$2.35* NZ $2.75 JAN 1983

eti

ELECTRONICS TODAY INTERNATIONAL

HI-FI

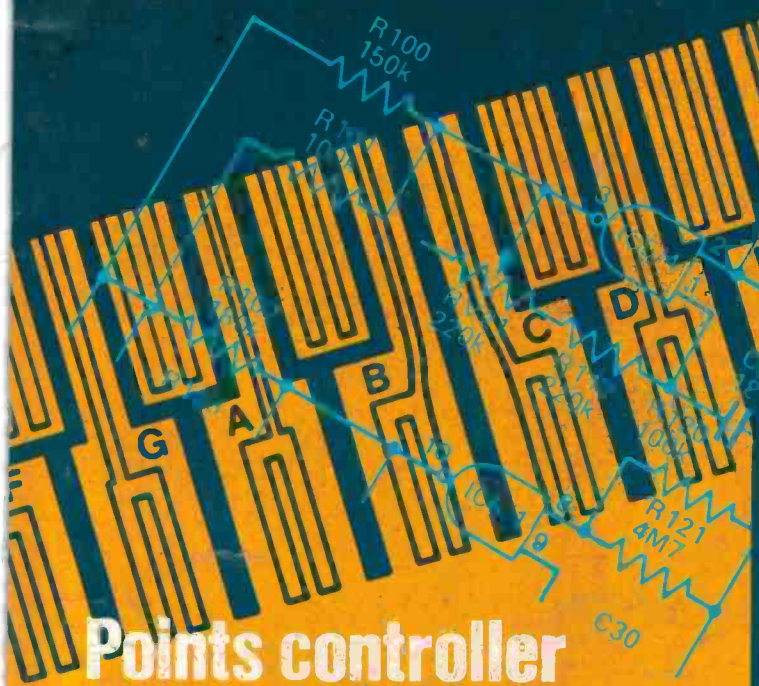
Marantz SC-6/SM-6 amp and preamp "..bordering on perfection"

POLYPHONIC `TOUCH ORGAN' TO BUILD

two octave range
two voices
speaker output

60W Amp. module

very low distortion using two nested differentiating feedback loops



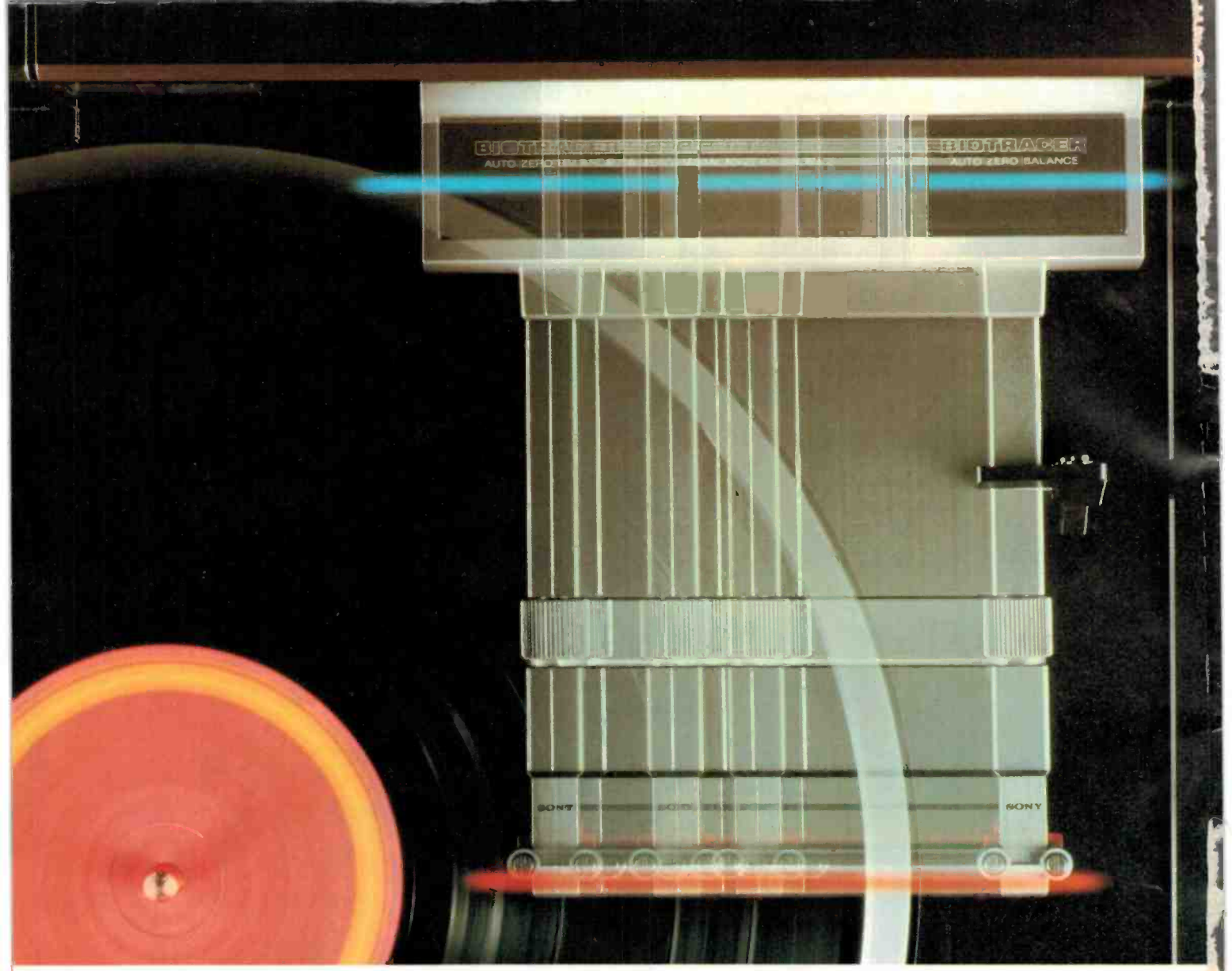
Points controller for model railways

Fault-finding your `660 Learner's Micro

SPECIAL OFFER!

LCD Multimeter for under $100

Introducing the MicroBee column!



Off on a tangent with Sony.

We didn't jump into tangential tracking turntables right off the bat. And Sony hopes you didn't either. Because while most lateral tonearms don't exactly shift gears as they travel down their path, they do run into some rough spots. A hang-up called "cogging" that inhibits totally free flowing movement, and hampers left and right stereo separation.

Sony has alleviated cogging and out of phase problems with an invention called Tangential Tracking Biotracer.

Controlled by two microcomputers and four sensors, the motion of the Biotracer tonearm is continuously fluid for precise phase alignment of the stylus.

PS-X800

To the average person these differences may sound slight. But if your standards are as high as Sony's, you'll understand the angle we're driving at.

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THE ONE AND ONLY

SON 0116

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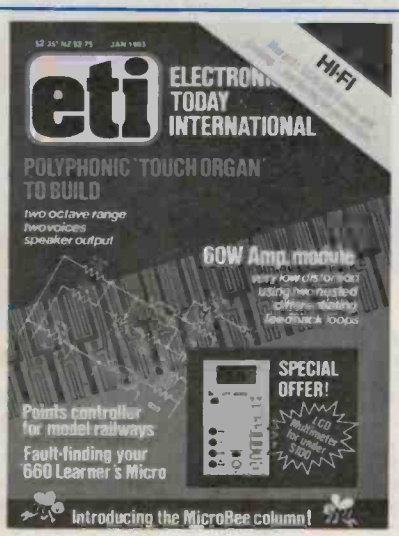
news

contests and special offers

general



A graphics montage of parts of the pc board and circuit from our Polyphonic Organ project adorns the cover this month.

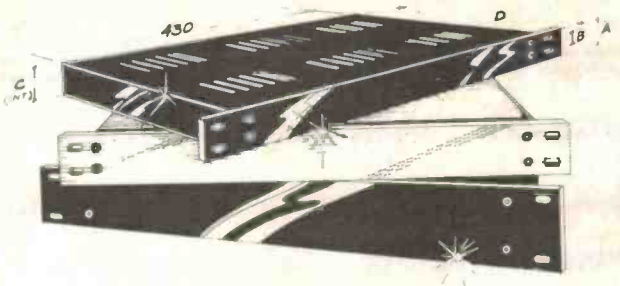
Cover design: All White

Registered by Australia Post — Publication No. NBP0407
ISSN No. 0013-5216

ALTRONICS ... ALTRONICS ... ALTRONICS ... ALTRONICS ...

YOUR BUDGET PROBABLY ~~WON'T~~ WILL STRETCH TO AFFORD OUR PROFESSIONAL SERIES ALL ALUMINIUM RACK CABINETS

NOW YOUR PREAMPS, AMPS, CONTROL MODULES MONITOR PANELS ETC. CAN LOOK EVERY BIT AS GOOD AS TECHNICS, NAKAMICHI AND OTHER TOP MANUFACTURERS



Cat No.	Finish	A	B	C	PRICE	5 or More
H 0401	Natural	44	34	38	$39.50	$38.00
H 0402	Natural	88	57	82	45.00	42.50
H 0403	Natural	132	89	126	49.50	45.00
H 0411	Black	44	34	38	39.50	38.00
H 0412	Black	88	57	82	45.00	42.50
H 0413	Black	132	89	126	49.50	45.00

Beware of other rack boxes that do not conform to international rack sizing.

THE BRILLIANT MARC NR 82 FI

FEATURING: Digital frequency Display, SSB/CW, FM/AM reception, B.F.O., Double Conversion, Double Super-het, crystal controlled (VHF) Local Oscillator, 4 inbuilt antennas and good looks, you will spend hours just learning how to drive it!

FREE DELIVERY ANYWHERE IN AUSTRALIA

See Review in Electronics Australia August 1982

3 Way Power ★ Digital Tuning ★ HI FI SOUND ★ 4 Inbuilt Antennae

only **$349** C9482

SPECIFICATIONS:
Semi-conductors: 1-LSI, 4 - IC's, 7 - FET, 34 - Transistors, 42 - Diodes
Frequency range:

LW	145-360	KHz	SW3	9-22	MHz	VHF3	88-108	MHz
MW	525-1600	KHz	SW4	22-30	MHz	VHF4	108-136	MHz
SW1	1.6-3.8	MHz	VHF1	30-50	MHz	VHF5	144-176	MHz
SW2	3.8-9	MHz	VHF2	68-86	MHz	UHF	430-470	MHz

Power supply: AC 240V 50Hz. DC 12V (8 x "D" cells). Ext. DC 12V Car/Boat.
Speaker: 12.5cm Permanent Dynamic Speaker (3.2 ohm)
Antenna: Ferrite Bar Antenna for LW, MW and SW1
3 x Telescopic Antenna for SW, VHF and UHF
Controls: Power ON-OFF switch — Digital display ON-OFF switch — Tape-Radio switch, Wide-Narrow band selector switch, AM band selector (LW/MW/SW1/SW2/SW3/SW4), VHF band selector (VHF1/VHF2/VHF3/VHF4/VHF5/UHF), Ant. Selector (Telescopic ANT./EXT. ANT.), Tuning control (direct gear drive), volume control, Bass control, Treble control, Squelch control, BFO pitch control, RF gain control, Antenna adjustor control, Mode switch (USB-NOR-LSB/CW)
Terminals: Ext. Speaker/Headphone Jack, Tape IN-OUT jack, VHF/UHF ANT. connector (coaxial), SW EXT. ANT. terminal (Screw), Ext. battery jack
Meter: Tuning Meter
Digital Frequency Counter Section:
Display: LW/MW/SW-1 KHz SW2-4/VHF1-5 MHz
Control: SW Calibrator Dimensions: 452mm (W) x 288mm (H) x 130mm (D)

ALTRONICS RESELLERS

Please note that resellers may not have all the items advertised in stock, and as resellers have to bear the cost of freight, prices may be slightly higher than advertised. ALTRONICS reseller prices should however represent a considerable saving over our competitors' prices.

SOUTH AUSTRALIA
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ADN Electronics 212 5505
Protronics 212 3111
SUBURBAN
PROSPECT
Jensen Electronics 269 4744
ELIZABETH GROVE
A.E. Cooling 255 2249
CHRISTIES BEACH
Force Electronics 382 3366
KESWICK
Freeway Electric Wholesalers 297 2033

VICTORIA
CITY
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Talking Electronics 550 2386
HUNTINGDALE
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SOUTH CROYDON
Truscott Electronics 723 3860
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SHEPPARTON
GV Electronics 21 8866
MILDURA
Electronic and Digital Services 23 3380

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Radio Despatch 211 0191
Electronic Agencies 29 2098
Jaycar 264 6688
SUBURBAN
LEWISHAM
PrePak Electronics 569 9720
CONCORD
Electronic Agencies 745 3077
DEE WHY
David Rygall Electronics 982 7500
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Applied Technology 487 2711
MATTRAVILLE
Creative Electronics 666 4000
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BROKEN HILL
Crystal TV 4803
COFFS HARBOUR
Coffs Harbour Electronics 52 5684
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Acorn Electronics 21 2409
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Down's Radio and TV 32 1044
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NT
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Kingston Electronics 29 6802
AVOCA
Freemans TV 84 2186

WEST AUSTRALIA
ALBANY
BP Electronics 41 2681
GERALDTON
Geraldton TV and Radio 21 2777
WYALKATCHEM
D & J Pease 81 1132
MANDURAH
Kentronics 35 3227
KALGOORLIE
Todays Electronics 21 5212

ACT
Scientronics 54 8334
Electronic Components 80 4654

RESELLERS WANTED IN ALL AREAS (including WA)

Phone: STEVE WROBLEWSKI (09) 381 7233 for details

LABORATORY MULTIMETER

100K OHMS/VOLT CHECKS TRANSISTORS AND MEASURES CAPACITANCE

Q 1040 Multimeter $72.50

Q 1041 Carry Case. $14.50

From Tokyo Laboratories, Japan

Remember the days when high grade precision laboratory multimeters were available only from UK and then they cost a King's Ransom?! — Well, that's history — The new Q 1040 is everything a high quality meter should be PLUS it checks transistor HFE and ICO and measures capacitors from 50 pf—50 UF.
★ 100K OHMS/Volt DC ranges ★ 8.5 UA movement ★ Fuse and diode movement protected ★ Inbuilt oscillator for capacitance measurement.
RANGES: DCV 250MV, 2.5V, 10V, 50V, 250V, 1000V. ACV 5V, 10V, 50V, 250V, 1000V (10K/V) DCA 10UA, 2.5MA, 25MA, 500MA, 10A ACA 10A Resistance x1, x10, x1K, x10K Transistors NPN/PNP HFE 0-1000 ICO 0-50UA Capacitors 50PF-3UF. .01UF-50UF.

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USA: Australian Consolidated Press, 21 East 40th Street, (Floor 23), New York NY 10016. Phone: (212)685-9570.

Electronics Today International is published by Murray Publishers Pty Ltd, 15 Boundary St, Rushcutters Bay NSW 2011. This issue was printed by Offset Alpine, cnr Wetherill and Derby Sts, Silverwater NSW, and distributed by Network.

* Recommended retail price only

A NEW YEAR and a new look! As this is the time of year for self examination and 'turning over a new leaf', we thought it appropriate to introduce a new 'style' for the pages of ETI, both in form and in content. The broad field of electronics never remains static, and neither should we.

Over the past six months we've examined trends and activity in a wide variety of fields that could be seen as falling under the general umbrella of electronics and looked at what we, as a magazine, have been doing too.

Apart from style, layout and typeface etc, you'll notice a few changes in the magazine this month. We will be introducing new features during the coming year, as a result of our researches. We trust they not only reflect what various reader groups are interested in, but will be informative to a broad section as well. Existing popular features, like Circuit File and equipment reviews etc, will continue. We have carefully examined the trends in project interest and purchasing over the past year, both from reader feedback and in discussions with kit suppliers — and have learned a surprising amount. This is an exercise we go through at regular intervals to see what we should be doing, and when. Sometimes our predictions are off-target, more often though, we're right on target. We aim to improve our on-target to off-target ratio this year.

Our aims in changing the style within the magazine are to 'modernize' the layout, to improve 'readability' and to prevent atrophy. Anything that atrophies, dies — and we don't aim to do that! We have retained the 'magazines within magazine' format as this seems to be thoroughly accepted by readers and advertisers alike, making the contents of particular interest easy to locate in each issue, whether it be articles, projects, reviews or advertisements. What happened to the 'Electronic Lifestyle' section? That's become a publication in its own right and we've reverted to the 'Sight and Sound' section we had previously. Electronic Lifestyle went on sale in December. Your non-technical family, friends and associates will doubtless find it informative.

Despite the doom and gloom promulgated almost everywhere these days, we here at ETI look forward to 1983 with interest and excitement. We trust you have had an enjoyable festive season and that the coming year brings more prosperity than the last.

Roger Harrison
Editor

Roger Harrison

services

Technical enquiries: We can only answer readers' technical enquiries by telephone after 4.30 pm Mondays to Thursdays. The technical enquiry number is: (02)33-5669. Technical enquiries by mail must be accompanied by a stamped, self-addressed envelope. There is no charge. We can only answer queries relating to projects and articles as published. We cannot advise on modifications, other than errata or addenda. We try to answer letters as soon as possible. Difficult questions may take some time to answer.

General enquiries: For enquiries about back issues, photostats of articles, artwork or submitting articles, call (02)268-9015 or write to the address on this page.

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next month

IMMERSION-TYPE TEMPERATURE CONTROLLER

This project is built around an ordinary fish tank heater and the CA3059 zero-crossing switch controller. It can be used in a wide variety of applications, from aquarium heating to home brewing. Although our prototype was built into a fish tank heater, the pc board is 'universal' enough to provide zero-crossing switch control of almost any heating element.

'CAMP LAMP'

This project powers a small fluorescent tube and has been designed to be portable, operating from a 10 V to 16 V supply — just the thing for campers! The whole unit can be fitted inside a plexiglass tube, making it convenient to use and very compact. A very efficient dc-dc inverter using MOSFET technology is employed.

MICROBEE EPROM BURNER

This is the first in a series of projects supporting the popular MicroBee personal computer. It is a simple design using low cost off-the-shelf components. The MicroBee was made to take EPROM-based software and this allows you to produce your own.

CIRCUIT FILE: ANALOGUE DELAY LINES

Held over from this issue owing to lack of space. Ray Marston goes into the subject of analogue delay lines in depth and follows up with some practical circuits.

DIGITAL DISC PLAYER REVIEWED!

We review one of the first digital audio disc players released here — the Sony CDP-101. How does this new technology really sound! Find out next month.

COLOUR CLOCK FOR TANDY'S "COCO"

Here's a couple of clock programs for the Tandy TRS-80 Colour Computer — now affectionately known as the "CoCo". They make good use of the machine's graphics and powerful extended colour BASIC. Your grandfather never saw clocks like these!

'660 PROGRAM POTPOURRI NO. 2

More whizz-bang programs for the ETI-660 Learner's Microcomputer. Try your hand at 'IAGO for two', 'Patches', 'Asteroid Shower', etc.

Although these articles are in an advanced state of preparation, circumstances may affect the final content. However, we will make every attempt to include all features mentioned here.

HEAT WAVE

WE'VE ASSEMBLED A GREAT BUNCH OF SPECIALS AT "RED HOT" PRICES!!

FUEL SENSOR

GENUINE MORAY UNIT SACRIFICED!!

This is the original unit as used in the EA Car Computer (Ref: EA July/August 1982).
They were very scarce (and expensive!) – until now!!
If you are assembling this project from parts you will need this unit. Remember! The Jaycar unit is the LATEST MODEL fresh from the U.K.

GREAT SAVINGS!!
ALMOST
30%
OFF

The Moray fuel flow sensor normally sells for up to $69.50
You can buy the SAME ITEM from us for – wait for it $49.50
THAT'S UP TO $20 SAVING!!

Hurry! Quantities strictly limited

LCD panelmeters

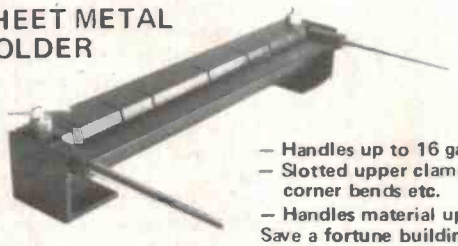
$49.50
DPM-200

$39.50
DPM-05

We have been unable to keep up with demand for these, that is why you have not seen them in our ads for the last few months.
DPM-200 – 3½ digit display with annunciators (pictured). 0.6" high. 200mV full scale. Each unit supplied with data sheet.
DPM-05 (Not illustrated). 3½ digit display with "plus", "minus" and "low batt". Annunciators with 0.5" readout.
Both units sample at 3/second.
If you want to express any physical measurement in a bright easy to read display these are for you. They contain all analogue-to-digital electronics and LCD drive circuitry. Send SAE for more information.

"PANBRAKE" SHEET METAL FOLDER

$69.50



– Handles up to 16 gauge aluminium!
– Slotted upper clamping bar allows complex corner bends etc.
– Handles material up to 445mm wide!
Save a fortune building metalwork yourself!!!
ONLY $69.50

Now you can afford one in your own workshop. Make your own chassis, boxes, brackets etc. (Please allow $8 for freight as it is very heavy!)

ELECTRET MIC INSERTS

CRAZY PRICE!!
JANUARY ONLY – 2 FOR $2.00
Each unit supplied with data sheet.
1000's of uses

$2 for 2

SUPER SPECIAL! URGENT

We have a quantity of 240 V Disco Strobes. Not a kit. Built in Woodgrain cabinet. 0-12 flashes per second. Brand new but re-worked warranty stock. Almost less than ⅓ normal price!

Only $12.50 each
Were $36.50

IF YOU THOUGHT MUFFS WERE SCARCE AT THE KLONDIKE. . . .

you should see our stores!!
Yes, we have the Sennheiser HD414 earmuffs back in stock – for a while anyway.
Grab a muff now (you will get either blue or yellow – no choice) for $5.95 per pair. (The high price reflects their quality Teutonic origin).

ONLY
$5.95
per pair

Green Screen

MONITOR – NEW LOW PRICE!!
A BREAKTHROUGH!!!

Now you can enjoy the benefits of high quality for less than the cost of some B/W monitors!
– 18MHz Bandwidth!!
– Direct Video Connection
– High Resolution

only $199

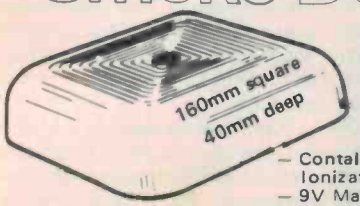
SPECIALS

WE'VE ASSEMBLED A GREAT BUNCH OF SPECIALS AT "RED HOT" PRICES!!

final runout of GE Consumer Products

WE HAVE SOLD OVER 1000 OF EACH OF THESE ITEMS. ONLY A FEW ARE LEFT NOW.

Smoke Detector



- Contains Americium 241 Ionization Chamber
- 9V Mallory Duracell included
- Contains very loud solid state buzzer
- 12 month factory warranty.

FROM $12.50

One of the greatest consumer flops of the last decade was the Ionization Chamber Smoke Detector. Even though it is a brilliant product (reliable compact, easy installation, fail-safe etc) it just did not sell. Human nature being what it is finds safety-oriented products just not worth the investment. We all know that accidents and fires never happen to US!! As smoke is the greatest killer in a fire, the market research gurus thought that such a product would have a wide appeal. When they were $49.50 no-one wanted them. The price fell to a very reasonable $29.50 and still they stayed on the shelf. We have now been instructed to clear them for less than ⅓ of $29.50.

QUANTITY PRICES

1-$14.50: 2-5 $13.50ea: 6-10 $13.00ea: 10 up $12.50ea

Burglar Alarm

GENERAL ELECTRIC

BURGLAR ALARM SLASHED!!!
HUGE SCOOP PURCHASE –
ONCE SOLD FOR OVER $100

FROM $23.95

Amazingly low price for a full feature ultrasonic proximity/burglar alarm. + Completely self contained + 12 month manufacturer guarantee + Instant or delayed alarm + Handsome imitation woodgrain + Cabinet measures 180(w)x85(h)x100(d)mm + Programmable multicode disable switch + Single 9V Alkaline battery* lasts one year + unit beeps when battery gets low + Contains receiver element designed for greater sensitivity without false triggering + Uses state-of-the-art LSI circuitry + Worth the money in parts alone + Comprehensive 24 page manual included + Comes complete with 4 window deterrent stickers + Absolutely no installation needed * Battery extra.

1-$29.50: 2-5 $25ea: 6-10 $24.50ea: 10up $23.95ea

4116 RAMs 150nS – GOING CHEAP

We have secured a quantity of 4116 (150nS) RAMs at a price which means great savings to you.
Why are they cheap? Well they don't actually have "4116" branded on them. They have "9016 FPC" on their little backs. They are used in a well known TV-game computer and this is the "House Number" for their 4116. If you have ever had to buy a non-standard replacement part you will know that the "House Number" part can be VERY expensive. We don't want to sell them as 9016 FPC's we want to sell them as 4116's – and at a great price. The normal (i.e. lower than most) price for our 250nS 4116 is $2.50 You can grab a 9016 FPC (150nS) 1-off for only $1.95!!!
For larger quantities see below:

This price includes sales tax!!

1-9 pcs $1.95
10-24 pcs $1.85
25-99 pcs $1.75
100+ $1.65

-1 Edgeconnectors * *

1-9 $3.50 ea

10+ $2.95 ea

Collectors special. Made by UECL of England. Sold in quantity for over $10 each. Each Diallyl Phthalate moulded connector contains 170 heavily gold plated bifurcated contacts. (2x 85 way). Each contact is solder eyelet terminated. The connector is 217mm long but you can cut it down to any length you wish. Outstanding quality.

AM/FM STEREO CAR CASSETTE

Unbelievably low price! (Pre Budget tax) That's right! An AM/FM Stereo Radio and Cassette! Features:

* 2 x 7 watts * One lever operation (fast forward and eject) * Tape run indicator * FM Stereo indicator * Auto stop * Adjustable pitch controls * Mounting hardware included.

STAGGERING VALUE ONLY $69.50

POWERTRAN TRANSCENDENT 2000

This is the famous UK designed single-board synthesiser from the UK kit experts POWERTRAN.
Jaycar imported a kit and had it professionally built for evaluation. It works beautifully and is very well put together. We estimate that it cost us over $700 including airfreight, duty, cost, customs and labour. We decided not to go ahead with an Australian version but we still have this beautiful prototype.
You can have it for $500 – No deals. Ring first to check to see if it has already been sold.

SAVE OVER $200!!

Ref: March 1982.
NEW LOW PRICE

This P.A. Module is chock full of high quality Jaycar goodies like, extruded jig drilled heatsink bracket, Beryllium Oxide washers etc.
Were selling at $79.50 but, despite inflation, despite sales tax now only $69.50.

ETI 499 150W MOSFET AMP
ONLY
$69.50
SAVE
$10!!

LOW COST WALKIE TALKIES

What can we say?

Both voice and morse transmission

ONLY 12.50 ea

SO-239

UHF PANEL SOCKET
½ Normal Price

$1.20

1-9 75c
10+ 59c

Jaycar NUMBER 1 FOR KITS

125 York Street, Sydney 2000
Phone: 264 6688 Telex: 72293

"Nevilles Corner"
Cnr. Carlingford & Pennant Hills Road,
Carlingford
Phone: 872 4422

Mail Orders To: Box K-39 Haymarket
Sydney 2000

POST AND PACKING CHARGES
$0-$9.99 ($1.20) $10-$24.99 ($2.40)
$25-$49.99 ($3.50) $50-$99.99 ($4.60)
$100 up ($6.20)

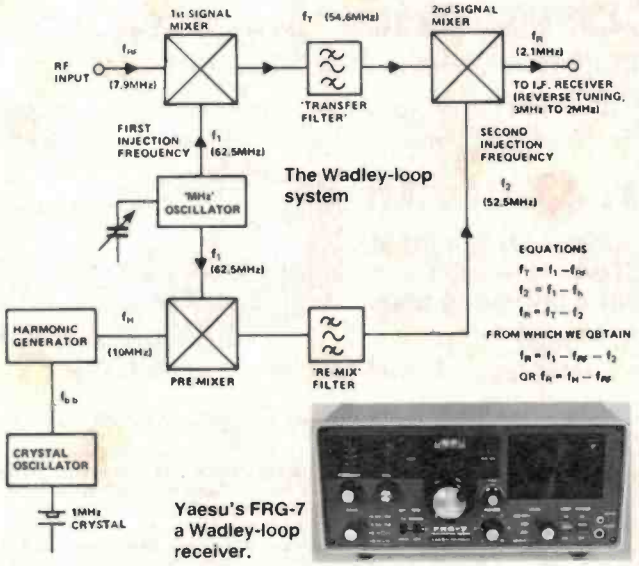
NEW SHOP HOURS
Mon-Fri 8.30 to 6.30pm
Sat 8.30 to 12.00pm
Thurs night to 8.30pm

MAIL ORDER BY BANKCARD VIA YOUR PHONE

YOU CAN PHONE CARLINGFORD ON 872 4444 AS WELL!

Radio pioneer passes on

Dr. Trevor Wadley, who devised the 'Wadley Loop' method of receiver tuning based on three stages of mixing that automatically cancelled oscillator drift, died recently in South Africa.



The Wadley-loop system

Yaesu's FRG-7 a Wadley-loop receiver.

The success of Racal Electronics was founded on Dr. Wadley's invention. When they were just a new and little-known English firm, Racal decided to back the then radical ideas of Dr. Wadley when he took the scheme to Britain in the early 1950s. He had offered it to a number of well-known British firms: all regarded it with scepticism. Only Racal were prepared to take the risk and so was born the RA17.

It is said that even Racal almost despaired at one stage in development until somebody found that by making a saw cut in the chassis the performance of the complex filters could be vastly improved. Such was the worldwide success of the RA17 that it rapidly took Racal to the top and made them a real force in all branches of RF communications.

Racal Electronics, now a major electronics and communications group, recently announced that it has made a net profit (before taxation) of over £73 million on a turnover that has reached a staggering £536 million.

The Wadley-loop system is widely used in shortwave and communications receivers today, made by many famous manufacturers. Receivers are made by Yaesu Musen (FRG-7 and FRG-7000 are very well-known), Drake and Standard. A South African firm associated with Dr. Wadley, Barlow-Wadley, made and sold a portable shortwave receiver around the world using the Wadley-loop tuning scheme.

The tuning scheme employs a system of additive and subtractive pre-mixing of the local oscillator so that any drift is cancelled. Receivers covering 100 kHz to over 30 MHz in 1 MHz segments, with readout to better than 1 kHz in the days before digital dials, were made and the scheme gave better performance than synthesiser systems employed at that time. Mass production and solid state circuitry brought down the cost of employing the scheme and 'consumer' shortwave receivers with Wadley-loop front ends appeared in the early 1970s.

Dr. Wadley, an engineer of brilliance and achievement, died recently in South Africa at the age of 61 years.

Free energy from the sun

Tandy Electronics is using solar cells which are suitable for battery charging and powering small devices like transistor radios or small electric motors.

The Tandy solar panel generates approximately half a watt of power in full sunlight and includes two mirror panels to help concentrate the sun's rays. It has a switchable output of 6 V at 80 mA or 12 V at 40 mA which can be used to charge batteries (like Tandy's 9 V Nickel Cadmium transistor radio cell), or to directly power radios, calculators, toys and many other small devices.

Tandy sells several solar cells and panels, ranging in price from $6.59 for a single 25 x 51 mm cell to $31.95 for a solar panel (a pre-wired bank of 32 solar cells with lenses and reflectors).

Tandy will also be selling a 120-project Solar Energy kit which, at $29.95, makes a highly entertaining and educational children's gift. The projects include experiments like a sun-dial, sun-powered transistor radio and a perpetual-motion pendulum. They also have a $16.95 Solar Motor kit consisting of an efficient solar cell pre-wired to a small dc motor. It can be used for powering small model boats, windmills, colour wheels and similar educational projects.

Electronics courses at Newcastle Tech.

Newcastle Technical College has scheduled a range of trade, post-trade and special courses in electronics for 1983.

A part time Electronics trade course covering all aspects of digital and analogue techniques is offered. Attendance is one day per week or two nights per week for three years. This trade course is also available in a block release attendance pattern of three days every third week for country students.

Post trade courses are available in Television Receiver Principles, Industrial Electronics and Semiconductor Electronics. Special courses include Microprocessor Evaluation, Microprocessor Circuits and Applications, Film and Television Production for Education and Industry, Principles of Two Way Radio and Two Way Radio Users Courses.

Enquiries should be made to **the Senior Head Teacher, School of Electronics, Newcastle Technical College, Maitland Rd, Tighes Hill NSW 2297. (049)61-0461 Ext 367.** Enrolments will be accepted on February 3, 4, 7 and 8, 1983 from 10am to 7pm.

New address for Zephyr Products

Zephyr Products, after 16 years in their old premises have moved into a new building which has showroom, office, factory and warehouse facilities.

Zephyr Products have recently been appointed as Victorian distributor for the Ralmar range of hi-fi car sound and accessory products. This range, together with RCF speakers, Primo microphones, MM mixers, Etone and Novic speakers, Motorola piezo electric tweeters and the new ZPE Series II power MOSFET professional amplifiers will be on display.

An expanded stock of Plessey Components and L M Ericsson Telecom approved isolation and audi transformers will be available for trade sales.

Zephyr Products' new address is **421 Warrigal Road, Moorabbin Vic. 3189. (03) 553-3266.**

Chloride has maintenance-free systems battery

One year after the release of their maintenance-free auto battery, the Exide Torquestarter, Chloride announced their first industrial battery series. The Exide RE Systems Battery Series is a range of sealed recombination electrolyte lead batteries.

One feature of the Exide RE Systems battery is that after accidental discharge to zero potential it will recharge with little or no loss of capacity, an ability Chloride believe is totally out of the reach of gell or cylindrical sealed battery types. It has high tolerance to overcharge and will hold its charge in storage for 18 months or more at 25°C ambient. It will give up to 1200 charge/discharge cycles and five to six years float service life. Thus the user has, in the one battery, the ability to give both standby and charge/discharge cycling duty.

It works just as well on its side or even upside-down, as it does the right way up. Neither acid nor gas escapes from its sealed case so there's no corrosion of the terminals and no risk of explosion. In fact, there is no way into the battery.

The design uses special felted fibreglass separators highly absorbent to carry the electrolyte in close contact with the plates. There is no free electrolyte whatever sloshing loose within the battery. This last feature has won the Exide RE Systems battery its unqualified approval by the Department of Transport for carriage upon aircraft, important to makers and users of battery powered equipment such as wheelchairs. The design produces no hydrogen by electrolysis and oxygen produced during charging is recombined within the battery virtually as it is formed.

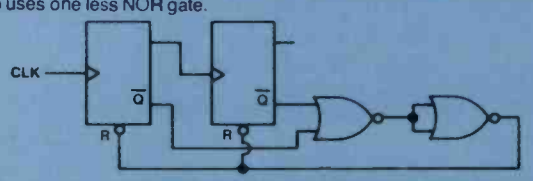
The new Exide RE Systems range of batteries comes in a great many shapes, sizes and performance categories. In 6 V, there are models offering from 1.2 to 10 ampere-hours. The 12 V models offer 1.2-24 ampere-hours. Chloride are expected to announce extensions to this range of models quite soon.

Chloride Batteries can be found at **147-149 Woodpark Rd, Smithfield NSW 2164.**

NOTES & ERRATA

Series 5000 Graphic Equaliser; November '82: In the circuit diagram on page 32, power supply section, diodes D2 and D3 are shown back to front. The pc board overlay is correct. In the parts list, R5 and R6 are shown as 15k, but 10k on the circuit. 10k is the correct value, though not critical.

Three-Channel Light Chaser, Ideas For Experimenters; October '82: Colin Burns of Mawson ACT wrote in to advise us of an error in this circuit. Both flip-flops should be cleared (reset) when their Q outputs (B and C) are high simultaneously. This is to produce a high output (A) from the NOR gate IC3a. The modification required to achieve this is shown below.
Only when both Q outputs are low will the flip-flops be cleared. This arrangement also uses one less NOR gate.



Audio Amplifiers Using Nested Differentiating Feedback Loops, Part 2; November '82: Equation (10) on the bottom of page 123 is missing the 'tau'. It should read $\tau_F = \mu_1 \beta \tau_x$. In Figure 11, the pictures for (a) and (c) have been swapped inadvertently.

What a nerve. Now there's a bionic ear.

The bionic ear will soon be a reality for millions of nerve-deaf people throughout the world. It was developed by the University of Melbourne in conjunction with a Sydney based firm, Telectronics Pty Ltd, part of the Nucleus group of companies, which is well known for its expertise in implantable prosthesis.

The Department of Science and Technology has agreed to fund further research and development for the nine year old project and it is now expected that the device will be available by the mid 1980s.

The device is based on the principle of electronically receiving, processing and coding sounds in a similar manner to that which occurs naturally in the nerve fibres of people with normal hearing. A coded signal is sent by an externally worn transmitter to a miniature receiver-stimulator implanted behind the ear. The receiver-stimulator converts the signals to electrical impulses which are conducted to the inner ear where the nerve fibres are stimulated electrically to enable the nerve-deaf to recognise speech and other sounds.

During the first phase of the project, Melbourne University implanted a prototype receiver into several patients, conducted clinical tests and evaluated the effectiveness of the device.

The second phase saw the University complete a portable prototype of a speech processor unit and a basic rehabilitation package suitable for immediate use and later development.

A biological test programme provided preliminary results which can be used as a basis for agreeing to a full clinical trial programme with health authorities.

The next phase of the project involves the full commercial development of the 'ear' which is being undertaken by the Nucleus group of companies.

This companion will never let you down

Companion is a close relative of Vitalcall, the personal medical emergency system which has given elderly and disabled people all over Australia a chance to enjoy a new sense of independence in their homes.

Like Vitalcall, Companion can quickly summon help in an emergency, simply by squeezing a lightweight plastic pendant. But Companion offers aid at a much lower cost and there are no ongoing payments (except for an occasional battery change).

Companion is a simple alarm system which, unlike Vitalcall, does not operate through the telephone system and therefore can be used in homes where there is no telephone at all. For this reason, it cannot provide the same back up features as Vitalcall. But because the function of Companion is less comprehensive it provides a cheaper alternative to the Vitalcall system.

Companion has 2 components, a lightweight plastic pendant and a small box containing a transmitter activated alarm. When the button on the pendant is squeezed by the user a signal is sent out to the Companion box which is kept in the home of a neighbour or friend situated within a range of 200 metres. This signal will cause the alarm siren within the box to sound loudly and intermittently and will continue doing so until whoever is in charge of the unit cancels the alarm.

Each Companion is separately coded so that if a neighbour is also using the device the risk of interference is minimised. It retails for approximately $195 and is covered by a money back guarantee so that if the device fails to operate because the chosen friend or neighbour is out of range, it can be returned in good order within 14 days for a full refund.

Contact the Vitalcall centre in your state for more information.

$\frac{d}{dx}\left(\frac{u}{v}\right) = \frac{v(du/dx) - u(dv/dx)}{v^2}$ $i^2 = -1$

$\int e^u du = e^u$ $y = \frac{\tan^4 5267}{(4 \times 783)}$ $\int_x^{x_2} \sin(x)/x$

$(3.14159 + 7.32i)(i + 100i) = (3.14159i - (7.32i \times 100i)) + ((3.14159 \times 100) + 7.32i)i$

$= (3.14159i - 732i^2) + (3.14159 + 7.32i)i$

$F(t) = \frac{1}{2\pi i} \int_{c-i\infty}^{c+i\infty} e^{st} f(s)\, ds$ $[r(\cos\theta + i\sin\theta)]^p = r^p(\cos p\theta + i \sin p\theta)$

$\hat{A} \cdot \hat{B} = \hat{A}\hat{B}\cos\theta$

....or get a new Hewlett-Packard HP-15C.

They're the options.

You can spend hours with a pencil working out a seven-equation problem or you can spend around 28 seconds with the HP-15C.

It's possible because of the two new sets of functions, never before built into a Hewlett-Packard calculator: Matrix and Complex number operations.

Once matrix elements are defined, matrix arithmetic inversions and transpositions are keystroke-easy.

Up to 64 matrix elements can be stored in the calculator's memory and these can be distributed among five different matrices, this model also has solve and integrate keys.

In addition, the HP-15C's arithmetic and transcendental functions (exponential, logarithmic, trigonometric and hyperbolic) operate on complex and real numbers.

And to make your decision even easier, the HP-15C programming features include up to 448 lines of dynamic continuous memory, five user-definable keys, 25 program labels, insert/delete editing, 10 flags, 12 conditional tests and indirect-programming control.

Do you really have any choice?

To see the new HP-15C calculator, call Hewlett-Packard Personal Computation Group for dealer locations.
Sydney: 887 1611; Melbourne: 890 6351;
Adelaide: 272 5911; Perth: 383 2188;
Brisbane: 304 133; Canberra: 80 4244.

HEWLETT PACKARD

HP78R/2

Is nothing sacred?

Yet another of the trusted and familiar objects of our youth has gone, the sober black shape of the Scope iron has been replaced with a glossy orange and black 1983 model which fortunately retains most of the working parts of the previous model.

The 'Superscope', first released in 1949 as Australia's earliest temperature controlled iron, had a traditional shape and black or grey handles. Changes to the iron include a more comfortable and impact resistant temperature switch and handle in bright orange and black. Scope advise that apart from the new handle and switch mouldings all other parts are interchangeable with previous models.

The new 'solder system' also includes a 240 V — 4 V power supply unit with electrostatic shield. This is in a matching orange/black housing with iron rest for conventional on-or-under the bench mounting. The thumb switch allows control of the tip temperature in the range 200°C — 500°C and also modulates the effective wattage 20 W — 140 W to suit the unpredictable nature of service and repair soldering.

A 10 W — 70 W 'miniscope' is also offered using the same PSU. A 12 V version of the 'Superscope' delivering 20 W — 180 W is widely used by Telecom technicians, auto electricians and farmers who are beyond 240 V reticulated power. Prices of the new models are unchanged and supplies are available through a wide range of trade and retail outlets.

For more information contact **Scope Laboratories, 3 Walton St, Airport West Vic. 3042. (03)338-1566.**

UV printed circuit exposure box

The latest Mentron UV exposure box is suitable for exposure of photosensitive materials such as the Dupont Riston 3000 series and 3M Scotchcal materials.

Designated as the 300NSUV, this unit exposes artwork down to approximately 0.55 mm track separations.

The 300NSUV has a number of features including an exposure timing switch, non-skid rubber feet and foam clamping.

Full details are available from the Australian distributors, **Royston Electronics, 27 Normanby Road, Notting Hill Vic. 3168. (03)543-5122 or 15/59 Moxon Road, Punchbowl NSW 2196. (02)709-5293.**

13.8 Volt power supplies

Benelec Pty Ltd distribute a range of 13.8 V power supplies suitable for powering equipment designed to operate from a nominal 12 Vdc battery supply.

The 'Panther' power supply, catalogue no. 9-102, is rated to supply 2 A continuously and 4 A peak. It features a LED 'on' indicator and short circuit protection. It is housed in a sturdy plastic case and is ideal for powering CB or marine transceivers. The Panther is SEC approved.

The 'Transwest Model MK III' is rated to deliver 4 A continuous output, up to 7.5 A on peaks. It features a neon 'on' indicator and short circuit protection. This supply is housed in a sturdy metal case with output terminals at the rear. An on/off switch is mounted on the front panel, along with the primary circuit fuse. Overvoltage protection is also included.

The 'Transwest Model MK IV' has the same features as the Model MK III but is rated to deliver 6 A continuously, up to 10 A on peaks.

Further information can be obtained from **Benelec Pty Ltd, P.O. Box 21, Bondi Beach NSW 2026. (02)665-8211.**

Sennheiser impedance measurer

Sennheiser has released a compact, battery-driven impedance measurer called the ZP3. It will measure impedances in loudspeakers and loudspeaker systems, in line transformers, deflection coils and audio transformers.

Fitted with six switchable measuring ranges, the ZP3 enables one to accurately determine whether the test object is of an inductive or capacitive nature.

The impedance value obtained is always accurate and easy-to-read on the 3½-digit LCD readout and a six-part subdivision of the measuring range from 20 R to 2 M, say Sennheiser. The maximum measuring error is smaller than 5%. There is no need to calibrate the ZP3 either before or after carrying out the measuring process.

The load placed upon the test object in each of the six measuring ranges is so slight that even sensitive components such as recorder heads, sound pickups and microphones can be measured without fear of damage Sennheiser claim. In addition to measuring impedances in the inductive range, the ZP3 is also suitable for determining capacitances and purely ohmic resistances.

For more information contact **R.H. Cunningham, 146 Roden St, West Melbourne Vic. 3003. (03)329-9633.**

FANTASTIC OFFER!

8-Function, 23-Range LCD digital multimeter

UNDER $100!

SEE PAGE 15

Heatsink insulators provide EMI/RFI shielding-decoupling

Sil-Pad, who make a wide range of thermally conductive insulators for semiconductors, has released a shielding-decoupling type claimed to reduce radiated emissions from semiconductors mounted on a heatsink by 60 dB or more.

Dubbed the Sil-Pad Shield, the product is a physically tough pad available in a variety of shapes claimed to have low thermal resistance and high dielectric strength.

The shield consists of a one mil. copper sandwich bonded between two layers of calendared nine mil. Sil-Pad material. Part of the copper is exposed for attachment of an earth lead to 'drain off' the signal and reduce radiation from the case of the device. A reduction of 60 dB or greater, generally considered to be excellent, can be achieved at frequencies above 10 kHz, Sil-Pad claim. For lower frequency applications, thicker copper in the sandwich can be specified.

Components that can utilise Sil-Pad Shields include: high speed switching transistors, relays, oscillators, DIP packages, chips etc. In a lot of instances, attenuation at component level will prevent the radiated signal from penetrating and interfering with other components and will also, in some cases, preclude total case shielding.

Shapes currently available are TO-3 and TO-220. Non standard shapes can be produced on request with a lead time of about eight weeks.

For further information contact **Mr. Peter Lloyd, Scientific Electronics, 6 Holloway Drive, Bayswater Vic. 3153. (03)762-5777.**

Combined digital/analogue meter

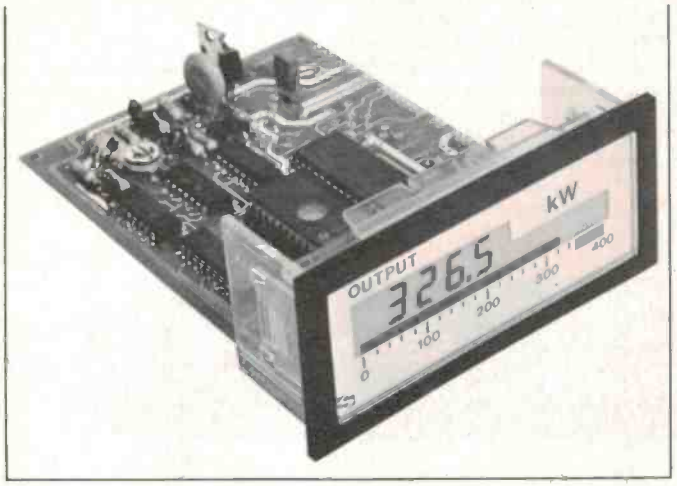
A panel meter which combines the readout precision of a digital display with a trend indication similar to that of an analogue meter has been developed by Sifam Ltd, England, and is available from C & K Electronics.

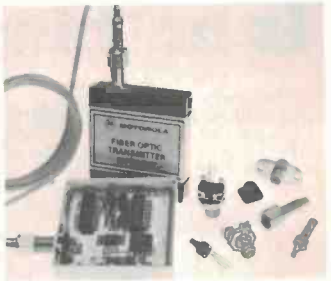
In addition to its dual display, the new meter also constitutes what is claimed to be the first 'off-the-shelf' digital meter capable of being programmed to read in any engineering unit, including non-linear quantities. It can also be programmed to function as a meter relay, initiating alarm or control signals at fixed or variable set points.

Called 'Harmony', the meter incorporates LCDs and microprocessing. The result is a compact, rectangular display resembling a conventional digital meter, but incorporating a horizontal trend-bar, the length of which fluctuates in proportion to the reading.

Essentially a millivoltmeter with a range of 0 — 50 mV dc and optional current ranges of 100 uA and 1 mA, the digital readout is in four digits with a maximum display of 9999. The trend-bar, made up of 31 segments, grows or falls alongside a printed scale located just beneath the digital display.

For further information contact **C & K Electronics (Aust.) Pty Ltd, 15 Cowper St, Parramatta NSW 2150. (02)635-0799.**





Soanar stock fibre optics

Soanar Electronics Pty Ltd have announced that they now stock fibre optic components and accessories at all Soanar Branches throughout Australia.

Optical fibre cable is available in continuous lengths in multiples of one metre to a maximum of one kilometre. The 125 micron fibre in 2.7 mm diameter cable is designed for high flexibility and tensile strength and can be supplied plain or prefitted with connectors at the factory.

For those people wishing to fit connectors themselves Soanar have cutting and stripping tools that remove the covering from the optical fibre and then cut the fibre squarely for a mirror-like surface. Two types of connector are stocked by Soanar. One type enables fibre optic cables to be joined together and the other type couples the fibre to active components.

Further information on these products is available from the Soanar Branch in your State or by contacting Head Office at **Soanar Electronics Pty Ltd, 30 Lexton Road, Box Hill Vic. 3128. (03)840-1222.**

Comprehensive fuse range

Fuses may seem like mundane items, but they're often worth their cost 10 000 times over for the protection they afford.

Benelec Pty Ltd stock a wide range of fuses in fast blow, slow blow and general purpose types.

They stock 5 x 20 mm glass cartridge instrument fuses in both fast and slow blow types with ratings from as low as 50 mA right up to 15 A. The fast blow types are designated catalogue no. 14-100xx, the slow blow types, catalogue no. 14-400xx. The catalogue number suffix indicates the rating. e.g: 14-10050 is a 50 mA type, 14-11100 is a 1 A type, 14-12100 a 10 A type.

In the 6.35 x 32 mm (3AG) models, Benelec carry general purpose and slow blow 250 V types as well as 32 V automotive types. The 14-300xx range are general purpose wire fuses available in ratings from 100 mA to 25 A. The 14-500xx slow blow range can be obtained in ratings from 100 mA to 20 A, while the 14-200xx automotive range can be obtained in ratings from 1 A to 30 A.

All fuses are available in packets of 10 pieces, boxes of 200 pieces or cartons up to 20 000.

Contact Benelec Pty Ltd for more information at **P.O. Box 21, Bondi Beach NSW 2026. (02)665-8211.**

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THIS MONTHS KITS

ETI-488 60 W AMP USING TWO NDFLs

Very low distortion amplifier module can be used to replace modules in existing systems or as the basis of a new amplifier system.

ETI-905 POLYPHONIC TOUCH SENSOR ORGAN

Organ features touch sensor keyboard, 25-note range, two voices and loudspeaker output.

ETI-334 AUTO TESTER

Just the thing to keep in the glovebox or toolkit to find those nasty electrical bugaboos that occur at awkward times. Simple to build, simple use.

ETI-1510 MODEL TRAIN POINTS CONTROLLER AND INDICATORS

This kit comprises a capacitive discharge power supply for operating the points solenoids and remote indicators that show which way the points have been set.

Electric fence $17.50

Check our prices

SEPTEMBER EA 1982

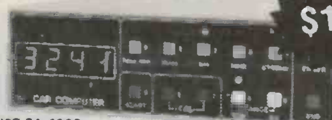
Ultrasonic Rule

$49.00

AUGUST EA 1982

Car Computer

$109



AUGUST EA 1982

Tacho/dwell meter with digital display

$62

MAY EA 1982

12/240 volt Inverter

$55

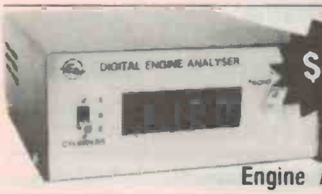
MAY EA 1982

Universal preamplifier for MM/MC cartridges

$35

MAY EA 1982

Engine Analyser Kit



$48.50

Eprom Programmer

$55.00

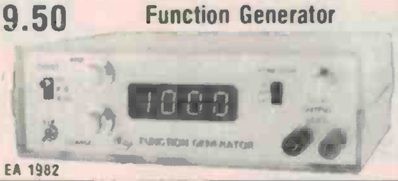
JANUARY EA 1982

Analogue and Digital Storage CRO Kit

$189.00

Function Generator

$79.50



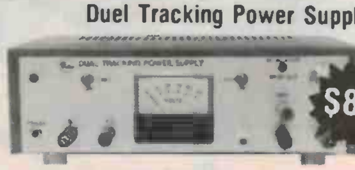
APRIL EA 1982

Stereo Synthesiser

$55.00

SEPTEMBER EA 1982

Duel Tracking Power Supply

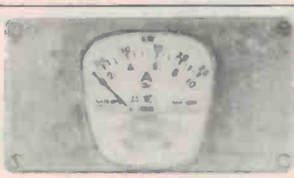


$83.50

Power Monitor

JULY EA 1982

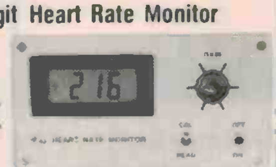
$18



Portable 3½ Digit Heart Rate Monitor

JULY EA 1982

$79.00



100w Sub-Woofer Amplifier

$85.00

JULY EA 1982

ETI-1508 TRAIN CONTROLLER

This dual-circuit unit provides throttle and brake controls that work in the same manner as on a 'real' train. The circuitry gives the driver the feel of inertia as well as loading. It can run anything from micro-gauge to twin 'O' gauge engines and cost is far lower than 'commercial' equivalents. Tentative parts list attached.

ETI-162 30 V/1 A FULLY PROTECTED POWER SUPPLY

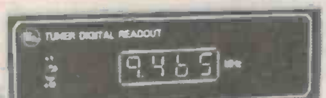
The last power supply we did was the phenomenally popular ETI-131. This low cost supply features full protection, output variation from 0 V to 30 V and selectable current limit. Both voltage and current metering is provided. Tentative parts list attached.

EA ELECTRONIC STARTER FOR FLUORESCENT LAMPS $5

OCTOBER EA 1982

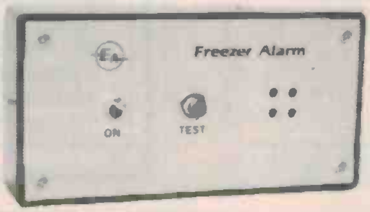
EA DIGITAL READOUT FOR SW RECIEVERS P.O.A.

OCTOBER EA 1982



EA EASY-TO-BUILD FREEZER ALARM $21

OCTOBER EA 1982



OVER 200 NOW SOLD EA INVERTER $189 INCLUDING TRANSFORMER

P & P $10.00

JUNE EA 1982

Minimum P & P $3.00 for kits

KITS — KITS — KITS

The Tools. from Cooper The Toolmaker.

Weller industrial SPI non-temperature controlled line voltage soldering irons, with iron plated copper tips, stainless steel barrels. Impact and heat resistant handles are lightweight.
Available as SPI25D 25 watt or SPI40D 40 watt irons.

The Weller WTCPN soldering station is temperature controlled and combines high volume capability with precision performance. The low voltage TC201 soldering pencil employs the exclusive "closed" loop method to control maximum temperature and protect sensitive components.

Lufkin
Official Supplier of Measuring Tapes to the XII Commonwealth Games in Australia 1982.

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MEMBERS INTERESTED IN DIRECT-CONNECT MODEMS?

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Place your orders now. For 10 or more boards, the price is $43.50 each. Send cheque with order to:

ETI-644 Modem pc boards
ETI Magazine
15 Boundary St
RUSHCUTTERS BAY NSW 2011

Back issues of the October 1982 issue, featuring the modem, can be purchased at the same time for $1.50 each for 10 or more.

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This offer applies in Australia only

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Name .....

Title .....

Company .....

Address .....

..... *Postcode* .....

My company's main activity is .....

and it employs ..... *people.* *

Please attach your business card or letterhead, fill in the above form and return to:-
Comdec Business Technology
4th Floor, 15 Boundary Street, Rushcutters Bay NSW 2011.

* This information will be kept strictly confidential

SPECIAL ETI READER OFFER
UNIVOLT DT-860 LCD DIGITAL MULTIMETER

- 3½ DIGITS
- 8 FUNCTIONS
- 23 RANGES
- PUSHBUTTON OPERATION
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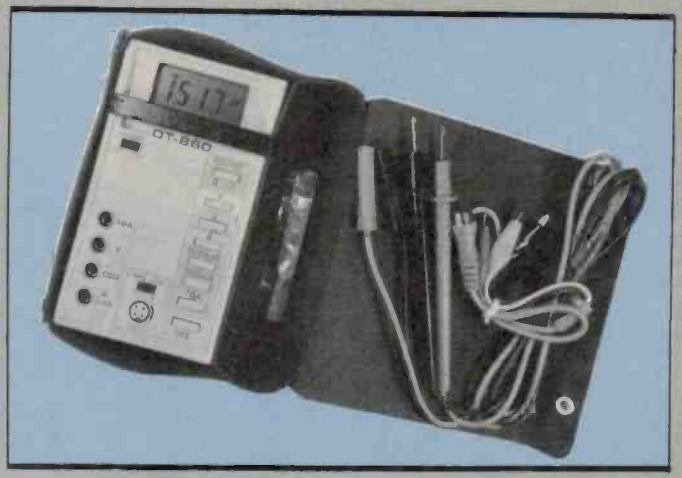

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We have tested a sample DT-860 in the ETI lab and found it met specifications, functioned well and was generally easy to use. The DT-860 appears to be a robust, well-made device. Any serviceman, technician, engineer or hobbyist would find it a very useful instrument.

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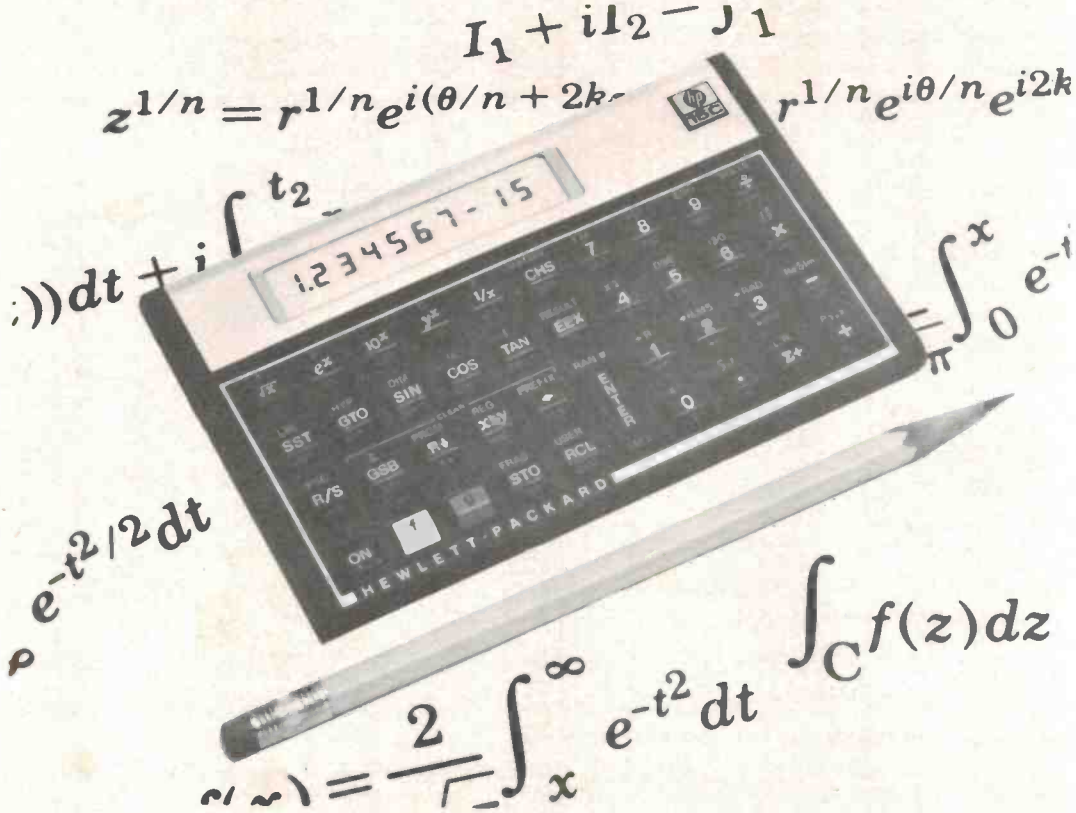

The HP-15C scientific calculator

The HP-15C is the perfect choice for the electrical or electronic engineer. Powerful and ingenious, it can operate in complex and matrix modes (it can even handle complex numbers forming matrices), solve for zeros and integrate functions. What more could you want?

Jonathan Scott

IT IS POSSIBLE that you have noticed recent press releases for two new pocket calculators from Hewlett-Packard, the 15C and 16C. Why then is this article here, consuming a seemingly large space describing something you have seen outlined before? Simply because the HP-15C is so perfectly suited to the electrical or electronic engineer and is so powerful, ingenious and advanced in its design that we feel it demands special mention. If you need a calculator which is capable of solving problems in the fields of electronics or general science, then this machine is tailored to your requirements. If you have been thinking of purchasing a programmable calculator, updating your current one, converting to a small 'pocket' computer to tackle your numerical tasks or just want to get your hands on one of the finest examples of hardware and software engineering in the marketplace today, then this is the time and the 15C is the machine. Interested? Then read on.

Features

The 15C follows two earlier machines in format, in that it is a low power consumption device with an LCD display and a soft off/on function. It has a number of features; some are standard for HP machines, some have appeared on only a few selected calculators before and some are completely new and unique. It is these last, coupled with the inclusion of *all* the features developed on HP scientific calculators to date (despite some of these features not being on some later models) which makes this little gem the one to sit up and take notice of. If you are already familiar with HP machines you can skip to the section marked 'Classier functions'; if not the following is designed to give you a brief introduction to the Rolls Royce series of pocket calculators.

The first and most perpetually pleasing feature which has been the trademark of all HP calculators from the 35 onwards is Reverse Polish Notation. This means that the calculator is stack orientated, or in short, it has no '=' button. It also has no '(' or ')' buttons, as these are all unnecessary. Other calculators have stacks as, of course, do computers, but they are not visible to the user. In the HP, the function you select is executed as soon as you touch the button identifying it. Thus of course, the numbers upon which you wish to act must be already present in the machine. At first this seems as

if it is a cumbersome and illogical method of doing it, but it is recognised in the scientific community as the best way, once you are accustomed to it.

There is a learning period associated with an HP calculator if it is your first, but the time spent will be paid back tenfold in short order. The more involved and vinculum-nested the problem, the greater the gain over the bracket-and-equals method. For the simplest two numbers-to-be-added problem the number of keystrokes is the same, but the thinking is easier. There are a lot of ways of trying to describe to one not initiated in the technique why it is better, but it can be explained simply by saying that the calculator tackles the problem in the way you think about it. So it is not necessary to try to write the problem out in single line, vinculumless form before entering it into the machine.

All HPs have a four-deep stack, as does the 15C which handles pretty stiff problems without access to other memory. A further benefit of stack accessibility is the retention and availability of the last operand put into the stack in the 'last X' register. This allows correction of your last keystroke if it was wrong.

Next is the almost standard facility (these days) of continuous memory. The 15C keeps not only all programs, all memory contents and all stack contents, but even the place in the program where it left off. It also remembers its mode etc, which means that it can leave one of its advanced functions mid way through and expect to resume later.

It provides all logarithmic functions, trigonometric and hyperbolic trigonometric functions and their inverses, as well as all the simple functions such as square and square root etc, which I shall not list here. It also supports statistical functions with the HP complete Sigma and inverse Sigma data-acquiring function, mean, standard deviation and linear regression (line of best fit) with correlation coefficient. It will round off and also generate pseudorandom numbers.

Like most low power calculators the 15C is not fast, but then you couldn't call it slow either as it will loop 100 times in just over 30 seconds. This is half the speed of the HP-41, two-thirds the speed of the 30-series LED display (not low power) HPs, and is comparable to the low power pocket BASIC machines. It is sufficiently fast that you are not required to pause after a trig function before pressing the next button, as is the case on some calculators. Note here that the LCD display does take a moment to come up, but the machine finishes what it is doing and handles the next key press quickly, so you can keep punching the buttons without waiting to see the answer reappear.

Functions with class — emphasise 'ass'!

In addition to the usual functions, the 15C has a number of pleasing incorporations which are not really advanced, but are very nice to have. Firstly it can address indirectly using a dedicated register. It will go to a calculated line number, program label or fetch data from a calculated register. It will also display a computed number of decimal places or significant figures and truncate to the set significance if required.

It has five alphabetic labels which may be used to reference subroutine special functions in a single keystroke with the 'user' mode set. This is handy if there are a few complex jobs you must do again and again on a lot of different numbers. These also identify certain routines to the advanced functions which we will describe shortly.

The machine will nest seven levels deep in subroutines and registers an error if you try to overshoot, too.

It has a memory pool, which is all the unused memory kept in a state where it can be converted into data registers or program steps or be used by an advanced function when required. Any surplus memory is returned to the pool when it is no longer required and memory is taken automatically when needed. There is no need to stipulate what the boundaries are, except that the data registers must be numbered, presumably to allow out-of-range errors to be trapped when indirectly addressing. Up to 443 lines of program or 64 registers can be held.

It also has permutation and combination functions which add a little extra convenience for statisticians. Factorial now calculates the Gamma function too!

By means of a cunning command ('test' and a digit following) all possible conditional tests between the first two stack registers and the lowest stack register ('X') and zero have been included. That is, you can see if the X register is less than ($<$), less than or equal to ($\leq$), greater than ($>$), greater than or equal to ($\geq$), equal to ($=$) or not equal to ($\neq$) either Y or 0, without any additional fuss.

Finally, there is a new pair of looping commands which act like the BASIC 'For-Next' loop command. Each one can be called to act on any particular register, incrementing or decrementing its contents by one or any integer up to 99 and testing with respect to an integer up to 999. That is quite a mouthful, and takes a little getting used to in practice, but effectively greatly expands the looping capability of each loop, consuming only one register to hold the count, the increment and the comparison value!

Here ends the *excellent* and begins the *extraordinary*.

Advanced functions x+iy, ∫, solve . . .

There are four advanced functions: the 15C will operate in a 'complex' mode which is when its stack and functions have real and imaginary parts; it will operate on matrices, placing descriptors of these in the stack or executing a choice of functions on them; it will 'solve' for the zeros of a function identified by a label and executed as a subroutine; and it will numerically integrate such a function. (These last two appeared on the HP-34C, but can be made more powerful in conjunction with the first two).

Starting with the complex mode, as this no doubt caught the eye of all students in the electrical/electronic fields, let us look in detail at these four facilities. When the complex flag is set (it is flag 8) a 'C' annunciator appears in the display. Also, five registers disappear from the free memory pool. These are used to create an imaginary stack parallel to the real one. From now on, all applicable functions operate as complex. If you hit multiply a full complex multiplication is performed, using real and imaginary X and Y registers. The same goes for square root, the trigonometrics, powering, logarithms, etc! So taking a complex number to a real or complex power is as easy as doing it for reals. The calculator is organised such that you may ignore the imaginary part and the results will be purely real, if the inputs were purely reals. The imaginary stack takes care of itself, not letting previously input or computed values from the imaginary side drop into the next calculations. Any time a number with a non-zero imaginary component becomes involved, the result is the true complex one. There are functions for viewing the imaginary component temporarily or entering the imaginary part of a number, but apart from these there is no hint of additional keystrokes or complexity required. Computations, particularly of trigonometrics, take a noticeable period of time which is hardly surprising, but for all other intents and purposes the machine is just as it was, but complex not purely real. At any time you can clear flag 8 and the imaginary facility goes away, freeing the five registers. (Last X is the fifth, so that the same error correction facility as has been on all HPs is available for complex results as well.)

Matrix mode is similar in that it is absent until invoked. When a matrix is created (dimensioned) the required memory disappears from the pool and the operator can then act on that matrix. Up to five matrices can be used, one for each of the five alpha labels, A through to E. A matrix may be dimensioned, re-dimensioned to a different size without loss of numbers in registers, dissolved, initialised to all elements of the same specified value, multiplied by a scalar or another matrix, inverted, have its determinant found or have a number of special matrix functions applied to it.

When called, the descriptor of a matrix appears in the X register. Instead of seeing a number, as is the case normally, the letter identifier of the matrix appears, along with two numbers telling you the current matrix size. This descriptor may be moved as usual in the stack. When you touch the multiply key, say, the matrix or scalar in the X register is multiplied with the matrix or scalar in the Y register. Touching the divide key gets you the inverse of one multiplied by the other, so again you can see that the calculator acts just as if it were dealing with purely real scalar numbers. Occasionally a matrix result cannot be placed in the same memory as one of the source matrices. Rather than the result becoming the matrix whose descriptor was in X, another matrix is defined as the result matrix. It receives the computed set of elements and its descriptor replaces the one which was in X. For example, if I wish to multiply $A_{2,3}$ (this means matrix A which has dimensions 2x3) by $C_{3,3}$, I call up A and C. Then I tell the calculator that I want E to hold the result. When I press multiply the display blinks and I finish up seeing the descriptor $E_{2,3}$ which has replaced the A and ▶

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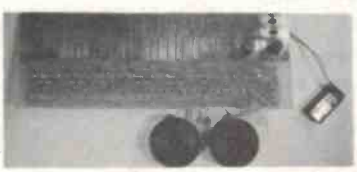

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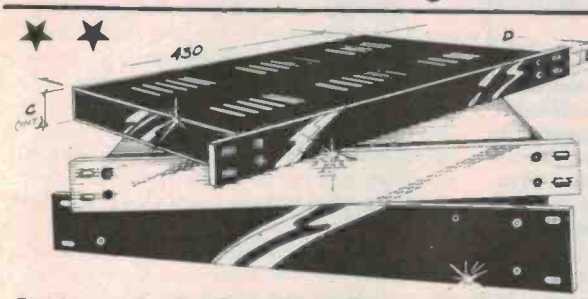

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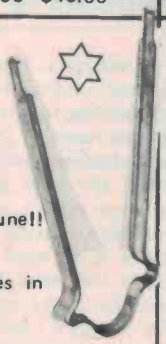

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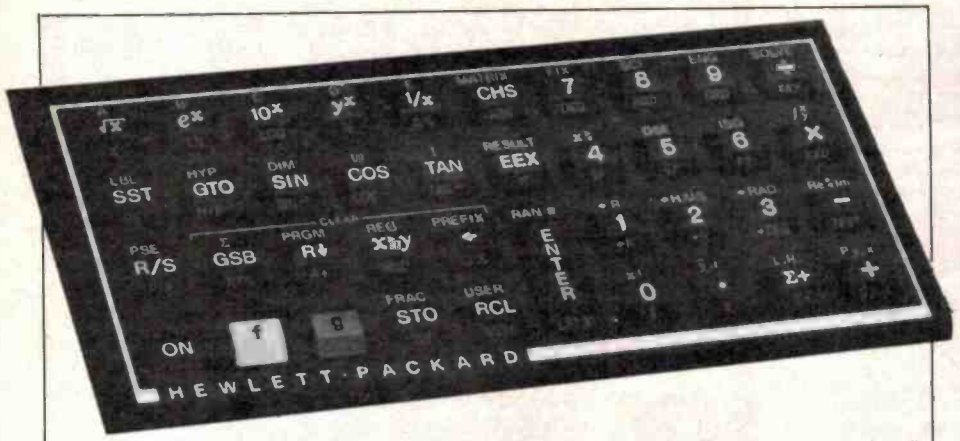

Close up. This view of the HP-15C keyboard gives you a good idea of exactly what you get. Like all HP calculators from the 35 series onwards, it employs reverse polish notation (RPN), hence the lack of an = key.

C descriptors in the stack. (The C descriptor is incidentally in 'last X'.) If I had not previously dimensioned E, or if E was the wrong size to receive the result, it is automatically set right by the function being called.

Complex numbers forming matrices can be handled using LU partitioned methods which are supported by the group of special matrix functions. These are invoked with a command similar to the one which allows the conditional tests to be implemented, namely the 'MATRIX n' command, where n is a digit. The rear of the 15C is printed with a list of errors, tests and matrix commands which correspond to the numbers 0-9.

The Solve and Integrate keys cause the numerical equivalent of the analytical processes of solution for zeros and integration to be performed. The command takes the form 'Solve A', where A is the program label which heads the function you wish solved. For instance, say you want to look for zeros of '$\sin X + e^X$'. This function is keyed in after the A label just as if you were evaluating it. Next you put in a point about which you wish to search for zeros, hit 'Solve A' and in a moment the result is returned. Similarly, integration occurs for the selected function between the limits set by the contents of the X and Y registers.

There is of course no special trickery in any of these four advanced functions. Newton's method is the basis of Solve, Simpson's of Integrate, while the Complex and Matrix functions are standard mathematical processes.

Why are those so powerful here? Firstly, these functions are always there. No need to use up RAM loading them and no need to carry them on cards or paper. Secondly, they are *fast* as they are ROM-based and machine code written. Much faster than you could implement them yourself. Thirdly, they are superbly integrated with the other functions in the machine. This brings us to the discussion of our earlier statement that the 15C is a superb piece of engineering.

Why, once you speak Reverse Polish, is it so easy to adapt to a new HP and why is it so quick to enter and solve a function? Fundamentally the HP-15C, like all previous HPs, but to a greater extent, has a degree of polish (*not* Polish) in its software and hardware which is quite unequalled in other machines. All the keystroke combinations are sensible; all unambiguous commands are accepted and quite often you'll find that some facility you decided you might like is already there. This feeling stems from the fact that each machine in the HP lineup has been extensively used by people like yourself before release. So all the little annoyances have been removed and all the extra conveniences and keystroke economies have been incorporated.

Polishes up well

I will give some examples from HPs in general, and the 15C in particular. When you are adding up a string of numbers with the Sigma function with a view to getting mean and standard deviations, you may wish to see what the total is. You could look in the memory which, according to the book, the machine is using for the running total, but there is no need. By hitting Recall Sigma, using the recall key for ordinary memories and the Sigma key you are using for storing, the X and Y totals are placed in the X and Y registers immediately. This is only sensible, is it not? In the 15C there is a pseudo-random number generator. Such functions, of course, have seeds. I did not have to look up in the book how to get at the seed — can you guess? — of course, just hit Recall Random#. Store Random# also puts away a new seed, should you wish to regenerate a sequence. (That is very useful indeed!)

Another sensibility is the method HP use for coding keystrokes in a program. If you look at the program you have written and you see '24, 57', this means that this command is the one you get by pressing the key fourth along on the second row, followed by the key seventh along on the fifth row. Obvious, isn't it? When you wish to run through a program step by step, you can press the SST key. When you depress it, the display shows you the next line to be executed. When released, the instruction is then executed. Simple, informative and sensible.

There are certain Matrix Functions on the 15C which would be destructive to some data. If you are entering or inspecting a matrix, pressing the appropriate key will cause the element's identity to be displayed, and releasing it executes the change. What if you press the key and — ERK! — it is the wrong element? Just hold the key down. After about three seconds the little beast figures out that you have probably made a boo boo and the word 'null' appears in place of the element descriptor. Now releasing the key leaves the value undisturbed . . . *phew!* A nice feature is the ability to see first a description of what is about to happen. Then once you realise what its effect will be it's nice to have the ability to recover from a destructive stroke.

Certain keys on the 15C are multifunctional, depending on what exactly you are doing at the time. For instance, the '⇐' key. When you are in the process of keying in a number like 27 988.63 and you hit a seven instead of a six, the arrow key removes only the last digit. When you have computed a result or effectively terminated digit entry, the key clears the whole register. Still more clever, when you are in program mode, the key deletes the current line altogether from the program, shifting up all the following instructions to close the gap. So the delete key, if we may call it that, is convenient and sensible in that it 'knows' what you want to delete.

In certain keystroke combinations, particularly involving the indirect addressing facility, it seems that the prefix keys f and g might need to be pressed more than once, because the second function part of a multikey command is a super or subscripted mark on its key. Inevitably, these extra prefix keys are unnecessary. The keys of HPs, and the 15C in particular because of its relative density of functions, are laid out in a careful manner so as to allow the ambigious key sequence to be separated by the calculator's operating system.

Hewlett-Packard have a reputation for excellence and 'friendliness' in their machines which will be solidly reinforced by the 15C. But now you have begun to think "this little beggar is going to be expensive!" Not so, really. The 15C sells for $190, or thereabouts, without sales tax which, for what it does, is probably the best value calculator on the market. Consider the HP-41, which starts around the $400 mark before peripherals. It is a much higher level machine, but because it does not have the advanced functions built in, it is not as fast or as convenient for tackling the short term problems encountered in the classroom and the laboratory. Anything the 15C can do the 41 can do also, but you will spend a lot longer fooling around getting there and will have more keystrokes in the execution, so it is, in our opinion, not as well suited for tasks below the level where mass storage is needed.

One further note concerning the 15C: It is, significantly, built in the USA, rather than Singapore of Taiwan or whatever. The reliability of HP calculators has always been very high, with the exception of the 30-series units which have established a reputation for being plagued with bad connection problems. It would seem that the return to assembly within the watchful eye of HP engineers is a move to guarantee that there will be a return to the high standard of reliability for which HP strive and which their original 35/45 calculators set. ●

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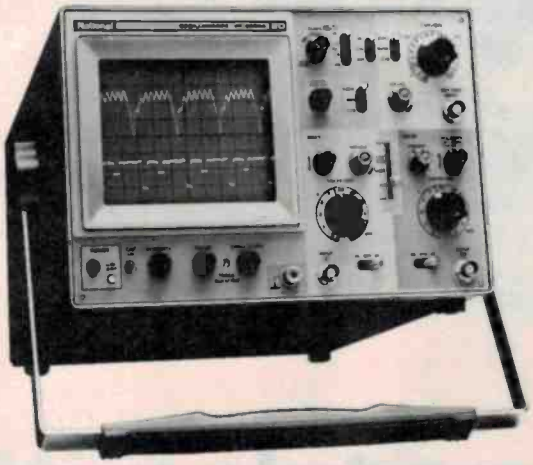

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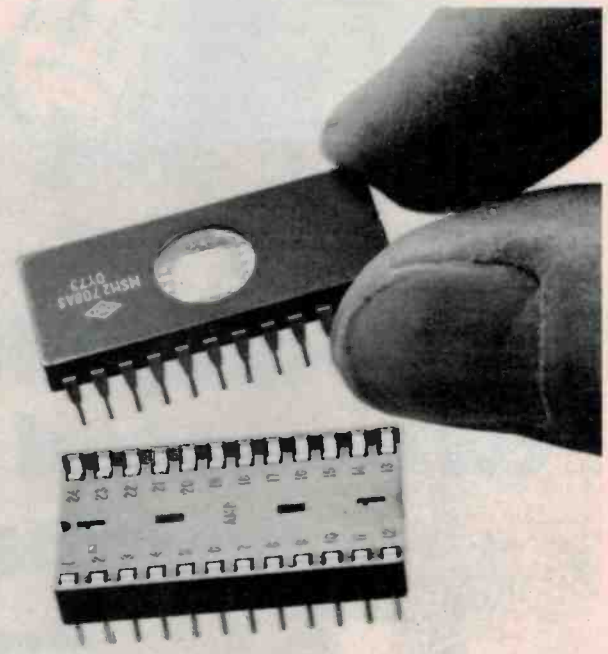

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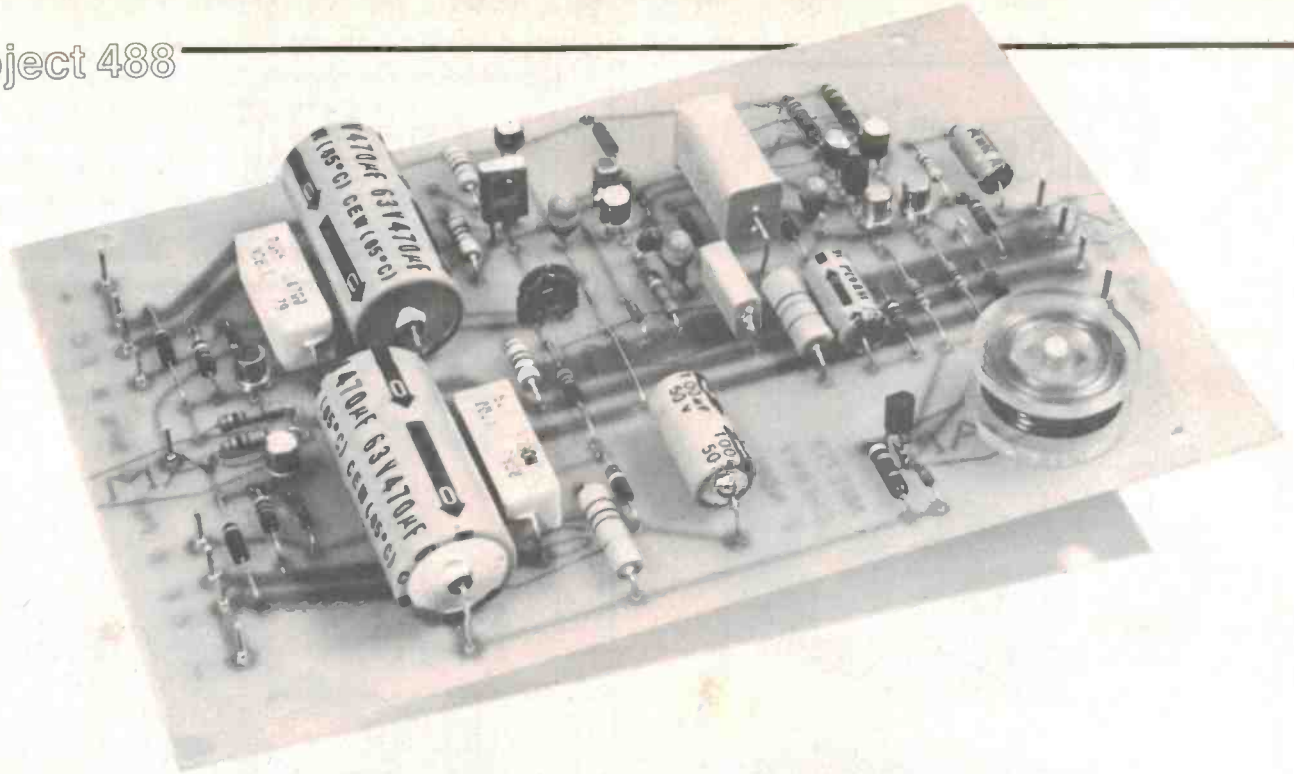


60 W amplifier module with two nested differentiating feedback loops

Edward M. Cherry

Associate Professor, Department of Electrical Engineering, Monash University

This is the third, and concluding, part of Professor Cherry's series on Audio Amplifiers Using Nested Differentiating Feedback Loops. Here is a practical amplifier design, presented as a module, that can be incorporated into a new system or used to replace power amp modules in an existing system. As the feedback technique promises, distortion is very low.

THIS AMPLIFIER will perhaps be of most interest to home constructors who want to re-build an existing system and upgrade its performance without the expense of new major components. The power output transistors employed are the well-known types MJ802 and MJ4502 which have been around for several years and have proved their reliability. Indeed, the whole design is mature and home constructors should have no difficulty in making it work. Total harmonic distortion in this amplifier is only a few parts per million at low outputs at 1 kHz — stacks better than some well-known marks of class-A amplifiers!

The two previous parts of this series appeared in the October and November 1982 issues of ETI.

Circuit description

Figure 15 is the complete circuit of one channel of the amplifier. The circuit is clearly based on Figure 10 (November '82 ETI), with major parameters

$$1/\beta = 32.9$$
$$\tau_X = 800 \text{ ns}$$

The value of β is set by the overall feedback resistors R11 and R12 (470R and 15k — see Equation 1, Oct. '82). τ_X is set by:

a) R4 and R5 (330R) plus C6 and C8 (68p) in conjunction with the chosen value of β (see Equation 13, Nov. '82);
b) R15 and C7 (1k8 and 470p — see Equation 14, Nov. '82);
c) R33 and C14 (8R2 and 100n) plus the 8 ohm nominal load and L3 (6u8 H);
d) R12 and C4 (15k and 33p) via the other constants in Equation 15 (Nov. '82).

The first stage requires little comment. Q1 and Q2 operate at 1.5 mA each, Q3 is a current source, Q4 is a common-base stage to equalise the quiescent voltages on Q1 and Q2; Q5 and Q6 constitute a current mirror. R1 and C2 form a 200 kHz low-pass filter against RF interference.

The Rush current amplifier operates at 3 mA, set by R18, and it incorporates a catching diode (D1) to accelerate recovery from overdrive. Almost any small-signal diode would do — 1S44, 1N914, etc.

Q1 and Q2 should be high gain, low noise types: BC109 and BC549 are among the cheapest available. The others could be almost any small-signal types: BC107 and

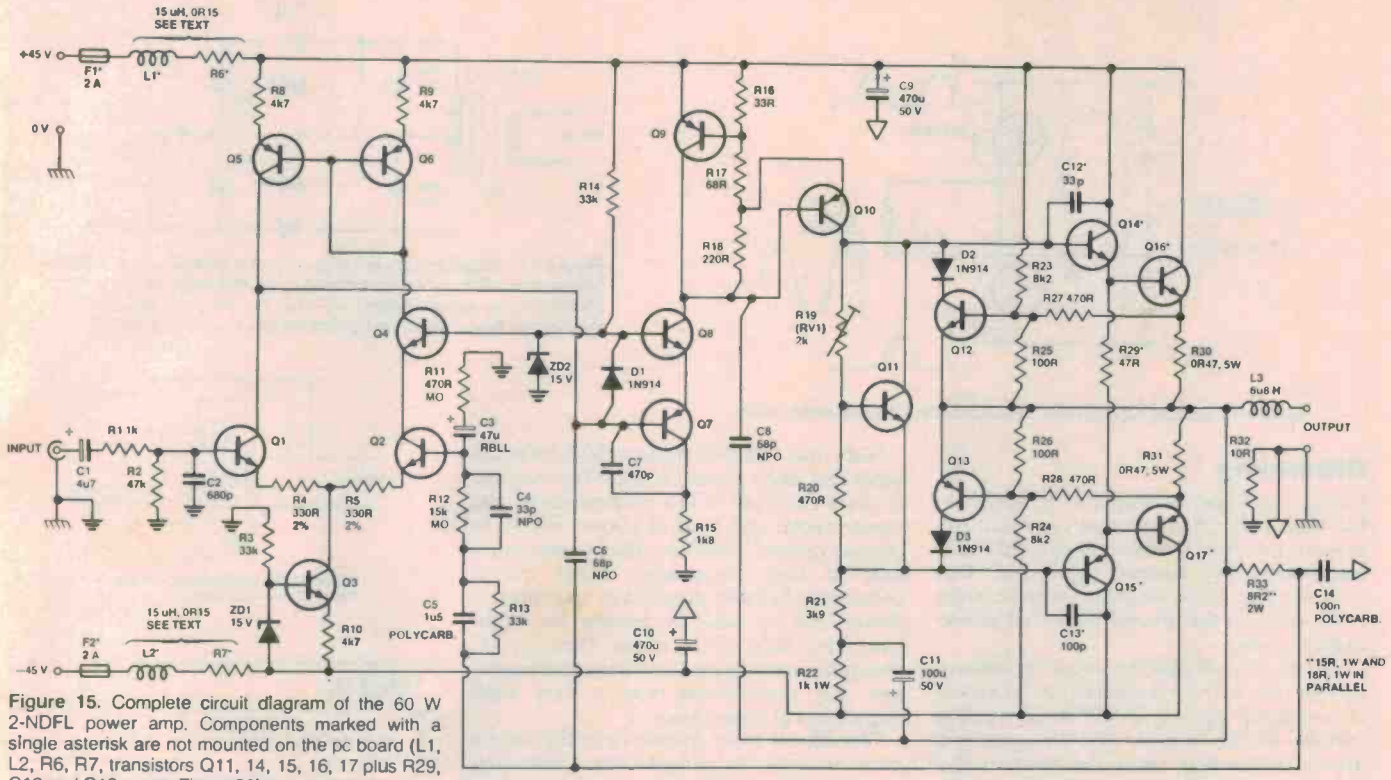


Figure 15. Complete circuit diagram of the 60 W 2-NDFL power amp. Components marked with a single asterisk are not mounted on the pc board (L1, L2, R6, R7, transistors Q11, 14, 15, 16, 17 plus R29, C12 and C13 — see Figure 20).

BC547 are readily available npn types, the BC177 and BC557 are suitable pnps.

The pre-driver, Q10, operates at 8 mA, and should be the prefered type BD140. Q9 protects the stage against damagingly large currents under fault conditions.

The driver and output transistors should be the types shown: BD139 and BD140 for the drivers, MJ802 and MJ4502 for the power transistors. Driver quiescent current is 25 mA, set by R29. The biasing transistor, Q11, could be any npn in a TO-126 pack that can be mounted on the heatsink; types BD135 and BD139 are readily available types that would suit. Quiescent current in the power transistors should be set to 40-60 mA by R19. *Be warned* that this quiescent current is almost zero until R19 is about three-quarters of its maximum resistance, after which the current increases very rapidly; be sure that R19 is set to *minimum resistance* when the amplifier is turned on for the first time.

A convenient way to check the quiescent current is by means of the voltage drop across R30 and R31; this should be 40-60 mV (total) for zero signal input to the amplifier.

Transistors Q12 and Q13 provide short-term protection for the power transistors. Short-circuit current is limited to about 4 A, and peak signal current is limited to 7 A. Long-term protection is provided by 2 A fuses in each supply rail; these should be 'ordinary' types, rather than delay or quick-blow. In the unlikely event of transistor failure, these fuses limit the loudspeaker current to 2 A, corresponding to 32 W into 8 ohms.

The common alternative of a single fuse in the loudspeaker lead is less satisfactory: it provides less protection for the amplifier; it provides less protection for the loudspeaker as the fuse must be rated to carry the full signal current, and it introduces distortion on large-amplitude, low-frequency signals.

Critical components

The majority of components in the amplifier are not at all critical. As already stated, almost any small-signal transistors and diodes can be used. Unless the contrary is indicated on the circuit, resistors can be standard ½ W types and capacitors can be the lowest available working voltage. A few components, however, do require special mention.

A feedback amplifier cannot be more linear than its feedback network, so the various components that constitute the feedback network should have small voltage coefficients. Specifically:

a) Overall feedback resistors R11 and R12 should be high-stability types, such as metal oxide or metal film;
b) C6 and C8 should be NPO ceramics, not hi-K types;
c) C5 and C14 should be polycarbonate, polystyrene or polypropylene types, but not polyester (for example mylar 'greencaps');
d) C3 should be an ordinary cheap aluminium electrolytic, definitely *not* one of the relatively expensive resin-dipped tantalum types (this is not a misprint!).

The 6u8 H inductor (L3) needs to be home-made. Winding data are given in the accompanying table, Table 1.

The bobbin should be mounted on the circuit board with a nylon screw; brass or steel must not be used, because of nonlinear eddy-current losses. ▶

HARMONIC ANALYSIS AT 1 kHz

harmonic	rated output 21.9 V 60 W	−20 dB 2.19 V 0.6 W
2nd	19 ppm	5 ppm
3rd	14	3.5
4th	2.5	2.5
5th	3.0	1.5
6th	<1	<1
7th	1.8	1.8
8th	<1	<1
9th	1.0	<1
10th	1.8	<1

Notice how the harmonics drop away at small signal amplitude. In this regard a class-B NDFL amplifier is more like a conventional class-A amplifier than a class-B amplifier.
1 ppm = 0.0001%

HARMONIC ANALYSIS AT 6 kHz

harmonic	rated output 21.9 V 60 W	−20 dB 2.19 V 0.6 W
2nd	115 ppm	40 ppm
3rd	100	25
4th	32	15
5th	40	9

Harmonics higher than the 3rd are ultrasonic and hence inaudible.

TABLE 1.

Winding details, L3.
Former
Turned from 25 mm diameter polystyrene rod to give 12 mm internal bobbin diameter with 7.5 mm winding space between cheeks.
Wire & winding
Take a 1190 mm length of 1.25 mm diameter enamelled copper wire and wind it onto the former. Leave 20 mm or so lead length at start and finish.

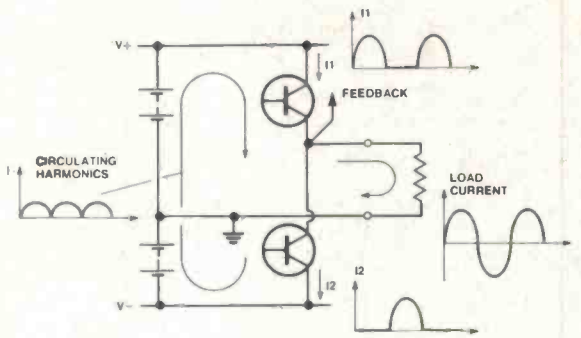


Figure 16. Circulating even-harmonic current in a class-B output stage.

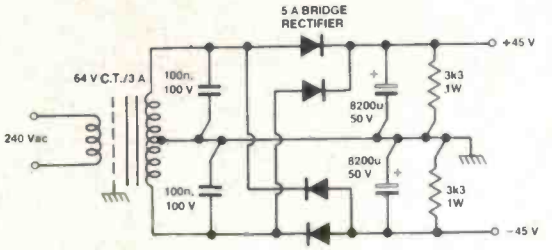
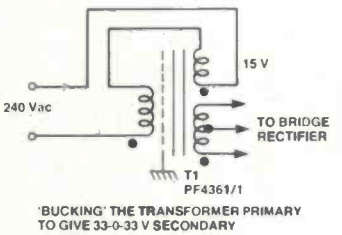


Figure 17. Suggested power supply for the amplifier. The transformer specified is not a common type, but using a Ferguson PF4361/1 as shown below will give the required result. This transformer has a 'flux shorting' strap to give a low external field.



'BUCKING' THE TRANSFORMER PRIMARY TO GIVE 33-0-33 V SECONDARY

Grounding

In any amplifier where the basic distortion has been reduced to a few parts per million, several distortion mechanisms not ordinarily considered may become significant. One such mechanism is associated with currents circulating in the ground leads and power-supply wiring.

Figure 16 explains the origin of this distortion. The current in each power transistor of a class-B stage is a half-wave rectified version of the output. The two currents, drawn alternately from the positive and negative supplies, are equivalent to a circulating full-wave rectified current and this is basically an even-harmonic distortion of the signal output. If there is any mutual inductance between the power-supply wiring (including the grounds) and the signal wiring (also including the grounds), then an even-harmonic distortion is induced in the amplifier and feedback is powerless to correct it.

The circuit board has been laid out so as to minimise this effect. The areas enclosed by some tracks are critical, and home constructors making their own pc boards are cautioned to follow the layout exactly; you can obtain artwork from ETI (see page 64) or, better still, purchase a ready made board.

Note that the circuit uses three distinct ground symbols:

a)  is the *quiet ground* track on the circuit board (one per channel).

b)  is the *noisy ground* track on the circuit board (one per channel).

c)  is the metal chassis ground (there are six connections to the chassis in total).

Each channel is connected to chassis ground at two points. The input socket is connected to the chassis (rather than insulated from it), the input lead from socket to circuit board is screened, and the quiet ground track is connected to chassis ground at the input socket via the screen. Similarly, the neutral output terminal is screwed into the chassis, the leads from the circuit board to the output terminals are a twisted pair and the noisy ground track is connected to chassis ground at the output terminals via the neutral output lead. The remaining two connections to chassis are in the power supply (Figure 17).

Note that a 10 ohm resistor, R32, links the quiet and noisy ground tracks. This resistor is short circuited at low frequencies by the input screen and neutral output wiring to chassis ground. However, the resistor takes over at high frequencies where wiring inductance becomes significant. (A capacitor should not be used to provide the high-frequency link, as it would form an LC resonant circuit with the wiring inductance and the combination has a very high impedance at resonance.)

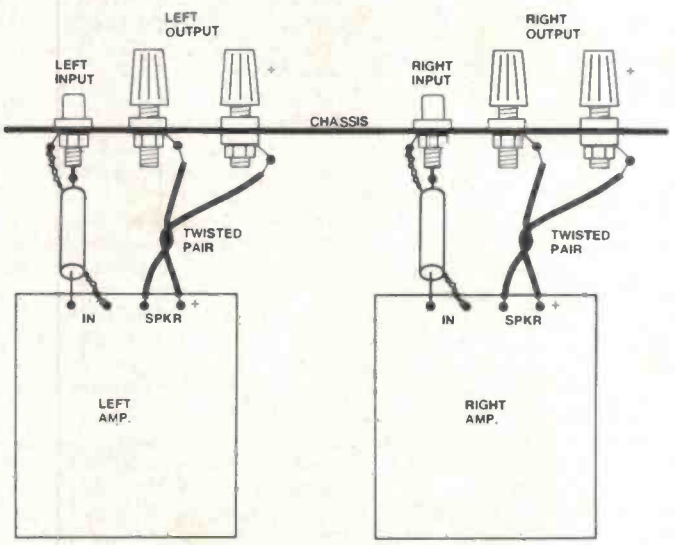
The 15 μH filter inductors in the supply rails are also for suppressing circulating currents (R6 and R7 represent the winding resistances of L1 and L2).

This amplifier employs only two nested differentiating feedback loops and its distortion is not down to the ultimate limit. The benefit of including the filter inductors is therefore marginal. The author is not blessed with 'golden ears' and cannot hear the effect of removing the filters, although the difference is clearly measurable. The filters should certainly be included in amplifiers that use three or more NDFLs. As the inductors must be home made, and therefore cost nothing but time, and as they do make a measurable (if small) improvement, most home constructors will probably wish to include them. Winding data are given in Table 2.

TABLE 2.

Winding details, L1, L2.
Former
Turned from 20 mm diameter polystyrene rod to give 12 mm internal bobbin diameter with 7.5 mm winding space between cheeks. Two are needed.
Wire & winding
Take two 1680 mm lengths of 0.75 mm diameter enamelled copper wire and wind onto each former leaving 20 mm or so lead length at start and finish.

The precise values of inductance and resistance are not important — ±50% is good enough — but do not use the 1.25 mm wire from L3 as something like 0.1 ohm series resistance is essential. For a similar reason, do not parallel the 470 μF bypass capacitors C9 and C10 with high-frequency types. Brass or steel mounting screws are perfectly satisfactory for the filter inductors, as linearity is not important. ▶



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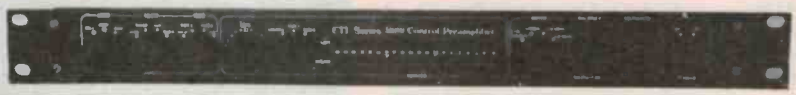

SPECIFICATIONS

Frequency response:	High-level input: 15Hz-130 kHz, +0, −1 db Low-level input — conforms to RIAA equalisation, ±0.2 dB
Distortion:	1kHz <0.003% on all inputs (limit of resolution on measuring equipment due to noise limitation).
S/N noise:	High-level input, master full, with respect to 300 mV input signal at full output (1.2V): >92 dB flat >100 dB A-weighted. MM input, master full, with respect to full output (1.2V) at 5 mV input, 50 ohm source resistance connected: >86 dB flat >92 dB A-weighted. MC input, master full, with respect to full output (1.2V) and 200 μV input signal: >71 dB flat >75 dB A-weighted.

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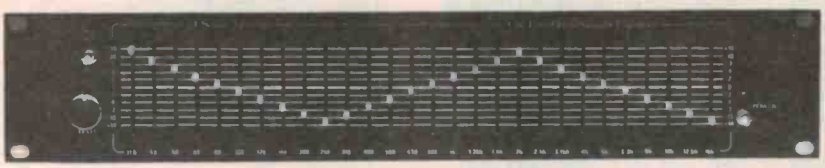
Please note that the "Superb Quality" Heatsink for the power amp was designed and developed by Rod Irving Electronics and is being supplied to other kit suppliers. This product cost $1,200 to develop so that your amplifier kit would have a professional finish as well as sound. We also have a new range of rack mounting boxes which will be released soon.

SPECIFICATIONS

Power output:	100W RMS into 8 ohms (±55 V supply).
Frequency response:	8 Hz to 20 kHz, +0−0.4 dB 2.8-Hz to 65 kHz, +0−3 dB. NOTE: These figures are determined solely by passive filters.
Input sensitivity:	1V RMS for 100W output.
Hum:	−100dB below full output (flat).
Noise:	−116 dB below full output (flat, 20 kHz bandwidth).
2nd harmonic distortion:	<0.001% at 1 kHz (0.0007% on prototypes) at 100 W output using a ±56 V supply rated at 4 A continuous. <0.003% at 10 kHz and 100 W.
3rd harmonic distortion:	<0.0003% for all frequencies less than 10 kHz and all powers below clipping.
Total harmonic distortion:	Determined by 2nd harmonic distortion (see above).
Intermodulation distortion:	<0.003% at 100 W. (50 Hz and 7 kHz mixed 4:1).
Stability:	Unconditional



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- Specially imported black anodised aluminium knobs
- Again as with the power amp we are offering this kit A & T at a price which we do not believe there is a commercial unit available that sounds as good. Same delivery as the P.A.

only $425

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SPECIFICATIONS

Bands:	28 Bands from 31.5 Hz to 16 kHz
Noise: 20 kHz bandwidth	<0.008 mV, sliders at 0, gain at 0 (−102 dB),
Distortion:	0.007% at 300 mV signal, sliders at 0, gain at 0; max. 0.01%, sliders at minimum.
Frequency Response:	12 Hz-105 kHz, +0, −1 dB, all controls flat.
Boost & Cut:	14 dB

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Low-frequency compensation

A feature of Figure 15 not discussed so far is a low-frequency compensating circuit, R13 and C5.

Amplifiers of the basic circuit topology of Figure 2 (Oct. '82) have a group delay which is different for different signal frequencies. Some frequencies take longer or shorter times than others to pass through the amplifier. High-frequency group delay in NDFL amplifiers can be corrected as described in the last part (Nov. '82), by a small capacitor in the feedback network (see Equation 15). Errors in low-frequency group delay, in both Figures 2 and 10 (Oct. and Nov. '82), are associated with the input coupling capacitor and the capacitor in series with R_{F1}. Low-frequency square-wave inputs are reproduced with a 'tilt' as in Figure 18(a).

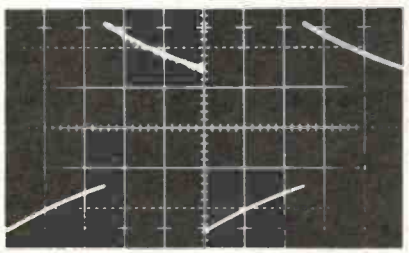


Figure 18a. Square wave response of the amplifier without group-delay compensation.

One approach to this problem is to use a truly direct-coupled amplifier, with no capacitors in series with the signal path; commercial audio power amplifiers of this type appeared in the 1970s. Unfortunately, such amplifiers are prone to drift. A significant dc voltage may appear at the output even when there is no input. Although it is possible to reduce drift in a power amplifier to an acceptable level, it is not possible with today's technology to build a system that is truly direct-coupled from pick-up input, through the RIAA network and the power amplifier.

In the last few years a generation of amplifiers has appeared which include some form of servo amplifier to correct the drift. All circuits known to the author re-introduce the problem of group delay, albeit in a lesser form.

The approach adopted in this design is to retain the coupling capacitors and thereby eliminate drift, but include a group-delay correcting circuit. Figure 19 shows the outline. Group delay is optimally compensated if:

$$R_{F3} = 2\,R_{F2}\,, \qquad (16)$$

$$R_{F2}\,C_{F2} = R_{F1}\,C_{F1} \qquad (17)$$

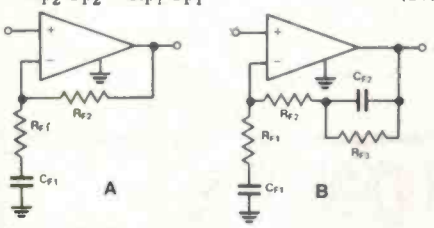


Figure 19. Circuit for compensating low frequency group delay: (a) basic uncompensated circuit; (b) compensated circuit.

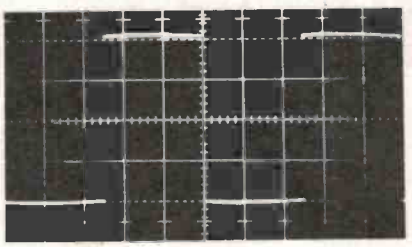
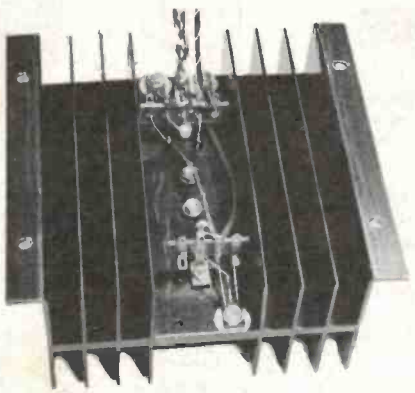


Figure 18b. Square wave response of the amplifier with group-delay compensation — note the improvement over Figure 18b.

Figure 18(b) shows the improvement in square-wave response.

Low-frequency group-delay compensation could well be included in audio power amplifiers and preamplifiers other than NDFL types.



Heatsink. Showing components mounted on the heatsink.

Construction

Assembly of the printed circuit board is quite straightforward. It is probably best to commence by soldering all the resistors in place. Note that R33 could be either a 2 W type (not common) or two 1 W resistors (15R and 18R) in parallel. Note that Noble brand resistors have been used for the emitter ballast resistors of Q16 and Q17 (R30 and R31). These have very low inductance and other types may be used and work successfully, but if you have trouble with high frequency instability, these resistors are likely to be the culprit. Mount R30 and R31 a few millimetres above the board. There are several other things to note about the resistors. R4 and R5 should be 1% or 2% tolerance and R11 and R12 should be either metal oxide or metal film types, as mentioned earlier.

Assemble the diodes next, making sure you get them all the right way round. Install the links next. Follow with the capacitors. Note that C5 and C14 must be polycarbonate types and C4, 6 and 8 must be NPO ceramics. None of the other ceramic capacitors should be hi-K types, as mentioned earlier. When mounting C9 and C11, see that there is three or four millimetres between the capacitor body and the adjacent 5 W resistors (R30 and R31) to allow for convection around the latter.

The transistors may be mounted now. See that each is oriented correctly. Wind L3 next and mount it on the board. Details are given in Table 1. It is not necessary to strictly follow the former dimensions given, but the inductance needs to be close to 6u8 H and wound from 1.25 mm wire at least, for low resistance.

To terminate connections leading to and from the board, pc stakes were used, as can be seen in the photograph.

Assembly of the components mounted to the heatsink comes next. The heatsinks in the original were 5" (127 mm) lengths of blackened Philips #56230, each having a thermal resistance to ambient of about 1°C/W at 50°C. Other types could of course be substituted. The specified thermal resistance permits continuous operation at full power. Smaller heatsinks (up to 2°C/W) could be substituted if the amplifier is to be used only for domestic sound reproduction. A 225 mm length of single-sided radial-fin type heatsink (e.g: D.S.E. No. H-3426 or Electronic Agencies H-2429 would suit). Other suitable similar types are Rod Irving's HS3, which is only 150mm long or a 150 mm length of

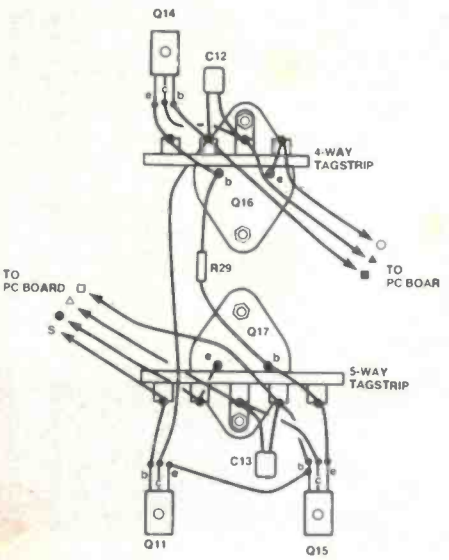
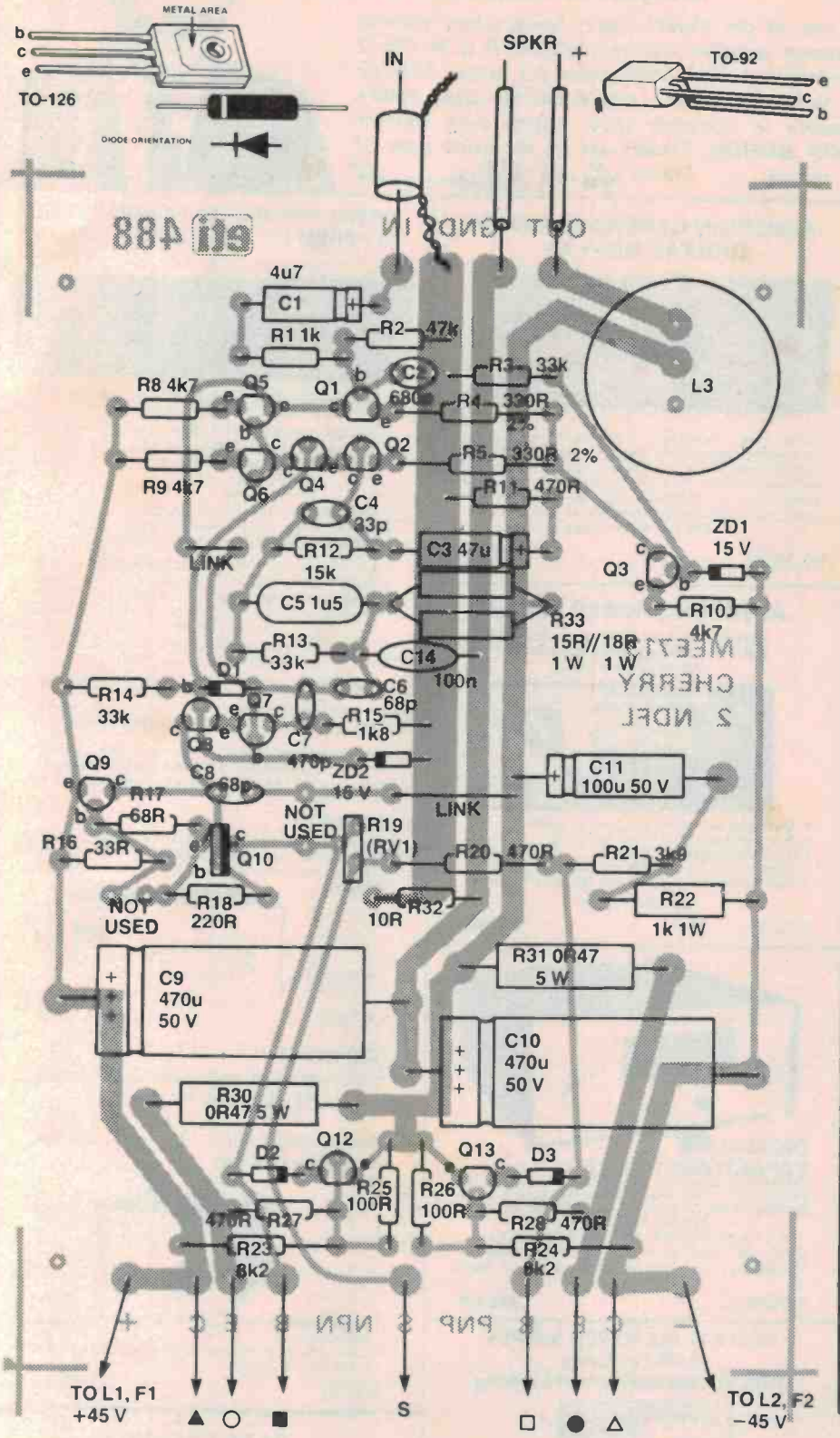


Figure 20. Wiring diagram for the components mounted on the heatsink.

PATENT PROTECTION

The principle of nested differentiating feedback loops, on which this amplifier depends, is patented in Australia and principal overseas countries.

Commercial enquiries should, in the first instance, be directed to the Legal Office, Monash University, Clayton Vic. 3168. Australian manufacturers can expect very favourable licencing terms.



PARTS LIST — ETI-488

Resistors ..... all 5%, ½W unless noted

R1	1k
R2	47k
R3, 13, 14	33k
R4, R5	330R, 2%
R6, R7	see text
R8, 9, 10	4k7
R11	470R, MO or MF*
R12	15k, MO or MF*
R15	1k8
R16	33R
R17	68R
R18	220R
R19 (RV1)	2k min. vert. mount trimpot.
R20, 27, 28	470R
R21	3k9
R22	1k, 1 W
R23, R24	8k2
R25, R26	100R
R29	47R
R30, R31	0R47, 5 W
R32	10R
R33	8R2, 2 W or 15R and 18R, each 1 W

Capacitors

C1	4u7, axial electro.
C2	680p ceramic
C3	47u axial electro.
C4	33p 100 V NPO ceramic
C5	1u5 polycarbonate
C6, C8	68p 100 V NPO ceramic
C7	470p ceramic
C9, C10	470u/50 V axial electro.
C11	100u/50 V axial electro.
C12, C13	33p 100 V ceramic
C14	100n/100 V polycarbonate

Inductors

L1, L2	15 uH (see text and Table 1)
L3	6u8 H (see Table 2)

Semiconductors

D1, 2, 3	1S44, 1N914, 1N4148 etc
Q1, Q2	BC109, BC549 etc
Q3, 4, 8, 12	BC107, BC547 etc
Q5, 6, 7, 9, 13	BC177, BC557 etc
Q11, Q14	BD139
Q10, Q15	BD140
Q16	MJ802
Q17	MJ4502
ZD1, ZD2	15 V zener

Miscellaneous

F1, F2	2 A standard fuse

ETI-488 pc board; one 4-way and one 5-way tagstrip; heatsink to suit (see text); pc stakes; bobbins for inductors, wire, etc.

* metal oxide or metal film.

Price estimate (less heatsink) **$30 — $35**

Autotron 'XA' type heatsink. Use one heatsink per channel.

Three small components are mounted on the heatsink adjacent to the transistors to keep certain leads short: R29, C12 and C13. Construction is very much simplified if a 4-way tagstrip is installed under one of the collector mounting bolts of Q16 and a 5-way strip under one of Q17's mounting bolts. Figure 20 shows details.

The collector and emitter leads from each power transistor to the circuit board should be twisted. The base leads to Q14 and Q15 could be twisted in with the corresponding collector and emitter leads (although this is not necessary) and the base lead of Q11 can be kept separate. Note that all transistors must be insulated from the heatsink.

The pc board is a Monash University 'universal' type for NDFL power amplifiers and there is provision on it for two components not used in the present amplifier (both near Q10). Note also that the BD140 specified for Q10 needs its leads dressed to fit the board — the collector and emitter leads should be bent about 0.1" sideways (see the overlay). ●

ALTRONICS ... ALTRONICS ... ALTRONICS ...

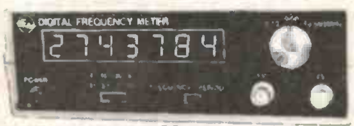
I'M ~~BUILDING~~ *have built* THE FIRST TWO

– what am I raving about? Well, having one of the World's finest home stereo systems (the brilliant ETI 5000 series amp and preamp together with my beloved B & W DM II loudspeakers of course!), I couldn't resist building ETI's 5000 series 1/3 octave Graphic Equalizers. I have been pestering ETI for well over a year – and **at last the many 1000's of 5000 series owners have the opportunity** *to complete their system with another* **classic, no compromise DAVID TILBROOK DESIGN.** *Details are on the other page of this ad.* Cheers *Jack O'Donnell*

DIGITAL FREQUENCY METER

See Electronics Aust. Mag. Dec. 81-Feb. '82

500 MHZ, 7 DIGIT RESOLUTION PLUS PERIOD MEASUREMENT FEATURE



IMPORTANT NOTES:
(1) This project is well within the scope of the "not so experienced" as virtually all components are contained on a single PCB.
(2) ALTRONICS USE ONLY THE SPECIFIED INTERSCIL LSI – BEWARE OF INFERIOR KITS THAT DO NOT CONFORM TO THE ORIGINAL DESIGN.

* Screened front panel * Bright high efficiency 7 segment display * Frequency ranges 0-10MHz, 0-50MHz, 10-50MHz (with optional pre-scaler) * 4 gating times – 01, .1, 1, 10 seconds, * 4 period measuring ranges 1, 10, 100 and 1000 input cycles give 0.1uS resolution. * High input sensitivity – 10mV to 30MHz, 100mV at 50MHz @ 1M input impedance, 200mV at 500MHz @ 75 ohms input impedance. * High accuracy – typically better than .005%/ count uncalibrated.

Costs a fraction of commercial counters.

EXCLUSIVE ALTRONICS KIT FEATURES:
* IC sockets provided throughout.
* Low aging 10,000 MHZ XTAL.
* Thermalloy heatsink for 5V regulator.
* Quality Pactec Instrument Case

K 2500 (50 MHZ version) $119.50
K 2501 Pre-scaler . . . . $ 26.00
(add for 500 MHZ version)

FUNCTION GENERATOR WITH DIGITAL DISPLAY

EA's new Function Generator covers the frequency range from 15Hz to 170kHz in three ranges with coarse and fine frequency controls. An economical 4-digit display has been incorporated to eliminate dial calibration. Sine wave distortion can be trimmed to around 0.5%.
See EA April, 1982

K 2505 . . . . $85.00

GREAT NEW MOSFET PA AMPLIFIER KIT FROM ETI

150 watts power output.

See June '82

UNCONDITIONALLY STABLE · SOUND STUDIO SPECIFICATIONS

OUTPUT IMPEDANCE Selectable to low Z voice coil or 100V or 70V line out.
INPUTS 2 mic inputs HI or low Z with speech filter.
1 Aux. input.

* Low noise 5534 op amps used.
* Noble W/wound power resistors used in output stage for guaranteed stability.

*** ALTRONICS EXCLUSIVE ***

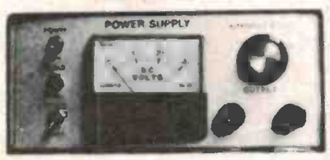
All due respects to ETI, but we felt the original case was lousey – So we've brought out ours utilising our snazzy H 0400 Black Rack Cabinet.

It looks terrific!! And for this month only, it's the same price as the original version.

K 5035 . . . . ONLY $239.00

ALTRONICS POWER SUPPLY

BASED ON EA LM 317K PROJECT
Every workshop, school and hobbyist should get one now!



* Overload and short circuit protected.
* Full voltage and current metering.
* 3-32 volt output at 1 AMP.
* Uses LM 317K variable regulator.
* Full instructions and every last part included.

VALUE PLUS!

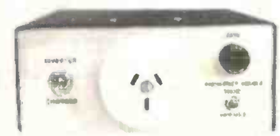
K 3200 . . . . $39.95

GO ANYWHERE 240V PWR. KITS

See EA May and June 82. These great new inverter kits enable you to power 240V appliances for your car, caravan or boat. (From Standard 12V car battery.)

40 WATT

Suits small appliances, i.e. turntable, tape deck, shaver etc. Variable frequency adjustment enables accurate speed control of turntable motors.



IC Sockets Provided

K6700 . . . . $55.00

300 WATT

Fully regulated and overload protected XTAL locked frequency.

* * * *

Use to power hi-fi, TV sets and for emergency lighting.

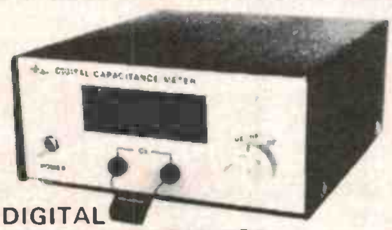
* Gold plating on both PCB edge and edge connector.
* Low age rate parallel resonant XTAL used.
* Sockets for all IC's.

K6750 . . . . $199.50

* THE EVER POPULAR MUSICOLOUR IV EA PROJECT *

Combination Colour Organ and Light Chaser. Four channel colour organ. Internal microphone or connect to speakers for colour organ operation. (The lights connected to each channel pulse in beat to the music proportional to portion of frequency spectrum concerned.) Four chaser modes forward and reverse. Output lamp load capacity a massive 2400 watts – that's 100 party globes. Full instructions and every last nut and bolt included. Great for parties, shop signs, display windows etc.

K 1004 . . . . $89.50



DIGITAL CAPACITANCE METER

Electronics Australia Project. Measures 1PF – 99.99 UF. 240V Mains Powered. Bright LED Display. Easy to build. Complete kit of parts and full instructions.

*** EXCLUSIVE TO ALTRONICS ***

Each kit now includes precision measured capacitors for accurate calibration of each range.

K 2520 . . . . $45.00

HIGH FIDELITY AM

Sounds every bit as good as FM With this absolutely brilliant EA Project

Project 82 AR12 – See December EA

Frankly, we felt AM was dead and buried for the serious audio buff – when EA told us their new wide band AM tuner had 16KHz bandwidth and made AM sound like as never before – we were still not convinced. But on hearing the New EA AM Tuner, I for one was astonished – AM Broadcasts now sound incredible, there is no other word for it.
And the 9KHz whistle filter really works!
The result is clear smooth sound reproduction that will be a joy to every constructer on this fantastic tuner project.
The Altronics Kit includes rack box and every last nut and bolt – even solder.
Full instructions included.

K5200 . . . . $249.00

NEW ETI 162 POWER SUPPLY

0-30V at 1 amp
With Voltage and Current Limiting

* Overload and Short Circuit Protected.
* Full Voltage and Current Metering.
* Fully variable voltage and adjustable current limiting.

Exclusive – Fully S.E.C. Certified Mains Transformer supplied.
If you're considering buying this kit from your local supplier or one of our competitors – first ring and ask them if the mains transformer is S.E.C. certified to ASC126 – chances are that it won't be.
So why not give us your order? An Altronics Quality Kit speaks for itself and with our overnight Jetservice we guarantee to deliver to your door faster than your local supplier.

K3205 . . . . $49.50

ELECTRONIC FLOURO STARTER

See EA October 1982

Save a fortune on Flouro Tubes

* Extends the life of your flouro tubes by 1,000's of hours.
* Instant "ON" – no more flickering at switch on.

K3210 . . . . $4.95

ALTRONICS ... ALTRONICS ... ALTRONICS ... ALTRONICS ... ALTRONICS .. ALTRONICS

BANKCARD JETSERVICE-DELIVERY NEXT DAY BANKCARD JETSERVICE-

ALTRONICS ... ALTRONICS ... ALTRONICS ... ALTRONICS ... ALTRONICS ... ALTRONICS

ALTRONICS ... ALTRONICS ... ALTRONICS ...

At last a graphic worthy of the 5000 NAMETAG SERIES 5000 1/3 OCTAVE GRAPHIC EQUALIZER

Another brilliant DAVID TILBROOK no compromise design

Free Jetservice over-night delivery on this Kit — Nov. & Dec.

SPECIFICATIONS:
Noise — at zero gain and 20 KHZ Bandwidth — 102 db. Distortion 1 KHZ — typically .007%. Bandwidth — 12HZ — 105 KHZ + 0 — 1 db. Boost/Cut + and — 14 db.

ALTRONICS EXCLUSIVES:
* All 1C sockets provided * Quality series Racking Case supplied * Genuine Philips Sygnetics Low Noise 5534 1C op amps supplied * Specially imported high accuracy linear slide potentiometers employed for precision control adjustment. (NOTE: Not compromise "Null Centre" types that some suppliers offer.)

K 5025 . . . . . See ETI Magazine November 1982 . . . . . **$199.50**

STUDIO FORMAT ETI 5000 STEREO CONTROL PREAMPLIFIER

There have been countless accolades exclaiming this brilliant design by Australia's top audio design engineer David Tilbrook — and with good reason!

As a demonstration of our faith in this classic designed preamplifier we proudly release the **STUDIO FORMAT 5000 PREAMP** which includes some very worthwhile refinements as detailed here:—
* Gold plated RCA Jacks on all phono inputs * 1 x pair gold plated RCA Line Plugs, supplied * Military spec. National Semiconductor LM 394's employed * Low capacitance screened cable, supplied; 1C sockets provided throughout; Multicoloured led display * Metal film 1% resistors used throughout all audio circuitry * Pretinned PCB's * Satin Black brush finished, aluminium control knobs

DELUXE STUDIO FORMAT 5000 PREAMP KIT Complete kit includes all ETI specified parts plus the Studio Format Package. Full instruction booklet included. SEE ETI MAG. JULY '81—OCT. '81 FOR FULL DETAILS.

K 5001 . . . . . **$275.00**

ETI 5000 STEREO MOSFET AMPLIFIER

See ETI magazine Jan. '81—April '81. New generation mosfet power semis facilitate David Tilbrook's classic power amplifier. Listening tests prove it surpasses even the best in conventional amplifiers in low fatique, high definition audio. Completely uncoloured crisp sound purity.

EVEN BETTER: This beautifully engineered amp design is based principally on two identical printed circuit boards with a minimum of other wiring, thus enabling even a relative "beginner" to accomplish building this project as long as the step by step instructions are followed.

The ALTRONICS Kit includes the DELUXE FINISH FRONT PANEL HEATSINK
* Original specified chassis bar design case * All metal work finished satin black * Flux shorting strap transformers used to minimise hum * Low leakage power supply electrolytics

SPECIFICATIONS: Power Output: 100 watts into 8 ohms x 2. Frequency Response: 8 HZ - 20 KHZ + 0 db — .4 db. Noise: 116 db below full output. Input sensitivity: 1V RMS for 100 W output. Distortion: Less than .001% at 1 KHZ and full output. Stability: Unconditional stable.

COMPLETE MOSFET AMP KIT K 5005 . . . . . **$289.00**

LOUDSPEAKER PROTECTION KIT

Protect your valuable loudspeaker system with this easy to build, professional appearance kit. This easy to construct kit, based on the latest ETI design (Oct. '82), provides both DC and overpower protection for your valuable HI-FI speakers.

Self-powered unit disconnects the speakers within 1/10th of a second of a fault occuring yet in no way effects the sound quality.

The ALTRONICS Kit comes in a superb 1 unit rack box including quality silk screened front panel.

EXCLUSIVES: * LED Monitoring of channel cutout * Fujitsu 10 amp relays * ALTRONICS Kit, stereo unit complete to last nut bolt and washer * Input/Output speaker cable terminals supplied.

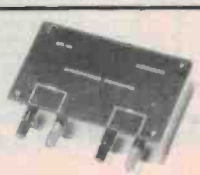
Install it in minutes — no AC or DC connections required — simply connects into the left and right channel speaker lines.

K 5050 Stereo Rack Version **$79.50**

SINGLE CHANNEL SPEAKER PROTECTOR KIT

For the economy conscious the same electronics employed with the K 5050 are available in single channel format. Jiffy box, printed front panel and all terminals supplied.

K 5051 . . . . . **$22.50**



ETI'S BRILLIANT NEW DIRECT-CONNECT COMPUTER MODEM

Employs unique 'Commutated Filter' design overcoming virtually all the problems involved with conventional modems.

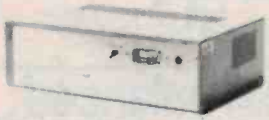
Super flexible unit facilitates communications between computers over cables, the telephone network and radio links.

Unit connects to a standard RS 232 interface and is capable of both 1200/75 Baud and 300/300 Baud transmission and reception * Line switching; answer and dialing facilities on board.

EXCLUSIVES: * Plated through, double sided PCB * Complete set of IC sockets * Kit requires 85 IN914 Diodes for programming these are included * Ceralock resonator and matching balanced load capacitor used for long life and high accuracy * Telecom approved isolating transformer and Reed relays included.

K 9644 . . . . . (See ETI Oct 82) **$169.50**

MODEM MONITOR AND CASE OPTION I



Having built the modems for our own computer use ALTRONICS strongly recommend (as do ETI) the inclusion of Audio and Visual Monitoring (signal strength). Our K 9645 includes all the components listed on Page 23 October ETI, custom ALTRONICS PCB, speaker, panel meter, front panel and case to house these options plus the full modem.

K 9645 Modem Option I. . . . . **ONLY $30.00**

NEW UNIVERSAL DC-DC INVERTER

SEE ETI MAG. SEPT. 1982

Rated at 200 watts this versatile inverter can be simply configured for virtually any desired input/output voltage required by the winding format of T2.

Typical input voltages: 12/24/32 V. Typical output voltages available: ± 50, ± 15, ± 40, 1400 V.

Now you can use high power hi-fi and PA amps for your boat, caravan etc.

K 6509 includes metal case **$39.50**

40W FLUORESCENT LIGHT INVERTER FOR 12V BATTERY OPERATION

Self-oscillating, push-pull inverter operates above the audible frequency range and is capable of driving two 20 watt or one 40 watt fluorescent tube to 150% of normal (240 volt operation) efficiency.

Great for camping, working on the car, and of course, during power blackouts!

Complete boxed kit, including all winding wire.

K 6505 Includes Metal Case **$37.50**

Free Delivery Australia Wide on these kits for January only!

$2 DELIVERY AUSTRALIA WIDE We process your order the day received and despatch via Australia Post. Allow approx. 7 days from day you post order to when your receive goods. Weight limited 10kgs.

$4 DELIVERY AUSTRALIA WIDE We process your order day received and despatch via Jetservice for delivery next day.

BANKCARD HOLDERS CAN PHONE ORDER UP TO 8PM (EST) FOR NEXT DAY DELIVERY — SOUNDS INCREDIBLE DOESN'T IT? Alright you cynics just try us! Weight limit 3.3kgs. Jetservice cannot deliver to P.O. box numbers (Australia Post would have a fit).

$10.00 HEAVY HEAVY SERVICE — AUSTRALIA-WIDE All orders over 10kgs must travel on the heavy service, that is — road express. Delivery time 7 days average.

ALTRONICS

105 STIRLING ST., PERTH
FOR INSTANT SERVICE

(09) 328 1599

All Mail Orders: Box 8280 Stirling St, Perth, W.A. 6000

BANKCARD JETSERVICE DELIVERY NEXT DAY BANKCARD JETSERVICE

ALTRONICS ... ALTRONICS ... ALTRONICS ... ALTRONICS ... ALTRONICS ...

NEW! NEW! JAYCAR

COOLING FANS 240VAC

new

Quality Ball Race construction, now you pay no more for quieter, much longer lasting and more efficient ball-bearing fans from Jaycar!

TWO POPULAR SIZES:

12 WATTS – 80x80x42(d)

$24.95

13.5 WATTS – 119x119x25(d)

$27.50

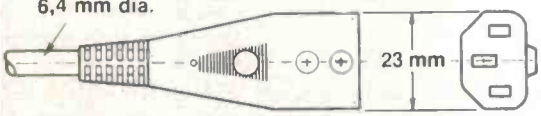
AT LAST!! INTERNATIONAL STANDARD (IEC 320) 240V APPLIANCE CONNECTOR

You asked for it and here it is. Fully approved 240V mains inlet to International Standard IEC 320.

- Front or rear panel mount
- 240V AC 6A rating
- Accepts IEC 320 International power cords
- Simplifies 240V wiring.
- Quick-connect/solder on terminals.

We also have the IEC 320 line plug assembly for ONLY $4.95.

Beware of non-approved units!



$2.95

low cost balanced mic transformer

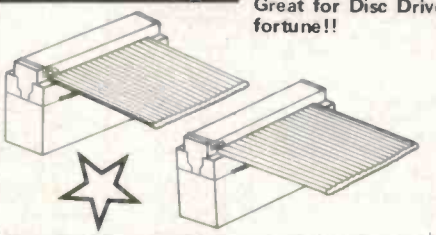
Sensational price for a completely MU-metal shielded unit!!

Until now you had to pay a fortune for a shielded balanced tranny!

- 2-600 ohm (CT) input/output
- 50k output/input
- Can be used either way round
- Standard 9mm bushing mount
- Colour coded leads.

Don't pay over $30!!!

17.50



NEW! INSULATION DISPLACEMENT CONNECTORS & RIBBON CABLE!!

I.D. Insulation displacement. The quick and reliable way of making multiple connections to computer peripheral connectors. Great for Disc Drives, Printers etc. Crimp them yourself and save a fortune!!

CONNECTORS;	
16 pin DIP HEADER	$1.99
24 pin DIP HEADER	$2.50
P.C. Edge Connector 34 way (Suits 5¼" Disc Drives)	$8.50
25 Pin Cannon 'D' Male	$8.95
25 Pin Cannon 'D' Female	$8.95
CABLE:	
16 way	$1.50/metre
25 way (suit DB25's & 24 way DIP)	$2.50/metre
34 way for Disc Drives	$3.45/metre

MAGAZINE BINDER

Keep your precious (and expensive) magazines in order for easy reference. Smart blue colour with gold lettering. Heavy gauge and richly chromed metal fittings.

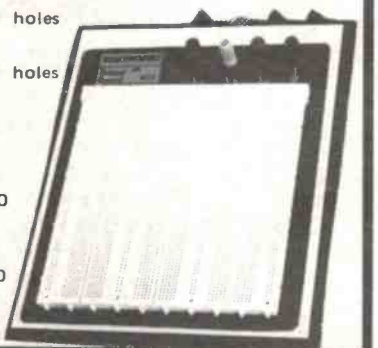
LOW IMPORT PRICE ONLY $4.95

4 up $4.50 each

EXPERIMENTER BREADBOARDS

Ample stocks of these boards plus the range has been extended.

WBDN 100 holes	$2.95
WBTN 640 holes	$9.45
WB2N 840 holes	$13.95
WB4N 1680 holes	$26.50
WB6N 2420 holes	$39.95



CannonXL connectors~great new range

5 pin and right angle types now in stock.

DESCRIPTION	PRICE
3 pin male line	$3.50
3 pin female line	$3.95
3 pin male chassis	$3.25
3 pin female chassis	$3.95
5 pin male line	$6.95
5 pin female line	$7.95
5 pin male chassis	$3.95
5 pin female chassis	$6.95
240V Mains line	$6.50
240V mains chassis	$5.25
3 pin male right angle line (Neutrik)	$4.95
3 pin female right angle line	$5.95
3 pin female line (Neutrik)	$4.95
3 pin male line (Neutrik)	$3.95

LOW CAPACITANCE SCREENED CABLE

You asked for it! This is the same high-quality screened cable that we use in the 5000 Blueprint preamp. We have had dozens of requests from people who wish to upgrade their preamp etc. As we have said before it's not cheap. But it is good.

1-99m 99c/metre

100m+ 80c/metre

Capacitance is about half cheap screened cable.

SUPER SPECIAL! URGENT

We have a quantity of 240 V Disco Strobes. Not a kit. Built in Woodgrain cabinet. 0-12 flashes per second. Brand new but re-worked warranty stock. Almost less than ⅓ normal price!

Only $12.50 each

Were $36.50

LINEX electronic lay-out

NEW

New! PCB Drafting aids from Denmark!!

2 sizes available

1:1 (same size art) $18.95

2:1 (2x size art) $29.95

Both complete with plastic protective wallet.

Now you can draw pcb patterns, component overlays, block diagrams etc., professionally with the "Linex" design template. Each template is precision die-cut & designed for use with a 0.5mm pen. The template has clearance pads to avoid smudging. Dozens of symbols are provided including:– • IC pads • Edge connectors (.1, .125, .15, .156 & .2") • TO-3 & TO-66 outlines • all TO-5 round IC's • Multiturn pots • TO-92, TO-220 etc • Most capacitors & resistors.

superbright LED

The average 15 cent LED has a light output of 0.8mCd (milli Candelas) at 20mA. Can you imagine a 200mCd LED? (at 20mA)? Well if you can't – buy one and find out. They are ideal for panel illumination or very low current work. (They will still give useful light at 1mA!).

Red with clear lens – 69c each

10 up only

62c each.....

SEE OTHER JAYCAR ADS FOR ADDRESSES AND PHONE NUMBERS

Polyphonic organ features 'touch sensor' keyboard

Barry Wilkinson
Roger Harrison

Featuring a 'touch sensor' keyboard constructed right on the printed circuit board, this polyphonic organ project covers a two-octave range, has loudspeaker output plus two 'voices' and can be operated from a battery or plug pack.

BACK IN August 1976 we published the "ETI Mini Organ", Project 602. This featured a 'touch sensor' keyboard utilising tracks on the printed circuit board which, when bridged by a finger, turned on a CMOS switch. The switch turned on an RC oscillator and set the pitch of the note produced. The technique was novel and effective. An added tremolo circuit could also be switched in and out using the same technique. However, the technique had one drawback. Moisture from the fingers would sometimes build up on the keyboard and bridge the key tracks for one note or another, and the note would hold on. Wiping the keyboard with a tissue or cloth would solve that, but it proved an occasional problem nevertheless.

The ETI 602 Mini-Organ was only monophonic, that is, could only play one note at a time, a limitation that did not escape many readers and constructors. In defence, one might point out that the entire brass and woodwind family of traditional acoustic instruments are also monophonic, but an 'organ' is traditionally polyphonic, which means any number of notes in its compass can be played simultaneously. Hence, this project is a polyphonic organ.

Many notes

There are two basic ways to generate many notes that can be sounded simultaneously. You can commence with a 'master' oscillator at some suitably high frequency and have a series of frequency dividers that divide this down stage by stage to produce the required range of notes. This has the advantage that only a single tuning control is required to set all the notes on frequency. That's fine and dandy, but the pitch interval between notes in the chromatic scale (i.e: the ratio of a note to the note above or below) is based on the twelfth root of two. This means that, to produce a scale based around middle C, at least, the lowest frequency you can start off with is around 2 MHz. A string of dividers constructed from discrete ICs would consist of many devices and be quite expensive. However, there is a device called a 'top octave synthesiser' which performs this task — but further dividers are required to produce the 'usual' range of notes. The drawback is the cost — the crystal and top octave synthesiser will set you back around $30 to start with!

For cost reasons, we've chosen the second method. Twenty five oscillators have been used to generate each of the notes in a two octave-plus-one range from F below middle C to F" above middle C.

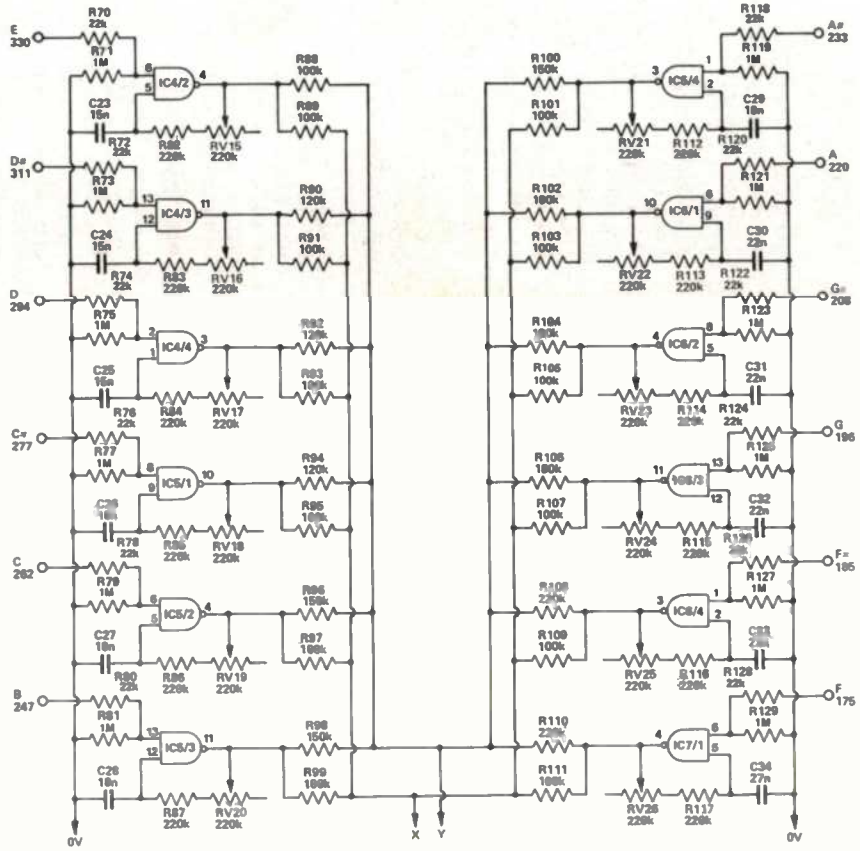
Each oscillator is implemented using a single two-input gate — and that includes the touch sensor keying! Hence all the oscillators require only seven quad-gate ICs — leaving two spare gates which have been used in the tremolo circuitry. This project uses even fewer ICs than the ETI-602 Mini Organ! In addition, Schmitt-input CMOS gates have been employed (4093s) as they have two distinct threshold points on the inputs which means they can be driven on or off with certainty, unlike conventional CMOS gates, such as the 4011s used in the ETI-602 which have only one threshold point. Using this, the problem with moisture on the keyboard holding notes on has been largely overcome. The action of each oscillator and how they are keyed is explained in detail in the *How It Works* panel.

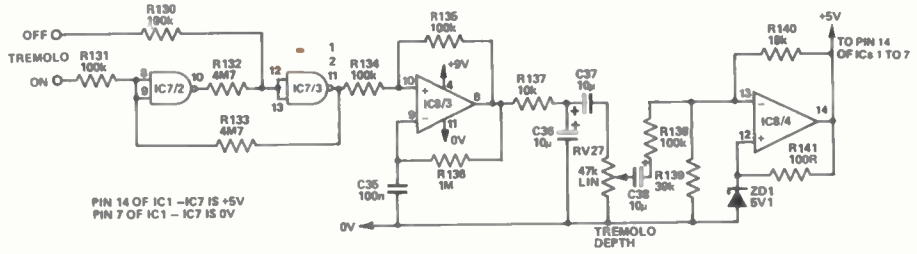
This project has tremolo circuitry and two 'voices', just like the ETI-602, but the circuitry has been arranged differently this time.

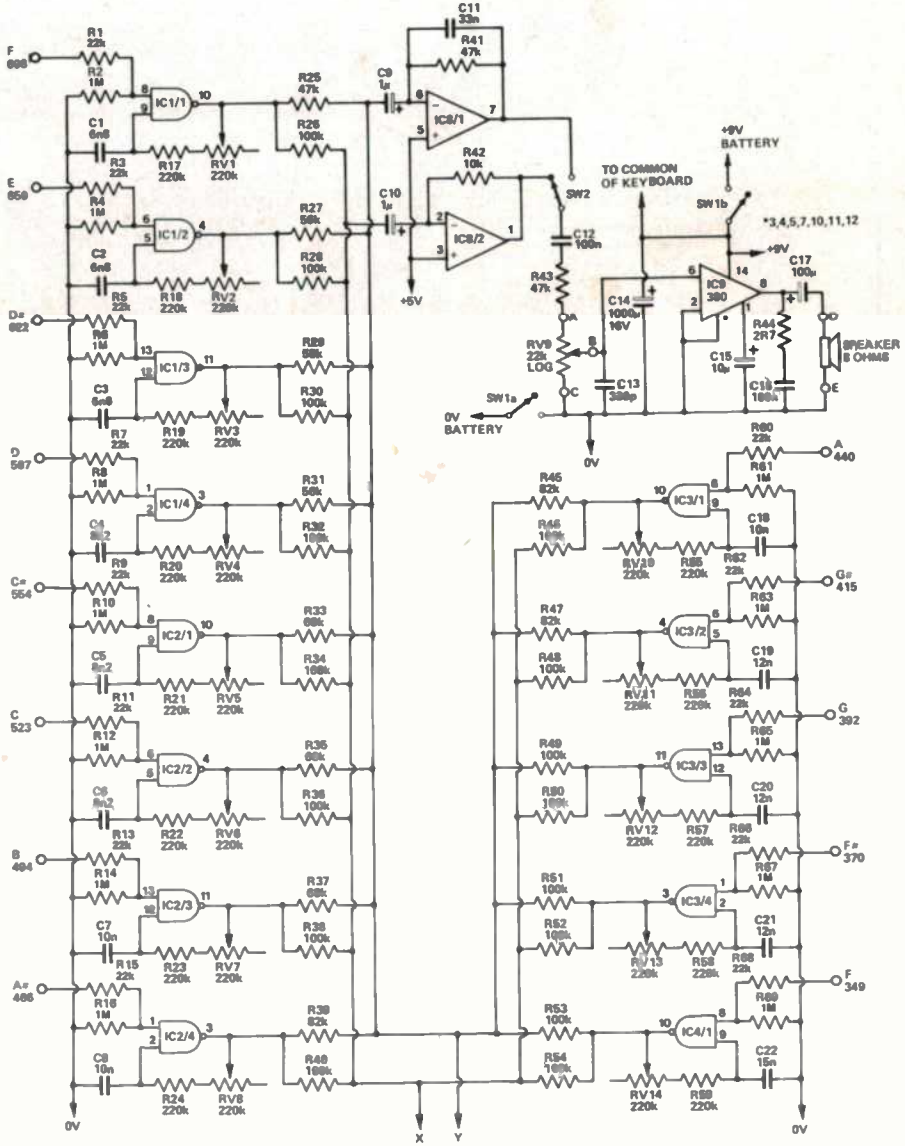
Loudspeaker output is provided by an LM380 audio power output amplifier IC. This is capable of driving 1 W into a four ohm load from a 9 V supply and for this reason we have specified the use of two small speakers. The common 50 — 75 mm diameter loudspeakers generally have an eight ohm voice coil. Connecting two in parallel gives a four ohm load and considerably more output. You can add a jack socket to take the organ's output to an external amplifier if you wish, in which case you'll get a much richer sound.

Construction

For clearly obvious reasons, you'll get best results using our pc board design. However, if you intend making your own pc board, we should point out that tarnishing of the copper on the keyboard area can be a problem. We solved that on the prototype by coating it with solder. It's a fair solution, but not all that pretty! However, we have recom- ▶


E 330
D# 311
D 294
C# 277
C 262
B 247
A# 233
A 220
G# 208
G 196
F# 185
F 175
0V
X
Y
IC4/2
IC4/3
IC4/4
IC5/1
IC5/2
IC5/3
IC8/4
IC8/1
IC8/2
IC8/3
IC7/1


OFF
TREMOLO ON
R131 100k
IC7/2
IC7/3
R132 4M7
R133 4M7
R134 100k
R135 100k
IC8/3
+9V
0V
R136 1M
C35 100n
C36 10µ
R137 10k
C37 10µ
RV27 47k LIN
TREMOLO DEPTH
R138 100k
C38 10µ
R139 39k
R140 18k
+5V
TO PIN 14 OF ICs 1 TO 7
IC8/4
R141 100R
ZD1 5V1
PIN 14 OF IC1 – IC7 IS +5V
PIN 7 OF IC1 – IC7 IS 0V


F 698
E 659
D# 622
D 587
C# 554
C 523
B 494
A# 466
A 440
G# 415
G 392
F# 370
F 349
0V
X
Y
IC1/1
IC1/2
IC1/3
IC1/4
IC2/1
IC2/2
IC2/3
IC2/4
IC8/1
IC8/2
IC3/1
IC3/2
IC3/3
IC3/4
IC4/1
IC9 380
+5V
+9V BATTERY
0V BATTERY
TO COMMON OF KEYBOARD
SW1a
SW1b
SW2
*3,4,5,7,10,11,12
RV9 22k LOG
SPEAKER 8 OHMS

A total of 25 separate oscillators are used to provide polyphonic output covering two octaves. Each oscillator is individually adjustable so that they can be accurately tuned to the required note. Apart from the set of note oscillators, there are three other sections to the circuitry: the tremolo circuitry, the voice selection/mixing and the audio output stage.

THE NOTE OSCILLATORS

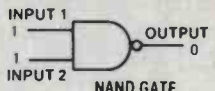
All the note oscillators have identical circuitry, only the frequency determining components are varied to provide the individual frequencies for the notes. The note oscillators are based on one gate from a 4093 CMOS two-input Schmitt trigger NAND gate. The basic circuit is shown in Figure 1.

The one gate combines both an oscillator and the keying action. What makes the gate oscillate is the feedback loop from the gate output to input 2 via the trimpot and resistor in series and involving the capacitor C.

A NAND gate is a digital IC and it operates according to certain 'rules', spelled out in a 'truth table'. Voltage levels on the gate's inputs or output are either 'high' or '1', which means they're at the positive supply voltage, or they're 'low' or '0', which means they are at the 0 V rail. With a two-input AND gate, the output will be high if input 1 AND input 2 are high, otherwise the output is low. Hence the name, AND. The NAND gate is a NOT AND gate which simply means that its output is inverted to that of the AND gate. Thus, if input 1 and input 2 are both high, the output will be low, not high. The truth table for a NAND gate is given in Table 1.

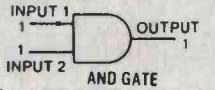
TABLE 1.

Input A	Input B	Output
'0' (low)	'0' (low)	'1' (high)
'1' (high)	'0' (low)	'1' (high)
'0' (low)	'1' (high)	'1' (high)
'1' (high)	'1' (high)	'0' (low)



NAND GATE

INPUT 1(1) NOT AND INPUT 2(1) = OUTPUT (0)



AND GATE

INPUT 1(1) AND INPUT 2(1) = OUTPUT (1)

While we said that a '1' or high normally means the supply voltage and '0' or low the 0 V rail, the inputs of a NAND gate are generally

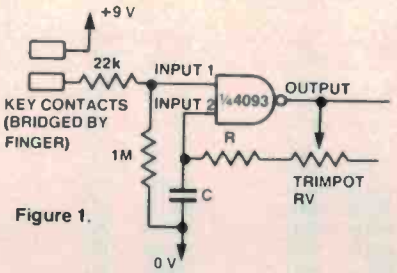


Figure 1.

specified to operate for voltages between these extremes. With a normal CMOS gate there is an input level threshold of about 50%. This means that if the input is at a level above 50% of the supply voltage it is high, if it is at less than 50% of the supply voltage it is low. The actual percentage (threshold) can vary from device to device (the limits are 30% to 70%). However, there is a point above which it is definitely high and a point below which it is definitely low. This is the *normal* input characteristic of CMOS gates. They only have one threshold point.

With a gate having Schmitt inputs, there are two distinct thresholds: there is a low threshold which, if the input level is below that limit, the input is low and there is a high threshold which, if the input level is above that limit, the input is high. Between the two thresholds, the inputs do nothing. The low threshold may be at 40% of the supply rail, the high threshold at 60% of the supply rail.

Referring to Figure 1, in order for this circuit to oscillate, input 1 must be driven high. Initially, it will be held low by the 1M resistor. If you look at the truth table, if either input is low, the output must remain high. Input 1 is taken high by the action of placing a finger across the key pads. Just before input 1 goes high, the output of the gate must be high and, owing to the trimpot RV and the resistor R, input 2 will also be high and capacitor C will be charged. Thus, when input 1 goes high the output will immediately go low as both inputs will then be high. Input 2, however, now starts to go low due to the feedback via RV-R, but this action is slowed down by the capacitor having to discharge via RV-R. When the voltage on input 2 reaches the low threshold, the output will suddenly go high. Thus, C will begin to charge again via RV-R. When input 2 reaches the high threshold, the output will revert to the low condition once more and the whole cycle will be repeated.

This continues with the output going high/low/high at a rate largely determined by the RC network formed by RV, R and C. (The difference between the low and high thresholds, the hysteresis, affects it too.) By varying the resistance of the trimpot RV, the frequency of the note oscillator can be varied. The circuit will oscillate so long as input 1 is held high by placing a finger on the key pad.

Note that each oscillator has been given a frequency variation range of 2:1 because of the values assigned to RV and R in each oscillator. The major frequency determining component in the actual circuit is thus the capacitor (C). Only standard value (E12 series) components have been specified so that components are easy to obtain and inexpensive as these are the most common values available.

VOICE SELECTION, MIXING

The output waveform of the oscillator described is a square wave, as you would no doubt have already realised. The output signals from each of the 25 oscillators are mixed together via a resistor network to the inputs of IC8/1 and IC8/2, two op-amps from an LM324 quad op-amp package. Apart from performing the mixing, this stage provides the 'voicing' as well. IC8/1 has a capacitor (C11) across the feedback resistor (R41) which changes the waveshape into a triangular form. This removes most of the harsh odd-order harmonics of the square wave, producing a 'sweeter' sound. As this type of circuit is frequency dependent, the mixing resistors from the oscillator output have different values so as to keep the amplitude constant across the frequency range. The desired voice is selected by switching between the outputs of IC8/1 and IC8/2 using SW2.

AUDIO OUTPUT STAGE

Final amplification of the signal, to drive a loudspeaker, is done by an LM380 IC power output amplifier (IC9). This can drive low impedance speakers and will deliver over one watt into a four ohm load. One or two miniature 8 ohm loudspeakers can be used for audio output. We used two 8 ohm speakers in parallel to give four ohms so that the LM380 will deliver maximum output. However, the output can be coupled to an external loudspeaker mounted in a proper enclosure (i.e: a hi-fi speaker), better sound being obtained in this way. The larger speakers are generally more efficient, which is opposite to what most people first think, and the LM380 generally clips when several notes are played together while driving the very inefficient miniature loudspeaker(s).

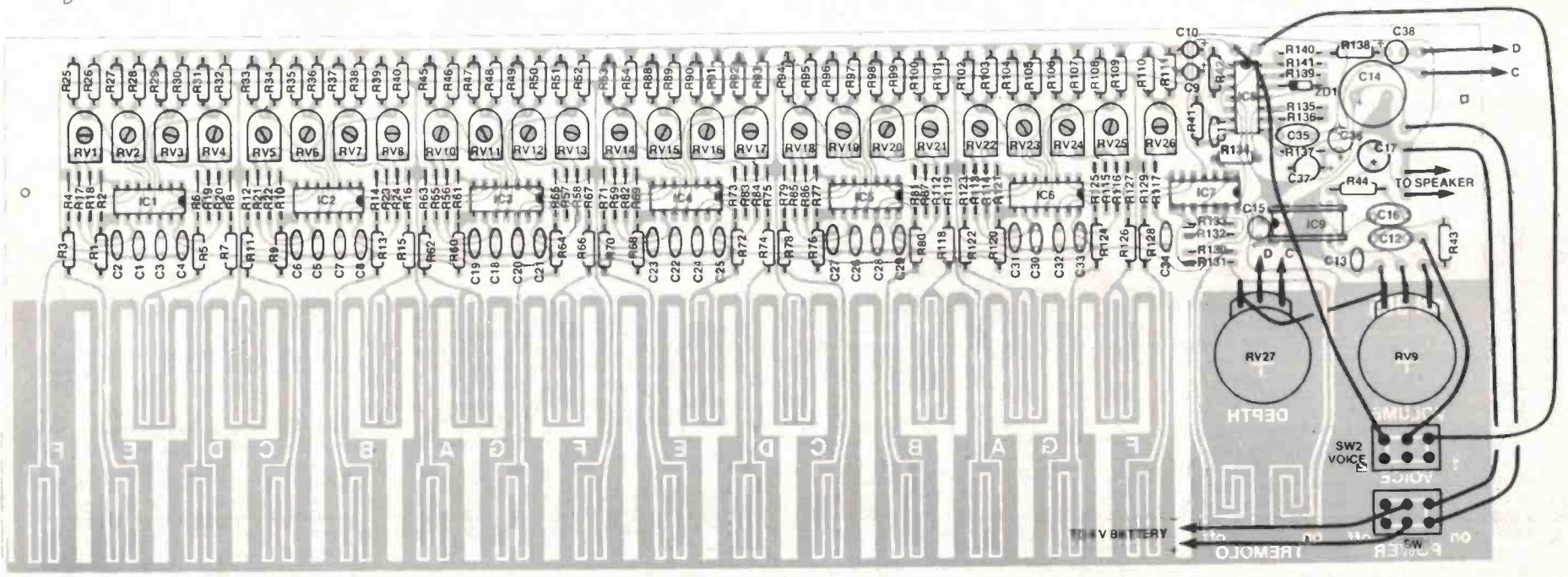
Capacitor C12 and resistor R43 provide some low frequency roll-off, reducing 'thump' when you touch a keypad. Volume control is provided by RV9. C13 rolls off the high frequencies, reducing the harshness of the sound. The RC network across the speaker outputs from IC9 (R44-C16) helps stabilise the LM380 at high frequencies. C17 provides dc isolation for the speaker.

TREMOLO CIRCUITRY

This part of the circuitry involves two gates from IC7 and the remaining two op-amps from IC8. Tremolo is started and stopped by touching the appropriate key pads. IC7/2 and IC7/3 are arranged as a RESET/SET (R/S) flip-flop. If pins 12-13 of IC7/3 are high, pin 11 will be low and thus pin 8-9 will be low, pulled down via R133. This is the 'tremelo off' condition. If pins 8-9 of IC7/2 are pulled high by touching the ON key pad, pin 10 of IC7/2, which would have initially been high, will go low, as will pins 12-13 of IC7/3. Thus, pin 11 of IC7/3 will go high. This is the 'tremolo on' condition.

Now, IC8/3 is arranged as a low frequency oscillator. When pin 10 of IC8/3, the non-inverting input, is low, pin 8 is held low, and so will pin 9 because of the feedback via R136. C35 will be discharged. When pin 10 of IC8/3 is driven high, pin 8 will go high too and C35 will begin to charge via R136. The voltage on pin 9 of IC8/3, the inverting input, will begin to rise at a rate determined by the RC combination of C35-R136. As the voltage on pin 9 rises, the voltage on the output of IC8/3, pin 8, will begin to fall — and so will the voltage on pin 10, the non-inverting input, because of feedback via R135. At a certain level, the op-amp output will be rapidly driven low by the feedback action, C35 will discharge and the whole cycle will start again. Thus, IC8/3 oscillates. It will do so at a rate of about 10 Hz, determined by the component values chosen.

The output is filtered to more or less a triangular shape by the RC network of R137-C36. Capacitor C37 provides dc blocking, the output being applied to the tremolo depth control, RV27. The signal is applied to the inverting input of IC8/4 which is a dc amplifier stage. The output of this stage is set to an average of about 5 V as the non-inverting input is 'clamped' at about 5 V by the zener ZD1. When the modulating signal from the 10 Hz oscillator is applied to the inverting input of IC8/4, the output voltage will swing about a 5 V mean, modulating the supply voltage to all the oscillators. The amplitude of the swing is determined by the tremolo depth control. Varying the supply voltage to the oscillators causes a small frequency variation, producing the tremolo effect. ▶



ETI-905 POLYPHONIC ORGAN PARTS LIST

Resistors

R1	22k	R30	100k	R62	22k	R91	100k	R119	1M	RV1-8	220k miniature trimpot, horizontal mounting.
R2	1M	R31	56k	R63	1M	R92	120k	R120	22k		
R3	22k	R32	100k	R64	22k	R93	100k	R121	1M	RV9	22k log. pot. (or 20k)
R4	1M	R33	68k	R65	1M	R94	120k	R122	22k	RV10-26	220k miniature trimpot, horizontal mounting.
R5	22k	R34	100k	R66	22k	R95	100k	R123	1M		
R6	1M	R35	68k	R67	1M	R96	150k	R124	22k	RV27	47k lin. pot (or 50k)
R7	22k	R36	100k	R68	22k	R97	100k	R125	1M		
R8	1M	R37	68k	R69	1M	R98	150k	R126	22k		
R9	22k	R38	100k	R70	22k	R99	100k	R127	1M		
R10	1M	R39	82k	R71	1M	R100	150k	R128	22k		
R11	22k	R40	100k	R72	22k	R101	100k	R129	1M		
R12	1M	R41	47k	R73	1M	R102	180k	R130-131	100k		
R13	22k	R42	10k	R74	22k	R103	100k	R132-133	4M7		
R14	1M	R43	47k	R75	1M	R104	180k	R134-135	100k		
R15	22k	R44	2R7	R76	22k	R105	100k	R136	1M		
R16	1M	R45	82k	R77	1M	R106	180k	R137	10k		
R17-24	220k	R46	100k	R78	22k	R107	100k	R138	100k		
R25	47k	R47	82k	R79	1M	R108	220k	R139	39k		
R26	100k	R48	100k	R80	22k	R109	100k	R140	10k		
R27	56k	R49-54	100k	R81	1M	R110	220k	R141	100R		
R28	100k	R55-59	220k	R82-87	220k	R111	100k				
R29	56k	R60	22k	R88-89	100k	R112-117	220k				
		R61	1M	R90	120k	R118	22k				

Capacitors

C1-3	6n8 greencap
C4-6	8n2 greencap
C7,8,18	10n greencap
C9-10	1u/16 V tant.
C11	33n greencap
C12	100n greencap
C13	330p ceramic
C14	1000u/16 V RB electro.
C15	10u/16 V RB electro.
C16	100n greencap
C17	100u/16 V RB electro.
C19-21	12n greencap
C22-25	15n greencap
C26-29	18n greencap
C30-33	22n greencap
C34	27n greencap
C35	100n greencap
C36-38	10u/16 V RB electro.

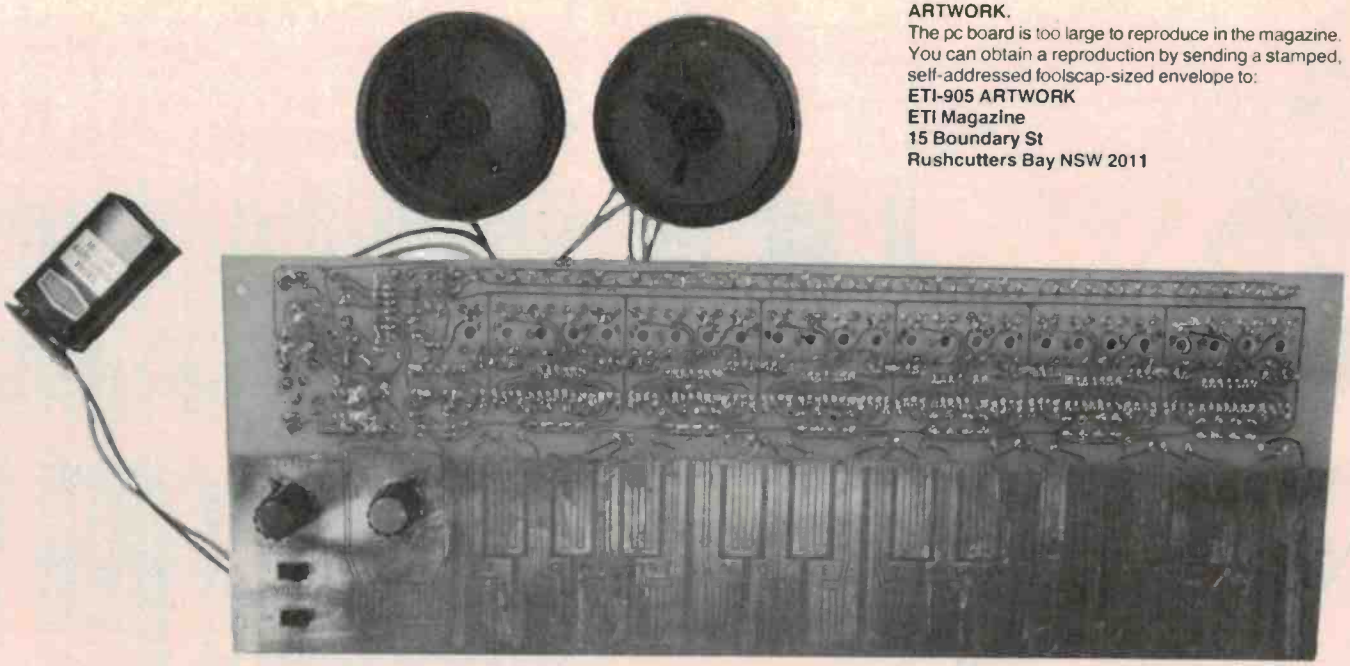
Semiconductors

IC1-IC7	4093B
IC8	LM324N, uA324PC
IC9	LM380N
ZD1	5V1 zener

Miscellaneous

ETI-905 pc board; SW1 — DPST slide switch; SW2 — SPDT slide switch; one or two 50 mm diameter 8 ohm speakers; battery holder to take 6 x AA cells; two small knobs; 30 x 30 mm square of tinplate or copper shim; hookup wire; case, etc.

Price estimate
$50 — $55



ARTWORK.
The pc board is too large to reproduce in the magazine. You can obtain a reproduction by sending a stamped, self-addressed foolscap-sized envelope to:
ETI-905 ARTWORK
ETI Magazine
15 Boundary St
Rushcutters Bay NSW 2011

RESISTOR SHOPPING LIST

As there are so many resistors used, here is a 'shopping list' to assist you. The Parts List can be referred to in conjunction with the component overlay when assembling the pc board.

2R7	x1	82k	x3
100R	x1	100k	x34
10k	x3	120k	x3
22k	x25	150k	x3
39k	x1	180k	x3
7k	x3	220k	x27
56k	x3	1M	x26
68k	x3	4M7	x2

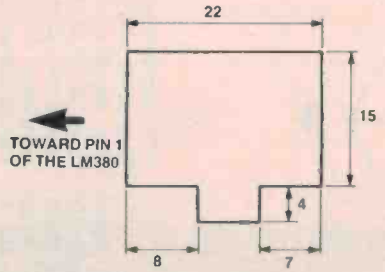
POTS & TRIMPOTS

22k	(or 20k) log pot.	x1
47k	(or 50k) lin pot.	x1
220k	min. horizontal mount trimpots	x25

mended to all the pc board manufacturers making boards for this project that the keyboard area either be nickel plated or gold flashed over nickel plating. The choice of homemade board versus a bought one is up to you.

No matter whether you buy one or make your own, make a careful check of the pc board before commencing construction. Check that all the holes are drilled to the correct size. This is particularly important with the row of trimpots. You may need to drill holes near the two ends of the board, above the keyboard area, so that mounting pillars can be screwed to the board. Exactly where and what size will depend on how you're going to mount the board, and that we'll have to leave up to you. Some suggestions are given later. Check that the two slide switches fit in the slots in the pc board. Enlarge the slots with a small flat file if necessary.

Having satisfied yourself that the board's all OK, all the trimpots can be fitted first. All the resistors can be soldered in place next, mounting them right down on the pc board.



HEATSINK FLAGS, LM380
MATERIAL: TINPLATE OR COPPER SHIM
TWO OFF
ALL DIMENSIONS IN MILLIMETRES

The LM380, IC9, should be soldered in place next. Make sure you orient it correctly. Now cut two 'flag' heatsinks, as shown in the accompanying illustration. You can use tinplate or thin copper 'shim'. Both can be obtained in small sheets from hardware stores. Motor spares stores may also stock copper shim. Tin the two tags at the botton, each on the side that solders to the LM380 pins. You'll need an iron capable of supplying quite a bit of heat and having a 'chisel' bit (see ETI, October '81, A Good Joint is Hard to Find . . .). Don't overdo the solder. Then, carefully tin pins 3-4-5 and 10-11-12 on the LM380. Take one of the flags and orient it as shown in the diagram. Hold the tag with the solder side against the appropriate pins of the LM380 using a pair of pliers. Apply the flat of the iron to the tag until you see the solder flows freely. Remove the iron and *keep the flag steady until the solder sets.* This process is known as 'sweating'. If you hold the flag with your fingers while doing this you'll know exactly what it means! Now sweat the other flag to the other set of pins of the LM380. Do this carefully. While the LM380 is quite rugged, don't overdo it with the soldering iron. If you make a slip and have to resolder it, let it all cool down first.

Having accomplished that task, insert all the other ICs and solder them in place, making sure — as always — you have them correctly oriented. ICs 1 to 7 are CMOS types. Use either an isolated soldering iron or an iron with an earthed tip. Handle the ICs by their ends, avoiding touching the pins. Solder the supply pins (7 and 14) first.

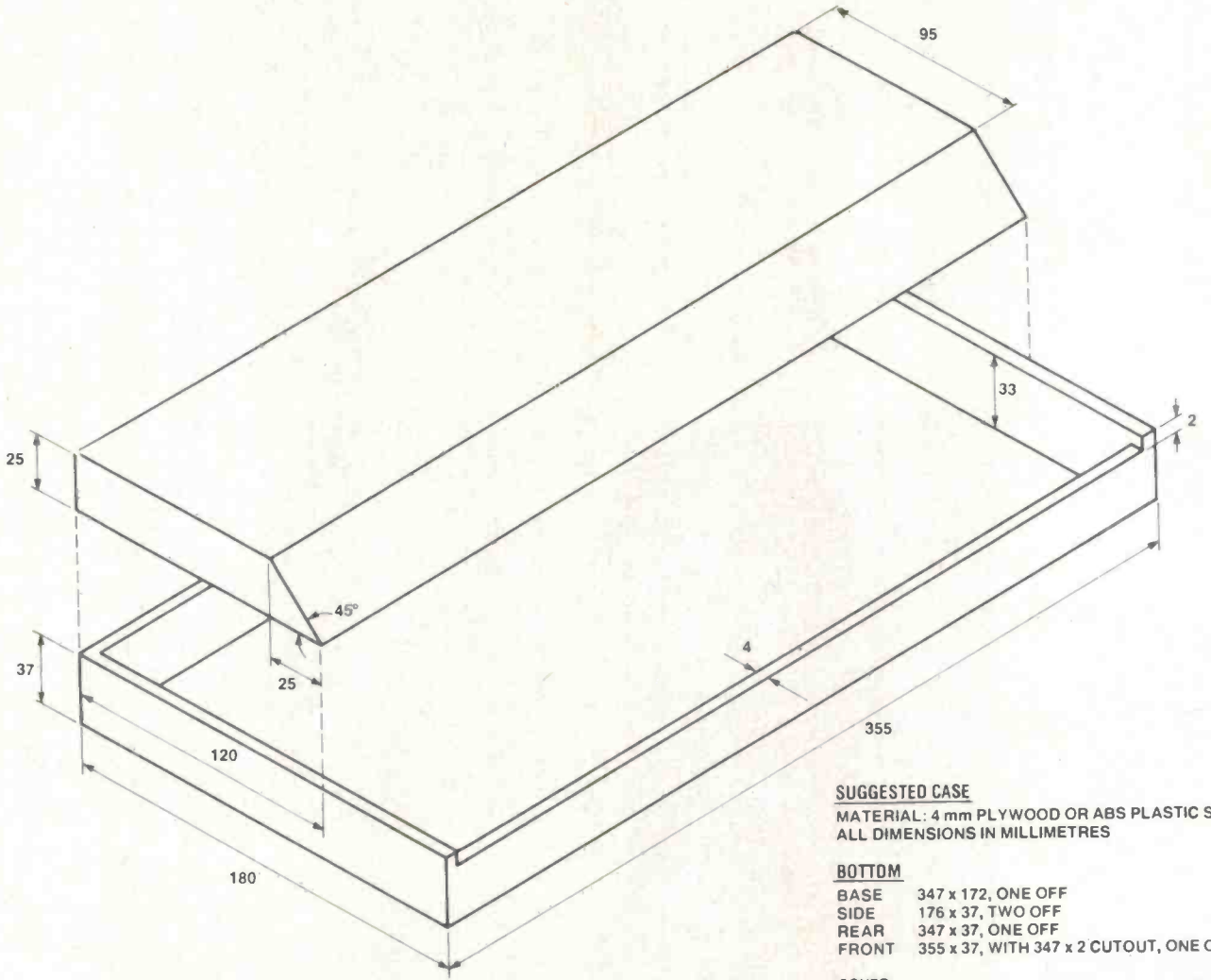
Now come the capacitors. The only thing you have to watch for here is the polarity of the electrolytics and tantalums.

It's probably a good idea at this stage to have a quick check over what you've done so far.

Now attach all the leads that run from the pc board to the two potentiometers, the two switches and the speaker(s). The three wires adjacent to C12 that run to the volume pot RV9 should be tinned copper wire. It makes life easier in a moment.

Now mount the two potentiometers, RV9 and RV27, and wire them up. Follow with SW1 and SW2. We glued our switches in place with quick-setting epoxy, but they could be screwed to the board. Attach the speaker(s) and the battery clip. Put knobs on the two potentiometer shafts.

Resist the urge to plug in a battery and try it out (it'll be out of tune anyway). First, *check everything.* Check the IC orientations especially. All OK? Now you're ready for the next bit. ▶



SUGGESTED CASE

MATERIAL: 4 mm PLYWOOD OR ABS PLASTIC SHEET
ALL DIMENSIONS IN MILLIMETRES

BOTTOM

BASE	347 x 172, ONE OFF
SIDE	176 x 37, TWO OFF
REAR	347 x 37, ONE OFF
FRONT	355 x 37, WITH 347 x 2 CUTOUT, ONE OFF

COVER

TOP	355 x 95, ONE OFF
SIDE	120 x 25, 25 x 45° CUTOUT, TWO OFF
FRONT	355 x 35, CHAMFERED EDGES, ONE OFF
REAR	347 x 21, ONE OFF

First try out

Set the VOICE switch to 2, DEPTH control fully anticlockwise (minimum) and the volume control about one-quarter advanced. Set all the trimpots to half travel. Switch on and touch one of the note keys. You should get a sound in the speaker. If not, try several other keys up and down the keyboard. Try VOICE 2 if you still get no response. If nothing happens there either, switch off and check connections and component orientations again. Correct any faults and try again. If you still have problems, check the voltage across pins 2 and 14 (+ve) of IC9 and pins 11 and 4 (+ve) of IC8. There should be 9 V or so on each. Also check that there's about 5 V across ZD1. With the TREMOLO off, check the voltage between the 0 V rail and pin 11 of IC8. There should be 5 V there. Then check the voltage between pins 1 and 14 (+ve) of ICs 1 to 7. There should be 5 V on each IC.

If all this checks out OK, you're going to have to do a bit of signal tracing. All this needs is a high impedance crystal earpiece and a 100n capacitor in series with one lead. With one lead on the 0 V rail, put the other lead on pin 2 of IC8 and touch one of the keys. You should get a sound. Try several other keys, or all of them, to see that you get a sound from each group of oscillators. If not, then check the circuitry around ICs 1 to 7. If the oscillators work, check that you're also getting signal across the two outer terminals of the volume control, RV9. If not, the fault is probably in the wiring of SW2 or IC8 is faulty. If you do get signal there, check with the earpiece that you're getting signal at pin 6 of the LM380. If not, RV9 wiring is probably faulty. If signal's there, check to see that it may be on pin 8 of the LM380. If so, then the speaker(s) or speaker wiring is faulty. If no signal there, the LM380 is probably faulty.

When the note oscillators work, try out the tremolo. If it doesn't work, check that IC7/2 and /3 is working correctly. You can do this with a multimeter. If that's OK, see that, with Tremolo ON, the multimeter needle vibrates when looking at the output (pin 11) of IC8/4.

Got it going? Now for that grand old Chinese ceremony "chu ning".

Tuning it up

First of all, put out the cat, tie up the dog and send the rest of the household away. This may be painful to others. If you possibly can, get hold of a digital frequency meter. Using one of these is by far the easiest way to tune each note oscillator to the required frequency. Simply attach the DFM input across the speaker terminals, sound each note in turn and adjust that note's trimpot to the frequency given in the accompanying Table. Looking from the keyboard side of the project, the trimpot for the lowest F is at the extreme left, lowest F# is the next trimpot, lowest G is the third trimpot from the left, and so on. Make sure the Tremolo is OFF. We used a marking pen and wrote the note on the board beside each appropriate trimpot.

The next best method is to tune the ETI-905 against a piano, organ or other fixed-pitch keyboard instrument. This is simple to do by sounding the required note on the piano, or whatever, then sounding the same note on the project and tuning it so that it sounds the same pitch (no 'beats' between them). Be patient and do it carefully, don't swing the trimpot violently one way then

the other. Tuning up this way is best done with the organ set to VOICE 2 and Tremolo OFF (turn the DEPTH fully anticlockwise).

There is another way, it's a little more tedious than the other methods, but yields good results, nonetheless. Get hold of a tuning fork (you could even build up and use the ETI-606 Electronic Tuning Fork, in Nov. '79 or Top Projects Vol. 6). Common tuning forks are "A 440" and "C 262" or middle C. You'll need three arms for this or a spare person. Seat yourself at a table or bench. Put a book or piece of sponge under the ETI-905 speakers. Set the VOICE switch to 2. Tremolo should be OFF. Set the tuning fork thrumming and hold the end of its shaft on the table or bench top to get a good, loud, sustained note. Touch the same note on the keyboard and adjust its trimpot so that its pitch is the same as the tuning fork's (i.e: no beats). Put the tuning fork aside and send your friend away, this next bit can be painful.

Say the note you just tuned was middle C (that's the C at the leftmost end of the keyboard). Now sound that C and the C above simultaneously, then tune the C above (C') so that there are no beats. But make sure that C' *is* above middle C. The trimpots should generally bring each oscillator into tune within a variation of ±30° of rotation from centre travel.

Now, count five notes up from middle C — C#, D, D#, E to F. Now sound F and middle C together. Tune F so that you get a pleasant sound with no beats. These two notes are now tuned a 'fifth' apart. Now sound the lowest F (right at the leftmost end of the keyboard) and the F you just tuned together. Tune the lower F so that you get no beats — making sure it's an octave lower. Now sound the topmost F and the F above middle C together and tune the topmost F for no beats. All three Fs should now be in tune. Starting at F above middle C, count up a further five notes — F#, G, G#, A to A# (B flat). Once again, tune for a pleasant sound with no beats. Then tune the A# an octave lower. The next one you will tune is D# (E flat) right up the top end of the keyboard. Tune its partner an octave lower. Where to go from here? Simple. Start down at the lower D#.

Count five notes up from the D# just above middle C — that's the G# to the right. Once again, tune for a pleasant sound with no beats, then tune the companion note an octave lower. Commencing at *that* note, count five notes up — to C#. Tune as before, then tune the octave companion (now to the right, higher in pitch). From C# above middle C, count another five notes up (F#), tune it, then the octave note. Count up to B, tune it, then the octave note. Continue — B to E, E to A, A to D, D to G, then check that the Gs are in tune with the Cs — the first notes tuned. They should be. If not, they should only be a little out and you can go back around the loop and make minor adjustments.

All tuned? Now learn to play Bach's Toccata in D minor!

NOTE FREQUENCIES

F	698.5
E	659.3
D#	622.3
D	587.3
C#	554.4
C	523.3
B	493.9
A#	466.2
A	440.0
G#	415.3
G	392.0
F#	370.0
F	349.2
E	329.6
D#	311.1
D	293.7
C#	277.2
C	261.6 (middle C)
B	246.9
A#	233.1
A	220.0
G#	207.7
G	196.0
F#	185.0
F	174.6

PLAYING TIPS

The 'keys' should be played with the ball of the finger, not the tip. There is no "touch" to the instruments — hitting the key hard will not alter the sound in any way. This is much like a real organ. Touch the keys smoothly and firmly.

Under extremely humid conditions, or if you have greasy fingers, some trouble may be experienced with notes holding on. Wipe your hands thoroughly and the keyboard, too.

A case

We have not described complete details of a case for this instrument as we would expect constructors to 'customise' a case to suit individual tastes or circumstances. However, we have drawn up the dimensions of a suitable case that may be constructed of 4 mm thick material — such as plastic sheet or plywood. The design has a 'top' and a 'bottom' and each need only be glued together. The board can be mounted in the bottom on standoff pillars. Several standoff pillars screwed onto the board could then support the case top. The accompanying drawings show the rudimentary details. The completed case could be covered in suitably patterned 'Contac', or something similar.

Batteries, supply

The project was designed to be powered by a 9 V battery or other sort of dc supply. It draws around 40 mA at average volume during playing, somewhat over 100 mA at full volume. You can use a No. 216 9 V (transistor radio) battery, but we recommend you get either an extra heavy duty type or an alkaline battery. Alternatively, you could use 6 x AA cells in a 'six pack' battery holder. You can dispense with the battery and use an appropriately rated plugpack if you like. A plugpack rated at 6 V/200 mA will deliver voltages around 8 - 9 V at current loads under 100 mA, and such a plugpack would be the best to use if you want to power the project from the ac mains. ●

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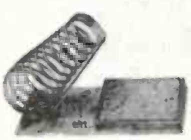

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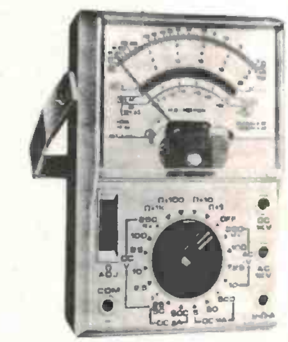

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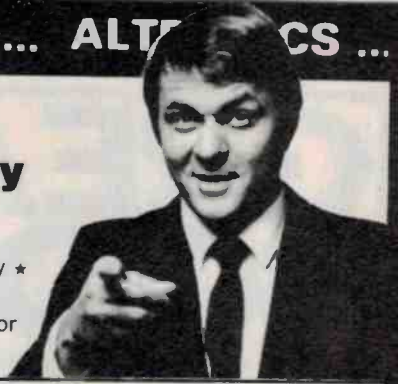

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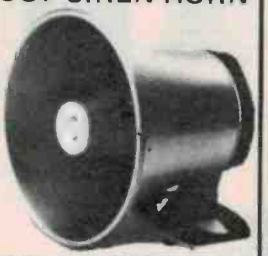

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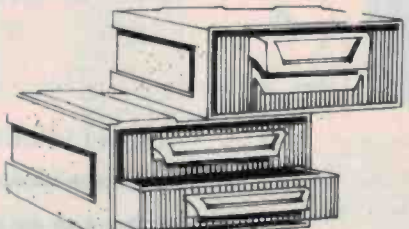

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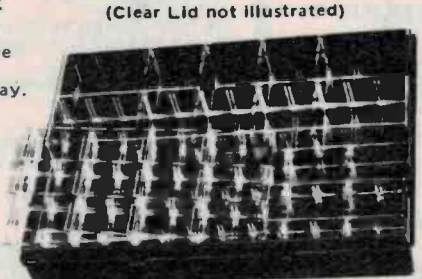

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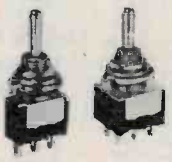

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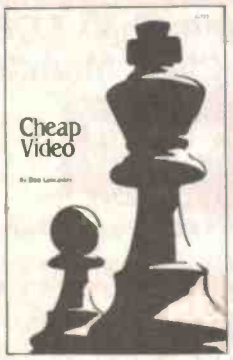

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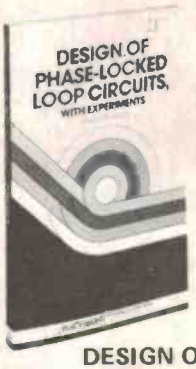

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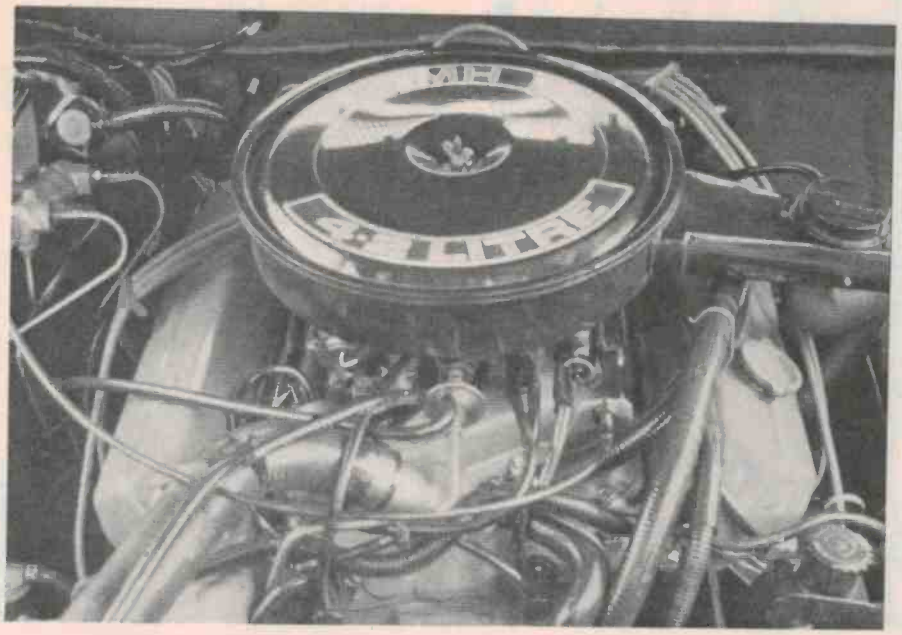


The 'Auto Tester'

Graeme Teesdale

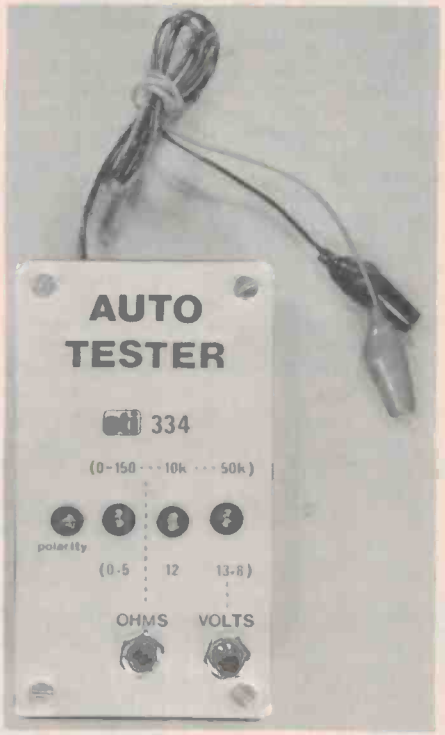
This handy little test gadget will help you sort out all those little bugaboos that can go wrong in automotive electrics. With this, you can check voltage drops, on and off charge battery voltages and resistances.

BUDDING MECHANICS are very often bamboozled by the electrics of a modern motor vehicle. An automotive or electronic type multimeter with its combination scales all crammed together simply adds to the confusion. This project was developed to make fault-finding a little easier by providing simple LED indication of 'set' points in voltage or resistance.

In a vehicle, voltage drop in cables of more than 0.5 volt can bring problems. The Auto Tester provides a clear indication of voltage drops less or greater than 0.5 V. The battery system, to perform up to scratch, must deliver at least 12 V on load and the battery should have a terminal voltage of more than 13.5 V when charging.

Resistances encountered in vehicles tend to have fairly well defined limits. Many devices have resistances under 10 ohms, a few range up to 150 ohms. Thus the first resistance 'set' point is at about 150 ohms. Much higher resistances are encountered in HT suppressors, etc. Generally, these are around 10k or 15k. Trouble can occur if they go faulty and exhibit a high resistance, generally greater than 50k. Thus, two other 'set' points for resistance are at 10k and 50k.

The unit was housed in a small, conveniently-sized jiffy box. The pc board designed for this unit will just fit comfortably into several different types on the market. Four indicator LEDs are provided: a POLARITY indicator, followed by one for each of the three set points in voltage and resistance. Two pushbuttons select which 'mode' you wish to use — VOLTS or OHMS.



Pragmatic. Simple, but functional. The project was housed in a small jiffy box with a Scotchcal panel added.

Where battery polarity is unknown, or in instances where the Auto Tester may be incorrectly connected, the POLARITY LED will light when the red, or positive, input lead is connected to the battery negative.

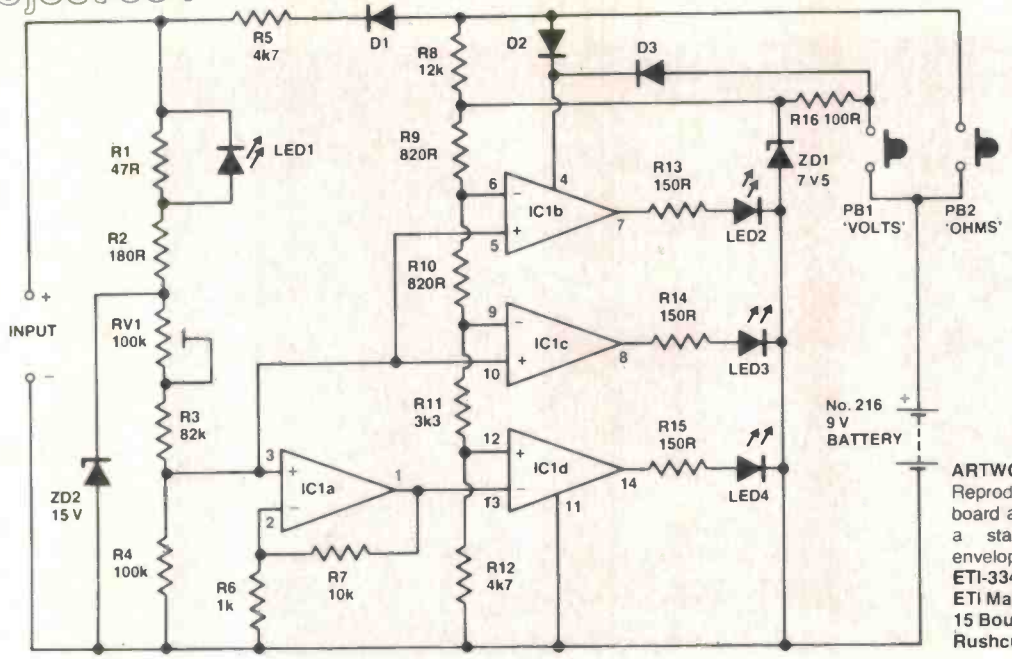
Protection against input overvoltage damage has been incorporated, so that voltage inputs of greater than 15 V are 'clamped' to avoid damaging the IC.

The Auto Tester, unlike most multimeters, will not be damaged if a dc voltage is applied to the input when it is being used in the resistance mode.

The unit is powered from a No. 216, 9 V battery mounted in the jiffy box. The circuit is based around the commonly available, low cost LM324 or uA324 quad op-amp. The battery will likely last its shelf life (probably a year or more) as consumption is only ever momentary, when you take a reading.

Construction

The project pc board has been designed to fit into almost any of the small jiffy boxes available. These are generally all-plastic or plastic cases with a light gauge aluminium 'lid'. We designed a Scotchcal front panel which will suit those boxes measuring 52 x 100 mm or a little larger. ▶



ARTWORK.
Reproductions of the front panel and pc board artwork can be obtained by sending a stamped, self-addressed A4-sized envelope to:
ETI-334 ARTWORK
ETI Magazine
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Rushcutters Bay NSW 2011

Before assembling the components to the board, check that is has no breaks or shorts between tracks, particularly between the IC pins. Also check that components like RV1, the zener diodes and LEDs have the correct lead hole sizes drilled. The board can be mounted by soldering the two pushbutton switches directly to the board and letting the board hang from their leads — it's quite a robust arrangement. If you're going to do this, see that the holes in the pc board for PB1 and PB2 are drilled the right size.

Next, check that the pc board fits inside the box. Make sure you orient the board correctly when you do this. If the board doesn't fit in without jamming you may have to carefully trim a little off one or both sides with a file until it fits properly. If it doesn't fit at all, get a bigger box!

Using the front panel artwork, mark out and drill the front panel, or lid, of the box. Fit the four LED mounts.

Once the board is ready to go, commence assembly by soldering all the resistors in

HOW IT WORKS — ETI 334

The clearest way of seeing how this circuit works is to break it down into simplified sections. The Auto Tester performs three main functions: voltage drop measurement, 12/13.8 V measurement and resistance measurement. In addition, an indication of reverse polarity connection is provided along with input overvoltage protection.

The whole circuit is built around an LM324 (or uA324) quad op-amp, IC1. Three op-amps from this are arranged as comparators and one as an amplifier. Let's look at the voltage drop measurement stage first. This portion of the circuit is shown in Figure 1.

Only the relevant components are included. When PB1 is pressed, power is supplied to IC1 via D3. Note that R1, LED1, R2 and ZD2 play no part here. RV1, R3 and R4 form a voltage divider. IC1a is arranged as an amplifier and IC1d as a comparator.

If the input leads are then connected across a cable having a voltage drop of less than half a volt, say 0.2 V, the voltage appearing at the non-inverting input of IC1a will be about 0.1 V (half the input volts) due to the divider action of RV1, R3 and R4. RV1 is set to provide this division ratio of about two. IC1a provides a gain of 10, and thus the output will be 1 V. This is lower than the 2.6 V on the non-inverting input of IC1d and thus its output will be driven high, lighting LED4.

If the voltage drop on the cable you have connected the input leads across reaches a little over a half a volt, say 0.55 V, the voltage on the non-inverting input of IC1a will be 0.275 V. The voltage on the output of IC1a, and thus the inverting input of IC1d, will be 2.75 V which exceeds the 2.6 V on IC1d's non-inverting input. The output of IC1d will thus go low and LED4 will extinguish, warning you of excessive voltage drop in the cable.

Note that, when performing voltage drop measurements, the positive lead must be connected at the end of the cable closest to the positive terminal of the vehicle battery.

When the input leads are open circuit and PB1 is pressed, D1 will be forward biased as it is connected to the 7.5 V rail (from ZD1) via R8. Thus, something a little under 7 V will appear at the 'top' of RV1, and about 3.5 V at pins 3, 5 and 10 of IC1. This will drive the output of IC1d low, and LED4 will be unlit. It won't change the condition of either IC1c or IC1d, so LEDs 2 and 3 will also be unlit. Thus, nothing happens if you press PB1 ('VOLTS') when the leads are not connected to anything.

Let us look at the other voltage measurements now. This section of the circuitry is shown in Figure 2. IC1b and IC1c are connected as comparators. Each has their inverting input connected to the voltage divider R9, 10, 11 and 12. This voltage divider is supplied from a regulated 7.5 volts, derived by ZD1 and R16. Thus, battery voltage variations will not affect circuit operation, provided the battery voltage doesn't fall to about 8 V or less. IC1b and IC1c have their non-inverting inputs connected together and these are attached to the input voltage divider.

Figure 1. Voltage drop measurement.

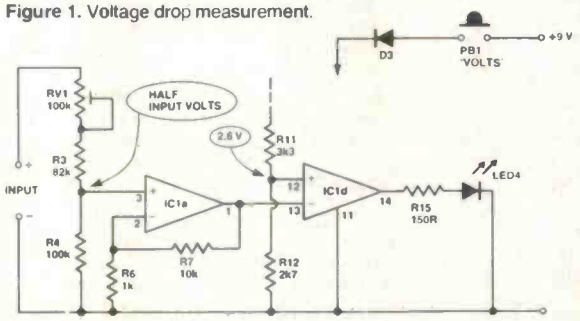
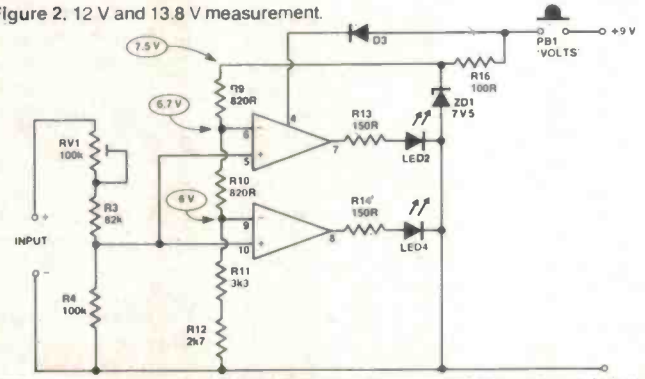
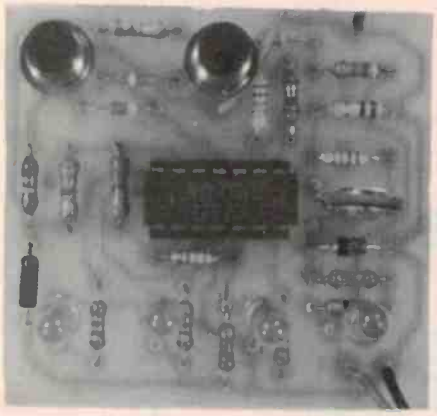
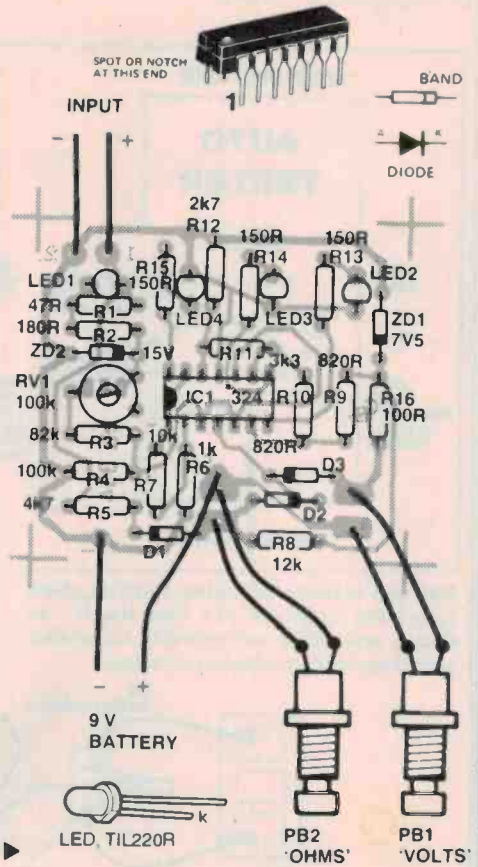


Figure 2. 12 V and 13.8 V measurement.







PARTS LIST — ETI-334

Resistors ..... all ¼W, 5% unless noted

R1	47R
R2	180R
R3	82k
R4	100k
R5	4k7
R6	1k
R7	10k
R8	12k
R9, R10	820R
R11	3k3
R12	4k7
R13, 14, 15	150R
R16	100R
RV1	100k min. trimpot, horizontal or vertical mount.

Semiconductors

D1, 2, 3	1N914, 1N4148 etc
IC1	LM324, uA324
LED1, 2, 3, 4	TIL220R red LEDs
ZD1	7V5 zener diode
ZD2	15 V zener diode

Miscellaneous

PB1, PB2	press-on pushbutton switches

ETI-334 pc board; jiffy box 52 x 30 x 100 mm or thereabout; No. 216 battery and battery clip lead; two alligator clips and leads, one red, one black; Scotchcal front panel, etc.

Price estimate **$15 — $17**

place, then the diodes D1, 2 and 3, followed by the two zener diodes. Make sure you get all the diodes in the correct way round.

If you're mounting the board to PB1 and PB2, solder these in place now, making sure their mounting 'shoulders' are level. Insert the four LEDs next, but don't solder them in place. Make sure you orient them correctly and don't trim off their leads. Temporarily mount the board to the front panel of the case. Push the LEDs into position and then solder and trim their leads. De-mount the board from the panel and fit IC1, RV1, the battery clip lead and the two input leads. ▶

When PB1 is pressed, power is supplied to IC1 via D3, as before. With no input voltage, the outputs of IC1b and c will both be low and LEDs 2 and 3 will be unlit. When the input leads are connected to a voltage a little over 12 V, the voltage on pin 10 of IC1c will be a little over 6 V. This will drive the output of IC1c high, lighting LED3. When the input voltage rises above about 13.5 V, the voltage on the pin 5 of IC1b will be a little over 6.7 V, driving the output of IC1b high, now lighting LED2 also.

Look at resistance measurement now. For this explanation, refer to the complete circuit diagram. As before, R1, LED1, R2 and ZD2 play no part here.

When PB2 is pressed, power is supplied to IC1 via D2. Some current is supplied to the resistive divider network, R9-10-11-12, by R8. This establishes a different set of voltages on the three comparator inputs. Pin 6, IC1b will now have about 3.8 V on it, pin 9, IC1c about 3 V on it and pin 12, IC1d about 1.3 V on it.

When the leads are connected to a resistance, current will be supplied to the resistance via D1 and R5. Say the resistance is 100 ohms. About 1.8 mA will be driven through it because there is about 8.5 V on the cathode of D1 and 8.5 divided by 4800 ohms gives about 1.8 mA. Thus, there will be a voltage drop across the 100 ohms of resistance of about 0.18 V. About 0.09 volts will appear on pin 3, IC1a. The output of IC1a will drive the inverting input of IC1d to about 0.9 V which is less than the 1.2 V on IC1d's non-inverting input. Thus the output of IC1d will be high, lighting LED4. If the resistance across the input is say 180 ohms, the voltage across the input leads will be about 0.32 V. About 0.16 V appears on pin 3, IC1a and 1.6 V on pin 13, IC1d. The output of IC1d will therefore go low, and LED4 will not light.

If the resistance across the input terminals is between 150 ohms and 10k, say 5000 ohms or so, then the voltage across it will be about 4 V. The voltage on pin 10, IC1c will be about 2 V, which is less than that on pin 9 and the output of IC1c will be low and LED3 will be unlit. If the resistance across the input leads is about 15k, say (such as a spark plug suppressor resistor), then the voltage across the input will be about 6.4 V and the voltage presented to pin 10, IC1c will be about 3.2 V. This is above the 3 V on pin 9 and the output will thus go high, turning on LED3.

If the resistance across the input leads is about 50k, then the voltage across the input will be about 7.8 V. The voltage on pin 5, IC1b will be about 3.9 V and the output of IC1b will therefore be high, turning LED2 on. Note that LED3 will also be on as the voltage on pin 10, IC1c is above that on pin 9 and IC1c's output will be high also. Thus, for all resistances above 50k (including an open circuit) LED2 and LED3 will light.

Followed that so far? Alright, let's look at the reverse polarity indication. The relevant portion of the circuit is shown in Figure 3.

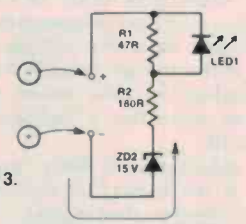


Figure 3.

REVERSE POLARITY INDICATION

If the input leads are transposed while trying to measure voltage, ZD2 will conduct as a diode in the forward direction (as shown by the arrow), passing current through LED1, which will turn on. It will also pass some current through R1, but that's immaterial. R1 is there so that current can pass to RV1 when the leads are correctly connected, otherwise no current would pass through LED1 as it would appear as a reverse-biased diode.

If you reverse the input leads while attempting to measure voltage drop, LED1 will only come on if the voltage drop is above about 1.3 V or so. Thus, it is important to watch lead polarity when measuring voltage drop in cables.

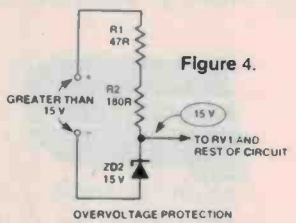


Figure 4.

OVERVOLTAGE PROTECTION

Overvoltage protection is provided by ZD2. Why have it? Well, if a battery cable comes adrift and you're attempting to measure voltages while the motor is running the generator/alternator can quite easily deliver outputs of 20 V or so. This can possibly destroy the LM324. In addition, it is not unusual to get inductively-produced voltage 'spikes' on the supply lines in a vehicle, which can also destroy the IC. If a voltage of greater than 15 V appears on the input leads to the Auto Tester, ZD2 will ensure that the voltage delivered to the LM324 does not exceed 15 V.

The various voltages and resistances given here can vary by +/− 10% or so without grossly affecting your interpretation of readings. What you are after, after all, is 'ballpark' measurements which will indicate if all is well, or not.

Beeforth On Oscilloscopes

If you have anything to do with electronics then I bet you can't think of many jobs where an oscilloscope isn't useful. I guess it all comes about from the old adage 'a picture is worth a thousand words'. Now, in less than a thousand words, I'll put you in the picture regarding TRIO's CS-1560All oscilloscope.

The 1560All is a dual trace, 15MHz, honest-to-goodness value for dollar instrument. It is well suited to industrial applications, TV servicing, production line testing, educational or hobby work. It is rugged, reliable, easy to use and very portable. Vertical sensitivity is good without sacrificing large signal input capability. Sweep rates are from a high 0.5μS to 0.5S per division and a high persistance P7 Phosphor is now available as an option to make full use of the slowest ranges.

Triggering can be normal or via a video sync separator and has to be the best in any low-cost oscilloscope ever made. How often have you used a big name, high performance oscilloscope for routine work and been driven mad by the constant fiddling needed to maintain a stable triggered display particularly when the input is variable. With one wave of a CS-1560All the problem vanishes. Up to its rated 3db point of 15MHz it will produce a locked display with only 0.2 of a division deflection amplitude. At 20MHz it requires only 0.3 of a division to lock and at 25MHz, 0.7 of a division. That is real triggering!

Along with the rest of TRIO's range, this instrument is slanted toward useability, the kind of convenience and practicability that makes you reach past the 'Gee wizz technoscope' to grab the little TRIO with the sharp, stable, bright blue trace that shows the whole picture quicker than I can tell it.

The best way to see why I'm so keen on the CS-1560All is to check it out for yourself at any Parameters location or stockist right throughout Australia.

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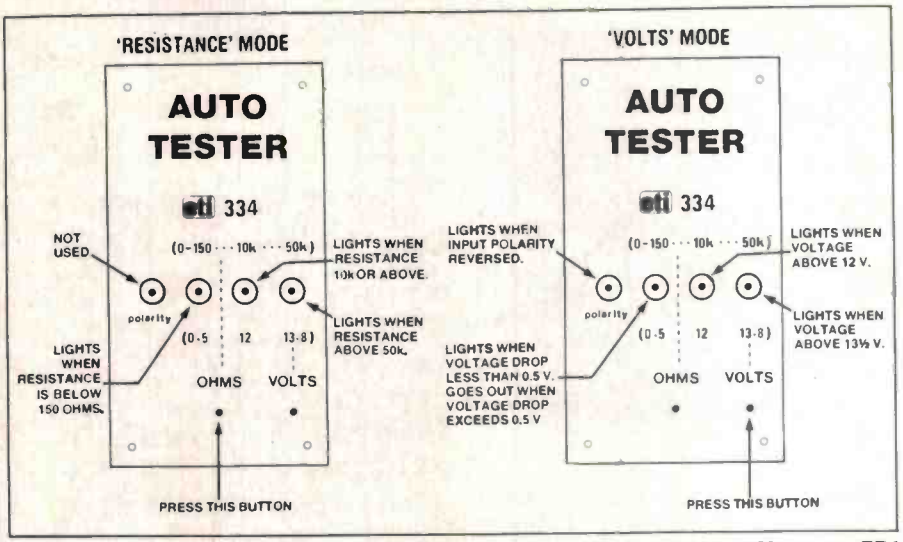
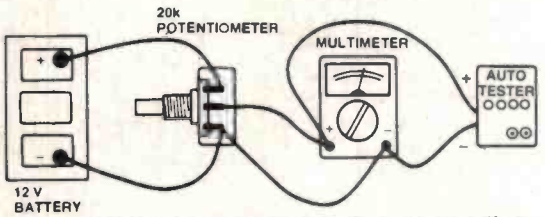


Now you're ready for testing. But first, check *everything* carefully. See that the IC, all diodes and LEDs are correctly orientated, according to the component overlay.



Calibration. Test setup for calibrating the Auto Tester.

Testing the unit

Fit a 9 V, No. 216 battery. Short the input clips together and press the VOLTS button. The 0.5 V LED should come on. If not, check component orientations, then resistor values. Fix any faults. Once you have that corrected, try again. When you get the 0.5 V LED to light, unclip the input leads and it should go out.

To calibrate the unit, you'll need to get hold of a multimeter, a well charged 12 V battery and a 20k potentiometer. Hookup the circuit shown here and adjust the potentiometer to give a 12 V reading on the multimeter. Press the VOLTS button and adjust RV1 so that the '12 V' LED just lights. Then, reset the potentiometer to get a 0.5 V reading, or a little more, on the multimeter. The '0.5 V' LED should just light. If it doesn't light, vary the potentiometer slightly until it lights. If the '0.5 V' LED lights when the multimeter reads more than ±0.1 V from 0.5 V, then you may have to change the value of R12. Increase it if the voltage is low, decrease it if the voltage is high. Just take the next highest or next lowest resistor value, you're only after a 'ballpark' indication, after all.

Set the potentiometer fully 'up' (fully clockwise). If the battery is well charged, then the multimeter should read 13.5 V or above and the '13.8 V' LED should turn on, along with the '12 V' LED. Now, reverse the Auto Tester input leads. The POLARITY LED should come on.

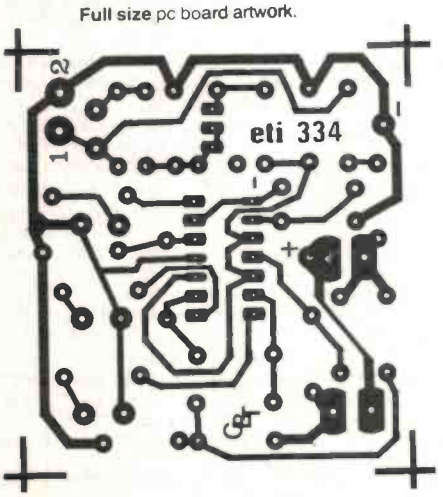
If you can't get the proper indications, check with the multimeter that you are getting 7.5 V (within ±0.3 V) across ZD1 when you press the VOLTS button. Also check the voltages on pins 6, 9 and 12 of IC1 when you press the VOLTS button and see they are close to those given in the How It Works.

If all is well, proceed with testing the OHMS mode. Disconnect the 12 V battery. Set the multimeter to read resistance (should be the X1 scale). Adjust the potentiometer until the multimeter reads about 100 ohms. Press the OHMS button and the '0-150' LED should come on. Turn the potentiometer until that LED goes out and keep turning till the '10k' LED turns on. It should turn on when the multimeter reads somewhere in the vicinity of 10k.

With the Auto Tester leads open circuit, both the '10k' and '50k' LEDs should turn on.

You are now ready for use. Happy fault-finding! ●

Full size pc board artwork.



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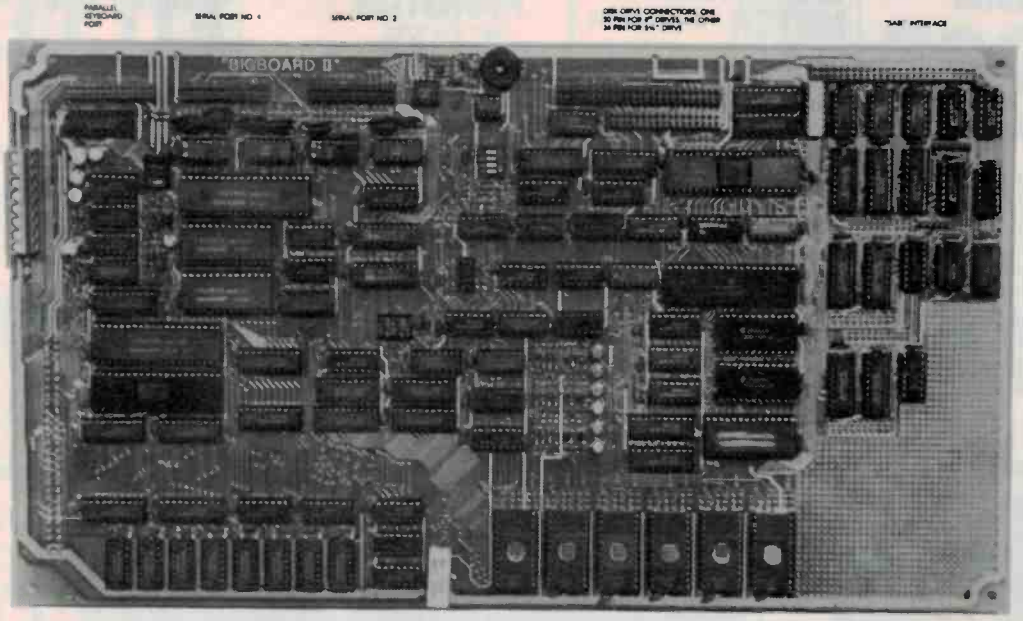
"BIG BOARD II"



STD Bus Connector

Prototyping Area

Jim Ferguson, the designer of the "Big Board" distributed by Digital Research: Computers, has produced a stunning new computer that we will begin shipping in November called "Big Board II", it has the following features:

4 MHz Z80 — CPU AND PERIPHERAL CHIPS

The Ferguson computer runs at 4 MHz. Its monitor code is lean, uses Mode 2 interrupts, and makes good use of the Z80-A DMA chip.

64K DYNAMIC RAM + 4K STATIC CRT RAM + 24K E(E)PROM OR STATIC RAM

"Big Board II" has the three memory banks. The first memory bank has eight 4164 RAMs that provide 60K of user space and 4K of monitor space. The second memory bank has two 2Kx8 SRAMs for the memory-mapped CRT display and space for six 2732 As, 2Kx8 staticRAMS, or pin-compatible E(E)PROMs. The third memory bank is for RAM or ROM added to the board via the STD bus. Whether bought as a bare board, a full kit, or assembled and tested, it comes with a 200 nS2732A EPROM containing the monitor.

MULIPLE-DENSITY CONTROLLER FOR SS/DS FLOPPY DISKS

The new Ferguson single-board computer has a multiple-density disk controller. It can use 1793, 1797, or 8877 controller chips since it generated the signal with TTL parts. The board has two connectors for disk signal with 34 pins for 5.25" drivers, the other with 50 pins 8" drives.

VASTLY IMPROVED CRT DISPLAY

The new Ferguson SBC uses a 6845s CRT controller and 8002 Video Attributed controller to produce a display that will rival the display of quality terminals. Characters are formed by a 5x7 dot matrix on 15.75 KHz monitors and 7x9 dot matrix on 18.60 KHz monitors. The display is user programmable with the default display 24 lines of 80 characters.

STD BUS CONNECTOR

The Ferguson computer brings its bus signals to a convenient place on the PC board where users can solder an DSTD, bus cards can be plugged directly into it, and it can as well be connected by bus cable to industry-standard card cages.

DMA

The new Ferguson computer has a Z80-A DMA chip that will allow byte-wise data transfers at 500K bytes per second and bit serial transfers via the Z80-A S10 at 880K bytes per second with serial processor overhead, though the monitor for the new computer uses the DMA chip mainly for transferring data to and from disk, the chip can readily be used for other things since its /"wait/ready" pin can be connected under software control to some half a dozen signal lines. When a hard-disk subsystem is connected to the "Big Board II" via its "SASI" interface, the DMA chip makes breathtaking disk performance possible.

"SASI" INTERFACE FOR WINCHESTER DISKS

The "Big Board II" implements the Host portion of the "Shugart Associates Systems Interface". Adding a Winchester disk drive is no harder than attaching a floppy-disk drive. A user simply 1: Runs a 50-conductor ribbon cable from a header on the board to any of several inexpensive controller cards for Winchester drives that implement the controller portion of the SASI Interface. 2: Cables the controller to an appropriate drive, and 3: Provides power for the controller-card and drive. Since our CBIOS contains code for communication with hard-disk, that's all a user has to do to add a Winchester to a system!

A Z80-A S10/0 = TWO ASYNCHRONOUS/SYNCHRONOUS SERIAL PORTS
A PARALLEL KEYBOARD PORT = FOUR OTHER PARALLEL PORTS USER 1/0

The new Ferguson single-board computer has one parallel port for an ASCII keyboard and four others for user-defined 1/0. When the computer is powered-up or reset, the monitor looks for a carriage-return at the keyuboard and serial ports. If the first carriage-return the monitor gets comes from the parallel keyboard, the monitor uses the board's video display circuitry to communicate with the user via a CRT. If the first carriage-return is typed at an ASCII terminal attached to a serial port, the monitor autabauds and makes the terminal the system console.

TWO Z80-A CTCs = EIGHT PROGRAMMABLE COUNTERS/TIMERS

The new Ferguson computer has two Z80-A CTCs. One is used to clock data into and out of the Z80-A S10/0, while the other is for systems and application use.

PROM PROGRAMMING CIRCUITRY AND SOFTWARE

The new Ferguson SBC has circuitry and drivers for programming 2716s, 2732(A)s, or pin-compatible (E)EPROMs.

CP/M

CP/M with Russell Smith's CBIOS for the new Ferguson computer is available for $190. The CB10S is available separately for $39.50.
Actual board size: 39.6cm x 22.2cm.

Pricing and Availability:

Availability: We should start shipping the second week in November. In single quantities, full kits cost $750.00 + tax, and A&T'd computers cost $895. There are attractive discounts that range to 35% for OEM's and dealers. For details about them please call Rod Irving on (03) 489 7099. ie: 3 Ferguson II "Big Board" are less 20% off the one-off price, hard disks disk controllers, boxes and power supply to suit both 8" & 5¼" systems will be available.

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* Heavy gauge front panel. Pre-punched and silkscreened. (NOT Scotchcal). * Low aging rate 10.000MHz crystal * Quality IC sockets provided (A MUST) * All metal film resistors used (1% 50ppm) * Thermalloy heatsink for +5V reg.

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FREE! TILTING BAIL WORTH $4.95 Included

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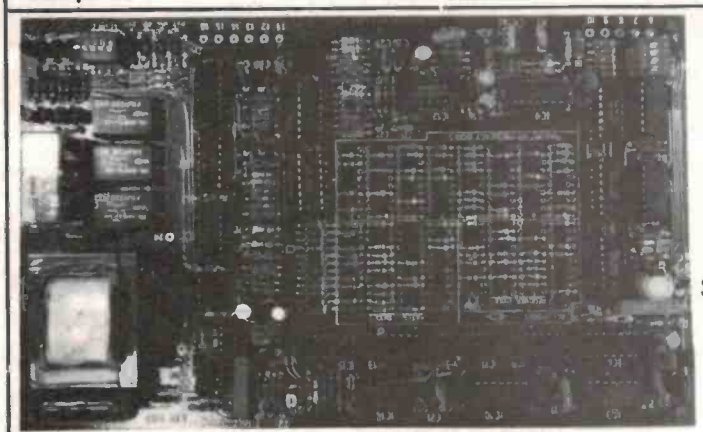

Two models (I) Short form which contains ALL PCB components as specified by ETI (BEWARE!!). The genuine ETI PCB with plated-thru holes, solder mask and component overlay is supplied. We also supply at NO EXTRA CHARGE a full set of quality I.C. sockets. A must with plated-thru PCB's Remember this when making comparisons.

(II) Full kit. Includes: all of above plus 12V plugpack, case, front panel, switch and LED bezel and Cannon DB-25 RS-232 connector. Makes a complete stand alonemodem.

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Ref: ETI October 1982

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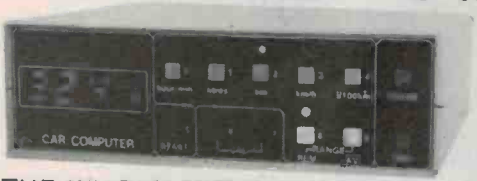

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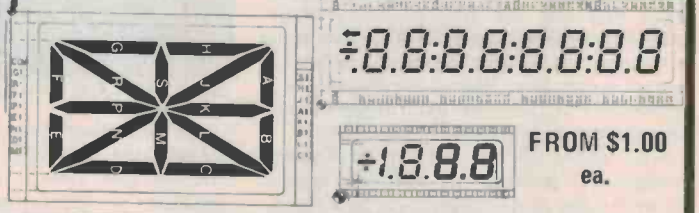

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Model railway points controller and indicators

This project employs a capacitive discharge type power supply to drive the solenoid actuators in model railway points switchers. An add-on indicator unit can be used in conjunction with it to show which way points are switched at any time.

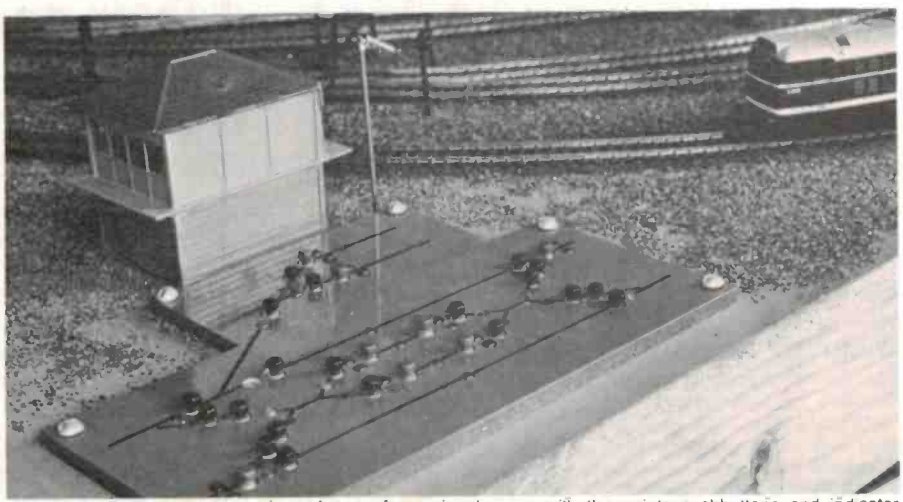
Jonathan Scott

THE IDEA of using a capacitive discharge supply to drive the solenoids in model railway points switchers is not new. Indeed, you can buy these at hobby shops for $20 or so, if you are not inclined to build one for yourself. However, this project incorporates refinements you may not have seen, along with a system of indicating the state of the points modelled after the fashion of the 'professional' signal box lighted map.

The capacitive discharge supplies bought 'over the counter' generally charge a capacitor of one to two thousand microfarads via a current limiting resistor from a rectifier and an ac source. This is quite adequate, but can be refined. If you charge the capacitor from a constant current source, it charges somewhat faster and one can provide an 'unready' indication while it's charging. The little extra speed one gains in charging is handy as several points often need to be changed in a short space of time and one's fingers dance from button to button when doing so.

With either system, the current limiting arrangement protects the solenoids against burnout if the supply happens to be accidentally connected indefinitely. The simpler system almost invariably incinerates something if you get a short somewhere.

The idea behind the capacitive discharge method is simply that the point changes in the first hundred milliseconds or so, any other power delivered is wasted. The high momentary current capability of a capacitor means that the solenoid always moves quickly. When you connect the charged capacitor to the points solenoid it will deliver a very high current which rapidly subsides to nothing or, at worst, the charge current which can be much less than the current required to actuate the solenoid. Thus, the solenoid remains cool even if connected (by some accident or other) indefinitely, avoiding burnout of the solenoid.



Signal map. This shows a view of one of my signal maps with the points pushbuttons and indicator LEDs installed.

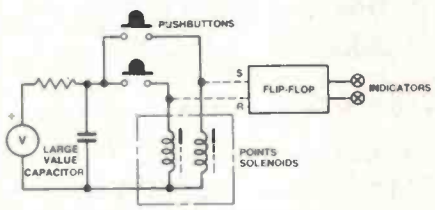


Figure 1. The controller/indicators scheme.

The outline of a capacitive discharge supply is shown in Figure 1, along with the outline of a 'remote point indicator', or 'remoter'.

The remoter is simply a 'memory' circuit which records which way the point was last changed. I used a simple flip-flop for this. Two LEDs or lamps are used to indicate the point's condition. These may be built into a signal map panel. This is basically just a line diagram of a track layout, or part thereof, with lights and switches in the symbolic positions of the actual points on the track layout. Train signal lights are also usually included on the map along with train position sensors, if used.

There is, of course, no need to have remoters. They are purely conveniences, rather than necessary functional items. Remoters are primarily important if you wish to have a layout which is as much like the 'real' thing as possible. However, for the few dollars or so extra cost each, they add a very pleasing touch of realism.

You can have any number of points in your layout and you'll only need one capacitive discharge supply unit. The one described can easily drive three points simultaneously if you need to operate some points together. One remoter is needed for each set of points.

Construction

Construction is relatively brief. The only part we can really cover here is the assembly of the pc boards and with the usual exhortation "assemble the boards according to the overlays", it's nearly all over!

There are two pc boards: ETI-1510a is the capacitive discharge supply, and ETI-1510b is for the remoters. Let us take the supply board first. It is easiest to mount the diodes and resistors first, then Q1 and IC1, followed by the capacitors. Take care with the orientation of the diodes and transistors as well as C1 and C2. Note that Q1 and IC1 should have heatsinks attached. You can make these from a scrap of aluminium; each heatsink should be at least 25 sq. cm in area. They can be bolted straight to the metal face of each device, but don't forget to smear on thermal compound first.

You may or may not wish to mount the 'charging' LED (LED1 on ETI-1510a) off the

PARTS LIST — ETI-1510a

Resistors ..... all ½ W, 5%
R1 ..... 2R7
R2 ..... 1k2

Capacitors
C1 ..... 1000u/25 V RB electro..
C2 ..... 3300u/25 V axial electro.
C3 ..... 10u/6 V tant.

Semiconductors
D1-D6 ..... 1N4001/2/3/4 etc
LED1 ..... TIL220R red LED
IC1 7805
Q1 ..... BD140

Miscellaneous
ETI-1510a pc board; hookup wire, etc.

Price estimate $8 — $10

PARTS LIST — ETI-1510b

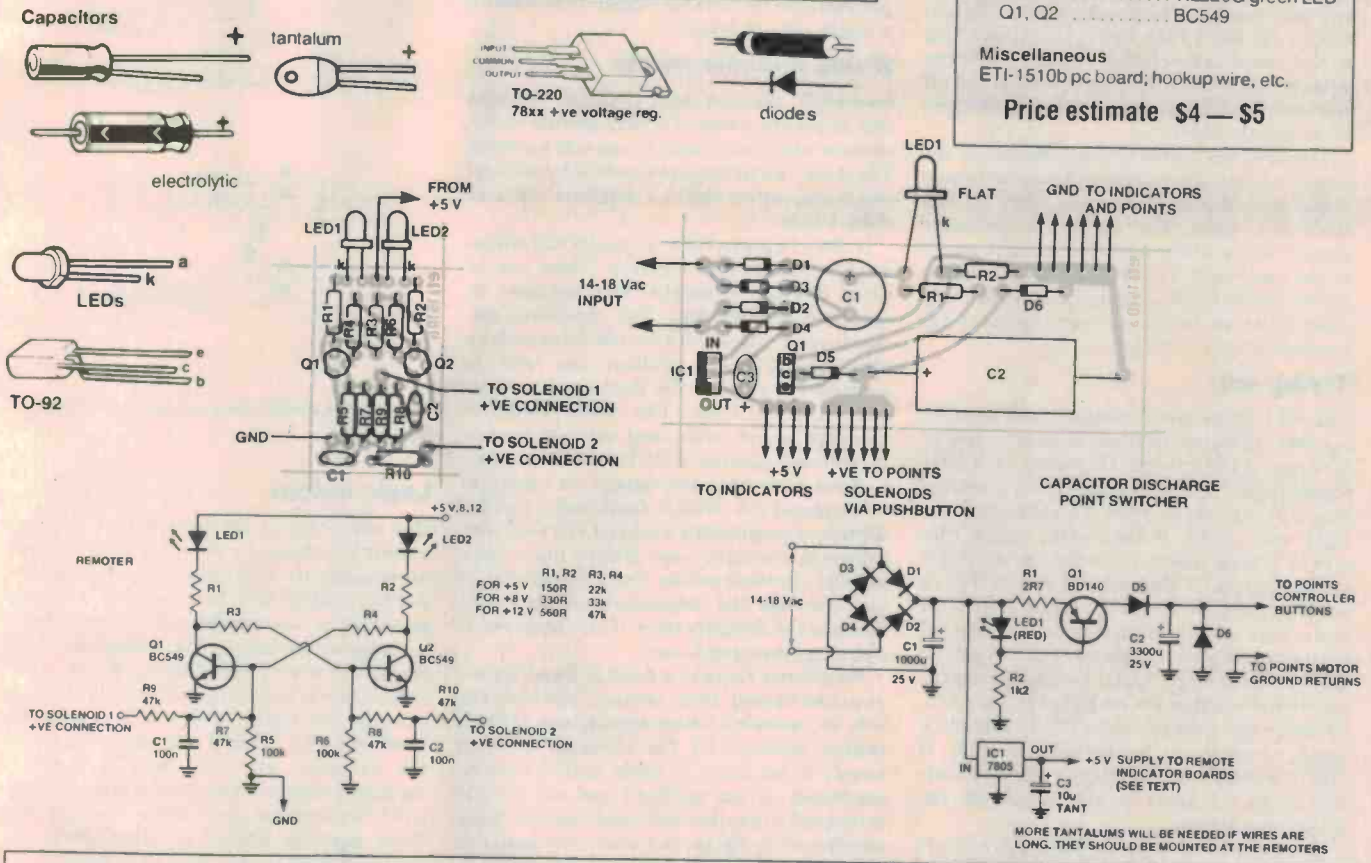
Resistors
R1, R2 ..... see text, circuit
R3, R4 ..... see text, circuit
R5, R6 ..... 100k
R7, 8, 9, 10 ..... 47k

Capacitors
C1, C2 ..... 100n greencap

Semiconductors
LED1 ..... TIL220Y yellow LED
LED2 ..... TIL220G green LED
Q1, Q2 ..... BC549

Miscellaneous
ETI-1510b pc board; hookup wire, etc.

Price estimate $4 — $5



HOW IT WORKS — ETI-1510

There are two distinct parts to the project: the first is a capacitor discharge supply used to operate the point solenoids, the second is a remote indicator unit.

The capacitor discharge supply unit charges a capacitor which is then discharged into the point solenoid, which then operates the points. This unit is capable of changing one point every half second or so, and can power a large number of points together.

The remote indicator unit, or 'remoter', has the job of 'remembering' which way the point set was last switched and indicates the direction with a pair of LEDs mounted as part of a signal map.

Consider the capacitor discharge unit. Diodes D1-D4 rectify the 14-18 volt ac input to provide a dc supply. Capacitor C1 smooths this for IC1 which regulates the voltage supply for the remoters. Up to fifteen remoters can be run off the output of IC1.

Transistor Q1 and surrounding components form a current source which charges C2 via D5. LED1 forms the voltage reference and doubles as an indicator which illuminates for the time when the capacitor is being recharged after use. Diode D5 prevents reverse biasing of the transistor when C2 is charged and C1 is below the peak input voltage value.

Using a current source for the charging element removes the need for a large series resistor and speeds up recharging as well as making the system short circuit proof.

Diode D6 is a "freewheel" diode which prevents possible reversing of the polarisation of C2 by the flyback voltage of a solenoid.

When a button is pressed, making a connection from the output of the unit to a point solenoid, C2 discharges into the coil, changing the point. After C2 is discharged the only current flowing through the coil is the recharge current of about 375 mA. When the button isolates the point solenoid, the current is free to charge C2, which takes about quarter of a second. When C2 reaches the input voltage, Q1 saturates, LED1 goes out, and the unit is ready to operate again.

The 375 mA charging current is insufficient to harm a solenoid if it is left connected for any reason. As the controller can withstand indefinite shorting itself, the whole system is protected against abuse and failure of switches, etc.

Each remoter consists of an R/S type flip-flop formed by two transistors. Assume initially that Q1 is on, and Q2 off. The collector current of Q1, via R1, illuminates LED1, and the saturation collector voltage of Q1 ensures that Q2 remains off.

When a solenoid is activated by the discharge of the capacitor, a large voltage spike appears across it. Suppose that the voltage across the coil appears on R10. Capacitor C2 filters out brief induced spikes, so that no signal other than the correct one can affect the circuit. When the longer duration discharge pulse appears on R10 some current reaches the base of Q2, turning it on. This turns on LED2 via R2 and removes the base drive from Q1, and it turns off. Thus LED1 goes out, and the collector voltage on Q1 keeps Q2 turned on via R3. The reverse operation occurs when a pulse appears on R9.

Transistors are used rather than an IC as they have a higher output drive, are less intolerant of supply voltages and ICs normally have more than one flip-flop in each package and you waste the rest.

board; like on the front panel of your controller, for example. This is a good idea if other people are using your layout as it helps them allow for the necessary delay between point switching operations of about half a second or so. Make sure you wire in LED1 the right way round.

The remoter board (ETI1-1510b) is quite straightforward. Best way to tackle this one is to mount the resistors and capacitors first. Then mount the two transistors making sure you get them the right way round. Finally, mount the two LEDs. Leave their leads long as the board can actually 'hang' from them. Alternatively, the LEDs may be mounted off the board and the board mounted somewhere conveniently nearby.

I secured my boards to the underside of the model railway baseboard with staples from a staple gun holding down the wires to and from the units. The capacitive discharge supply was actually mounted at right angles to the baseboard. The remoters were held flat on the baseboard by stapling the wires fairly close to the pc board. This arrangement has proved entirely satisfactory.

Trying out

The ETI-1510a board (supply) can be tried out first. Hook up the input to an ac source of between 14 and 18 volts. On switch-on, LED1 should light then extinguish about a second later. If not, check that it's connected the right way round. If that's OK, check that you're getting about 1½ times the ac input voltage across C1 (between 20 and 25 Vdc or so should appear across it). If not, switch off and check that diodes D1 to D4 are all correctly oriented. Correct any faults as you go. When you've got LED1 to light on switch-on, then check that the output of IC1 is +5 V. Measure the voltage across C2. It should be equal, or nearly so, to the voltage on Q1. If LED1 won't go out, or there's less than one volt aross C2, odds-on you've got D6 the wrong way round.

Temporarily hook up the supply to a points solenoid and see that it operates as expected.

You can check out the remoter(s) by temporarily connecting it to the +5 V from the supply board. One or other of the LEDs will light. Say LED2 on the remoter lights. Connect the 'SOLENOID 1' input momentarily to the positive terminal of C2 on the supply. LED1 should light and LED2 should extinguish. If not, check transistor and LED orientations. If this works, then temporarily connect the 'SOLENOID 2' input to the positive terminal of C2 and the LEDs should swap over.

When wiring in the remoters, it may be necessary to add some extra supply bypassing to prevent random toggling of the LED indicators. Add a tantalum with a value between 4u7 and 10u. You'll need one of these per extra metre of cable length if the cable is a metre long or longer.

Wiring multiple points

Invariably, you will want to install multiple sets of points, some of which operate alone, some of which may need to operate together. There are two wiring options which exist and which may prove useful if you have not seen them before.

It often happens that two points will always need to be switched together. These can be wired directly in parallel and operated by only two pushbuttons. The capacitive discharge supply described should drive such an arrangement easily, without the need to increase the value of the discharge capacitor (C2 on ETI-1510a). The 3300u capacitor specified would easily and reliably operate three parallel points in my layout. If you need to drive more, then the capacitor's value can be increased (try 4700u). Conversely, you can decrease the capacitor's value if you find your solenoids are light ones and/or don't have parallel operated points. Don't forget that, if you increase the capacitor's value, you'll increase the charging time. If you decrease it, charging time speeds up.

Sometimes there is a need to have one set of points 'slaved' from another, but have the first set operated independently also. This is readily achieved by the inclusion of some simple diode logic. A diode with its anode connected to one solenoid and its cathode connected to another will leave the first point unaffected by the second when switched, but will ensure that when the first is switched, the second also operates. This can be implemented with ordinary silicon rectifier diodes such as EM401s, 1N4001s, etc.

The various wiring arrangements are illustrated in Figure 2.

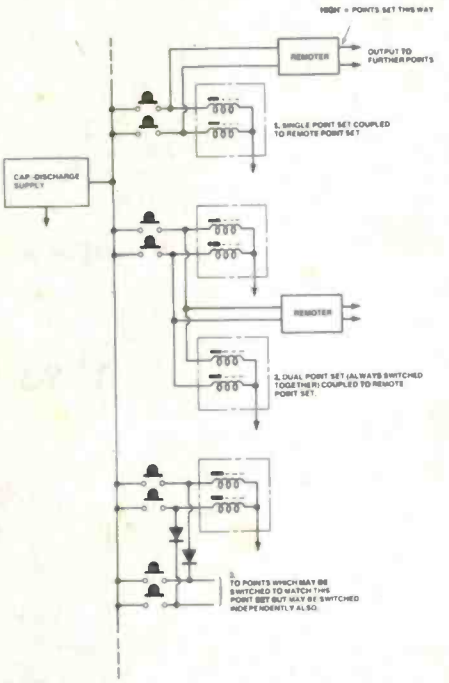


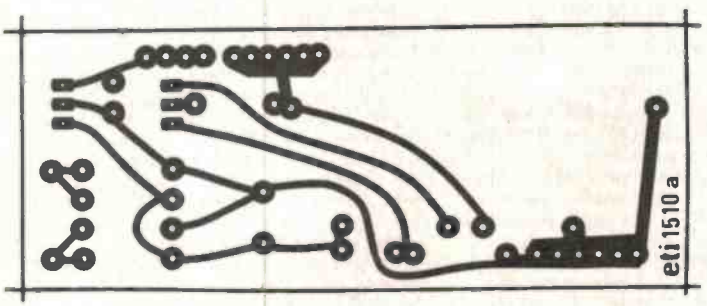
Figure 2. Showing the three fundamental schemes for wiring points.

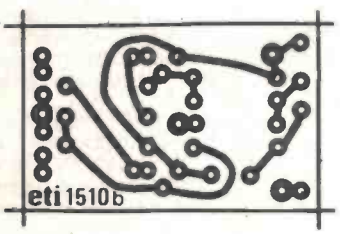
Logic output

One advantage of remoters is that they can output the state of a point set as logic levels for feeding into a digital system or computer. Astute readers will have noticed a certain provision in these model railway projects for a computer interface. The collectors of the transistors in each remoter circuit give a 'low' voltage when the respective side is that one carrying the traffic. For a 5 V supply, the levels are TTL. This is the main reason that the remoters are run from a carefully regulated supply, apart from a desire to keep LED illumination level fairly constant. For those needing CMOS or other levels the resistor values for 8 V and 12 V supplies are shown on the diagrams. (R1-2 and R3-4 will vary.)

Coupled with position sensing systems, the remoters can allow a simple anticrash logic system to be hardware implemented!

Printed circuits. Full size artwork of the two pc boards.





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A collection of the most popular types of circuits and projects to interest most electronics constructors. The projects cover a wide range and are divided into four basic types: radio, audio, household and test equipment.

BEGINNERS GUIDE TO DIGITAL ELECTRONICS
BP61 **$3.36**
Covers all essential areas including number systems, codes, constructional and sequential logic, analogue/digital/analogue conversion.

ELECTRONIC GAMES
BP69 **$5.92**
How to build many interesting electronic games using modern ICs. Covers both simple and complex circuits for beginner and advanced builder alike.

RADIO CONTROL FOR BEGINNERS
BP79 **$5.92**
How complete systems work with constructional details of solid state transmitters and receivers. Also included — antennas, field strength meter, crystal controlled superhet, electro-mechanical controls. Section dealing with licensing etc. not applicable to Australia.

EASY ELECTRONICS-CRYSTAL SET CONSTRUCTION
BP92 **$6.56**
For those who wish to participate in the intricacies of electronics more through practical construction than by theoretical study. The circuits are based on those from earlier publications but have been modified to use modern inexpensive components and home wound coils.

IC PROJECTS FOR BEGINNERS
BP97 **$6.56**
Especially written for the less experienced hobbyist, and offers a range of fairly simple projects based around a number of popular and inexpensive linear and digital ICs. Complete layout and point-to-point wiring diagrams included.

ELECTRONICS — IT'S EASY VOL. 1 **$5.95**
Meters, resistance, capacitance and inductance, emitter followers, op amps, power supplies and electronic filters.

ELECTRONICS — IT'S EASY VOL. 1 **$12.95**
Same content in a hard-cover form.

ELECTRONICS — IT'S EASY VOL. 2 **$5.95**
Digital sub-systems counters and shift registers, A-D and D-A conversion, digital instruments and test equipment, computers, transmission links and oscilloscopes.

ELECTRONICS — IT'S EASY VOL. 2 **$12.95**
Same content in a hard-cover form.

SIMPLE PROJECTS FROM ETI **$2.95**
Two volumes containing easy projects plus chapters on construction techniques and useful information on components.

HOBBY ELECTRONICS PROJECT BOOK **$4.95**
Fifty projects ranging from very simple ones for complete beginners to more elaborate ones for those with more experience. There's a complete guide to soldering and instructions on how to make your own pc boards.

HOW TO BUILD ELECTRONIC GAMES **$3.95**
Alien invaders, electronic die, sound effects, two slot car controllers, electronic poker machine, the family ferry and lots more.

HOW TO BUILD GOLD AND TREASURE DETECTORS **$3.95**
Tells you how metal detectors work and how to construct the different types of detectors: discriminating, BFO, induction balance and a professional deep-seeking unit. How to build a geiger counter.

constructional projects general

DESIGN OF TRANSISTOR CIRCUITS, WITH EXPERIMENTS
21626P **$20.75**
A self-teaching course in transistor circuits — seven chapters explore the fundamentals of active semiconductors and their operating principles and procedures. Experiments in design and semiconductor testing provide hands-on experience.

UNIQUE ELECTRONIC WEATHER PROJECTS
21484P **$13.25**
Fun and easy-to-build projects include an IC barometer to serve as a tornado warning and a 'thermostat with a brain' to help conserve energy.

BUILD YOUR OWN HI-FI & AUDIO ACCESSORIES
220B **$3.04**
Essential for keen hi-fi and audio enthusiasts. Projects include stereo decoder, three-channel mixer, FET preamp for ceramic pick-ups, mic preamp with adj. bass, stereo dynamic noise limiter, loudspeaker protector, voice-operated relay, etc.

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Some circuits are new, others are familiar designs. Projects can be split and/or combined for specialised needs.

50 CMOS PROJECTS
224B **$4.64**
Many interesting and useful projects — multivibrators, amplifiers and oscillators; trigger devices; special devices.

MAJOR SOLID STATE AUDIO HI-FI PROJECTS
BP29 **$3.04**
Three projects for the more experienced constructor: 12.5 W/ch stereo amplifier, eight input stereo/mono mixer and 4x14 W quadraphonic amplifier. Full constructional details provided.

HOW TO BUILD YOUR OWN METAL AND TREASURE LOCATORS
BP32 **$5.92**
Electronic and practical details on the simple and inexpensive construction of heterodyne metal locators.

HOW TO MAKE WALKIE-TALKIES
BP43 **$5.12**
This treatise on low power transmitter-receivers (walkie-talkies) covers many aspects from licensing requirements and bands, through practical circuitry and construction to the various types of aerials that may be used.

PROJECTS IN OPTO-ELECTRONICS
BP45 **$5.92**
Included are simple circuits using ordinary LEDs as well as more sophisticated designs such as infra red transmitters and detectors, modulated light transmission and also photographic projects etc.

RADIO CIRCUITS USING ICS
BP46 **$4.64**
This book describes ICs and how they can be employed in receivers for the reception of either amplitude or frequency modulated signals. Also discussed are stereo decoder circuits, quadrophonic circuits and voltage regulator devices.

POPULAR ELECTRONIC PROJECTS
BP49 **$4.96**
Includes a collection of the most popular types of circuits and projects which cover radio, audio, household projects and test equipment.

HOW TO BUILD YOUR OWN SOLID-STATE OSCILLOSCOPE
BP57 **$5.12**
Project divided into sections for builder individually to construct and test — then assemble into complete instrument. Includes short section on scope usage.

SINGLE IC PROJECTS
BP65 **$5.12**
Simple to build projects based on a single IC. A few projects use one or two transistors as well. A strip board layout is given for each project plus special constructional and setting up info. Contents include low level audio circuits, audio power amps, timers, op-amps and miscellaneous circuits.

ELECTRONIC GAMES
BP69 **$5.92**
A number of interesting electronic games projects using ICs for both the beginner and advanced enthusiast.

ELECTRONIC HOUSEHOLD PROJECTS
BP71 **$5.92**
Most useful and popular projects for use around the home. Includes two-tone buzzer, intercom, smoke and gas detectors, baby alarm, freezer alarm etc. etc.

REMOTE CONTROL PROJECTS
BP73 **$6.56**
Covers radio, infra-red, visible light, ultrasonic controls. Full explanations are provided so that the reader can adapt the projects for domestic and industrial as well as model use.

POWER SUPPLY PROJECTS
BP76 **$5.92**
This book gives a number of power supply designs, including simple unstabilised types, fixed voltage regulated types and variable voltage stabilised designs. The designs are all low voltage types for semiconductor circuits.

POPULAR ELECTRONIC CIRCUITS — BOOK 1
BP80 **$6.56**
Yet more circuits from Mr. Penfold! Includes audio, radio, test gear, music projects, household projects and many more. An extremely useful book for all hobbyists, offering remarkable value for the designs it contains.

ELECTRONIC PROJECTS USING SOLAR CELLS
BP82 **$6.56**
Includes a number of projects that benefit from solar power and obviate the problems encountered with batteries, such as weight and bulk, frequency of replacement, and failure when batteries are exhausted.

DIGITAL IC PROJECTS
BP84 **$6.56**
Companion to No. 225 Practical Introduction to Digital ICs and BP61 Beginner's Guide to Digital Electronics. The projects included in this book range from simple to more advanced projects — some board layouts and wiring diagrams are included.

AUDIO PROJECTS
BP90 **$6.56**
Covers a wide range of audio projects including pre-amplifiers and mixers, power amplifiers, tone controls and matching etc. A number of board layouts and wiring diagrams are included.

LOOK! More books!

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ELECTRONIC TIMER PROJECTS
BP93 $6.56
These may have a high degree of accuracy with quartz control or they may be quite simple designs, using only a few components. A number of specialist timer projects are car windscreen wiper delay unit, darkroom timer, metronome etc.

ELECTRONIC PROJECTS FOR CARS AND BOATS
BP94 $6.56
Fifteen fairly simple projects designed for use with 12 V electrical systems but in some cases can also be employed with 6 V and/or positive earth systems as well.

MODEL RAILWAY PROJECTS
BP95 $6.56
Projects include such things as controllers, signals and sound effects units. Construction stripboard layouts are provided for each project.

CB PROJECTS
BP96 $6.56
A number of useful designs include a speech processor, interference filters and a simple CB radio receiver. Stripboard layouts, wiring diagrams and notes on construction are provided.

POPULAR ELECTRONICS CIRCUITS — BOOK 2
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A companion for BP80, this book provides a wide range of designs for electronics enthusiasts who are capable of producing working projects from just a circuit diagram without the aid of detailed constructional information.

MINI-MATRIX BOARD PROJECTS
BP99 $6.56
This book provides a selection of 20 useful circuits which can all be built on a mini-matrix board which is just 24 holes by 10 copper strips in size. Simple and easy for those with not much experience in electronics.

MULTI-CIRCUIT BOARD PROJECTS
BP103 $6.56
All circuits are based on one specially designed pc board. Recommended to the less experienced hobbyist.

ELECTRONIC SCIENCE PROJECTS
BP104 $7.52
These projects range in complexity from a simple colour temperature meter to an infra-red laser. There is an electronic clock regulated by a resonating spring and an oscilloscope with a solid-state display. How to build them and use them is fully explained.

AERIAL PROJECTS
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Practical aerial designs including active, loop and ferrite which are relatively simple and inexpensive to build. The complex theory and mathematics of aerial design have been avoided.

MODERN OP-AMP CIRCUITS
BP106 $6.56
A collection of widely varying circuits and projects based on the op-amp ICs.

HOW TO GET YOUR ELECTRONIC PROJECTS WORKING
BP110 $6.56
Helps you to overcome the problems of a circuit that doesn't work by indicating how and where to start looking for many of the common faults that can occur when building up a project.

circuit techniques and design

TTL COOKBOOK
21035P $17.50
A complete look at TTL logic circuits — what TTL is, how it works, and how to use it. Many kinds of practical TTL are included, such as digital counters, electronic stopwatches, digital voltmeters, etc.

ACTIVE-FILTER COOKBOOK
21168P $21.95
Learn how to construct filters of all kinds — highpass, lowpass, bandpass. The book is easy to understand — no advanced maths or obscure theory is used.

ELECTRONIC CIRCUITBOOK 1: PROJECT CONSTRUCTION
21241P $7.50
Your basic guide to project construction, covering component identification, power supplies, proper tool selection, troubleshooting techniques, oscilloscope use, custom-made enclosures, and more.

CMOS COOKBOOK
21398P $19.25
This book explains CMOS technology and its application to 'real world' circuitry. A mini-catalogue is included, which lists over 100 devices, giving their pinouts and application notes.

IC TIMER COOKBOOK
21416P $15.95
Gives you a look at the hundreds of ways IC timers are used in electronic instrumentation.

IC CONVERTER COOKBOOK
21527P $20.75
Written for the practising engineer, technician, hobbyist or student, this book will be an invaluable working guide to the understanding and use of IC analogue/digital and digital/analogue converters.

DESIGN OF OP-AMP CIRCUITS, WITH EXPERIMENTS
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The design of the fundamental circuits that are the basic building blocks of more sophisticated systems. A series of 35 experiments illustrates the design and operation of linear amps, differentiators and integrators, voltage and current converters, active filters, and lots more.

555 TIMER APPLICATIONS SOURCE BOOK, WITH EXPERIMENTS
21538P $11.25
This book describes the construction of the 555 timer and gives numerous practical examples of its applications in all areas of electrical and computer engineering, including 17 simple experiments.

DESIGN OF ACTIVE FILTERS WITH EXPERIMENTS
21539P $15.95
Introduction to the theory, implementation and design of active filters using the 741 op-amp.

DESIGN OF PHASE-LOCKED LOOP CIRCUITS, WITH EXPERIMENTS
21545P $15.95
An excellent introduction to the theory, design and implementation of phase-locked loop circuits using various TTL and CMOS devices. Includes manufacturers' data sheets and describes the use of breadboarding aids in the wide range of laboratory-type experiments.

AUDIO IC OP-AMP APPLICATIONS
21558P $13.25
This book discusses IC op-amps and their application in audio systems, and describes the numerous advantages of using op-amps, including small spatial needs, low power consumption, reliable performance and low cost. Assumes a basic understanding of op-amp theory.

UNDERSTANDING CMOS INTEGRATED CIRCUITS
21598P $9.95
This book tells you what CMOS ICs are, how they work, and how they can be used in electronic circuit designs. Many practical circuits, complete with parts values, are included.

DESIGN OF TRANSISTOR CIRCUITS WITH EXPERIMENTS
21626P $20.75
A self-teaching course to provide the background and explanations necessary to teach the reader the art of designing transistor circuits.

GUIDE TO CMOS BASICS, CIRCUITS, AND EXPERIMENTS
21654P $14.95
If you are already familiar with TTL devices and are ready to examine the benefits of CMOS, this book is your complete source. It tells you what CMOS devices are, their characteristics and design rules. 22 experiments demonstrate the concepts discussed.

PRACTICAL TRANSFORMER DESIGN HANDBOOK
21657P $35.50
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This book provides a complete look at the internal architecture of the Z80, the heart of many microcomputers, and even shows how to build a microcomputer, the EX80, using this powerful chip.

DESIGN OF VMOS CIRCUITS, WITH EXPERIMENTS
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The authors look at the technology which makes dramatic advancements possible with VMOS, and show how these components can easily and effectively be integrated into common circuit designs to enhance their responses.

IC OP-AMP COOKBOOK
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EXPERIMENTS IN ARTIFICIAL INTELLIGENCE FOR SMALL COMPUTERS
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RF CIRCUIT DESIGN
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SOLAR CELLS
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ELECTRONIC DESIGN WITH OFF-THE-SHELF ICS
50274P $14.70
It contains virtually all the information you need to design and build electronic circuits, systems and subsystems with readily available ICs. Shows how to interface them into highly complex systems.

MODERN FILTER DESIGN
94663P $49.95
This book details the advances in active RC filters, both from a practical standpoint and from a state-of-the-art point of view. It is the first book that gives detailed analysis and design procedures for switched capacitor filters.

COIL DESIGN AND CONSTRUCTION MANUAL
160B $6.56
How to make RF, IF, audio and power coils, chokes and transformers. Maths is simplified.

50 PROJECTS USING CA3130 ICS
223B $4.32
The CA3130 is an advanced operational amplifier capable of higher performance than many others: circuits often need fewer ancillary components. Audio projects. RF projects. Test equipment. Household projects. Misc. projects.

PRACTICAL INTRO TO DIGITAL ICS
225B $4.32
Introduction to digital ICs (mainly TTL 7400). Besides simple projects, includes logic test set to identify and test digital ICs. Also includes digital counter-timer.

50 CIRCUITS USING GERMANIUM, SILICON AND ZENER DIODES
BP36 $3.36
50 interesting and useful circuits and applications using the germanium and silicon signal diodes, silicon rectifier diodes and zener diodes etc.

50 PROJECTS USING RELAYS, SCRS AND TRIACS
BP37 **$5.92**
Practical working circuits using silicon controlled rectifiers, relays and bi-directional triodes. With a minimum of difficulty you can use them in motor control, dimming and heating control, timing and light sensitive circuits, warning devices and many others.

50 FET PROJECTS
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Projects include amplifiers and converters, test equipment, tuners, receivers and receiver aids, mixers and tone controls etc etc. The FET used is not critical. This book is of interest and value to SW listeners, radio amateurs, hi-fi enthusiasts and general experimenters.

50 SIMPLE LED CIRCUITS
BP42 **$3.36**
50 interesting and useful circuits and applications using the LED. Also includes circuits for the 707 Common Anode Display for the beginner and advanced enthusiast.

IC555 PROJECTS
BP44 **$6.56**
One wonders how life went on before the 555! Included are basic and general circuits, motor car and model railway circuits, alarms and noise makers plus section on subsequent 556, 558 and 559s.

PROJECTS IN OPTO-ELECTRONICS
BP45 **$5.92**
Included are simple circuits using ordinary LEDs as well as more sophisticated designs such as infra-red transmitters and detectors, modulated light transmission and also photographic projects etc.

RADIO CIRCUITS USING ICS
BP46 **$4.64**
This book describes ICs and how they can be employed in receivers for the reception of either amplitude or frequency modulated signals. Also discussed are stereo decoder circuits, quadrophonic circuits and voltage regulator devices.

LM 3900 IC PROJECTS
BP50 **$4.64**
Unlike conventional op-amps, the LM 3900 can be used for all the usual applications as well as many new ones. It's one of the most versatile, freely obtainable and inexpensive devices around. This book provides the groundwork for simple and advanced uses — it's much more than a collection of projects. Very thoroughly recommended.

50 CIRCUITS USING 7400 SERIES ICS
BP58 **$5.12**
50 interesting and useful circuits and applications using these inexpensive and versatile devices.

50 CMOS IC PROJECTS
224B **$4.64**
Projects include multivibrators, amplifiers and oscillators, trigger devices and other special devices.

SECOND BOOK OF CMOS IC PROJECTS
BP59 **$5.12**
Leading on from book number 224 '50 CMOS IC PROJECTS', this second book provides a further selection of useful circuits mainly of a fairly simple nature. Contents have been selected to ensure minimum overlap between the two books.

COUNTER DRIVER AND NUMERAL DISPLAY PROJECTS
BP67 **$5.92**
Well-known author F.G. Rayer features applications and projects using various types of numerical displays, popular counter and driver ICs, etc.

VMOS PROJECTS
BP83 **$6.56**
Though primarily concerned with VMOS power FETs and their applications, power MOSFETs are dealt with too, in a chapter on audio circuits. Projects include audio circuits, sound generator circuits, dc control circuits and signal circuits.

DIGITAL IC PROJECTS
BP84 **$6.56**
Helps the reader to develop a knowledge of the workings of digital circuits. Board layouts and wiring diagrams are included.

HOW TO USE OP-AMPS
BP88 **$7.52**
Design notes and applications on many topics including basic theory, amplifiers, power supplies, audio circuits, oscillators, filters, computers and control engineering. It's written around the 741 IC but includes design notes for most of the common op-amps.

ELECTRONIC TIMER PROJECTS
BP93 **$6.56**
These may have a high degree of accuracy with quartz control or they may be quite simple designs, using only a few components. A number of specialist timer projects are car windscreen wiper delay unit, darkroom timer, metronome etc.

ETI CIRCUITS BOOKS 1/2/3 **$2.95 ea**
Many of these circuits have been published in the 'Ideas for Experimenters' section in ETI.

ETI CIRCUIT TECHNIQUES VOLS 1/2 **$4.75 ea**
The how, what, which, where, why and how much anthology of electronic components, circuits and techniques.

test equipment and fault finding

AUTOMOTIVE TUNE-UP AND EMISSION CONTROL SERVICE
21712P **$20.75**
Car owners who wish to save money and maintain their cars at peak performance will learn from this book how to adjust, repair and maintain the systems that ensure best operation.

TROUBLESHOOTING WITH THE OSCILLOSCOPE
21738P **$15.95**
Excellent for the professional service technician or the serious hobbyist, as it combines step-by-step procedures for using the scope with the specific nuts and bolts of TV receiver troubleshooting.

EFFECTIVELY USING THE OSCILLOSCOPE
21794P **$14.95**
Excellent for the professional service technician or the serious do-it-yourself, as it combines the correct step-by-step procedures for using a scope with the specific nuts and bolts of TV receiver troubleshooting.

MICROCOMPUTER DESIGN AND TROUBLESHOOTING
21819P **$26.75**
Tells you how to design microcomputer systems and make them work without an expensive commercial development system or the need for costly test instrumentation. The author also provides a complete description of two popular microprocessors — the 8085 and the 6502.

USE OF THE DUAL-TRACE OSCILLOSCOPE
40023P **$23.75**
This programmed text breaks down the process of operating a scope into a series of logical steps starting with the deflection of the electron beam and continuing through proper use of the triggering controls to measure the phase difference between two waveforms.

ELECTRONIC TROUBLESHOOTING HANDBOOK
52585P **$10.50**
This workbench guide shows you how to pinpoint transistor troubles in minutes, how to test almost everything electronic and how to get the most out of low cost test equipment.

PRACTICAL REPAIR AND RENOVATION OF COLOUR TVS
BP34 **$4.32**
This book shows how to obtain a working colour TV for very little outlay by repairing and renovating a set that has been 'written off' by a dealer. Includes practical details of how to construct your own CRT tester/rejuvenator and cross hatch generator.

HOW TO BUILD YOUR OWN SOLID STATE OSCILLOSCOPE
BP57 **$5.12**
The oscilloscope is divided into various sections which can be individually constructed and tested and then assembled together to complete the whole instrument. Also tells you how to use the instrument.

TRANSISTOR RADIO FAULT-FINDING CHART
BP70 **$1.92**
Used properly, this chart should enable the reader to trace most common faults quickly. Across the top of the chart are four rectangles containing brief descriptions of the faults. Selecting the appropriate fault, the reader simply follows the arrows and carries out the suggested checks in sequence until the fault is cleared.

ELECTRONIC TEST EQUIPMENT CONSTRUCTION
BP75 **$5.92**
Describes construction of wide range of test gear including FET amplified voltmeter, resistance bridge, field strength indicator, heterodyne frequency meter etc.

POWER SUPPLY PROJECTS
BP76 **$5.92**
Includes simple unstabilised types, fixed voltage regulator types and variable voltage stabilised designs. The designs are all low voltage types for semiconductor circuits.

HOW TO GET YOUR ELECTRONIC PROJECTS WORKING
BP110 **$6.56**
Helps you to overcome the problems of a circuit that doesn't work by indicating how and where to start looking for many of the common faults that can occur when building up a project.

TEST GEAR — METERING AND POWER SUPPLY PROJECTS **$3.00**
Includes many types of meters, audio noise and signal generators, simple CMOS tester, oscilloscope calibrator etc.

TEST GEAR — VOL. 2 **$3.95**
Projects include audio oscillator, transistor tester, true RMS voltmeter, RF signal generator, versatile logic test probe, microwave oven leak detector etc.

ELECTRONIC PROJECTS FOR YOUNG SCIENTISTS **$3.95**
PH meter, geiger counter, helium-neon laser, sound level meter, solar cells, negative ion generator and much more.

electronic music/audio/video

AUDIO CYCLOPEDIA
20675P **$66.00**
A complete in-depth look at the art of audio — from the basic principles of sound to solid-state and integrated circuits. Over 3000 entries and hundreds of illustrations and circuit diagrams cover acoustics, amplifiers, recording, reproduction, test equipment, audio measurements, and much more.

ELECTRONIC MUSIC CIRCUITS
21833P **$24.95**
How to build a custom electronic music synthesiser, outlines numerous other circuit designs and then shows you how to modify them to achieve particular responses. Many of the circuits can be used as special-effects boxes for guitars and other musical instruments.

INTRODUCTION TO ELECTRO-ACOUSTIC MUSIC
81515P **$15.95**
This book assumes no previous technical knowledge. It discusses the relationship between the technology and the composition of electro-acoustic music.

MODERN RECORDING TECHNIQUES
21037P **$19.25**
Explains the equipment controls and techniques found in a modern recording studio and how to use them creatively and correctly to produce a desired result. Numerous photographs, diagrams and charts.

SOUND SYSTEM ENGINEERING
21156P **$32.50**
Dealing with audio systems as a whole, it includes installing and equalising the sound system and interfacing the electrical and acoustic systems. Instrumentation, the acoustic environment and designing for acoustic gain are covered.

TUBE SUBSTITUTION HANDBOOK
21746P **$8.75**
Complete, accurate, up-to-date guide to direct substitutes for receiving and picture tubes. Contains over 6000 receiving tube substitutes, over 4000 monochrome and colour picture tube substitutes, and 600 communications substitutes. Also includes pinouts for quick operational checks.

HOW TO BUILD SPEAKER ENCLOSURES
20520P **$8.75**
A practical guide to the 'whys' and 'hows' of constructing high-quality top-performance loudspeaker enclosures.

ACTIVE-FILTER COOKBOOK
21168P **$21.95**
Learn how to construct filters of all kinds — highpass, lowpass, bandpass. The book is easy to understand — no advanced maths or obscure theory is used.

DESIGN OF ACTIVE FILTERS WITH EXPERIMENTS
21539P **$15.95**
Introduction to the theory, implementation and design of active filters using the 741 op-amp.

AUDIO IC OP-AMP APPLICATIONS
21558P **$13.25**
This book discusses IC op-amps and their application in audio systems, and describes the numerous advantages of using op-amps, including small spatial needs, low power consumption, reliable performance and low cost. Assumes a basic understanding of op-amp theory.

VIDEO TAPE RECORDERS
21521P **$17.50**
In this completely revised second edition, the author tells in simple language how helical VTRs work and how to operate and service them. Includes numerous examples of circuits and mechanical systems.

OOPS! More books!

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CHEAP VIDEO COOKBOOK
21524P $11.75
Complete discussion of a new, low-cost way to get words, pictures and opcode out of your computer and onto any ordinary TV screen, using a seven-IC easy-to-build circuit which you can build for less than $20.

AN INTRODUCTION TO VIDEO
BP100 $6.56
This book is written in layman's language and is for anyone who is thinking about buying or renting or who has just bought or rented a video recorder and wants to get the best out of the machine.

MOBILE DISCO HANDBOOK
BP47 $4.64
Most people who start mobile discos know little about equipment or what to buy. This book assumes no preliminary knowledge and gives enough info to enable you to have a reasonable understanding of disco gear.

ELECTRONIC MUSIC AND CREATIVE TAPE RECORDING
BP51 $5.92
Shows how electronic music can be made at home with the simplest and most inexpensive of equipment. Describes how the sounds are generated and how these may be recorded to build up the final composition.

PRACTICAL CONSTRUCTION OR PREAMPS, TONE CONTROLS, FILTERS, ATTENUATORS
BP60 $4.96
This book shows the enthusiast how to construct a variety of magnetic tape recording, microphone and disc preamplifiers, and also a number of tone control circuits, rumble and scratch filters, attenuators and pads.

ELECTRONIC SYNTHESISER PROJECTS
BP81 $5.92
For the electronic music enthusiast, an invaluable reference. This book is full of circuits and information on how to build analogue delay lines, sequencers, VCOs, envelope shapers, etc. etc. The author takes a clear and logical approach to the subject that should enable the average enthusiast to understand and build up what appears to be a quite complex instrument.

AUDIO PROJECTS
BP90 $6.56
Covers a wide range of audio projects including preamplifiers and mixers, power amplifiers, tone controls and matching etc. A number of board layouts and wiring diagrams are included.

ELECTRONIC MUSIC PROJECTS
BP74 $5.92
Provides constructors with practical circuits for the less complex music equipment including fuzz box, waa-waa pedal, sustain unit, reverb and phaser, tremolo generator etc. Text covers guitar effects, general effects, sound generators, accessories.

SONICS 1982 YEARBOOK $5.35
An interview with Kraftwerk, how to cope with recording, lighting, rock acoustics, guitars, equipment reviews and more.

SONICS MAGAZINE $2.35 ea
The Australian music magazine dedicated to the art and craft of sound. Published April, July, October, Yearbook in December. $15 for one year subscription. Please indicate starting issue.

computers for beginners

COBOL FOR BEGINNERS
39378P $21.95
It is a solid text for introductory programming courses in Cobol, using a format that is easy to understand, yet comprehensive enough to make supplementary readings unnecessary.

THE PET PERSONAL COMPUTER FOR BEGINNERS
61827P $20.95
This handy guide is written for use with all varieties of PET computer, from the original 2001 to the new 8032 Super PET. It is suited to novices with no practical experience and provides advice and practical examples.

BIG THINGS FROM LITTLE COMPUTERS
77859P $19.25
A layperson's guide to personal computing with all the basic information and lots of examples of how personal computers can be used.

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BEGINNER'S GUIDE TO MICROPROCESSORS & COMPUTING
BP66 $5.92
Introduction to basic theory and concepts of binary arithmetic, microprocessor operation and machine language programming. Only prior knowledge assumed is very basic arithmetic and an understanding of indices.

A MICROPROCESSOR PRIMER
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Learning about microprocessors is easy with this book, written in a style that is easy to follow. The shortcomings of this basic machine are discussed and the reader is shown how these are overcome by changes to the instruction set. Relative addressing, index registers follow as logical progressions.

AN INTRO TO BASIC PROGRAMMING TECHNIQUES
BP86 $6.56
Ideal for beginners seeking to understand and program in BASIC. Book includes program library for biorhythms, graphing Y against X, standard deviations, regressions, generating musical note sequences, and a card game.

BEGINNING BASIC
39806A $19.95
Intended for beginners with no computing experience, one should be able to intelligently program in BASIC in a short time.

BEGINNING FORTRAN
46011A $19.95
Starts with simple elementary examples and proceeds to intermediate level programs. Also includes references, tutorials, flow charts, deck set-ups and matrix algebra.

UNDERSTANDING COMPUTERS
39815A $17.95
This book describes how computers work. For people who use small computers, it starts with the most elementary gates and works up to the complete computer. Gives an understanding of languages and how they operate in the computer.

NAILING JELLY TO A TREE
39842A $24.95
This guide to software teaches you about machine language, assembly language programming and BASIC. The emphasis is not on learning to write programs but on learning to use the thousands of available programs that have already been written.

PEANUT BUTTER AND JELLY GUIDE TO COMPUTERS
39813A $14.95
A simple, easy-to-digest source of information on personal computing for the potential buyer who is less than an expert in the field.

INTRODUCTION TO WORD PROCESSING
88076A $17.95
Written for the non-technical reader, this book tells about the concepts common to all word processing systems, then analyses all features in detail.

YOUR FIRST COMPUTER
88045A $12.50
An easy-to-understand beginner's book to small computers. Understanding them, buying them and using them for personal and business applications.

FROM CHIPS TO SYSTEMS: AN INTRODUCTION TO MICROPROCESSORS
88063A $19.95
Explains exactly what a microcomputer system is and how it works. Introduces fundamental concepts and covers all aspects of microprocessors and related components: internal operation, memories, interfacing and system development etc.

COMPUTERS FOR EVERYBODY
39849A $8.95
In this easy-to-understand book it is explained how a computer can be used at home, in the office or at school. Includes a consumer's guide to computer equipment that will help the reader decide what to buy and who to buy it from.

computers hardware & techniques

USING THE 6800 MICROPROCESSOR
21512P $13.25
This will guide the reader through the conception, configuration, writing and running of a variety of programs that demonstrate practical use of a 6800 system.

Z80 MICROCOMPUTER DESIGN PROJECTS
21682P $20.75
This book provides a complete look at the internal architecture of the Z80, the heart of many microcomputers, and even shows how to build a microcomputer, the EX80, using this powerful chip.

MICROPROCESSOR CIRCUITS VOL. 1
21877P $14.75
Presents basic microprocessor concepts in simple language for beginners and teaches you to construct a useful microcontroller system. Offers 30 demo circuits which take you through assembly, operation and programming of a microcontroller.

INTERFACE PROJECTS FOR THE APPLE II
69387P $15.95
A series of interface projects that are easily built and enable the user to realise the computer's potential through project construction. Projects are primarily hardware-orientated, with some software supporting the hardware.

PET INTERFACING
21795P $25.25
Demonstrates how to build numerous interfacing devices for PET hardware. BASIC language programs are used throughout, and the book includes a discussion of the microprocessor's internal architecture and general hardware/software interfacing.

6809 MICROCOMPUTER PROGRAMMING AND INTERFACING, WITH EXPERIMENTS
21798P $21.95
Gives a solid understanding of how to program and interface the high-performance 6809 microprocessor. The author completely explores internal structure, addressing modes, data movement instructions, registers, arithmetic logic and test instructions for the 6809.

Z80 MICROCOMPUTER HANDBOOK
21500P $17.50
This thorough handbook covers hardware, software and microcomputers built around the Z80.

THE S100 AND OTHER MICRO BUSES
21810P $13.25
The key to successful computer expansion is a complete understanding of the bus system, through which the computer communicates with peripherals. This book will give you that understanding.

MICROCOMPUTER DESIGN AND TROUBLESHOOTING
21819P $26.75
Tells you how to design microcomputer systems and make them work without an expensive commercial development system or the need for costly test instrumentation. The author also provides a complete description of two popular microprocessors — the 8085 and the 6502.

DON LANCASTER'S MICRO COOKBOOK, VOLUME 1
21828P $20.75
This 'cookbook' starts with the very fundamentals of microprocessors and microcomputers and takes you through number systems, codes, memory, etc, until you can work intelligently with micros.

DON LANCASTER'S MICRO COOKBOOK, VOLUME 2
21829P $20.75
Carries on where Volume 1 left off.

APPLE INTERFACING
21862P $15.95
Using this book, you will be able to perform useful experiments which will provide a much clearer understanding of the fundamentals of computer interfacing and computer electronics. A better understanding of interactions between hardware and software will enable you to communicate more effectively with your Apple.

MICROPROCESSOR CIRCUITS VOL. 1
21877P $14.75
Presents basic microprocessor concepts in straightforward language for beginners. Teaches you to construct a useful microcontroller system through progressive demonstration circuits.

8080 MICROCOMPUTER EXPERIMENTS
39808A $29.50
This 'hands on' book includes 105 experiments presenting programs and diagrams as required for clarification.

A STEP-BY-STEP INTRODUCTION TO 8080 MICROPROCESSOR SYSTEMS
39804A $16.95
Doesn't require any electronics or computer background. This book describes the 8080 architecture and instruction set through simple examples. Some basic software is introduced.

DIGITAL CIRCUITS WITH MICROPROCESSOR APPLICATIONS
46032A **$39.50**
An introductory text, this book provides readers with the basic ideas and tools needed to analyse and design digital circuits and computer systems. Discusses microprocessor computer organisation, machine language number systems and gate circuits.

MICROPROCESSOR INTERFACING TECHNIQUES
88029A **$24.95**
Teaches you how to interconnect a complete microprocessor system and interface it to the usual peripherals. The hardware and software skills needed to effectively interface peripheral devices are covered along with various buss standards and A/D conversion.

PRACTICAL INTRO TO DIGITAL ICS
225B **$4.32**
Introduction to digital ICs (mainly TTL 7400). Besides simple projects, includes logic test set to identify and test digital ICs. Also includes digital counter-timer.

BEGINNER'S GUIDE TO MICROPROCESSORS & COMPUTING
BP66 **$5.92**
Introduction to basic theory and concepts of binary arithmetic, microprocessor operation and machine language programming. Only prior knowledge assumed is very basic arithmetic and an understanding of indices.

A MICROPROCESSOR PRIMER
BP72 **$5.92**
Learning about microprocessors is easy with this book, written in a style that is easy to follow. The shortcomings of this basic machine are discussed and the reader is shown how these are overcome by changes to the instruction set. Relative addressing, index registers follow as logical progressions.

PRACTICAL COMPUTER EXPERIMENTS
BP78 **$5.92**
How to build typical computer circuits using discrete logic. This book is a useful intro to devices such as adders and storers as well as a general source book of logic circuits.

THE 6809 COMPANION
BP102 **$6.56**
It is not a beginners introduction to microprocessors in general but a discussion of the features of the 6809 and a reference work for the 6809 programmer in particular.

COMPUTERS & COMPUTING YEARBOOK 1980
$4.95
Includes beginners buying guide, the Apple, Tandy's TRS-80, the Vector MZ, introducing BASIC, S100 VDU, EPROM programmer, microcomputer power supply and lots more.

COMPUTERS & COMPUTING YEARBOOK 1982
$4.95
Includes disks, CP/M and your computer, learners microcomputer, programming in CHIP-8, alphasort, fast plotter, PET talk, the System 80 etc.

computing software

CP/M PRIMER
21791P **$21.95**
A complete one-stop course on CP/M, the very popular operating system for 8080, 8085 and Z80-based microcomputers. Complete terminology, hardware and software concepts, startup of a CP/M system, and a complete list of CP/M-compatible software.

THE CP/M HANDBOOK (WITH MP/M)
88048A **$19.95**
Contains a step-by-step description of all the CP/M command features. Designed for the beginner, the book progresses to detailed explanations of the file transfer program, the debugging program and CP/M's text editing program.

HOW TO GET STARTED WITH CP/M
39832A **$19.95**
This practical book eases the reader into the essentials of the system, giving an overview of the operating system, an idea of what it will be like to use and what it can do for the reader.

AUSTRALIAN MICROCOMPUTER HANDBOOK
72505 **NOW $15.00**
Normally $25.00. A detailed buyer's guide to microcomputer systems and application packages in commercial, industrial, scientific, educational and home/hobby areas.

THE C PROGRAMMING LANGUAGE
10163P **$21.95**
C is a general purpose 'low-level' programming language. It is not specialised to any particular area of application, but its absence of restrictions make it convenient and effective for many tasks.

THE 68000: PRINCIPLES AND PROGRAMMING
21853P **$19.95**
An easy-to-read, systematic approach to the 68000 advanced 16-bit microprocessor. The book guides you through the complex architecture, instruction set, pinouts and interfacing techniques. Written for design engineers, programmers and students.

PROGRAMMING IN BASIC FOR PERSONAL COMPUTERS
30739P **$14.75**
Simple instructions show how to give BASIC commands and statements a wide range of applications, from programming video games to developing business or scientific programs.

PROGRAMMABLE CALCULATORS
46008A **$24.95**
This book suggests which calculators to buy, their possibilities and limitations, and the how-tos of programming them.

TAKE A CHANCE WITH YOUR CALCULATOR
39807A **$14.95**
An introduction to modern mathematics, this book deals with programming of programmable calculators and includes probability problems.

AN INTRO TO BASIC PROGRAMMING TECHNIQUES
BP86 **$6.56**
Ideal for beginners seeking to understand and program in BASIC. Book includes program library for biorhythms, graphing Y against X, standard deviations, regressions, generating musical note sequences, and a card game.

BASIC FOR EVERYONE
61481P **$19.75**
349 pages of BASIC information for all purposes.

BEGINNING BASIC
39806A **$19.95**
Intended for beginners, this book discusses how a programmer and a basic computer interact with the computer, problems likely to be met by the beginner, the need for and uses of documentation etc.

FIFTY BASIC EXERCISES
88056A **$17.95**
Designed to teach BASIC through actual practice, this book contains graduated exercises in math, business, operations research, games and statistics. The programs were designed to run directly on a TRS-80 and will run with minor or no changes on any system with Microsoft BASIC.

INSIDE BASIC GAMES
88055A **$19.95**
The medium of games teaches readers how to design error-free, interactive BASIC programs. Rules, algorithms and coding differences for the PET, APPLE II and TRS-80 are also included

MICROSOFT BASIC
39823A **$19.95**
Includes branching and loops, arithmetic in BASIC, strings, editing, arrays and files, the disk and a description of the Radio Shack Level II BASIC.

INTROOUCTION TO FORTH
21842P **$14.95**
The most complete book available on the MMS FORTH version of FORTH, but also a fundamental approach to programming in all versions of FORTH. Many programming examples are provided, with direct comparisons to the Microsoft Level II BASIC version of these programs.

STARTING FORTH
42922P **$23.75**
A clear and complete guide to FORTH, this book covers fundamental principles and then a full set of high-level FORTH commands. It concludes with advanced techniques and style.

A FORTRAN PRIMER
80454P **$6.95**
Assumes no previous knowledge of program writing. It covers the fundamentals of the FORTRAN language, enables extensive program writing and concentrates on programming style.

INTROOUCTION TO STRUCTURED FORTRAN
46007A **$19.95**
Written for the beginner, the text incorporates the new FORTRAN 77 with a discussion of structural programming. Includes a discussion of time-sharing, pseudo language programming and WATFIV statements

MICROSOFT FORTRAN
39846A **$24.95**
An introductory text on FORTRAN in general and Microsoft FORTRAN in particular. The latter is exceptionally well suited for use on microcomputers using CP/M and others of the 8080/8075/Z-80 family

BEGINNING FORTRAN
46011A **$19.95**
Introduces readers to FORTRAN. Included are references for further study, brief tutorials on key punching, flow charting, deck set-ups and matrix algebra.

QWIKTRAN
39824A **$19.95**
Quick FORTRAN for Micros, Minis and Main Frames. Starts with the basic concepts of computing and Qwiktran, a fundamental subset of FORTRAN IV. Lots of examples to increase the reader's proficiency.

THE UCSD PASCAL HANDBOOK
35536P **$23.75**
Language descriptions organised in a quick and easy reference are given in this book for readers with no prior experience of Pascal programming.

INTRODUCTION TO PASCAL
91522P **$19.95**
The second edition of this popular book has been updated to conform to the new international standard of Pascal. The contents illustrate the design and construction of Pascal programs, involving a wide range of basic computer algorithms in a practical context.

PASCAL
46028A **$19.95**
For people with little or no programming experience, this book gives lots of examples that clearly explain proper usage of language features. Discusses top-down programming, debugging, self-documentation etc

THE PASCAL HANOBOOK
88053A **$23.50**
This book summarises the entire Pascal vocabulary, including the variations introduced by different commercial versions of Pascal. All in dictionary format.

PASCAL PROGRAMS FOR SCIENTISTS AND ENGINEERS
88058A **$23.50**
Over 60 of the most frequently used scientific algorithms, along with their program implementation in Pascal, are in this book.

COBOL FOR BEGINNERS
39378P **$21.95**
It is a solid text for introductory programming courses in Cobol, using a format that is easy to understand, yet comprehensive enough to make supplementary readings unnecessary.

STARSHIP SIMULATION
39810A **$11.95**
This book offers both a specific simulation which can be implemented, modified and played, and a complete look at how to put together a simulation on almost any subject.

BASIC PROGRAMS FOR SCIENTISTS AND ENGINEERS
88073A **$19.95**
This book contains scientific and engineering application programs written in BASIC.

COMPUTER GRAPHICS PRIMER
21650P **$21.95**
Almost every page has a colour drawing, photograph, picture or a schematic to help you learn computer graphics quickly and easily. Programming concepts apply to all microcomputers, and examples are given in BASIC for the Apple II.

INTRODUCTION TO TRS-80 GRAPHICS
39818A **$17.95**
It begins with the basic concepts of line drawing and leads the reader on to geometric shapes, moving figure animation and other more advanced topics.

CIRCUIT DESIGN PROGRAMS FOR THE TRS—80
21741P **$21.75**
A number of programs written to aid you in using your TRS-80 and Level II BASIC for the design and analysis of many electronic circuits. The programs analyse information on rms values, periodic waveforms, integrated circuit timers and bipolar transistor circuits.

MOSTLY BASIC: APPLICATIONS FOR YOUR TRS-80 — BOOK 1
21788P **$19.25**
28 ready-to-use BASIC programs which have been completely tested and debugged. Programs include a telephone dialler, digital stop-watch, spelling test, house buying guide, gas mileage calculator, and others. Complete with explanations of each program, sample runs, and complete program listing.

MOSTLY BASIC: APPLICATIONS FOR YOUR TRS-80 — BOOK 2
21865P **$19.25**
32 ready-to-run BASIC programs, including two to test your ability in history and maths, a Dungeon of Danger that's strictly for fun, eleven household programs, seven on money and investment, two to test your ESP level, and more. Complete with explanations, sample run and listing for each program

INTERMEDIATE PROGRAMMING FOR THE TRS-80 MODEL I
21809P **$14.95**
Step-by-step instructions for the TRS-80 user who wants to progress from BASIC to machine and assembly language programming with the TRS-80 Model I system. A complete how-to guide with numerous examples.

...and for good measure...

TRS-80 — MORE THAN BASIC
21813P $15.95
Learn to program in Z80 mnemonics by using the book's error-tolerant interactive monitor program. Over 26 commands available, with total documentation that helps you change the commands to meet specific applications.

TRS-80 ASSEMBLY LANGUAGE MADE SIMPLE
21851P $19.25
If you have an understanding of BASIC programming, this book will help you learn to plan, write and hand-assemble your own assembly language programs in memory, using the T-bug and Level II BASIC ROM subroutines.

PROGRAMMING THE TRS-80 POCKET COMPUTER
30531P $13.25
This book explains all aspects of problem-solving in BASIC, and covers cassette machine interfacing and how to make the best use of the system's keyboard and display.

TRS-80 ASSEMBLY LANGUAGE SUBROUTINES
31188P $19.25
A wide spectrum of applications is discussed in this book, which provides easy-to-use routines that can be used as they stand or modified.

32 BASIC PROGRAMS FOR THE TRS-80 COMPUTER
39827A $29.50
Programs for the TRS-80 Level II or Model III BASIC (with 16K or more user memory).

APPLE BASIC
39099P $19.25
This book gives the beginner a thorough introduction to BASIC programming on an Apple computer, and covers all areas of programming, including graphics, games, mathematical programs, and a great deal more.

CIRCUIT DESIGN PROGRAMS FOR THE APPLE II
21863P $23.75
A series of ready-to-run Apple II programs ideal for electronics design engineers and others faced with solving problems related to plotting and verification of experimental data. The programs may be used as subroutines in larger programs, and many can be translated to run on other microcomputer systems.

APPLESOFT LANGUAGE
21811P $13.95
Written for Apple II micros that use the Microsoft language, this introduction covers each aspect of programming in non-technical language, from elementary concepts to advanced techniques.

APPLE MACHINE LANGUAGE
90230P $21.95
This straightforward book teaches machine language programming through BASIC, the transition being made step-by-step. Many sketches of video displays are provided, as well as exercises with answers.

APPLE PASCAL GAMES
88074A $19.95
Explore all the essential elements of UCSD Pascal and learn the important Apple Pascal extensions.

PASCAL PROGRAMMING FOR THE APPLE
95454P $18.95
This book teaches UCSD Pascal on the Apple II. Many examples, programs for financial applications, graphics, file structures and sound reproduction are supplied.

32 BASIC PROGRAMS FOR THE APPLE COMPUTER
38834A $29.50
Full of programs with practical applications, educational uses, games and graphics.

PET/CBM BASIC
61751P $19.25
This book provides a thorough introduction to BASIC programming on a PET computer, explaining programming concepts for graphics, including three-dimensional letters, bar graphs and the use of sound effects in PET programs.

THE PET PERSONAL COMPUTER FOR BEGINNERS
61827P $20.95
This handy guide is written for use with all varieties of PET computer, from the original 2001 to the new 8032 Super PET. It is suited to novices with no practical experience and provides advice and practical examples.

PET BASIC 1
95524P $19.25
For users of the PET computer, this book covers such topics as creative graphics, humour and interesting small programs.

PET GAMES AND RECREATIONS
95529P $18.85
Presenting an interesting mixture of diversions guaranteed to entertain and educate. Ideal for beginners, yet also challenging to computer veterans, the book features progressive levels of difficulty and five different types of games.

32 BASIC PROGRAMS FOR THE PET COMPUTER
39825A $29.50
Each chapter fully documents a different bug-free program. If readers have a good working knowledge of BASIC, they can devise and implement their own program changes.

THE ATARI ASSEMBLER
90236P $19.25
This practical book gives detailed instructions for using the Atari Assembler cartridge for novices with some knowledge of BASIC programming. Fundamental information programming in assembly language is given.

ATARI GAMES AND RECREATIONS
90242P $19.25
Beginners and advanced users can use the preprogrammed games in this book to improve their skill. Charts, flash cards, an error dictionary and graph paper designs are among the features.

EXPLORE COMPUTING WITH THE TRS-80 (AND COMMON SENSE)
96137P $17.95
This introduction to microcomputers and the BASIC language is suitable for novices and users of the TRS-80. Among the topics covered are creating tables, arts and graphics, games and simulation.

32 BASIC GAMES FOR THE EXIDY SORCERER
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Full of programs with practical applications, educational uses, games and graphics. Each chapter documents a different bug-free program.

THE ART OF PROGRAMMING THE 1K ZX81
BP109 $6.56
This book explains how to use the features of the ZX81 including its random number generator, graphics and timer. PEEK and POKE are explained and you should learn enough to develop programs of your own.

PROGRAMMING THE 6502
88046A $18.95
Principles of assembly language programming for the 6502 microprocessor are taught in this introductory text. Includes a discussion of trade-offs between hardware and software and detailed explanations of the 6502's internal registers and buss operation.

6502 APPLICATIONS BOOK
88015A $17.95
Use this book and a few low-cost components to build a complete home alarm system, an electric piano, a motor speed-regulator, a time-of-day clock, a simulated traffic control system and a Morse code generator, etc.

6502 GAMES
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You learn how to play ten sophisticated games and also learn assembly language programming. Also learn the techniques of algorithm design and data structures.

8080 MACHINE LANGUAGE PROGRAMMING FOR BEGINNERS
39814A $12.95
The book will take the reader step-by-step through the most common 8080 op codes and it will do so at a level anyone can understand.

PROGRAMMING THE Z80
88047A $19.95
This book will enable every reader to write complete application programs for Z80-based computer systems. Includes exercises to measure progress and comprehension at each level of programming.

PROGRAMMING THE Z8000
88072A $19.95
A complete introduction to programming concepts and techniques for use with the 16-bit, Z8000 microprocessor. Presents detailed descriptions of the architecture and functions of this 'super chip'.

START WITH BASIC ON THE COMMODORE VIC 20
97070P $14.75
Helpful exercises and step-by-step instructions show you how to program in BASIC utilising all the graphic functions on the Vic 20.

computing for business

BASIC FOR ACCOUNTANTS
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Shows accountancy students and accountants how to use a computer to perform the repetitive tasks associated with record keeping, calculating and report writing. Using the BASIC language attention is concentrated on debtors, inventory and general ledger systems.

COMPUTER BASED BUSINESS SYSTEMS
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A short introduction to the sorts of systems used by a typical business to handle its typical activities. The book aims at providing a general understanding and therefore avoids technological detail.

THE COMPUTER SOLUTION
80195P $13.50
It should be of interest to business people contemplating, implementing or already using computer data processing or to any non-technical person curious to know why and how computers are used in Australian businesses and organisations.

SMALL BUSINESS COMPUTERS: A GUIDE TO EVALUATION AND SELECTION
81134P $14.95
Ideal for the inexperienced user, this text emphasises management considerations in determining the feasibility, economics, evaluation, selection, contracts and practicality of installing a computer.

SMALL BUSINESS COMPUTER SYSTEMS
81136P $14.95
This book provides a bridge between the accountant and the DP professional by explaining every step of the trading and reporting process in DP terms. It is especially useful to people engaged in the specification process or in auditing DP accounting systems.

THE VISICALC BOOK — APPLE EDITION
98397P $22.25
If you are using Visicalc on your Apple II and want to learn more about its expanded uses then this book will show you how to build a model, enter your data and solve problems about profit/loss projections, pricing/costing estimates etc.

THE CP/M HANDBOOK (WITH MP/M)
88048A $19.95
Containing a step-by-step description of all the CP/M command features, the book progresses to detailed explanations of the file transfer program, the debugging program and CP/M's text editing program.

YOUR FIRST COMPUTER
88045A $12.50
A beginner's guide to small computers, understanding them, buying them and using them for personal and business applications. Includes peripherals, languages and application packages.

DON'T (OR HOW TO CARE FOR YOUR COMPUTER)
88065A $16.95
A guide to computer and peripheral preservation. Specific advice for the computer, floppy disks, hard disks, the CRT terminal, the printer, tape units, the computer room, software and documentation are included.

INTRODUCTION TO WORD PROCESSING
88076A $17.95
Written for the non-technical reader, this book tells about concepts common to all word processing systems, then analyses all features in detail, from screens to scrolling and formatting.

SMALL COMPUTERS FOR THE SMALL BUSINESSMAN
39831A $24.95
The book tells readers how and where to shop for a computer successfully; what to expect their computer to do for them; how to select software; whether or not to use a consultant; how to introduce the computer to the staff and how much computer is necessary.

INVENTORY MANAGEMENT FOR SMALL COMPUTERS
39848A $24.95
Owners of retail businesses and their employees need this book. The program provides an inventory control system so that you know what stock is on hand, where it is located, what price was paid for it and the selling price.

BASIC FOR BUSINESS FOR THE TRS-80
90352P $22.25
This book covers the application of BASIC language to business uses on the TRS-80 models II and III.

FROM THE COUNTER TO THE BOTTOM LINE
39811A $24.95
A demystifying guide to basic accounting needs and computer use. Includes inventory and purchasing, billing, accounts receivable, accounts payable and general ledger.

amateur radio, DX, communications

INTRODUCTION TO RADIO ASTRONOMY
21246P **$8.75**
It gives background information on the structure of the universe, classification of galaxies and radio-wave propagation. It covers in detail reception of extraterrestrial radio signals and their sources and the types of antennas. It also explains how to construct several practical, low-cost radio telescopes.

TUBE SUBSTITUTION HANDBOOK
21746P **$8.75**
Complete, accurate, up-to-date guide to direct substitutes for receiving and picture tubes. Contains over 6000 receiving tube substitutes, over 4000 monochrome and colour picture tube substitutes, and 600 communications substitutes. Also includes pinouts for quick operational checks.

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A practical approach to the design of RF amplifiers, impedance-matching networks and filters. Uses a minimum of complex maths.

COMPUTERS AND THE RADIO AMATEUR
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For the radio operator who wants to know how computers function and how they can be used with other equipment.

SOLID STATE SHORT WAVE RECEIVERS FOR BEGINNERS
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HANDBOOK OF RADIO, TV, INDUSTRIAL & TRANSMITTING TUBE & VALVE EQUIVALENTS
BP2 **$2.25**
Equivalents book for amateurs and servicemen. More than 18 000 old and new valves from UK, USA, Europe, Japan et al. CV (military) listings with commercial equivalents included.

RADIO CIRCUITS USING ICS
BP46 **$4.64**
Describes how ICs can be employed in receivers for the reception of either amplitude or frequency modulated signals. Stereo decoder circuits and the devices available at present for quadrophonic circuits are discussed.

LONG DISTANCE TV RECEPTION (TV-DX)
BP52 **$6.56**
Written by UK authority, the book includes many units and devices made by active enthusiasts. A practical and authoritative intro to this unusual aspect of electronics.

RADIO STATIONS GUIDE
BP55 **$5.92**
This is an aid for all those who have a radio receiver. Shows the station site, country, frequency and/or wavelength, as well as Effective Radiation Power of the transmitter and in some cases, the station's call sign as well.

AN INTRODUCTION TO RADIO DXING
BP91 **$6.56**
One section is devoted to amateur band reception and the other section covers broadcast band reception, with advice on suitable equipment and the techniques employed when using that equipment. The construction of a number of useful accessories is described.

AERIAL PROJECTS
BP105 **$6.56**
Practical aerial designs including active, loop and ferrite which are relatively simple and inexpensive to build. The complex theory and mathematics of aerial design have been avoided.

general

AUTOMOTIVE TUNE-UP AND EMISSION CONTROL SERVICE
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Car owners who wish to save money and maintain their cars at peak performance will learn from this book how to adjust, repair and maintain the systems that ensure best operation.

INTRODUCTION TO AUTOMOTIVE SOLID-STATE ELECTRONICS
21825P **$14.95**
For the professional as well as the home mechanic — explains the functions of most on-board automotive black boxes and logic systems, including anti-skid braking, electronic spark control, diagnostic systems and trip computers.

SECURITY ELECTRONICS
21419P **$11.25**
The principles of operation of the electronic devices used in the various types of security systems are described. Intrusion detection and alarms, object detectors, bugging and debugging devices, computer protection, as well as the planning of systems.

ELECTRONIC SECURITY DEVICES
BP56 **$5.92**
Besides including both simple and more sophisticated burglar alarm circuits using light, infrared and ultra-sonics, this book also gives circuits for gas and smoke detectors, flood alarms, fire alarms, doorphones, baby alarms, etc.

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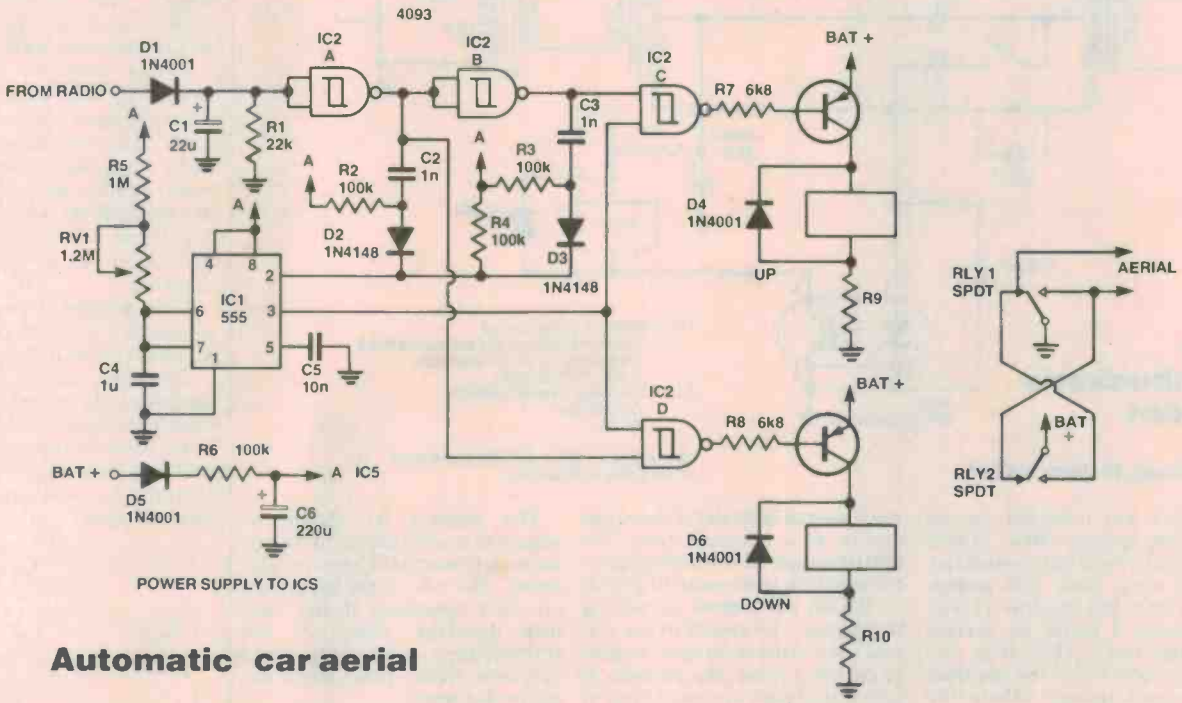
These pages are intended primarily as a source of ideas. As far as reasonably possible all material has been checked for feasibility, component availability etc, but the circuits have not necessarily been built and tested in our laboratory. Because of the nature of the information in this section we cannot enter into any correspondence about any of the circuits, nor can we produce constructional details.



Automatic car aerial

This circuit will impress your friends and deter those dastardly vandals who seem determined to make us drive around with bent coat-hangers for radio aerials, says **Steve Gagen of North Balwyn Victoria.**

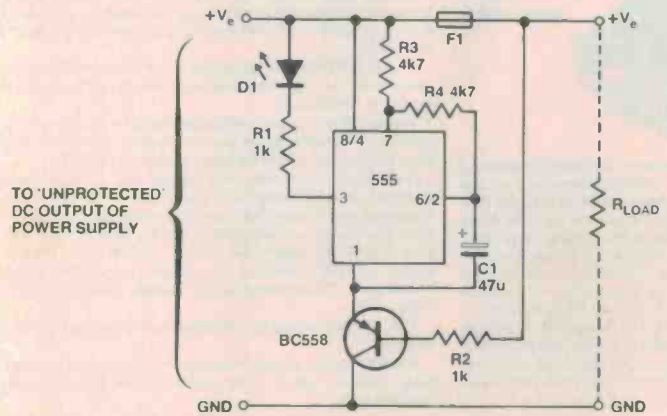
Electric car aerials can be bought quite cheaply, but they require a switch to make the aerial go up and down. You don't always remember to retract the aerial when leaving your car, and that's when the vandals strike.

The circuit takes its signal directly from the on/off switch of the car radio. When the radio is turned on, C1 rapidly charges up, and a negative going pulse from IC2a triggers the 555. The positive signal from the radio gates the 555 to the 'up' relay, turning it on for a time determined by R5, RV1 and C4 (adjustable between 1.1 and 2.4 seconds).

When the radio is turned off, R1 and C1 allow about a five second delay before the aerial retracts. This stops the aerial going up and down as you operate the self starter which cuts power to all accessories in most cars.

The diode-resistor-capacitor network in the IC power supply is to remove transients which may cause false triggering. It should be left connected to the battery at all times, and not wired through the ignition switch. Since the ICs will draw less than 10 mA, battery drain is insignificant. The rating of the relays should be at least 5 A, preferably 10 A, since electric car aerials start with a tremendous current surge.

R9 and R10 should be chosen to suit the relay. I have chosen the wiring for SPDT contacts, but DPST relays could also be used.



Fuse fail indicator

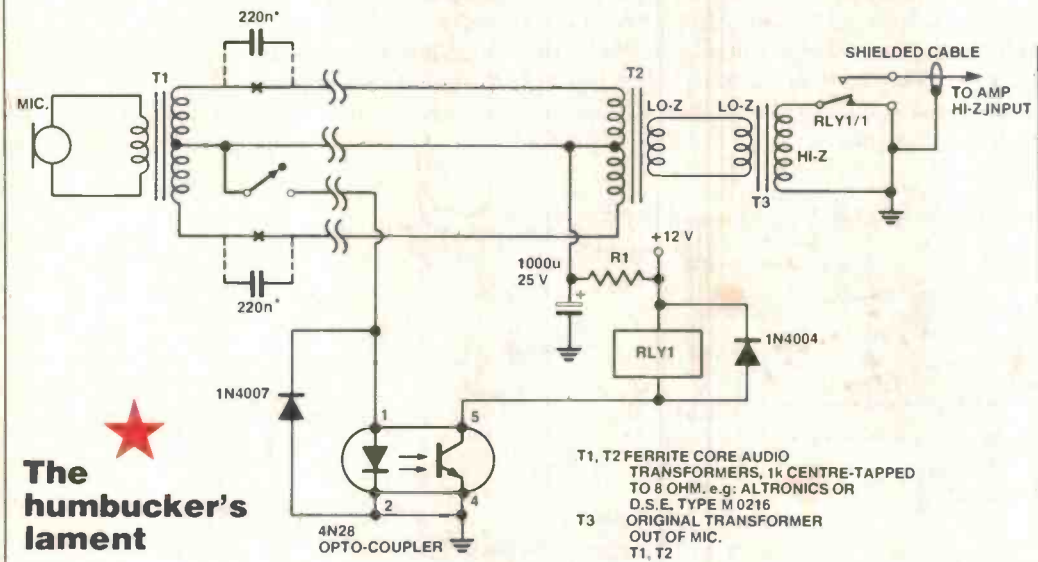
R.N. Sinclair of Coogee NSW sent in this circuit which indicates an open circuit fuse by flashing the LED D1.

The circuit is based around the popular 555 timer IC which is arranged as a multivibrator with its frequency/period determined by C1, R3 and R4. R1 is the current limiter for D1.

When the fuse is intact, the BC558 is off but when the fuse fails and there is an open circuit the BC558 switches on, supplying power to the input of the 555 (pin 1). A load must be present to switch the transistor on and consequently the LED.

The fuse fail indicator must not be used when the power supply is greater than 15 V.

IDEA OF THE MONTH



T1, T2 FERRITE CORE AUDIO TRANSFORMERS, 1k CENTRE-TAPPED TO 8 OHM. e.g: ALTRONICS OR D.S.E. TYPE M 0216

T3 ORIGINAL TRANSFORMER OUT OF MIC. T1, T2

*CAPACITORS ONLY NECESSARY IF HUM LOOPS ARE A PROBLEM.

The humbucker's lament

W.C. Gregg, St. Mary's NSW

This idea was invented 'on the spot' when doing a labour of love at a school. A mic was needed in a remote area, some 200 metres distant from the amplifier. Looking around I found an unused telephone-type cable that ran from the room where the amplifier was located to near where the mic needed to be.

The circuit is pretty well self-explanatory. Two low-to-high impedance audio transformers were used at each end of the cable, driven as a balanced line. The centre-tapped hi-Z windings gave me a dc link to do switching with — it's an old remote signalling technique. The switch in the mic was used to drive an opto-coupler to switch a relay, the contacts of which provided mic switching at the amplifier input. Using a relay switched directly via the line causes hum problems from pickup by the relay coil.

The resistor R1 should be adjusted to give about 10-15 mA current through the opto-coupler input. The two 220n capacitors are only necessary if any hum loop develops. Keep all the transformers away from stray magnetic fields. Don't earth the centre-tap wire.

This system has been used at distances up to 1 km. To the naked ear, there is no degradation in frequency response.

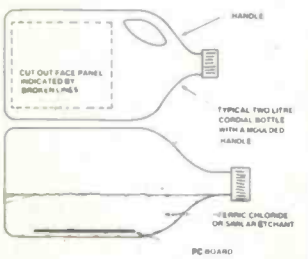
Etching tank

A discarded cordial bottle is a simple, but effective, etching tank as discovered by **N.F. Bush of Canterbury NSW.**

I was recently making up several pc boards and found that I did not have a suitable etching tank. The containers which I have used on other occasions were flimsy and etchant was always spilt all over the place. So I grabbed an old cordial bottle and cut it out as shown on the diagram.

I was amazed at how successful it was as I could move it around and didn't spill a drop.

The used etchant can be discarded easily by unscrewing the lid and pouring it out. There's not much mess to clean up afterwards and the bottle can be washed thoroughly and stored until needed again.



'IDEA OF THE MONTH' CONTEST

NEW PRIZE! WORTH $90!

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Cut out and send to: **Scope/ETI 'Idea of the Month' Contest, ETI Magazine, 15 Boundary St, Rushcutters Bay NSW 2011.**

"I agree to the above terms and grant Electronics Today International all rights to publish my idea in ETI Magazine or other publications produced by them. I declare that the attached idea is my own original material, that it has not previously been published and that its publication does not violate any other copyright*".

* Breach of copyright is now a criminal offence.

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Scope Panavise Multi-purpose Work Centre.

Scope Laboratories, who manufacture and distribute soldering irons and accessory tools, have offered to sponsor a contest with a prize to be given away every month for the best item submitted for publication in the 'Ideas for Experimenters' column — one of the most consistently popular features in ETI. Each month we will be giving away a Scope Panavise Multi-purpose Work Centre, Model 376/300/312, comprising a self-centering head (376), standard base (300) and tray base mount (312), all worth about $90! Selections will be made at the sole discretion of the editorial staff of ETI Magazine. Apart from the prize, each winner will be paid $10 for the item published. You must submit original ideas of circuits which have not previously been published. You may send as many entries as you wish.

RULES

This contest is open to all persons normally resident in Australia with the exception of members of the staff of Scope Laboratories, Murray Publishing, Offset Alpine, Australian Consolidated Press and/or associated companies.

Closing date for each issue is the last day of the month. Entries received within seven days of that date will be accepted if postmarked prior to and including the date of the last day of the month.

The winning entry will be judged by the Editor of ETI, whose decision will be final. No correspondence can be entered into regarding the decision.

Winner will be advised by telegram the same day the result is declared. The name of the winner, together with the winning idea, will be published in the next possible issue of ETI.

Contestants must enter their names and address where indicated on each entry form. Photostats or clearly written copies will be accepted but if sending copies you must cut out and include with each entry the month and page number from the bottom of the page of the contest. In other words you can send in multiple entries but you will need extra copies of the magazine so that you send an original page number with each entry.

This contest is invalid in states where local laws prohibit entries.

Entrants must sign the declaration on the coupon that they have read the above rules and agree to abide by their conditions.

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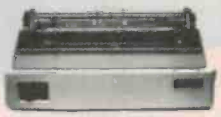

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Signal-to-Noise: –102dB with respect to 1 Volt
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Boost/Cut: 14dB (28dB total)
Distortion: 100Hz-0.007%
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(essentially irrepective of cut or boost)
Current consumption (DC) Approx 100mA @ ± 15V (Requires 30V AC CT)
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Latest addition to the thoroughbred 5000 Series stable! David Tillbrook has once again produced a 'No Compromise' design. This new component, a 1/3 octave equaliser, gives you ABSOLUTE CONTROL over the acoustics of your particular listening enviroment. You get 3 SEPARATE CONTROLS for every octave of audio bandwidth to virtually eliminate the subtle nuances that are particular to your listening area.
1/3 octave equalisers have been used by professional engineers in Recording Studios and live concerts for over a decade now. It is no accident that the advent of the 1/3 octave equaliser and studio quality live sound have gone hand-in-hand. BUT THERE'S A CATCH. One of these equalisers is not enough. You will have to buy 2 (for stereo). Quite a lot of money – but worth it if you want the best.

For those whose budget does not extend to $389, may we suggest the 2010MkIIA octave (10 band) equaliser. This unit is rack mounted and in the same format as the 5000 series equaliser. It is stereo (in one 3½" cabinet) with one slider per octave. Basically an upgrade of the ETI 485 graphic, it represents outstanding value for money at only $139.00.

The Jaycar kit includes a fully prepunched plated chassis, prepunched heavy gauge front panel with silkscreened front panel to match the other 5000 components. It is absolutely original. You can purchase the kits one at a time for $199 ea. or, for two, $389 – a $10 saving. If you are one of the hundreds of happy 5000 users we are convinced that you will be just as delighted with this unit.

BUY 2 AND SAVE $10 – ONLY $389

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Once again, imitation is the sincerest form of flattery. The Black Monolith 5000 Mosfet Power Amp has the following EXCLUSIVE features:
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- SUPERFINISH front panel. STILL THE BEST now with blind tapped holes.
- New heavy duty heatsinks for the driver transistors. 100% extra heatsink area and black anodised for greater efficiency. (Not in original design).
- Ventilation holes in metalwork at critical points. (Not in original design).
- Extra 3 pin DIN socket on rear panel (total 2) to power new 5000 components. (1/3rd Octave 5000 series Equaliser coming soon!). Not in original design but now a must with the new additions in the family.

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Write in (SAE) for a new glossy leaflet on both amps.

SPECIFICATIONS

POWER OUTPUT	Around 100W RMS into 8 ohms
FREQUENCY RESPONSE	8Hz to 20kHz, +0 – 0.4dB 2.8Hz to 65kHz, +0 – 3dB Note: these figures are determined soley by passive filters
INPUT SENSITIVITY	1V RMS for 100W output
HUM	–100dB below full output (flat)
NOISE	–116dB below full output (flat, 20kHz bandwidth)
2nd HARMONIC DISTORTION	<0.001% at 1kHz (0.0007% on prototypes) at 100W output using a ±56V supply rated at 4A continuous
3rd HARMONIC DISTORTION	<0.003% at 10kHz and 100W <0.0003% for all frequencies less than 10kHz and all powers below clipping
TOTAL HARMONIC DISTORTION	Determined by 2nd harmonic distortion (see above)
INTERMODULATION DISTORTION	<0.003% at 100W (50Hz and 7kHz mixed 4:1)
STABILITY	Unconditional

"BLUEPRINT"

5000 PREAMPLIFIER

★

"One Swallow does not make a spring"
– Neither does a few gold RCA sockets!
Several of our competitors are imitating our "Blueprint" preamp by adding a few bits and pieces, notably gold plated RCA sockets to their standard kits. Unfortunately they have missed the point. We supply gold plated sockets in our "Blueprint" preamp but only where it makes sense to do this, i.e. on the inputs – NOT the outputs. 16 gold sockets are provided by us. This, however, does not make a "Blueprint". THIS DOES:
- Low capacitance screened cable - 12 metres of it. NOT Taiwanese cable as supplied in other kits. Our cable costs us NEARLY 5 TIMES MORE than the Taiwanese stuff.
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- Apart from the 16 gold RCA's we throw in a pair of gold plated line RCA plugs – worth $5.
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You can't make a silk purse out of a sow's ear. Send SAE for full specs.

BLUEPRINT $299

★ SPECIFICATIONS

Frequency Response	High level input: 15Hz-130kHz, +0, –1dB Low level input-conforms to RIAA equalisation +0.2dB (see detail on Phono specs.)
Distortion	1kHz 0.002% on all inputs (limit of resolution on measuring equipment due to noise limitation)
S/N noise	High level input, master full, with respect to 300mV input signal at full output (1.2V) 92dB flat 100dB A-weighted MM input, master full, with respect to full output (1.2V) at 5mV input, 500 ohm source resistance connected 86dB flat 92dB A-weighted MC input, master full, with respect to full output (1.2V) and 280uV input signal 71dB flat 75dB A-weighted

ETI-478MM Moving Magnet input stage	
Gain	½, 1kHz
Frequency Response	Conforms to RIAA Equalisation +0.2dB
Total Harmonic Disorder	0.001%, 1kHz, 10mV RMS input
Headroom	28dB with respect to 5mV RMS input signal. Le. 135mV RMS
Noise	Total equivalent input noise, 122nV 'A' input shorted, 216nV flat, input shorted
S/N ratio	1mV 5mV 10mV Flat 73dB 87dB 93dB A-weighted 78dB 92dB 98dB
ETI-478MC Moving coil input stage	
Gain	24
Frequency Response	7Hz – 135kHz +0, –1dB
Total Harmonic Disorder	0.003%, 1kHz, 30mV input
Noise	Total equivalent input noise 83nV flat, input shorted 42nV 'A' input shorted 56nV flat, after RIAA Eq. input shorted 34nV 'A', after RIAA Eq. input shorted

We regret to advise that we have been forced to increase our prices due to sales tax & component cost increases.

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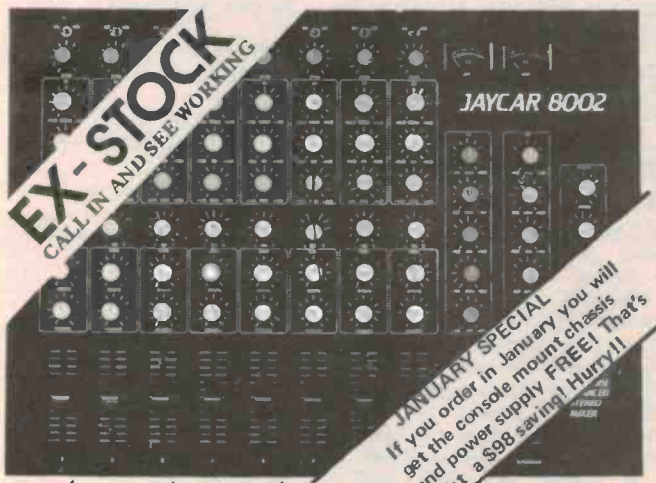

8 CHANNEL MIXER KIT

The Jaycar 8002 Mixer was originally conceived to be the successor to the very popular ETI-414 Master Mixer. The 414 was basically configured as a 'stage' mixer and suffered from a number of severe technical limitations – notably poor signal-to-noise figures. Enormous advances in Audio IC's have occurred since the 414 was designed. Jaycar engineers have taken advantage of this. The incredibly low noise and distortion figures of the 8002 are a testimony to the sound basic design of the mixer coupled with the performance capability of these IC's. Whilst the 8002 is the ideal 8 channel compact stage mixer, other applications have been kept in mind.

AS A "STUDIO" MIXER. The prime requirement of a studio mixer is that it must be quiet – i.e. have good S/N. Due to the fact that the "miracle" 5534 IC's are used in the 8002 studio applications are entirely feasible. In addition to this, metal film resistors are used in critical signal areas.

AS A DISCO MIXER. The balanced input feature of the 8002 is not really necessary for disco use. This section can easily be bypassed with either a moving magnet (Dynamic Cartridge) preamp, or a moving coil preamp The sensible format of the 8002 and tremendous equalization facilities should make this mixer popular for disco use.

- Balanced (600 Ohm) Mic. Inputs/Line Inputs.
- Cannon Connectors included in the price.
- Bass, Mid & Treble Equalization on each Input.
- "Effects" (i.e. Echo etc.) capability.
- Foldback and Stereo Pan on ALL 8 Inputs.
- 60mm Slide Faders used throughout.
- 19" Rack Mount capability (or Console Mount).
- Professional Black Front Panel with Format borders & multi-coloured knobs to assist function identification.
- VU Metering.

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COMPLETELY BUILT AND TESTED – NOT A KIT!!

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JANUARY SPECIAL

Because January is a "slow" month we've slashed $20 off the very popular "Voyager" Car Computer! Hurry! This month only!

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- INSTANT FUEL CONSUMPTION IN LITRES/100KM AND MPG!! (MOST OTHERS HAVE ONLY ONE OF THE ABOVE) JUST SWITCH FROM ONE TO THE OTHER AS YOU DRIVE ALONG.
- INSTANT SPEED, TIME AND OTHER FUEL DATA.
- VISUAL AND AUDIBLE EXCESS SPEED ALARM.

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'super siren'

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SHOPAROUND

This page is to assist readers in the continual search for components, kits, printed circuit boards and other parts for ETI projects and circuits. If you are looking for a particular item or project and it is not mentioned here, check with our advertisers.

ETI-488 60 W amplifier

Professor Cherry's practical realisation of the nested differentiating feedback loop technique he discussed in the October and November issues. This project employs readily available components throughout, even the MJ802 and MJ4502 output transistors are widely available.

At the time of going to press, two firms had indicated they'd be stocking kits. In Sydney, it'll be **Jaycar**; in Melbourne, **Rod Irving Electronics**. You might also try **All Electronic Components** in Melbourne.

If you're hunting up components, most are common stock items in electronics suppliers. The **MJ802** and **MJ4502** are available from **All Electronic Components, Billco** (on order at press time), **Magraths** (now in A'Beckett St, Melb.), **Raycross, Rod Irving Electronics** and **Ellistronics**. **Radio Parts** have the MJ4502 in stock, but not the MJ802. Artwork for the pc board can be obtained by sending a stamped self-addressed, A4-sized envelope to:

ETI-488 pc board
ETI Magazine
15 Boundary St
Rushcutters Bay NSW 2011.

ETI-905 polyphonic organ

Serenade your sweetie as the sun sets slowly o'er the sea — or somesuch! Kits for this one will be available from **Altronics** in Perth, **Rod Irving Electronics** in Melbourne and **Jaycar** in Sydney. No special components are used — but take heed of our notes on the pc board if you're contemplating doing the board yourself. Artwork can be obtained by sending a stamped, self-addressed, A4-sized envelope to:

ETI-905 artwork
ETI Magazine
15 Boundary St
Rushcutters Bay NSW 2011

ETI-334 Auto-tester

Just the thing to keep in the glovebox or toolkit. This one uses all standard, off-the-shelf parts so you should experience little trouble shopping around for those bits you don't have in your junkbox. Kits will be stocked by **Electronic Agencies** in Sydney, **Rod Irving Electronics** and **All Electronic Components** in Melbourne.

ETI-1510 points controller and remote indicators

This project is a follow-up to the ETI-1508 Model Railway Controller published in the last issue. It comprises two parts: a points controller capacitor-discharge power supply board and a remote indicator board. There's nothing unusual about any of the parts used, so if you care to make your own boards, the electronic bits should be available from your friendly local electronics shop. However, as a number of kit suppliers are stocking last month's train controller (in one form or another), the same suppliers will be carrying the two ETI-1510 units as kits. These are: **Altronics** in Perth, **Electronic Agencies** and **Jaycar** in Sydney, **Rod Irving Electronics** and **All Electronic Components** in Melbourne.

Ritronics moves to city

Ritronics Wholesale, a division of Rod Irving Electronics, now occupies the premises at 48-50 A'Beckett St, Melbourne, just next door to the Oxford Hotel (ah, sweet memories of studentship at the Royal Melbourne Institute of Technology, just across the road. The Oxford provided a much-needed escape from the boring round of lectures and lecturers).

It seems that Melbourne's A'Beckett street, what with Magraths and Ritronics moving in, is starting to become a southern reflection of Sydney's York St, where no less than five electronics retailers are lined up cheek-by-jowl right in the heart of the city. Who next among Melbourne's famed electronics retailers will move into what is obviously a prized address?

Printed circuit board and panel suppliers

Almost every pc board ever published by ETI may be obtained from the following suppliers:

All Electronic Components
118 Lonsdale St
Melbourne Vic. 3000

RCS Radio
651 Forest Rd
Bexley NSW 2207

Panels, meter scales and dial faces may be obtained from:

E.D.C.
17 Elizabeth Ave.
Dulwich Hill NSW 2203

For pc boards produced over the past three to five years, the following suppliers generally keep stocks on hand:

Electronic Agencies
115-117 Parramatta Rd
Concord NSW 2137
and
117 York St
Sydney NSW 2000

Radio Despatch Service
869 George St
Sydney NSW 2000

Rod Irving Electronics
425 High St
Northcote Vic. 3070

James Photronics
522 Grange Rd
Fulham Gardens SA 5024

Jamal Products
P.O. Box 168
Victoria Park WA 6100

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McDougall Rd
Sunbury Vic. 3429

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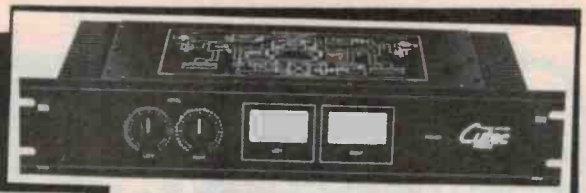
Rectangular Red Leds **18¢** each. Red—5mm LEDS from **12¢** each
Fujitsu 2716 2K x 8 EPROM **$5.40.** 2732 32K ROM 300 N/S **$7.60**
8116 16K DYN. RAM 200 N/S **$2.10**

ALL PRICES INCLUDE TAX

Jumbo Sale



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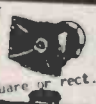
SPECIFICATIONS:
60 + 60W RMS at 8 ohms, 90 + 90W RMS at 4 ohms, 160W RMS MONO 8 ohms
Frequency Response: 20-50KHz — Signal to noise ratio: 100dB
Damping factor: over 45 — Total harmonic dist: less than 0.03%
Input sens: 0-0.5dB at 0dB-1V — Cross modulation dist: less than 0.03%
Input Imp: 40K ohs (600 ohs line) — 240V AC input.

60 WATT HORN TWEETERS



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JVC to other models, length 1.5m	$7.85
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6 pin din plug to 6 pin din plug, length 1.5m	$4.50
5 pin din to 5 pin din, reverse pins for video use	$3.95
5 pin 180 deg. dubbing adapter, reverses pins	$5.95
10 pin video camera male plug- suit VHS	$9.95
10 pin video camera female line socket- suit VHS	$9.95
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14 pin video camera female line socket- suit BETA	$14.50
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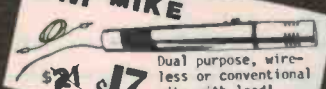

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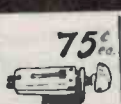

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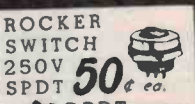

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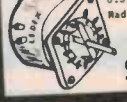

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Made in Sweden by TRANSDUKTOR **$15**

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Monitors over 33,000 frequencies from 26 to 88 MHz, 108 to 180 MHz and 380 to 514 MHz. Bands included within this range are HF and UHF CB, 27 and 155 MHz MARINE, Australian LOW BAND, AIRCRAFT band, VHF SATELLITE band, 10 Mx, 6 Mx, 2 Mx and 70CMx AMATEUR BANDS, VHF High BAND as well as UHF two-way band.

Mechanically rugged the SX-200 uses high quality double-side Epoxy-Glass printed circuit boards throughout. Some of its other outstanding features include 3 MODE SQUELCH circuitry which allows the lockout of spurious and carrier only signals, extremely low spurious count, AM and FM detection on all bands, FINE TUNING control for off channel stations, 240 VAC on 12 Volt DC operation, Accurate QUARTZ CLOCK, Squelch operated OUTPUT for switching a tape recorder etc, 16 Memory channels, MEMORY BACKUP which lasts up to two years, high SENSITIVITY and SIGNAL-TO-NOISE ratio on all bands, CRYSTAL FILTER for excellent SELECTIVITY and easy servicability due to component layout as well as a 90 day warranty.

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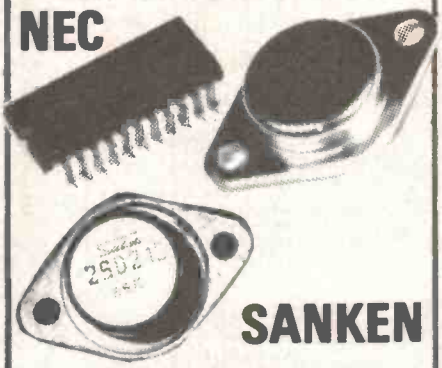

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New amateur bands gaining ground, but some losses

British amateurs have been granted the use of 18 and 24 MHz, but some have lost the use of 431-432 MHz while US amateurs have at last been granted use of 10 MHz. Also, British Class A licence holders can now use 50-52 MHz.

British amateurs were granted use of the 'new' 18 and 24 MHz bands, established by WARC '79, on 1 October '82 on a non-interference basis. Operation is CW (A1A) only, maximum antenna gain in any direction is limited to 0 dB over a dipole, horizontal polarisation only. Power is limited to 10 W to the antenna. Band limits are 18 068 — 18 168 kHz, and 24 890 — 24 990 kHz.

The sub-band 431-432 MHz has been allocated to private mobile radio services in the London area and UK amateurs have been requested to volantarily vacate this segment within 100 km of central London.

However, in a surprise move, the British Home Office has *released the use of 50-52 MHz to a limited number of* Class A licencees *for research purposes* outside broadcasting hours on a non-interference basis (i.e: night time).

US amateurs were granted use of the 'new' 10 MHz band on 28 October '82. Those holding General, Advanced or Extra Class licences can use CW and RTTY from 10 100 kHz through 10 150 kHz, except for the segment 10 109-10 115 kHz which is withheld for government services in the US. Maximum power permitted US amateurs on the band is 250 W input to the final transmitter stage, not including valve filaments.

UHF-SHF switches

Addington Microwave Components and Semiconductors has available solid-state single-pole multi-throw switches with octave and greater bandwidths operating within the frequency range of 0.5 to 18.0 GHz.

These units are designed to operate under stringent military environmental conditions and are used extensively in EW, ECM, communications, and missile applications.

Integral drivers, which are TTL compatible, are available as an option.

Contact Eaton Corporation, Addington Microwave Components & Semiconductors, 680 West Maude Ave, Sunnyvale CA 94086, USA.

New frequency counters

A new range of compact, portable, high accuracy solid-state frequency counters, with crystal controlled timebases is now available from Global Specialties Corporation.

Bringing laboratory accuracy to the workshop or field, the three frequency counters consist of:

Max 100 — 100 MHz frequency counter. It measures 5 Hz-100 MHz and features an easy-reading, bright eight-digit LED display, direct reading with 1 Hz resolution. The Max-100 comes complete with clip lead input cable. Take it anywhere, run it on internal rechargeable batteries or from your car cigarette lighter socket or any external 7.2-12 Vdc supply.

Max-550 — a wide range, 1 kHz counter in a claculator-sized case.

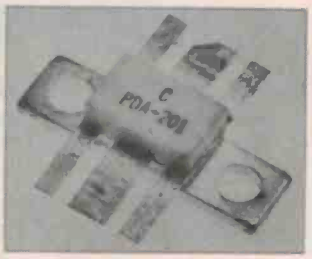
The Max-50 — provides economy and precision in a pocket-sized instrument and measures 100 Hz-50 MHz.

Any frequency counter of 50 MHz can have its range extended up to 500 MHz and above by using the PS-500 prescaler.

It features a BNC input connector, diode protected 50 ohm input, and claimed 250 mV sensitivity from 50 to 500 MHz. Its output is quoted as minimum 400 mV (peak-to-peak) capacitively coupled, available at a phono jack connector. Direct or 10 prescale outputs are switch selectable.

Power is supplied to the PS-500 through a coaxial dc-type power connector.

Global Specialties Corporation is represented in Australia by Vicom International Pty Ltd, 57 City Road, South Melbourne Vic. 3205. (03)62-6931.



Unique 1 GHz hybrid power amp chip

Communications Transistor Corporation has produced a device described as a 'universal building block' for medium power RF circuit operation at frequencies up to 1 GHz and power level to +27 dBm.

Designated PDA 201, the device is a differential amplifier employing three matched 1 W/3 GHz transistor chips housed in a beryllium oxide stripline package for efficient heat dissipation.

Differential amplifiers are used as building blocks for most small-signal linear integrated circuits. But Communications Transistor Corp saw a need for a differential amplifier that could handle large signals at high frequencies and perform many circuit functions that are difficult and costly to implement with discrete components.

The 201 provides tightly matched and thermally coupled active elements for stable operation and excellent common-mode rejection. It can be combined with a few external components to solve many rf design problems, such as:

- Wideband amplifiers covering several octaves.
- Class A linear amplifiers with very low intermodulation distortion.

Minimum gain is specified as 25 dB with a 4 dB noise maximum, though typical figures are 28 and 3.5 dB. Maximum operating voltage is 18 V and source current is 250 mA maximum (the other figures cited here represent operating conditions of 200 mA with a 15 Vdc supply). Output compression of 1 dB does not occur until output reaches 26 dBm, and the third-order intercept is typically at 40 dBm.

The PDA 201 hybrid circuit is available from stock for a price of US$50 each in 100-piece lots. CTC is a subsidiary of Varian **Associates, 301 Industrial Way, San Carlos, Calif. 94070 USA.**

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50 watt max. power 8 OHM Z.

Amazing performance budget price. Frequency response 2 KHZ-18 KHZ. 110mm Diam. Hole centres 79mm. Australia's best value at this price.

C 3020 . . . . . .$7.50
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DOME TWEETER 60 WATT
60 watt max. power.

Silky smooth frequency response. 1.5 KHZ to 20 KHZ. Wide Angle dispersion. Massive power handling capacity. Diam. 94mm. *High spectrum. Purity. incredible low price!*

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MIDRANGE 50 WATT
Midrange clarity that has to be heard to be appreciated!

Absolutely 1st class reproduction of mid-range - piano, vocal, guitar, violin etc. **Huge 50 watts max. input.** 8 OHM. Frequency response 700 - 5 KHZ. *Value Plus!*

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WOOFER 307 mm (12 in.)
40 watts max. power 8 OHM.

Roll edge cone suspension. Resonant fo 30 HZ. Frequency range 30-2 KHZ. Smooth faithful bass speaker. **Ideal Hi-Fi replacement.** 48mm voice coil.

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OUR POWER RATINGS are conservative RMS ratings NOT music power or peak power ratings that some manufacturers quote.
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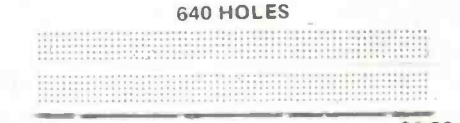

P 1005 . . . . . $9.80

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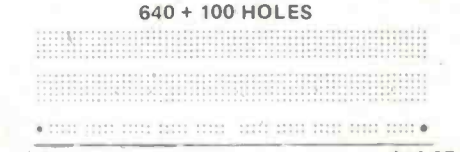
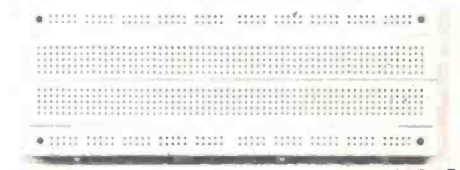


P 1007 . . . . . $11.95

640 + 200 HOLES



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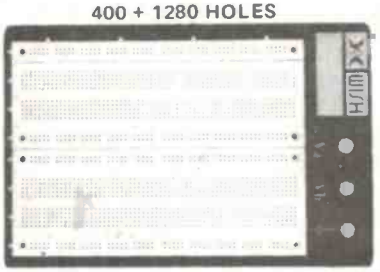

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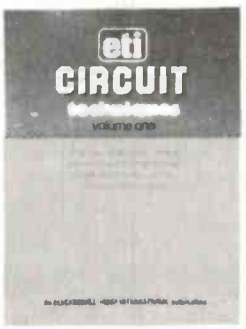

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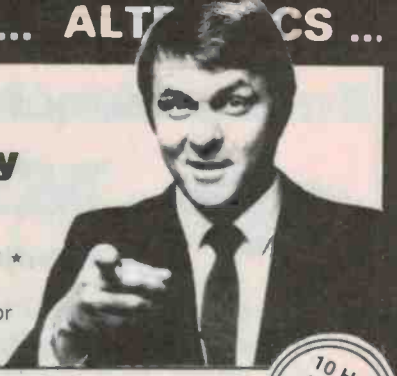

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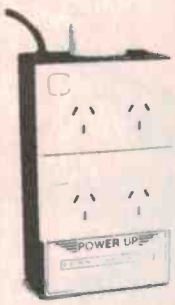
Jack O'Donnell

See EA November, 1982



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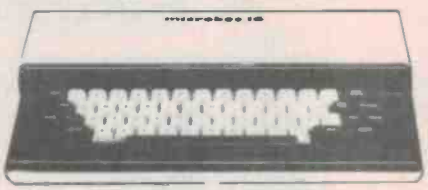
SPECIFICATIONS

• Vertical deflection	
Sensitivity	5mV/div to 5V/div ·5%, 10 calibrated steps 1mV/div to 1V/div ·6% (When using ×5 amplifier) Uncalibrated continous control between steps 1 - 2.5 (provided with click-positioning function)
Bandwidth	DC to 15MHz, -3dB (at 4div) DC to 7MHz, -3dB (at 4div) (When using ×5 amplifier)
Rise time	24ns, (for ×5) 70ns typ
Signal delay line	
Max. input voltage	600Vp-p or 300V (DC + AC peak, at 1kHz),
Input Coupling	AC, GND, DC
Input impedance	Direct 1M ohm, approx. 30pF
Operating modes	CH1, CH2, DUAL, ADD, DIFF
X-Y operation	
Sensitivity	CH1 X axis, CH2 Y axis 5mV/div to 5V/div (when using ×5 amplifier, 1mV/div)
Phase difference	DC to 10kHz within 3
X bandwidth	DC to 500kHz -3dB
Dynamic range	4div or more
CH1 output	
Output voltage	20mV/div or more (terminated into 50Ω)
Band width	50Hz to 5MHz, -3dB
Output impedance	Approx. 50Ω

• Horizontal deflection	
Trigger modes	AUTO, NORM, TV (+), TV (-)
Trigger source	CH1, CH2, LINE, EXT
Trigger coupling	AC
TV sync	TV sync-separation circuit
Internal	1div or more (V sync-signal)
External	1Vp-p or more (V sync-signal)
Trigger sensitivity	Frequency / Internal / External 20Hz to 2MHz / 0.5div / 200mV 2 to 15MHz / 1.5div / 800mV
AUTO low bandwidth	30Hz
Trigger slope	
External trigger input	Input impedance approx. 1M ohm, 30pF or less
Sweep time	Max. input voltage 100V (DC + AC peak, at 1kHz) 0.2μs/div to 0.2s/div ·5%, 19 calibrated steps Uncalibrated continuous control between steps 1 - 2.5 (provided with click-positioning function)
Sweep time magnifier	10 times (·7%)
Max. sweep time	100ns/div (20ns/div and 50ns/div, not calibrated)
• Amplitude calibrator	
Waveform	Approx. 1kHz ±10% (typ), square wave
Voltage	0.5V ±5%
• Power requirements	100/120/220/240V ±10% 50 to 60Hz, approx. 40W
• Dimensions	Approx. 275(W) × 190(H) × 400(D)mm
• Weight	Approx. 8.5kg

The Famous Microbee Microcomputer in stock now at Altronics



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★ 32-64K UPGRADE PACK ★

Cat D1045 . . . . . $175.00

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SPECIFICATIONS OF THE MPF-II

CPU		R6502
ROM		16K Bytes
RAM		64K Bytes
BASIC Interpreter		More than 90 instructions stronger than those for Apple II.
Video Display	Type	Memory mapped into system RAM.
	Mode	Text low resolution graphics, high-resolution graphics (three modes are mixed).
	Screen Format	960 characters (24 lines, 40 columns).
	Character Type	5 x 7 dot matrix.
	Character Set	Upper case ASCII, 64 characters.
	Graphics Capacity	1920 blocks (low resolution) in a 40 by 48 array. 53760 dots (high resolution) in a 280 by 192 array.
	Numbers of Colors	6 colors.
Keyboard		49 alphanumeric and function keys.
Cassette Interface Software Cartridge Interface		Use various cassette tapes and cartridges as data-storage units.
Printer Interface		Connects to printers with Centronic Interface.
Display Interface		Connects to color home TVs or video display.
Remote Control Paddle		Used for education & entertainment.
Speaker		8Ω, 2¼ inches, 0.25W
Power		A switching power supply is provided to convert AC power to required power supply.
Dimensions		9.84 x 7.16 x 1.24 inches

- You can use the MPF-II in the home, school, engineering applications or just for fun.
- The MPF-II can be connected to any colour TV and cassette recorder.
- Options include video monitor, thermal printer, full size keyboard remote control pad, RS 232C Interface board, Floppy Disk Drive, speech synthesiser board, sound generation board, Chinese character controller and a host of software cassettes and cartridges.

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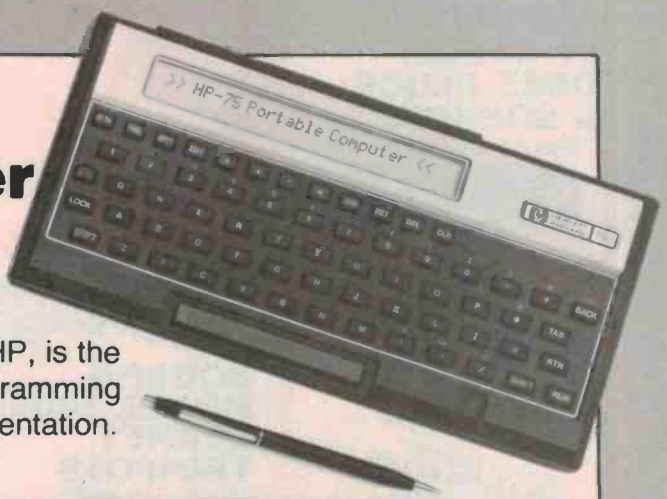
New portable computer from Hewlett-Packard



This new personal computer, the first of its kind from HP, is the size of a notebook and features BASIC language programming power and software such as VisiCalc and graphics presentation.

The HP-75C functions as a portable computer by itself, as part of a portable system with compact briefcase peripherals or as a desktop personal system. It measures 254 mm x 127 mm x 32 mm and weighs only 737 grams. It has the ability to run on batteries and retain memory while turned off. It is powered by three rechargeable nickel cadmium batteries which are good for two to three weeks of normal use.

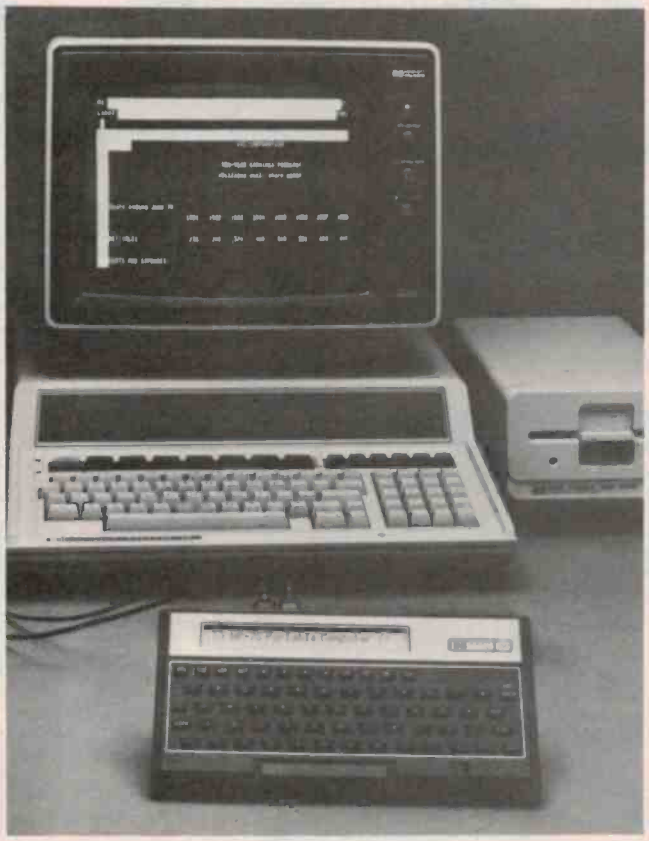
The HP-75C features 16K RAM built-in which can be increased to 24K with the plug-in 8K memory module. Three plug-in ports accept 8K or 16K ROM modules and there's a 48K ROM built-in operating system. The operating system features 169 instructions of which 147 are BASIC commands, statements or functions.

A built-in Interface Loop (HP-IL) allows communications with instruments, peripherals such as printers or graphics plotters and other computers. Touch-typing is possible on the typewriter-like keyboard. A 32-character, liquid crystal display serves as a movable window on a 96 character line and features character descenders.

The HP-75C has a manually operated mass storage system consisting of long, thin strips of magnetic card which you pull through a magnetic card reader. These cards provide 1.3K of storage each.

Software available is for specific applications such as engineering, math and statistics and general solutions such as electronic spreadsheets and graphics presentations.

For further information contact **Peter Delbridge, Hewlett-Packard, 31-41 Joseph St, Blackburn Vic. 3130. (03) 890-6351.**



Loan helps build super microcomputer

A $700 000 loan from a State instrumentality will help a Melbourne company manufacture a locally designed microcomputer which is claimed to be technologically years ahead of international competitors.

The loan from the Victorian Economic Development Corporation is one of the largest it has given and is in accordance with the Government's policy to encourage the development of high technology industries in Victoria.

The computer, known as Unison, will be manufactured by L & L Australia Pty Ltd at its new Kilsyth plant and was designed by Mr. Bill Hollier, a computer scientist from Melbourne University.

Unison will be available in three basic forms. In its largest and most expensive form it is the size of a suitcase and can accept input from 32 screens and can perform instructions at a speed approaching that of the large mainframe computers. It is regarded as the start of the next generation of microcomputers in that it takes up the same space as existing micros while its performance is compatible with the larger mini computers.

The company plans to manufacture 5000 units a year and it is aiming to sell to the education and scientific markets, offering special financial incentives to schools.

As to what the capabilities and features of the computer are, that is left to your imagination, as the Victorian Economic Development Corporation did not give us any information. So we don't know whether it is as good as they claim it to be. ■

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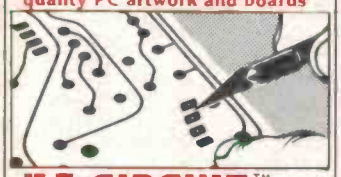

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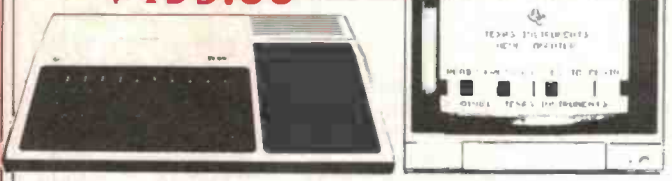
TI PERSONAL HOME COMPUTER

TI-99/4A

$499.00 INCLUDES SALES TAX



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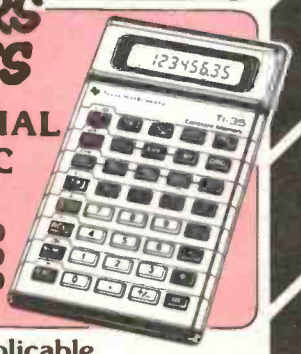

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*4511B	69c	81LS95	87c	LM741 DIP	36c
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welcomehere

Microprocessor design tools and selection seminars

Tektronix has announced a Microprocessor Design Tools seminar which will focus on the hardware and software tools required to develop the microprocessor for a particular application.

The one-day seminar will cover the usage of Universal Development Systems with software tools like PASCAL language directed editors, compilers and debug. The UNIX operating system and hardware tools such as high speed transparent emulators and universal logic analysers will also be discussed.

The seminar will be a full-day event, held in Sydney on February 22, and in Melbourne on February 8, and is intended for engineers and managers engaged in wrestling with the ever-increasing task of developing products or devices using microprocessors. A fee of $30 per person will cover a luncheon and a set of seminar materials. For further information please contact Sonya Stokell in Sydney (02)888-7066 or Jill Scott in Melbourne (03)813-1455.

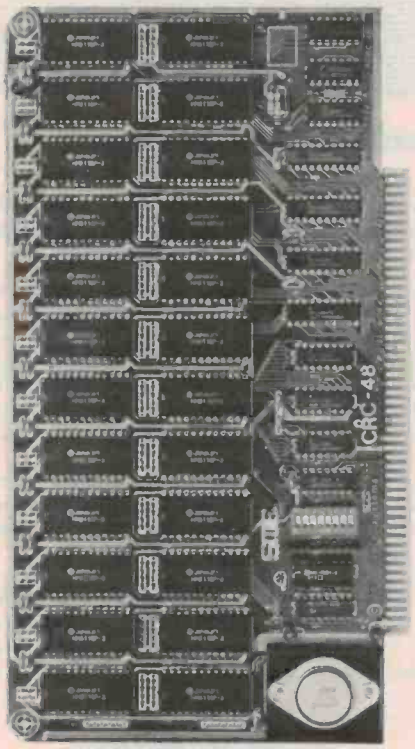
Tektronix is also conducting a series of one-day seminars on how to select the right 8- and 16-bit microprocessor for your application. The topics discussed will cover Fabrication Technology, Chip-Architecture, Development Tools and other selection criteria.

The seminars are intended for: decision makers who need to know what the microprocessors can do and how to better understand the chip selection process; experienced engineers who need to quickly learn the internals of a micro and how it affects the selection process; less experienced engineers who are suddenly thrust into the task of developing hardware or software and must make the best decision on which microprocessor to use.

Each seminar will be a full-day event and will be held in Adelaide on February 15, Perth on February 17 and Brisbane on March 1. A fee of $30 per person will cover a luncheon and the seminar materials. For further information and venue details contact Angie Witthaus in Adelaide (08)223-2811, Anna Kudray in Perth (09)325-8433 or Julie Bow in Brisbane (07) 394-1155.

This board won't forget

SME Systems have a new CRC-48 48K CMOS static memory card, a fail safe memory system that retains data when power is removed from the board.



The board is designed for use in high speed 6-8 MHz computer systems. With full S100 buss compatibility the CRC-48 fits in with other SME Systems S100 products. An on board battery is used to retain power to the CMOS memory devices whenever the system is powered down for any reason.

A major feature of the CRC-48 board is its exceptionally low power consumption. In a power failure situation memory retention to a full complement of 6116 devices is typically around 250 hours on the inbuilt 30 mA/hr battery.

Because CRC-48 uses only 48K of memory, the board can be bank switched in or out completely. Flexibility is offered by the board in its ability to use both EPROM and static memory on the one board.

SME Systems are at 22 Queen St, Mitcham Vic. 3132. (03)874-3666. ▶

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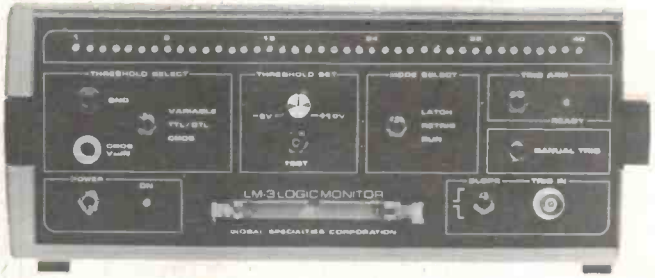
Triggerable logic monitor

The LM-3 triggerable logic monitor from Global Specialties Corporation is a new type of logic test instrument.



It combines 40 variable precision-threshold logic-state indicators with a highly flexible triggerable latching circuit in a single benchtop package. The variable-threshold facilities allow the LM-3 to monitor up to 40 logic points simultaneously on any type of circuitry, while the different triggering modes mean that the LM-3 can be used to follow logic states or 'freeze' the display in different ways to examine a particular circuit condition.

The LM-3 is supplied with a 40-conductor ribbon cable terminated with 40 coded 'easy-clips' that fit on to the circuit pin, test point, breakpoint or buss-line combination being tested, and 40 discrete light-emitting diodes on the instrument's front panel indicate the logic state of each point.

Input impedance is 500k at 6pF and the instrument works at up to 5 MHz and can capture 100ns events.

Four operating modes are provided on the LM-3. Apart from the normal 'run' mode there is a 'retrig' mode where the display follows the data until a switch-selectable rising or falling edge appears at the trigger input and then latches until the next selected edge appears. In the 'latch' mode the display follows the data and ignores the trigger input until the instrument's 'arm' button is pressed, when the next trigger input will latch the display. In addition, both 'retrig' and 'latch' modes can be used with a manual pushbutton.

Global Specialties Corporation is represented in Australia by **Vicom International Pty Ltd, 57 City Rd, South Melbourne Vic. 3205. (03)62-6931.**

Alfatron has winchester drives

Alfatron has announced that it has the rights to distribute the NCL hard disk drives from Japan.

These Winchester drives are claimed to offer a very low cost entry to the microcomputer user into fast access, high capacity disk drives. The interfaces currently available are the GPIB and Multibus.

The current model is a 10M unit and it is expected to have higher capacity units available soon.

The SA-700 analyser available from Alfatron, features emulation of CPU, EPROM programmer (2716 — 27128) and a standalone computer.

It can accept diskettes from a wide variety of other machines (including MDS) and as it has a hardware control program, is able to emulate user programs in real time. Programs may also be downline loaded via an RS232 serial port.

More information is available from **Alfatron Pty Ltd, Industrial Electronics, 1761 Ferntree Gully Rd, Ferntree Gully Vic. 3156. (03)758-9551.**

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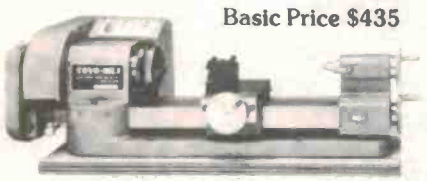

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The MINI DRILL comes in two models, MINI DRILL I, a standard speed drill offering 6 speeds from 850-3100 rpm, with a 6.5mm drilling capacity. Weight 5.4kg, ideal for model makers, instrument and repairers, etc. The high speed MINI DRILL IH has 2 speeds 8,000 + 12,000 rpm with a drilling capacity from No. 80 to 6.5mm and weighs 5.4kg, is suited for drilling printed circuit boards etc.

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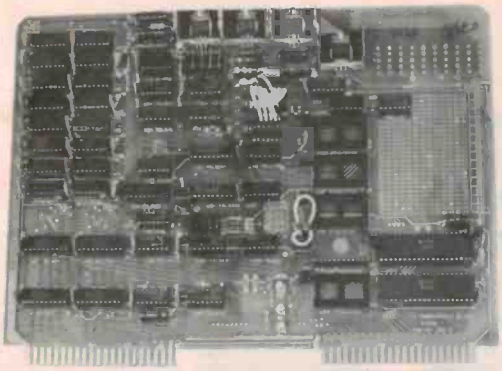

The Computerist Inc products

The Computerist Inc US has released a 6809 microcomputer system based on their range of microcomputer boards. Called the 'Focus' system it incorporates Flexi Plus, Dram Plus and Video Plus, together with 640K on dual 5¼-inch DD DS disk drives.

The system features an integral EPROM programmer, RS232 interface and 20 mA ports, six 8-bit parallel I/O ports, up to 132 x 30 display and optional IEEE 488 interface and additional RS232 interface. Available software includes TSC Flex and Extended BASIC. The system is also available in an OEM configuration in an economical three slot card cage.

The Computerist Inc. has also released a 128K RAM version of the 32K Dram Plus. Designed for Rockwell AIM65, Synertek SYM-1 and Computerist Flexi Plus expansion, it retains the features of four byte wide EPROM/RAM sockets for a maximum of 32K, 16K/32K EPROM programmer, Dual 6522s for four 16-bit timers and 40 programmable I/O lines, quality through plated hole, solder mask, silk screened pcb, and wire wrap area. An improved bank select feature has also been provided. More information is available from **Energy Control, P.O. Box 6502, Goodna Qld 4300. (07)288-2757.**

Toshiba's personal computer

The T100, now available from Toshiba, is equipped with 64K RAM, 32K ROM for BASIC language and 16K video RAM as standard memory units.

Up to two ROM and RAM packs the size of an audio cassette tape can be installed inside the T100. These options each have 32K of memory. By installing a ROM pack and cutting off the BASIC of the built-in ROM of the CPU, you can use the languages, operating system and applications stored in the ROM pack. The RAM pack can be used as a program file and data file. The RAM pack, even if removed from the unit, stores programmed data for one year.

The T100 provides very high resolution graphic displays on its eight colour CRT, which presents an array of 640-dot horizontal lines and 200-dot vertical lines.

More information can be obtained from **Toshiba (Aust) Pty Ltd, Talavera Rd, Nth Ryde NSW 2113. (02)887-3322.** ■

Club Call

The Zebra-Xray 80 newsletter and the Australasian ZX Users newsletter have merged into what is now known as the Australasian ZX Users Newsletter. The editors are Paul Janson and Tony Mowbray and they can be contacted at P.O. Box 397, Dapto NSW 2530.

This year the cost of subscription to this newsletter is $15 or $2 for a single issue. The first four issues of Zebra-Xray 80 are still available for $7 or $2 for a single issue.

Subscription price of Vol 3 (82) of this newsletter will be $10 which covers nine issues and includes all postage costs.

The Melbourne Atari Computer Enthusiasts (MACE) Group is a strictly Atari 400/800 personal computer user group. It has just over 100 members in all states of Australia and New Zealand. A newsletter called the Australian Atari Gazette is sent to members each month.

Meetings are held on the first Sunday of each month at 12 pm at 3M Australia, cnr of Blackburn and Ferntree Gully Roads, Melbourne, where the latest software and hardware from around the world is shown.

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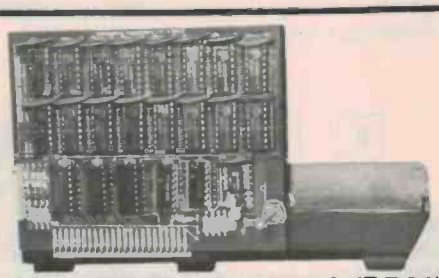

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VEN 0261

Fault-finding the ETI-660 Learner's Microcomputer

Graeme Teesdale

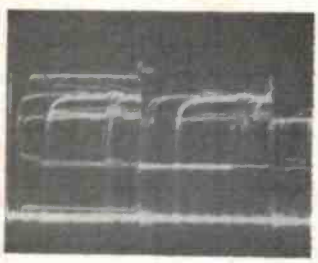
Having trouble firing up your '660? Has your '660 developed a fault? Or do you just want to learn more about the beast's internal workings? This article illustrates some techniques of fault-finding for this project as well as showing you more about its internal operation.

THIS ARTICLE endeavours to give constructors of the ETI-660 Learner's Microcomputer some fault-finding techniques to narrow down the *area* where a fault may exist, whether you are attempting to get your project up and running or trying to fix a problem which has developed later.

For many constructors, the ETI-660 is probably the most ambitious project ever undertaken. It would probably be the most difficult to fault-find!

I will have to assume here that you have carried out the tests recommended during assembly. An oscilloscope was the only instrument used in preparing this article. If you possibly can, get hold of one, or access to one. The oscilloscope needs to be a dual beam type and have a vertical amplifier bandwidth of 10 MHz or greater. I used a Hewlett-Packard model 1740A 100 MHz oscilloscope for the tests illustrated here, mainly to obtain good results to photograph. However, you won't need anything as sophisticated or as costly as that! A dual beam 'scope is really a *must* because it allows you to view synchronised data from two sources or trigger the 'scope on one signal while investigating a related signal.

As a first example, have a look at what is *not* going to help you!



Looking at a data buss line (D0)

The above waveform was taken from the data buss line D0 and it is very difficult to see exactly what is happening.

SCO (Pin 6, 1802)

D0 (Pin 15, 1802)

Now here's something a bit more useful! This trace is still of the data buss, except that the CRO was triggered from the SC0 state code line pin 6, of the 1802 CPU. When using the 'scope on the '660, *always* have the Y amps switch to *dc*, so that you can see 'high' and 'low' levels immediately.

Flow chart

Fault-finding is a logical procedure where you work from *common* or *general* elements of the circuitry, toward *specific* elements. Fault symptons will give you a starting point. How does this work? To illustrate the procedure, and to give you a specific guide, I have drawn up a *fault-finding flow chart* for the '660.

Go through it carefully to see how it is structured. You may well have done some of the checks already. This chart won't lead you directly to the component or chip at fault, but it will certainly narrow down the area of the fault. From there you have relatively few things to check, which makes life considerably easier and fault-finding much less frustrating.

Note 1: At this stage we can assume that the initialisation software is running and that the 6821 (IC5) has been initialised also. The CPU is waiting for you to press one of the following keys:

Note 2: If a sound is heard in the speaker, the CPU must have acknowledged that you pressed key 0. Pressing the keys from 0 to F should produce an increasing-length tone with each successive key pressed.

In response to key 0 being pressed, the data in the address field (i.e: on the left of the bar along the bottom of the screen) of the display should be updated each time you press a key between 0 and F.

Note 3: If the keyboard doesn't cause a CPU response, then check the conditions on the 'A' port of the 6821 — I/O lines PA0-PA7. i.e: pins 2 — 9 of IC5.

The keyboard is divided into a 4 x 4 matrix with normally open contacts (note: constructors using the FES-310 pushbuttons should check that pin 1 of each button is aligned to the pin 1 dot indicator on the pc board).

Pins 2 to 5 of the 6821 connect to the 'columns' of the keyboard matrix, while pins 6 to 9 connect to the 'rows'. The column inputs are software programmed to be inputs, the internal pull-up resistors make pins 2-5 at logic 1 (high). Using the CRO, check that pins 2-5 are high. The remaining pins — 6 to 9 — are continually toggled inputs or outputs. Refer to Figure 1 for typical waveform.

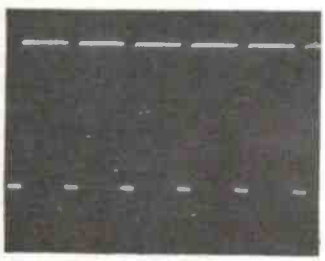


Figure 1.

Timebase set to 0.5 ms/cm

Y amp. set to 1 V/cm

Maintain the same timebase setting but change both Y amp sensitivities to 2 V/cm. Connect them to pins 9 and 5. Press the RESET key followed by the 0 key. Note the change in pulse rate on pin 9 and the changing of pin 5 to a low output. The software is endeavouring to locate the key depressed.

Pressing RESET followed by 8 will cause the CPU to run a CHIP 8 program, hence the keyboard scan subroutine is no longer used. Pins 6 to 9 of the 6821 drop to 0 (low).

The timing signals of the 6821 'read' cycle can be observed by connecting the CRO Y amp inputs to pins 22 (or 24) and 21. A 'chip select' (CS) for the 6821 is generated from the encoded 'N' lines of the 1802 (pins 17, 18, 19). The input code generated by the 1802 is decoded by IC17. (Note: on the circuit diagram, page 36 Nov. '81 ETI, pin 2 of IC17 is connected to pins 22/24 of IC5. Pin 21 of IC5 is the read/write line. When it is high and pins 22/24 high, data is transferred from the keyboard matrix to the data buss.)

Refer to Figure 2. The top trace is the 'select' pulse on pins 22/24 of IC5. The bottom trace is the read/write (R/W) signal generated by A2. With these two pulses going high

together one can assume that the 6821 is being *read* by the CPU.

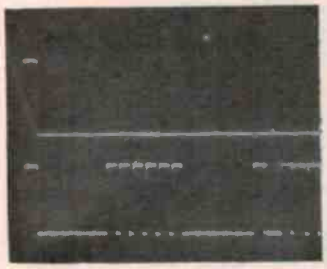


Figure 2.

Pins 22/24, IC5

A2

T/B 10 us/cm
Y amp 2 V/cm

To carry out a comparison, it is essential to trigger the 'scope on the top trace (pin 22/24, IC5) and look at the bottom trace for the condition of address line 2 (A2 — R/W for the 6821). At this stage, the 6821 appears to be working as expected. It is now necessary to check that the 1864 (IC4) is also selected by the decoded N lines. (An error in labelling appears at IC17 on the circuit diagram. Pins 1/14 of IC17 are shown to go to pins 17/19 of IC3 — that should be IC4.)

The tone generator latch in the 1864 is loaded by a '64' output instruction. To obtain any output from the AUDIO pin (pin 39) of the 1864, it is also necessary to activate the AUDIO OUTPUT ENABLE pin (AOE — pin 4). Referring to the circuit diagram you will see that pin 4 of IC4 is connected to pin 4 of IC3 (Q output). To allow the internal counter to toggle freely, pin 4 of the 1864 must be high. The frequency input to the audio generator is the TPB pulse generated by the 1802.

Connect the 'scope to pin 34 of the 1864 and you should observe a short duration positive-going pulse train. The TPA and TPB pulses occur once in each machine cycle and are used by I/O devices to interpret codes and to time interaction with the data buss. Set the CRO timebase to 2 us/cm to observe TPA or TPB.

Connect one Y amp of the 'scope to pin 4 of the 1864 and the other to pin 39. Repeated pressing of the RESET key should result in an audio frequency square wave appearing and should be heard from the speaker. If not, check the value of R20 (390R) and wiring to the speaker. Trace the track from R20 to the speaker. Just adjacent to pin 20 of IC5 is a through-board link. See that it's in place and properly soldered on both sides. If all is OK, replace the speaker with a *known good* one.

Note 4: The 1864 generates both composite and separate horizontal and vertical sync. signals. For monochrome operation, the composite sync. output ($\overline{\text{CSYNC}}$, pin 30) is combined with the RED video output (pin 29) in a simple resistive network to produce composite video output. Note that this is a high impedance output and cannot be connected directly to the 75 ohm input common to most video monitors. The video refresh cycle of the display section of the 1864 is synchronised with the 1802 using $\overline{\text{INT}}$ (pin 36 on both chips), $\overline{\text{EF}}$ (pin 18, IC4) and $\overline{\text{EF1}}$ (pin 24, IC3) and the state code lines SC0 and SC1 (pins 5 and 6 of IC3).

Pin 18 on the 1864 pulses at twice the frame frequency, goes low for four horizontal lines prior to the start of display and low again for four horizontal lines prior to the end of display.

Connect one Y amp of the 'scope to pin 18 and the other to pin 36 of the 1864 and observe these pulsing lines. The pulsing lines indicate that the 1864 is requesting a display update. Now connect the 'scope inputs to pins 5 and 6 on the 1864. Your waveform should look something like that in Figure 3.

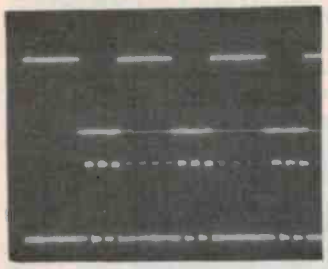


Figure 3.

SC1

SC0

T/B 10 us/cm
Y amps
2 V/cm

Pin 30 of the 1864 has the composite sync. output on it. Connect the 'scope to this pin and you should get something like Figure 4.

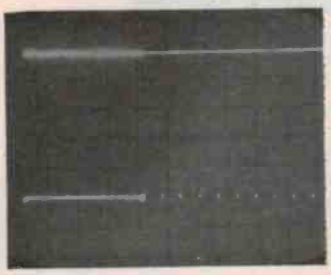


Figure 4.

T/Ba
20 ms/cm
T/Bb
0.1 ms/cm
Y amp 1 V/cm

You should observe little bright-up dots 20 ms apart (50 Hz), the frame frequency sync. pulses (actually, they're 19.8 ms apart — 50.6 Hz). Now speed up the CRO time base to 0.1 ms/cm or faster. You should observe the horizontal sync. pulses. Figure 4 shows both frame and horizontal sync. pulses. This was achieved using the expanded timebase feature of the 'scope I used. Change the input lead over to pin 29 of IC4. Set the timebase back to 5 ms/cm. Figure 5 shows the RED video output signal, in this case as the luminance output signal.

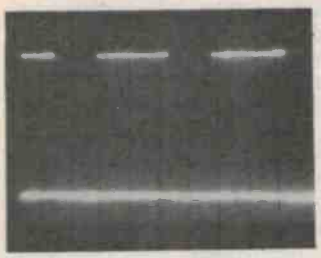


Figure 5.

Red video output, 1864

T/B 5 ms/cm
Y amp 1 V/cm

The signals from pins 29 and 30 are combined in the resistor matrix R11-7-10 to produce a composite video signal of the right sync.-to-video levels. Figure 6 shows the resulting combination.

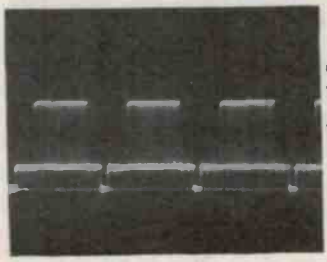
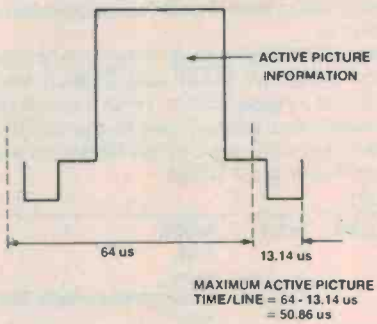
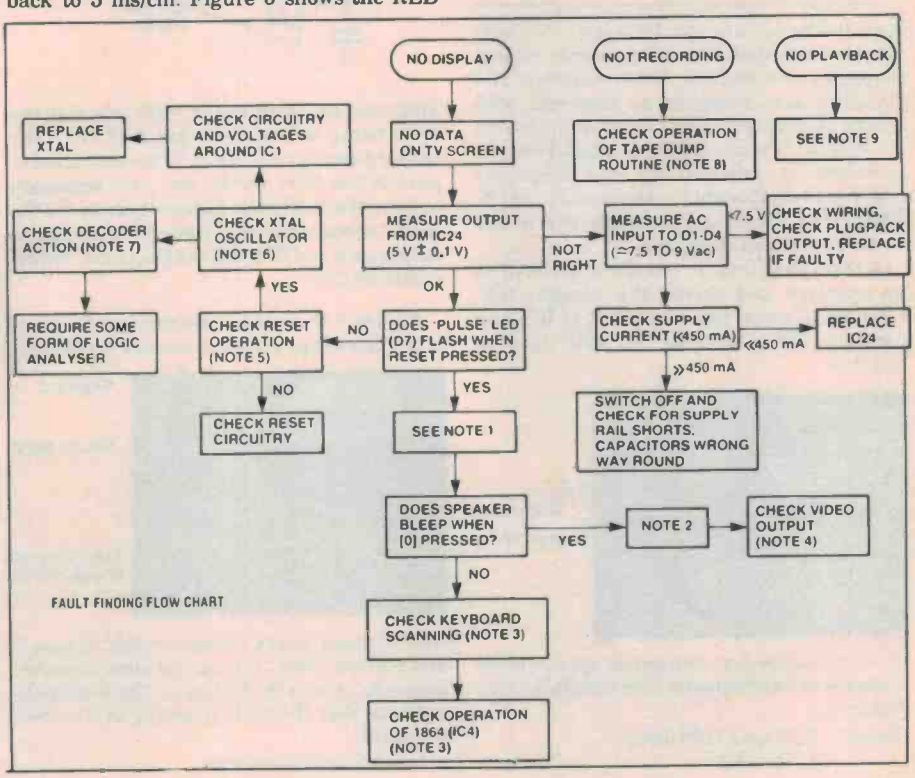


Figure 6.

Composite video.

T/B 5 ms/cm
Y amp
0.5 V/cm





Connect the 'scope input to the junction of resistors R7, 11 and 10, set the Y amp to 0.5 V/cm and compare your results with ours, shown in Figure 6.

The maximum dc level of the waveform represents *peak white* on the screen and the bottom of the sync. pulses represents black level or zero volts dc. This is why an inverter is required in the ETI-760 video modulator (Q2) when a composite video signal is fed into the FET output modulator (Q3). If you are obtaining the same amplitude signal as in Figure 6, but video display is not present on your TV, check your modulator. (Note: R11 is shown on the '660 circuit diagram as 2k2, but in the text it is given as 5k6. A value of 2k2 should be used to give proper sync. levels.)

Note 5: The 1802 receives a reset signal from the 1864 controller chip. On power-up, capacitor C3 pulls pin 38, the $\overline{\text{CLRIN}}$ input of IC4, low (0) for the approximate period of 3 x R2C3 time constant. The low level input into the Schmitt trigger on pin 38 of IC4 will cause $\overline{\text{CLROUT}}$, pin 3, to go low also. $\overline{\text{CLROUT}}$ is connected to the $\overline{\text{CLEAR}}$ input of the 1802, pin 3. The post-Schmitt trigger output provides the 1802 with a clean, clear signal.

Connect one 'scope input to pin 3 of the 1802. There should be a 'high' here. Press RESET and it should go low on depression of the button.

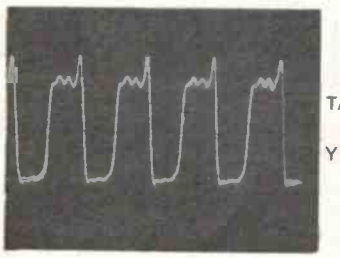
The 1802 is provided with four control modes using the $\overline{\text{WAIT}}$ and $\overline{\text{CLEAR}}$ lines (pin 2 and 3 respectively). Table 1 shows the four modes and the two used by the '660. For correct operation, pin 2 of the 1802 must also be high when pin 3 is high.

TABLE 1.

CLEAR	WAIT	MODE
0	0	load
0	1	reset
1	0	pause — modes used by '660
1	1	run

Note 6: The clock for the 1802 is a 1.773 MHz signal generated from the master crystal frequency of 8.86 MHz. Two sections of IC1 (74LS00) are connected as inverters with inputs biased up by a low value resistor from the output. Positive feedback around the two inverters is provided by the frequency dependant components — the crystal and C5. The latter allows slight adjustment of the crystal's resonant frequency.

A third gate from IC1 is also connected as an inverter and drives the divider, IC2. Connect a 'scope input to pin 3 of IC1 and compare the trace you get with that in Figure 7.



T/B 0.05 us/cm
Y amp 1 V/cm

From the 'scope, you can get an approximate measure of the frequency. For example, from Figure 7:

Period = 2.25 cm x 0.05 us/cm
$= 1.125 \times 10^{-7}$

$$\text{Frequency} = \frac{1}{\text{Period}}$$

$= 8.88 \times 10^{6}$
$= 8.88$ MHz

Which is pretty close to the intended 8.86 MHz, showing you the oscillator's operating in the right ballpark.

The waveform at pin 3 of IC1 is divided by five in IC2. Change the 'scope input now to pin 1 of IC3. Change the timebase to 0.2 us/cm and compare your waveform with that in Figure 8.

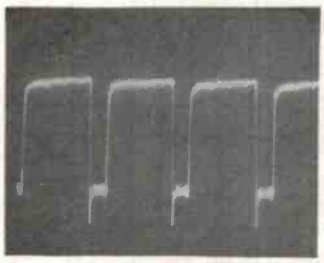
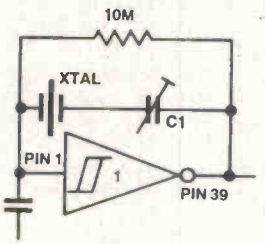


Figure 8.
Pin 1, 1802
T/B 0.2 us/cm
Y amp 1 V/cm

It is normal practice to supply the clock input of a microprocessor with a 1:1 mark/space ratio pulse. However, in this case it is not possible because of the odd division ratio from the crystal frequency to generate the necessary 1.773 MHz clock. The 1802 would not accept the output pulse from IC2 directly, but did accept the inverted version, hence the need for IC1d.

The crystal is normally connected between pins 1 and 39 of the 1802 (clock and XTAL), in parallel with a resistance of typically 10 M.



This was not used in the '660, pin 1 of the 1802 being driven from pin 6 of IC1. The output from pin 39 of the 1802 is connected to pin 2 of the 1864. By the way, it is necessary to have the 8.86 MHz base frequency for the colour encoder circuitry (the crystal oscillator output, pin 8 of IC1, goes to the colour multiplexer, IC20).

Figure 9 shows the waveform on pin 39 of IC3. Check that you get a similar waveform.

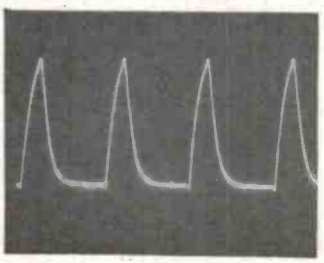


Figure 9.
Pin 39, 1802
T/B 0.2 us/cm
Y amp 1 V/cm

Now connect the two 'scope inputs to pins 5 and 6 of the 1802. You should observe waveforms as shown in Figure 3. These outputs indicate that the CPU is trying to do something like:

(1) fetch an instruction
(2) execute an instruction
(3) acknowledge an interrupt request
(4) process a DMA request

The latter two are normally used as a result of the 1864 causing a display update.

Note 7: With the 1802, the 16-bit address data is multiplexed onto a common eight lines, MA0-7. i.e: pins 25 to 32 of IC3. The higher order byte of a 16-bit memory address appears on the memory address lines first. Those bits required by the memory system, A8-A11, can be stored into an external address latch (IC6) by the timing pulse TPA.

Connect the 'scope inputs to pins 4 and 15 (MA10) of IC6 and trigger the 'scope on the TPA pulse. Compare your waveforms with Figure 10.

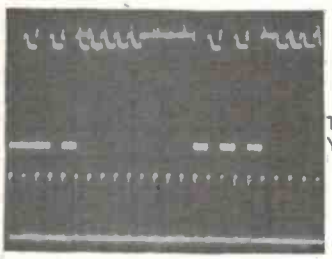


Figure 10.
MA10
T/B 10 us/cm
Y amp 2 V/cm
TPA

The data presented to IC6 is latched when the TPA pulse is low. The high address lines A10 and A11, from the latch, are supplied to the address decoder, IC8. While the monitor is running and scanning the keyboard, the chip select lines of IC11 (pin 20) and ICs 9 and 10 (pin 14 on each) should be pulsing. Connect the 'scope inputs to pins 14 and 15 (address decoder outputs) and check your waveforms against those in Figure 11.

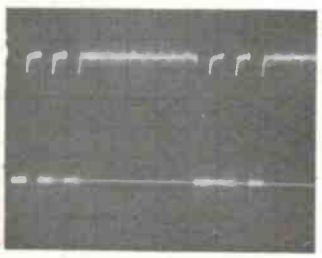


Figure 11.
Pin 20, IC11
T/B 10 us/cm
Y amp 1 V/cm

See that you get the chip select signal on IC11 pin 20.

The RAM chips IC9 and IC10 are selected because the display data is stored here, along with monitor 'scratch pad' data, in the memory block 0400 to 07FF. Table 2 shows the chip select logic — which memory block is selected by which output (chip select line) of IC8.

TABLE 2.

A11	A10	CHIP SELECT ACTIVE	MEMORY BLOCK
0	0	pin 15, IC8	0000 — 03FF
0	1	pin 14, IC8	0400 — 07FF
1	0	pin 13, IC8	0800 = 0BFF
1	1	pin 12, IC8	0C00 — 0FFF

Using the 'scope, observe pin 20 of IC11 while you press and hold down the RESET button. Pin 20 should go low and remain low. On reset, the memory address lines are reset to 0000, therefore the address decoder will generate a chip select for the bottom memory block, 0000 — 03FF. Failure to achieve this will indicate a fault in the address latch (IC6) or decoder (IC8).

The monitor EPROM (IC11) must be selected by a RESET otherwise the 1802 will run on some other addressed random data. The decoder chip, IC8, divides the lower memory block into 1K blocks by using A10 as the least significant bit (LSB).

If the problem has not been found by any of the test sequences described here, it is now necessary to locate someone that has a logic analyser. This instrument is connected onto the data buss and several timing pulse outputs. It tracks and stores in its own memory the microprocessor's operation after a certain trigger 'word'. The stored information is displayed on a terminal or 'scope. This then allows the user to determine whether the microprocessor is following the monitor program or where it went to instead.

Note 8: The code for the tape load routine is generated in software and sent out from the 1802 using the Q output, pin 4. Pressing RESET followed by 2 should cause —

(1) audio tone to be heard from the speaker

(2) the pulse LED to flash at a high rate.

If you look at pin 4 of the 1802, you should see a waveform as shown in Figure 12.

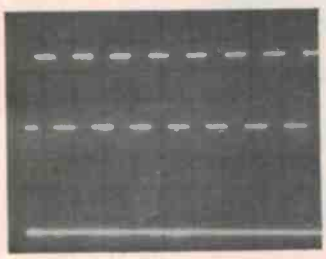


Figure 12.

Pin 4, 1802

After 6 — 10 seconds, the leader tone gives way to the actual data from memory being loaded in 256-byte lumps as a two-tone FSK signal. A 'scope connected to pin 5 of IC7 should produce a signal amplitude of approximately 2.4 V peak-to-peak. If no sound output occurs, refer to note 3 on the operation of the 1864. No Q output pulse (pin 4) will indicate a fault in the EPROM software. Take your EPROM to someone that has a microprocessor system that will allow you to check the listing contained in IC11, the 2716.

Note 9: The signal from the tape recorder is fed into one of the op-amp sections of IC7. Output from this is used to drive the flag input (EF2) of the 1802. For the CMOS input to recognise a change in state, the signal from the op-amp (pin 9) must exceed about 3.5 V. Connect your tape recorder output to the tape input socket of the '660 and start it running (with a tape installed!). Using the 'scope, observe the amplitude of the waveform on pin 23 of IC3. Remember, it must exceed 3.5 V peak for the 1802 flag input to change state. If not, look for insufficient gain from the op-amp or lack of recorder level. Check the values of R31, 32 and 33.

Conclusion

Here's hoping this article has led you along the right path to find faults in your '660 and perhaps shown you a thing or two more about its operation that you didn't know before.

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MICRO WORLD REPORT

Summary Of Commands

Unlimited possibilities for creative graphics are now possible with OZ-LOGO and Your MicroBee.
Study this summary of commands and imagine what you can do.

Turtle Movement Commands:

nF	Move n steps in direction of heading (unless blocked)
nR	Turn clockwise thru 90° n times
J	Jump to Home (leave hidden snap mark at jump off cell). [Note: always valid even if HOME blocked]

Trail Marking Commands

D	Marker DOWN so trail left
U	Marker UP so no trail
E	Erase what is "under" the Turtle
nD	Marker down, trail being snap number D.

Screen

C	Clear Screen
$	Make copy of screen into album page given by SNAP character
*	Restore copy to screen
n*	Blow-up onto Turtle territory the current SNAP using SNAP number n as the blow-up character.
:	Restore copy to screen, with [ ] solid blobs. Used for maze dumping as solid [ ]'s are not penetratable.
n.	Makes n the current SNAP number. Corresponding SNAP now displayed on top RH corner.

Snap

'	Rotate album snap (top LH corner) through 90 degrees.
!	Reflect album snap about vertical axis : unimplemented.

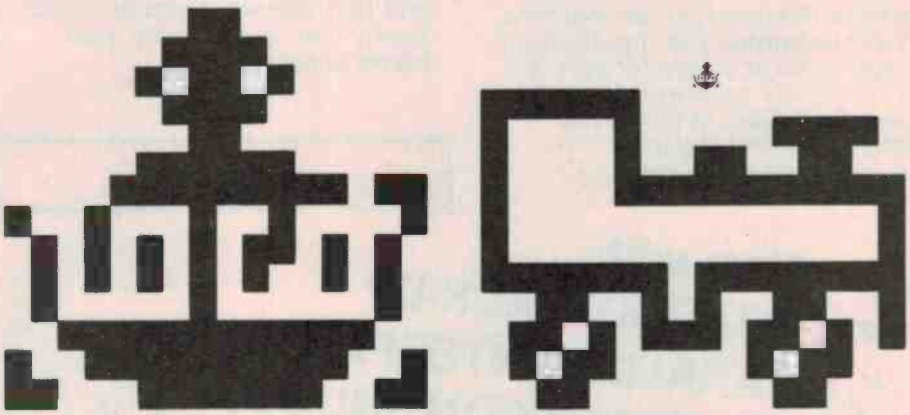
Conditionals

&	BLOCKED = 1 If ahead blocked, else has value 0
n[	Compare accumulator A with number n. If equal, value passed on is 1, else 0. "[" essentially means Compare.
n#	If n not equal to A has value 1, else value 0.

A and B numbers

n+	Add a n times to number A.
n—	Subtract 1 n times from A (but stop when A = 0).
A	The value of A.
B	The value of B.
%	Swap A and B.

We're Moving into 1983 with OZ-LOGO



OZ-LOGO — An endless Learning Language for Australian Children.

OZ-LOGO (developed by Dr. Harvey A. Cohen, La Trobe University, Melbourne and consultant member of the original M.I.T. Team in 1973 - 1974) is a derivation of LOGO, a computer language based on a philosophy of education developed over a 12 year period by Professor Seymour Papert and the Staff of the Artificial Intelligence Laboratory at the Massachusets Institute of Technology (M.I.T.)

OZ-LOGO is a Graphics Language based on LOGO but with many features so as to capitalise on the outstanding graphics capabilities of the MicroBee.

Just as with LOGO, the prime "Drawing" mechanism is via the Turtle, which goes in the foward, in the direction of its heading.

OZ-LOGO will be available in February 1983 as a ROM Based Program for the MicroBee 16 and 32K Plus.

THE PLUS SERIES! More Languages, More Features and More Software.

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Watch for new releases of easy-to-use Powerful Educational Software for Your MicroBee.

NEW SOFTWARE

ROBOT MAN is a familiar challenging Arcade Game for the whole family and gives you another reason to enjoy your MicroBee.

PASCAL S +

Developed by Geoffrey Townshend, is a Computer/Interpreter system for substantial sub-set of PASCAL.

PASCAL S + offers excellent features for structural programming. It is a natural choice for beginners because it was developed as a teaching language. PASCAL S + will be a ROM Pack based program available in early 1983.

LOOK what the MicroB

NEW 'PLUS' SERIES WITH EXTRA FEATURES

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The 16K PLUS with features such as built in music generation, high and low resolution graphics, with a screen display of 16 lines each containing 64 upper and lower case characters. When you also consider all of the standard extras like continuous memory, built in printer and input/output interfaces and parallel port, 4.5 volt battery back-up and self testing BASIC in ROM, the MicroBee 16K PLUS is unbeatable in its class.

32K PLUS

All of the standard features of the 16K PLUS with twice as much usable RAM. When you add the new Word Bee ROM Pack, you have a powerful word processing capability which does a lot more than play the many games available for the MicroBee. Add a printer and maybe even the Tasman Turtle and just see what you and your family can now do with your home computer.

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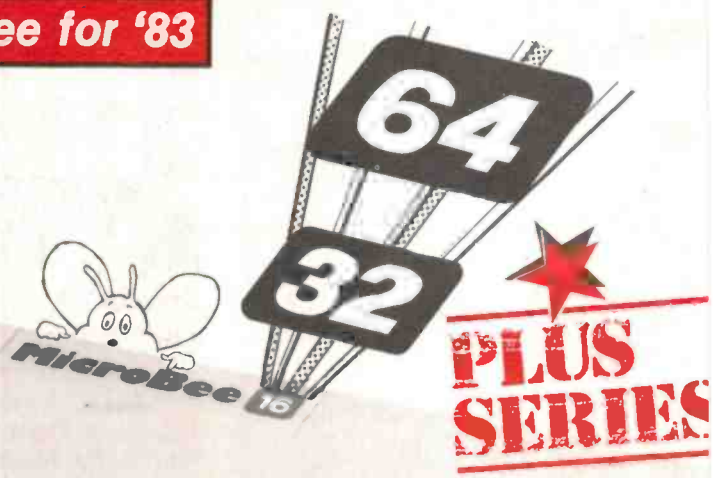

A Happy Bee New Year

ee Family can do NOW!

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MicroBee 64K PLUS

The MicroBee 64K also runs MicroWorld BASIC which is supplied on cassette. **You do not need disk drives to use your MicroBee 64.** Just load the tape and thanks to the unique CMOS continuous memory, you can run any program available for the 16K or 32K PLUS. With the built-in monitor ROM, with commands to enable you to examine memory, run programs, block move, compare and search through memory, the MicroBee 64 will load and save programs from cassette tape and read and write to disk drives.

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Control R (Scroll file towards end, with freeze feature).
Control B (Full Block functions).

17 SEPARATE DOT COMMANDS
SAVE AND LOAD TAPE FILES

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MicroBee PERIPHERALS

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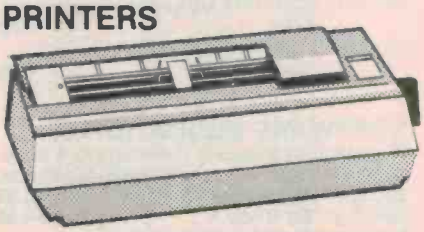

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In addition to the WordBee ROMPACK a vast quantity of exciting software is continually being prepared for the MicroBee with cassette based programs like EDPACK II for education and entertaining programs with MISSILE WARS, GRAPHIC GAMES and the PCG Tutorial available for the PLUS Series.

MicroBee

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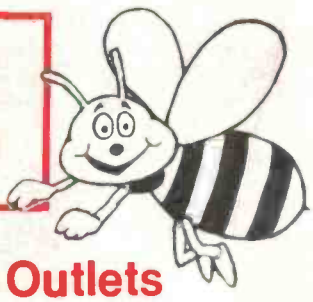

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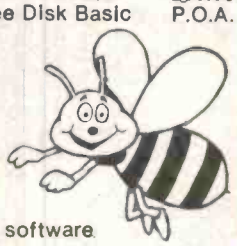

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Hints for CHIP 8 programmers

Part 2

IN THIS PART you can learn how to put *big* scores on the screen, explore the operation of the sound generator and learn how to use it in programming and cap it all off with a bunch of fun subroutines from the indefatigable Frank Rees.

Music Maker

Peter Collins, Springvale South, Vic.

While exploring new uses for the '660 I decided to write a 'song' using notes from the *Song In the Key of Yale* program published with the *Programming in CHIP 8* article, November 1981. This was fine, but how could I develop songs in different keys? I then decided to develop the following program to assist. Keys on the keyboard are used to control the program and step through the tones, displaying the hex value of each note on the screen. Here's what each key does:

KEY 0: Tone generator starts at the highest tone and steps *down* in pitch.
KEY 5: Stops the tone at the step it is on.
KEY 1: Repeats the tone of a value displayed on the screen.
KEY 4: Manually *increases* the tone one step for each key press.
KEY 6: Manually *decreases* the tone one step for each key press.
KEY 2: Causes program to jump to song routine.

You can write a song by setting the duration of the tone required using Variable 1 (V1) and setting the tone using Variable 0 (V0). Then follow with a 'do tone' instruction — 27B0 if no space between tones is required, or 'do tone with space' using 278C. If the tone duration and pitch are not changed a further 'do tone' instruction will repeat the tone. If a change in either pitch or duration is required, or both, these are changed before the next 'do tone' instruction by settng the values of V0 and V1 as required.

Spaces are located in routines which can be called as required. A short space is located at 078E and 'special' spaces are located at 0776, 077A, 077E and 0782 by setting V4 then jumping to a timer loop which controls the duration of the space.

Five-digit scoring

Raymond Jones, Eltham Nth, Vic.

This routine extends the counting capability of the '660. Instead of the normal 0 to 255 count available with the interpreter this counter allows 0 to 99999 count, just the shot for those long duration, high scoring games.

It is intended to be used as a subroutine. All variables used are stacked from 07F8. The value to be added must be variable A, i.e: VA.

Note that VA cannot exceed 245. If a score higher than this is required to be added then the routine will need to be accessed twice, or more (245 = F5).

The coordinates of the score are:
Horizontal — V6
Vertical — V5

Program operation:
0700 — 070E initialisation.
0710 — 074C incrementation & sorting.
074E — 0756 storage and retrieval of variables.
0758 — 0776 display of value.

When used in a program it will be first required to initialise the counter by going to 0700, i.e: a 2700. To erase the present score in preparation for the new score jump to 0754, i.e: a 2754. To display the new score jump to 0710, i.e: a 2710.

To check the operation of the subroutine, use this simple program:

0600 2700 2754 6AXX 2710 1602

where XX is the value to be added (hex).

If all works OK then save it on tape for future use in your extravagant programs (save from 0700 to 0777 to avoid erasing a program you may be working on).

Fun routines

Frank Rees, Boort, Vic.

Here's something to have fun with. Table 4 lists a group of routines which can be incorporated in other programs by themselves, or can have a program written around them. As they stand you can enter and run the complete set and see what it does. It can write a four letter word on screen (oooohh! — Ed.), it can make black white and white black, no argument, then sort the screen out with a routine you may have heard about but not 'seen' — *the bubble sort*.

Each of the routines is 'called' as a subroutine with a 'key wait' separation between each subroutine call.

As I said before, the routines can be used on their own and can be made more effective. For example, try writing out all but the Four Letter Word routine by putting a GOTO, to jump, or replace, unwanted instructions. Have a go at changing one instruction to change word length.

To speed up the bubble sort routine a bit, reset and change the instruction at location 0616 (0216) from 6B19 to 6B01. The Bubble Sort routine is well down memory so you can use it with other ideas you may like to try without needing to relocate it. A very effective display is created by producing a random dot pattern followed by a bubble sort and then repeat without erasing the screen between runs. Leave it running for a *few hours* and watch it. Fascinating!

Both the Screen Invert and Bubble Sort routines demonstrate the need for machine code to speed things up, but in their present form they make observation on working possible without any delay.

The technique used in the Bubble Sort can be slow, even though machine code and more advanced techniques are used in many practical applications. Be sure after a bubble sort to reset and have a look in screen memory, starting from the top, to see what's been going on.

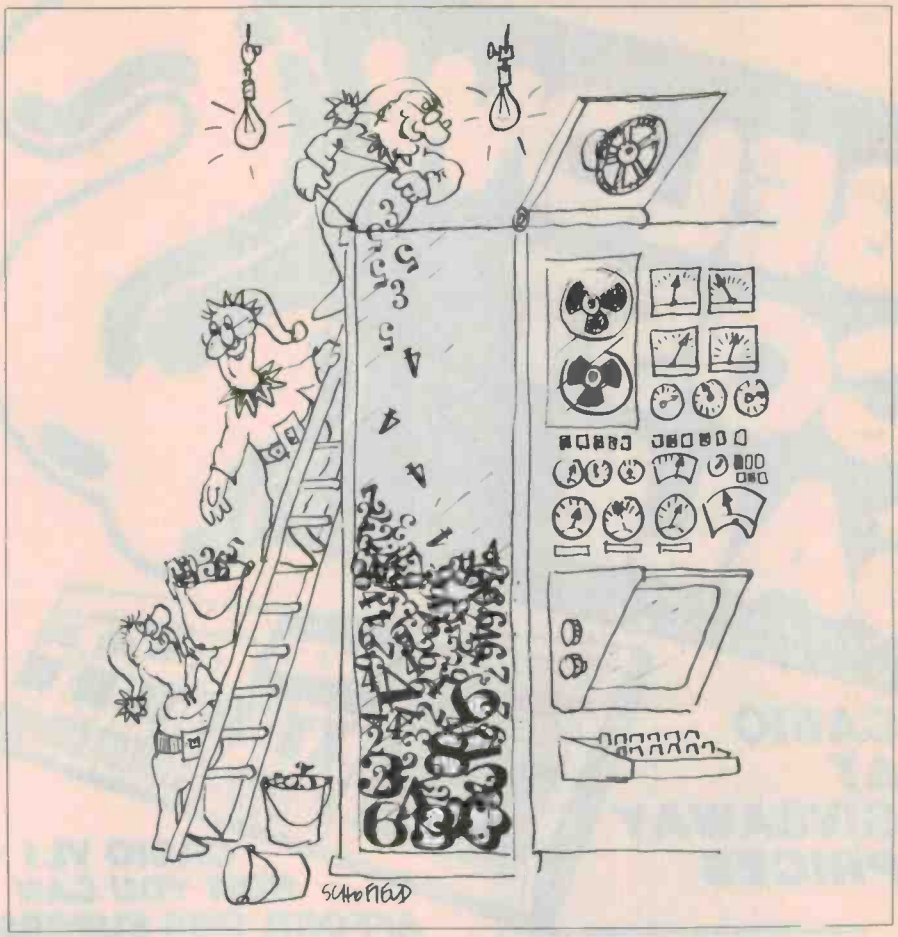
The program runs 'as is' in the ETI-660 with its CHIP 8.D3. For other dialects, the instruction at locations 0638, 0644, 0746 and 076C will need to be changed to A100. In CHIP 8.D2 computers without extra memory, no other changes are required as addresses 0200-03FF and 0600-07FF are the same locations. For other CHIP 8 computers with extra memory at 0600-07FF, you will need to add a 1600 instruction at location 0200. All others will need to have the program relocated to 0200-03FF and this involves changing 1MMM and 2MMM instructions.

References to 16MM, 17MM, 26MM, and 27MM would be changed to 12MM, 13MM, 22MM and 23MM respectively.

The program contains some useful ideas for study. Try the 'complement' function of the inverse screen routine at locations 063E to 0643 on paper, in binary.

You can run the Four Letter Word routine as a game on its own. Change the instruction at 0608 from 2634 to 1600. For random dots to sort, change the instruction at 0640 from 8205 to C2FF.

Have fun!



FIVE DIGIT COUNTER

```
0700  6000 6100 6200 6300 6400 6512 670A 174E
0710  A7F8 F765 80A4 8075 4F00 1720 7101 1716
0720  700A 8175 4F00 172C 7201 1722 710A 8275
0730  4F00 1738 7301 172E 720A 8375 4F00 1744
0740  7401 173A 730A 8475 5F00 1746 740A A7F8
0750  F755 1758 A7F8 F765 8612 F429 D655 7604
0760  F329 D655 7604 F229 D655 7604 F129 D655
0770  7604 F029 D655 00EE
```

MUSIC MAKER

```
0600   6400 E4A1 17AA 6401 E4A1 17A6 6402 E4A1
0610   17A2 6404 E4A1 179C 6406 E4A1 1798 1600
0620   268A 2782 268A 2782 26A0 611A 6021 278C
0630   602A 278C 6021 278C 6130 6025 278C 277E
0640   610C 6021 278C 278C 6025 278C 6120 602A
0650   27B0 277E 610F 602A 27B0 611C 6021 27B0
0660   610C 601C 278C 278C 278C 6120 601F 27B0
0670   277E 26A0 611A 6021 278C 602A 278C 6025
0680   278C 6130 602A 27B0 16B6 610F 602A 27B0
0690   6021 27B0 601F 27B0 6120 601C 27B0 00EE
06A0   610F 602A 27B0 6021 27B0 601F 27B0 611C
06B0   601C 278C 00EE 277A 60BC 6120 27B0 2776
06C0   60FF 610A 27B0 2776 27B0 2776 60E0 6118
06D0   27B0 2776 60FF 27B0 277A 60C4 610E 27B0
06E0   277A 60BC 27B0 1600

0776   64D0 1784 6477 1784 64D0
0780   1784 6433 7401 3400 1784 00EE 27B0 64F0
0790   7401 3400 1790 00EE 7001 179E 70FF 6501
07A0   17AE 6502 1620 6501 17AE 6500 6000 610F
07B0   F000 F115 F118 F207 3200 17B6 4502 00EE
07C0   27D0 6405 E4A1 1600 4501 1600 7001 17B0
07D0   00E0 A7FE F055 6A20 6B15 F029 DAB5 07F0
07E0   A7FF F065 6A1B F029 DAB5 A7FE F065 00EE
07F0   F807 BEF8 FEAE EE72 F6F6 F6F6 73D4
```

CONTROL ROUTINE

0600	1602	GO TO 0602	universal no operation
0602	00E0	ERASE	clear screen
0604	2612	DO SUB 0612	call subroutine 1
0606	F00A	V0 = KEY	key wait only
0608	2634	DO SUB 0634	call subroutine 2
060A	F00A	V0 = KEY	key wait only
060C	2740	DO SUB 0740	call subroutine 3
060E	F00A	V0 = KEY	key wait only
0610	1600	GO TO 0600	loop back to start

SUBROUTINE 1 - FOUR LETTER WORD GAME

0612	1614	GO TO 0614	universal no operation
0614	6A10	VA = 10	use as X coordinate display
0616	6B19	VB = 19	use as Y coordinate display
0618	620A	V2 = 0A	use as filter
061A	610F	V1 = 0F	use as filter
061C	C0FF	V0 = RND.FF	L1,random number from 00 to FF
061E	8012	V0 = V0 AND V1	filter out all above 0F
0620	8300	V3 = V0	copy V0 in V3 for test
0622	8325	V3 = V3 - V2	equals V0-V2 if V0=Ato F, VF=0
0624	3F01	SKF VF = 01	otherwise go get another number
0626	161C	GO TO 061C	by looping to L1
0628	F029	I = DISP,V0	prepare V0 for display
062A	DAB5	SHOW 5@VA,VB	display at X=VA,Y=VB, 5 bytes
062C	7A04	VA=VA+04	add to X coordinate to move right
062E	3A20	SKF VA = 20	after four letters
0630	161C	GO TO 061C	choose another letter
0632	00EE	RETURN	return to instruction after caller

SUBROUTINE 2 - INVERT SCREEN

0634	1636	GO TO 0636	universal no operation
0636	6100	V1 = 00	use to add to pointer
0638	A480	I = 0480(A100)	set pointer to screen start
063A	F11E	I=I+V1	current pointer calculation
063C	F065	V0 TO V0=MI	load V0 there
063E	62FF	V2 = FF	start of complement function
0640	8205	V2=V2-V0	complement FF-M → M
0642	8020	V0=V2	copy V2 into V0
0644	A480	I=0480(A100)	set pointer to screen start
0646	F11E	I=I+V1	current pointer calculation
0648	F055	MI=V0 TO V0	store V0 there
064A	7101	V1=V1+01	add to pointer counter
064C	3100	SKF V1=00	finish if 100 done
064E	1638	GO TO 0638	otherwise go do next
0650	00EE	RETURN	return to instruction after caller

SUBROUTINE 3 - BUBBLE SORT

0740	1742	GO TO 0742	universal no operation
0742	6200	V2=00	use for byte count
0744	6300	V3=00	use for swap flag
0746	A480	I=0480(A100)	start of bytes-to-be-sorted pointer
0748	F21E	I=I+V2	add byte counter to pointer
074A	F165	V0 TO V1=MI	get two bytes from calculated location
074C	9010	SKF V0 ≠ V1	if bytes equal
074E	1758	GO TO 0758	skip test for swap
0750	8500	V5=V0	copy V0 in V5 for test
0752	8515	V5=V5-V1	if V0 < V1, then V5-V1
0754	3F00	SKF VF=00	causes flag VF to be = 0
0756	2764	DO SUB 0764	other 1se swap subroutine called
0758	7201	V2=V2+01	add one to bytes counter
075A	32FF	SKF V2=FF	skip if 100 bytes done
075C	1746	GO TO 0746	otherwise go do next bytes
075E	3300	SKF V3=00	skip if swap flag indicates no swap in last 100 bytes
0760	1742	GO TO 0742	otherwise go through 100 bytes again
0762	00EE	RETURN	return to instruction after caller

SUBROUTINE 3A - SWAP

0764	8410	V4=V1	copy by 1 to V4
0766	8100	V1=V0	copy byte 0 into V1 (swap routine)
0768	8040	V0=V4	copy byte 1 into V0
076A	6301	V3=01	set swap flag
076C	A480	I=0480(A100)	set pointer to start of sort
076E	F21E	I=I+V2	calculate current address
0770	F155	MI=V0 to V1	store swapped values of V1 and V2
0772	00EE	RETURN	return to instruction after caller

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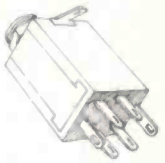

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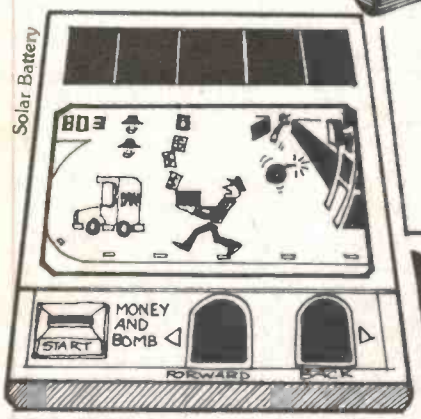

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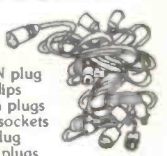

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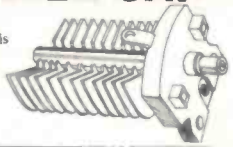

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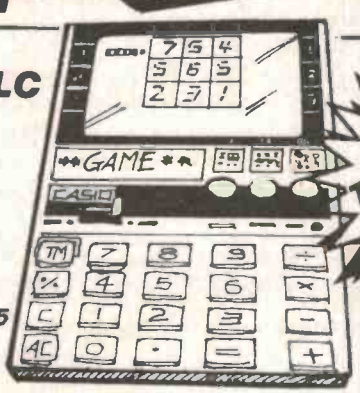

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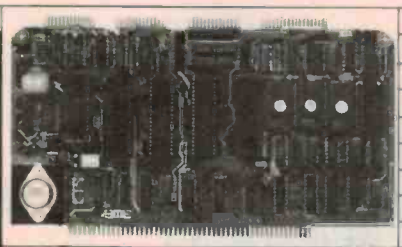

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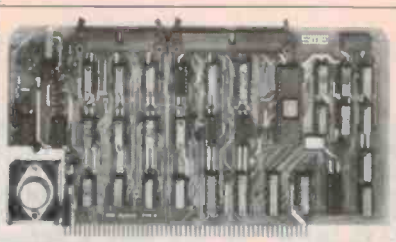

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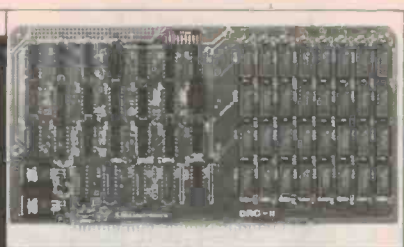

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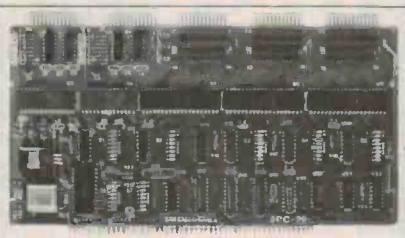

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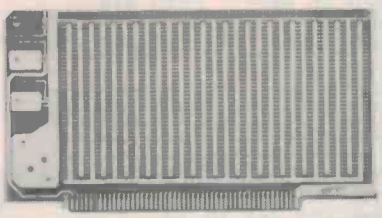

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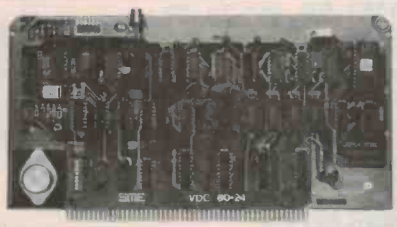

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Bee-O-Rhythms

Tom Moffat
Fern Tree, Tasmania

WE'VE ALL HEARD of biorhythms, haven't we? Very popular in the mid-1970s, almost a cult, with many of the attractions of astrology. Today there are still many believers.

We all know that much of life exists in cycles . . . Lunar cycles, Sunspot cycles, menstrual cycles, economic booms and depressions, the four seasons, day and night, ice ages . . . all going up and down, or round and round.

Proponents of the biorhythm theory say that the human body experiences cycles that start together at birth and then fluctuate at different but steady rates throughout the rest of life. The way this works is set out in the program listing, so we won't repeat it here.

There is an organisation in Basel, Switzerland, called 'Biorythmik Centre' that seems to take a very serious view of biorhythms. They claim that a study at the Swiss Federal School of Technology in Zurich has confirmed that biorhythms do indeed exist.

Here are some quotes from their report, reproduced without comment:

"It has been repeatedly proved and confirmed that the tendency to physical or intellectual failure is particularly pronounced on critical days.

"If a businessman uses regeneration (negative) days for making preparations, he establishes all conditions for successful conferences, executive measures, and decisions in the positive phase.

"Medical treatments, inoculations, dental operations, etc are least likely to cause pain and to be followed by complications during the positive phase.

"Enhanced powers of concentration during the positive phase make it easier for students to assimilate the material that has to be learned.

"Industries that take account of biorhythms have found their accident rate falling by 30%, and their production and sales increasing by 20 to 30%.

The program

This MicroBee version is developed from what is probably one of the earliest biorhythm implementations for computers. It appear to have originated in an article in Byte magazine sometime in the mid-70s. It's been written and re-written for many small computers over the years, and it seems to have made its way into at least one well-known Australian mainframe system.

It's a good program with a clever way of using a non-graphics printer to draw the curves. But the earlier versions had a problem. The biorhythms they churned out were wrong! There was a mathematical problem in the method of calculating how many days old the subject was, such that results during the early months of life came out negative and the figures for later years were offset accordingly.

Users of this new program will be happy to know that it's working with a completely different age calculating algorithm and results will be correct (I hope . . .). But how many mainframe systems did the original version of the program get written into? How many of these mainframe systems were in businesses that reported 'spectacular' results from biorhythms?

The program print-out was done, as usual (with my system) with an antique Model-15 teletype machine, built before the days of ASCII characters. So, 'X' means multiply, and 'OUT5 ON' and 'OUT5 OFF' should read 'OUT#5 ON' and 'OUT#5 OFF'. One of these days I'll get a decent printer, I promise . . .

```
00100 REM BIORYTHM PROGRAM BY TOM MOFFAT, 5,9,82
00110 REM TO BE USED WITH OR WITHOUT PRINTER.
00120 DIM T(12),S1(52)
00130 FNO=(SIN(FRACT(A1/@X6.28)+1)X25+3
00140 CLS: INPUT 'WHAT IS YOUR NAME? ',N1$
00150 INPUT 'DO YOU WANT A DESCRIPTION? (Y OR N)',K1$
00160 IF K1$='N' THEN 330
00170 CLS: PRINT 'THE THEORY OF BIORYTHM STATES THAT LIFE EXISTS IN'
00180 PRINT 'THREE CYCLES, ALL STARTING AT BIRTH. THE PHYSICAL CYCLE'
00190 PRINT 'HAS A PERIOD OF 23 DAYS, THE EMOTIONAL CYCLE IS 28 DAYS,'
00200 PRINT 'AND THE INTELLECTUAL CYCLE IS 33 DAYS.'
00210 PRINT '     WHEN A CYCLE IS UP, THE FUNCTION IS OPERATING AT'
00220 PRINT 'PEAK EFFICIENCY. WHEN IT IS DOWN, THE FUNCTION IS'
00230 PRINT 'RESTING, AND AT ZERO CROSSING, THE CYCLE IS SAID TO BE'
00240 PRINT 'CRITICAL, A TIME WHEN CAUTION IS INDICATED. WHEN TWO'
00250 PRINT 'CYCLES COINCIDE AT CRITICAL THE DAY IS SAID TO BE'
00260 PRINT 'DOUBLE-CRITICAL. WHEN ALL THREE COINCIDE AT CRITICAL,'
00270 PRINT 'THE DAY WILL BE A TOTAL DISASTER.'
00280 PRINT '     NOW, 'N1$', YOU MAY SAY THAT THIS WHOLE CONCEPT IS'
00290 PRINT 'A LOAD OF OLD CODSWALLOP. IF SO, PRESS ANY KEY TO EXIT.'
00300 PRINT 'BUT IF YOU'RE GAME, PRESS ANY OTHER KEY TO CONTINUE.'
00310 K1$=KEY$
00320 IF K1$='' THEN 310
00330 CLS
00340 INPUT 'PLEASE ENTER YOUR BIRTHDAY (DD,MM,YY):' D,M,Y
00350 GOSUB 780
00360 A=Z
00370 INPUT 'WHEN DO YOU WANT YOUR CHART TO BEGIN (DD,MM,YY)?' D,M,Y
00380 GOSUB 780
00390 A=Z-A
00400 INPUT 'AND FOR HOW MANY DAYS?';L
00410 DATA 31,28,31,30,31,30,11,31,30,31,30,31
00420 FOR I=1 TO 12
00430 READ T(I)
00440 NEXT I
00450 OUT5 ON
00460 CLS
00470 PRINT TAB (10);'XXX PERSONAL BIORYTHM CHART FOR ';N1$;' XXX'
00480 PRINT TAB (10);'PHYSICAL = P; EMOTIONAL = E; INTELLECTUAL = I'
00490 PRINT
00500 PRINT ' ';'DATE',
00510 PRINT TAB (13) 'DOWN';
00520 PRINT TAB (35) 'CRITICAL';
00530 PRINT TAB (62) 'UP'
00540 PRINT ' ',(A62 45)
00550 A1= FLT(A)
00560 P=INT(FNO(23))
00570 E=INT(FNO(28))
00580 I=INT(FNO(33))
00590 FOR X=0 TO 52
00600 S1$(X)=' '
00610 NEXT X
00620 S1$(28)='.'
00630 S1$(P)='P'
00640 S1$(E)='E'
00650 S1$(I)='I'
00660 PRINT STR(D); STR(M); STR(Y); TAB(10);
00670 FOR X=0 TO 51
00680 PRINT S1$(X);
00690 NEXT X
00700 PRINT S1$(52)
00710 IF L=1 THEN OUT5 OFF: END
00720 L=L-1
00730 A=A+1
00740 D=D+1
00750 IF M=2 AND D=29 AND Y=(Y/4)X4 THEN 550
00760 IF D(=T(M) THEN 550 ELSE LET M=M+1: D=1
00770 IF M(=12 THEN 550 ELSE LET M=1: Y=Y+1: GOTO 550
00780 M1=FLT(M): Y1=FLT(Y)
00790 Z=INT(30.57XM1)+INT(365.25XY1-32537.25)+D
00800 IF M(3 THEN RETURN
00810 IF Y=(Y/4)X4 THEN LET Z=Z-1 ELSE LET Z=Z-2
00820 RETURN
```

```
XXX PERSONAL BIORYTHM CHART FOR BABY NEW YEAR XXX
PHYSICAL = P, EMOTIONAL = E, INTELLECTUAL = I

DATE        DOWN                    CRITICAL                    UP
-----------------------------------------------------------------
1  1  83                             I
2  1  83                          .  IEP
3  1  83                          .     IE P
4  1  83                          .        I E  P
5  1  83                          .           I E  P
6  1  83                          .              I E P
7  1  83                          .              I E
8  1  83                          .              PI
9  1  83                          .           P  I
10 1  83                          .        P     E I
11 1  83                          .     P     E  I
12 1  83                          .  P     E  I
13 1  83                       P  .     E     I
14 1  83                    P     .  E     I
15 1  83                 P        E     I
16 1  83              P        E  .     I
17 1  83           P           E  . I
18 1  83        P        E     I  .
19 1  83        P  E        I     .
20 1  83           E     I        .
21 1  83        E     P  I        .
22 1  83        E     I     P     .
23 1  83        E  I              .
24 1  83           IE             P
25 1  83        I     E           .     P
26 1  83        I        E        .        P
27 1  83        I           E     .           P
28 1  83           I           E  .              P
29 1  83              I           E                 P
30 1  83                 I        .     E           P
31 1  83                    I     .        E        P
1  2  83                    I     .           E  P
2  2  83                       I  .           P  E
3  2  83                       I  .     P        E
4  2  83                       .  PI                E
5  2  83                    P  .     I              E
6  2  83                    P  .              I     E
7  2  83                 P     .                 I  E
8  2  83              P        .                 EI
9  2  83           P           .                 E  I
10 2  83        P              .     E              I
11 2  83        P              .  E                 I
12 2  83           P           E                    I
13 2  83              P           E  .              I
14 2  83                    P  E     .                 I
```

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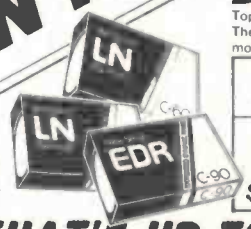

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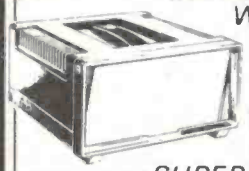

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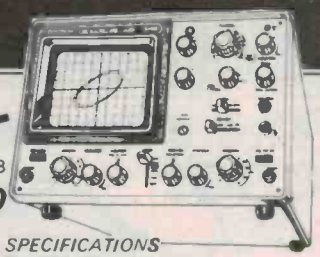

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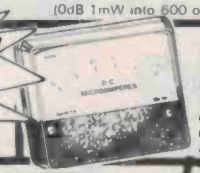

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All Dick Smith stores are open from 9am to 5.30pm (Sat. 9am to 12 noon)* except Queensland stores which open and close half hour earlier. Many stores are open for late night trading. Phone your nearest store for details.

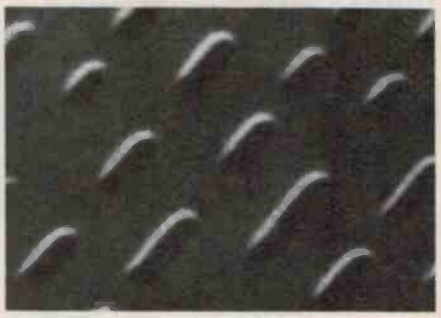
*North Ryde not open Saturday.

Prices correct and stock available at press time.

DSE/A403/LM

Philips demonstrate Compact Disc

With the digital bits still ringing in our ears from the Sony Compact Disc Player demonstration, we heard the Philips system reveal the wonders of digital recording. The demonstration was not without a few minor technical problems but they didn't detract from the clarity and brilliance of the live performance, reproduced through the medium of the digital disc.



The compact disc pit structure, magnified 12 500 times.

The disc is 'read' by focussing the laser light through the underside of the disc and optically reading the reflections.

The standard compact disc developed by Sony Corp. and Philips, and licensed along with the player technology to other makers, is only 12 cm in diameter, allowing for much smaller players than at present. The plastic-sheathed discs never wear out or scratch.

The compact Sony-Philips format won out in industry competition over alternative designs developed by West Germany's AEG-Telefunken and Victor Co. of Japan. A total of 34 companies now hold licences to manufacture and market Compact Disc players and nine record companies in Japan, Korea and Europe have licences for record production. US companies are conspicuously absent, waiting until the market is established before they follow suit.

Initially the Compact Disc players will cost $660 to $1000, but experts expect prices to plunge within a year or two to less than $200 as makers reach mass-production levels. More important, it appears that digitally recorded discs, the program material essential to the sale of the players, will be available in greater quantity and at lower prices than originally expected. PolyGram of West Germany, Philips' associate company, plans to offer about 600 long-playing albums by the end of 1983. And Japanese-based software ventures such as CBS/Sony, Toshiba-EMI and Pioneer will be marketing several hundred titles during the coming year. The discs will be priced at up to $18 and play for up to 60 minutes.

The Compact Disc digital audio system had to happen, but the fact that it happened now is because Philips had all the right technologies and resources. In the late 1960s Philips made strategic, long-term investments in three optical electronics systems, the Compact Disc, Digital Optical Recording and Video Long Play or Laservision. Philips also had at its disposal technologies in the areas of glass, studio recording, mastering, semiconductors, computers, telecommunications and record manufacture.

Few experts doubt the Compact Disc player's potential for success, but no one expects them to replace conventional turntables entirely. People will still want to play their conventional analogue records. But the introduction of the Compact Disc player may inspire consumers to upgrade their stereo systems and it foreshadows a time when music will be stored in computers, available by phone lines for home listening.

AWA-Thorn's new VCR

AWA-Thorn's new 'top of the range' VHS video cassette recorder, the ATV-20 is now on sale in Australia, superseding the ATV-5.

The new compact design incorporates the five motor drive system, having a separate motor for each function. It has an infrared, 14-function remote control which can be stored out of sight in the unit when not in use. New features are a time elapsed indicator, Dolby noise reduction system and a picture control to sharpen or soften the picture you view. The timer section now has a battery back-up which retains all selected programmes and time settings for up to one hour in the event of a power failure or accidental power disconnection.

It is expected to retail at $1199. More information can be obtained from **AWA-Thorn, 348 Victoria Rd, Rydalmere NSW 2116. (02) 638-9022.**

AWA-Thorn's new ATV-20

National's 'super video'

National's 'super video', their new NV777A VTR will replace the NV-7200A, released 12 months ago.

Included in the features of the NV777A are a three-head system for super still/super still-advance and super fine slow playback, noiseless reverse play and one touch timer recording. National claim that the one touch timer recording is unique and has recently been introduced on their new model NV300A.

The NV777A also has insert editing, tape remaining indicator, double-safety tape mechanism, three-day memory back-up system, one-button channel tuning, 16 channel capacity, 31 mode infra-red remote control and all the other functions on the NV7200A (excluding double speed playback).

Like the other products in National's range of home video equipment, the NV777A comes with a three year conditional warranty and home demonstration and installation policy.

National Panasonic is located at 95-99 Epping Rd, Nth Ryde NSW 2113. (02)887-5333.

New video package from Atari

Atari has started shipping its new video package, the 5200 Home Entertainment System. Retailing at around US$270, the 5200 is in the high end of the home systems market and nearly twice the price of its predecessor, Atari's 2600 Video Computer System.

A feature of the new system is the graphics of the ten game cartridges which make some of the 5200 games closely resemble the arcade versions, an improvement over the corresponding cartridge used on the 2600, observers said.

The 5200 is similar in appearance to Atari's 400 home computer but it doesn't have a keyboard. In 1983 Atari plans to bring out an adapter that will allow cartridges for the 2600 to be played on the 5200.

At the presentation for the 5200 system and the new 'E.T.' game cartridge, the president of Atari's Consumer Electronics division admitted to being a little concerned about competitors. Mattel's M-Network game cartridges are being marketed and have been designed to be used in Atari's 2600 VCS. Colecvision, the newest entry in the home systems market, is challenging Atari and Mattel with the quality of its graphics.

Yamaha K-500 cassette deck

Yamaha's new cassette deck, the K-500, has a pure Sendust head and two-motor transport system.

The Sendust head coil windings have half the number of turns used in conventional designs and Yamaha claim that this results in improved linearity, wider dynamic range and improved channel separation. In the two-motor design the takeup reel is driven by an independent motor for both fast-wind and record/play operations. Yamaha say that this system completely relieves the capstan motor of excess load, resulting in a wow and flutter of 0.05%.

The signal-to-noise ratio, using CrO_2 tape, is better than 60 dB with Dolby off, 68 dB with Dolby B on and better than 76 dB with Dolby C on. The frequency response, with CrO_2 tape, is 40 Hz to 18 kHz and with metal tape it is 40 Hz to 20 kHz. Total distortion is less than 1%.

If you would like to find out more about the Yamaha range of hi-fi equipment you can do so at **Rose Music, 17-33 Market St, South Melbourne Vic. 3205 or 18 Kent Rd, Belmore NSW 2192. (02)750-8999.**

The Remx 'Stereo XPander'

This little gadget is an 'interface' unit that goes between your magnetic cartridge and your preamp input. It is claimed to enhance your stereo imaging performance of your record playing system and give greater sonic detail.

In the limited blurb provided with the unit submitted for test, the makers say:

"The optimum loading establishes an ideal resistive termination for maximum signal transfer and good damping to maintain control under dynamic signal conditions."

Remx say that the input resistance of the unit is matched to any magnetic cartridge and the output resistance is matched to any phono input. Clearly, the unit is designed to provide optimum, or as near optimum as can be achieved, matching for the cartridge and to reduce 'cartridge impedance interaction'.

Until quite recent times, many preamps in hi-fi amplifiers returned the feedback to the input stage, right at the input. This is quite valid, providing the load on the input has constant characteristics under signal conditions. If not, the impedance of the driving source interacts with the feedback network, changing the dynamic response of the amplifier — cartridge impedance interaction. The most telling effects are on frequency response during playing and stereo image.

While modern design techniques have, to greater and lesser degrees, obviated this problem, there are still many amplifiers around, and being sold, that will exhibit the fault.

Interposing an 'interface' unit between the cartridge and the preamp input can be an effective cure. This is the purpose of the Remx Stereo XPander.

Remx claim the unit has very high linearity, THD less than 0.001%, crosstalk better than 80 dB, a bandwidth from 20 kHz to 100 kHz, maximum output of 12 mV and gain better than 3 dB.

It is powered by a small plugpack of any convenient voltage between 6 and 12 Vdc. When the unit is off an internal relay bypasses the unit. An LED on one end indicates when the unit is on. Four gold-plated RCA sockets provide input and output connection.

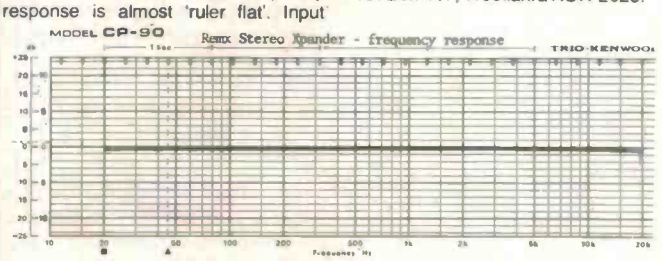
We had the chance to evaluate the unit here at ETI, both on the bench and in a stereo system. Well, what did we find?

At the time we had the unit, we couldn't find a preamp amongst staff that suffered from cartridge impedance interaction, so its effect on that problem is a little hard to report on. It would have to be tried on a 'suck it and see' basis. However, we were able to measure its characteristics.

As the chart shows, the frequency response is almost 'ruler flat'. Input noise was measured at −62 dB in a 20 Hz to 20 kHz, flat, bandwidth with respect to 10 mV input and the input terminated with a 330 ohm resistance. Distortion (THD) was much higher than anticipated, second harmonic predominating. This measured 0.22% at 100 Hz, 1 kHz and 10 kHz with a 10 mV input. Gain was measured at 5 dB and maximum output before distortion became unacceptable, 1 V RMS. Clipping was non-symmetrical, and 'soft'.

Overall, performance could only be regarded as mediocre, but if cartridge impedance interaction in your system is a problem, you might like to try the Remx Xpander as a solution if you don't want to go to the expense of buying a new preamp or integrated receiver/amplifier.

The unit should be available in selected hi-fi stores in January. For further information, contact Remx at P.O. Box 417, Woollahra NSW 2025.



One unique instrument deserves another

PE75.(Left) The perfect choice for the lead vocalist. Superb projection and low end power. High sensitivity for rich warm sound at lower levels. Superb internal shockmounting, silent on/off switch, ultra tight cardioid pattern.

PE47.(Below) Tone control in the palm of your hand. Frequency tailoring for vocal and instrumental use. Bass and treble contols. Mellow sibilant vocals or harsh brass. Excellent for unexpected stage problems. **Uses:** All vocals, piano, drums, guitar, cymbals.

PE65.(Left) Handles the highest levels with extreme accuracy. Wide response, tight pattern. Internal shockmount. Silent on/off switch. **Primary use:** Toms, bass drum, snare, cymbals, guitar, piano. **Secondary uses:** Brass, acoustic bass, vocals.

PE85.(Right) Superb vocal system mike. All the qualities of the PE75 plus a more rugged grill and wind filter. Includes impedance matching transformer and Shock Stopper™ swivel mount to eliminate stage vibration. **Uses:** All vocalists.

PE35.(Left) Presence and clarity helps vocals cut through. Bass lift and top end lift give the vocalist more projection and top end power. Internal filter and shock mount for handling and pop rejection. **Uses:** Hard working vocalists.

PE9.(Right) Low cost, high quality. Cardioid pattern. Locking on/off switch.**Primary uses:** Brass, flute, reeds, harmonica. **Secondary uses:** Guitar, vocals (with windshield).

PE45.(Above) Crisp top end to cut through. Wide dynamic range and tight cardioid pattern. Internal shockmount. Brings instruments up in the mix. **Primary uses:** Guitar amp, bass drum, snare, electric bass, electric piano. **Secondary uses:** Cymbals, brass, piano, vocals.

PE15.(Right) Best low cost vocals mike available. Smooth wide range sound, cardioid pattern. On/off switch, pop filter.

SHURE

AUDIO ENGINEERS (Vic)
2A Hill Street
THORNBURY Vic 3071
(03)44 3295

MARKETEC P/L
18 King William Street
Sth Fremantle WA 6162
(09) 335 8275

hifi

AUDIO ENGINEERS P/L
342 Kent Street
Sydney NSW 2000
(02)29 6731

NOMIS ELECTRONICS
689 South Road
BLACK FOREST SA 5035
(08)293 4896

AUDIO ENGINEERS (Qld)
47 Castlemaine Street
MILTON QLD 4064
(07)369 9670

Please send me information on the following Shure mikes: ☐ PE9 ☐ PE65 ☐ PE45 ☐ PE47 ☐ PE15 ☐ PE35 ☐ PE75 ☐ PE85. Name:.....

Address.....

Glover & Assoc. AE/15

Marantz SC6 preamplifier and SM6 power amplifier

This review contains the first set of published data relating to the new IEC test method for evaluating high frequency distortion. The results are quite outstanding. The SC6 and SM6 are an exceptionally good combination, says Louis, with a performance bordering on perfection.

Louis Challis

THIS REVIEW HAS been written twice because of the need to provide technical data and adequate documentation of what is fast becoming one of the hottest topics in the professional audio field in Australia today. The reasons for this extend beyond Australia to the august International Electro-Technical Commission and to a new draft test method for evaluating odd order and even order high frequency distortion. This draft test method will be described by us as the 'IEC High Frequency Total Difference Frequency Distortion'. The technique was developed in Australia and presented by the Australian Committee to the IEC as a preferred alternative to the Finnish transient intermodulation distortion method of rating and analysis.

Obviously there are good reasons for moving for a suitable alternative to the Finnish proposed method of analysis, one of them being the complexity and cost of that method. The Australian Committee are firmly resolved in their support of the Australian proposal which I also believe is the best method currently available for the evaluation of dynamic distortion analysis, not only for amplifiers, but more significantly for tape recorders, communication circuits and all associated situations.

We have conducted a series of evaluations of the Australian method and over the last few months we have also been evaluating the Japanese method, as embodied by the Italian version of the circuit published in 'Wireless World'.

There is a reasonably good correlation between the results provided by the two methods, although the frequencies at which the Japanese technique is used are only suitable for amplifiers and not for other electro-acoustic systems. For this reason we believe the Australian draft proposal which operates at frequencies of 10 kHz and 14.97 kHz mixed on a one to one basis is the correct choice. Commercial versions of the Australian system are likely to operate at slightly lower frequencies in order to render them even more suitable for the wide range of possible applications.

This review contains the first set of published data relating to this test method and presents results that are quite outstanding.

The SC6 and SM6 stereo console preamplifier and stereo power amplifier are two of the Marantz 'Esotec' range which we had seen in the trade literature but apart from that had not previously seen or heard them. Their major feature, and in fact the main talking point of this review, is that the stereo power amplifier output stages offer the option of both a true Class A operation and the more conventional Class AB operation which the units describe as Class B operation. This is done to satisfy the 'Electronic Purists' in our consumer society who firmly believe that only Class A operation can achieve perfection with the total removal of crossover distortion and the lowest possible level of harmonic distortion. Like all the other units in the Marantz Esotec range, the SC6 and SM6 are expensive and have an appearance which I consider to be a little too conservative, especially when compared with the latest generation of consumer electronics from America, Japan and Europe.

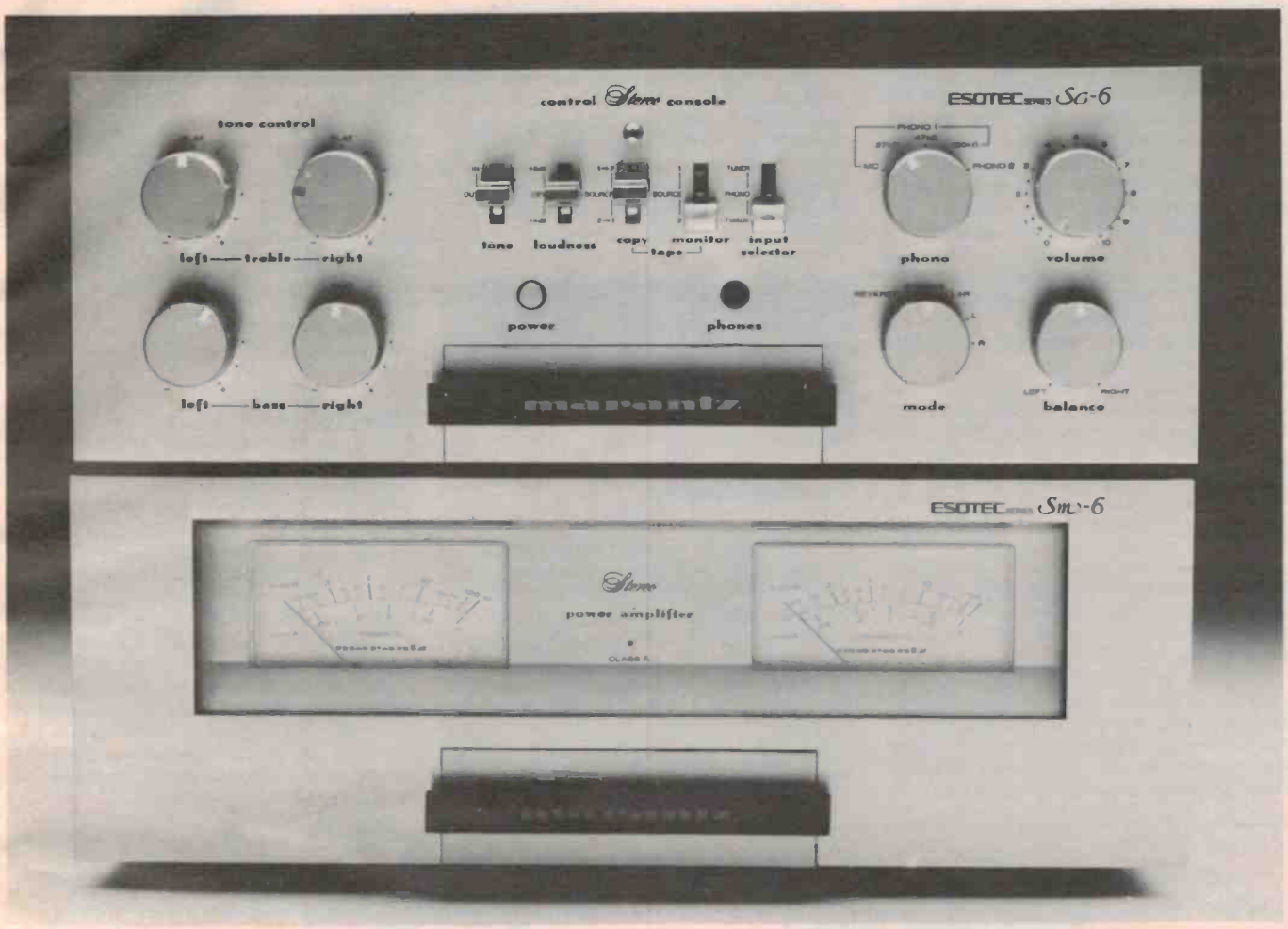
MARANTZ SC6 PREAMPLIFIER AND SM6 POWER AMPLIFIER

SC6	
Dimensions:	*416 mm wide x 146 mm high x 244 mm deep*
Weight:	*6.5 kg*
Price:	*$489 recommended retail*
SM6	
Dimensions:	*416 mm wide x 146 mm high x 332 mm deep*
Weight:	*14.5 kg*
Price:	*$689 recommended retail*
Manufactured:	*In Japan for Marantz USA*
Distributor:	*Marantz (Aust) Pty Ltd, 19 Chard Rd, Brookvale NSW 2100. (02)939-1900.*

SC6 features

The SC6 stereo control console features a golden hued brushed satin aluminium fascia with three main groupings of controls. On the left hand side are the two separate treble controls and two separate base controls. On the right hand side of the console are four rotary controls. The first control is for phono selection which provides a choice of a moving coil cartridge or 27k, 47k, and 100k input impedances for moving magnet cartridges and a second moving magnet cartridge input for phono 2. The second control is the volume control, the third control is the mode switch for stereo, reverse and left plus right channels combined, whilst the fourth control is a balance control with centre indent.

In the top centre of the deck are five large toggle switches which, from left to right, are a tone control in or defeat function and next to this is a loudness control setting with centre off and +8 dB at the top and +4 dB



Conservatism. Some brilliant 'avante garde' technology is hidden beneath the conservative shells of the SC6 and SM6.

at the bottom. Adjacent to this switch are two tape control switches for copying and monitoring from or into two separate tape recorders. The last control on the right is the input selector for phono, tuner or TV auxiliary. Below these switches are the power on/off switch and a headphone socket. Behind the bottom fascia panel are two push buttons for selecting output 1 or output 2, a 'high out' filter and a subsonic equaliser filter. This subsonic equaliser filter is intended to reduce the impact of rumble generated either by the turntable or from warped records and it is poorly described in the technical handbook.

The back of the control console features a series of gold plated RCA type coaxial sockets with a pair of shorting plugs in the phono 1 input. These plugs are supplemented by a strict labelled warning that when these terminals are not being used, the shorting plugs should be left in position. This unit is provided with a mains voltage selector.

The switched and unswitched sockets on the back panel, which are normally provided for American and Japanese-type markets, have been deliberately disconnected to meet Australian design requirements. The chassis and the cabinet are strongly fabricated from heavy weight steel. The unit is well ventilated to allow for its location in semi-enclosed situations, such as in furniture, where this type of unit could be expected to be used.

SM6 features

The SM6 power amplifier presents a somewhat simpler, yet considerably more attractive appearance than the SC6 stereo control console. The front panel features a large glass display window panel behind which are located the two separate power output meters separately calibrated for 'Class A' and 'Class B' operation. The Class B metering range covers more than a 50 dB dynamic range with calibrations from less than 10 mW at one end to greater than 120 W at the other. The Class A meter covers a range from 10 mW to 30 W. When the Class A operation is selected, a red light is activated and if one was not aware of the pull out panel on the front lower section of the fascia one would not even be aware of the additional controls provided. These controls are a power on/off switch and the Class A selection button on the left. And on the right is a switch for selecting speaker system 1 or 2, or 1 and 2 by the use of two push buttons.

The rear of the amplifier features two independent gain controls for the left and right channels and two sets of inputs labelled 'Direct' and 'Subsonic'. The Direct input allows dc coupling to the input stage of the amplifier while the subsonic input provides very low frequency roll-off. The speaker connections are by means of four sets of black and white universal terminals which are well insulated, large and practical. The switched and unswitched parallel pin power outlets on this unit have been internally disconnected to meet the Australian design rules. At the bottom right hand corner is a mains fuse.

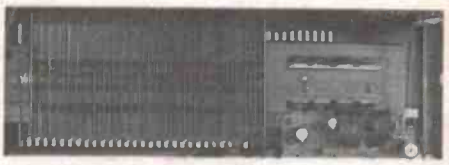
The unit is also fitted with a mains voltage selector on the rear panel and arrived already connected for 240 V. The cabinet is very strongly made with hammer tone finished steel featuring a very large expanse of perforated linear slots covering more than 80% of the top of the cabinet and more than 50% of each side of the cabinet. The bottom of the chassis is also extensively perforated and the amplifier features a much greater open area for ventilation than the majority of amplifiers we have reviewed. ▶

Inside the SM6

The output stage of the amplifier features the heat pipe thermal dissipation system, developed by NASA in the mid 70's, which was discussed in the review of the Sony TA-F80 amplifier (ETI, May 1981). This radiator device is claimed to be many hundreds of times more effective than conventional heat sinks and is supplemented by a speaker protection circuit which is intended to switch off the output stage in the presence of either excessive current or overload conditions which might otherwise damage or destroy the output stage. This is particularly important when the amplifier is operating in the Class A mode which generates the maximum possible thermal energy. This mode calls for the maximum amount of heat dissipation and obviously a very fast response time, if the unit is to protect the output stage. The power amplifier features an unusual layout with the heat pipe's thermal output stage at the extreme right hand of the rear of the amplifier. The heat pipe is connected through the centre of an array of eight output transistors. These extend beyond the transistor block right across the rear of the amplifier with the finned heat radiator providing the effective heat dissipation for both Class A and Class B operation.

The front of the amplifier features a large encapsulated mains transformer on the left hand side, two large electrolytic capacitors in the middle, the control circuitry and protection circuitry on the right hand side at the front. The main protection circuits and fuses are also located on a terminal block at the top of the main control amplifier circuit.

At the extreme front of the chassis are the power output meters and their associated electronic metering amplifiers. The chassis construction is unusually strong and although much of the wiring is conventional twisted pairs, it is neatly laid out and the unit is obviously well designed. Although the amplifier looks relatively simple in appearance, it is nonetheless a complex and unusual piece of electronics.



Heatsink. Heat pipe in the SM6.

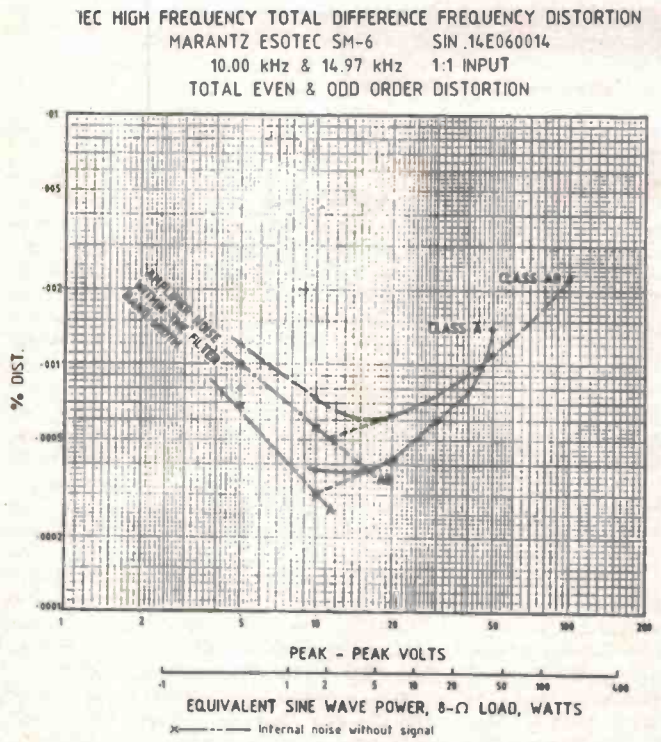
Testing, testing

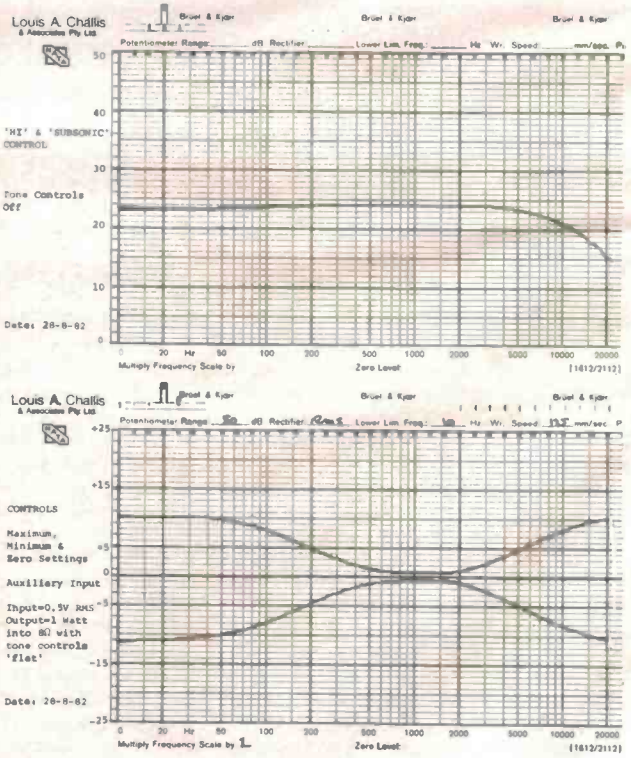
The evaluation of the Marantz control console and power output amplifier stages were initially carried out as separate tests and then the results combined to provide an overall picture. When the control console and power amplifier are interconnected the frequency response is excellent, extending from less than 10 Hz to beyond 100 kHz with both the tone controls centred, as well as with the tone controls defeated. Over the frequency region 10 Hz to 20 kHz the response is basically ruler flat, particularly when the subsonic and associated high pass filters are de-activated. The sensitivity of the auxilliary tuner and tape inputs are, respectively, 12 mV and 12.5 mV for a one watt output into eight ohms.

The moving coil cartridge input required only 21 uV and the moving magnet cartridge input required 210 uV. The overload level for the moving coil cartridge input is 22 mV while the overload point for the moving magnet cartridge is 270 mV, both providing a particularly healthy safety margin. The moving coil cartridge provides input impedances of 75 ohms while the measured moving magnet cartridge impedances are 27k, 47k and 100k which are exactly as specified by the manufacturer.

The harmonic distortion of the preamplifier operating alone is less than 0.005% at its maximum output and under most normal operating conditions is less than 0.002%. The main power amplifier is essentially flat from 0 Hz to beyond 100 kHz in the direct mode, and is typically 2 Hz to beyond 100 kHz in the subsonic mode.

I was intrigued that the designers should want to provide both Class A and AB operation in the one unit as very few people could reasonably be expected to desire such a feature. In the Class AB mode the power output, although specified as 120 watts, actually has a maximum value at clipping of 182 watts. This output is 1.8 dB re the 120 watt level and is more than adequate for the general applications in which the amplifier could be expected to be used.





Obviously the parameters that I was most interested in evaluating are the levels of the individual harmonic components and the total harmonic distortion. These were not what we thought they would be for either mode of operation. At 120 W output (in the Class AB mode of operation) the total harmonic distortion with a 100 Hz signal is 0.0047%, at 1 kHz it is 0.0014% and at 6.3 kHz it is 0.0017%. These are exceptionally good performances and there are only a few amplifiers around that are able to better these figures. At 30 W output the distortion in both the Class A and Class AB modes is not greatly different. At 100 Hz they are respectively 0.01% and 0.009%. At 1 kHz the distortion is 0.002% and 0.0009% and at 6.3 kHz it is 0.0013% and 0.0018%. Obviously with differences that are so small the reviewer and the designer are only really playing a numbers game.

Subjectively, the important test is of course, neither determined at 30 W nor at 120 W. What happens at the 1 W level is probably more important for most people listening under reasonable sound levels and classical music is usually listened to at this level. At 1 W output with a 100 Hz signal there is not a significant difference between the A and AB modes which are both 0.006% (being controlled by flux leakage), but at 1 kHz there is a significant numerical difference with 0.0009% and 0.0018%. At 6.3 kHz the levels are 0.0007% and 0.0024%. These are *exceptionally* low distortions, with the best being only slightly higher than a few parts per million. A significant portion of the lowest distortion measured is actually being produced in our test oscillator rather than in the power amplifier (0.0001% to 0.00015%). The differences are measurable but anybody who claims that he can hear the difference is "a better man than I am".

The IEC high frequency total difference frequency distortion parameters also proved to be exceptionally good and in fact, the lowest we have yet seen from any amplifier tested. It is interesting to note that in the Class A mode the distortion levels are less than those produced in the Class AB mode at power levels up to approximately 25 W output. Class A distortion was greater than that of Class AB at high levels. Equally significant, the amplifier background noise measured within the filter band width is significantly lower in the Class A mode than it is in the Class AB mode. This characteristic further justifies some of the other claims presented for the use of the Class A option.

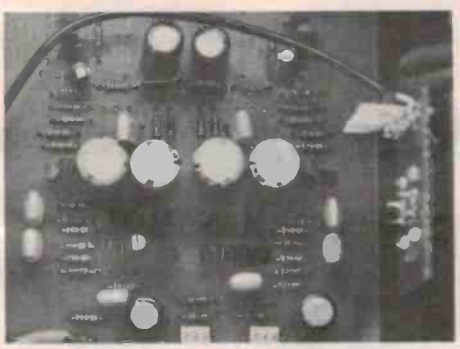
The slew rate test of the amplifier (utilizing the Japanese method) showed it to have impeccable performance and the transient intermodulation distortion measured by the archaic SMPTE method proved to be exceptionally low and much less than 0.01%.

The hum levels proved to primarily 50 Hz leakage hum pickup from the moving coil cartridge input and 50 Hz and 150 Hz from the moving magnet cartridge input. These were measured relative to the 1 W level and still proved to be extremely low, although admittedly, not the lowest we have seen. The subsonic filter not only cut out the low frequency components but also inexplicably rolled over at the top end by 3 dB and 10 kHz and 9 dB at 20 kHz. The tone controls provided useful and effective adjustment amounting to ± 10 dB at 50 Hz and ± 10 dB at 20 kHz. The loudness control is slightly better than most, providing two contour level slopes to cater for low and moderate listening levels. All of the manufacturer's claims for the signal-to-noise ratio, distortion, crosstalk and sensitivity were equalled or bettered in every single case. The most notable performance being in terms of the harmonic distortion generated by the amplifier which is as close to perfection as one could reasonably expect (more importantly, it is right on the limits of our measurement system).

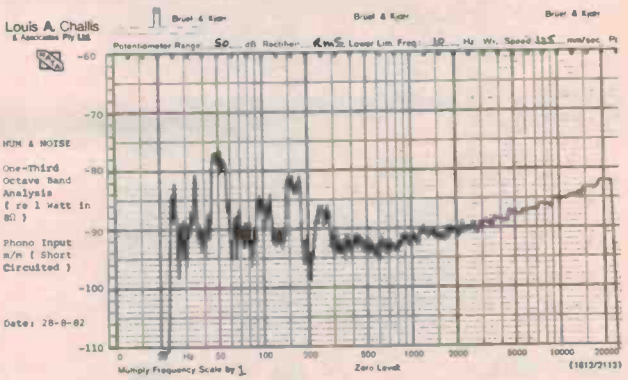
Subjectively

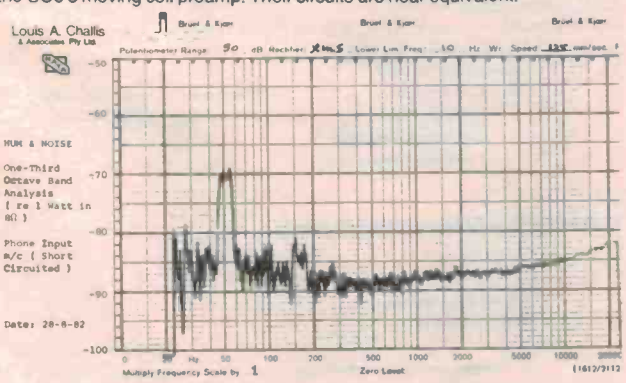
To evaluate the SC6 and SM6 I took them home and connected them up to three different sets of speakers, a record player and a cassette player. The records that I decided to evaluate included two new ones, one of which is undoubtedly one of the most unusual conventional records ever made and released for sale to the public.

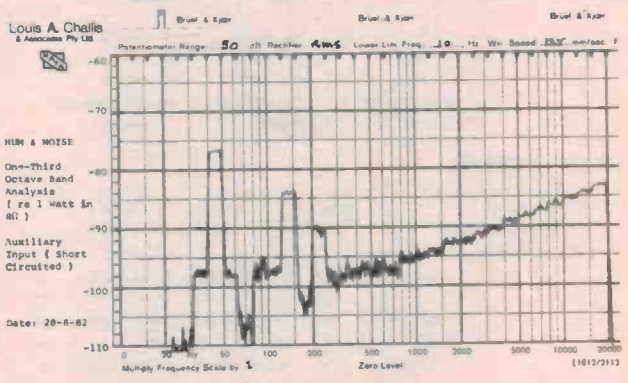
This record, called the 'Sheffield Track Record' (lab 20) is produced by Sheffield Laboratories in Los Angeles by the Direct Recording Method. It was released at the CES in America earlier this year and became available to dealers in the USA and Australia ▶



MC preamp. Constructors of the ETI-473 MC headamp will recognise the topology of the SC6's moving coil preamp. Their circuits are near equivalent.







at the beginning of September. The record is unusual in that the recording engineers have cut the tracks on the Neumann lathe with the maximum possible groove spacing so that the full energy of the low frequencies and base transients was recorded without any compression. Because of this, the total playing time of the record is somewhat shorter than usual, being only about 16 minutes. They claim to have done everything possible to make the record perfect. This particular record contains more peak transient energy, higher resolution and more dynamic range than has previously been recorded by any other analogue record. This probably makes it one of the best test records ever produced for evaluating amplifiers, loud speakers and, in particular, record player cartridges.

The amplifier is capable of handling continuous peaks of up to 180 W output into the speakers with normal programme levels averaging between 5 and 20 W. I tried to play this record in the Class A mode and found that the power output of the amplifier in this mode was just not up to the task. So then I played one of the latest original master recordings from Mobile Fidelity (George Solti conducting the Chicago Symphony Orchestra and Chorus on Mobile Fidelity Sound Labs records MFSL2.516.). This is an exceptional record and better suited to Class A operation.

I was unable to detect any trace of difference between the amplifier when operating in either the Class A or the Class AB modes. This, of course, is not the amplifier's fault for when you have distortion components that range between 2 parts per million and 20 parts per million it would take a better set of ears than mine (or those of anybody else whom I brought in to listen) to detect the difference.

The Marantz SC6 stereo control console and SM6 stereo power amplifier are an exceptionally good combination. The performance that they are able to produce borders on perfection. The amplifier offers both Class A and Class AB modes of operation with distortion products that are just about at the extreme limit of our measurement ability. The performance is so good that it appears to me that the inclusion of the Class A mode is not strictly warranted. However, for somebody who wants perfection this control console and power amplifier comes near to the best level that one could hope to achieve. The only improvements I could commend to Marantz would be to fix the subsonic filter response at the top end and to improve the design of the front panel of the SC6 to make it a little more 'avant garde' and a little less conservative. ●

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MEASURED PERFORMANCE OF: MARANTZ MODEL SM-6 POWER AMPLIFIER
SERIAL NUMBER:

FREQUENCY RESPONSE:

(-3dB re 1 watt, 0.5V Input to Aux.)	Tone Controls Defeated				
	Left	< 1	Hz	to >100	kHz
	Right	<40	Hz	to >100	kHz
	Tone Controls Centred				
	Left	10	Hz	to 100	kHz
	Right	10	Hz	to 100	kHz

SENSITIVITY: (control-console connected to amplifier)
(for 1 Watt in 8)

	Left	Right
AUX	12.5 mV	12.0 mV
TUNER	12.5 mV	12.0 mV
TAPE	12.5 mV	12.0 mV
PHONO M/M	210 µV	210 µV
PHONO M/C	21 µV	21 µV
OVERLOAD M/M	270 mV	280 mV
OVERLOAD M/C	22 mV	23 mV

INPUT IMPEDANCE:

	Left	Right
AUX	40 kohm	40 kohm
TUNER	40 kohm	40 kohm
TAPE	40 kohm	40 kohm
PHONO M/M	27k, 47k, 100k,	27k, 47k, 100kohm,
PHONO M/C	75ohm	75ohm

HARMONIC DISTORTION:

(A) (At rated power of 30 Watts (A) into 8 = 15.5 Volts)

	100Hz		1kHz		6.3kHz		
	A	AB	A	AB	A	AB	
2nd	-88.0	-87.7	-107.9	-104.1	-103.4	-96.5	dB
3rd	-80.9	-92.2	-94.2	-104.9	-99.4	-102.9	dB
4th	-113.3	-112.6	-120.8	-113.9	-110.8	-101.6	dB
5th	-97.6	-97.2	-111.4	-107.9	--	--	dB
THD	0.01	0.009	0.002	0.0009	0.0013	0.0018	%

(B) (At 1 Watt Into 8)

	100Hz		1kHz		6.3kHz		
	A	AB	A	AB	A	AB	
2nd	-96.3	-110.5	-102.3	-102.3	-102.7	-102.1	dB
3rd	-85.2	-84.4	-108.0	-97	--	-105.9	dB
4th	-114.9	-113.5	--	-106.4	--	-105.1	dB
5th	-116.1	-115.1	--	--	--	--	dB
THD	0.006	0.006	0.0009	0.0018	0.0007	0.0024	%

(C) (At Rated Power of 120 Watts (AB) Into 80 = 31Volts)

	100Hz	1kHz	6.3kHz	
	AB	AB	AB	
2nd	-84.5	-93.5	-97.3	dB
3rd	-82.0	-93.4	-93	dB
4th	-101.7	-103.5	-96	dB
5th	-98.3	-112.3	--	dB
THD	0.01	0.0031	0.003	%

TRANSIENT INTERMODULATION DISTORTION:
Less than 0.1 %
(3.15kHz square wave and
15kHz sine wave mixed 4:1)

I.E.C. High Frequency total difference Frequency Distortion

	CLASS A	CLASS AB
10 volts P.P.	.00038	.0008
20	.00042	.00063
30	.0006	.00076
40	.00078	.00082
50	.0014	.0011
100	--	.0022
Mode	"odd harmonics"	

NOISE & HUM LEVELS:
(re 1 Watt Into 8)

AUX -73dB (Lin) -79dB(A)

(with volume control set for 1 watt output with,
0.5V input (Aux)
5mV input (Phono M/M)
0.5mV input (Phono M/C)

PHONO M/M -72dB (Lin) -77dB(A)
PHONO M/C -68dB (Lin) -75dB(A)

MAXIMUM OUTPUT POWER AT CLIPPING POINT:

(IHF-A-202)
(20mS burst repeated at
500mS intervals)

= 182 Watts

therefore Dynamic Headroom = 1.8 dB (re 120 Watts)

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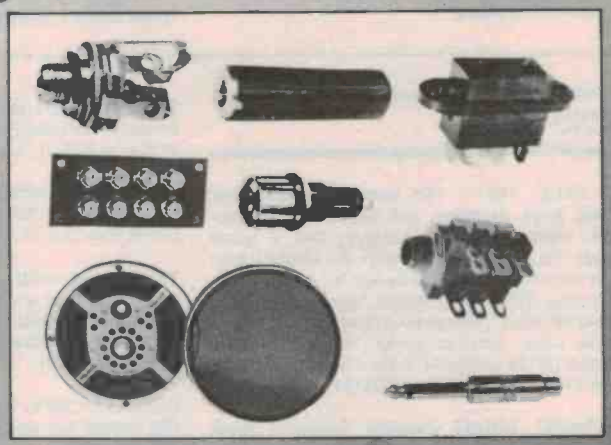

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PL30-9/60VA dual 15V at 500mA and 9V at 5A

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MORDAUNT SHORT Pageant Series II loudspeakers for sale, one pair, $300. Enquire Tim Jewell, 18 Alexander Ave, Campbelltown SA or phone (08)336-6952.

3M WOLLENSAK, set of six high-speed cassette copiers, model 2760AV. 2 ch, ½ track. Very good condition, $850. Butt, Box 503, Glen Innes NSW 2370.

SELL: GUITAR amplifier, as new, Elfa 5 W hardly used, excellent condition. $85. Phone (02)449-9130.

HARMON KARDON integrated valve amplifier. 30 WRMS/ch using EL34s. This superb sounding amplifier has just recently been modified throughout. Extra brand new tubes, $390. (02)46-5451.

FOR SALE: SPEAKERS, Goodmans 15 inch woofers. These speakers have only been used once. Less than one year old. Half price at $195. (02)46-5451.

DISC CUTTING lathe: Presto with spare cutter head and styli. Also power amp limiter and Rola 66 tape recorder level meters and patch panel. $400 ono. Phone (02)651-2214.

MISCELLANEOUS

FOR SALE: MAGAZINES. 74 EA, April 66-July 80. 63 ETI, April 71-June 82. 23 Electronics International. 32 others. 70¢ each, $100 the lot. Phone (02)387-3097.

FOR SALE: 4¼ inch 240 V Muffin fans, $7.50 ea. (02)452-3925 ah.

VALVE WANTED, 6U5 (magic eye). Equivalents are 6G5, 6H5, 6M2, 6T5. Write to Martin Smith, 21 Ashburton St, East Victoria Park WA 6101. (09)361-6764 (reverse charges).

WANTED: K901 (EDISON) delay relay (115 Vac heater). Has octal base and glass envelope similar in size to 6V6GT. D. Bruce (03)583-1638.

DUAL BEAM CRO, Leader LB0514, 10 MHz. As new, NZ$450. Graeme Teesdale, 13 Glendale Drive, Hamilton N.Z.

TEKTRONIX 465B oscilloscope, as new, dc to 100 MHz. Dual channel, dual timebase, delayed sweep, fully calibrated. Three months warranty, manual and probe included, $3500. Phone Dom (02)546-2463 ah.

OSCILLOSCOPE: Five inch dual-beam Cossar. Old model but excellent condition, $100. Phone (02)387-3097.

SELL: SIEMENS M100 teleprinters, 240 Vac, internal supply, serial TTL I/O, all good order. $250. Delivery by arrangement. W. Watkins, P.O. Box 1117, Orange NSW 2800.

TI-59 CALCULATOR and PC-100C printer for sale with all literature, charger etc. As new condition, $350 ono. C. Dalitz, 9 Dine St, Randwick NSW 2031. (02)398-6961.

TELEQUIPMENT D55A 10 MHz true dual beam oscilloscope with delay timebase, $300. Philips PM6503 transistor analyser (solid-state), $100. Tesla 25 MHz single trace oscilloscope, $200. TI58 calculator, $60. Sharp PC1211 computer, $100. (02)527-2873.

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WANTED: COPY of Radio Electronics Nov 78. Will pay $2.00. A photocopy of Part 1 Tank game acceptable. Send to 'Killmarnock', Nullamalma, via Inverell NSW 2360.

COMMUNICATIONS

FOR SALE: ICF-2001 receiver, two months old, not suitable for my use, $150 ono. G. Willson, 15 Hirt Ave, Murray Bridge SA 5253. (085)32-0259 bh or (085)32-4597 ah.

SWAP: COMMODORE 8K with sound, software and full documentation for telereader CWR-670E or FR6-7700 or equivalents. Phone David (07)246-1474.

COMPUTERS

FOR SALE: Dream 6802 computer with power supply, cassette, some programs and full documentation, $120 ono. (069)22-5335 after 5pm.

FLOPPY DISK drive power supply, 5 V at 3 A, −5 V at 0.7 A, 24 V at 2.8 A. Open frame, compact, with harness for 2 x SA800. $100. (07)376-3323.

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PADDLES for VIC 20, $25 + $2 p&p. To order or for further information write to BIP Hardware, 34 Knights Rd, Galston NSW 2159.

SORCERER 32K, Devpac, manuals, cables, WP and other programs, $750 ono. Godbout XX S100 32K static RAM, $250. Hazeltine terminal, $100. Terry (02)682-4649 ah.

SELL: Exorciser buss to SS-30 I/O card adaptor board, allows use of SS-30 I/O cards on Exorciser buss, $150. Ken (03)873-3903.

ETI-660, case, colour components, amplifier, modulator, transformer, leads, 24" monitor, $300. Willi, 9 Malua Cres, Mill Park Vic. 3082. (03)404-2063.

FOR SALE: Control Data tape transport system, complete and to the best of my knowledge in working order. $800 ono. Will consider separating and selling parts. Phone Ken George (03)878-7574.

SELL: ETI-660 (Monochrome) complete in case with 3K RAM, programs etc. $90. G. Hunt, 19 Menzies Close, Frankston 3199. (03)787-5876.

FOR SALE: Sinclair ZX-80 with manual, leads, PSU, dust cover, cassette recorder, loads programs. Cost $150, sell $60 ono. Complete 1981 ETI & EA, $10. (02)84-6564.

FOR SALE: CALIGRAF program for ZX80/8K ROM, ZX81 (6K RAM plus printer). Produces upper and lower case, proportionately spaced printout, $11.95. R. Morgan, 61 Rathowen Pde, Killarney Heights NSW 2087.

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SELL: TRS-80 games — Nova, Galaxy, Cosmic, Attack, EDTASM+, Advent, Crowley, ATC, etc. Half cost ono. David Brighton, Franklin Rd, Huonville 7109.

BRAND NEW VIC-20: Not even opened, only $380. K. Fong, 6/46 Mitre St, St. Lucia Qld 4067.

FOR SALE: ETI-660, plug pack, 3K, colour, in wood case, modulator. No reasonable offer refused. J. Higgs, "Galliers", North St, Thirlmere NSW 2572. (046)81-8583.

BBC Model A (16K), brand new, in carton. Complete with 'welcome' package and users guide. Cost over $1400, will sell $1150 ono. Phone (03)789-3226.

SELL: APPLE II europlus with sculptured keyboard, green phosphor monitor, 16K RAM card, Microsoft softcard, disk drive and tape archiving. $3000. Phone (03)20-2150 ah.

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FOR SALE: SHARP PC1211 pocket computer and printer with manuals, application programs. $120. Phone (062)72-3711.

FOR SALE: SYSTEM 80 business MKII, excellent condition, only five months old. Suit new buyer, lots of software, $700 ono. Phone Len (02)569-6271.

FOR SALE: SYSTEM 80 (late model), 16K with sound switch. $200 of programs with magazine, the lot $700. W. Pfeffer, 22 Burns St, Capalaba Qld 4157. (07)390-2326.

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ATTENTION! Does anybody have a 'spare' keyboard encoder or cassette interface for the old DGS100 systems? (Desperation: severe.) Ring after 5pm, Ben (02)848-8141.

MICROBEE DOCUMENT editor: a word processing program. 15 page instruction manual and complete listing, $10. Manual, listing, plus tape $15. H. Proctor, 27 Roberts Avenue, Mortdale NSW 2223.

SELL: Two XMX80 printers, $700. Apple interface, $39. One APF disk drive, $175. APF colour monitor, $580. 400 x Verbatim disks, $3 ea + st, all new. Greg (03)578-6108 ah.

FOR SALE: MICROBEE 32K, ED/ASS, monitor, cass/rec, software, all manuals, cost approx. $800. Sell $650. (043)28-4442.

SUPER-80: EPROM BASIC, power supply, 16K RAM expandable to 48K on-board, all IC sockets, manuals provided. $295. R. Sandland, 9 Downes St, Epping NSW. (02)86-6731.

FOR SALE: HOMEMADE 2650 computer, software, junkbox, $850. 16K Z81, excellent condition, printer not working, $450. David Wheatley, 4 Martin Cres, Milperra NSW 2214.

ZX81 PROGRAMS: 15 programs, set $10. Catalog $2. Cheque/postal order to Poseidon Software, 72 May Street, West Preston, Melbourne Vic. 3072.

SELL: DUMB TERMINAL, IE Model 33, 72 char/line, 24 lines. 110-500 band plus service manual, working. $130. Adrian 398-7224 or 331-6333.

FOR SALE: S100 TCT 16K memory board using prime LP chips. $105 each or two for $200. (047)36-3698.

FOR FREE: CHIP 8 User Group programs. Send S.A.E. with details of which CHIP 8 machine to Frank Rees, 27 King St, Boort Vic. 3537.

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'Playing a series of direct-recorded discs, warped discs, discs with nasty low frequency content and discs requiring unusual trackability performance, showed clearly that this system borders on the superlative in areas where even most good turntables only provide good to above average performance.'

'. . .the resonance characteristics of the TT1000 are the lowest we have yet seen from any turntable irrespective of its selling price.'

'This is top-of-the-line equipment for people who rate hi-fi as their greatest pleasure in life'. — *Louis Challis, Electronics Today International, April 1981.*

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When it was bench-tested by ETI Magazine in an exhaustive lab study, Louis Challis stated 'The Marantz SM1000 Amplifier has the capability to provide superlative performance at home, in a laboratory, in a studio, or in a rock band with the ease and panache of a professional.

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ST8

SM1000

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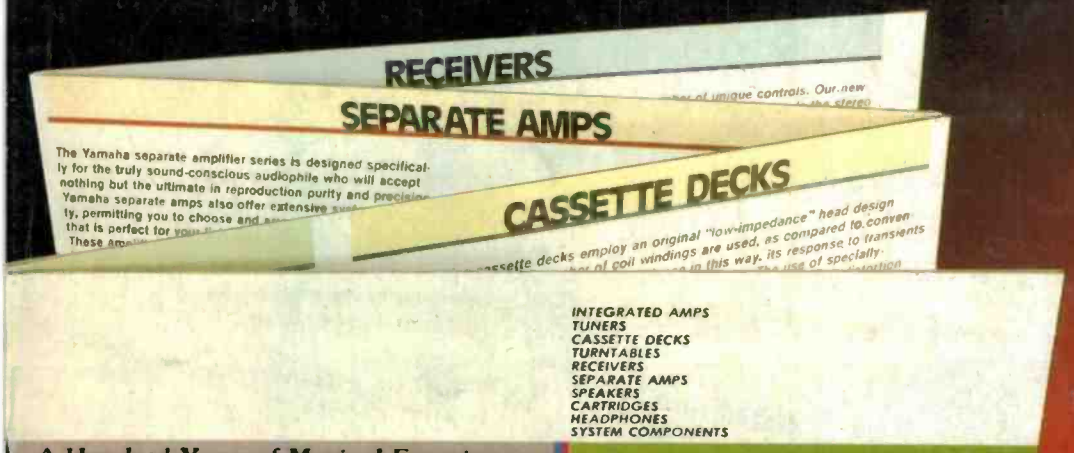

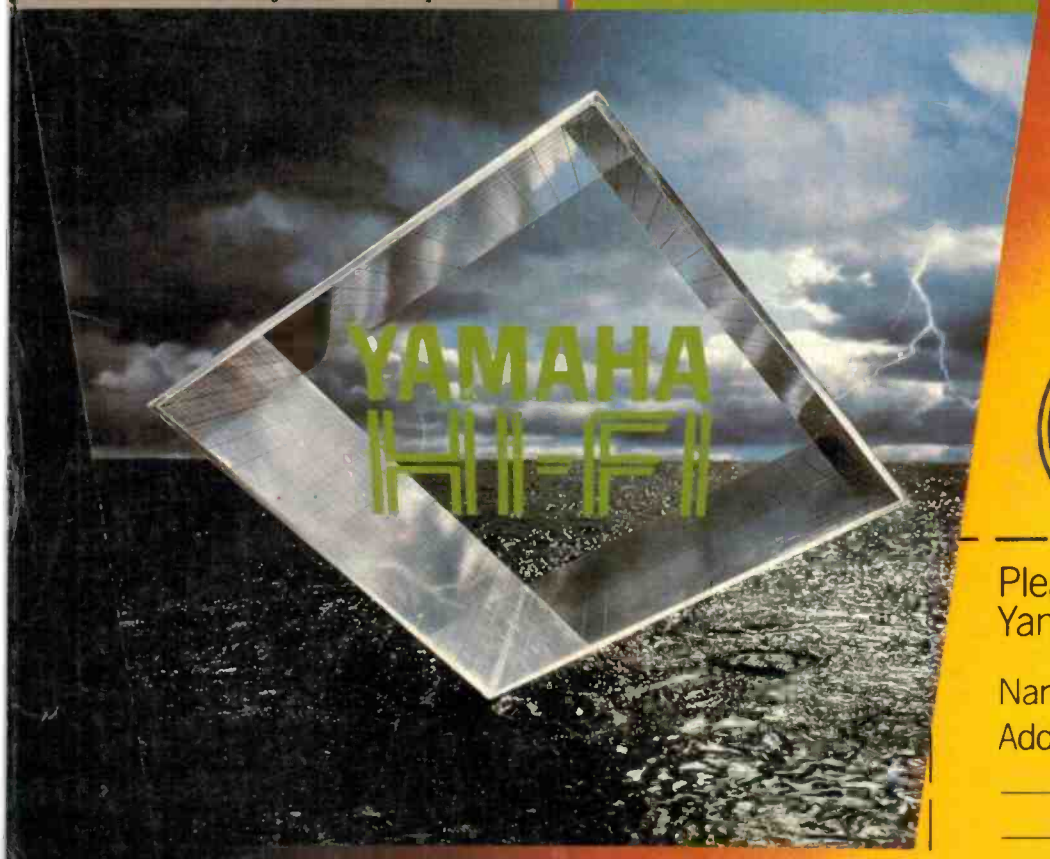

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