω minimum

SUPPLY VOLTAGE
10-15V DC

CURRENT CONSUMPTION
15A maximum

STABILITY
Unconditional



Here are actual size artworks for the amplifier PCB (85cs8a), the front panel, and the side panel.

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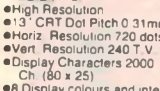

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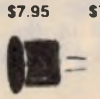

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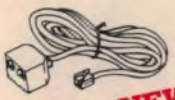

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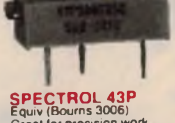

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FREE PCB OFFER:

Build this simple car ignition killer

As a special promotion for this month only, Electronics Australia has arranged for the supply of 1000 free printed circuit boards for our popular Ignition Killer project. This is a sneaky anti-theft device which is easily installed in any car.

Printronics Pty Ltd have kindly agreed to supply 1000 premium quality boards for this project. The boards will be on fibreglass copper laminate, with oxide-coated copper tracks, protected by dry film solder resist which has been solder levelled. Naturally the board will also have a screen-printed component overlay. To see how these fine boards are made, read the special feature article on Printronics, beginning page 12 of this issue.

There is only one way to obtain one of these free printed boards. You must fill in the coupon in this article and send it to *Electronics Australia* together with a stamped, self-addressed envelope. The offer is limited to 1000 free boards and so the first 1000 readers will be lucky ones. Do not send requests for the board to Printronics Pty Ltd. The offer is only available by sending the coupon to *Electronics Australia.*

The project

Our "Ignition Killer" works like this: imagine a thief has just broken into your car. He starts the engine and begins to drive off. Just as he does, the engine dies. He immediately cranks the engine and a few seconds later it starts. Again he begins to drive off and again the engine dies. In desperation he tries a third time only to have the engine die again.

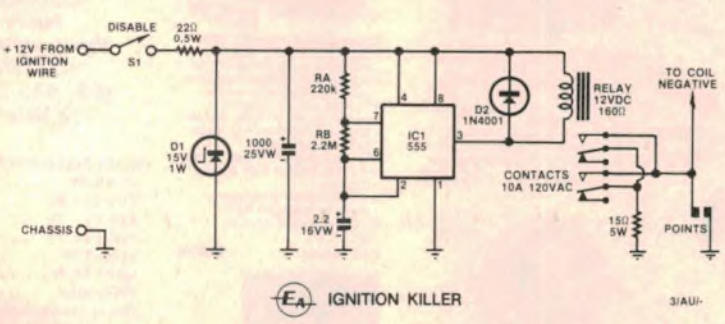
The above sequence of events should automatically deter any joyriders and many so-called professional thieves as well. After all, it is difficult to get any joy out of the car that only moves a few metres at a time. In this situation, most thieves will simply assume that the car has an engine problem and will abandon it for easier "game".

The simple circuit that creates this mayhem is simply an astable oscillator based on the ubiquitous 555 timer IC. The output of the 555 oscillator is connected to a relay which in turn has its normally open contacts wired in parallel with the car's points or coil switching transistor (see Fig.1).

A few seconds after the car is started, the oscillator output goes low, causing the relay to operate and short out the car's points. With no points signal the ignition system cannot produce a spark and so the engine dies. A few seconds later the oscillator output returns to the high state, the relay turns off and the contacts open. The engine can now be started and will run for a few seconds until the next low cycle of the oscillator.

The circuit is powered from the car's ignition wire and uses no power when the ignition is not switched on. Thus it will not flatten the battery when used to protect the car for extended periods.

A further advantage of the circuit is that it can be used on any car, even the latest models with built-in computer diagnostics. None of the existing ignition circuitry on the car is disturbed. A 15Ω, 5W resistor is connected in series with the relay contacts to prevent any possibility of damage to the ignition coil in case the killer circuit is energised permanently. This might happen if a thief broke into the vehicle and hot-wired the ignition.



The circuit consists of a 555 timer IC driving a relay.

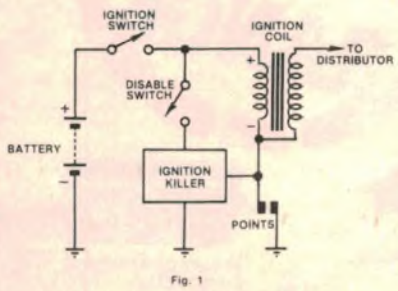
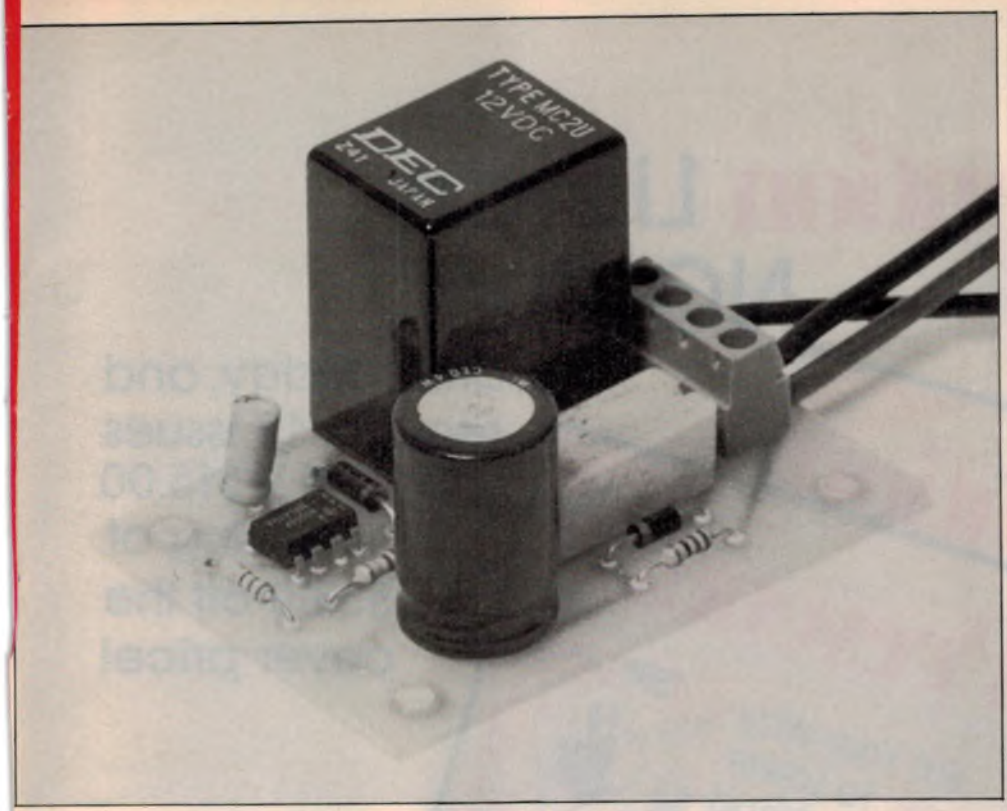


Fig. 1

The Ignition Killer is connected to the negative terminal of the ignition coil, in parallel with the points (or coil switching transistor).



The three external leads go to the disable switch, chassis and coil negative.

How it works

The circuit consists of astable oscillator IC1 (555), a relay and a handful of minor components.

Inside the 555 timer IC is a resistor divider network which sets reference voltages of 1/3 Vcc and 2/3 Vcc on internal comparators. At switch on, the pin 2 trigger input is pulled low by an external 2.2μF capacitor, while the output is high. This means that the relay will be off and so the engine can be started.

The 2.2μF capacitor immediately begins charging via the 220kΩ and 2.2MΩ timing resistors. When the voltage across it reaches 2/3 Vcc, the 555 output (pin 3) switches low and the relay turns on to short out the points (or the coil switching transistor). At the same time, pin 7 goes low (ie, the discharge transistor turns on) and the 2.2μF capacitor begins discharging

Pin 3 will remain low, and hence the relay remains on, until the capacitor is discharged to 1/3 Vcc. At this point, pin 3 switches high again, the pin 7 discharge transistor turns off, and the 2.2μF capacitor re-charges towards 2/3 Vcc. Thus, the cycle repeats indefinitely while ever power is applied. It follows, therefore, that the car can be started only during the charging cycle and stalls immediately the voltage across the timing capacitor reaches 2/3 Vcc.

The 1N4001 diode connected across

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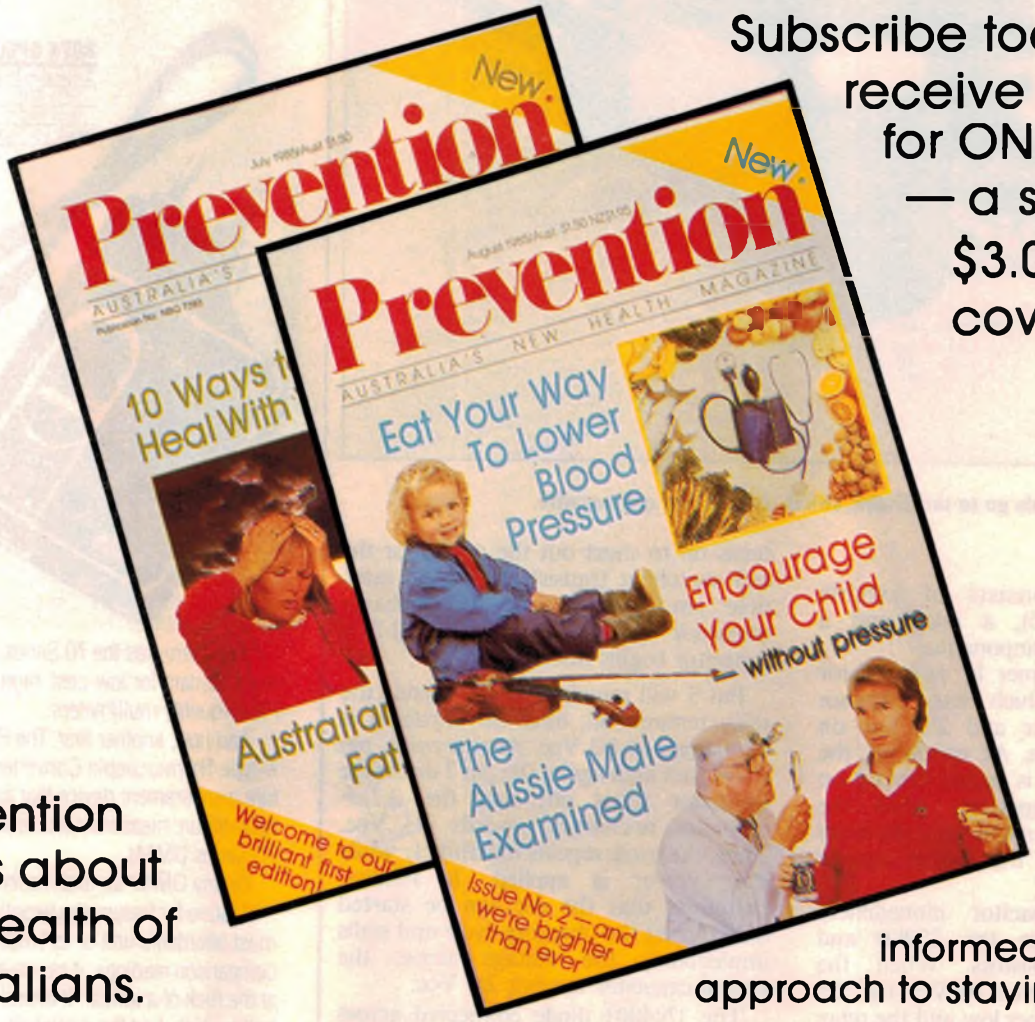

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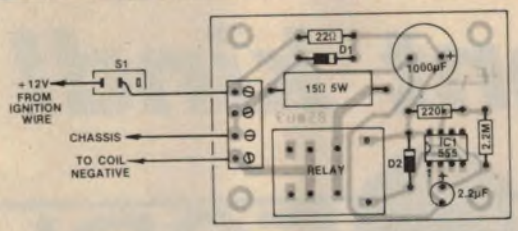
Good Health — in a Nutshell!

Ignition killer for cars



Construction is easy — just follow this wiring diagram. Mount the 15Ω resistor slightly proud of the PC board.

the relay contacts shorts out the relay coil back EMF to prevent damage to the output circuit of the 555. The 22Ω resistor, 15V zener and 1000ΩF capacitor provide supply line filtering and decoupling. The 15V zener clamps supply line transients to 15V, thus protecting the 555 from excessive voltages.

Construction

Construction is straightforward with all parts except the switch mounted on a small printed circuit board (PCB) coded 85au9 and measuring 69 x 48mm. This can be housed in a metal case measuring 102 x 70 x 51mm, although any similarly-sized plastic case would also be suitable.

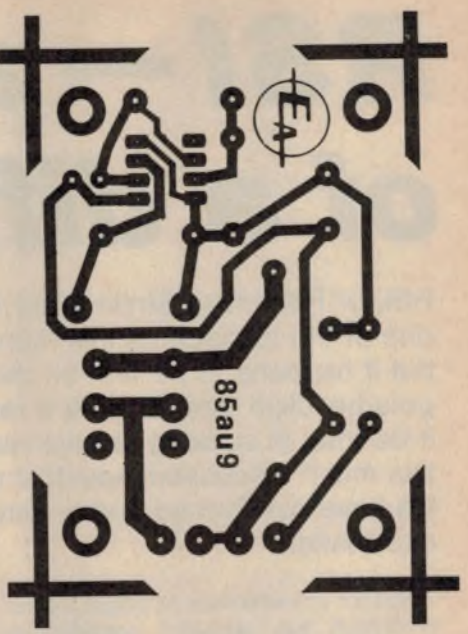
We mounted the PCB assembly on the lid of the case using four 6mm spacers and machine screws and nuts. A small hole was drilled in the end of the lid closest to the terminal block to allow entry of the connecting leads. This hole should be fitted with a small rubber grommet to prevent damage to the lead insulation.

Installation of the unit is probably the most important part of the construction. To enable the unit to function effectively, it must remain undetected by the potential thief. This not only means hiding the unit itself and disguising any exposed wiring, but locating the unit so that the sound of the relay operating cannot be heard.

The best place for the unit is probably in the engine bay against the firewall. Power for the unit should be taken from the ignition wire, preferably at a point remote from both the ignition switch and the coil. This reduces the chances of a thief spotting the extra lead when "hotwiring" the car. A single-pole on-off switch, accessible from the driver's position, should be placed in the power lead running to the unit so that the unit can be disabled and the car driven normally.

It goes without saying that this switch should also be well hidden.

The earth wire should be connected to the nearest earth point, which may actually be inside the case if this is electrically connected to the vehicle chassis (say via self-tapping screws). The most exposed connection is the wire leading to the negative or points side of the coil. This connection should be disguised by using wiring similar in appearance to the existing coil leads, and by bundling the leads together.



Here is an actual size artwork for the PC board (see coupon page 83).

Once the unit is installed, it can be checked for correct operation. First, switch the unit off and check that the car can be started and that the engine runs normally. Now switch the unit on — the engine should run normally for a few seconds, then cut out. It should now be possible to restart the engine after a short delay, whereupon the engine should again run normally for a few seconds before cutting out.

If your car's engine is very easy (or very hard) to start you may wish to alter the engine run and stop times we have chosen. This can be done quite easily by changing either of the two timing resistors or the timing capacitor. The formulae for the time periods in seconds are:

- Engine run time = $0.685(R_A + R_B)C$;
- Engine stop time = $0.685(R_B)C$.

In our circuit, R_A = 220kΩ, R_B = 2.2MΩ, and C = 2.2μF. By substituting these figures into the above equations, we get an engine run time of 3.6 seconds and an engine "kill" time of 3.3 seconds.

PARTS LIST

1 PCB, code 85au9, 69 x 48mm
1 aluminium case, 102 x 70 x 51mm
1 4-way PC-mounting terminal block
1 DPDT 12V relay with 10A 120VAC contacts
1 SPST toggle switch
4 6mm or 8mm spacers
1 small rubber grommet

SEMICONDUCTORS

1 555 timer IC
1 15V 1W zener diode
1 IN4001 diode

CAPACITORS

1 1000μF 25VW PC electrolytic
1 2.2μF 16VW PC electrolytic

RESISTORS

(¼W, 5% unless stated)
1 x 2.2MΩ, 1 x 220kΩ, 1 x 22Ω, ½W, 1 x 15Ω, 5W.

MISCELLANEOUS

Machine screws and nuts, self tapping screws, automotive hook-up wire, solder etc.

RSI — and a hangup of a different kind!

RSI, or Repetitive Strain Injury, is only one of the subjects in this month's Forum but it happens to be first on the list and gets headline treatment as a result. Could it be that, in seeking elusive reasons for this much discussed industrial malaise, we have overlooked a very simple explanation?

FORUM

Conducted by Neville Williams

RSI (or tenosynovitis or carpal tunnel syndrome) has attracted considerable attention, during the past couple of years, as a possible problem facing anyone who works for long periods at an electronic keyboard. With the forearms held relatively motionless and the fingers doing most of the work, certain tendons can become overstressed and allegedly suffer damage to the extent that the operator is no longer able to continue in the particular occupation.

The subject was debated at some length in "Forum" for June and, while keeping my options open, I did mention that I had personally experienced some muscular discomfort after exchanging my "aging Adler" for a word processor. I put it down mainly to the longer periods of concentration and the lack of mobility which the word processor encouraged, but a doctor friend was more inclined to blame faulty posture.

At his insistence, I pruned the table legs by several centimetres to lower the keyboard, kept the screen at the original height, and sought consciously to move around in my chair, rather than remain immobile like that classic statue "The Thinker".

. . . pruned the table leg by several centimetres to lower the keyboard

The result, I am happy to report, is that the shoulder and arm pains vanished and, with them, any immediate personal apprehension about RSI.

But then came a letter from a long-time friend in the industry, Winston Muscio, author of the book "Australian Radio — The Technical Story", reviewed in the June '84 issue. The letter reads:

Dear Neville,

Your article on RSI, tenosynovitis, etc, was most interesting. However, in the case where the problem arises with constant use of computer keyboards, word processors, etc, I believe there is a very simple explanation which thus far appears not to have been given much consideration.

As you may know, "touch" typing commonly revolves around the placement of eight fingers on the "home" keys, all typing being performed by departures therefrom. This being the case, there is a natural tendency to allow these keys to act somewhat in the nature of a support for the hands and wrists.

This is all very well with mechanical typewriters, where significant force is needed to actually operate the keys.

Due to the much reduced force necessary to operate an electronic keyboard (perhaps 10% of the former effort) it is not possible to use the home keys for support to anything like the same extent. Thus a touch typist's hands are virtually suspended above the keyboard for hours on end, with the arms and wrists supporting them.

. . . the problem has come so very clearly to the fore with the passing of "steam" typewriters!

No wonder the problem has come so very clearly to the fore with the passing of "steam" typewriters! Is there anything basically wrong with this explanation or is it just so simple that it has been overlooked for so long?

I understand that there has been some recent investigation into wrist supports for keyboard operators, which might suggest that the cause of the trouble is now being recognised. By way of an aside, I have never heard of users of the "hunt and peck" method of typing complain of the problem.

The writer goes on to discuss another subject but let's stay with RSI for the moment.

I had never given special consideration to touch typists, mainly because touch typing has been a skill not commonly shared by EA technical staff — or EA editors either! Most of us were selected primarily for adeptness with soldering iron and test equipment, on the assumption that the ability to type articles in draft form could be picked up somewhere along the way.

Most of us ended up doing reasonably well with flailing arms and less than the appropriate number of fingers. We would be exposed to the risk, I guess, not so much of keyboard tenosynovitis as of tennis elbows!

. . . all those public servants with their fingers glued to their work! . . .

As for wrist supports, I must confess to a certain amusement at the notion of an office full of keyboard operators, all with cords running from their wrists to the ceiling above. The resemblance to puppets might be unintentional but none the less inescapable.

Any "hang-up" to do with puppets could conceivably be overcome by wearing magnetic wrist bands, which would be repelled upwards by an adjustable magnetic field below the table. The field might even be modulated at a low frequency to provide a degree of massage!

That would certainly get rid of the puppet cords but what an opportunity for office wags to produce chaos by reversing the polarity of the repulsion field. Just think of all those public servants with their fingers glued to their work!

But, seriously, Winston Muscio's idea about the support provided by typewriter "home" keys makes at least as much sense as my own observations about long periods of concentration and immobility.

As a lifelong "hunt and peck" typist, however, I am not in a good position to comment further. I leave that to others.

CD specifications

Winston Muscio's other contention has to do with the performance characteristics of compact discs and again I quote:

Right from the start, the advantages of the compact disc format have been recognised. Apart from improved dynamic range and lower distortion (particularly at high recording levels) the characteristic which had made the most profound impression on listeners has been the complete absence of background noise of any kind. Previously, a silent background could be experienced only for relatively short periods with new LP discs, played on high grade equipment.

Among other performance parameters specified by manufacturers (and included in your reviews of CD players) much is made of the high order of channel separation, the enormous dynamic range possible and the very high signal/noise ratio.

These characteristics are all by-products of the basic system but it does seem that the figures quoted are very much in excess of actual requirements in the real world of sound. Examples are as follow:

***Channel separation:** Of what real value is a channel separation of more than 90dB in the making of a practical stereophonic recording, where the difference in SPL observed at the two inputs derived from any given sound source forming part of the musical program is unlikely to exceed 30 or 40dB? What does the other 50dB or so contribute, unless one is recording a completely different program in each of the two available channels?*

***Dynamic range:** When a recorded musical program is being reproduced, if the maximum SPL is of the order of 100 phons (dBA if you like) and the dynamic range is 70dB, the minimum sound level will be completely lost in the ambient noise level of the listening room. With another 20dB or so of dynamic range possible, just what can it contribute to practical listening?*

Are there many musical scores which call for a dynamic range of more than 60dB? Even in the case of digitally mastered LP discs (not compact discs) your record reviewer complains of excessive dynamic range (EA, June '85, page 114). Do we know what that range actually was?

***Signal/noise ratio:** In most cases, CD players reviewed in EA return a S/N ratio in excess of 90dB (presumably over a bandwidth of nine octaves or more). The average FM broadcast transmitter has a S/N ratio of around 67dB in stereo mode. Yet, with adequate signal strength into a good receiver, absolutely nothing can be heard during the silent passages when, for example, a compact disc is being played over the ABC FM network. In these circumstances, what does the additional 20dB or more contribute?*

(Signed) Winston T. Muscio.

There's a certain irony in the above letter in that, over the years, I have had many conversations with the writer — almost invariably in the context of how best to achieve improved audio fidelity in everything from broadcast programs and recordings to domestic loudspeaker enclosures. He's now suggesting that, with compact discs, we've overshot accepted requirements by a considerable margin!

At first glance, we may appear to have done so, but I'm inclined to believe that, based on current understanding and current expectations, any such margin is "comfortable" rather than "considerable". Let's look again at those same three headings:

Channel separation: Winston Muscio suggests that the difference in SPL (sound pressure levels) produced by a given sound source at the respective L/R (left/right) inputs of a stereo recording system is unlikely to exceed 30 to 40dB. But have a care: that must not be interpreted as a measure of permissible crosstalk.

... with compact discs, we've overshot accepted requirements ...

If an initial 30-40dB difference in SPL is not to be unduly prejudiced, the overall record/replay system must itself exhibit a substantially higher order of left/right channel separation — certainly not less than 60dB and, as such, considerably more than is available from a normal phono system.

However, the above figures relate only to relative L/R signal amplitude, as measured, without any consideration of inter-channel phase relationships. To be sure, phase is a random quantity, particularly in space, but our ears are nevertheless very aware of phase/time differences.

Who really knows, at this stage, where that awareness begins and ends and to what degree it contributes, not just to a perception of acoustic environment — ambience, echo, etc — but to our ability to distinguish individual sound sources?

In short, is an order of channel separation based on a measurement of relative signal amplitude sufficient to ensure freedom from ambiguity in terms of signal phase?

Until we know the answer to that question, it is rather comforting to know that compact discs, at least, offer somewhat greater channel separation than we currently think we need.

Dynamic range: I couldn't agree more that there is a practical limit to the dynamic range that can be tolerated in a domestic listening situation but I would need to qualify that statement in several ways.

In the first place, the dynamic "window" in a record/replay system really needs to be wide enough to accommodate unexpected extremes in the original performance and, as well, provide some latitude for subsequent processing.

The much improved quality of the latest generation of "black" discs is due, in large measure, to a much wider dynamic window in the pre-vinyl stages and the consequent reduction in the number of recordings released on a "that'll have to do" basis.

Whether or not we settle on 60dB or any other like figure as a reasonable limit for domestic listening, the availability of a generous dynamic window is a valuable asset in keeping well clear of marginal noise at low signal levels or marginal overload at high levels.

The second point I would make is that dynamic range is not simply the difference between what is subjectively very loud and subjectively barely audible. There's more to it than that, as will become evident from watching closely the indications of a peak-hold fluorescent bargraph indicator on a modern amplifier.

With a concert organ, what are subjectively very loud passages may push an amplifier to say, half full output. Yet an acoustic guitar or other percussive instrument may flick the output to maximum on peaks, without necessarily sounding very loud at all!

In such a case, the wide dynamic window is serving, not to produce a subjectively loud signal, but one that has startling "attack" because transients are not being clipped or crushed on the way through.

Transients like that would not normally survive on analog tape and, even now, may not make it through an FM transmitter but it's nice to know that they are intact and available on a fully digital compact disc played at home — thanks to the extra dynamic headroom.

There's one other point worth thinking about. Winston Muscio suggests that, at an SPL of 30dB, signals would be completely lost in the ambience of the listening room. I wonder!

In the debate about the S/N ratio in analog and digital tape recordings, repeated claims have been made that coherent signals can still be discerned subjectively when they are as much as

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FORUM — cont.

15dB below the noise floor. If this is also true of room ambient noise, the range of discernable (as distinct from comfortable) signal levels for home listening would be significantly greater than commonly allowed for.

Signal to noise ratio: Much of what has been said about dynamic range is relevant to an evaluation of S/N ratio, since the two are interdependent.

However, it may be appropriate to point out that the perception of low level noise is highly subjective and heavily dependent on age. As I have mentioned on other occasions, aural sensitivity, especially at the higher frequencies, diminishes steadily with the passing years, rendering all of us progressively less sensitive to background hiss.

It's probably reasonable to suggest that S/N ratio has achieved a logical limit when, during pauses in the audio signal, a system sounds "absolutely silent" to young ears — this on the further assumption that the peak level has been preset to a generous but not unreasonable figure for the particular listening area.

Whether or not that condition is met for everyone by an FM transmission as specified (S/N ratio = 67dB) is something else for you to argue about.

Thanks, Winston, for "stirring the pot", although I have just remembered that Professor E. M. Cherry did something similar at the Melbourne AES Convention (Feb '85 issue, p100) when he suggested that the CD format "could have been relaxed considerably with little loss of audible quality".

Learning Morse Code the easy(?) way!

Dear Neville,

After seeing your "Forum" article in EA for April '85, I came across a par in the February issue of QST magazine on the subject of subliminal learning. It reads as follows:

"Vince Luciani, K2VJ, is offering a different approach to learning Morse Code: subconscious or subliminal learning.

"Said to be prepared by experts in the field of subliminal learning, Subliminal Code Learning is aimed at those who have difficulty initially learning the code or attempting to increase their recognition speed.

"On one side of the tape, Author Luciani announces the entire code alphabet, complete with the dots and dashes for each letter. But you won't hear any of it. Instead, you hear relaxing music. The code is presented subliminally for only your sub-conscious mind to hear and learn.

"The other side of the tape contains vital affirmations that are meant to help you appreciate the code as fun, and learning it as a pleasure.

"The tape is available from Vince Luciani, K2VJ, PO Box 682, Cologne, NJ 08213, USA. The price (in USA) is $10.95 plus $1.50 for shipping and handling. A money back guarantee is offered."

In view of your comments in the April issue, I thought that you would be interested to learn that this product is on the commercial market in the USA.

Keith Griffin (VK410)

Subliminal cassettes

The accompanying letter from Keith Griffin is self-explanatory but sheds no further light on this puzzling subject. People talk about subliminal tapes and, as here, offer them for sale but we wait in vain for someone to come forward with an explanation of how signals that supposedly defy detection by sensitive instruments can be sufficiently accessible and lucid to register on the sub-conscious mind.

Could it be that whatever is added to the tapes isn't perceived either? That all we hear is natural sound or relaxing music? That the real effect is to so relax and condition the sub-conscious that we concentrate on and reinforce what is stored there already? That we react in the way we want to react?

Someone might say that, if a cassette helps to make one fluent in Morse Code, it's worth every cent of the price. Maybe it is but there's still something aggravating about getting the right result for what you suspect is the wrong reason!

by BRYAN MAHER

OP AMPS Explained

PART 18

In this, the last episode of our series on operational amplifiers, we look briefly at methods of generating voltage waveforms or filtering given waveforms to obtain the desired waveshape.

A variety of waveforms are shown in Fig. 1 where an attempt has been made to put all possible shapes into seven classes, as explained in the caption. We say of waveforms, A, B, C and D that no derivative exists at those sharp corners because the rate-of-change or derivative dV/dt there would be larger than any value you care to nominate, at least for the ideal waveshape. For real signals generated by electronic circuits, there actually is a derivative, of extremely high value.

A large number of circuits have been designed and used to generate the square waves of Fig. 1(a), one being shown in Fig. 2. Here the ICs are not acting as operational amplifiers because the positive feedback pushes each amplifier into saturation. For high frequency applications, crystal control is possible.

Low frequency square wave generators are much more useful than they might appear at first thought, if they are followed by other linear circuits. The result of driving a linear integrator with a square wave, for instance, produces a staircase waveform. For this idea to be successful, the squarewave must have very short rise and fall times and also must fall accurately to zero. Additional circuitry must be added to the integrator to discharge it to zero at the end of each staircase cycle or, alternatively, to arrange reversal of the squarewave polarity to cause the staircase to step back down again.

The integrator should have a very small input resistor R_i and a large capacitor so that each step will rise quickly then hold level till the next step. Clearly this is an "additive sample-and-hold" action.

Sloping waveforms

Oscilloscopes, computer display screens and television are perhaps the most common application of the sawtooth and triangle waveforms depicted in Fig. 1(b) and Fig. 1(c) respectively. Generation of an accurate triangle waveform can be achieved using the circuit of Fig. 3. The two quadrature voltage outputs at points A and D are shown in Fig. 4. Operation of the circuit is explained in the captions and, with the values shown, the generated frequency is 300Hz. If very stable supply rails are used (see last month's episode on voltage regulators), and high gain ICs and high stability resistors are chosen, the frequency and slope will be very constant.

Other attractive properties are that the linearity of the slopes can be excellent (linearity error < 0.01%) and the fact that the period is directly proportional to the value of R2.

Now to generate a sawtooth, as in Fig. 1(b), all you need to do is add a low leakage silicon diode in parallel with the leftmost R2. This works best with high value R2; ie, long periods. The diode simply shuts off on one polarity, allowing the slow rise, then switches itself on for the other polarity, forcing fast discharge

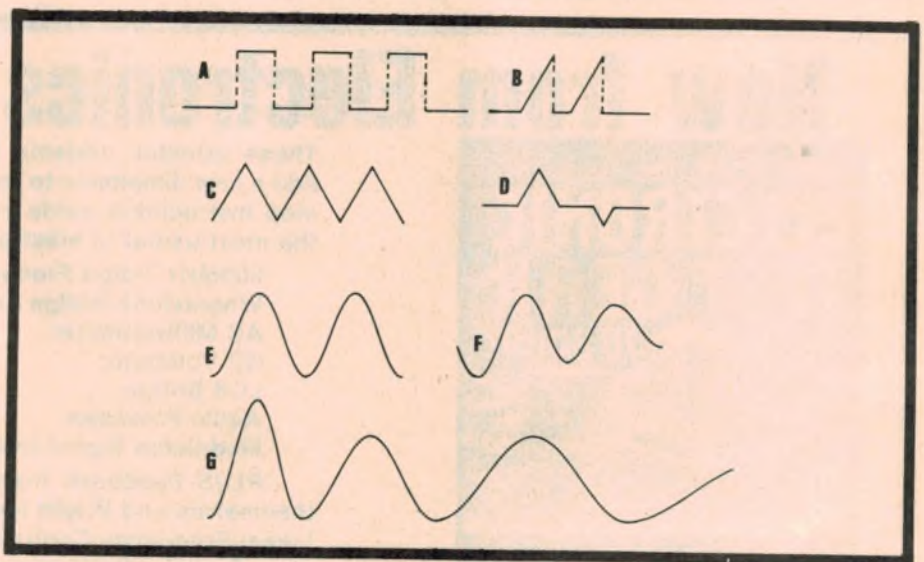

Fig. 1. This attempts to classify all possible voltage waveforms. Square waveform A consists of only constant voltage values with abrupt changes at points where (almost) no derivative exists. Type B is similar with the addition of straight line slopes. At C we see only straight line slopes together with sharp corners where no derivative exists. Type D is more or less a mixture of the previous three. E, the pure sine wave, has constant frequency, period and maximum voltage values; contains no harmonics. Waveform F has constant fundamental frequency and period but varying voltage amplitude; it therefore contains harmonics and sounds more interesting. Type G is all smooth as are E and F, but as well as changing maximum voltage amplitude also has varying fundamental frequency and period which makes it sound quite different to F.

of C1 and hence the fast drop. Of course a relay or a FET switch can be used instead of the diode. For very long periods (even hours) you must use low leakage C1 and Q1 needs to be a high quality FET input IC like the AD545 or LH0052.

Strange waveforms

Strange voltage waveforms like Fig. 1(d) are sought by workers wanting to calibrate circuits such as level or window discriminators. Fig. 5 shows a successful method which has been used to generate six varieties, two of which are shown. The figure captions tell the story. Incidentally, your author hasn't flipped his lid drawing that figure with it's "divide by 1.5" stage; it's just a multiply by 2 followed by a divide by 3.

The output of zero crossing detector No. 2 is high whenever the triangle Fig. 5(b) is positive, and low when the triangle is negative. Both upwards and downwards level changes are used to clock the divider, thus the divider input is effectively double the input frequency. The rest of the digital divider is a standard divide-by-3 circuit with square wave, Fig. 5(c), output to the FET switch. Operating in synchronism with the triangle, the FET switch simply turns the triangle on sometimes and off sometimes to give V(out) as shown in Fig. 5(d).

Alternatively, if we divide by 2.5, we have the switching waveform Fig. 5(e) turning the FET switch on for a greater part of the time, resulting in output as shown in Fig. 5(f).

By designing the divider to divide by any number you like, you can produce all sorts of wonderful waveforms V(out), all derived from the one original full triangle Fig. 5(b).

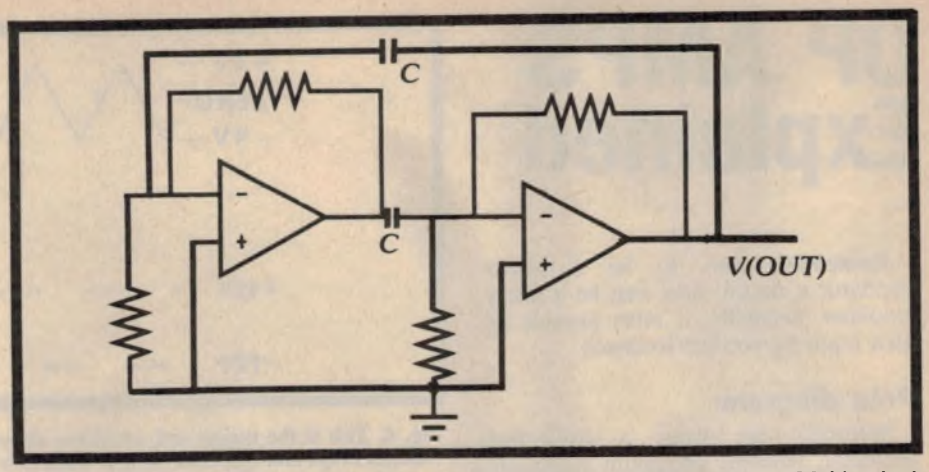

Fig. 2. One of the many possible methods for the generation of square waves. Making both capacitors C equal, the period and frequency are decided by a complex function of C and a combination of the Rs and the threshold voltage of the intergrated amplifiers used. It can be built using almost any inverting ICs, from TTL type 7400 to linear amplifiers (operating here in a non-linear mode).

Sinewave generation

Hundreds of different circuits have been designed to generate a voltage waveform exactly proportional to the trigonometrical sine function. Most high quality low frequency methods are variations on a fundamental theme shown in block diagram Fig. 6(a). The success of your design can be gauged by measuring the harmonic content of the voltage signal generated.

Recall our previous discussions on feedback theory (part 2, April 1984 and part 14, May 1985). We reduced all linear feedback amplifiers to one equation called the transfer function:

$$T = G/(1 + GH)$$

where T is the closed loop gain, G the open loop gain, H the feedback gain, with all "gains" being complex functions of frequency.

Also we discussed circuit stability in terms of the circuit poles, which are the complex roots of the denominator polynomial (1 + GH) in the equation above.

For amplifiers with an input and an output, we desire the system to be stable, under control and definitely NOT oscillating. However, now our wish is to build an oscillator, a free-running circuit requiring no external input. So we use positive feedback by which the output will feed back to the input a signal exactly in phase, to be amplified and passed around the loop again. As phase delays cannot be avoided, we deliberately contrive the loop to have exactly 360° delay, which has the same effect as no delay, giving reinforcement at each pass around the closed loop.

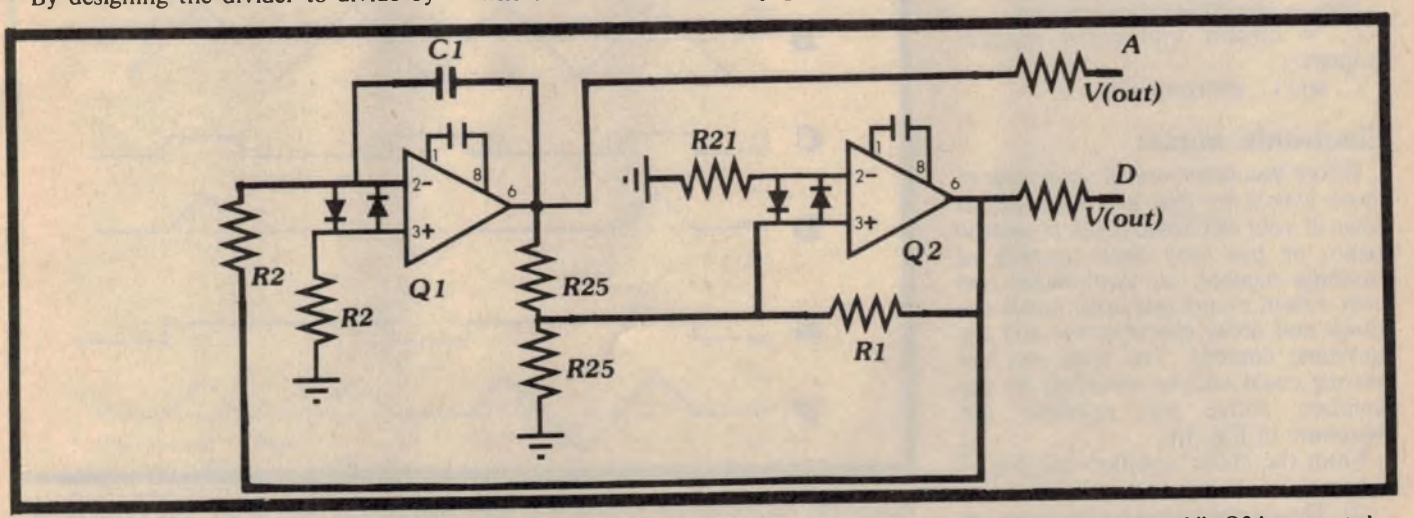

Fig. 3. The circuit for an oscillator to generate accurate triangle waveforms. Q1 operates as a linear operational integrator, while Q2 is connected as a non-linear Schmitt trigger or "zero crossing detector". The closed loop consists of Q1, R25, Q2, and R2. R1 provides a little positive feedback to Q2 to ensure sharp crossovers, R2C1 is the integrator time constant.
If we choose C1 = 0.047μF, R2 = 53kΩ, R25 = 50kΩ, R1 = 125kΩ and R21 = 20kΩ, and operate the circuit on $\pm$ 12V rails, V(out) at A will be a triangle of $\pm$4 volts with period 3.3ms, frequency 300Hz, while auxiliary output at D will be a quadrature square wave $\pm$12V, with the same period.

OP AMPS Explained

Remember that to be a linear oscillator a circuit must first be a linear amplifier. Secondly, it must provide its own input by positive feedback.

Pole diagram

Naturally we want a controlled oscillator, wherein maximum amplitude remains a constant. As previously, we consider the pole diagram, that plot of the positions of the poles in the complex plane. Fig. 7 shows all possibilities, according to the gain and losses and feedback angle.

In Fig. 7(a), the overdamped case, and (b), the critically damped case, the losses are too high for the circuit to ever oscillate. The output voltage is absolutely dominated by an exponential decay term. The circuit cannot oscillate because the poles are all real.

In (c), with less losses or more gain, the circuit will oscillate for a while when excited, generating a waveform as Fig. 1(f) which is called a damped sine or cosine waveform. Here the circuit can oscillate (at least for a while) because the poles are complex. The output voltage has the rather frightening damped equation:

$V(out) = V(max)(exp(-t/2T))(C_1 Cos(At) + C_3 Sin(At))$ . . .(1)

where $A = Sqrt((2Pi\ f_o)^2 - (1/2T)^2)$

A is the damped angular frequency

T = circuit time constant

Exp = the exponential function

Sqrt = the square root function

f_o = circuit undamped natural frequency

C_1 and C_3 are constants

Electronic music

Before you come out of your state of shock caused by that last equation, sit down at your electronic organ or electric piano, or just play some records of anything modern, ie, synthesisers and such. Listen to any one note, notice the attack and decay characteristic and the harmonic content. The note you are hearing could well be described by the equation above and resemble the waveform of Fig. 1(f).

From the above equation and Fig. 7 we see that:

(1) The damped angular frequency A is lower than the undamped natural frequency ($2Pi\ f_o$).

(2) More damping makes A lower still.

(3) But A and f_o are at least constants for any one circuit.

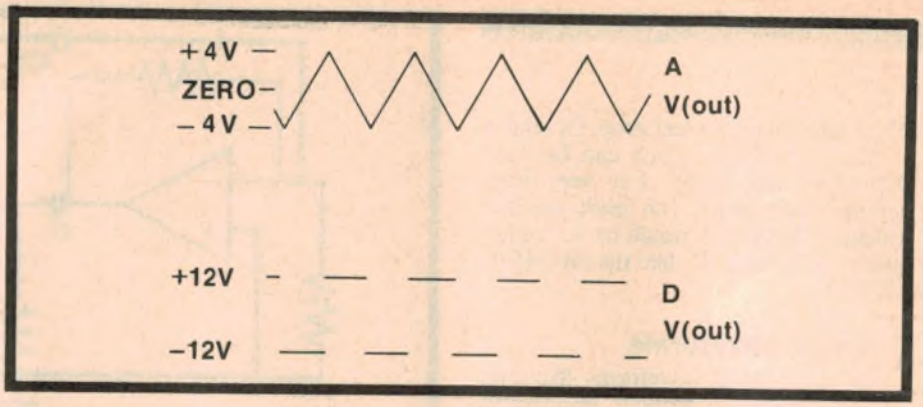

Fig. 4. This is the timing and waveform diagram for the circuit of Fig. 3, showing the output voltages of Q1 and Q2. Observe that when D is high A is sloping downwards. Also when D is low A is sloping upwards. These phase relationships follow from the fact that integrator Q1 is inverting, and the slope (not the level) of Q1 output is controlled by the level of Q2 output. Because D and A change a quarter of a cycle apart (in time) the two outputs are said to be "in quadrature".

(4) Oscillations are possible because the poles are complex.

(5) Oscillations are damped because the poles' real part is negative.

Raising the gain or reducing the losses of the circuit would bring the poles closer to the imaginary axis (the vertical axis in Fig. 7). If we are clever enough to arrange exactly enough gain to just offset the circuit losses, the poles will be on the imaginary axis, as in Fig. 7(d), ie, the poles' real part is zero.

This corresponds to a circuit effectively undamped, hence it has infinite Q, and is a perfect sinewave generator. The A term in equation (1) reverts to the simpler undamped form:

$A = 2Pi\ f_o$

$V(out) = C_1 Cos(2Pi\ f_o) + C_3 Sin(2Pi\ f_o)$ . . . (2)

"Enough of these equations" you are thinking, "let's have some circuits".

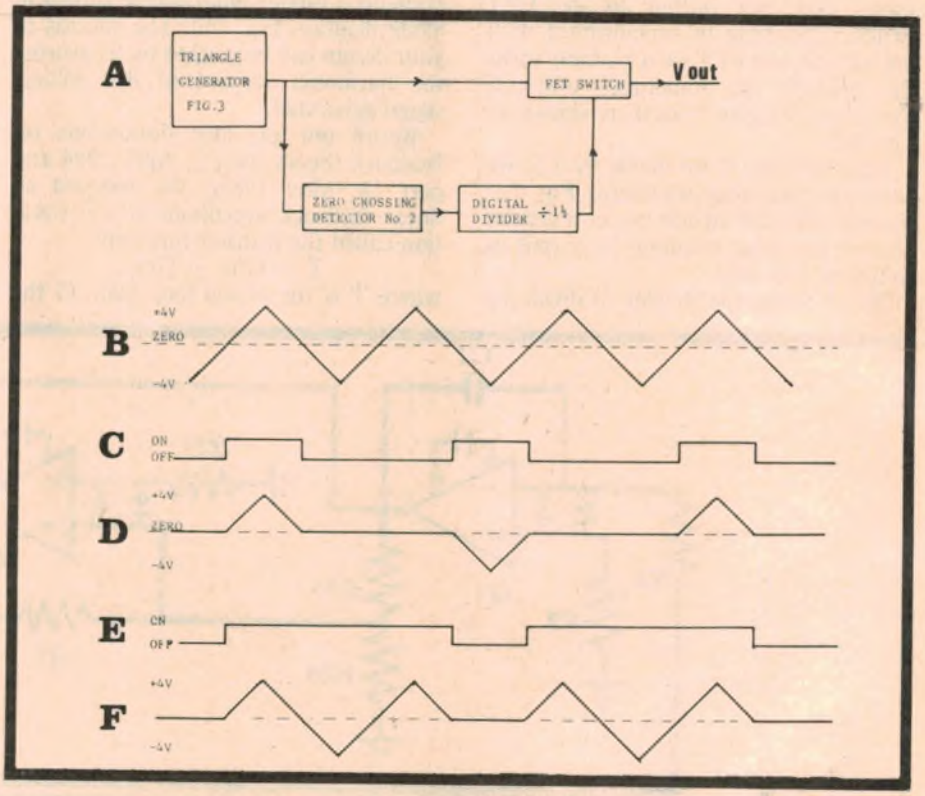

Fig. 5. The method for the generation of waveforms such as those of Fig. 1(d). Using the free-running triangle generator of Fig. 3, a second zero-crossing detector, a strange digital divider and a FET switch, many different looking waveshapes can be derived. A shows the block diagram common to all versions except for variations in the digital divider. B is the triangle waveform from the generator of Fig. 3. C shows the switching waveform from the "divide by 1.5" stage, and D shows the resulting V(out). Simply by changing the division ratio to 2.5, we can produce a V(out) as shown at F.

A great many sinewave oscillator circuits have been devised, with well-known types such as Colpitts, Wein Bridge, Pierce, Miller and phase shift. An implementation of the latter, shown in Fig. 6(b), is clearly following the fundamental theme of Fig. 6(a). The circuit consists simply of an op amp with DC gain given as usual by $(-R_f/R_i)$ and a separate AC coupled feedback path of three RC circuits.

As each RC loads the preceding RC, it is not simply three time constants, but nevertheless those three RC networks can produce more than 180° phase shift at some frequencies and less at other frequencies. But at one and only one frequency f_o, the phase shift is exactly 180°. Therefore at frequency f_o, as the op amp is inverting, the complete phase shift around the circuit is 360° and by our previous explanation, the circuit oscillates at this frequency f_o.

For a variety let us look at a second, different approach, perhaps a type you have not seen. A little more mathematics will introduce a fascinating idea. Perhaps you have wondered "just why is the sinewave the only one containing no harmonics?"

Looking for some unique property, we observe that Sin (or Cos) is the only repetitive waveform whose derivative (rate of change) function is the same shape as itself, but shifted.

From school or somewhere we remember the little rhyme: "The derivative of Sine is Cos. The derivative of Cos is minus Sine." If we write:

$y = \text{Sin}(wt)$

where $w = (2\text{Pi } f)$, f = frequency, and t = time then the derivative may be written as either dy/dt or Dy and the second derivative (the derivative of the derivative) as d^2y/dt^2 or D^2y.

Using the Dy notation:

$y = \text{Sin}(wt)$

$Dy = w\text{Cos}(wt)$

$D^2y = D(w\text{Cos}(wt)) = (-w^2)(\text{Sin}(wt))$

Looking at the first and last of those three lines:

$D^2y = -w^2y \ldots (3)$

or

$D^2y + w^2y = 0 \ldots (4)$

and if we make $w = 1$ then

$D^2y = -y \ldots (5)$

$D^2y + y = 0 \ldots (6)$

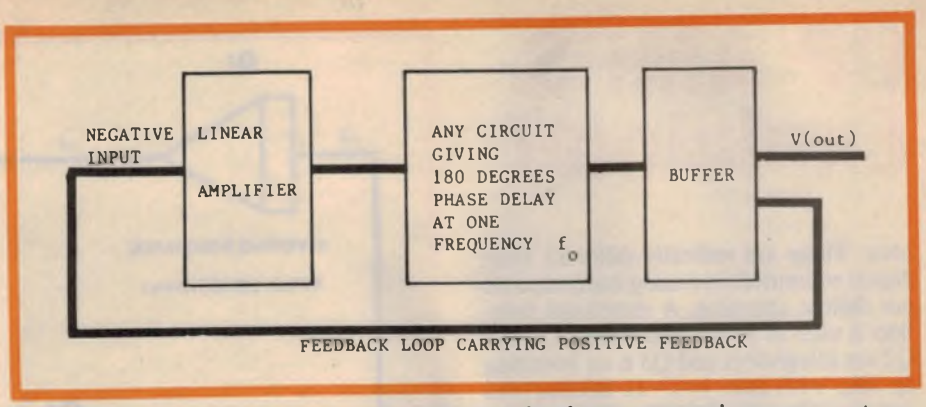

Fig. 6(a). The general block diagram followed by most low frequency pure sinewave generators or oscillators. The "purity" of the sinewave, ie, how accurately it approximates the trigonometric sine functiuon, depends on the linearity of the amplifier, the phase delay circuit and the buffer. V(out) could alternatively be taken from the amplifier and the buffer may be inherent in the high input impedance of the amplifier.

Because the feedback is rotated 180° in the phase-delay section, then applied to the amplifier negative input, the total phase rotation within the whole circuit is 360°. Hence the feedback is in fact positive.

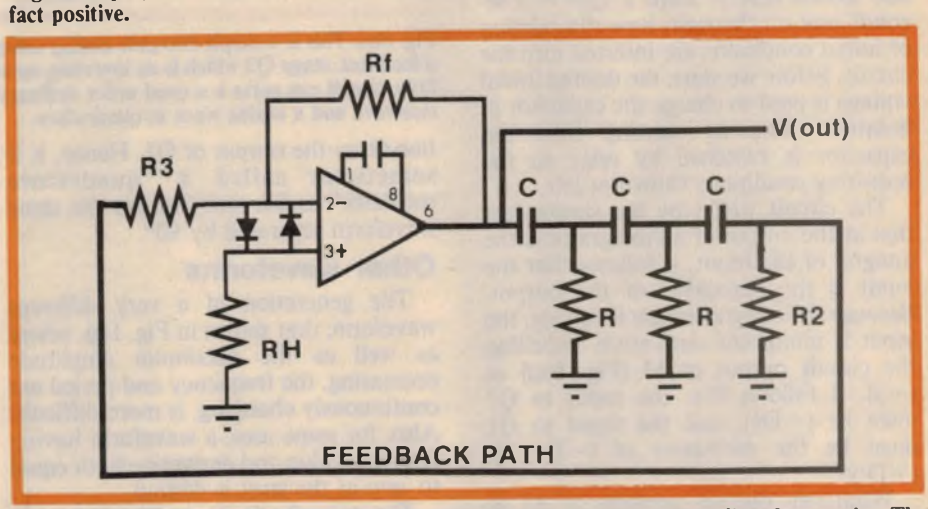

Fig.6(b). The phase shift type oscillator is simple and popular for low to medium frequencies. The output frequency is $f_o = 1/(2\text{Pi}\sqrt{6}\,CR)$ Hz where R3R2/(R3 + R2) = R, C is farads and R is in ohms. Also Ri = R + (combination output impedance of the phase shift network C,C,C,R,R,R2). The forward gain = (−Rf/Ri) and the forward loss is the attenuation loss at frequency f of the phase shift network. For oscillations to occur, we need Forward Gain = Forward Loss.

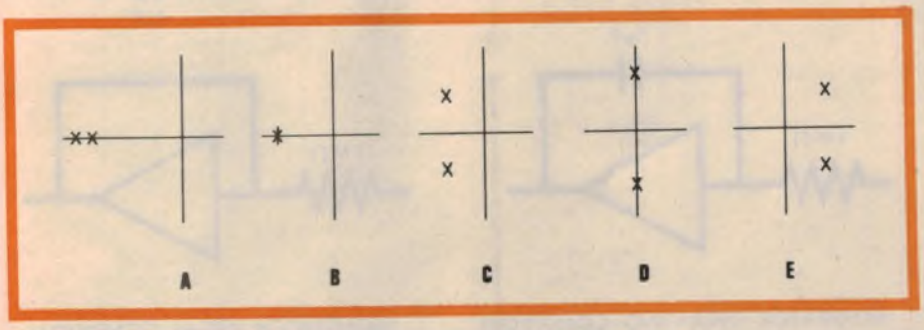

Fig. 7. Partial pole diagrams for attempts to generate a sinewave voltage using the scheme as in Fig. 6. The poles shown here are the complex roots of the denominator polynomial (1 + GH) of the circuit transfer function. In this figure the horizontal axis is real part and the vertical axis is the imaginary part of complex poles shown as X: at A, circuit is overdamped, not oscillatory; B is critically damped, not oscillatory; C is underdamped, and a damped sinewave is generated as in Fig. 1(f); D is undamped, Q = infinity, and a perfect sinewave is generated; and E is unstable, Q = infinity, and the sinewave envelope grows until the circuit saturates at rail.

These equations contain derivatives, so they are called "differential equations", and thousands of them are known. Some are easy to solve, some are not. One solution method consists of making an electronic circuit which mimics the mathematical equation so that the circuit will act as an oscillator generating a voltage proportional to the mathematical solution to that equation. As one equation can have multiple solutions, we must give the circuit "initial conditions", which means that we insert appropriate voltages at the start to cause the particular solution we desire.

Analog computers

Circuits which compute solutions to differential equations in this way are known as "Analog Computers", and can be anything from a couple of integrated circuits and a battery to an impressive array of hundreds of amplifiers, integrators, other circuits and power sup-

OP AMPS Explained

plies. These are radically different from digital computers as analog computers do not digitise anything. A shorthand notation is used as in Fig. 8(a) where Q1 and Q2 are integrators and Q3 is an inverting op amp with gain = (−1). Because the equation is second order, (the highest derivative is the second) the circuit has two integrators.

More detail of Q1 and Q2 is shown in Fig. 8(b), depicting at left an ordinary operational integrator of time constant one second (CR = 1MΩ x 1μF = 1 second), and on the right how the starting or initial conditions are inserted into the circuit. Before we start, the desired initial voltage is used to charge the capacitor in isolation, then at starting time the capacitor is switched by relay to the operating conditions shown at left.

The circuit works by the simple fact that as the output of an integrator is the integral of the input, it follows that the input is the derivative of the output. Because the integrators are inverting, the input is minus the derivative. Labelling the circuit output at M [Fig. 8(a)] as (+y), it follows that the input to Q2 must be (−Dy), and the input to Q1 must be the derivative of (−Dy) or (+D²y).

Whatever output appears at M is simply inverted by Q3, so Q3 output is (−y). Now equation (5) says that the property

$D^2y = (-y)$

characterises the sine wave. We make the circuit have such a property just by forcing the voltages proportional to D²y and (−y) to be equal. How do you do that? Easy, just join them with a piece of wire! So the output of Q3 is simply connected to the input of Q1.

The circuit output function (+y) has no choice now, it must be one of the possible solutions to equation (5). The possible solutions are any linear combination of sine and cosine functions, no other. To choose y = sine you must start with the initial conditions shown in Fig. 8(a): Q1 charged to 1V and Q2 to zero.

Fig. 8(c), drawn by the computer on an XY chart recorder, shows three possible outputs from the circuit, all with angular frequency:

w = (2Pi f) = Sqrt(2.0)
= 1.4142 radians per second
= 0.225Hz.

As a sinewave oscillator, producing y = sine, this circuit is suitable for low frequencies. As a bonus it can also simultaneously produce the cosine function from the output of Q1. Hence, it is sometimes called a "quadrature oscillator" as Sin and Cos are the same waveform separated by 90°.

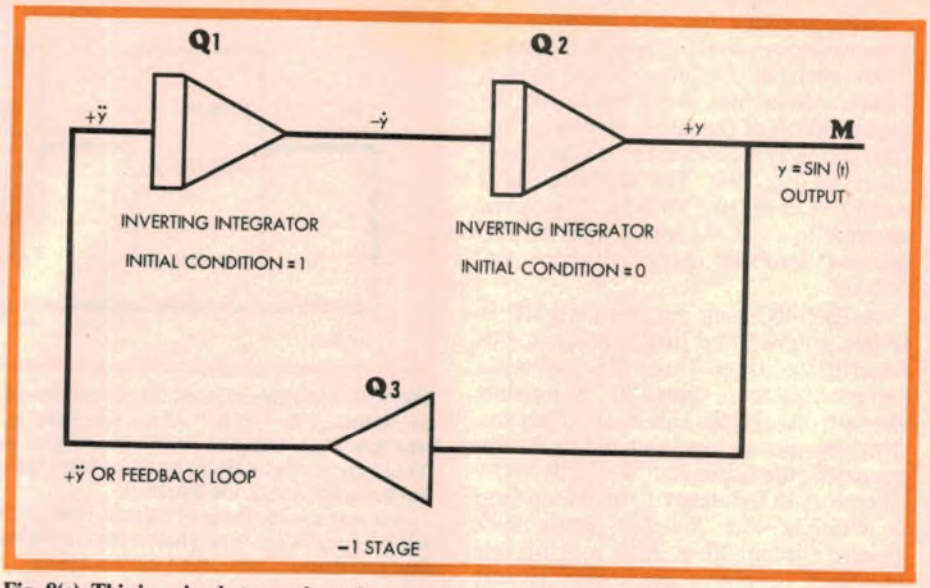

Fig. 8(a). This is a simple two-pole analog computer consisting of two integrators Q1 and Q2, and a feedback stage Q3 which is an inverting op amp with gain = (−1). As explained in the text this little circuit can solve a second order ordinary differential equation, and in so doing generates a sinewave and a cosine wave in quadrature.

Other waveforms

The generation of a very different waveform, that shown in Fig. 1(g), where as well as the maximum amplitude decreasing, the frequency and period are continuously changing, is more difficult. Also, for some uses, a waveform having function value and derivative both equal to zero at the start is desired.

The example shown in Fig. 9, known as "$J_2(t)$, the Bessel Function of Order Two of the First Kind", has such properties. The figure was drawn by the computer on an XY chart recorder using a circuit also of two integrators, but with a considerably different arrangement of feedback paths as the circuit is now required to solve a very different differential equation.

Filters

In a great many instances our radio receiver or record player pickup is actually generating the signal for us, but the waveform produced may not be to our liking. Maybe the output of the radio is the wanted voice signal badly distorted by noise, or the output from the record player is deficient in bass.

These are situations where filter circuits can be used to change the signal to the desired form.

For the radio, we need a circuit which

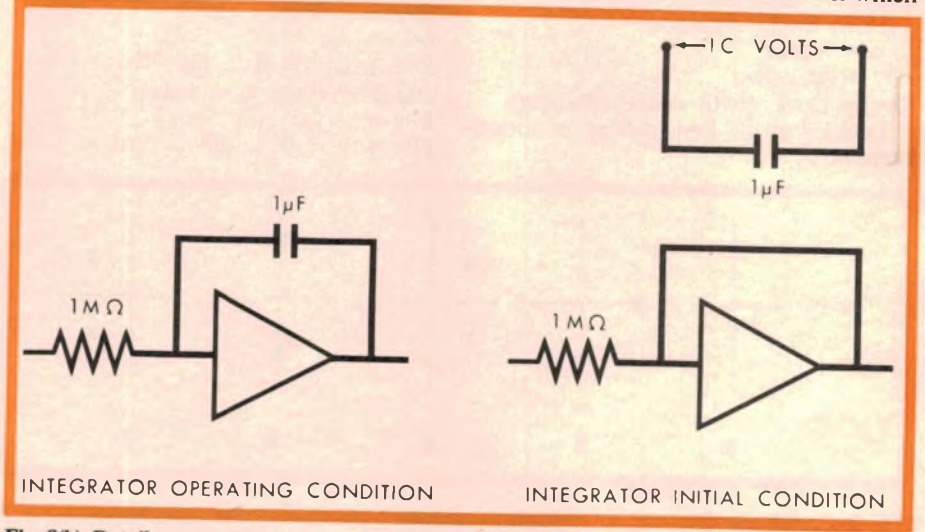

Fig. 8(b). Details of the integrators Q1 and Q2 of Fig. 8(a). The initial condition is inserted into the circuit by first removing the capacitor from the circuit, charging it to the required potential from an external source and then re-inserting the charged capacitor into the integrator at the exact starting time. This is assumed for all integrators in the analog computer and is indicated by the triangle-rectangle symbol used for Q1 and Q2 in Fig. 8(a). Any usable voltage charge, including zero, may be used as the differential equation and the desired output demands.

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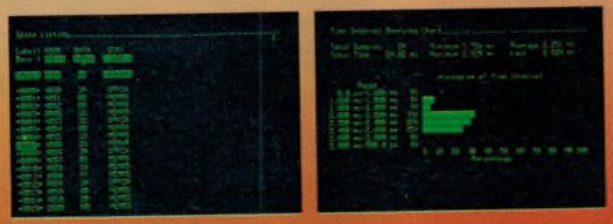

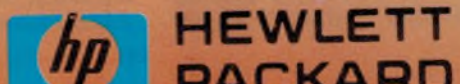

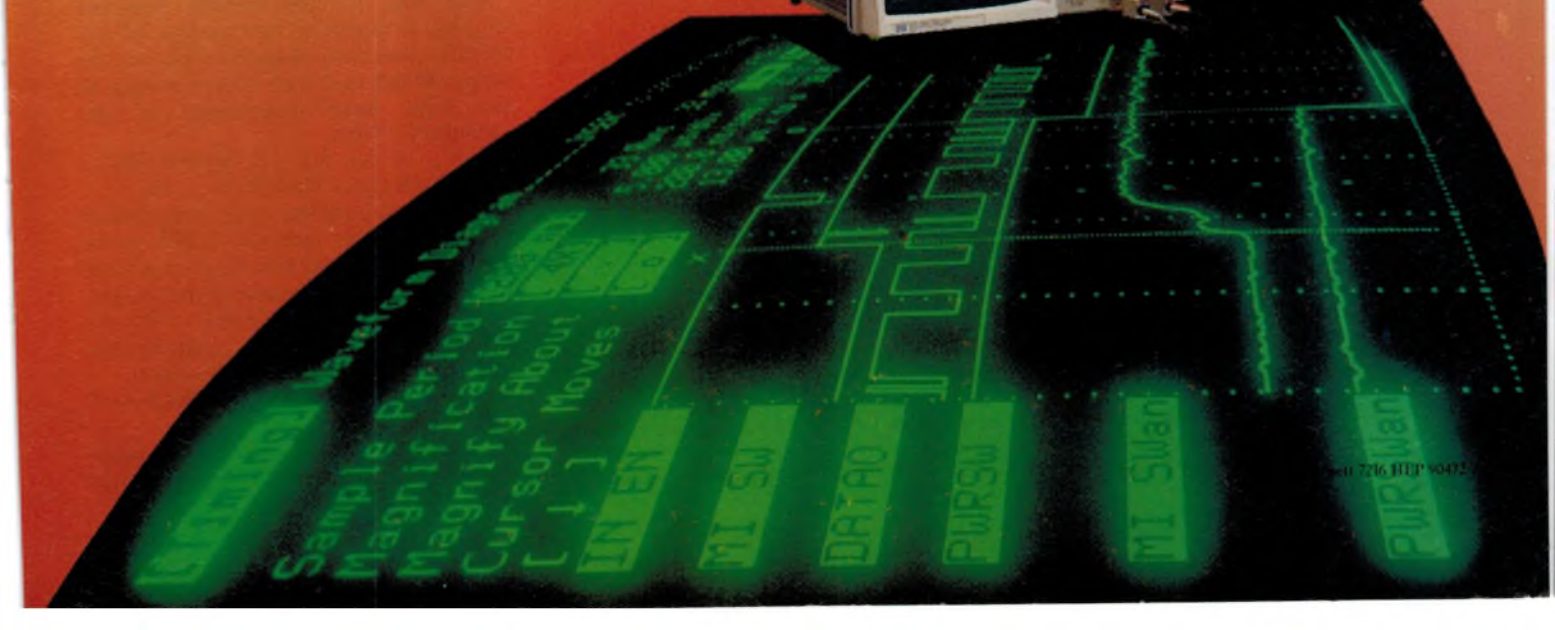

OP AMPS Explained

will pass the wanted lower speech frequencies but stop the unwanted higher noise frequencies. For the record player we need a circuit having more gain at low frequencies than at high.

In some cases, we do not generate the waveform we want but rather find it easier to generate some other waveform, then use filters to change it to the desired waveshape.

Filters come in a myriad of types, but many are based on the two fundamental circuits shown in Fig. 10. These are passive circuits. The upper is called "Low Pass" because it has a unity transfer function at DC but attenuates (reduces) the signal at higher frequencies. The lower part of the figure shows a "High Pass Attenuator" which passes nothing at DC, passes a little at low frequencies, and passes 50% of the input at very high frequencies (if R = R1). They are called "passive" because no gain or power supplies are used. They are also called "linear" because only linear components (resistors, capacitors or air-cored inductors) are employed.

Passive filter sections may be cascaded to form "ladder" type circuits whose analysis is complicated because each section is loaded by the following one. A more popular alternative is to follow a passive section by a small amplifying stage. The gain may be unity or higher and the amplifier's high input impedance and low output impedance is used to isolate (buffer) the filter section from following circuitry.

Fig. 11 shows the idea where a non-inverting amplifier, with gain of 100 (or 40dB) follows a single series-resistor-shunt-capacitor filter. Having gain, it is called an "Active Filter".

Active filters

The response is shown in Fig. 12, starting at +40dB at very low frequencies, but eventually dropping off towards zero at high frequencies. While it is called "Low Pass", it's bandwidth must be defined by some convention as you cannot nominate any actual point where the response curve starts to fall.

With logarithmic response and frequency axes as shown, we use the Butterworth definition and call the bandwidth the distance on the frequency axis from DC to the frequency at which the amplitude response has fallen 3dB below its DC value. In Fig. 12, as we start with 40dB gain, this −3dB point occurs wherever the gain is down to 37dB, and this point is called f_c Hz or w_c radians per second. Because there are 2Pi radians in one circle or cycle, $w_c = 2Pi\ f_c$.

Of course, w_c and f_c denote the same frequency, and the same point of the figure, but with different units f_c is referred to as the "corner frequency".

The slope of this simple response curve is −6dB per octave or −20dB per decade of frequency, when well past the −3dB point. This looks quite good on log scales, but if we redraw Fig. 12 using a linear frequency scale, the curve is very gradual. Remembering that a drop of 6dB in volume is not markedly noticeable, you will see that this circuit is not marvellously successful.

Clearly, we need more slope on that response curve. One possible method is just to do it all again, as in Fig. 13, and this is sometimes done, but could be considered wasteful in components, dollars and labour. In most cases we can do better, but that will involve a little mathematics.

Recall our earlier analysis of op amp circuits (parts 1, 3 and 14 in March 1984, April 1984 and May 1985) wherein we used G to denote the gain of any circuit section, noting that G is more than a number. Because of the time constants of every circuit, including filters, G is always a complex function of frequency.

Mathematical assumptions

We always assume that the op amps used in active filters will be chosen such that their open loop gain is very much higher than the required filter gain; that the op amp bandwidth is much higher than the filter bandwidth f_c; that the integrated circuit input impedance is much higher than remaining circuit impedances; and that IC input currents are negligibly small. Should we find such conditions not satisfied, we must take them into account in the design.

Having said that, in Fig. 11 the only important time constant will be that caused by the filter, the series resistor R1 and shunt capacitor C1 at the LHS of the diagram.

Analysis using the complex frequency S gives the Transfer Function, or gain as a function of frequency, thus:

Transfer Function = V_{out}/V_{in}

$= (100)(1/C1R1)/(S + (1/C1R1))$ . . . (7)

The root of the denominator $(S+(1/C1R1))$ of equation (7), which occurs at $S=(-1/C1R1)$, is the Pole of the circuit. As there is only one such root, this circuit is called Single Pole.

For Fig. 13, the transfer function V_{out}/V_{in} is given by the product of the transfer functions of each section as the stages do not load each other (because of the high input impedance of the amplifiers). Thus:

$V_{out}/V_{in} = A1\ A2\ (1/C1R1)(1/C2R2) / (S+(1/C1R1))(S+(1/C2R2))$ . . . (8)

where A1, A2 are the stage gains chosen by the feedback resistors; C1R1 is the time constant of the first filter stage; and C2R2 is the time constant of the second.

If we choose C1 = C2, R1 = R2, A1 = A2 = Ao, and as w_c is an inverse function of time constant, we have:

$V_{out}/V_{in} = (Ao^2C\ w_c^2)/(S^2 + Bw_cS + C\ w_c^2)$ . . . (9)

Where Ao = the DC gain of each stage; $w_c = 2Pi\ f_c$ = the 3dB point frequency of each filter;

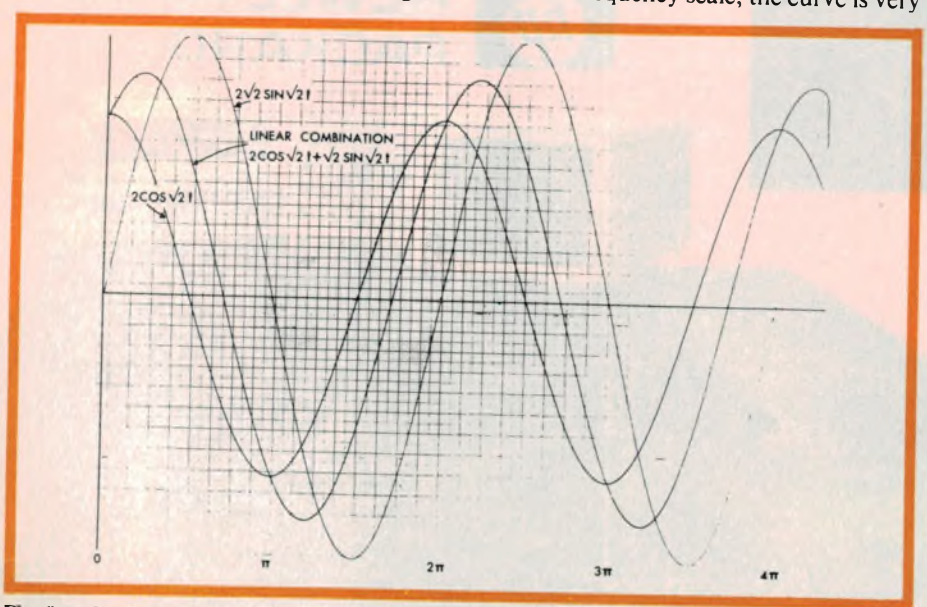

Fig. 8(c). Some of the many outputs possible from the circuit Fig. 8(a). By suitable choice of initial conditions, any one of these can be made to appear at the output point M in Fig. 8(a). Because the differential equation used does have two orthogonal solutions, both the sine and cosine functions can be obtained simultaneously, one from each of Q1 and Q2. This waveform diagram was drawn directly by the circuit on to an X-Y plotter in real time, vertical axis = volts, horizontal axis = seconds.

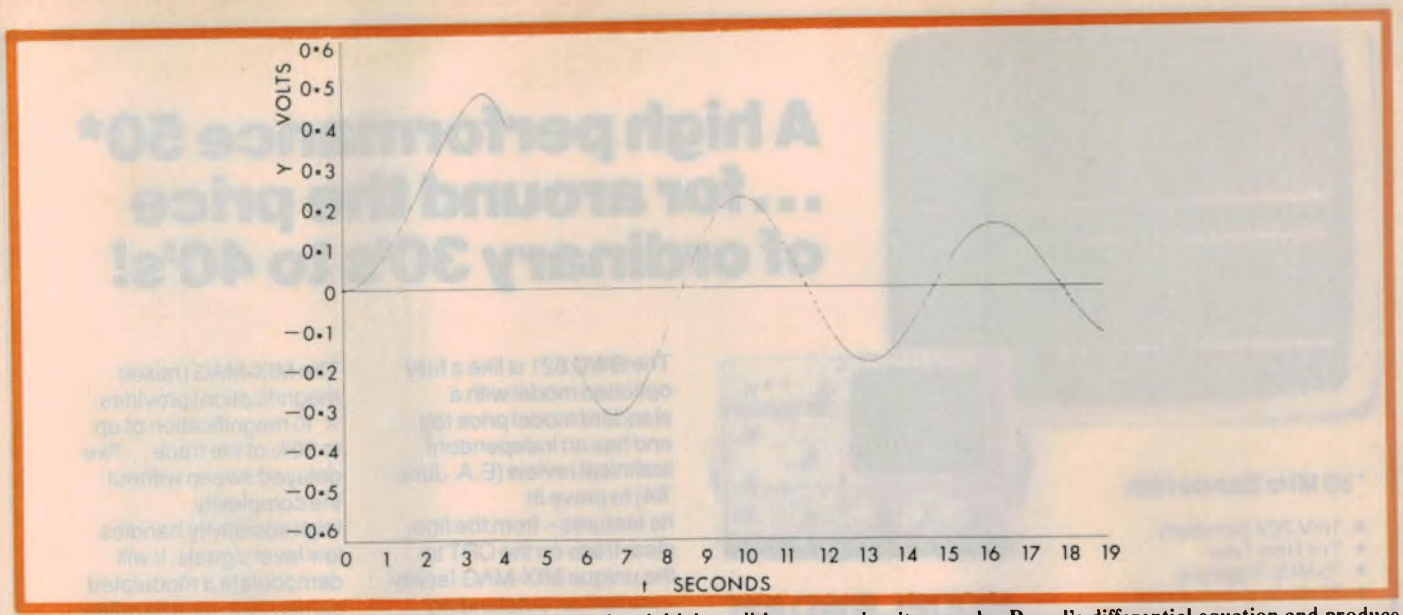

Fig. 9. By adding a few components to Fig. 8(a), and appropriate initial conditions, our circuit can solve Bessel's differential equation and produce an output voltage at M which is proportional to any one of the Bessel functions. The example here is nown as J2 (t), the "Bessel function of order two of the first kind". It is an important example of a voltage waveform depicted in Fig.1(g), as the maximum and RMS amplitude, the frequency and the period are all continuously varying. This picure was drawn by the circuit directly on an X-Y chart recorder. These waveforms are of great interest to students of many topics including frequency modulation and active filters.

S = the complex frequency variable;
B and C are dimensionless constants which must be found.

Notice that the equations are of the form one polynomial over another, the denominator of order 2 or quadratic in S, the numerator "of order zero" ie, just numbers. Because polynomials of order 2 have two roots, this circuit is a two-pole filter.

The slope of the roll-off section of any Butterworth filter is:

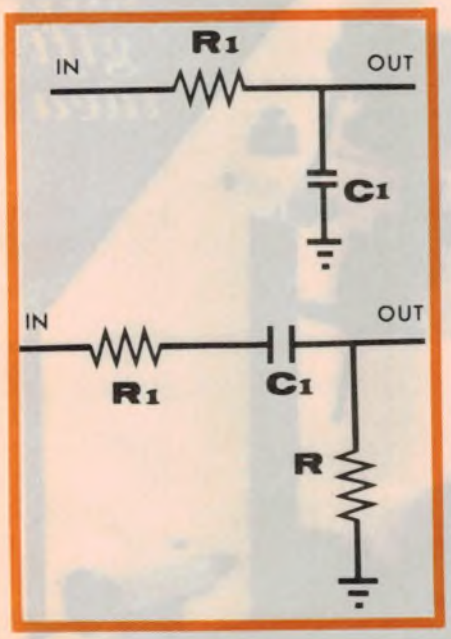

Fig. 10. Two passive filters. The upper circuit is Low Pass which passes zero frequency (DC) with no losses but attenuates higher frequencies. The lower circuit is a High Pass Attenuator which has an output equal to half its input for very high frequencies, and progressively less for lower frequencies.

Butterworth slope = 6N dB per octave = 20N dB per decade where N is the number of poles;
per octave means f,2f,4f,8f etc; and
per decade means f,10f,100f,1000f etc.

So the two pole system Fig. 13 has a slope of −12dB per octave or −40dB per decade.

Second order MFB filter

Fig. 14(a) shows a circuit known as a Multiple Feedback Low Pass filter as it has more than one feedback path. It is a true second order circuit capable of inverting gain $(-R_f/R_i)$ and can be implemented a number of ways by various choices of the component values. It can be shown by analysis that its transfer function V_{out}/V_{in} is given by:

$$V_{out}/V_{in} = (-R_f/R_i)(C\ w_c^2) / (S^2 + Bw_cS + Cw_c^2) \ldots (10)$$

The values for B and C are different from those used previously.

Filter types

Fig. 14(b) defines the following terms:
Passband: The range of frequencies up to w_c.
Stopband: The range of frequencies above w_1 where the response has been sufficiently reduced.
Transition band: The range of frequencies between w_c and w_1.
Ripple Depth: The worst drop below the 0dB (normalised DC value) level anywhere in the passband, shown on the vertical axis as distance 0db to P.

Fig. 14(a) and those which follow, and the use of the generalised polynomial coefficients B and C, open a whole new world to us where we can choose whatever filter slope we would like, as

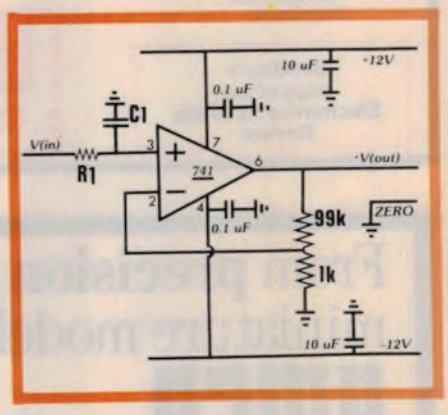

Fig. 11. Above is a single pole active filter. The combination of Fig. 10 with an op amp makes the simplest form of filter with gain. If the feedback resistors are 99k and 1k, to give a gain of 100 or 40dB at DC, then the overall response from V(in) to V(out) is as shown in Fig. 12. The passband or bandwidth of this Low Pass filter is from DC up to frequency fc where the response has fallen to 3dB below the low frequency value.

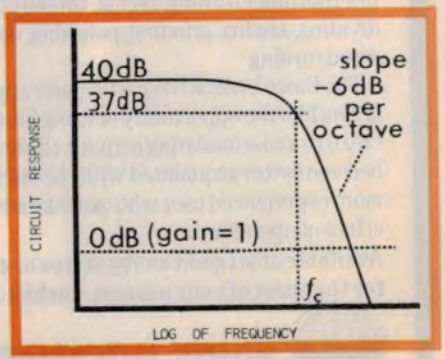

Fig. 12. The gain of the simple Low Pass active filter in Fig. 11. Observe full gain at DC and low frequencies, less gain as frequency rises.

OP AMPS Explained

well, as choosing a passband with the response remaining closer than 3dB below the DC value if we wish. That is, we can choose the shape [Fig. 14(b)], choose any width of transition band and choose any desired depth 0dB to P.

To make the transition band narrower we cascade more filters, using the very low output impedance of the amplifiers to isolate sections. Also we can use different circuits with higher quality factor Q where:

$$Q = (\text{Sqrt}(C))/B$$

The ripple depth defined by Butterworth, 3dB, is not the only possibility. Other choices of coefficients B and C, and perhaps other circuits, can produce different shapes for the response curve, and less than 3dB ripple depth. These shapes are given names such as Chebyshev (sometimes spelt Tbchebyshev), Inverse Chebyshev, Bessel, and others.

It is easiest to construct filters of high order by simply cascading repeated sections each of order 2 (second order), then add one of order 1 if we want any odd order number. For this reason reference texts concentrate on only these two orders.

To construct any filter we could take the following steps:

(1) Decide the desired shape of amplitude response curve [Fig. 14(b)] to suit our needs.

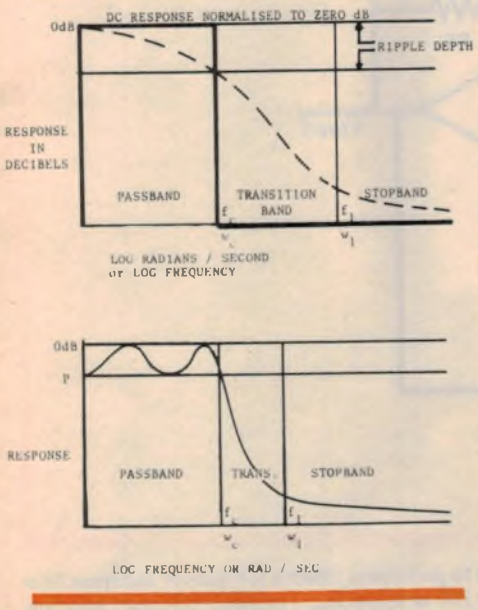

Fig. 14(b). Upper: Butterworth response. Lower: One type of Chebyshev response.

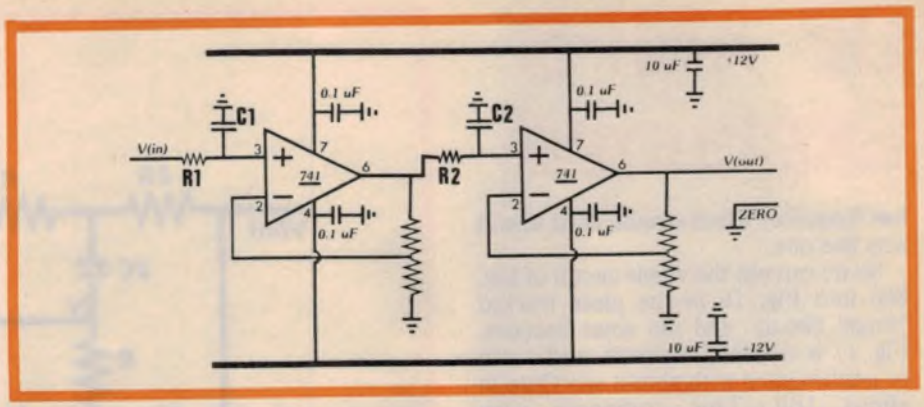

Fig. 13. A two pole active filter could be made this way by cascading two identical one pole units but is wasteful in components. We can do better using circuits which implement two poles in one stage.

(2) Choose the ripple shape we desire: Butterworth, Chebyshev or other.
(3) Choose a suitable circuit and number of stages to be cascaded.
(4) Consult a suitable table or graph showing values of the coefficients B and C for the circuit we have chosen and the ripple depth 0dB to P we desire.
(5) Construct it with confidence.

Suitable tables or graphs of the coefficients B and C will be found in the literature, and three excellent books are named in the references.

Other circuits

Designs abound from which you can choose suitable circuits. Should a non-inverting two pole stage be desired, Fig. 15 is an excellent example. But if you desire higher Q then consider the essence of a tuned circuit as a filter, such as in Fig. 16 (easily implemented at radio frequencies using inductance and capacitance, but not for low frequencies). So we use an ingenious idea ... that sinewave oscillator in Fig. 8(a) is in fact a

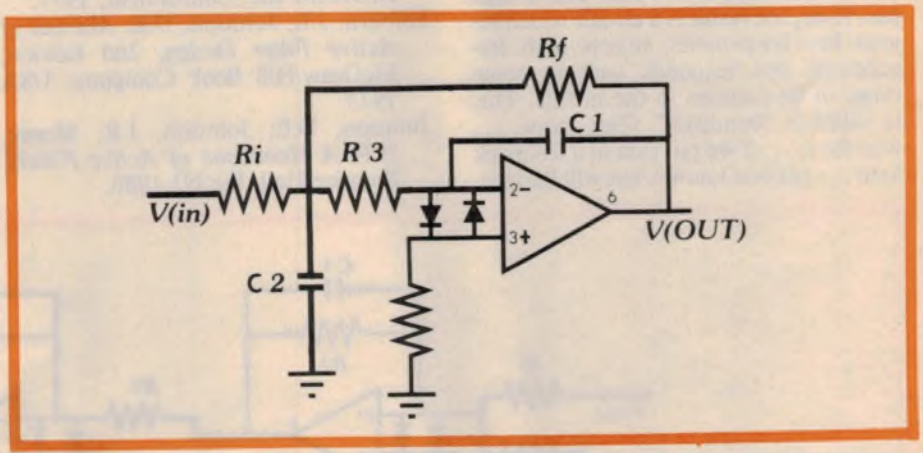

Fig. 14(a). The second order multiple feedback Low Pass filter achieves second order properties with less components than the cascaded first order in Fig. 13. This circuit is inverting and the DC gain is (−Rf/Ri). Either Butterworth or Chebyshev characteristics can be obtained by the right choice of component values.

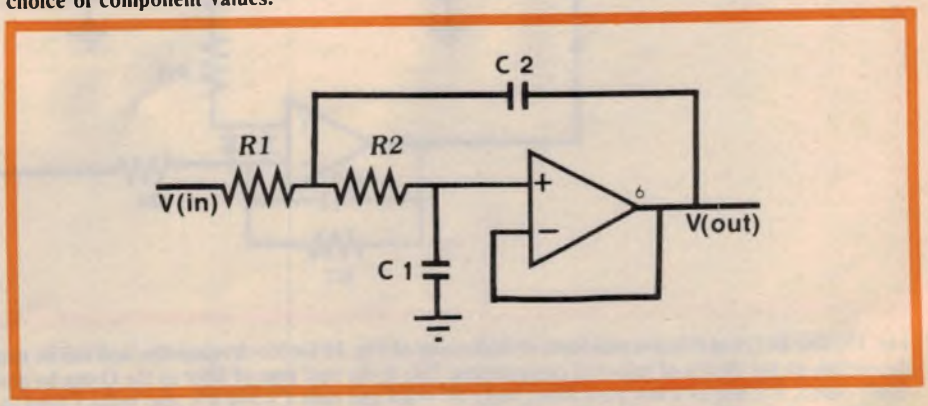

Fig. 15. The essential elements of the non-inverting two pole Low Pass filter.

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low frequency tuned circuit, or at least it acts like one.

So we can put the whole circuit of Fig. 8(a) into Fig. 16 in the place marked "tuned circuit" and see what happens. Fig. 17 is the detailed result, and it can be implemented with almost any Q up to about 100. This compares very favourably with Butterworth and Chebyshev which are limited to a Q of about 10. High Q value produces nice steep slopes in response curves.

High pass filters

In general, exchanging the positions of capacitor and resistor in a filter makes it into a High Pass Filter which has zero response at DC or zero frequency, and a transition band followed by a passband at the high frequency end. The design ideas in general follow the same lines as we have discussed for low pass with everything reversed.

Bandpass and notch filters

If we combine a low pass with a high pass filter, the result is a circuit which rejects low frequencies, rejects high frequencies, but responds well to some range of frequencies in the middle. This is called a "bandpass" filter. Now . . . wait for it . . . if we put that in a feedback loop . . . yes you know what will happen.

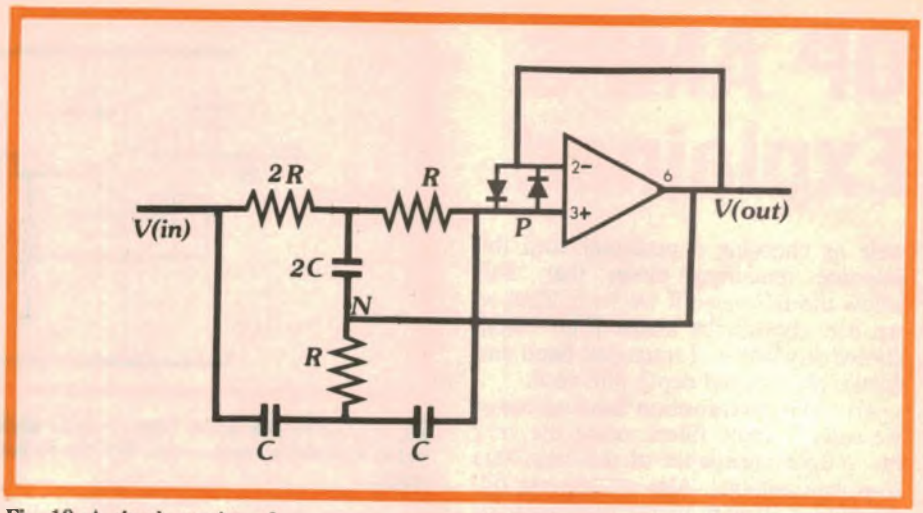

Fig. 18. A simple version of the high Q notch or "narrow band-reject" filter is composed of a "parallel T" or "twin T" filter with the common point N driven by the output.

The complete circuit will perform the inverse function, it will reject that band of frequencies in the middle but accept all frequencies above and below. Such a filter is shown in Fig. 18 and is officially called a "band reject" type but is more commonly known as a "notch" filter.

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Hilburn, J.L; Johnson, D.E: *Manual of Active Filter Design,* 2nd Edition, McGraw-Hill Book Company, USA 1973.

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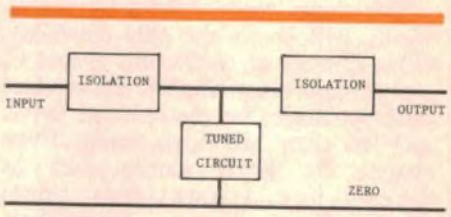

Fig. 16. This is a basic filter, capable of high Q if neither output nor input load the tuned circuit. Commonly used at radio frequencies where the tuned circuit is simply an LC "tank". As LC circuits are impractical at low frequencies, the low frequency oscillator of the dual integrator or analog computer type of Fig. 8(a) can be employed, acting as a tuned circuit. A practical realisation is shown in Fig. 17.

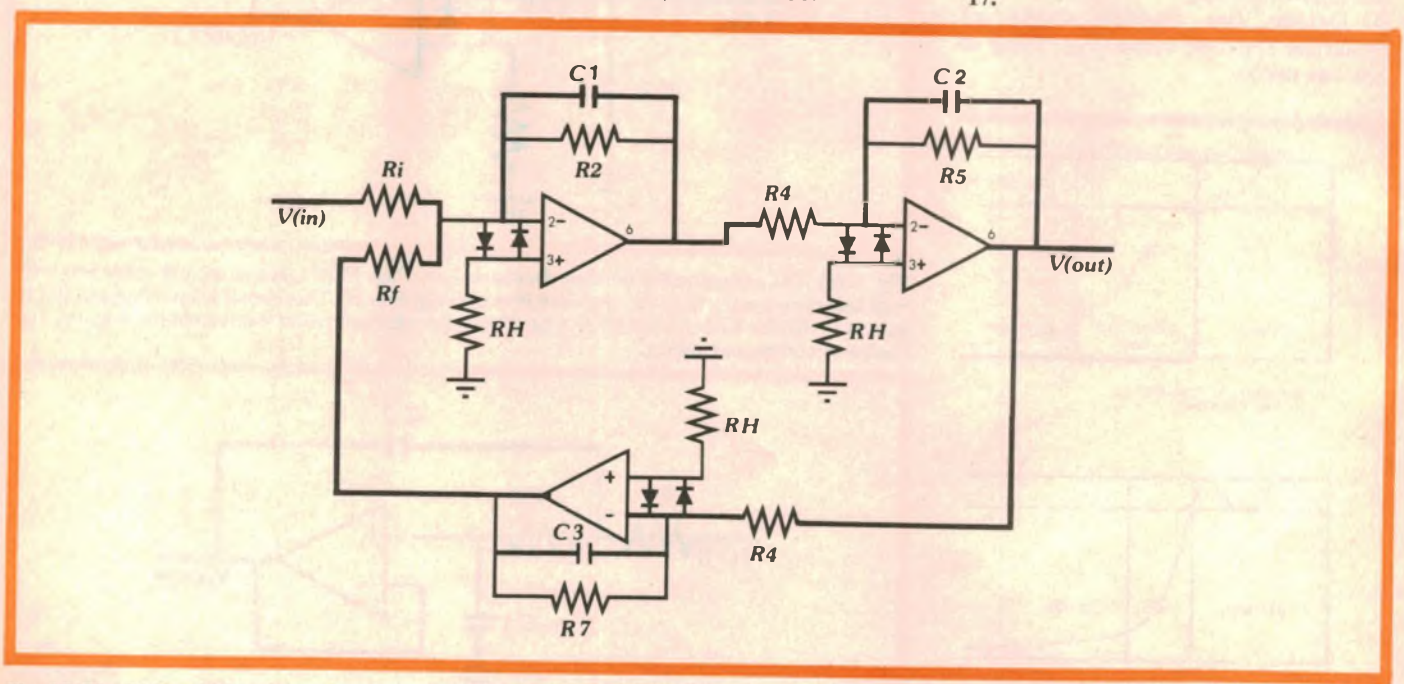

Fig. 17. The Bi-Quad Filter is one form of realisation of Fig. 16 for low frequencies, and can be made to perform as either a low pass or bandpass filter depending on the choice of values of components. This is the best type of filter as the Q can be made 100 or more. It is a two-pole type, non-inverting, easily tuned. For use as a low pass filter, make R7 = R4 and omit C3 and R5; also make C1 = C2; low frequency gain is (+ Rf/Ri). For use as a bandpass filter, make C3 = C1, omit C2 and R7; also make R5 = R4.

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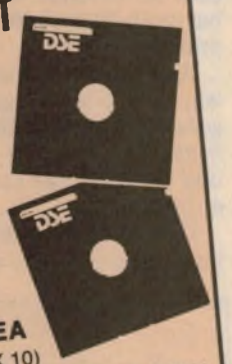

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Mordaunt-Short MS-10 and MS-30 loudspeaker systems

If there is an identifiable trend in loudspeakers at the moment, it is to more compact loudspeaker systems. Large boom boxes are out, high performance compacts are in. Catering to this trend are these two models from Mordaunt-Short, the MS-10 and MS-30 two-way bass reflex systems.

Mordaunt-Short is one of the less well-known brands of loudspeaker but it is from an English company which has developed a reputation for good loudspeaker engineering over a number of years. The two models under review cater for different sections of the market but both follow the same broad design principles.

As already mentioned, both are two-way bass reflex designs although one is a good deal smaller than the other. The model MS-30 is the more conventional unit which would cater to a wide range of listeners.

Dimensions of the MS-30 are 490mm high, 250mm wide and 275mm deep. Mass is 7.3kg. The enclosure volume is about 24 litres. The woofer is a nominal 20cm in diameter with neoprene rubber roll surround. It has a lightweight curvilinear cone (meaning an elliptical rather than straight-sided cone) of paper construction with an effective cone diameter of about 160mm. The tweeter is a 25mm diameter dome of fabric construction.

The enclosure is ported with a 50mm diameter tube 70mm deep. It is also lined with a synthetic fibre material, to help damp internal reflections and lower the Q of the system. The external finish is either walnut or dark rosewood artificial veneer.

The Mordaunt-Short MS-30s are two-way bass reflex enclosures recommended for stand mounting.

The crossover is a half-section network giving 12dB/octave slopes for both tweeter and woofer. The capacitors are bipolar electrolytics and one of the inductors is air-cored while the other has a ferrite core.

Some enthusiasts are not keen on the use of bipolar electrolytics or ferrite cored inductors because they can be a source of non-linearity at high drive levels. However, Mordaunt-Short loudspeaker systems have an answer to this criticism which is usually not valid in any case, in a properly designed crossover network.

The answer is the Positec overload protection system which allows the MS-30 to be used with amplifiers rated up to 300 watts per channel. Not only does the protection system prevent damage from excessive drive levels, amplifier clipping or supersonic instability but it also prevents DC burnout in the event of an amplifier fault.

The Positec system turns out to be remarkably simple. It does not depend on an active monitoring system plus a relay to disconnect the drivers. Rather, it uses positive temperature coefficient thermistors in series with both the tweeter and woofer.

At low or no-signal levels these thermistors have a very low resistance. However, if the power delivered through them becomes excessive they heat up and their resistance increases markedly, to choke off the current flow through the associated driver.

At least, we assume that is the theory, since there is no explanation of the system in the owner's manual or the published specifications. We gleaned this information solely by examination of the crossover circuit boards which had two inscrutable components, rather like ceramic disc capacitors in appearance, in series with the drivers. As it turned out, subsequent tests confirmed our supposition, that they were thermistors.

Frequency response of the MS-30 is quoted at 60Hz to 20kHz ±3dB. Impedance is a nominal 8 ohms and sensitivity is quoted at 89dB for 1 watt at 1 metre (on pink noise). Maximum sound pressure levels, again using pink noise, are quoted as 103.5dB or 112.5dB for one second duration.

We would rate the sensitivity of the

MS-30 as about average for today's speakers and can confirm that they can be driven to very good levels on transients with a high power amplifier. However, on music played with very sustained high power levels, such as some organ and rock music, they will tend to shut down.

This does not occur at normal loud listening levels though, so unless you are as deaf as a post or the audio equivalent of a "petrol-head", it is not likely to be a problem.

We found the frequency response to be quite smooth although the tweeter does exhibit a little peakiness in the region of 4kHz and 7kHz and the response tapers off beyond 15kHz. As far as the bass is concerned, it is quite smooth and well maintained down to around 45Hz, tapering rapidly below that.

The impedance characteristic of the MS-30 is typical of a bass reflex system, with the major peak at around 75Hz and the minor peak below 15Hz. The minimum value of about 5.2 ohms occurred at between 4kHz and 5kHz but this is unlikely to cause any problems with the large majority of amplifiers.

We would rate the sound quality as having wide appeal. The overall response is quite smooth and the gradual rolloff at the extreme treble means that the MS-30 is not quite as "critical" of program quality as other speakers with a very extended or pronounced treble response.

Mordaunt-Short strongly recommend the use of their proprietary stands to raise the units off the floor and we can confirm that this is desirable (as with most loudspeakers) to obtain clean sound definition in the lower registers.

Attractive miniatures

The MS-10 speakers from Mordaunt-Short are quite different. Much smaller than the MS-30s, they are intended for bookshelf mounting, close to but not right up against the wall. Nor can they be closely surrounded by books or other paraphernalia, as they have a rear facing port which must not be impeded in its action.

While they are not the smallest full-range loudspeakers ever to be produced, the MS-10s must be one of the most attractive. The enclosures are finished in a black ash synthetic veneer which is set off by the black grille cloth. While this would probably give a very sombre appearance to a larger system, it looks very smart for these small units.

Dimensions of the enclosure are 285mm high, 195mm wide and 180mm deep. This gives an enclosure volume of just on six litres. Weight of each enclosure is 3.2kg.

The Mordaunt-Short MS-10s, shown with an audio cassette for size comparison.

The woofer must be one of the smallest bass drivers currently made. With a nominal diameter of 110mm and a fabric roll surround, the effective cone diameter is just on 75mm. Complementing this is one of the smallest tweeters around, with a 12mm diameter plastic dome. It also features ferrofluid in the voice coil gap, to aid cooling during high power operation.

The crossover network is similar to that of the MS-30, employing two bipolar electrolytic capacitors and one ferrite cored inductor. Again, the MS-10s have the same Positec protection system, using positive coefficient thermistors.

The rear mounted port is 42mm in diameter and 65mm deep. Strangely, neither the specification sheet nor the owner's manual for the MS-10 states how close the units may be placed to a wall for best results.

Only an observant owner would note the finely printed label on the rear of the unit, stating that the cabinet may be positioned as little as five centimetres from the rear wall. The same label states that, "for critical listening, the grille should be removed and replaced after use".

This is hardly a practical proposition and one that we would not encourage. In our opinion, grille cloths should not ordinarily be removed from loudspeakers as it renders them more liable to cone damage from careless fingers.

Frequency response of the MS-10 is quoted at 90Hz to 20kHz within ±3dB while efficiency is 87dB for 1 watt at 1 metre. Maximum sound pressure level is quoted as 100dB on a continuous basis or 107dB for one second duration. These are quite respectable levels for such a small speaker and will suit the needs of many people with confined living space.

Impedance of the MS-10 is again quoted as a nominal 8 ohms and the actual impedance is above this figure over the entire audio range.

Bass response is quite well maintained down to about 60Hz but shows a tendency to "frequency doubling" if driven hard below this point. The treble response is very smooth overall, with some slight prominence in the region of 12 to 13kHz. It really is a very good tweeter with outstanding treble dispersion which is to be expected from such a small point source.

Simulated failure

Our review of these loudspeakers would not be complete unless we had put the Positec protection system to a real test. We wanted to simulate the effect of a typical amplifier failure whereby a substantial DC voltage is applied to the loudspeaker. For example, an amplifier rated at 40 watts per channel can be expected to have DC supply rails of ±30V. When it fails, it will usually then apply 30V to the speaker. Often the internal fuses will not fail and so the speaker burns out if not protected by relays or some other method.

Accordingly, we set up a substantial DC power supply with an output of 30V.

continued on p132

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

September 1935

Electric burglar alarm: a new electric alarm system for bank vaults was on display recently in Atlantic City. The device dials police headquarters and automatically gives the name and location of the bank.

Aluminium solder: soldering aluminium has for years been synonymous with such things as jumping over the moon. We have been given a sample of Kester aluminium solder which really does solder. So firmly that the aluminium will break before the joint. That's a fact — we've done it.

Radio censorship: the USA government threatened to cancel the licenses of stations casting advertisements of a slimming preparation which doctors regard as unsafe. It is thought that the government may soon set up censorship for broadcast advertisement.

TV from the mountains: some 5-metre experiments were recently conducted from the top of Kurrajong. Stations worked from the mountain top were in every part of Sydney. The power used at the time was very low — not more than about 8 watts.

The most interesting point about this amateur effort is that it demonstrated the value of height. Will we ultimately see a television station installed in the mountains? This seems to have demonstrated that it is difficult to project into all the valleys of Sydney unless there is practically an optical range. There is no spot in Sydney which will adequately fulfill this condition.

Peoples radio: Hitler's "People's Set", standardised and sold at considerable reduction, sold 344,311 in 1933 to 1,130,038 ordinary sets.

Solid-state rectifier: the latest Westinghouse product is a heavy duty rectifier for low tension work. The single plate is capable of rectifying 20A at 5V.

Fast listening: in a speed limit case in Leeds (England), the chairman of the bench is reported as saying that it was ridiculous to have a radio receiver in a car, advising the owner to get rid of it.

RADIO TELEVISION AND HOBBIES 2/6

September 1960

Opera singing: (from a record review) This disc of lovely singing will explain to listeners the reason for Miss Sutherland's recent outstanding success overseas. Her voice remains beautifully even throughout the range, its superb quality unimpaired at both extremes of the register, her coloratura passages effortlessly agile, and her legatos sensitively phrased.

New BBC studio: the new BBC Television Centre at Shepherd's Bush is claimed by the BBC to be one of the finest in the world. Designed to cater for the future as well as present, its function is to produce about 1,500 hours per annum of electronic program material. This is equivalent to about 1,000 full length feature films.

Radio telescope: following the recent success of the Jodrell Bank radio telescope in tracking and controlling the US Pioneer Five space probe, another first may be chalked up, this time to the radio telescope at Cambridge.

The position of a nebula five thousand million light years away has been fixed. The nebula, designated 3 C 295, is now the most distant object ever seen in the whole universe. It is said to be receeding from the earth at almost half the speed of light.

Future cars: ever since their introduction about 70 years ago, motor vehicles have rolled on wheels. It is now certain that, for some applications at least, wheels will be eliminated.

A new type of vehicle, operating on an air levitation system is making its appearance in England and the United States and is backed by some of the best brains in the automobile industry.

Non-electric soldering iron: a new soldering iron does not require external heat of any kind. The heat is provided by a patented cartridge which contains a thermic mixture in a steel shell.

The iron recharges with a new cartridge. Within seconds of being "fired", the cartridge is designed to attain a temperature of about 860 degrees Fahrenheit and maintain it for six to eight minutes.

CRO tube: information can be displayed for almost indefinite periods and later used to give a display as required by means of new direct viewing storage oscilloscope tube.

The tube has two electron guns, the first of which "writes" information in the form of electrical signals on a storage layer or mesh. The second gun enables the stored sign to be displayed at will on the phosphor screen.

New cement: for thermal insulation this new cement is non-corrosive and non-rusting to metals and other similar materials. Exceptionally quick in setting it can be premoulded and will not shrink on hardening.

Rules about using radios: (from the editorial). During the past month two men learned the hard way that regulations governing the use of tradio transmitters are there to be observed.

In Western Australia a man was prosecuted for originating false messages purporting to come from a yacht in distress. The search, which was instituted as a result of the messages, involved considerable expense and risk to the participants.

In Victoria, another man set up a transmitter on the 19-metre band, broadcasting music and advertisements, allegedly "for the benefit of the Greek community." He pleaded that the transmissions were completely innocuous.

Jo Jo the piano-playing robot

The inimitable Ray Charles look-alike, Jo Jo Ivory, seated at the piano in the Sheraton Motor Inn's cocktail bar.

In recent months, one of Sydney's glamour night spots has been well publicised because of its unique entertainment attraction. Billed as a piano-playing robot, Jo Jo Ivory plays a piano, sings the accompaniment, gives a nice little patter between tunes and even requests the occasional drink.

by LEO SIMPSON and LOUISE UPTON

Could this really be? There is at least one genuine piano playing robot, which is on exhibition in Japan, but that is an extremely complex instrument. We suspected that Jo Jo Ivory was not a robot at all.

A visit to the Sheraton Motor Hotel confirmed our suspicions but we think that Jo Jo Ivory is still an intriguing entertainer. He is installed (it does not seem right to refer to him as a machine) on a little stage within the Sheraton's cocktail bar. He is seated at a black baby grand piano and he does the full bit, moves his hands over the keyboard, operates the pedals and sings along. Or at least, he appears to, with the most cursory of observations.

If you were drunk, you might be convinced but otherwise it is fairly obvious that Jo Jo does not actually play the piano. He merely moves his hands along the keyboard but his fingers do not touch the keys. Nor are the hands precisely where they should be to play the music of the moment.

The piano plays itself and Jo Jo Ivory is little more than an automated puppet. The piano does not use the pneumatic mechanism of old though — it uses up to minute technology.

Jo Jo's baby grand piano actually has a Vorsetzer mechanism installed below the keys. Vorsetzers have been around for a long time, since 1904 in fact, when the first piano playing mechanism was invented by a German. Vorsetzer is the

German word for "sitter-in-front".

The particular Vorsetzer which does Jo Jo's hard work was made by Superscope Inc, of the US, under the brand name "Pianocorder". (This was marketed in Australia until a few years ago but now appears to be unavailable in this country).

The Pianocorder is a solenoid operated machine. Eighty of the 88 piano keys are each actuated by a solenoid underneath the keyboard. While you might think that a solenoid is a crude device to operate a piano key, the Pianocorder design controls the force applied by the solenoid to the key (and hence the loudness of the note played) by applying DC pulses of varying width to each solenoid coil. The wider the pulse width, the more force is applied to the key.

Large solenoids are also used to operate the soft and sustain pedals of the piano.

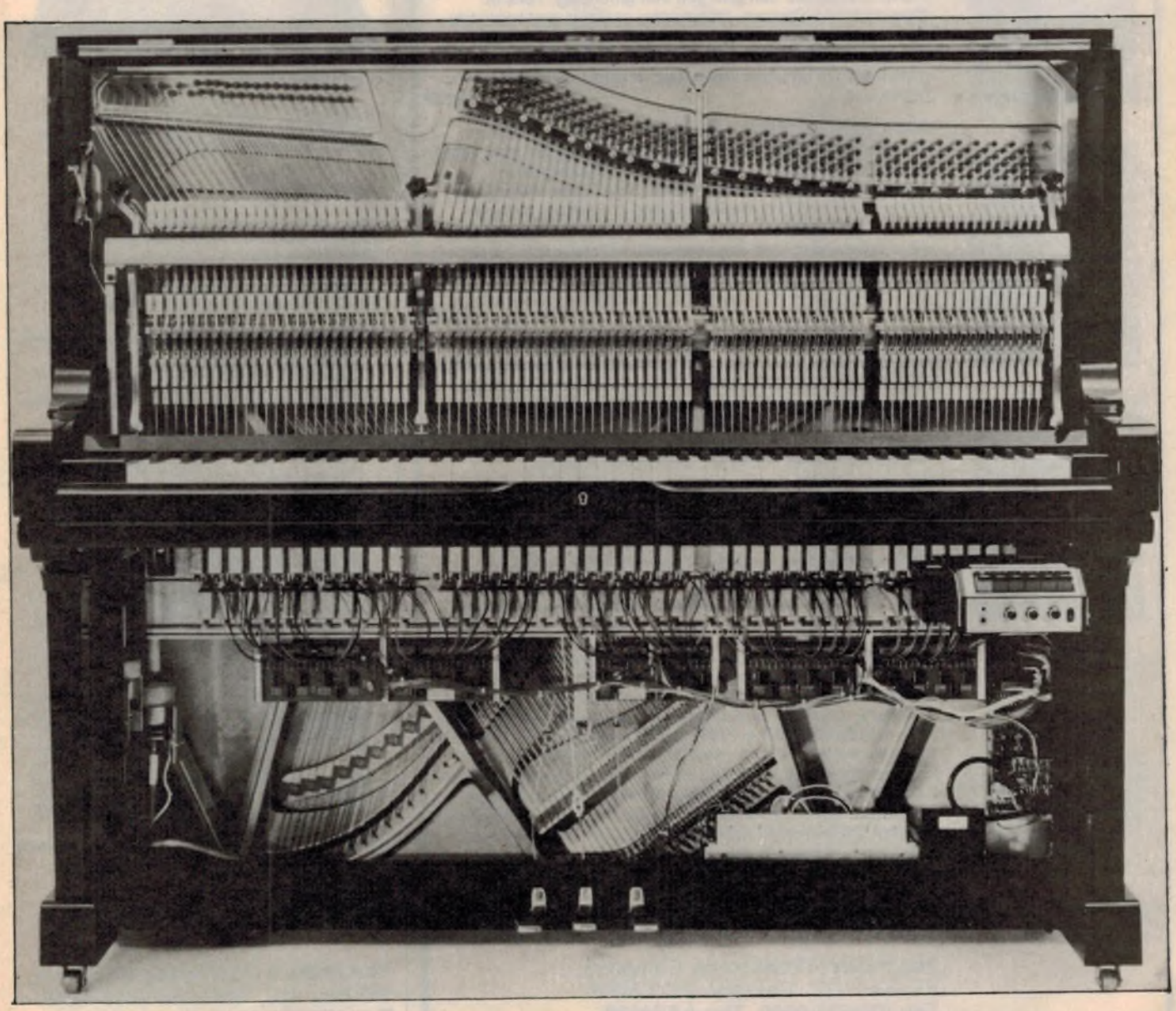
All the data required to play the piano notes, the timing and loudness, is stored on an ordinary cassette tape, which runs at twice normal speed, at 3¾ inches per second. The data is the same as computer programs on tape, in the form of a "frequency shift key" tone which is 2.25kHz for zeros and 4.5kHz for ones.

This serial data is fed out from the cassette player and converted to 8-bit parallel data by the logic circuitry. The data is decoded to determine what notes are to be played at any one instant and also fed to a digital to analog converter to provide loudness information. The tape deck used for this installation is a Tascam 133 multi-track machine. This controls the piano, and has additional data tracks for the animation of Jo Jo and the voice track, which is not digital.

No less than 22 solenoid valves control the air-pressure fed to the various actuators which animate Jo Jo. His mouth opens and closes, his head turns from side to side, his arms move and so do his hands and fingers. A 96 channel programmer is interposed between the cassette deck and the solenoids, to decode the animation signals.

Several other items of electronic equipment complete the list of gear to drive Jo Jo, in addition to the air compressor. There is a Crown D75 power amplifier fed via a DB 6150 noise reduction system and a third octave graphic equaliser (the last item supplied by Jaycar Electronics). These items provide the voice channel and drive a loudspeaker which sits behind the animated puppet.

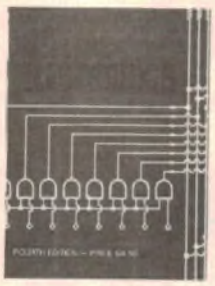
It all adds up to an amusing entertainment attraction, albeit an expensive one. The cost for the entire installation was a cool $130,000. You can go and see it for the cost of a few drinks.



Above: an upright piano with a standard Vorsetzer attached. The Sheraton's baby grand features a similar set-up.

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. **$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'. 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. No previous knowledge of digital electronics is necessary. **$4.50**

BASIC ELECTRONICS. This popular text has now been re-issued. *Basic Electronics* is almost certainly the most widely used reference manual on electronics fundamentals in Australia. It begins with the electron, introduces and explains components and circuit concepts and progresses through radio, audio techniques, servicing test instruments, television, etc. 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**

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 Ignition 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**

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Books & Literature

Integrated circuit design

Custom-Specific Integrated Circuits. Design and Fabrication: by Stanley L. Hurst. Published by Marcel Dekker, inc, 1985. Hard covers, 235 x 158mm, 366 pages. Illustrated with diagrams, photographs and tables. ISBN 0-8247-7302-0. Recommended retail price is $66.

The aim of this book is to teach custom and semi-custom design and fabrication of integrated circuits.

The author argues that in some cases, the use of off-the-shelf ICs is not the most advantageous method of circuit design. The alternative is full custom and semicustom IC design. Full custom refers to the most efficient design-on-silicon possible given time and cost restraints. Semi-custom design utilises a cell-library approach or the uncommitted masterslice approach.

Following the descriptions of these aspects, the second chapter reviews basic semiconductor technologies. These include Bipolar, TTL, IIL, ECL and MOS. The information for each technology is very detailed and includes the method of IC fabrication.

Chapter three talks about programmable devices such as read-only memories and programmable logic and gate arrays and logic sequencers. The next chapter goes onto masterslice semi-custom techniques. Uncommitted functional cell arrays are discussed and wiring and routing considerations are detailed. Computer aided design considerations are also included.

A practical guidance is given in these chapters of original equipment manufacturer commitment procedures.

The custom-specific design using cell libraries follows in the fifth chapter. The final chapter concludes the discussions and predicts the further use of custom design in the future.

Each chapter provides an enormous number of references for further reading on the subject matter. Many photographs, diagrams and examples are given throughout. Appendices are included which discuss semiconductor fundamentals and useful data.

This book is extremely comprehensive and practical. It covers the various methods available to reduce the design time of a microelectronic circuit to fit a specialised requirement. A recommended text for students, designers and scientists. Our review copy came from the publishers. (J.C.)

Microprocessor handbook

The microprocessor handbook: by Elmer C. Poe, published by Howard W. Sams & Co, Inc, 1983. Soft covers, 214 x 135mm, 236 pages, illustrated with tables and diagrams. ISBN 0-672-22013-X. Recommended retail price is $23.95.

Basically, this book contains all relevant information for the popular 8-bit and 16-bit microprocessors. Included is the IC pinout, instruction set, read/write timing diagrams, register set/programming model and the addressing modes for each of the processors.

The processor detailed are: the 8080, 8085, Z-80, 6800, 6802, 6809 and 6502 for the 8-bit types and the Z8000 and 68000 for the 16-bit microprocessors.

Support chips for the Intel 8000 series and the Motorola 6800 series microprocessors are also detailed. These include the parallel input/output ICs, the 8255 and 6820. For serial ICs, data for the 8251A and 6850 is given.

For each of the microprocessors, the information given in the book is covered in the same style and format. This enables the reader to directly compare one microprocessor with another.

It is a useful book for people interested in the various types of microprocessors available. Our review copy came from Jaycar Electronics, catalog number BS-0716. (J.C.)

Radio & TV Directory

World radio TV handbook: 39th edition. Published by Billboard Ltd, 1985. Soft covers, 229 x 145mm, 599 pages. Illustrated with maps. ISBN 0-902285-10-6. Recommended retail price $33.50.

This fully comprehensive handbook covers the World's radio and television services. Each country listing includes the call sign, frequency, power, location (address) and personnel for every station. Foreign language programs and transmitting times are also included.

Information contained within the book is concise and easily readable. It covers long, medium and short wave broadcasters. Regional maps of the world are a very helpful addition and include principle transmitter sites.

Apart from containing the above mentioned information there are chapters on religious broadcasting organisations, equipment reviews and a user's guide to the handbook.

Equipment reviews include receivers, active preselectors and active antennas.

Overall this handbook presents invaluable information to the DXer, amateur and radio enthusiast. Our review copy came from Technical Book and Magazine Co Pty Ltd, 289-299 Swanston St, Melbourne, Vic. (J.C.)

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It is NOT cheap but then again it will definitely last a lifetime. It is built like a Rolls Royce. (We doubt whether 20 years continuous use would wear out the German made flexible arms for example). Spare fluoro tubes are available either from us or electrical outlets. If you have trouble with fine PCB work or component identification but still want both hands free, this is for you. We thoroughly recommend this quality Australian made product.

Technical Information
Illumination: **22W Fluorescent**
Weight: **8.16kg**
Lateral Extension: **254mm**
Vertical Extension: **254mm**
Fixing: **Heavy table base (grey) with two chrome plated flexible arms.**
Lens: **(see text)**

STEREO SYNTHESISER

Ref: EA September 1982

By employing a "Bucket Brigade" IC and Comb filtering, very realistic stereo sound spatial effects can be obtained. It is ideal for VCR's and other mono sources that would benefit from stereo. The circuit though sophisticated, is easy to build.
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SPECIAL ANNOUNCEMENT

GREAT NEW RANGE OF BEGINNERS BOOKS

Over the past two years we at Jaycar have become very concerned at the upwardly spiralling prices for good technical books. You can imagine our delight when we discovered the range of low cost books from USBORNE UK.
Unfortunately the books are at present confined to the beginners area - but they are EXCELLENT beginners books. Each book is magnificently illustrated in full colour with easy to read text.

Introduction to the New Technology

- 170(W) x 240(H) 144 pages with illustrations.
This incredible book provides preliminary information on a wealth of subjects related to new technology. The book is in 3 basic sections (each with its own index).

1. The Information Revolution
This section describes such subjects as: Electronic Mail, Teleshopping, Telebanking, Electronic Publishing, Videotex, New TV Technology, The Electronic Office, Future Telephones & Systems, Word Processing, Satellite Communications, Electronic Banking and the cashless Society, Fibre Optics, Electronic Factories and much more. A glossary of the new terminology is also included.

2. Robotics
This section describes the fascinating field of Robotics for the novice to the field. It describes industrial and training robots as well as special robots such as cruise missiles etc. It describes what robots can and (presently) cannot do and even has a section describing a simple robot that you can build!
Once again a glossary of robot terms is provided along with an index.

3. Lasers
This section explains the origins of lasers, how they work and typical applications. Also explained are Holograms, Laser Discs, Laser Weapons and much more. Very well written with extensive illustrations. Glossary and index included. This book would make an ideal gift for a young scientist.
Cat. BU-1200
ONLY $9.95

How to Make Computer Controlled Robots

200(W) x 250(H) 48 pages with illustrations.
This incredible book shows you how to actually build a working robot from common materials such as balsa wood etc. Details of electronic control circuits are also provided. (Prior knowledge of electronics is required). Details of interfacing electronics with common computers such as VIC20, C64, Spectrum & BBC also provided. Templates for all wooden components also provided as well as control programs. Great fun just to read!
Cat. BU-1212
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INTRODUCTION TO ELECTRONICS

170(W) x 240(H) 48 pages.
An ideal first book for the raw beginner. Subjects covered include: What IS electronics? About electronic current. Building circuits. Looking at resistors, Symbols & diagrams. Storing electric charge. Introducing the transistor. Transistors in circuits. More about voltage/voltage dividers, Digital circuits. Amplifiers. About the microchip. Testing & designing circuits, a colour code computer program. How to solder. Circuit diagrams etc.
Once again the combination of explanatory text and graphic diagrams is fantastic. A full index is provided along with glossary.
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Beginners Computer Handbook

170(W) x 240(H) 144 pages with illustrations.
This magnificently illustrated book is an ideal first book. It assumes that you know virtually nothing! It explains what 'programming' means and describes many popular machines on the market and what they can (and cannot do).
We feel that the authors have done an excellent job combining clear expressive text with excellent illustrations to explain how micros work and how they are programmed. An ideal gift.
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Check the specs:

DC VOLT	0.1mV - 1000V
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DC CURRENT	1uA - 10A
AC CURRENT	1uA - 10A
RESISTANCE	0.1 - 20 Mohm
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- ★ Protected
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Cat. QM-1530

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$79.95

AT LAST! A low cost 10 Amp Digital Multimeter/ Transistor Tester & Capacitance Meter!

Jaycar is proud to announce a genuine low cost high performance combination Multimeter/Capacitance meter for the enthusiast! This unit is all the most commonly needed test gear rolled into one!

Similar units are on the market to sell from around $150 to over $200. Why pay more when you can get a Jaycar direct import for less?

DC VOLT	0.1mV - 1000V
AC VOLT	0.1mV - 700V
DC CURRENT	1uA - 10A (20A max 30 secs)
AC CURRENT	1uA - 10A (20A max 30 secs)
RESISTANCE	0.1 - 20M ohms
CAPACITANCE	1pF - 20uF (2%)
CONTINUITY	less than 30 ohms @ 1mA
hFE TEST	0-1000, 10uA 2.8V
DIODE TEST	1mA (Buzzer & LED)

FEATURES:

- ★ 0.5" high digits
- ★ High quality probes supplied!
- ★ LED and Buzzer continuity test
- ★ Precision thin film resistors for long term stability
- ★ CMOS logic 1000 - 2000 hours battery life!
- ★ Meter protection. Fused
- ★ Complete with battery, quality probes, spare fuse
- ★ Floating decimal point
- ★ Auto polarity
- ★ Impact resistant case

Cat. QM-1540

INTRODUCTORY PRICE

$119.00

PROGRAMMABLE MOBILE ROBOT

Features: ★ 4 bit microprocessor controlled ★ 3 speed gears selected by programming through micro ★ Can travel in 4 directions plus angles and curves ★ Has lights and audio ★ Complex routines can be easily programmed (up to 48 commands long).

Cat. XR-1024

ONLY $49.95

MIXERS BACK IN STOCK!

These are sophisticated mixers that have excellent specifications - SEE PAGE 86 of our 1985 CATALOGUE for full features and specs.

STEREO AUDIO MIXER

Cat. AM-4200

ONLY $125.00

PRO-QUALITY CONSOLE

Cat. AM-4202

ONLY $399.00

THE ULTIMATE CAR THEFT DETERRENT

The most sophisticated car alarms these days use ultrasonic sensors inside the cabin of the car to detect unauthorised entry. If the perimeter sensors fail the ultrasonic gets them as a second line of defence. It is virtually impossible not to trigger them once you are inside the car.

Jaycar has made a scoop purchase of the UK made AT-90 Ultrasonic Detector Module. This unit is basically a proximity detector which connects to your car alarm system.

When the AT-90 is installed it fills the inside of the car with a steady pattern of ultrasound (ignition off, car closed). A movement within the vehicle or disturbance of windows or roof causes a disruption to the pattern and the AT-90 sends a signal to your main car alarm triggering it.

JAYCAR SELLS THE KIT FOR $55.00

BUT - you can add a built and guaranteed AT-90 to your alarm system TODAY for only $24.50!!

Cat. KJ-6665

SAVE $30.50

SX-2000 Full Featured Electronic Ignition SLASHED!

The SX-2000 is the UK based Sparkrites best ever selling electronic ignition. It is a reliable Transistor Assisted Ignition design with very high performance.

- Static timing light
- Anti-theft disable switch
- Instant conventional ignition switch over
- "Systems Functioning" lamp indicator
- Inbuilt heatsink
- Special mounting clips attach straight to coil (Patented feature)
- Easily transferred from car to car.

At $59 Jaycar consistently runs out of the KIT version of this ignition ALL THE TIME. This unit is not a kit but the fully BUILT AND TESTED version. So when we tell you the price you will be thoroughly astounded!

FOR SEPTEMBER this unit is only $39.50!!

Hurry! Stocks are limited!

Cat. KJ-6650

SAVE $20

ELECTRONIC IGNITION SENSATIONS! SPARKRITE SX-500

Jaycar has made a massive scoop purchase of a great little Transistor Assisted Electronic Ignition. It is not a kit. It is fully built and tested!

- Builtin static timing light
- Only 4 wires to connect!
- Fits all 12V neg earth vehicles (inc. motorcycles) that use a coil and contact ignition.
- 3 position switch which enables you to immobolise vehicle or switch back to conventional ignition instantly
- Helps keep ignition in tune
- Stops arcing of breaker points
- Greatly extends points life
- Generally improves performance

The unit is supplied in a metal case with all wiring and fitting pieces included!! Instructions included.

Normally this unit would sell for about $49.95. But at Jaycar you pay ½ that in September!

GRAB THEM WHILE THEY LAST!

Cat. KJ-6653

ONLY $24.95 ea

BRITISH MADE - QUALITY!

SAVE $25

MAIL ORDER HOTLINE (02) 747 1888

UNBELIEVABLE KIT SALE

SENSATIONAL PRICES ON 5000 AMP-SYSTEM KITS

Check the special prices for the famous ETI 5000 series deal of a lifetime.

FAMOUS JAYCAR 'BLACK MONOLITH' SERIES AMP

NORMALLY $339

THIS MONTH $299

SAVE $40

For further savings check the package deal below.

FAMOUS JAYCAR 'BLUEPRINT' 5000 SERIES PRE-AMP

NORMALLY $319

THIS MONTH $275

SAVE $44

Check below for package price further savings.

FAMOUS 1/3 OCTAVE GRAPHIC EQUALISER 5000 SERIES

NORMALLY $199 ea

THIS MONTH 2 for $319

SAVE $79

For further savings check below.

THIS SPECTACULAR PACKAGE DEAL

PACKAGE DEAL 1

5000 'Black Monolith' Power Amp
5000 'Blueprint' Pre-amp

TOGETHER FOR ONLY **$550**

SAVE over $100 on normal prices

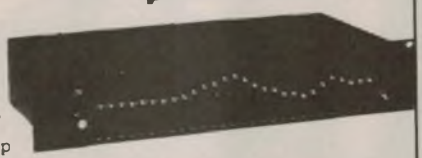
PACKAGE DEAL 2

5000 'Black Monolith' Power Amp
NORMALLY $339
5000 'Blueprint' Pre-amp
Normally $319
5000 Series 1/3 Graphic Equaliser
Normally $398

NORMALLY $1056

THIS MONTH YOU GET THE LOT FOR $799

A MASSIVE SAVING OF $257.00



Freight by Comet anywhere in Australia $13.50

NOTE: If demand temporarily exceeds our ability to supply kits we may part ship. This will get you started on what is after all a fairly ambitious project. We will only honour the prices, however, if you order NOW!

Jaycar ELECTRONICS

Incorporating ELECTRONIC AGENCIES

NUMBER 1 FOR KITS

MAIL ORDER HOTLINE (02) 747 1888

N.S.W. SHOWROOMS

SYDNEY: 117 York Street. Tel: (02) 267 1614
CARLINGFORD: Cnr. Carlingford & Pennant Hills Road. Tel: (02) 872 4444
CONCORD: 115/117 Parramatta Road. Tel: (02) 745 3077
HURSTVILLE: 121 Forest Road. Tel: (02) 570 7000
GORE HILL: 188/192 Pacific Highway (Cnr Bellevue Avenue) Tel: (02) 439 4799

QUEENSLAND: **BURANDA:** 144 Logan Road. Tel: (07) 393 0777

MAIL ORDERS: P.O. Box 185, CONCORD 2137

HEAD OFFICE: 115-117 Parramatta Road, CONCORD 2137
Tel: (02) 747 2022 Telex: 72293

SHOP HOURS

Carlingford, Hurstville & Gore Hill
Mon-Fri: 9am - 5.30pm, Thurs 8.30pm, Sat 12pm
Sydney
Mon-Fri: 8.30am - 5.30pm, Thurs 8.30pm, Sat 12pm
Concord
Mon-Fri: 9am - 5.30pm, Sat 12pm

POST & PACKING

$5 - $9.99	$2.00
$10 - $24.99	$3.75
$25 - $49.99	$4.50
$50 - $99.99	$6.50
$100 - $198	$8.00
Over $199	$10.00

COMET ROAD FREIGHT ANYWHERE IN AUSTRALIA ONLY $13.50

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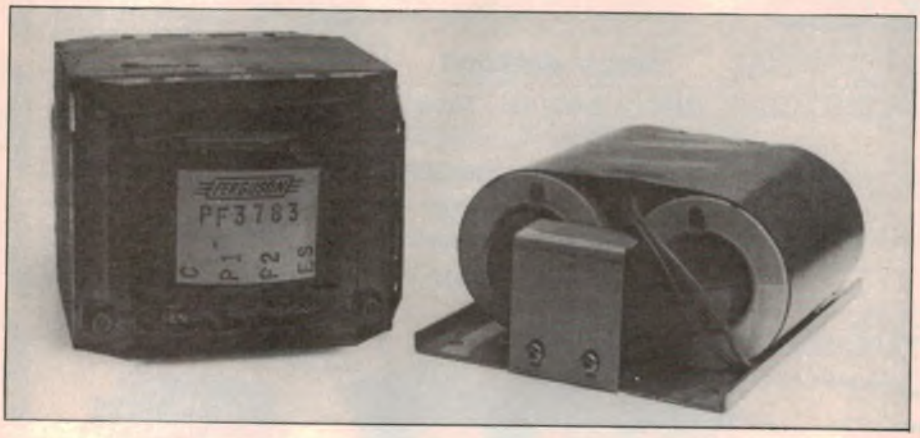
Product reviews, releases & services



Ferguson to produce "R-Core" transformers

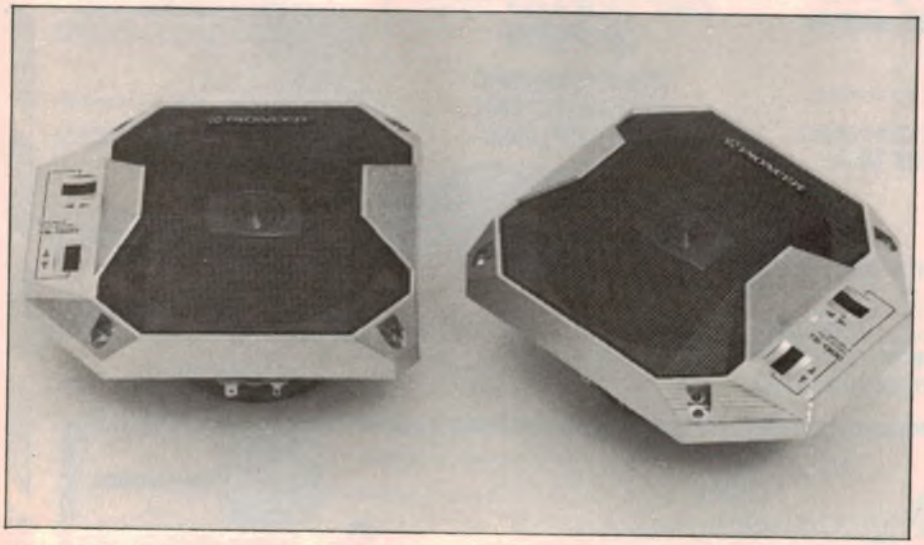
Ferguson Transformers are now manufacturing R-Core transformers to special order and has installed special winding machinery to handle the new product line.

The round section core offers considerable advantages in many types of equipment requiring transformers rated between 20 and 500VA.

The new construction offers the advantage of a 30% weight and size saving. In addition, the leakage flux is only a tenth that of E-I types and noise is greatly reduced since the core is sectionless. The transformer can thus be placed closer to CRTs without introducing flicker.

The R-Core construction meets the requirements of the various safety standards including UL and CSA. Initially, Ferguson will be manufacturing to order only.

For further information contact Ferguson Transformers Pty Ltd, PO Box 301, Chatswood, NSW 2067. Telephone (02) 307 0261.



PIONEER CAR SPEAKERS — looking for a pair of loudspeakers to go with our new 100W Car Stereo Amplifier? The new TS1300 car speakers from Pioneer are rated at 100W and feature a tweeter that can be adjusted for angle in either of two planes, vertically or horizontally. Recommended retail price is $199 per pair. For further information contact Pioneer Electronics Australia Pty Ltd. 178-184 Boundary Road Braeside, Victoria, 3195. Telephone (03) 580 9911.

PCB layout by computer

Technical Imports Australia has introduced a brand new PC software package that eliminates the tedium of producing printed circuit boards by hand with tape. According to the company, it also eliminates the high cost of a dedicated system.

The Auto-Router, as it is called, is a collection of software tools and circuit element templates which automate the task of routing tracks on a double-sided PCB.

Auto-Router runs on most MS-DOS compatible personal computers using the 8088/8086 chips and having 512K RAM. AutoCad is a pre-requisite to run the full package. Recommended price for the Auto-Router is $1740.

Further information is available from Technical Imports Australia, PO Box 176, Crows Nest, NSW 2065. Telephone (02) 922 6833.

Copper tape has many uses

Now available from Gifford Productions, Copperfoil Tape is thin pure copper backed by a special adhesive formulated to withstand high temperatures. It is ideal for soldered connections.

Suggested uses include prototype circuits, repairing printed circuits, burglar alarm systems, model railways, and moisture and level detection.

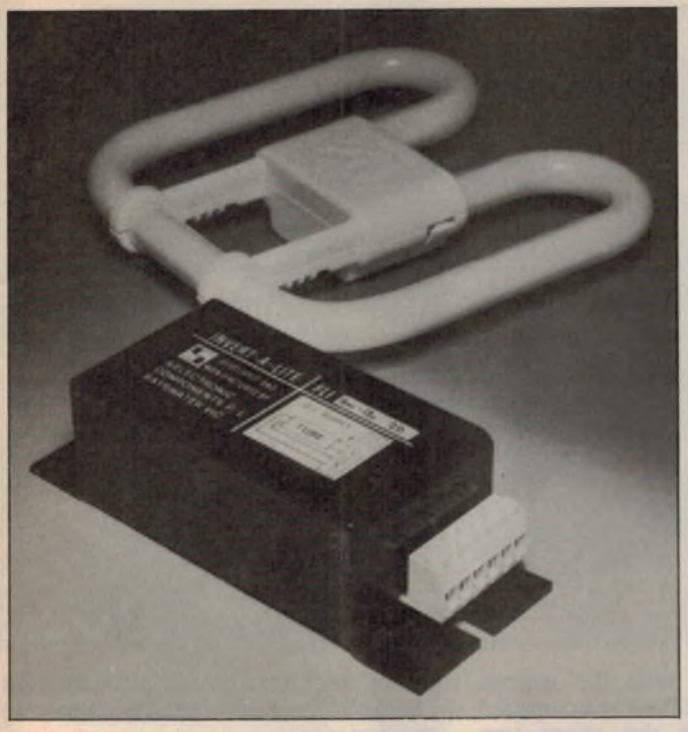
For further information contact Gifford Productions, PO Box 62, St Kilda, Victoria 3182. Telephone (03) 534 3462.

Shock sensor for burglar alarm

IRH Components now have available the Murata PKS series shock sensor which is ideal for use in burglar alarm systems as a vibration sensor. The PKS series can be set on desks, filing cabinets, doors, windows or automobiles; the sensor will transform any mechanical shock or vibration into an electrical signal.

The PKS series has a sensitivity of 40mVp/1G with capacitance of .01μF and a temperature range of -20°C to +60°C. Its compact build makes this shock sensor an ideal choice for security applications.

For further information contact IRH Components, 32 Parramatta Rd, Lidcombe, NSW 2141. Telephone (02) 648 5455.



New inverter for 2D fluoro lamp

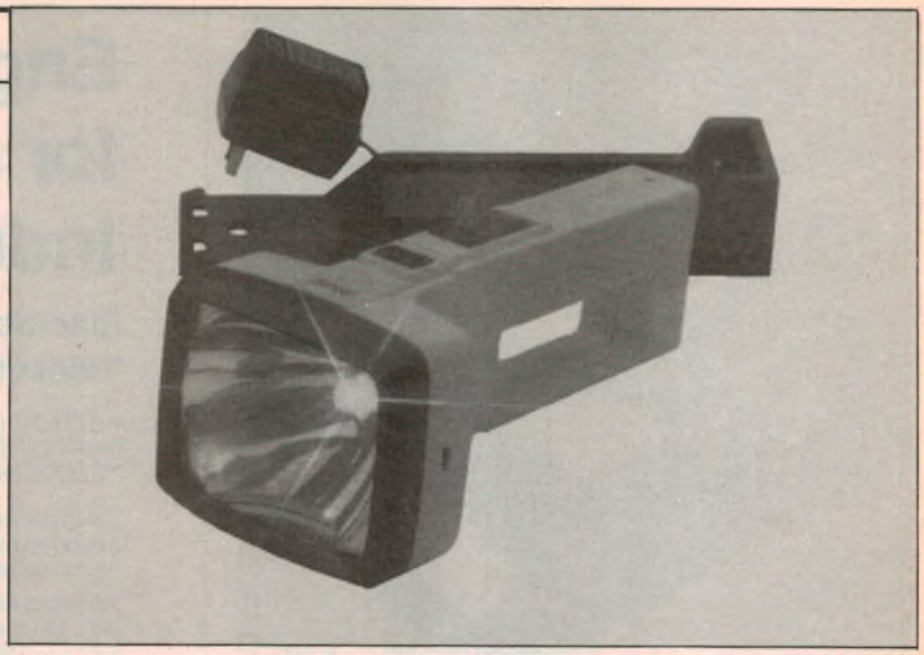
Selectronics has released a new compact inverter. Called Invert-a-Lite, it has been specifically designed to enable the popular 16W 2D fluorescent lamp to operate from a 12V or 24V supply.

The Invert-a-Lite is a fully solid state unit, encapsulated for ruggedness and resistance to moisture. Additional features are screw terminals for ease of installation, low current drain and reverse polarity protection. No ballast or starter is needed.

For further details contact Selectronic Components Pty Ltd, 25 Holloway Drive, Bayswater, Victoria 3153. Telephone (03) 762 4822.

New Products...

Rechargeable torch from Arlec



Arlec Pty Ltd has just introduced the RT800 — a rechargeable torch with several novel features. The RT800 incorporates three large capacity NiCd batteries which provide more than two hours of continuous use at maximum brightness. These batteries can be recharged continuously either from the mains or using the car battery.

The torch will stand either vertically or horizontally on any suitable surface, and the head can be swivelled through 90°. This feature enables the beam to be directed onto a particular spot while leaving the operator's hand free to carry out a job. An adjustable wire loop under the head can be used to suspend the torch from a wall or car bonnet.

In addition to the usual on/off switch, the RT800 also features a dim switch. This allows the torch to be used for much longer periods by reducing the light intensity and thus the current consumption. A wall bracket is supplied with the torch and this serves two purposes: (1) it enables the torch to be found quickly in an emergency, and (2) it functions as a battery charger.

The torch may be left on continuous charge in the holder without damage to the batteries.

For further information contact Arlec Pty Ltd, 30-32 Lexton Rd, Box Hill, Victoria 3128. Telephone (03) 895 0222.

Low cost word processor

The Epson company has entered the low-end word processing market by announcing a bundled hardware and software package which will retail for less than $2000.

This price will include the Epson PX-8 lap computer, an 80-column portable AC/DC printer and Wordstar.

The PX-8 features 64K of main memory and 6K of video RAM. ROM is 32K. The computer has a liquid crystal display (LCD) which shows eight lines by 80 characters. It also has an RS232C interface and a Z80 microprocessor.

Further information is available from Epson Australia Pty Ltd, Units 2 and 3, 17 Rodborough Rd, Frenchs Forest, NSW 2086. Telephone (02) 452 5222.

Fast, low-power CMOS static RAMs

A new line of 16K static CMOS RAMs from Solid State Scientific which feature access times as fast as 45ηs, low standby current of 0.5μA, and protection against alpha particles is now available in commercial and MIL SPEC 883C versions.

Designated the 21C16, they are organised as 2K words by eight bits, which typically operate on 40mA, and are furnished in a JEDEC standard 24 pin pinout. They use a full CMOS six transistor static memory cell that provides high speed operation and very low standby current.

The 21C16 is suitable for cache memories used in high speed minis, for fast new high-end 32 bit microprocessors like the 68000 and the 80286, and very high speed data communications buffers and the telecommunications processors.

Its high density and low power also reduces the amount of space required in writeable control storage systems for minicomputers and provides significant advantages for fault-tolerant minis requiring battery back-up.

For further information contact Sprague Electric, 56 Silverwater Road, Auburn, 2144.

NICHOLSON ELECTRONICS
ELECTRONIC ENGINEERS

TRADE SERVICES

Philips Tuner ECL2060 Exchange or Repair	$10.00
Other Varicap Tuners (Repair Only)	$14.00
Philips Mini Turret Tuner (Repair Only)	$12.00
I.F. Alignment Service Modules or TV	$16.00

MODULES

Philips U Series (K9/K11) Repaired	$16.00
Philips Power Supplies K9/K11 Repaired	$32.00

AWA THORN

4KA Exchange Modules

Power Scan	$30.00
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Convergence Yoke	$25.00
Convergence Handset	$25.00

THORN 3504 EXCHANGE MODULES

Power Supply	$30.00
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Chroma	$18.00
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Convergence	$20.00

HMV 212 MODULES (Repaired only at present)

S/M Power Supply	$30.00
IF/SND	$26.00
Horizontal Timebase	$30.00
Luminance	$20.00
Chroma	$20.00
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Convergence	$25.00

Custom Designed Test Equipment (1 week delay on all items).

TEST TUNER VHF/UHF—Isolated Output. Eliminates Tuner in any TV Internal Power Supply **$58.00**

PICTURE TUBE TESTER REJUVENATOR. Tests-Emission-Heater Cathode Shorts. Rejuvenate and removes cathode grid shorts. Includes 3 sockets and universal lead allowing almost any tube to be tested **$99.00**

SHORTED TURNS TESTER — Fits in toolcase. Includes 9v battery. Test for shorted turns in yokes L.O.P.Tx and other inductors . . . **$36.00**

ZENER DIODE TESTER — Direct readout of Zener voltages from 2v to 100v in two ranges. Internal power supply **$42.00**

VCR ALARM — Fits inside the VCR. Emits loud hee haw sound if the unit is lifted. Includes module — Mini Key switch. Ceramic transducer and 9v battery **$36.00**

Line Output Switch Mode Power Supply Tester Analyst. Clips in place of Line Output Transistors or chopper. Reads Drive, BT, Shorts, Pulse, Width, without Destroying expensive Transistors. **$120.00**
High Voltage Regulated Supply. Variable to 120 Volts/1 AMP folds down when overloaded **$120.**
Solid State Leakage Tester. Measures Leakage to 150 megohms Ideal for Testing Leakage in Transistor diodes Triacs Thyristors, etc. **$46.00.**
Car Burglar Alarm. Includes Flashing Dashlight-Key Switch Door-boot and Bonnet Switches, 10 seconds delay on doors, Instant on Boot and Bonnet. Flashes Lights — Beeps Horn **$70.00.**
Other Test Equipment still being developed. Colour Bar Generator — Signal Strength meter-Sweet and marker Generator — UHF Down Converter. Enquiries welcome.
BU126 chopper Transistors **$2.50** or **$2.00** 10up. BC548 BC558 General Purpose **14c 5up, 12c 10up** 2N3055-60v 10A POWER **$1.60 5 up, $1.40**

3 MONTHS WARRANTY ON ALL WORK AND TEST EQUIPMENT

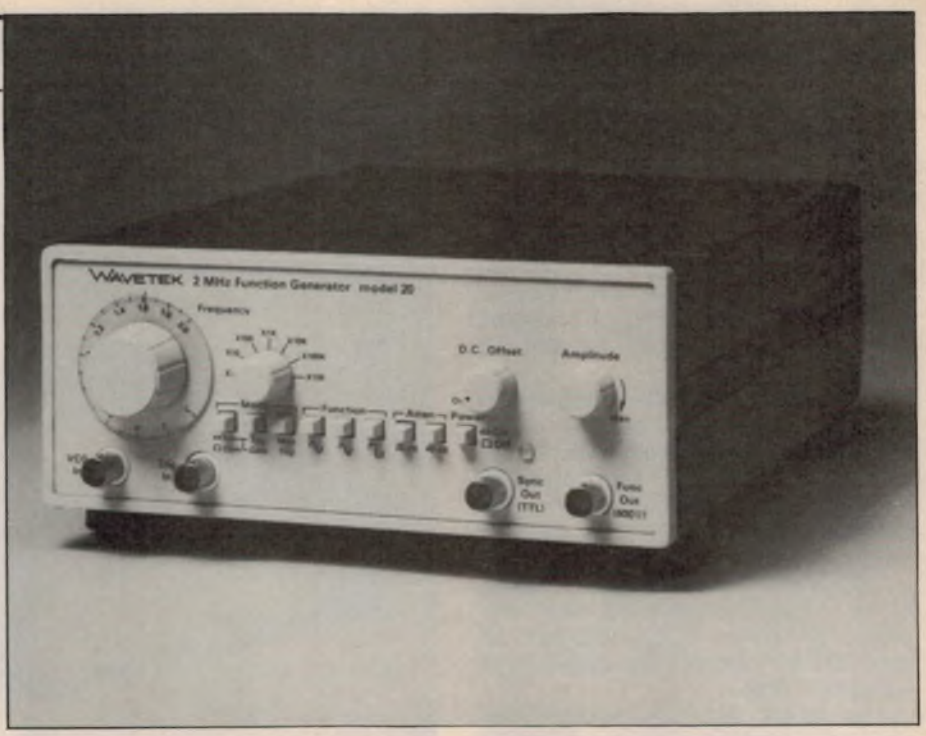
Prices do not include Freight Charges.

30 BRANDE STREET, BELMORE, SYDNEY, NSW 2192

(02) 759 8359 ***MAIL ORDERS WELCOME***

New Products...

Low cost function generator



New from Wavetek (California) is a function generator that covers the range from .002Hz to 2.1MHz in seven overlapping ranges. Each multiplier setting gives a full 1000:1 frequency range, and frequency may be set with the calibrated dial, externally modulated, or swept over the three decades available per range.

The Model 20 Function Generator operates directly from the line using an external transformer/battery charger, and will also operate from an external DC or AC source. In addition, it can also operate from NiCd batteries.

The unit has triggered and gated waveforms. In the triggered mode, the output is a DC baseline until a manual or external signal initiates a single cycle of the selected waveform. The gated mode produces a burst of waveform cycles for the duration of the external triggering signal.

The function output is fuse protected against accidental connection to power line potentials. The unit produces high-level outputs to 20V peak-to-peak. Attenuation is 0dB, -20dB selectable with 20dB variable for a total 80dB of amplitude range.

For further details contact Scientific Devices Australia Pty Ltd, Office 2, 35-37 Hume St, Crows Nest, NSW 2065. Telephone (02) 43 5015.

New Products...

Keyless car security

Dick Smith Electronics Pty Ltd has released a new car alarm that does not require a key. Instead, the alarm is switched remotely with a personal transmitter which is extremely small and lightweight.

The alarm features pushbutton activation or deactivation and comes with two personal remote switches, an alarm module, a siren and mounting hardware. The transmitters are user encodable for added security and the system has battery back-up capability.

The system works as a current sensing device — ie, it is activated when any power is drawn. When activated, it automatically cuts off the ignition and sounds the siren.

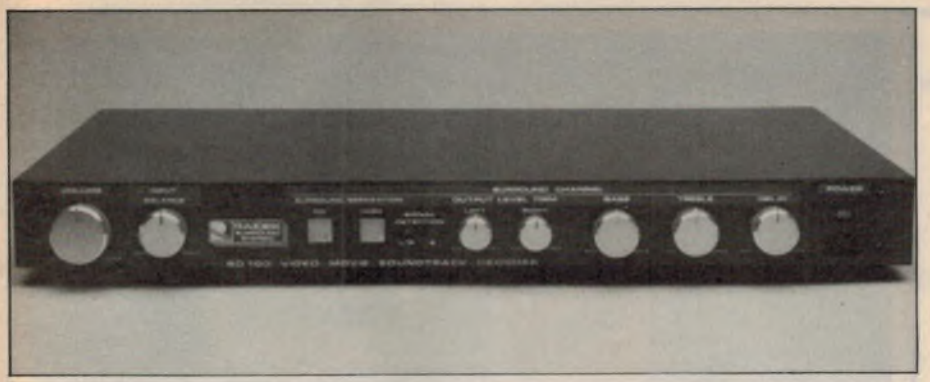
The alarm also has provision for connecting external sensors (eg, boot and bonnet switches). Recommended retail price is $159.

For further information contact Dick Smith Electronics Pty Ltd, PO Box 321, North Ryde, NSW 2113. Telephone (02) 888 3200.

PTC thermistors with external M3 thread

To protect individual components or entire circuits against thermal damage, Siemens now offer PTC thermistors in SW8 screwtype metal cases with M3 thread. These sensors are available in nominal threshold ratings from 60°C to 140°C, in steps of 10°K. The maximum operating temperature is 180°C and the dielectric strength 1.5kV. The resistance is less than 100Ω at 25°C, and 550Ω maximum at temperatures below the nominal threshold.

The steep rise characteristic and the facility for screw mounting make the



Surround sound decoder for video movies

An Australian company has developed a system to maximise the sonic effects of video movies. The Raidek Surround Stereo System has been developed to decode the additional channel from normal home stereo video cassettes which carry exactly the same two channel soundtrack as the Dolby stereo films, complete with the encoded surround channel.

The Raidek SD100 Video Movie Soundtrack Decoder (which also works with stereo movies broadcast or simulcast on TV) connects directly between a stereo VCR and a normal hifi system. The unit includes a proprietry decoder circuit (the operation of which matches the MP matrix encoding system used in the production of 35mm Dolby stereo movies), a delay line for the rear "surround" channel which takes advantage of the Haas effect to improve front to back separation, and two in-built 25W RMS power amplifiers to drive rear speakers.

Further information can be obtained from Raidek Sound Industries Pty Ltd, 30 Williams Road, North Rocks. Telephone (02) 871 7873.

new thermistors ideal for protecting individual components as well as entire circuits. The new sensors can respond very quickly at critical level because the screw thread ensures good thermal coupling.

For further information on this product contact Siemens Ltd, 544 Church St, Richmond, Victoria 3121. Telephone (03) 420 7204.

Arlec soldering iron kit

Arlec Pty Ltd have released a low cost soldering iron kit, the STK250. The kit consists of a 240V iron with spare bit, a safety stand, tip cleaning sponge and a coil of resin cored solder.

The soldering iron has a fast heating 25 watt element which makes it ideal for all those small to medium soldering jobs. A strong plastic handle is designed to remain cool during prolonged periods of use, and the barrel is stainless steel which will not corrode.

For further information on this product contact Arlec Pty Ltd, 30 Lexton Rd, Box Hill, Victoria 3128. Telephone (03) 895 0222.

Twin lamp indicator and switch

This is a combined twin lamp indicator and switch, which utilises a snap acting, low-level or solid-state Hall Effect switching action. This configuration ensures good switching results for both high and low level current switching applications.

The lamps are connected separately to allow for separate indication of different functions or connected together to provide a full display. The extended bezel acts as a barrier to prevent accidental switch operation. The front bezel measures 18mm x 24mm. It snaps through a panel cutout of 15mm x 21mm and is held firmly in place by four individual clips.

The Series 41 lenses are available in five different colours both in split and full screen. The standard T1¾ longlife midget lamp is standard (6V to 48V). Higher supply voltage requirements need a voltage dropping resistor or transformer.

For further information contact Associated Controls Pty Ltd, 55 Fairford Rd, Padstow 2211. Telephone (02) 709 5700.

New Products...

Wire-wrap from Cooper Tools

The technique of wire-wrapping is commonly employed in situations when soldering is not suitable. These situations include high density connections, and connections subject to stress, vibration, corrosive atmosphere or significant changes in temperature. In addition, wire-wrapped connections can be easily removed and re-wrapped.

A comprehensive selection of wire-wrap tools is now available from the Cooper Tool Group and include electrically-powered, air-powered and manual tools. Also included are stripping, cutting and skinning tools, and unwrap tools and accessories.

For further information contact The Cooper Tool Group Ltd, Nurigong St, Albury, NSW 2640. Telephone (060) 21 5511.

Below: the Wire-Wrap tool from Cooper Tools.

Tape cartridge back-up system

Wangtek has released a tape cartridge back-up system that features IBM PC, XT and AT compatibility. Using a combination of a precision drive mechanism and "Burst" track on the tape, the Wangtek drive will position its head relative to this "home track", thus allowing tape cartridges to be read in any other Wangtek drive.

Designated model PC-36, the package comes complete with cables, menu driven disk-based software and the drive unit. Mass storage is available on a single cartridge of 20 to 60 Mbytes with a 5 Mbytes per minute throughput. IBM PC-DOS 2.0, 2.10 and 3.0 will support the drive controller which plugs directly into the PC or PC/XT expansion slot.

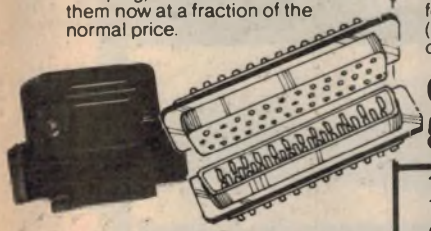
Further information is available from Daneva Australia Pty Ltd, 64-66 Bay Road, Sandringham, Victoria, 3191. In Sydney Daneva may be contacted at 47 Falcon Street, Crows Nest, 2065. Telephone (02) 957 2464.

Dollar Devaluation? Not at Sheridans!!

Electronics Galore! 1001 Stupendous Bargains!

RS232C Connector Sets

25 way RS232 connector sets at massive savings. Complete set with plug, socket and hood. Grab them now at a fraction of the normal price.



only $4.95 complete set

Resettable Counters.

ALL NEW

Brand new stock! These counters operate on 12V DC, 50mA at up to 10cps.

only $10

DIP Switch sale

Top quality .1" DIL type DIP switches going out at tiny prices.

10 way . . 5 for $6.00
5 pole . . . 5 for $4.75
3 way . . . 5 for $3.75

I.D.C type D-Submini Connectors

Perfect for the latest 'flat cable' I.D.C. connection cables. 25 way plug and socket. What an incredible bargain!

only $12.00 THE PAIR

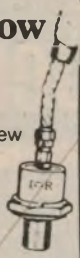
LAST FEW!! Save 66% on Philips Electros

Get in early. Stocks of Philips computer grade electros are going out at crazy prices. All brand new unused stock.

10,000uF/40V. $6.00
22,000uF/10V. $4.00
47,000uF/10V. $5.00
100,000uF/10V . . . $6.50

300V/150A Stud Rectifiers below Wholesale!!

Astounding savings! 300V forward or reverse voltage (please specify). All brand new current stock.



only $7.50
5 for $32.50

12 digit LED display

An experimenters delight. These superb 7 segment displays have right hand decimal point. Eight inputs for segments and 12 inputs for digits (cathodes). Anodes are internally connected. Limited stocks, grab them while they last.

save 40%

only $1.00 WITH DATA SHEET

Brilliant Flashing LEDs

MADE BY TELEFUNKEN

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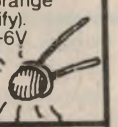

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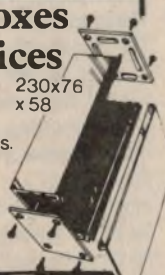

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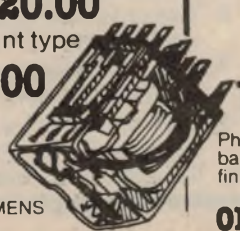

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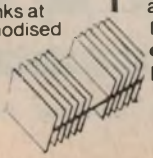

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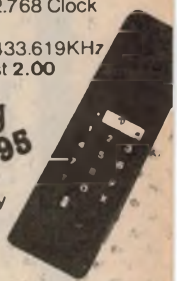

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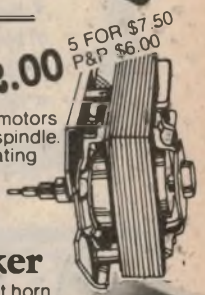

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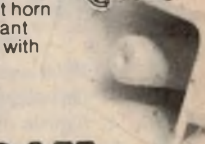

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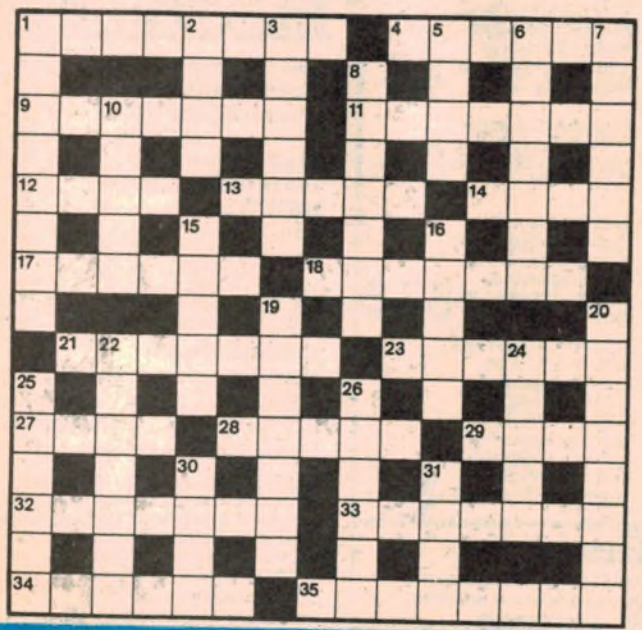


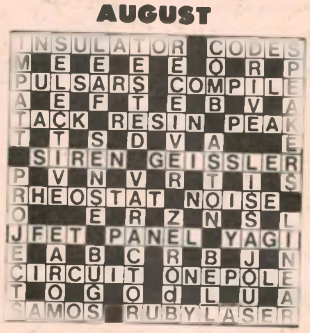
ACROSS

1. Metal used in certain capacitors. (8)
4. Adjusts components. (6)
9. Electrically oxidise a surface. (7)
11. Kind of disc. (7)
12. Picture problem. (4)
13. A gradual loss of magnitude. (5)
14. Inventive dissembler who fabricates whoppers. (4)
17. Physical quality related to work. (6)
18. Repetitions of video scenes. (7)
21. Space probe. (7)
23. Radio-transmitting fixture. (6)
27. The electronics funds-transfer system. (4)
28. Kind of semiconductor where electrons are the major carriers. (1-4)
29. Beginning of a monocrystalline boule. (4)
32. By birth, Galvani, Volta, and Fermi were such. (7)
33. Name of a force on a moving charge. (7)
34. Locating device in a control. (6)
35. Discoverer of X-rays. (8)

DOWN

1. Kind of parameter shown in electronic characteristics. (8)
2. Constituent of car battery. (4)
3. Non-uniform. (6)
5. Phonetic alphabet term. (4)
6. Type of cell with horizontal electrodes. (7)
7. Name of a series of satellite launch vehicles. (6)
8. Significant intervals in sound frequencies. (7)
10. Gas produced by electric discharge. (5)
15. Oscilloscope control acting on ordinate. (1-4)
16. High-pitched sound, sometimes from a radio unit. (5)
19. A use for the induction coil. (7)
20. Imperial form of binary 1100. (3,5)
22. Unlike charges do it. (7)
24. Type of room for chip fabrication, etc. (5)
25. Specification of a wave. (6)
26. Name of US spacecraft which docked with Soyuz. (6)
30. A pyrometer could measure its temperature. (4)
31. Suffix used for sub-atomic particles, accelerators, and electronic devices. (4)

SOLUTION FOR AUGUST



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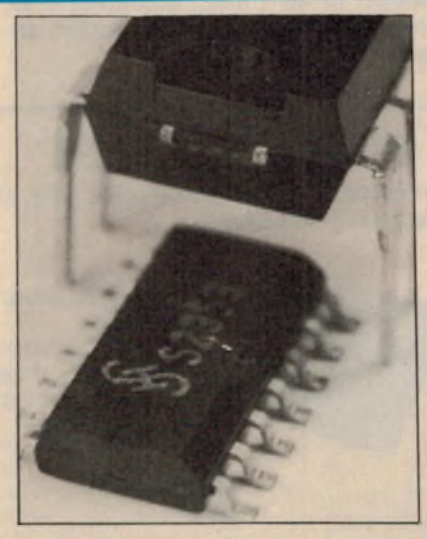

primarily intended for use as frequency-determining components.

For further information contact Siemens Ltd, 544 Church St, Richmond, Victoria 3121. Telephone (03) 420 7204.

REVIEWS OF RECENT
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BEETHOVEN

Piano Sonata No. 23, Op 57, The Appasionata. Sonata No. 7, Op 10, No. 3. Murray Perahia CBS Masterwork Analog Disc 7464 39344 1.

This is the first time I have heard Perahia in anything but sensitively shaded Mozart. I cannot imagine anything more drastically different in style than that of Mozart and Beethoven in the Appasionata. Mozart at his most furious never approached the brutish frenzy of the first movement.

Here is no passion of love but brutish violence and anger. There have been many opinions put forward in explanation of this outburst. The most likely is that Beethoven had become aware that he had contracted syphilis and was venting his anger at the discovery. Indeed, the heroic doses of mercury they prescribed in those days is thought to have caused his subsequent deafness.

Not unexpectedly, Perahia scales down the bashing anger of the first movement though in his hands there is no lack of fury. He just tempers it a little and sets it against the lyricism of the second subject. It is never less than totally effective. Briefly, he makes Beethoven more couth. And the great variety of sonorities he uses help the overall proportions.

Perahia is especially effective in the lovely plangent second movement. On me it has the effect of leaning backwards. It is really a set of variations with the melody always prominent.

In the Finale, Beethoven struggles to rid himself of his burden of anger and sorrow — with great success. It is a sectional rondo and one of the most peculiar movements Beethoven ever wrote.

The coda could not be taken faster than Perahia attacks it here and the piano tone is absolutely lifelike. The dynamic range, too, is always comfortable.

The Seventh Sonata is less frequently heard. The piano sonatas are generally considered to be Beethoven's most personal statements and this one is far happier than the Appasionata. The bustling first movement suggests a political argument — the composer was a very political animal — interrupted by some angry contradictions.

Perahia takes the second movement idyllically in true Beethoven style, far from the seraphic innocence of his Mozart. In the Finale, Beethoven is at peace with everything and supplies an amiably busy ending. (J.R.)

VERDI

Requiem. Anna Tomowa-Sintow (soprano), Agnes Baltsa (mezzo), Jose Carreras (tenor) and Jose van Dam (bass-baritone). Concert Association of the Vienna State Opera Chorus, Chorus of the National Opera, Sofia, Vienna Philharmonic Orchestra conducted by Herbert von Karajan. DGG Digital Recording (two boxed discs) 415 091/1.

The extreme width of the dynamic range betrays one into thinking that Karajan uses a heavy German hand in the early part of this wonderful Requiem. The orchestral surges sound too wide. In the Kyrie, the tenor seems desperately to force his voice.

Admittedly, the other soloists sound more relaxed but there are many violent contrasts which underline the old accusation that the work is too "operatic". To compensate, there is a glorious crescendo in the brass at the beginning of the Tuba Mirum.

On the other hand, the following passages are so soft that I thought for a moment my machine had stopped. That cursed dynamic range!

While dwelling on the less successful parts of the recording I might mention that the diction is so indistinct that I was often left wondering what language was

being used by both principals and chorus. Vocally, both women are most alluring without any trace of Eastern European wobble. The light bass is also fine but the tenor makes his efforts too obvious. Nor is he always dead on pitch.

When one has finally struck a compromise with the dynamic range problem, Karajan's role becomes clearly perceptible and elegant. The women and the baritone are faultless in tone and control and the marvellous Amen at the end of the first half, with the word's two syllables on the first chord of the plagal cadence retains all its magic, even when one is not necessarily in full accord with the reading.

In the Dies Irae, the timps tend to thump dully. Remember the old early recording of the work under, I think, Sabatini when Schwarzkopf delivered the penultimate words of the Libera Me Parlando with such a thrilling effect? I once asked her why she didn't repeat this effect on a subsequent recording and she replied modestly "it was what the conductor wanted."

Occasionally, all through, the four soloists in concert sing a little on the loud side, or perhaps are too near the mike. Now and again my equipment had trouble handling it. In the Offertorio the sound is good throughout and it is interesting to compare the tenor's efforts with the effortless techniques of the other three. The robust fugue in the Libera Me is splendidly imperative followed by the humility of the closing bars in which the women are quite seraphic. The orchestra and choir are fine.

Altogether a worthy if not always perfect set to own. (J.R.)

SCHUMANN

Symphonic Etudes. Arabesque Op 18. Maurizio Pollini (piano). DGG Digital Disc 410 916/1.

Pollini uses the first version he published of these studies. In a later edition he shortened the Finale, to some small benefit I think. He also includes the five early studies which Schumann repressed altogether. These are sometimes used on the concert platform — that great Schumann player Richter always does — but which many think are better served as a small encore.

Pollini's is a grand performance of the variations, big in manner and subtle in intent. The piano tone is full but frays a little at the edges in a tendency to reverberation. Schumann had the happy capacity to compose works that take the hands all over the instrument in a very characteristic style. Pollini is appropriately busy.

By the way, I might mention here that Schumann, to improve his stretch, used to sleep with some self-designed gadget on his hands which completely ruined them later for playing. There is no lack of variety in the many variations or changes of sonority in Pollini's touch. I am puzzled to decide whether the resonance is due to the recording or Pollini's overpedalling and have decided against the latter.

He uses a multiple touch with great effect. The sleeve notes make the whole of Schumann's conception plain and point out the difference in the variations with great skill. No wonder Schumann labelled them symphonic.

The fill is a nicely balanced account of the Op 18 Arabesque. (J.R.)

BARTOK

The Miraculous Mandarin (Ballet). Music for Strings, Percussion and Celeste. Detroit Symphony Orchestra conducted by Antal Dorati. Decca Digital Disc 411 984.

Bartok wrote little for the theatre, just an early static but beautiful opera, Count Bluebeard's Castle, and this ballet under review. The ballet had such a revolting story that it was soon hustled off the stage. This is set out in succinct detail in the record notes, which I quote in edited form.

Scurrying strings and hammered out woodwind chords suggest the turmoil of the city where, in a brothel, three thugs force a young girl to entice men from the street so that they may be robbed. She attempts to ensnare the passing men.

An elderly rake who is penniless is soon thrown out. She next lures inside a timid youth. He has no money either and is similarly despatched. Then comes a gorgeously attired Mandarin. The girl begins to dance a languid Waltz lasciviously but the Mandarin remains impassive.

Soon her dancing inflames her own passions while the Mandarin tries to possess her and pursues her relentlessly.

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The thugs leap out, rob him and then attempt to kill him, first by suffocating him under cushions, then by stabbing and finally by hanging.

They try in vain but his eyes are fixed on the girl. Only when the thugs cut him down and the girl takes him in her arms do his wounds start to bleed, desire flickers out and he dies.

These notes are sufficient to help newcomers follow the complex score which is as ugly as the story. But it is quite hideously coherent. Some bars are reminiscent of Stravinsky's Sacre and towards the end the chorus is well integrated. The sound is first rate.

On the reverse side, newcomers will find the Music for Strings, Percussion and Celeste a difficult nut to crack at first, though repetition should reveal its many beauties. It too is graphically described by the notes. The whole exercise is perhaps not the most enticing of Bartok's works but one which every student should possess. (J.R.)

IMPRESSIVE RECORDING

Serebrier conducting Wagner: Lohengrin, Prelude to Act III. Tristan & Isolde, Prelude and Love Death. Ride of the Valkyries. The Maestersingers, Prelude. The Sydney Symphony Orchestra conducted by Jose Serebrier. RCA stereo LP VRL1-0486.

The first minute of this disc was sufficient to make me sit up and take notice. The orchestra had a big sound, especially at the bass end, which suggested generous acoustics and good microphone placement, while the shimmering cymbal crash that followed could only have come via a digital master. And, sure enough, a quick check on the small print confirmed those impressions:

"Digitally recorded by the ABC in the Sydney Town Hall, July 1983".

Band 1, the Lohengrin Prelude is quite a short item (2'48") but sufficient to reveal the orchestra in fine form.

Band 2, Tristan and Isolde, is quite different in character, requiring sustained continuity and control in the sound rather than dynamic extremes. This selection occupies 17'13".

But band 3, the familiar "Ride of the Valkyries" (4'56") provides the real opportunity for the orchestra to display its sonic resources, and the engineers their equipment. It's a brilliant performance and a brilliant piece of black disc recording that could lead to its frequent use as a demonstration piece.

Track 4, the Maestersingers Prelude (9'43") rounds off an excellent disc, providing a large sound in a spacious sonic environment, with excellent definition, unmarred by noise and distortion.

In their rather brief jacket notes, RCA pay tribute to the conductor who, at 22 years of age, as associate conductor of Stokowski's American Symphony Orchestra (New York) was acclaimed by his mentor as "the greatest master of orchestral balance". Since then, he has spent two seasons with George Szell in Cleveland, has toured America, Europe and Australia and made numerous recordings for RCA.

The overall playing time of just over 35 minutes is less than generous but, if you appreciate classical excerpts, you'll enjoy what you hear. (W.N.W).

PLEASANT GOSPEL SOUND

The Listener's Collection; and Instrumental Keepsake. Stereo LP, Word 7-01-894910-6 (From Word Records Aust, 18-26 Canterbury Rd, Heathmont, Vic 3135. Phone (03) 729 3777).

Produced and arranged by Bruce Koblish, this new Word release features relatively recent and popular Gospel songs, arranged for "easy listening". It is predominantly instrumental, with the occasional addition of chorus, and "woven together" (according to the jacket notes) "with rich strings, sensitive woodwinds and mellow horns".

You may or may not be familiar with the songs and no lyrics are provided but that need not detract from the basic idea of simply relaxing and listening to just over 40 minutes of pleasant Gospel sound. The titles:

I Dedicate All My Love to You — Surrender — Lord of the Harvest — El Shaddai — Thy Word — Bethlehem Morning — Hosanna — We Will Stand — No More Night — You're the Only Jesus.

The sound quality is clean and well balanced and appropriate for family background listening. Indeed, in cassette form, it should appeal to the many motorists one sees, these days, with a fish symbol on the rear window! (W.N.W.)

FROM FINLAND

Jean Sibelius: Symphony No 2 in D Op 43. Finlandia, Op 26. The Cleveland Orchestra, conducted by Yoel Levi. Compact disc, Telarc CD-80095. (From P.C. Stereo Pty Ltd, PO Box 272, Mt Gravatt, Qld 4122. Phone (07) 343 1612.

Imposed by the Russians on Finland in 1899, the so-called "February Manifesto" was a repressive measure aimed at further depriving the nation of its autonomy, by curtailing freedom of speech and assembly. The resulting protest "celebrations", ostensibly organised to raise money for a pension fund for newspapermen, provided Sibelius with the opportunity and the motivation to compose the two works on this disc.

Two years previously, the Finnish government had bestowed a life grant on

STEVIE WONDER

Love Songs, 16 Classic Hits. Stevie Wonder. Stereo LP, Mowtown SFL1-0125. Distributed by Starcall/RCA.

According to the dates on the jacket and label, this is a recent (1984) compilation of Stevie Wonder hits from the period 1966-71, re-recorded from Mowtown masters. Described as love songs, they range from frantic to sentimental, with a break at the end of side one, for "Alfie", played on harmonica, with instrumental backing. (Who was it said that they preferred his harmonica playing to his singing?)

Being re-issues, Stevie Wonder fans may already have some or all of the originals and the logical course is to list the titles so you can check them out:

My Cherie Amour — Yester-me, Yester-you, Yesterday — Never Had A Dream Come True — If Your Really Love Me — Never Dreamed You'd Leave Me in Summer — A Place in the Sun — Alfie — For Once in My Life — We Can Work It Out — I Was Made to Love Her — Don't Know Why I Love You — Blowin' in the Wind — Shoo-be-doo-be-doo-da-day — I'm Wondering — Signed, Sealed, Delivered I'm Yours.

Technically, the sound quality is to normal pop-scene stereo standards and you need have no worries on that score if you want a string of Stevie Wonder hits for your collection. (W.N.W.)

Records & Tapes

the grateful 32-year-old composer, intended to free him from financial problems. He was already well known throughout Scandinavia and Europe and continued to compose music of a strongly nationalistic character, which tended to set him apart both in style and appeal.

Robert Kajanus, conductor of the Finnish National Orchestra and a contemporary and friend of Sibelius, interpreted this Second Symphony as a political statement. I quote from the Telarc booklet by Marc Mandel:

"In an article following the premiere, Kajanus described the Andante (the second movement) as 'the most broken-hearted protest against all the injustice . . .' He called the Scherzo (third movement) 'a picture of frenetic preparation', and the Finale 'a triumphant conclusion intended to rouse in the listener a picture of lighter and confident prospects for the future".

Whether or not this was Sibelius' express intention is a matter for debate but he is certainly saying something and Kajanus' suggestion could fit the man, the music and the situation. Playing time for the Symphony is 42 minutes.

"Finlandia" (77'43") is one of a number of works frequently coupled with the symphonies of Sibelius. It originated as a set of orchestral preludes for six historical tableaux presented at the abovementioned "celebrations", which explains its diversity of moods and dynamics. For many, the most familiar segment is a hymn-like melody, which was adopted into church hymnals as the tune "Finlandia" for the psalm/hymn "Be still my soul".

Recorded last year in the Cleveland Masonic Auditorium, using Telarc's time proven technology, the recording offers generous, well balanced sound and the wide dynamics required by the program, free of any problem of edginess on the large string section. Certainly well worth a hearing. (W.N.W.)

NEW MUSICAL

Andrew Lloyd Webber's "Song & Dance". Starring Sarah Brightman and Wayne Sleep. LP double album, Starcall 20114. Distributed by RCA.

For anyone with no prior knowledge of Lloyd Webber's rather unusual musical, there could well be a problem in coming to grips with this new, specially recorded show album.

In this respect, it is in strong contrast to the "Chess" album, reviewed in the July issue. Based on a familiar theme, "Chess" involved a full cast of stage musical stereotypes in the no less familiar context of east-west political rivalry. It arrived complete with synopsis and lyrics and added up to entertaining audio fare at the first hearing.

"Song & Dance" has no accompanying synopsis or lyrics — just a centrefold montage of stage shots, without captions, which suggest a storyline in song, involving a lone soloist, Sarah Brightman, fronted by a theatre orchestra and backed by a troupe of dancers. How it all fits together is not immediately obvious.

Sarah Brightman, Lloyd Webber's wife, is an extremely versatile 23-year-old dancer and singer with an effective voice range of three octaves, and a style range from Andrews to Merman! She is cast here as a wide-eyed English girl, just arrived in New York, who gets caught up with an already married showbiz type. When the affair falls through, she comes up smiling, philosophical enough to conclude that "It's not the end of the world".

Record 1 is devoted entirely to that and other Brightman songs and you can stitch the storyline together from the titles and her letters home to Mum — also in song.

Record 2 is predominantly choreographic orchestral, with tracks titled simply "Introduction and Theme" followed by "Variations" 1 to 23! Right at the end is an unexpected song — called "Unexpected Song" — again by Sarah Brightman!

The recording was made at a special performance in Webber's own "Palace" theatre in London before an invited (and highly enthusiastic) audience. It was recorded by BBC engineers for presentation on American TV, and, as such, is technically good. However, I would see it as one of those albums that will have its greatest appeal after you've seen and enjoyed the show. (W.N.W.)

Next month in Electronics Australia

HF Amateur Transceiver

Build yourself this HF amateur band transceiver from Dick Smith Electronics for just $329. It follows on from the Explorer UHF and Commander VHF amateur transceivers and boasts 30W PEP output; digital readout; CW, LSB and USB modes; and a sensitivity of better than 0.3dB (10dB S+N/N). It can be built to cover any 500kHz range within 2-30MHz (3.5MHz version described).

Mosfet Power Amplifier

Held over from our September issue, this Mosfet power amplifier module delivers 145W RMS into 8Ω and 225W into 4Ω at just .02% distortion. It features on-board loudspeaker protection and is easy to build.

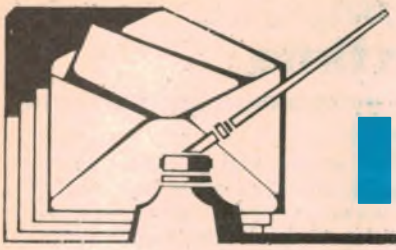
Special Feature on Home Security

Next month will include a special supplement on home and car security equipment. There will be information on all the latest alarm sensor technology and helpful hints on installation.

A Look at LCDs

This major article will discuss the principles of liquid crystal displays, their design and manufacture, their many applications, and the methods of driving them. Multiplexed operation will be explained, as will the techniques used to obtain colour displays.

Note: Although these articles have been prepared for publication circumstances may change the final content.



Information centre

No spark from dwell extender

In the February 1970 edition of *Electronics Australia* there was a circuit for a dwell extender. Just recently I made the device and although the article says that it increases spark energy, upon connecting it all up and wanting to start the engine there was no energy at all coming to the spark plugs. Everything checked out OK, but there was still no energy coming through.

After disconnecting the wire from the dwell extender to the negative terminal on the coil, the engine started. When I touched the wire to the terminal the engine stopped.

Could you please tell me what the problem is? The dwell extender is supposed to increase the spark energy instead of cutting it back to zero. (P.S., Heathcote, NSW).

● The most likely explanation is that either the SCR or the parallel diode is breaking down due to high voltage kickback from the coil when the points open. If this happens, there will be no spark. Try substituting a C122E for the SCR and use a 1N5408 1000V diode.

We should point out that this circuit is now outmoded. While it does increase the coil energy (in theory), it does nothing to relieve the switching load on the points. If you are considering adding electronic componentry to your ignition system, you would be far better to go the whole hog and install one of our transistor-assisted ignition systems with dwell extension.

A suitable Transistor-Assisted Ignition system was published in our February 1983 issue (File No. 3/TI/17), while breakerless triggering circuits for this unit were published in December 1983 (File No. 3/TI/19) and September 1984 (File No. 3/TI/20).

Problems with tacho/dwell meter

When looking through EA May 1982, I noticed a project for a tachometer/dwell meter that seemed within my grasp. I assembled two, checking the components carefully before inserting them in the PCBs. In each case, the display works for both the tachometer and dwell meter. However the numbers in both modes hunt, by thousands in the tacho mode. There appears to be no pattern, going from 1600 down to 200 for example.

I rechecked the components and replaced the IC with no result. I checked the PCB for errors and continuity. I used an oscilloscope to check pulses from board to display and between other points on the board.

I have been working on this intermittently for two months and am getting frayed at the edges. Some directions concerning my problem would be most welcome. (A.T., Greenmeadows, Napier, NZ).

● First, check that the output voltage from the regulator is around +9.4V and that the voltage on pin 14 of the DPM-200 module is a steady +7.5V. The voltage on the common pin (4) should be +4.7V. If all these voltages are correct, check for open or short circuits to the pins of the DPM-200 module.

Apart from that, we can only suggest that you clean between the pins of the DPM-200 using a sharp needle. The DPM-200 functions as a millivoltmeter, so any leakage current between the pins of the module will lead to false readings.

Finally, we are puzzled as to how you could get a reading of 1600 on the tacho range since this would represent 16,000rpm! Note that the rpm value is the display reading multiplied by 10. This means that the unit should be calibrated to read 150 (1500rpm) for a 4-cylinder engine, 100 (1000rpm) for a 6-cylinder engine and 75 (750rpm) for an 8-cylinder engine.

Transistor-assisted Ignition system

I have assembled and used the Transistor-Assisted Ignition system in my car since the updated version was published and have been extremely happy with its performance. The result has been a noticeable increase in power/economy and much cleaner burning in the head and plugs.

In New Zealand, the use of CNG (compressed natural gas) as an alternative to petrol is becoming extremely popular, not least of all because its cost is 40% that of petrol. The range is somewhat limited and so it is necessary to be able to swap between gas and petrol.

I would like to still use the TAI I constructed but would need to introduce a switchable 15° (approx) delay on petrol as gas needs this degree of advance to burn properly. There are dual curve ignition systems available here which I believe to be unreasonably expensive and not as good as the EA TAI design.

Do you have any ideas on how I might go about designing and constructing this delay unit? (A.C., Auckland, NZ).

● One approach would be to modify the distributor by fitting a second set of points. These could be mounted on the breaker plate opposite the original set of points, but offset by the required 15°.

It would then simply be a matter of using a dash-mounted toggle switch to select between the two sets of points. Make sure that the second set of points do not foul the advance mechanism in the distributor.

Wrong ranges on Function Generator

I recently built the Function Generator with digital readout as described in EA, April 1982.

Instead of the ranges varying from 10Hz to 1700Hz, 1000Hz to 17,000Hz and 10,000Hz to 170,000Hz on ranges 1, 2 and 3 respectively, it ranges from 10Hz to 170Hz, 100Hz to 1700Hz and 1000Hz to 17,000Hz.

The values of the timing capacitors were checked and were OK. The value indicated on the display corresponded with the frequency at the output terminals. All other functions work correctly.

Also is it possible to connect pin 3 of IC7b to a switch and plug, and use the digital display as a frequency counter?

● We suggest that you check the frequency determining components on pin 7 of XR2206 function generator IC.

In particular, check the values of the 1MΩ and 5kΩ trimpots and the 4.7kΩ resistor, and check that the output of the 7905 3-terminal regulator is at −5V.

Note that the readout must be multiplied by 10 on range 2 and by 100 on range 3.

A DFM (digital frequency meter) adapter circuit for the Function Generator was described in our June 1984 issue. This adapter circuit amplifies the input signal so that it exceeds the positive and negative thresholds of Schmitt trigger IC7. Copies of the article are available from our Information Service for $3 post paid.

Unstable Multiband Superhet

I recently built the Multiband Superhet (EA, November 1980). The receiver works OK except for severe "motorboating" or instability whenever the volume control is advanced more than one quarter of its travel.

Using a CRO, I noticed high frequency oscillations on the loudspeaker line and the LM380 got very hot. The motorboating is more like a low pitched chirp and, when this happens, completely cuts out the signal.

Please note that I am using the receiver correctly as indicated on pages 49 and 51. I have received many stations but am forced to listen to them at low volume. Can you help? I've built many EA circuits — this is the first one to give problems. (K.V., Petaling Jaya, Malaysia).

● The LM380 IC has proven to be a notoriously troublesome device, both in this circuit and in others. There are two possible solutions to the problem: (1) you could substitute the TBA820M IC and modify the circuit as in the Stereo Television Sound Receiver (March 1985); or (2) you could use a separate discrete transistor amplifier as published in November 1984 EA.

Driveway Sentry has bugs

I recently completed construction of your Driveway Sentry Mk.2 (EA, March 1985) and although the project basically works well, it is plagued with several bugs.

First, the circuit is prone to false-trigger at random during both hours of darkness and daylight. I finally ascertained that this false triggering coincided with the operation of mains-powered equipment in other parts of the house, particularly fluorescent lights.

Another problem is that the circuit will often lock on and cycle through two or more timing cycles before finally switching off. Finally, the daylight sensing LDR appears very sensitive and inhibits the circuit down to very low ambient light level. Apart from partially masking the LDR, could the circuit be modified to make the sensor slightly less sensitive?

● With regard to the false triggering problem of your Driveway Sentry Mk. 2, there are several approaches which may help. The first job is to determine whether the false triggering is originating in the detection circuitry (IC1, etc) or in the timing circuit (IC2).

A convenient method of testing the circuit would be to disconnect the anode of D3 from IC1b and allow the circuit to operate for some time. Should the false triggering still occur, the problem has definitely been pinpointed to IC2. If, on the other hand, no false triggering is apparent, the fault is most likely to be in the detection circuitry.

Should IC2 prove to be the cause of false triggering, try decreasing the value of the 180kΩ resistor connected to pin 12. Also, try soldering a 0.1μF ceramic capacitor across the supply pins of IC2. If the manual trigger option is included, keep the associated wiring short.

If the detection circuitry appears to be faulty, try soldering 0.1μF capacitors across the ambient LDR and across the IC supply pins.

It is likely that the multiple cycling is due to the same problem as the false triggering.

The daylight inhibiting function can be made less sensitive by decreasing the value of the 18kΩ resistor connected to LDR2. As this will also affect the circuit hysteresis you may also need to make a similar adjustment to the 82kΩ feedback resistor connected to pin 9 of IC1c.

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Nasal output from sound processor

After constructing several VCR Sound Processors (EA, April 1984), I have only one annoyance to contend with and hopefully rectify with your help. Is there any way to subdue or eliminate the "nasally" sound that is present in the right channel output of this unit. Normal equalisation and graphics have no audible effect on this annoying sound. (A.K., Chipping Norton, NSW).

● Because of the comb filter effect used to synthesise stereo it is inevitable that there will be some colouration effects in the music content. It is not possible to produce a simple cure.

Problem with EPROM copier

I have a problem with the EPROM Copier project published in your December 1984 issue.

I built the project but am unable to get it to work at all. All components and the layout have been double checked and, using a CRO, I have obtained all the waveforms shown in Fig. 2 of the article at the appropriate points of the circuit.

I am trying to copy from a 2716 onto another 2716. Can you suggest any mistakes that I may have made or whether other constructors have found any difficulties with this circuit? Also have any modifications been made to the circuit since the December 1984 issue? (B.H., Kilburn, SA).

● Firstly, we assume that you are not using TMS2716 EPROMs from Texas Instruments. This EPROM requires three separate supplies and a different

programming procedure to other 2716s (see Notes and Errata, April 1985).

A second possible reason for the copier not functioning correctly is that the copy EPROM has not been erased correctly before programming. If these problems are not the cause, then we suspect either incorrect switch settings or incorrect supply voltages.

We suggest that you use the table shown in Fig. 1 in the original article to check that the correct voltages appear on the pins of the master and copy EPROMs during programming. Check also that the Vpp pin is at +25V during programming.

Remote Infrared TV Sound Control

I built the Remote Infrared TV Sound Control (EA, January 1983) but have a problem with it. The receiver part counts down either due to the afternoon sun, heating appliances or for no obvious reason at all. It appears that the detector diode becomes saturated due to the high ambient light (radiation), which is resulting in poor gain.

Could you please suggest a circuit variation, or any other solution, to decrease the sensitivity of the diode to other forms of radiation. Decreasing the 47kΩ series resistor to 39kΩ, as I have done, only partly decreased the ambient radiation sensitivity but at the same time, naturally, sensitivity to the transmitter has also decreased, although not too drastically. (P.I., Rostrevor, SA).

● The most likely cause of your problem is RF interference picked up by the amplifier circuit (Q1-Q4). In particular, the amplifier is sensitive to the high level of interference generated by the line flyback pulses in the TV set. Try moving the amplifier further away from the line output stage.

Deluxe Car Burglar Alarm

I recently constructed the Deluxe Car Burglar Alarm (EA, May 1984) using the reed entry switch and came up with a few minor problems.

(1) Occasionally when the reed switch is activated the alarm triggers off.

(2) When the alarm is triggered the tone of the siren dips occasionally.

Could you please offer some advice that may remedy these problems, especially the first. (T.B., St Albans, Vic).

● The most likely cause of the problem is that capacitor C4 (47μF) is not discharging completely, possibly due to high internal impedance. We suggest that you try replacing C4 with a low-leakage type. If this fails, try replacing the reed switch.

It is quite normal for the siren tone to dip occasionally. This is due to beat effects between the oscillators that drive the siren circuit.

Trouble with Low Fuel Indicator

Having constructed the Low Fuel Indicator (EA March '82), I seem to be having a problem with the device. It functions as it should except when the fuel in the tank is around the critical level. Within about five litres of the point where it should trigger the unit starts buzzing every time I turn a corner or use for example the headlights, brakelights, etc. The buzzing can be extremely annoying.

My vehicle has no instrument stabiliser and the sender unit has least resistance when the tank is empty, so I have used the negative triggering circuit and the 10Ω resistor and 16V zener.

In the last six years since I have been buying EA, I have not come across a project for a gas detector. I would like to install one in my caravan to detect propane gas. A number of cars on the road have converted to LPG and would also benefit from this project.

Have you given any thought to this type of thing and can you help? (S.M., Woodville West, SA).

● The false triggering that occurs during cornering is due to the fuel sloshing about in the tank. To overcome this problem, try increasing C1 (pin 2, IC1) from 2.2μF to 33μF. Note, however, that the buzzer will now sound only after a half minute delay if the ignition is switched on and the car has an empty fuel tank.

This is the first time that we have heard of any problems with this circuit due to voltage transients. The following modifications are recommended as a cure: increase R1 to 180kΩ; increase R2 to 560kΩ; increase R3 to 4.7kΩ; increase RV1 to 100kΩ; and connect a 33μF low leakage electrolytic capacitor between pin 3 of IC1 and ground (positive to pin 3).

These modifications are designed to ensure that pin 3 of IC1 does not drop below pin 2 due to supply voltage transients.

We are unable to help you with a gas detector. We have published several circuits but the sensors for these projects are no longer available.

Revamping an old tape deck

I have on hand an old but rugged and well-constructed reel to reel tape deck. I would like to try to revamp it with modern heads and circuitry. I aim to end up with something like a commercial standard "two track" recorder. It would also seem to be a simple operation to change the tape speed to 15ips.

Could you please refer me to a firm who might be able to supply modern heads and circuit boards? (O.J., Inglewood, Qld).

● Unfortunately, we know of no firms which can supply suitable heads and circuit boards. It is doubtful whether the project would be viable in any case, since these parts are quite expensive, particularly when purchased as spare parts from hifi distributors.

Hifi Review . . . ctd from p103

With some trepidation, we applied this to the MS-10. "Whump" went the woofer cone and the current rose immediately to around 6 amps. A quick calculation shows that around 180 watts was being dissipated in the woofer voice coil. This would normally burn it out in short order but the Positec protection system knocks the current back to a fraction of an amp in about a second or so. Apart from that, nothing untoward happened, we are pleased to say. The fault condition must be removed for the thermistors to revert to their normal low resistance condition.

Thus Positec is a most worthwhile feature which allows the speakers to be used to their full potential, with higher power amplifiers than normal prudence would allow. So both the MS-10 and MS-30 can be used with amplifiers from 30 to 300 watts per channel.

Both loudspeaker systems can be thoroughly recommended, depending on your space and listening requirements.

Recommended retail price of the MS-30, at the time of writing, is $550 per pair and for the MS-10, $350 per pair.

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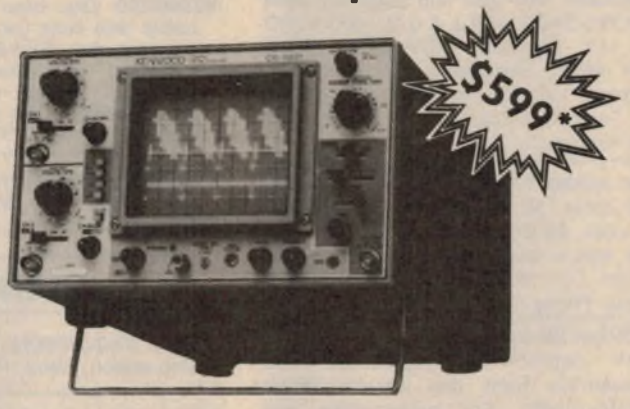

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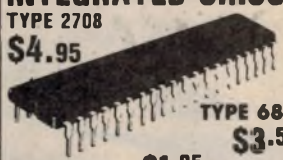

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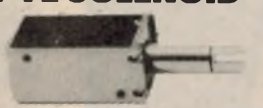

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24V DC 10 WATT CLOSED ● PULL . . 18MM 50 GRMS ● 12MM 100 GRMS ● 6MM 300 GRMS ● 2MM 1 KG ● AT 10MM SNAPS IN SHARPLY OFF 13.8 VDC ●

$7.95 P-P NSW $1.50 INTERSTATE $2.50

HIGH GRADE POTTER AND BRUMFIELD RELAY

P-P $1.50 **$3.50**

KU series ● 240 VAC 50Hz operation ● 3 sets of 240V 10 amp change over contacts ● perspex cover and mounting base included ● size 50mm x 37mm x 35mm ● ex-computer ● as new condition. At less than 1/3 of the normal price.

REGULATORS

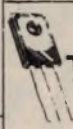
7812 + 12V 1A
7805 + 5V 7905 − 5V 1A

10 MIXED $7.95

78L05 5V + 100mA
79L05 5V − 100mA

10 for $3.95 P-P $1.50

MJE 350 TRANSISTORS



PNP 300V .5A

P-P $1.50 **10 FOR $3.50**

DIODES

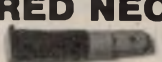
650piv 3 AMP
50 FOR $9.50

IN 4004. 400 piv 1 AMP **50 FOR $4**

IN 4148. 75 piv 200mA **50 FOR $3.50**

P-P NSW $1.35. INTERSTATE $1.70

RED NEON

240V AC  INDICATOR LAMP

10mm SQ REFLECTOR. 40mm LONG PUSH FITS 9mm HOLE

10 FOR $6.95 P-P $1.50

TRIAC

TYPE 225D

SENSITIVE GATE

400V. 10AMP

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OR $1.95 EA. P-P $1.50

TUNING CAPACITOR

$5.75

P-P NSW $2.00 INTERSTATE $2.75

3 gang, 60pF, 200pF AND 415pF IDEAL for A.T.U., etc. Top quality Ball bearings, 55X45X40mm.

A AND R POWER TRANSFORMER

Primary Tapped from 200V to 250V 50Hz.

Secondary 0—20. 30.48V 2.5 Amps.

Size 95X80X85mm

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$2.25 EACH  BY X21L 100

100 PIV. 80AMP PRESS FIT

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PLESSEY CAPACITOR

IDEAL FOR  55X30 mm

CAPACITOR DISCHARGE IGNITION

1.5μF 440Vac 50Hz. 1200Vdc

P-P $1.35 **$3.95** EACH

MODEL MOTOR

1½ TO 3VDC
Mini Size
34 x 24mm
Shaft
1.5 x 8mm

High RPM. Good Torque. A1 Quality

$2.75 EACH P-P $1.35

GEARED MOTOR

240VAC 50Hz 3W

$3.50 P-P $1.50

5 RPM Plenty of torque With Cam and N/O N/C microswitch 15 switch contacts per min OA size 65 x 60 x 35mm.

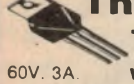
HIGH POWER HORN SIREN WITH PROGRAMMABLE TIMER

TOP QUALITY ● WEATHERPROOF ● 5½" DIA ● 12VDC 10W ● WARBLER TONE ● OUTPUT 105dB @ 1M ● ADJUSTABLE FROM 30 SECONDS TO 5 MINUTES ● INBUILT ●

ONLY **$33.95** P-P NSW $3 INTERSTATE $4.50

STANDARD MODEL (NO TIMER) **$20.95** PLUS P-P

TRANSISTOR



TIP 31 NPN with Heat Sink

60V. 3A.

10 FOR $7.50 P-P $1.50

CRYSTAL

3.579545 MHz. Mini Solder in.

95c P-P 75c

FOR REGISTERED POST, ADD AN EXTRA $3.65 TO PACK & POST CHARGE.

WE BUY

ADVERTISING INDEX

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Only Siemens offers a full 12 months warranty on popular 3.5" and 5¼" floppy disc drives. This reinforces Siemens reputation for reliability in floppy disc drives . . . reliability that's due to brushless direct drive DC motors.

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- ☐ Competitive prices. Check with your Siemens distributor. You'll be pleasantly surprised.
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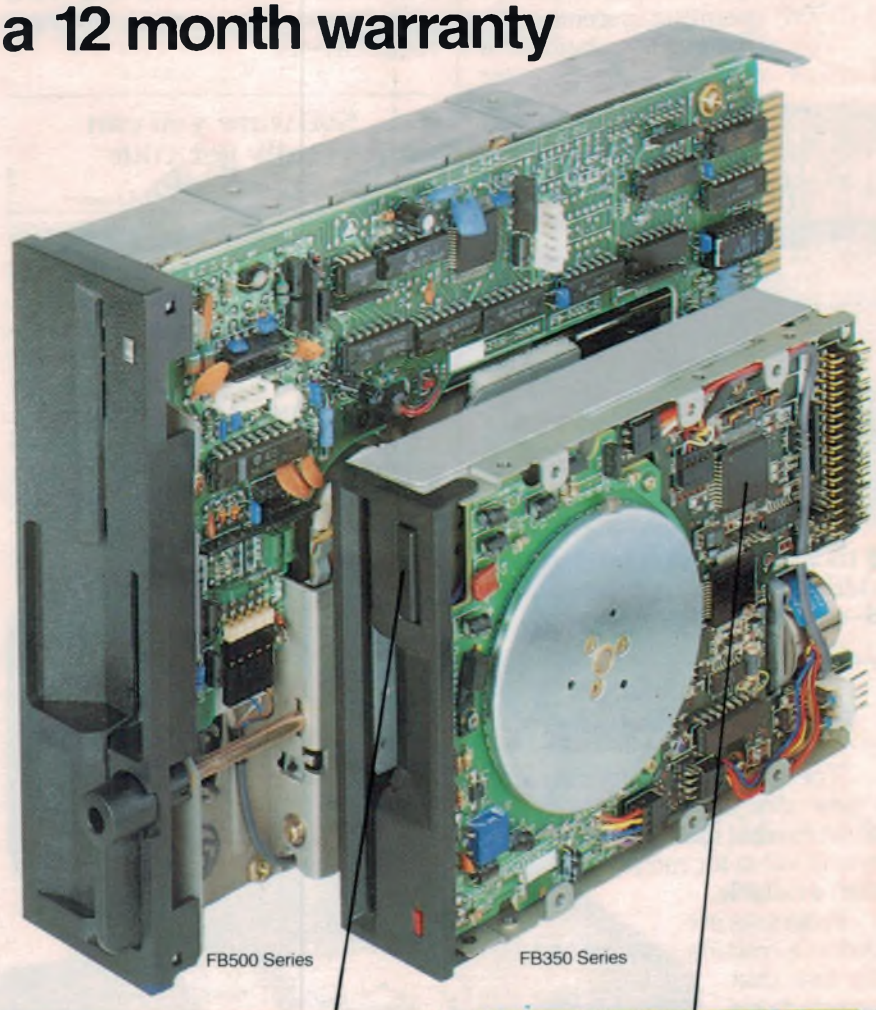
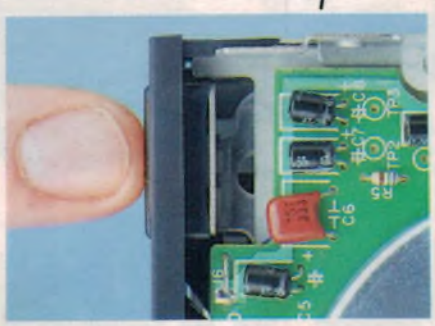
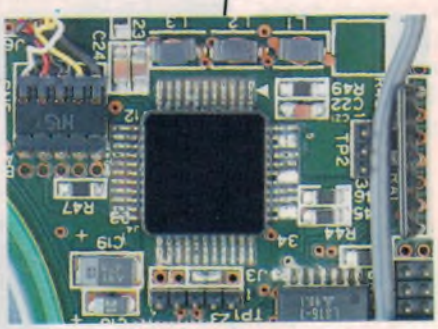
- ☐ Noiseless operation, due to a radial gap motor.

Note: Both sizes are available in four models . . .

Phone your nearest distributor for detailed technical information.







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Who says business and pleasure don't mix?

With the introduction of the CPC664, Amstrad has stolen a further march on its competitors in the home and personal computer market.

Featuring a built in floppy disc drive mated to an improved version of the popular CPC464 computer, the CPC664 incorporates both AMSDOS and CP/M* operating systems.

You also have the choice of a full colour or green screen monitor

Introducing the Amstrad CPC 664 with floppy disc drive

and there is provision for a second disc drive and data cassette recorder to be connected to the system.

Rapid loading. Instant cataloguing.

The ease and convenience of the new disc drive is a welcome addition to what must rate as the best all round value-for-money system available.

Programs are loaded in a fraction of the time that a cassette takes and cataloguing is instantaneous. Both sides of the disc can be used, each offering up to 169K of formatted space, with CP/M system tracks attached. Other improvements include a light yet positive membrane keyboard, a regrouping and restyling of the keypads and much broader sound and graphics capabilities.

This means the CPC664 not only offers greater scope for entertainment and educational uses, but it also meets many serious business requirements.

Software you can really get your teeth into.

The system comes complete with an introductory disc covering both CP/M and Dr Logo. In addition, almost all existing CPC464 programs run on the CPC664. Add to that Amstrad's own range of disc-based CPC664 software and the excellent range of custom CP/M programs available already, and you have a system that breaks a lot of new ground for both home and business users.

There's a vast range of games and educational programs from Amstrad and Melbourne House, plus serious business programs like AMSWORD, Masterfile, DEVPAC, Entrepreneur, Micro-spread and Amstrad Business Control System, to name a few.

A complete disc system from around $800

The Amstrad CPC664 is the equal of many business computers costing hundreds, even thousands, of dollars more. Yet, amazingly, the complete system with computer, disc drive and monitor is yours from around $800.

The system is distributed and guaranteed throughout Australia by AWA-Thorn and is available at leading retailers and computer stores. Ask for a demonstration today and you'll agree — no other system adds up to Amstrad.

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