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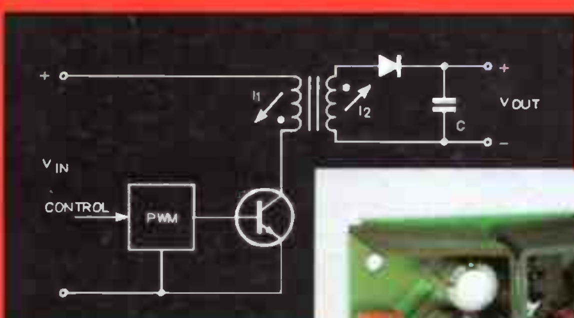
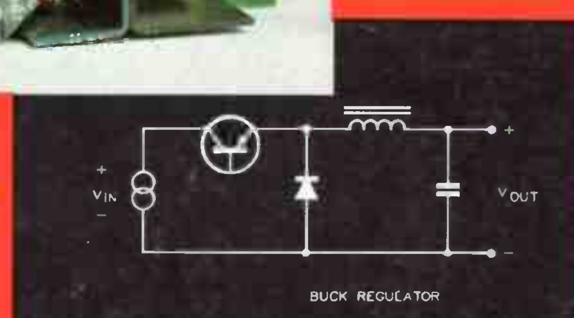


BUILD OUR 100W 'U-F' TOPOLOGY AMP

What's new in modems!



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Australian Electronics Monthly

Elektor Electronics

NEW FACES

This issue we welcome aboard two enthusiastic new members to the AEM team: Richard Pakalnis and Andrew Keir.

Richard steps into the role of National Advertising Manager and will be well-known to some of you, readers and advertisers alike, as during the early '80s he sold advertising on "Your Computer" magazine as well as starting their Microbee Column, and was advertising manager on another electronics magazine for a period. During 1985-86, Richard travelled Europe and Japan – some readers may remember his article on the Tsukaba World Expo in our September '85 issue; a multi-talented fellow, is our Richard. Lithuanian by birth, raised in Britain and educated in Sydney, Richard speaks several languages, including Wordstar, Mailmerge, dBase and fluent Strine.

Andrew – Andy – Keir, now our Assistant Editor, hails from Wales, where he first became interested in electronics at the age of 10. Andy will also be well-known to some readers, being an active amateur operator (VK2AAK), and from his previous position at Dick Smith Electronics where he spent the past three years, first in R&D, then latterly in the Technical & Enthusiasts Division with responsibility for kits and communications products. Prior to that, Andy worked in the servicing game. He ran his own electronic servicing business for a while, then moved into computer servicing, from minis to micros and a host of high-tech peripherals. He emigrated here in 1972. Ever the enthusiast, Andy built his first transmitter at age 11, but it was some years before he could obtain his amateur licence in the UK. Since that time, he has always been interested in one aspect or another of electronics, ranging across audio, video, amateur radio, computing and 'fiddling'. A dab hand at project design and with software, you'll be seeing the fruits of Andy's labours in the magazine from time to time.

We all look forward to exciting times ahead, and bringing you an even better version of Australia's Top Electronics Magazine with each issue.

Roger

Roger Harrison
Editor/Publisher

NEW 'PHONE NUMBER:

For editorial, advertising, subscriptions, sales and general enquiries, our new 'phone number is:

487 1207

Our Technical Enquiries number remains the same – 487 1483. But, please, call us – Andy Keir or Roger Harrison – only after 4.30 pm EAST.

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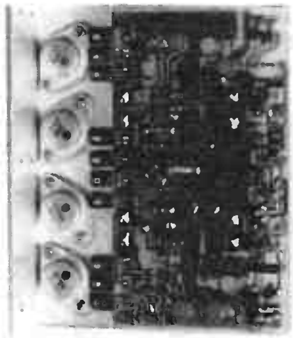
COVER

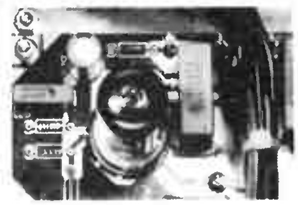
Statronics' off-line 70 W switching power supply — designed and manufactured wholly in Australia. Design, Val Harrison.

PROJECTS TO BUILD



CIRCUITS & TECHNICAL

ELEKTOR IN AEM



PRACTICAL COMPUTING

NEXT MONTH!

PUTTING THE 6005 MODULE INTO THE SERIES 5000 CHASSIS
David Tilbrook details how to upgrade the Series 5000 using two of the new AEM6005 100 W 'U-F Topology' modules.

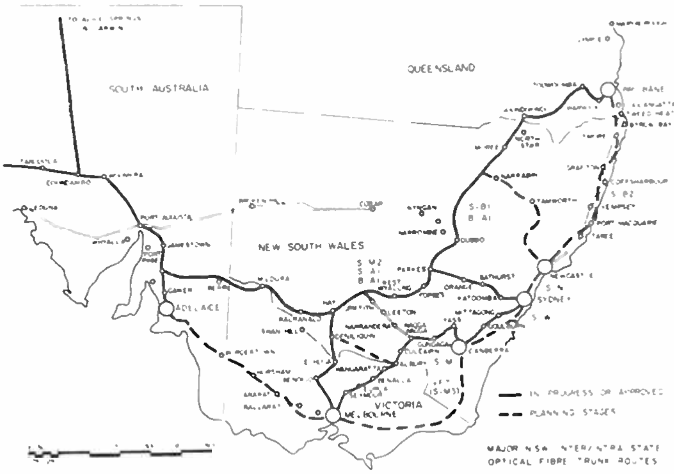
A RTTY ENCODER COMPANION TO THE LISTENING POST DECODER
Here's the project so many of you have requested — simple RTTY transmitting tone encoder companion to the hugely popular AEM3500 Listening Post project.

CHOOSING AND USING A DIGITAL MULTIMETER
In case you hadn't noticed, digital multimeters have taken over where analogue multimeters once reigned supreme. Our feature looks at the critical functions and parameters of DMMs and how to select an instrument.

STORAGE BATTERIES
We are living in a battery revolution! Rechargeable batteries are assuming an increasingly wider role these days. We take a look at their characteristics and applications.

While these articles are currently being prepared for publication, unforseen circumstances may affect the final contents of the issue.

Telecom ramps up optic fibre trunking



Telecom Australia has approved plans to proceed with the installation of major interstate and intrastate optic fibre trunk routes commencing 1988/89, one such installation being the longest cable project ever undertaken in New South Wales. (See accompanying map).

The first project to commence will be the interstate Port Augusta to Brisbane cable, running some 1780 km. 'Taps' will be run out from this trunk to Sydney and Melbourne.

The optic fibres to be employed will introduce new technology as they are designed to operate at 1550 nanometres (nm) wavelength and will be using a 2.4 Gigabit line system.

Other planned routes include a tap from the Port Augusta-Brisbane trunk to Newcastle via Narrabri, a direct Adelaide-Melbourne link, a Brisbane-Sydney link down the coast via Newcastle, a Canberra-Melbourne link, a parallel link Canberra-Sydney and a Riverina district (south-east NSW) link between Albury and Deniliquin.

Work time spent on the various projects is expected to very nearly double during 1987-88, compared to '86-87, fom 44 000 to 78 000 man-hours.

Learn electronics from TV or tape

For those who have always wanted a basic course in understanding electricity and circuits, a new ABC-SBS education series could be a winner.

The new series, run by a group called Learning Network, will provide formal training for those who need an introduction to dc circuits.

You can enrol at selected colleges and universities around Australia and they in turn will provide textbooks, assignments and tutors to help you through the televised course.

It has the support of several Federal Government ministries including the Minister for Industry and Technology, Senator John Button.

Erina Rayner, Executive Director of Learning Network, says the courses will be a tremendous asset to the tens of thousands of Australians who cannot get to colleges because of either distance or time pressures.

"It is also a great reintroduction to education for those who have been away from study since school and may be nervous about their ability to cope," she says.

Learning Network, a joint venture between private enterprise and the Victorian Government, acquires the best internationally-available programs and also will help orchestrate production of Australian series.

The first programmes went to air in early March. The courses cover a range of topics. Some are specific training courses to help you acquire work skills.

Erina Rayner says that those who formally enrol in the courses get permission to videotape segments for their own use during the period of the course.

Enrollment in the courses is done through participating colleges, for information, ring **Learning Network on (03) 690 9866 or (008) 33 1996.**

Olex optical grows

Olex has appointed two recently-graduated engineers to its Optical Networks Division at Tottenham in Victoria.

Miss Janine O'Keeffe, who completed a four-year degree at the Royal Melbourne Institute of Technology last year, has been appointed to the position of Network Engineer.

She studied electronics, communications and digital laboratory systems before specialising in communications engineering in her final year.

Miss O'Keeffe will work on designs for installation of cables in a wide range of applications, from data communications in a small factory to local area networks and large business networks.

Mrs Brigitte Maillot has been appointed to the position of Customer Service Engineer, in the Optical Networks Division. Mrs Maillot, who was born in France, came to Australia seven years ago and studied electrical engineering part-time at the Chisholm Institute of Technology.

Joint development of CD video

Matsushita (Osaka, Japan), Philips International B.V. (Eindhoven, The Netherlands) and Nippon Gakki/Yamaha (Hamamatsu, Japan) announce their commitment to the CD Video system and confirm joint development of CD Video players.

This will enable all three companies to demonstrate CD video players at the summer Consumer Electronics Show in Chicago. The sales of these new CDV products should start in the northern hemisphere autumn this year.

It has been agreed that this new system will be introduced under the name "CD Video" throughout the world.

Major software companies have already announced their support and commitment to the CDV system.

It is expected that more hardware manufacturers will join in the marketing of CD Video players hopefully making introduction of this new system a success.

Would you talk to a computer on the phone?

America's largest phone company, AT&T, is running trials in San Francisco (where else?) to see how people react when a computer answers their queries on the phone.

The company is developing a system that will recognise what they call "standard requests" for assistance, and then route the call.

The trial system running in San Francisco only recognises speech and asks questions. A live operator puts through the call and then judges how the customer reacts to the computer.

AT&T reckon it will be some years before they trust a computer to answer and route a call on its own. Preliminary reports suggest people in urban areas prefer talking to a machine than to another person.

So what's new in modems?

Andrew Keir

Nothing stands still for very long in the world of electronics and this is doubly true when we look at computers and their peripherals. The market's appetite for bigger, better and faster everything is reflected in the seemingly endless range of new models or accessories with better specifications and more features. In this article we are going to take a look at recent developments in one of the most popular accessories used in computing today.

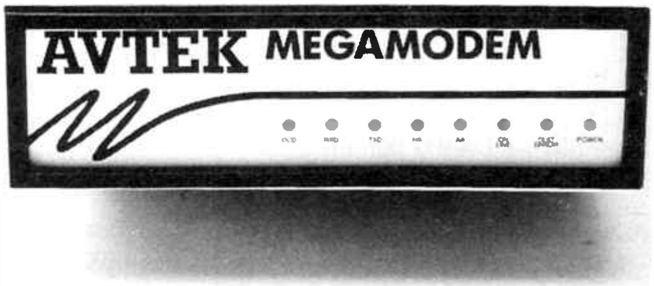
DATA COMMUNICATIONS is an area which has grown up in parallel with the small computer market. Quite early in the piece business people and hobbyists alike realised the benefits of getting computers to talk to each other. For the hobbyist the ability to "type" to his mates across town or connect to a remote bulletin board system added an interesting new dimension to his activities. Commercial users were able to provide mainframe access to their remote branches or get information from professional databases.

Whilst computer communication over leased lines had been a reality for some time, it was the availability of low cost modems designed for use over the public switched telephone network (PSTN) that really opened up the whole scene. In the wake of Telecom's relaxation of regulations regarding direct connection of "foreign things" to the telephone network, the early acoustically coupled modems gave way to approved direct connection types offering all sorts of new possibilities. Because they were physically connected to the line it was possible to get modems to automatically dial out or answer incoming calls. A plethora of communications software sprang up to support the new features. Modem sales increased, resulting in lower prices. The industry gained momentum and as we will see when we examine the features available in some of the latest offerings, it's still going strong.

The current trend in modem development is concentrated in three areas: Speed, integrity of data and device intelligence. The CCITT V.21 standard at 300 BPS full duplex provides a quite reliable level of performance on lines of unpredictable quality as encountered in the switched telephone network. It has become a "de-facto" standard for many smaller systems. Whilst V.21 is still included in most designs it is now being seen as too slow for many applications.

Designers are now pushing speeds far in excess of those once thought possible over switched lines. The widely employed V.23 standard of 1200 BPS with 75 BPS back-channel, as used with "Viatel," is now offered in most modems but many manufacturers are also offering the V.22 standard of 1200 BPS full duplex. Multi-speed modems have been around for a while. Top of the line models are the four speed models, usually with "1234" in the name and offering the four switched network speeds of V.21, V.22, V.23 and V.22bis (300 BPS, 1200 BPS, 1200/75 BPS and 2400 BPS). There are also "123" models offering the three lower speeds. Automatic speed recognition is a significant feature which is becoming widely available in many models.

Integrity and security of data has always been a problem over the switched network. Apart from having to cope with the vagaries of line quality and possible data loss from noise or dropouts, there exists the well-publicised problems with unauthorised persons gaining access to private computer systems using dial-up modems. Designers have been quick to address both these areas by providing such features as error correcting protocols and ring-back security.



Avtek's Megamodem is the latest model in a long and distinguished lineage. The basic model offers V.21 and V.23 and is Hayes-compatible. V.22 can be added as an upgrade as the Megamodem features an expansion bus.

Features and functions

Many modem users will be familiar with communications software which incorporates some sort of error correction. Protocols such as Xmodem are in wide use and are quite efficient in providing error-free data transfer. In keeping with the trend toward more intelligent modems, some manufacturers are offering inbuilt error correction. Some schemes operate in a fashion similar to Xmodem, others are based on protocols similar to the X25 packet switching methods. Unfortunately at this point there does not seem to be an agreed standard between manufacturers as to which protocol to use. Most designs offering this type of feature will only work with another modem of the same type. This may not be a drawback if communication only takes place with the same system all the time but without a widely accepted standard it is doubtful that many will be throwing out their copy of Xmodem.

The issue of data security has long been a thorn in the side of system operators where sensitive data is involved. Various schemes have been devised to overcome the problems of uninvited access and amongst these, ring-back security has proved to be popular and useful. Ring-back security is a system in which the answering terminal asks the caller to type in a password, the answering system then looks up a phone number associated with the password, disconnects and rings back. This method ensures that access is only available from pre-determined phone numbers. Whilst ring-back systems have been available as separate entities for some time it is only recently that such features are appearing as built-in modem functions.

The move to add more and more integral features to the modem without sacrificing compatibility with a wide range of compuers has resulted in a conscious effort to take the intelligence out of the computer and put it in the modem. Once a decision is made to use an internal microprocessor in a modem it is reasonably straightforward to add new functions by simply updating the resident firmware. This scheme allows the use of less intelligent terminals where there is an obvious cost saving over tying up an expensive microcomputer. The well-known Hayes "Smartmodem" set the standard for intelligent modems some years back and as a result of the popularity of the command set used by Hayes many software packages, as well as modems from other manufacturers, support the Hayes commands.

The 7910 "World chip" modem IC caused a revolution in design when it was introduced a few years ago. It offered a multi-standard, multi-speed modem in a single chip and required only a minimal amount of support hardware to produce a complete modem. Future designs are likely to be based on similar innovations and an exciting example of this type of technology is the Intel Corporation's new 89024 modem chip set. The 89024 modem consists of two devices: an 89026 application specific processor and an 89027 analogue front end interface. The highly integrated 89024 modem will support full duplex operation at speeds of up to 2400 BPS and includes in firmware the complete Hayes command set, according to Intel.

Additional capabilities of the 89024 include a full set of RS232 and CCITT V.24 terminal interface signals; telephone line control signals such as off-hook and ring indication; programmable output levels for phone line gain adjustment; built-in diagnostics; DTMF (tone) or pulse dialling and automatic recognition. Readers can expect to see some interesting new designs based on these chips in the not too distant future.

The Nice Modem 2 features auto-dial with both pulse and tone dialling, a ring-back security feature, visual and audio indicators, CCITT and Bell standard operation, plus baud rate buffering and conversion.

Products on parade

We have had a look at the sort of features which can be expected so now let's look at some specific products which are representative of the local market and see just who is offering what.

Designed for the Microbee computer, the **Microbee Automodem** represents the more basic type of design. The modem is capable of V.21 (300 BPS) and V.23 (1200/75 BPS) and will auto-dial and auto-answer when under control of the Microbee Telcom software. If you own a Microbee this modem is a good choice. See your Microbee distributor or contact Microbee Systems in Gosford, NSW.

Another local producer offering some interesting products is ABE Computers of Burwood, Victoria. This company offers basic modem kits from as low as $95.00 up to multi-speed, multi-standard modems in built and approved form. The company's "Max" range presents an interesting concept in that the modem is based on a motherboard which is common to all models in the range. Upgrading to a model ▶

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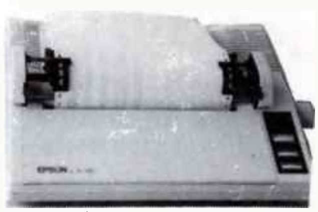

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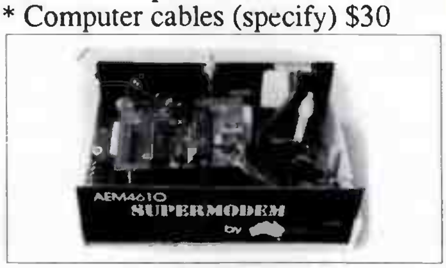

GPA Supermodem: Note V22 board installed

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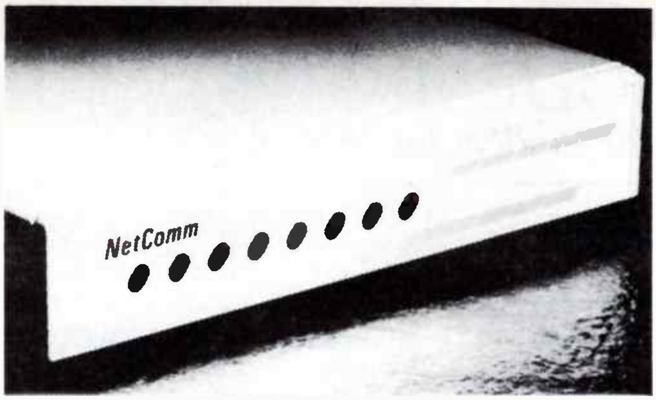


Netcomm's SmartModem 1234A provides 2400, 1200, 1200/75 and 300 bps full duplex CCITT and Bell standard operation, and supports a superset of the industry "standard" AT command set. Smart indeed!

with more features simply means fitting different modules.

Micro-educational of Newcastle NSW offer the **GPA Supermodem**, otherwise known as the **AEM4610**, described as a build-it-yourself kit over the April to August 1986 issues of the magazine. For just $395.00, the Supermodem features auto-answer, auto-dial, auto-disconnect and employs Hayes-type commands. Speeds offered are 300/300 BPS and 1200/75 BPS (full V.21 and V.23), although 1200/1200 BPS (V.22) is available as an option. It features an expansion bus to accommodate later additions, such as the V.22 option. The GPA Supermodem comes built-up and with a warranty. It is also sold in kit form through the designers and manufacturers, Maestro Distributors. A short-form kit comprising pc board and EPROM with resident software is available through AEM for $142, post paid.

Also from Newcastle is the Automatic Ice Company who produce a range of **plug-in card modems** ("In-modems" is the jargon) **for both the Apple and IBM PC** type of computer. The company also makes a stand-alone model which is not computer specific. A significant level of intelligence can be provided by having a modem living inside the computer where it has access to the system's bus and this company's products are no exception. The basic model in the range is an auto-answer, auto-dial, Hayes-compatible intelligent device with V.21, V.23 and V.23 reverse (75/1200 BPS). The modems are supplied with Videotext and communications in software or firmware. Prices start around the $300.00 mark.

The name of Avtek is well known amongst modem users and their **Multi-Modem** has been and still is a popular device. The company's newly released **Megamodem** however, represents quite a leap forward in design. The basic model has V.21 and V.23 capability and is Hayes compatible. An upgrade to give V.22 is available also. One of the unique features of this modem is the expansion bus which allows additional features to be fitted as they become available. For example, up to 64K of static memory can be fitted, capable of buffering around 30 pages of information. The unit also features ring-back security, built-in error correcting protocol and battery backed memory to retain operating parameters and phone numbers etc. Prices commence around $499.00 and Avtek are based in the Sydney suburb of Chiswick.

Consolidated Electronics of Victoria (now part of the Cunningham Consolidated group) offer a wide range of models from the **CEL 2301**, a V.21 and V.23 non-intelligent device, to the soon to be available **Cedata** 1234 model which will allow speeds of up to 2400 BPS full duplex (V.22bis). The range includes multi-speed and multi-standard devices, many of which support the Hayes standard.

TREVOR HARTLEY TAKES THE BIT BETWEEN HIS TEETH

Banksia Information Technology Limited (BIT) is a Hong Kong based company that combines the manufacturing and distribution advantages of East Asia with the research and development creativity of other countries, notably Australia, their blurb says.

BIT is owned by David Hartley and two international partners. David, who now lives in Hong Kong, is well known for his association with Hartley Computer which he founded in 1974. In mid-1985, David decided that he wanted to pursue more entrepreneurial activities and so resigned as chairman of Hartley computer and set out to establish BIT.

David is convinced that many world-class products are developed in Australia but many fail or never reach their full potential because of the poor manufacturing and export environment in this country. BIT aims to provide a vehicle for such products to be manufactured in Hong Kong or other suitable Asian country, and then distribute them in the USA, Europe, Africa, Asia and Australasia.

BIT has established a relationship with a Hong Kong manufacturer to produce an IBM PC-compatible range of computers named "Le Clone". In response to quality and consistency problems with low cost Asian compatibles these units are made to specified standards BIT says. BIT configures each unit order and subjects them to individual quality assurance prior to shipping. As well as "Le Clone, BIT has developed a family of printer accessory products for the personal computer user. The line-up includes the PS-P printer switch which allows switching of two attached printers to a single PC, the PB-P256 large capacity (256K) printer buffer and the ACS-P4 automatic channel selector which allows up to four PCs to be automatically connected to a single computer on demand. Also included in the range is the PCE-P channel extender which will allow a parallel printer to be remotely located up to 300 metres from the computer.

An example of the company's communications products has been discussed in the main article. A complete family of modem and multiplexer products will be progressively released by BIT from August 1986 onwards.

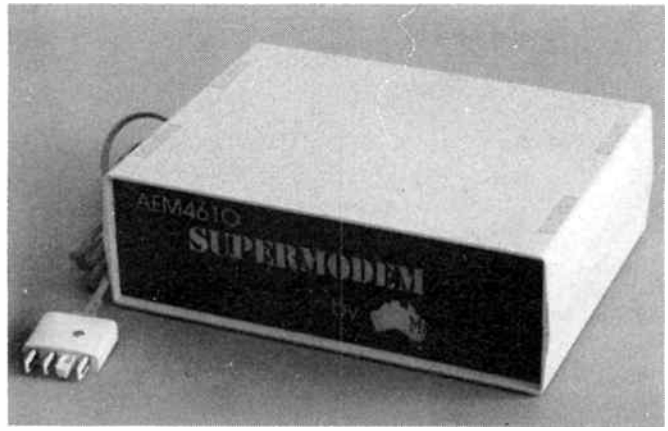
BIT's international contacts, their location in Hong Kong and their wide range of products, services and expertise should be of great interest to product developers, manufacturers and importers/distributors throughout the world. BIT is represented in Australia by **Mike Boorne Electronics, Suite 3, 61A Hill St., Roseville 2069 NSW. Telephone (02) 46 3015.**

Over in the West, the Nice Computer Company of Australia is offering their **Nice Modem Two**, a Hayes compatible intelligent modem providing auto-dail, auto-answer, ringback security and Baud rate scanning as well as V.21, V.22 and V.23 speeds. Baud rate buffering and converion is also provided which makes the unit ideal for Viatel use in conjunction with computers which do not support split rates on their serial ports. Price is around $699.00 and the company is based in West Perth, WA.

NetComm Australia is a respected name in data communications products and, as would be expected, offer a comprehensive range of modems from basic V.21 and V.23 models to some very 'whiz-bang" devices indeed. Just about any feature you could want is to be found somewhere in the range including auto-dial, auto-answer, Hayes compatibility and automatic baud rate detection. I believe they only recently released a multi-standard modem for Commodore 64 and 128 owners. NettComm also offer a range of plug-in card modems suitable for IBM PC type computers.

The **Blitzer 12E** modem by Banksia Information Technology is imported and distributed by Mike Boorne of Roseville NSW. The modem is an external, stand-alone asynchronous device which offers V.22 and V.21 standards as well as their Bell equivalent.

The modem can be used in transparent mode as well as fully automatic operation using the Hayes AT command set. Tone or pulse dialling is supported, as is auto-answer and call-in-progress monitoring which is capable of detecting dial tone, busy tone, answer tone, silence and voice. An appropriate message is sent to the DTE when any of the preceeding



The GPA Supermodem from Micro-Educational first saw the light of day as the AEM4610 Supermodem project, published between April and August 1986. Designed by the Darling brothers of Maestro Distributors, it features a Hayes command set, V.21 and V.23 operation, plus V.22 available as an option as it has an internal expansion bus.

conditions is detected. The modem will monitor the incoming signals when in auto-answer mode and adjusts itself automatically to the sending speed of the remote modem. When originating a call the modem selects the appropriate mode according to the data rate on the serial link. Prices start from under $400.00, which represents very good value for such a sophisticated device. A new Blitzer model with the same features but incorporating V.23 operation is to be released shortly, we understand.

The **SAM 1275** 'professional' modem from Pulsar Electronics is claimed by the manufacturers to be one of the most comprehensively tested pieces of computer equipment ever released on the market, with more than one thousand test ▶

For Apple owners, the Automatic ICE Company have this "smart" in-modem that provides Hayes-compatibility, V.21 and V.23 (inc. V.23 reverse) signalling and Videotext (i.e: Viatel) communications.

sites in place before the issue of the final product, according to Pulsar.

The three main communications speeds of V.21, V.23 and V.22 are all supported and the unit is claimed to be "totally Hayes compatible". Features include auto-dial, auto-answer, comprehensive error detection and handling, ring-back security, baud rate conversion and automatic selection of tone or pulse dialling. For more information contact ESIS Pty Ltd, of Roseville NSW, or Pulsar in Tullamarine, Vic.

The **DSP series** of modems from Data Bridge Electronics of Ormond, Victoria is the first to receive an Australian Design Award. The Industrial Design Council panel examine in detail such aspects as function, ergonomics, durability, market need, ease of maintenance, value, safety and manufacturing techniques so this award says a lot about the overall quality of the product. The product must, of course, also be Australian.

DSP modems are available in V.22, V.22bis and multi-speed configurations and feature remote diagnostics. Hayes compatibility and ring-back security as well as a remote configure option for use where skilled technicians are not available at the remote site. In order to take advantage of the remote configure option, both modems need to be Data Bridge DSP series devices. Data Bridge claim that the DSP series modems will continue to receive when signal strength is down as low as −43 dB compared to −35 dB for most modems, which results in a far lower error rate even on lines of dubious quality, the company claims.

If this article has whetted your appetite for some of the latest goodies in data communications products, then stand by because I've left one of the most exciting devices to last. If, on the other hand you are a little confused as to what modems and data communications are all about, you might like to refer back to Jon McCormack's articles of April and May issues last year, in which he went into "*Dabbling in the Dial-up Data Jungle.*"

The final word in modems?

In preparing this article I am grateful to Rosser Communications of Pymble NSW who, as modem specialists, provided some very interesting and informative material. One of the items which chief executive Mr Alexander Rosser found most exciting also struck me as one of the most fascinating devices I had looked at.

Imported by NetComm, the **Trailblazer** from Telebit Corporation is perhaps the most exciting concept in modems to emerge in recent times. It uses innovative new technology whereby, when two Trailblazers commence communicating they analyse the characteristics of the line in use and then adapt themselves to it. Rather than using one broadband carrier, these modems use a great number of closely spaced carriers, each carrying only a few bits per second of data. The result is a maximum effective throughput of over 14 000 BPS and astounding tolerance to noise and defects on the line. As an indication of this, Mr Rosser conducted a trial in which he spoke on top of the modem with a telephone in parallel and it still averaged 4800 BPS!

The modem includes V.22 and V.22bis so that it can still communicate with standard modems. Full error correction, automatic re-training if the line characterisitcs change and a host of other features make this a very complete unit.

I don't know if too many computer hobbyists will be investing in the Trailblazer, but I can see it would certainly appeal to commercial users sending large amounts of data over the switched telephone network.

Food for thought isn't it?

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Automatic Ice Company,
10 Smith Street,
Charlestown 2290 NSW.
(049) 63 3188

Avtek Electronics Pty Ltd
Ground floor, 21 Bibby Rd,
Chiswick 2046 NSW.
(02) 712 3733

Consolidated Electronics,
PO Box 1021,
Thornbury 3071 Vic.
(03) 484 0791

Data Bridge Electronic
Communications Pty Ltd
604 North Road,
Ormond 3204 Vic.
(03) 578 0814

ESIS Pty Ltd
PO Box 281,
Roseville 2069 NSW.
(02) 487 2032

Intel Australia Pty Ltd
Level 6, 200 Pacific Hwy,
Crows Nest 2065 NSW.
(02) 957 2744

Maestro Distributors,
Calool Street,
South Kincumber 2256 NSW.
(043) 69 2913

Micro-Educational Pty Ltd
8/235 Darby Street,
Newcastle 2300 NSW.
(049) 26 4122

Microbee Systems Pty Ltd
1 Koala Crescent,
East Gosford 2250 NSW.
(043) 24 2711

Mike Boorne Electronics
Suite 3, 61a Hill Street,
Roseville 2069 NSW.
(02) 46 3015

NetComm (Australia) Pty Ltd
PO Box 284,
Pymble 2073 NSW.
(02) 888 5533

Nice Computer Company
of Australia Pty Ltd
GPO Box S1517,
Perth 6001 WA.
(09) 321 6636

Rosser Communications,
PO Box 152,
Pymble 2073 NSW.
(02) 449 8233

FM antenna design

Dear Sirs,

I have been searching for information regarding the building of an FM radio antenna. So far, I have been to three public libraries without success. The closest book I could find was the Amateur Radio Handbook 1982, which gave me a good idea on construction techniques. But unfortunately, it only had measurements for specific frequencies and not for the broad band required for FM reception.

I rang a local communications firm who gave me the number of the District Radio Inspector. He suggests I find someone with some back issues of your magazine as he thought there was an issue explaining how to build an FM antenna. Could you please advise if this was so, and what issue? If not, could you recommend some books or could you set out the formulas for working out the spacing and lengths of the driven element, reflector and director elements, boom etc?

G.L. Fidge,
Morwell, Vic.

We published an FM Antenna project in the May 1986 issue, project AEM3012. Back issues cost $4.00, post paid. It is a 'log periodic' design. The design procedure for these antennas may be found in the "ARRL Antenna Book", ISBN 0-87259-414-9. Dick Smith Electronics stocks copies.

Roger Harrison

Chip? capacitors

Dear Sir,

Could you please clear up a couple of problems which I have encountered with the EPB ignition project published in the February issue. My first problem is that resistor R14 is shown as 4k7 in the parts list but the schematic diagram gives it's value as 47k. Which is correct?

My second problem is that, being reasonably new to electronics, I am unable to identify the capacitors C5, C6, C10 and C11. These are described in the article as "50 V CHIP". Retailers which I approached had no idea what was meant by the term "CHIP" and a radio technician I asked said the only "chip" capacitor he knew of was a high frequency, low inductance, leadless device that is soldered directly onto the printed circuit tracks. Could you identify these capacitors for me please? Are they simply disc ceramics or possibly monolithics? Is the term "chip" a colloquial term used by those in the know? If so, it would be appreciated if the proper names for all components was used when publishing a project.

Whilst on the subject of the EPB project, I had some difficulty in finding where R5 fitted into the scheme of things and also, would you have any idea where I could obtain the 630 V polycarbonate capacitor as Brisbane retailers don't stock anything over 250 V.

I would like to take this opportunity to thank you for a most interesting and informative magazine.

G. Fussell,
Burpengary, Qld.

Thanks for your kind words. We apologise if we have caused some difficulties with the component descriptions. The capacitors concerned are extremely small, high quality ceramic devices such as Jaycar types RC-5495 and RC-5496. These are referred to as "blue chip capacitors" and are conventionally leaded, low inductance types used for by-passing applications. The term "chip capacitor" is also used when referring to surface mounted devices as described by your technician friend, and this is where the confusion has arisen. We will try to be a bit more descriptive in the future.

See the Notes & Errata published with the follow-up on the EPB project this month concerning R5. The correct value for R14 is 4k7, as per the parts list. The 220n/630 V polycarbonate capacitor may be a little hard to locate. If you haven't already done so, try Delsound and Fred Hoe & Sons, both located in Brisbane. Otherwise, you'll have to try stores interstate.

Andrew Keir

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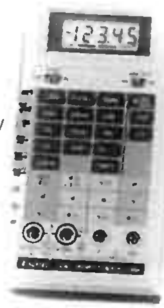

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100nA max resolution. 0 75%

Ohm 200ohm-20Mohm. 6 ranges0 01ohm max resolution. 0 2%

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Vac 200V. 750V 1mV max res 0 75%

Adc 200u - 2A 0 1 uA max res 0 75%

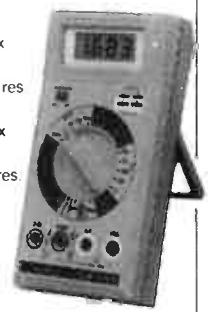
Ohm 200ohm - 2Mohm 0 1ohm max res 0 75%

Diode Testing

Battery Testing 1 5V 1 5mA

$64.40

EDM-1111A WITH CAPACITOR & TRANSISTOR TESTING



- 3½ digit LCD display
- Transistor hFE testing
- Capacitance measuring
- Toughened yellow industrial case

V dc 0 2-1000V 100uV max res 0 5%

V ac 0 2-750V 100uV max res 1 25%

A dc 200u-10A 0 1 uA max res. 1%

A ac 20m-10A 10uA max res. 1 5%

Ohms 200ohm-20Mohm 0.1ohm max res

Diode Check

Continuity

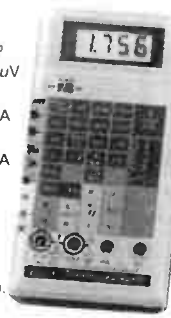
Capacitance 2nF-20uF

1pF max res 2%

Accessories included Test clips. spare fuse. Owner's Manual. battery

$118.90

EDM-1116A



- 3½ digits LCD display
- Transistor hFE testing
- Capacitance measuring
- 8 functions. 0 5% basic accuracy

Vdc 0 2-1000V. 5 ranges 100uV max resolution. 0 5%

Vac 0 2-750V. 5 ranges 100uV max resolution. 1 0%

Adc 2mA-10A. 4 ranges 1uA max resolution. 1 0%

Adc 2mA-10A. 4 ranges 1uA max resolution. 1 5%

Ohm 200ohm-20Mohm. 6 ranges 0 1ohm max resolution. 0 75%

Capacitance 2nF-20uF. 5 ranges 1pF max resolution. 2.0%

Transistor hFE. npn and pnp

Diode testing

Continuity Buzzer

Accessories included Test leads. spare fuse. Operator's Manual. battery

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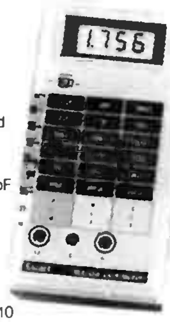

- 3½ digit LCD display
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RANGES —

Capacitance 200pF-200uF. 7 ranges 0 1pF max resolution. 1%

Inductance 2mH-200H. 6 ranges 0 1uH max resolution. 2%

Resistance 20ohm-20Mohm. 7 ranges 10 10Mohm max resolution. 1%

Accessories included Test clips. spare fuse. Instruction Manual

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- Extra large (52mm) tongs
- Peak hold
- 0 5% basic accuracy

Aac 200A. 1000A (±1%) 0 1A resolution

Vac 200V . 750V (±1 2%) 100mV resolution

Vdc 200V. 1000V (±0 5%) 100mV resolution

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- 1Mohm input impedance

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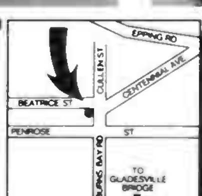

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Sound reinforcement amp is locally made

Sydney-based pro-sound company, Showcraft, has announced the release of their locally designed and manufactured amp, model P1400, rated to deliver 750 W/channel into 4 ohms.

The design of the P1400 is the result of consultation with major rental companies and the designer's own experience in the industry to develop an amplifier which satisfies the demanding requirements of todays touring PA systems, Showcraft say.

The P1400 uses MOSFET technology and incorporates ultra dynamic power limiting which is sensitive to load and thermal power of the output devices, as well as being unconditionally stable into all loads, impedences and short circuits at any frequency.

The amplifier has been through an extensive test program before being released to the market, including having 16 units endure 12 months of heavy touring throughout Australia without any problems.

The P1400 is the first in a range of professional amplifiers to be designed and manufactured by Showcraft. Full details from **Showcraft, 937 Bourke St, Waterloo, NSW 2017. (02) 698 3288.**

New PA speakers

A brand new range of compact speakers for PA and sound reinforcement has been released by OHM of Great Britain. The MR 228 is the flagship of the range, featuring two custom built 200 mm bass/mid drivers and two horn drivers which extend the freequency response to 22 kHz OHM claim.

The MR 228 delivers 300 watts, and combined with its low weight, provides for a very flexible system, says OHM. Both male and female Cannon and jack sockets are provided for added convenience.

The MR 128 is the baby brother of the MR 228 family. The low weight and smooth lines make this unit ideal for installations, although it is equally happy on the road, having the same input configurations and finish as the MR 228, according to the manufacturers.

To complement the MR 228, OHM has launched the MR-WOOFER sub-bass bin. This unit can be operated using the in-built passive crossover, or it can be run equally well in the active mode. In the passive mode an MR 228 can be paralleled with the MR-WOOFER to provide a complete full-range system needing only one amplifier.

For more information contact Andrew Harrisson or Stuart Cameron at **Hi-Phon Distributors, Unit 7, 56 Victoria Street, North Sydney, NSW. (02) 923 2011.**

DIL package reed relay

IRH Components are now stocking FRL730 DIP reed relays from Fujitsu. Featuring one, Form A rhodium contact rated at 10 VA (100 Vdc max, 0.5 Adc max and 2 A carry), the FRL730 is fully epoxy encapsulated in a standard 14-pin dual in line package and is suitable for immersion cleaning.

Standard coil voltages are 5 Vdc and 12 Vdc with a coil dissipation of 65 mW (5 V dc coil).

In-built electrostatic shielding and a protective diode are also available as options. Contacts are sealed in an inert gas atmosphere to ensure reliable, stable contact resistance. The FRL730 is ideal for low level applications in communications, measurement and data processing.

Further information on the Fujitsu FRL730 relay is available from **IRH Components, P.O. Box 14, Lidcombe NSW 2141 (02) 648 5455.**

New counter offers high stability

Philips claim their new PM 6669 frequency counter breaks through the traditional price/stability barrier for instruments of this kind with its unique new mathematically temperature-compensated crystal oscillator (MTCXO).

Up to now, high-stability counters have used costly oven-stabilized oscillators. The stability of lower-cost instruments has been limited by the use of standard crystal oscillators or TCXOs (temperature-controlled crystal oscillators).

In the MTCXO principle, the timebase crystal oscillator is individually calibrated by factory measurement of its temperature-dependent frequency curve, which is then permanently stored in a non-volatile memory. In use, the Δf value for any operating temperature is looked-up and used to correct the measured frequency value before it is displayed.

An additional benefit of this constant and automatic temperature compensation is that the PM 6669 needs no long warm-up period; the specified accuracy is available instantly after power-on.

PM 6669 also has a number of other features normally found only in higher-priced instruments, for example high-sensitivity wideband input circuitry with automatic, error-free triggering on all input waveforms, continuously variable attenuation and a switchable low-pass filter for noise suppression.

The full 9-digit display allows complete presentation of the measurement result, while unstable or insignificant display digits can be blanked to ensure optimum value of the displayed information at all times.

As standard, PM 6669 has a measuring range that extends from 0.1 Hz up to 120 MHz. An optional high-frequency input extends the range right up to 1.1 GHz.

For further information, contact: **Philips Scientific and Industrial, 25-27 Paul Street North, North Ryde NSW 2133 (02) 888 8222.**

Servisol

The George Brown Group has been appointed the Australian importers and distributors for the Servisol range of electronic chemicals.

The product range includes Servisol Foam Cleanser, Silicone Grease, Circuit Freezer, Anti Static Spray, Plastic Seal, Aero Clean, Heat Sink Compound, Aero Duster, Video 40, Super 40 and Rapid Fire Extinguisher.

Further information from **George Brown Group, Marketing Division, 456 Spencer Street, West Melbourne 3003 Vic. (03) 329 7500.**

Statronics

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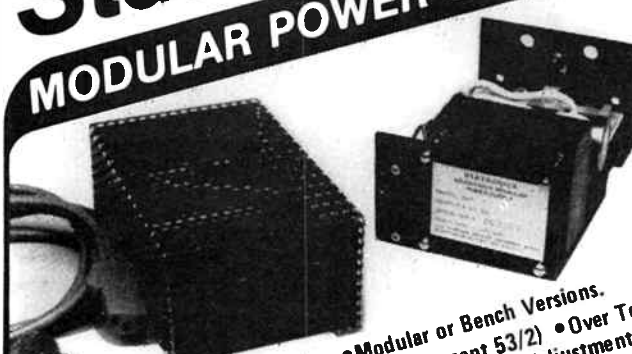

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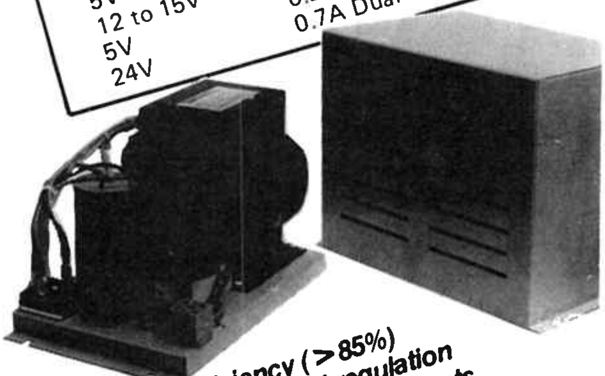
VOLTAGE	CURRENT	MODEL
12 to 15V	1A Dual	53/2
12 to 15V	3A	53/3
24V	2.5A	53/4
5V	3A	53/5
12 to 15V	1A Dual)	53/6
5V	0.25A)	
24V	0.7A Dual	53/7



• Extremely high efficiency (>85%)
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28V	5A	240V	FE2
24V	5A	110V	FE3
28V	5A	110V	FE4
13.8V	10A	240V	FE5
13.8V	10A	110V	FE6

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24V	15A	FER3R

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200-280	5,12,12	10	70x25x15
90-280	5,12,12	15	95x30x20
90-280	12	15	95x30x20
200-280	5,12,12	20	95x30x20
200-280	5,12,12	30	95x30x25
Converters			
21-63 DC	5,5	5	25x25x15
21-63 DC	5,12,12	7.5	70x25x15
21-63 DC	5,12,12	10	70x25x15
21-63 DC	5,12,12	20	95x30x20
21-63 DC	5,12,12	30	95x30x25
Conventional "Open Frame" Type			
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200-280	5,12,12	70	150x65x50
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Understanding 'switched-mode' power supplies

Roger Harrison

Many people in electronics are surprised to learn that 'switching-type' power supplies have been around for many years indeed, in one form or another. These days, they're found in a positively huge variety of applications, but the intricacies of their workings remains something of a mystery, it seems. Let us dispel at least some of the mystery enshrouding switched-mode power supplies. Read on!

PRACTICALLY EVERY ITEM of electronic equipment made today is powered from a dc source — be it a battery or a power supply. Most electronic equipment requires not "just a dc power source", but one that has a well-regulated output, free of extraneous hum and noise. A power supply effects a conversion of power from a primary source to the required output. Three types of power conversion are in common use: ac-to-dc conversion, dc-to-dc conversion and dc-to-ac conversion. The latter is a very specialised application, whereas the widest range of applications call for either ac-dc convesion or dc-dc conversion.

One of the greatest concerns in power conversion is efficiency. So-called 'linear' power supplies exhibit efficiencies in the range 40-55%. The other 60-35% is dissipated as heat — a total loss. Switched-mode power supplies, on the other hand, generally exhibit efficiencies in excess of 80%. In addition, for "off-line" power supplies, which operate directly from the ac mains, bulk and expensive power transformers can be down away with, yet very high input-to-output isolation, as is offered by a mains transformer, can still be maintained. Doing away with the transformer means a considerable reduction in size and weight of a supply — an important consideration in a wide variety of circumstances.

Amtex distributes the range of Boschert switchers, and claim to have the widest selection of off-the-shelf supplies available, running to some 76 individual units.

Background

Forerunner of the switched-mode power supply was the electromechanical vibrator – but not that consumer 'brown goods' item beloved of masseurs and sex therapists! When vacuum tube technology was in its heyday, developing the necessary high tension voltages from fixed, low voltage battery supplies was a problem. Where primary-cell battery supplies were inconvenient or impossible to use, the only way to stepup the primary supply voltage was to convert it to "ac". The vibrator was simply an electromechanical switch that interrupted dc current supplied to the primary of a transformer. They operated in the range from about 100 Hz to several hundred Hertz. The resulting secondary voltage was rectified to supply the required "HT" voltage. The principle was further developed so that, instead of having a power-wasteful thermionic or copper oxide rectifier on the secondary, extra contacts on the vibrator synchronously switched the secondary current each half cycle to provide dc output. ▶

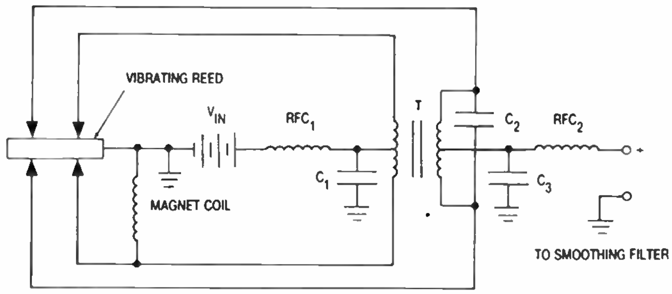


Figure 1. Circuit of a typical vibrator supply. They were used from the late 1930s well into the 1960s.

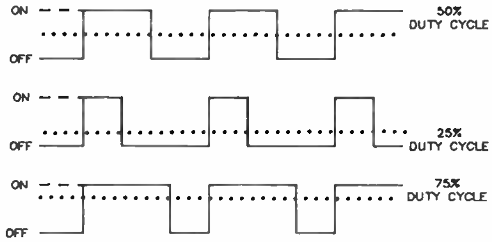


Figure 2. How pulse-width modulation works. At a 50% duty cycle, where the pulses are of equal width, the average energy is half the peak level. At 25% duty cycle, the average energy is one-quarter the peak level, while at 75% it's at threequarters the peak level.

Such a system is shown schematically in Figure 1. The capacitors and RF chokes filtered the higher frequency switching transients. So you see, right from the start, switched-mode supplies were "noisy"!

The vibrator had a major failing in that the dc output voltage was totally dependent on the dc supply voltage; there was no regulation. Nor was there any regulation against resistive losses in the transformer etc causing the output to vary with varying load.

A dc output power supply may be required to convert energy from another dc source, as with the vibrator, or from an ac source. For many applications, the output voltage needs to be regulated – held constant withing given limits – against variations in the primary supply and against variations in load. Where a dc supply is the primary source, the process is called "dc-to-dc conversion". Where an ac supply is the primary source, the process is called, naturally enough, "ac-to-dc conversion"; if the ac mains is the primary supply, such supplies are often called "off-line" supplies.

In the former case, the primary dc supply is first converted to a series of pulses which may then be transformed to the required level and rectified. In the process, regulation is effected. In the latter case, with an ac primary supply, the ac is first converted to dc. The regulation and switching processes are often integrated (I don't mean in an IC, although that is done for at least part of the circuitry) to provide an economical, efficient circuit.

The term "switchmode" was coined and registered by Motorola, hence the widespread use of "switched mode", or "switched-mode", often shortened to just plain "switchers".

Switched-mode supply circuitry may be divided into two "classes": converter-regulators (dc-ac-dc converters with feedback regulation) and switching regulators. Both employ a regulation technique involving 'pulse-width modulation'. Switched-mode supplies use rectangular pulses. Each pulse is used to dump a 'parcel' or energy into a storage medium – a magnetic field (from a coil) or an electrostatic field (in a capacitor). The stored energy is then released over time. Control of the output, and thus regulation, is effected by increasing the 'width' (that is, the duration) of the pulses for more output, or decreasing the width for less output. The principle is illustrated in Figure 2.

There are five basic types of dc-dc converters employed in switched-mode supplies:

1) The flyback converter,
2) the forward converter,
3) The half-bridge converter,
4) the full-bridge converter, and
5) the "Cuk" converter.

Most converters operate at frequencies in the range 10 kHz to 200 kHz, although the upper limit is gradually being pushed up. Higher operating frequencies means smaller transformers and lower value, and thus physically smaller, filter/storage capacitors and hence smaller volume supplies for the same power than lower frequency units.

The first four are widely used and it is these we will cover here. The fifth – pronounced "chook" – is a relatively new high frequency, high efficiency converter for specialised applications.

There are two basic types of switching regulator:

i) The "buck" type, and
ii) the "boost" type.

They have application in dc-dc conversion where high efficiency and regulation is required, and operate at frequencies in the 10 kHz to 200 kHz range. These days, a wide variety of IC switched-mode regulators are available from many manufacturers.

The flyback converter

The basic flyback converter circuit is shown in Figure 3. The switching transistor, Q1, is controlled by the pulse-width modulator circuit. While Q1 is on, the current through the transformer primary (I1) increases linearly. Now, the transformer is wound on a special core and is actually an inductor with a secondary winding. Unlike a normal transformer, it stores substantial energy in the magnetic flux created in the transformer by the primary current.

When Q1 turns off, the flux in the transformer core begins to decrease, inducing a voltage in the secondary – called the 'flyback voltage' – such that the diode conducts, permitting current to flow (I2) which charges capacitor C and provides current to the load. Typical (idealised) waveforms are shown in Figure 4.

While the primary current builds up during the time the transistor's on, secondary current does not flow as the diode prevents it. When Q1 is off, secondary current flows, the load current causing it to decay. The voltage across capacitor C decays when Q1 is on, but I2 charges it when Q1 is off, maintaining the capacitor voltage.

If the output load increases, the voltage across C will tend to decrease. However, by increasing the time Q1 is on, allowing I1 to build up to a higher value, a higher secondary current will flow when Q1 is off, increasing the charge on C, thus maintaining the output voltage. By comparing the output voltage with a reference voltage and using the difference to control the pulsewidth modulator, the circuit will automatically maintain the output voltage at a constant value.

The transformer provides voltage step-up or step-down as well as input-to-output isolation, if so required.

The 'ideal' flyback-type converter is very efficient as it is theoretically lossless since the switching element (Q1) has either no voltage across it, or is conducting no current. However, in practise Q1, the transformer, the diode and capacitor all have finite – though small – losses. This type of circuit has been widely employed in low power applications (50 W or less).

The general form of a typical off-line flyback converter is illustrated in Figure 5. Note that no mains transformer is used, the incoming ac being directly rectified.

Some applications call for multiple outputs. The extra out-

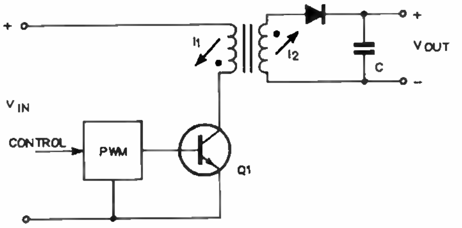


Figure 3. Basic form of the flyback switching converter. Control for the pulse-width modulator (PWM) may be supplied by feedback from the output to provide output regulation. The dots adjacent to the transformer primary and secondary (and in subsequent diagrams) indicate the same end of each winding and the positive voltage end during the active part of the switching cycle.

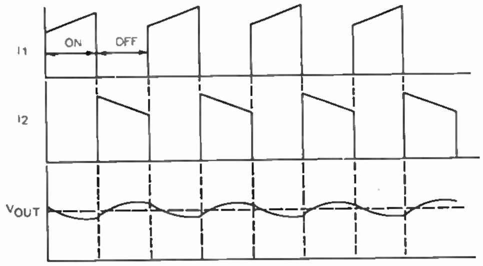


Figure 4. Typical (idealised) waveforms in the flyback converter.

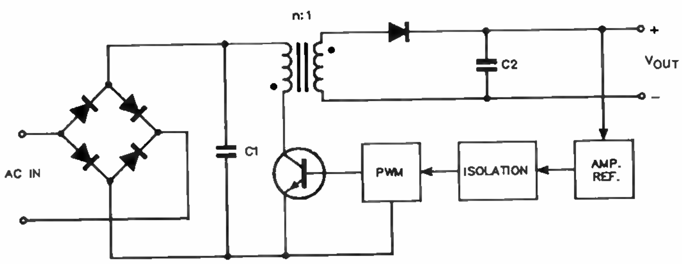
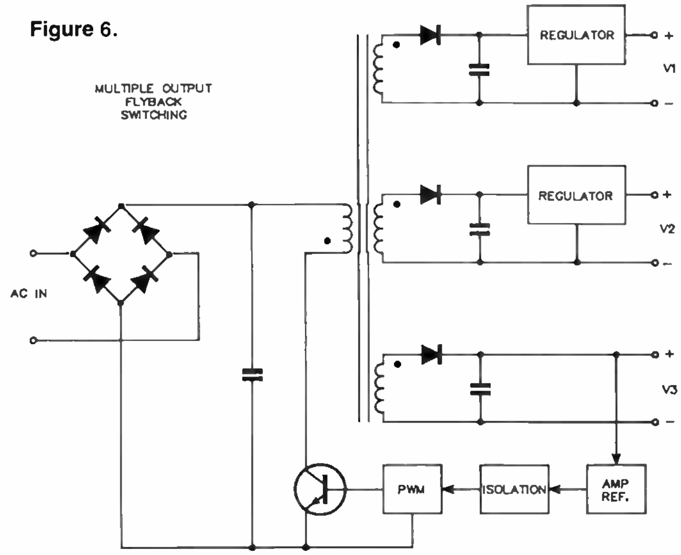


Figure 5. COMPLETE FLYBACK SWITCHING SUPPLY

Figure 6.



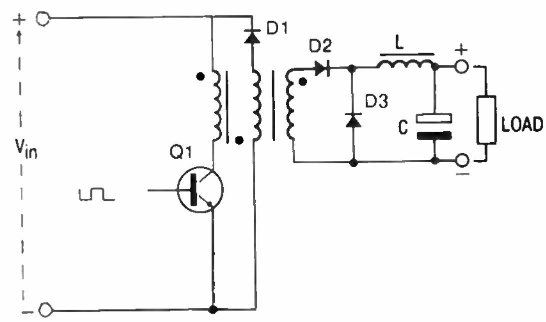


Figure 7. General arrangement of the forward converter. Note the similarities with Figure 5.

puts are provided by additional secondaries wound on the transformer. In such cases, common linear-type three-terminal regulator ICs are employed to regulate the extra outputs. The general form is shown in Figure 6.

The forward converter

The forward converter is very similar to the flyback converter, as can be seen if you compare Figure 7 with Figure 5. However, there are some fundamental differences. The addition of the output inductor (L) and diode D2 is what makes the difference. Here, energy is stored in L rather than the transformer. As Q1 switches the primary current on and off, D2 conducts each time Q1 conducts, charging C via L and supplying current to the load. Diodes D1 and D3 are reverse biased at this time. When Q1 is off, the decaying current in the transformer primary induces a voltage in the two secondaries opposite to that when Q1 is on. Now D2 is reverse biased and D1 conducts, returning the transformer magnetising current to the supply. Also, as D2 is not conducting, no current flows to C via L and the collapsing field in L forward biases D3, maintaining load current and the charge on C.

As you can see, and as the name suggests, power is transferred during the ON-cycle of the switching element, unlike the flyback converter. Output regulation can be effected using pulsewidth modulation control in the same manner as Figure 5.

The forward converter, like the flyback converter, has the advantage of simplicity and minimum components. Another major advantage, especially for low output voltages, is that the ripple on the output is minimised by the choke, L, the ripple being generally lower than can be achieved with the flyback converter. However, the extra winding on the transformer makes it bulkier and more complex as the windings need to be trifilarwound (all three wires twisted together and wound as one) for maximum coupling to keep losses down. Also, during the period Q1 is off, it is subjected to twice the supply voltage.

As these converters work at frequencies between 50 kHz and 150 kHz, the transistor Q1 and the diodes must have fast switching characteristics. This type of circuit is generally restricted to relatively low power applications up to 80 watts.

The half-bridge converter

By using two transistors to switch the primary current, the transformer can be simplified and other advantages gained. Figure 8 shows the general technique – dubbed the "half-bridge" forward converter. Here again, energy is stored in the inductor, L and operation is very similar to Figure 7.

Here, both transistors are turned on together, the primary current inducing a secondary current which is transferred to ▶

the load via L. D1 and D2 are reverse biased at this time. When the transistors are off, D3 maintains the load current, now supplied by the collapsing flux in L, while the collapsing current induced in the primary by the collapsing field in the transformer core is returned to the supply via D1 and D2 which are now forward biased as the primary voltage polarity is reversed.

Transistors Q1 and Q2, together with diodes D1-D2, form the opposite 'arms' of a bridge circuit. Only two arms comprise the active switching elements, hence the name Half-bridge.

This circuit has the advantage of only requiring a simpler, relatively small, conventionally-wound transformer. In addition, while the transistors are off, they are only subjected to the source voltage and hence, lower voltage devices may be used. A little extra complexity is necessary in the drive circuitry for the switches, but a little extra electronics is generally a small price to pay. The half-bridge forward converter is seen in switchers up to 500 watts or so.

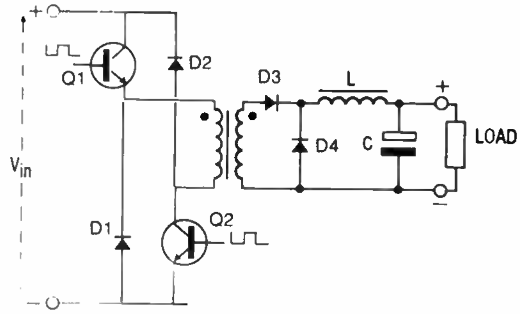


Figure 8. The half-bridge forward converter simplifies the transformer construction at the expense of a little extra circuit complexity. But that permits lower cost and higher power operation. The two transistors are turned on and off simultaneously.

The full-bridge converter

As the name implies, all arms of the bridge circuit have active switching elements and energy is delivered to the secondary during each half of the switching cycle. This necessitates a different arrangement for delivering current to the load. Figure 9 illustrates.

Here, a centre-tapped secondary is necessary, and a full-wave rectifier. The arrangement reduces ripple on the output even further, and is less demanding on the output inductor. Here too, the transistors which are off are only subjected to the supply voltage. The full-bridge converter is often seen where high power outputs and/or well-controlled regulation is required.

A variation encountered is illustrated in Figure 10. Here, the transformer is centre-tapped and the transistors driven out of phase, which gives rise to its name – the "push-pull" converter.

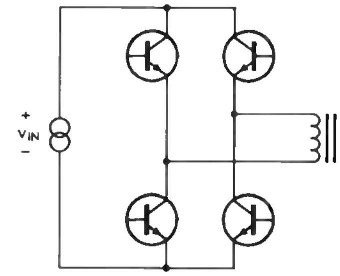


Figure 9. The full-bridge forward converter employs four transistors, each diagonally opposite pair being switched on and off together. Lower output ripple and greater control is the advantage here, at the expense of more circuit complexity.

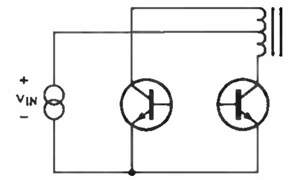


Figure 10. The push-pull forward converter requires a more complex transformer, but simpler drive electronics than Figure 9.

Switching regulators

The two basic forms of switch regulators are shown in Figure 11. The buck-type regulator, 11(a), is probably the most widely used. While the switching element is shown here as a transistor, FETs are also employed. When the switching device is turned on, current from the dc source flows to the load and the capacitor via the inductor, which stores energy in its magnetic field. The diode at this time is reverse biased. When the device is turned off, there is no current to maintain the magnetic field in the inductor, so this begins to decay. This induces a current in the coil, opposite in polarity, so the diode is now forward biased, maintaining the load current and charge on the capacitor.

Regulation is effected using pulse-width modulation as illustrated in Figure 2, and the sort of feedback circuit shown in block diagram form in Figure 5. The buck-regulator is used in voltage step-down applications and is very useful where the output voltage may vary over a range from zero to within a volt or two of the dc source.

The boost-type regulator, 11(b), supplies current to the load and smoothing/storage capacitor when the switching device (again, this may be a transistor or FET) is turned off. When the switching device is turned on, the dc source supplies current to the inductor which builds up a magnetic field. When the switching device turns off, the field in the inductor's core decays and it supplies current to the load via the inductor and diode, also maintaining the charge on the capacitor. As the inductor is in series with the dc source, the output voltage is higher than the dc source. This necessitates a higher voltage device than is necessary with the buck-type regulator. During the on-cycle, load current is supplied from the capacitor, which necessitates a larger value, higher voltage capacitor

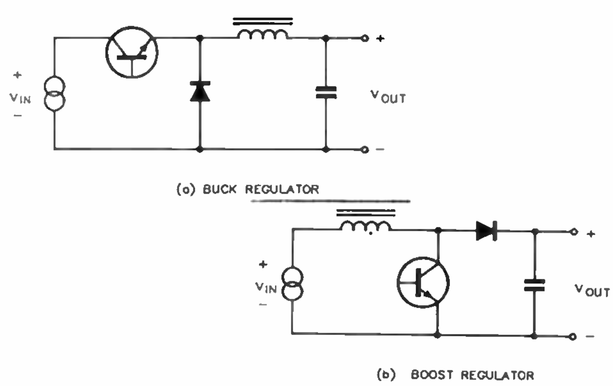


Figure 11. The basic form of the buck-type switching regulator is shown in (a), while the boost-type is shown in (b). The buck-type is the more common for reasons explained in the text.

than the buck-type.

These last two factors limit the boost regulator's use to specialised applications and it is the buck-type regulator that finds the widest application.

We would like to express our thanks to the following firms for their generous assistance with time and material during the preparation of this article: A.J. Distributors, Philips Scientific & Industrial, and Statronics.

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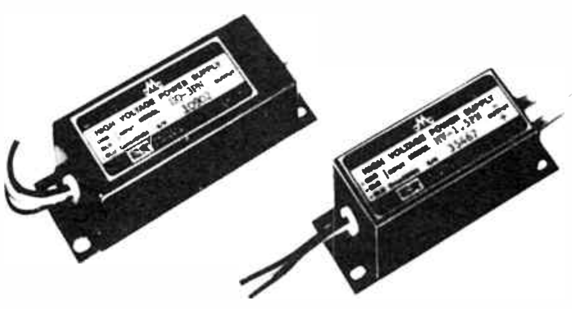

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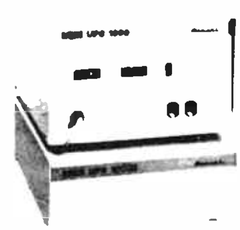

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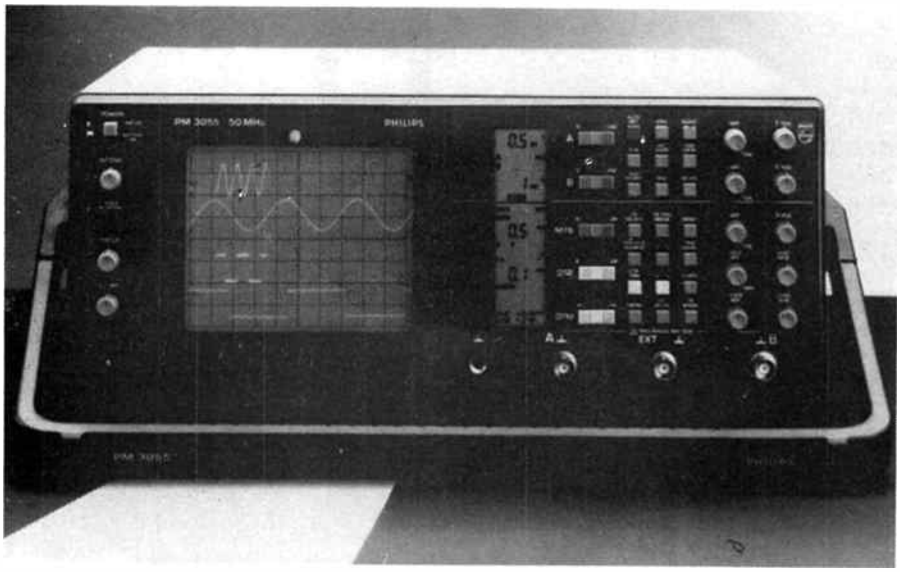
Philips PM 3055, the CRO with a 'magic button'



Introduced in the middle quarter of last year, Philips' new PM 3050-series 50 MHz CROs are strikingly different, their biggest feature being an "autoset" button which 'magically sets-up the CRO once you've hooked it up to a circuit.

THIS INSTRUMENT should do away with what is colloquially known as the "CRO Driver's Licence". Traditional oscilloscopes, as readers will well appreciate, are known for their carefully laid-out, but crowded, front panels. Inevitably, when familiarising yourself with a new instrument, or one you've not used previously, you get the feeling you need to go to "CRO Driver's School" and get a licence to drive the machine. Philips' incorporation of microprocessor technology in their new line of 50 MHz oscilloscopes has enabled the design of an instrument with a push-button front panel and some 'smarts' which enables automatic setup — a very powerful, functional feature.

Philips offer two instruments in the range: a single timebase unit, the PM 3050, and a dual timebase unit, the PM 3055. We obtained the latter unit for review.

Overview

The immediately obvious, and most striking, feature of the PM 3055 is the front panel design. Gone are the multitude of varying size rotary controls and slide switches so familiar on the necessarily crowded front panels of traditional oscilloscopes. In its place is a cleverly organised array of buttons and rocker switches — the function controls, all arranged so that you 'read' the front panel 'like a book'; that is, from left to right, top to bottom.

The power on-off switch is mounted right in the top left hand corner. Arranged in a vertical row beneath it are the trace and display controls. Immediately to the right of the screen is a liquid crystal display which shows all the function settings. To the right of this are all the function controls. All the Y-input channel controls are at the top, beneath them are the timebase controls. All the set-and-forget X and Y rotary controls are grouped to the right. Beneath the control panel are three BNC input connectors: Y-input A, external X-input and Y-input B, and a banana socket (ground). A terminal for the calibrate signal output is positioned in the lower left corner of the front panel. The beam modulation, or Z-axis, input is on the rear panel.

The CRT screen is rectangular, measuring 80 x 100 mm, with an internal graticule of 8 x 10 divisions of 10 mm (1 cm) with 2 mm subdivisions. Continuously variable illumination of the graticule is provided. The standard screen phosphor is "P 31", a short persistance phosphor. "P 7" long persistance phosphor is an option. Total CRT acceleration voltage is given as 16 kV, ensuring a bright spot at high writing speeds.

The vertical deflection amps provide a display range of 2 mV/div. to 10 V/div. in 1-2-5 steps. If the (optional) PM8936/09 10:1 probe set is used, the input sensitivity is automatically adjusted on the LCD display when they're plugged in. Input impedance of the Y amps (below 1 MHz) is 1M parallelled by 20 pF. Maximum input voltage is 400 V (dc + ac peak). The dc input bandwidth over the 20 mV to 10 V range is quoted as greater than 50 MHz (six-div. sinewave), and at 2, 5 and 20 mV, greater than 35 MHz. Worst-case rise time is given as better than 10 ns/div. When ac-coupled, the lower -3 dB point is given as less than 10 Hz.

The main timebase provides a sweep range from 0.5 seconds to 50 ns in a 1-2-5 sequence. The variable control provides a 2.5:1 variation range, while the timebase magnifier provides a 10x expansion. The delay timebase covers a range of 1 ms to 50 ns in a 1-2-5 sequence. Triggering facilities include TV line and frame for positive and negative video, alternate trace, auto peak-to-peak or dc, external and line (mains frequency). The trigger source may be selected from channels A or B on the main timebase as well as the delay timebase. Trigger bandwidth is quoted as 100 MHz.

The X-deflection amp can be used via channels A or B (with the same display range of 2 mV-10 V/div.) or via the EXT. input which has a sensitivity of 100 mV/div. X-amp bandwidth is quoted as greater than 2 MHz (six-div. input signal), while input impedance below 1 MHz is given as 1M parallelled by 20 pF. Maximum input voltage is 400 V (dc + ac peak).

The Z-MOD input is TTL compatible. A 'high' input of more than 2.0 V will blank the display, while a 'low' input of less than 0.8 V will produce maximum trace brightness. Analogue control between these limits is possible.

The CAL. signal is a 2 kHz rectangular pulse with a 1.2 V peak output. It may be short-circuited to ground without ill effect.

The instrument employs a switched-mode power supply and may be powered from an ac line source ranging between 100 and 240 V (nominal, the limits are 90-264 V), and a frequency of between 50 and 400 Hz (limits: 45-440 Hz). No manual adjustment is required.

The unit measures 387 x 530.5 x 146.5 mm overall, including feet, knobs and handle. It weighs 7.5 kg.

Options

A wide variety of options may be purchased for the instrument. Already mentioned is the PM8936/09 probe set. (Note that probes are not supplied). This comprises a pair of 10:1 probes with 1.5 m long cables and spring-loaded hook tips. Input impedance is quoted as 10M parallelled by 13.5 pF, while the 'useful system bandwidth' is given as dc to 100 MHz. Maximum non-destructive input is 500 V dc + ac peak.

An IEEE-bus interface box, the PM 8953, is offered, allowing connection to a computer ▶

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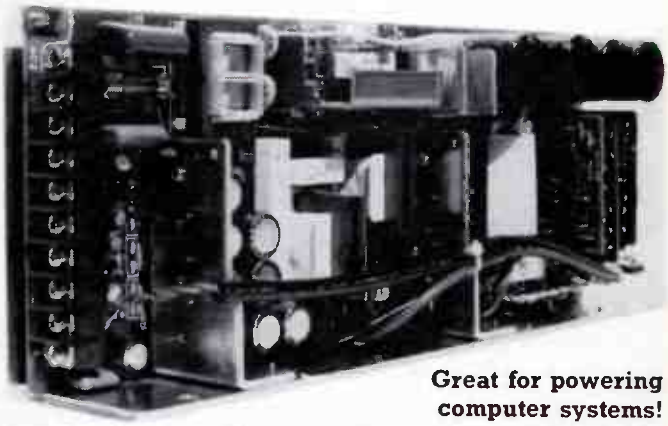

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MODEL NO	OUTPUT A	OUTPUT B	OUTPUT C	OUTPUT D	OUTPUT E
ETU-5MF01	+5V 3 ~ 15A	+24V 0.4 ~ 1.5A	+12V 0.4 ~ 1.5A	−12V 0.4 ~ 1.5A	−5V 0 ~ 1A

NOTE. If any lower voltage is required on either B, C or D output(s), provision is made for a TO220 78-series regulator to be inserted on the PCB.

End of model sell-out!

The MF Series has been replaced by a new model and the distributors, A.J. Distributors Pty Ltd, have only a strictly limited number left — and they are all to be offered below cost!

Who said it? — you reap the benefit!

All units supplied with a circuit and data sheet.

Electrical Characteristics

PARAMETER	CONDITIONS	LIMITS
Input Voltage	Jumper selectable on the PCB	85 to 132 VAC 170 to 264 VAC 47 to 440 Hz 240 to 360 VOC
Input Line Regulation	Full input voltage range +5V output Other outputs 3 terminal regulator Non reg	 0.2% max 0.6% max 1.0% max
Load Regulation	Load change from 20 to 100% of rated output current at rated input voltage +5V output Other outputs 3 terminal regulator Non reg	0.6%max 1.0% max 5.0%/A (typ)
Ripple and Noise	Peak to peak	1% +75 mV max
Over Current Protection	120% of rated output current (typ)	+5V output
Short Circuit Protection		Other outputs
Over Voltage Protection	+5V output	6.0 – 7.0V (typ)
Operating Temperature	Convecting cooling	0 to 50°C no derating
Storage Temperature		−25 to 85°C
Weight		2.0 kg (4.4 lb)

A.J. Distributors has made this offer available exclusively to readers of Australian Electronics Monthly, the magazine is acting as a clearing house for orders.

OFFER CLOSES LAST MAIL 31 MAY 1987, or until sold out.

If you want to inspect a sample, call into our offices any weekday during business hours. We're located at: First Floor, Fox Valley Centre, Cnr Fox Valley Rd and Kiogle St, Wahroonga NSW. The entrance is in Kiogle St.

$95 less sales tax.

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Delivery, anywhere in Australia — $6.50

Here's a chance to snap up a 'professional' high power switching power supply at a never-to-be-repeated price!

RUSH THE COUPON NOW, send to:
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COUPON

Please rush me . . . National MF Series power supply unit(s) at $95.00 each (less tax), or $111.00 each (inc. tax), plus $6.50 for delivery.

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or digital controller. This permits the instrument to be used in automated testing applications, for example. Automatic calibration facilities are included.

Other options include front panel memory backup, various X and Y outputs, polaroid camera, a battery pack that provides up to four hours of operation, 19" rack-mount brackets and a range of probes.

On the bench

I'm happy to report that the PM 3055 is a delight to use! The ergonomic panel layout — to be read like a book — is unsurpassed in functionality. The range controls for the vertical and horizontal channels are all left-right operated rocker switches which step automatically when held down. It takes about four to five seconds to step from one end of the range to the other on the vertical ranges and about five to six seconds to step through the main timebase ranges. As the majority of controls and functions provided are much the same (if not exactly the same) as seen on many CROs in this class, it's unnecessary to examine them here so I'll just touch on relevant points of interest.

Whenever the unit is turned on, it initialises with the vertical in channel A only, 10 V/div. dc, main timebase set at 1 ms/div. triggered on ch. A, p-p, positive-going. The trace brightness can be adjusted from fully off to a very bright trace with 'bloom' (a halo around it) at the fully magnified sweep speed of 5 ns/div. At very slow sweep speeds, where a single spot traverses the screen, one can see a 'reflection halo' following the spot across the screen a little above it, even at only moderate brightness settings. It's no problem really, and is common to many CROs as it's simply a limitation of the CRT technology. The focus adjustment works well, but I would also have preferred an 'astigmatism' control.

Sensibly, the designers have used the "horses for courses" principle and retained the use of rotary pots for all the variable controls. All the switched functions and parameters are controlled by 21 "soft-touch" keyswitches. Nineteen of them switch the functions and parameters usually seen on dual-timebase CROs, while two — the MENU and AUTOSET keys — are unique.

The MENU key, when pressed, clears the liquid crystal display and, when you press any of the other 19 keys, shows their individual functions. Some keys have only two functions, while others have up to five (e.g: the trigger source). Pressing the X and Y range switches displays the range extremes.

The AUTOSET key, highlighted by being a bright green in colour, does exactly what it says. Hookup a signal — on one or both Y inputs — and press the Autoset key. Seconds later, the PM 3055 has set the amplitude, sweep speed and triggering to obtain a clear, stable display. Fascinating to watch! This powerful feature does away with the often tedious manual setting procedures of first running through the coarse adjustments, then fine-tuning, which can be particularly frustrating on complex, difficult to trigger signals. Autoset triggers the timebase on the lowest frequency input. I learned the hard way that you don't leave an open probe plugged into the other channel when viewing a single input — it sets up on the stray hum!

All the controls have a positive feel. A low-volume 'pip' is heard as controls step through their ranges. The liquid crystal display is a real boon. You can clearly see at a glance all the functional settings and range parameters. Warnings are displayed when the timebase is triggered or not triggered and when any ranges are uncalibrated.

Triggering was excellent, even on "difficult" signals with mixed high frequency and low frequency components. Many conventional CROs in this class provide trigger filtering, enabling you to trigger on the high frequency or low frequency components of an input signal. This facility is missing from the PM 3055 but would appear to be little missed as it's not widely used. In any case, judicious use of the trigger controls should enable you to trigger quite well on complex signals from my experience. Note that both TV line and frame triggering is provided.

Graticule illumination is from two points at the top of the screen and illuminates the graticule quite well all over, something many CROs fall down on.

The construction of the PM 3055 is another of its unusual features. The chassis is a single piece injection moulding made of an "en-

— to page 95

DICK SMITH ELECTRONICS

PTY LTD

It's April! You'll think we're joking when you see this month's BARGAINS!! Get down to your local DSE store now

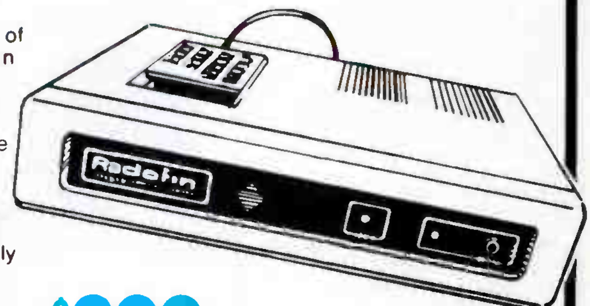
Matte Silver Spray Paint

Anti-glare silver paint for a smooth, elegant finish to that special project. Quick drying paint is ideal for front panels, cases, etc. 150g spray can. Cat N-1076

$2.47 Was $4.95

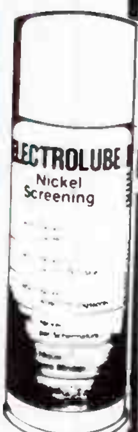
VDX 1000 Videotext Decoder

Now you can have Videotext information in your home! Hundreds of pages of information can be viewed in a colour or monochrome TV! The Videotext computer bank. Once you become a registered user of the Videotext service you can assess one of the greatest libraries of current information available, news, entertainment, medical/legal advice, shopping, goods for sale, business information and much more! Normally you'd have to own a computer and expensive peripherals to access Videotext — but now, DSE makes it available to everyone! Cat X-9700



$299

Nickel Screening Conductive Coating



Electro-conductive spray turns plastic project boxes into electrically conductive surfaces. Ideal for RF screening and many other useful applications. Cat N-1049

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A quick drying matte finish spray. Suitable for giving your project that professional finish. Cat N-1070

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Your passport to international entertainment. Tune into local AM, FM plus SSB and 11 SW bands.
• PLL for precise tuning • 16 preset memory function • Auto search • Direct frequency key in and triple speed manual tuning • Connections for antenna, headphones, DC and line out. Cat D-2999

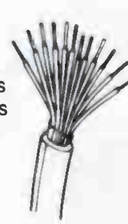
- Alarm Clock
- Two loud speakers
- Quartz controlled

$699 SAVE $100

Telephone-Type Cable

12 Conductor

The type of wire used by Telecom for telephone wiring. Ideal for intercoms or other multi-wire circuits Individually insulated and colour coded. Solid copper conductors.



Cat W-2140 $1.55/m
100m or more $1.40/m

Coaxial Cable

High quality low loss TV coax, for low signal area installations. Air cored (dielectric), similar size to 3C-2V.

75Ω ohm 5C-2V
Cat W-2082 75¢/m
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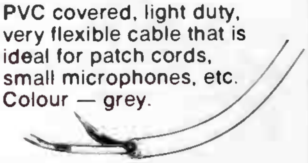
Shielded Audio Cable

Mono Light Duty

PVC covered, light duty, very flexible cable that is ideal for patch cords, small microphones, etc. Colour — grey.



Cat W-2030 45¢/M
100m or more 41¢/m

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Was $7.95 **Now $5.95**
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Half Price Cable

Mini twin heavy duty cable (½ price of $15 per roll) W-2012
Was 0.40 **Now 0.20**
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Resistance Substitution Wheel

Convenient size with large, easy to read value selection that enables you to select values from 5 ohms to 1M ohm in 36 steps. Complete with leads and insulated crocodile clips.
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$12.95

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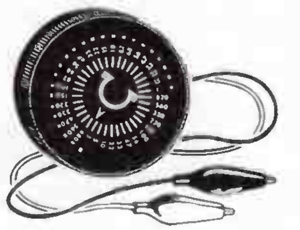

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A high quality moving coil meter with full scale accuracy better than 2%. Pre-calibrated; easily adapted to suit virtually any requirement! Cat Q-2020

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The very latest — and the very best — digital multimeter. And multi is the word. Also checks capacitors PLUS transistors and diodes. It's got an audible continuity checker! Cat Q-1500

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Personal LCD with Auto Ranging

An amazing feature-packed 3.5 digit multimeter that's the size of a pocket calculator: only 10mm thick! It may be small but boasts a number of impressive features.
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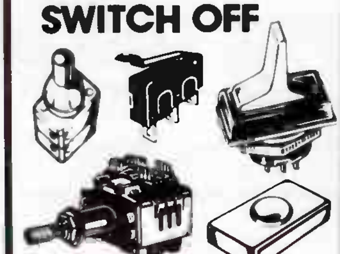
SWITCH ON TO DSE BEFORE THE BARGAINS SWITCH OFF



Switch p/button SPST illum 12V yellow S-1523
Now $10.95
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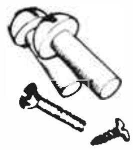


Metric Screw Packs

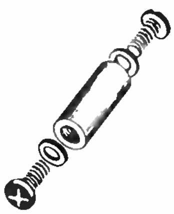
Description	Quantity	Cat No	Price
Asst P/H	160pc	H-1500	$1.00
S/Tap Screws	150pc	H-1505	$1.00

Grommets

Heavy duty grommets made of Black Rubber. Essential when cable passes through a metal chassis as they will prevent frayed cables and live chassis.
Cat H-1719

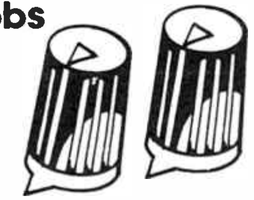
Hole Size	Bore	No. in pack	Price	10 up
12mm	9	8	$1.25	$1.15

Insulated Spacers



The ideal spacer for insulating the chassis from your PC board. They come complete with screws.
25mm 4 H-1872 $3.25 $2.48

Coloured Plastic Knobs

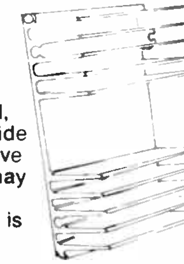


What a colourful idea! Now your projects can really look the part with these snazzy coloured knobs. Use them to colour code sections (great on multi-channel mixers, lighting consoles, etc). 16mm diam, standard metric (fluted shaft) fitting. Inserts can be changed to suit the occasion! Choice of four with-it colours.
All one price:

87¢ each

Orange Cat H-3802, Red Cat H-3800, Green Cat H-3806, Blue Cat H-3804.

Versatile Power Heatsink



The ingenious design of this heatsink makes it possible to mount it either flat on a panel, or at right angles to it (eg inside a case). The side fins also have tongue and groove so they may be joined sideways. Drilled version takes 2x TO-3's. Size is 78 x 110 x 33mm. Cat H-3460
Undrilled 1-4 $6.36 ea
5 or more $5.72 ea

Assorted Metric Screw Pack

Over 200 pieces of the most popular small sizes: M2.5, 3 and 4 nuts and screws — cross, round and countersunk head. Plated finish, ideal to have on hand in the workshop! Cat H-1680

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Quite often, the products we advertise are so popular they run out within a few days, or unforseen circumstances might hold up shipments so that advertised lines are not in the stores by the time the advert appears. And very occasionally, an error might slip through our checks and appear in the advert (after all, we're human too!) Please don't blame the store manager or staff: they cannot solve a dock strike on the other side of the world, nor fix an error that's appeared in print. If you're about to drive across town to pick up an advertised line, why not play it safe and give them a call first... just in case! Thanks. Dick Smith Electronics.

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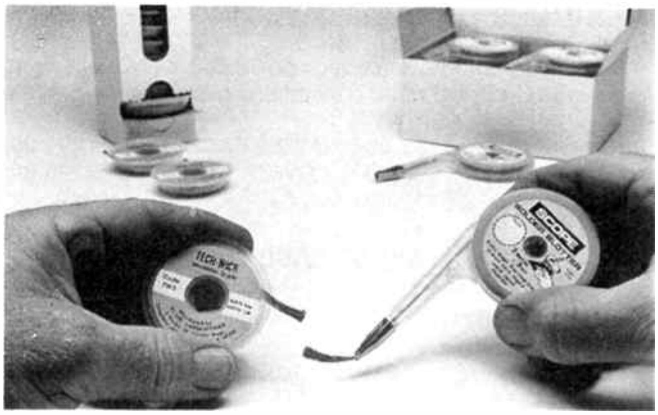


Scope for some wick-ed work here!

Scope Laboratories now offers a choice in desoldering braids, a braided copper 'wick' saturated in flux, used to mop up molten solder whenever you have to undo a joint (. . . a soldered joint, that is).

Scope's "Solder Blotter" is standard desolder braid which is contained in a plastic dispenser having a metal-tipped 'nozzle' through which the braid is dispensed. This allows you to hold the dispenser while keeping your fingers away from the iron's heat and also enables it to be used in awkward spaces.

"Tech-Wick" has the same high absorbency fluxed braid, says Scope, but offers the economy of a basic no-frills container.

The Solder Blotter dispenser carries two metres of the 3 mm-wide braid, while the Tech-Wick dispenser carries one and a half metres of it.

Both products are now available through electronic retailers and supply houses, including Dick Smith Electronics stores, Australia-wide.

So, if you're a sucker for servicing sets, you can do some wick-ed work on wonky joints with these bonzer braids!

Portable Mixer kits

Hi-Com Unitronics, of Caringbah in Sydney, now has module kits for the Elektor Portable Mixer described in our "Elektor in AEM" section in the February issue.

The project is ideal for bands, school and amateur productions and, being modular, it can be configured to both your pocket and your needs.

Proprietor, Tony Hui, has gone to the trouble of sourcing all the specified components — even making a few improvements. Ready-punched and silk-screened front panels are provided, giving the project a professional touch.

Hi-Com Unitronics is providing support for a variety of the projects described in AEM's Elektor section, as well as stocking a range of the otherwise-hard-to-get components.

Contact **Hi-Com Unitronics, 7 President Lane, Caringbah 2229 NSW. (02) 524 7878.**

Catch this catalogue

Jaycar's 1987 'Engineering Catalogue' is their biggest yet. At 116 pages, it lists their 4000-odd product range, copiously illustrated with photographs and line drawings.

This year, the data section includes an enormous IC pinout table covering memory and microprocessor ICs plus the widely used 74-series digital logic ICs (including C, F, H, L, S, AS, HC, LS, SC, ALS and HCT types).

Jaycar say their catalogue is designed for the dedicated enthusiast and professional alike. You can obtain one for a dollar by calling in at any of Jaycar's stores in Sydney and Brisbane, or by sending $2.00 and a large SAE to **Jaycar, PO Box 185, Concord 2137 NSW.**

No more Crapp at Dick Smith Electronics

Retail industry identity, Garry Crapp, has resigned from Dick Smith Electronics where he was General Manager of Technical and Enthusiast Products.

One of the firm's longest-serving employees, Garry started with DSE as the company's one and only service technician. He went on to become kit manager, a job which grew until it encompassed everything that wasn't a computer or consumer product, from sourcing semiconductors to selecting amateur radio gear.

A keen electronics enthusiast and well-known radio amateur, Garry was instrumental in recent years in introducing a range of 'high-tech' construction kits to Dick Smith's inventory. These included popular HF, VHF and UHF amateur band transceivers, a number of antennas, VHF and UHF GaAsFET preamps and a radio direction finder.

Garry leaves to pursue his own interests, which includes consulting, importing, manufacturing and R&D.

All the best, Garry. We know where you're at — that mid-career feeling of vague staleness, looking for new challenges doing what you know best, a hankering to run your own 'thing' your way . . .

PROJECT BUYERS GUIDE

This issue's feature project, the AEM6005 100 W Ultra-Fidelity MOSFET Amp will be stocked as a kit by both Eagle Electronics and Force Electronics in Adelaide, we understand. Pretty well all the components are widely stocked by electronics retailers, with the exception of the dual-JFET input device. The recommended '461 device is stocked by Stewart Electronics in Melbourne.

The AEM2000 Lab Standard Power Supply has been designed by Gerald Reiter of Force Electronics who will be stocking kits of the 100 W version of the project.

The AEM4507 Amstrad Frequency Counter Interface can be built from the average enthusiast's junk box! You should have no difficulty finding components as they are standard lines at every electronics retailer worthy of the title. The Star Project this issue, a switched RF attenuator, is supplied in kit form by Dick Smith Electronics, cat. no. K6323. It costs $37.95.

The Elektor Valve Preamp is definitely for dedicated enthusiasts. Be warned – it will be expensive and you'll have to search for parts! The volume control specified is an Alps type. Autosonics in Sydney distribute Alps components, but you will have to order it specially. Search the TV spares distributors for the valves. For the capacitors, try HiCom Unitronics in Sydney, Eagle Electronics and Force Electronics in Adelaide. You might also enquire at All Electronic Components in Melbourne for the valves and capacitors. For the adventurous, write to Audiokits Precision Components, 6 Mill Close, Borrowash, Derby DE7 3GU, England.

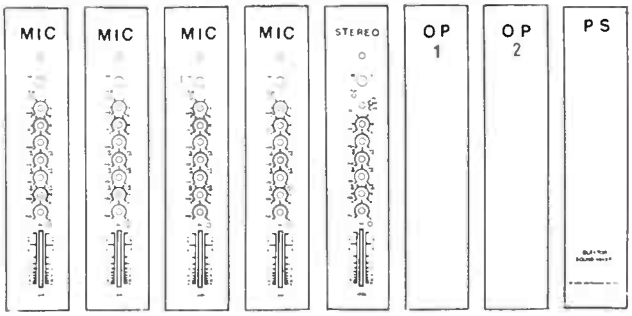
The Biphaser and SCART adaptor projects use components that are reasonably obtainable, but you may have to search a little for the FETs. In Melbourne, Radio Parts and Active Electronics are good sources; in Sydney, see Geoff Woods and Hi-Com Unitronics.

The Stereo VU Meter employs the Telefunken U2066 LED VU driver IC. Telefunken devices are distributed here by Promark. Try Hi-Com Unitronics for the ICs and other components.

The G.E. H11F3 Hall-effect optocoupler is stocked by Stewart Electronics in Melbourne if you're interested in experimenting with some of the suggested circuits in the article on pages 48 to 50.

HI COM — HI COM — HI COM

ELEKTOR SOUND MIXER



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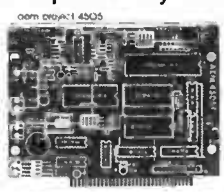
16 modules	C3	350 × 740mm	$70

AEM 4505
Code to Speech Synthesiser



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AEM Headphone Amplifier Kit

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AEM 4605 Super simple modem with new slim line case
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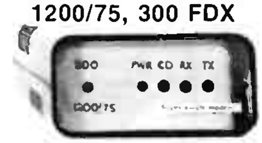
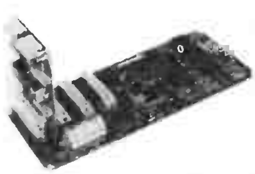


$112 AEM Sept 1986

with plug pack to suit plus $12.50

ELEKTOR SERIAL DIGITISER KIT



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120	54.00	●	●	●	●	●	●	●	●	●				
160	65.00		●	●	●	●	●	●	●	●	●			
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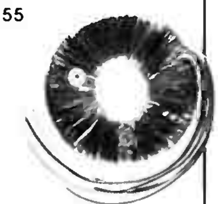

COMPONENTS

Description	Price	Description	Price
E2716	8 80	75452	2 20
E2732	9 00	CA3140	1 30
E2764	8 80	AY3 1015D	12 50
E27128	10 50	AY5 3600	11 50
E27256	13 50	AY3 8910	12 50
NEC 4164	POA	6502	11 00
NEC 41256	POA	6522	12 50
V20 CPU (70108D)	28 00	6802	9 00
8087	280 00	6882[illegible]	5 00
8088 2	12 50	6809	15 00
81C55	7 50	Z80A CPU	6 00
8237	13 50	Z80B CPU	6 50
8250	17 00	Z80 CTC	6 00
8253	6 50	Z80 DART	12 90
8255	5 00	SL490	10 50
8259	5 50	SL486	9 50
1488	1 00	ML926	8 00
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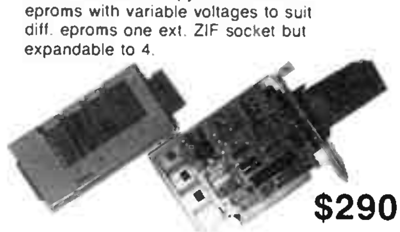

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Elektor Electronics in AEM

The projects and circuits chosen for inclusion in the Elektor section are selected on the basis of interest, local relevance and component availability. Intending constructors should consult our 'PROJECT BUYERS GUIDE' in this issue for a guide to component sources and possible kit suppliers.

CONTENTS

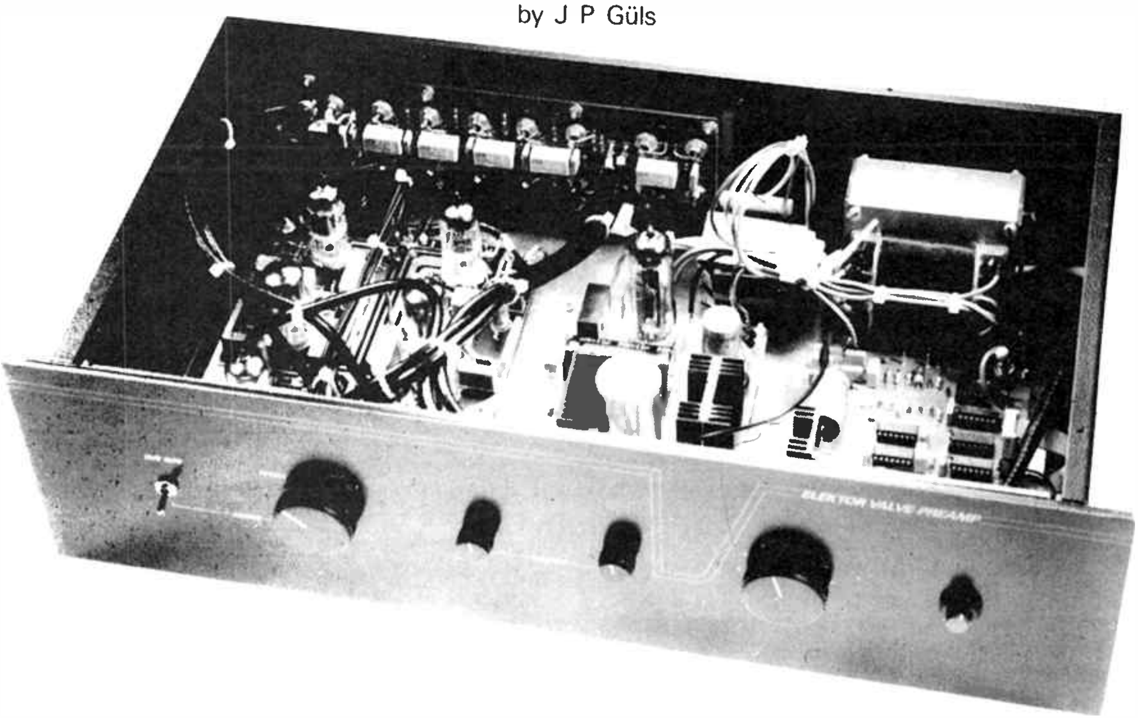
PROJECTS

ARTICLES

Unfortunately the artwork for Elektor project pc boards published last issue and in this issue did not arrive from overseas in time for inclusion. We will publish them in the next available issue following their arrival.

VALVE PREAMPLIFIER — 1

by J P Güls



We reproduce this article primarily as a matter of interest to those audio experimenters interested in the technology and circuit techniques. From the figures, it achieves excellent performance without the need for any type of feedback network.

Despite their becoming gradually obsolete, valves are still very popular with a good many audio enthusiasts. In this article we will not go into the pros and cons of the use of valves, or enter into the discussion about the so-called "valve-sound". We purposely leave that up to the constructor, and have reason to do so, since this is a remarkably simple to build preamplifier which is none the less capable of outperforming quite a number of other, more complex, designs.

The SRPP principle

The present preamplifier is based on a design principle referred to as *Shunt Regulated Push-Pull (SRPP)*. Not particularly well known for AF applications in the USA and Europe. SRPP designs were mainly used for high-frequency input stages realized with suitable VHF/UHF valves. In Japan, however, a designer called Anzai first developed AF input stages utilizing the SRPP principle in the late 1960s. Since then, many other designers have worked on improving the SRPP circuit, which, however, never came to commercial fruition because of the then fast spreading use of transistors. Interestingly, the SRPP principle can not be applied to transistor or opamp-based circuits, since the absence of a feedback circuit would lead to considerable distortion.

Typical of the SRPP-based input circuit is the use of cascaded triodes in a push-pull set-up. As shown in Fig. 1, each half of valves V_1, V_2 and V_3 is operated at a cathode-anode voltage of about 150 V. The negative grid bias is obtained from the drop across the cathode resistors. For those readers who are less familiar with valve circuits, it is useful to know that the relative voltages that exist at the grid(s) and the anode of a valve are usually specified with respect to the cathode. Therefore, the grid of, say, V_{1a}, is positive with respect to ground, but negative with respect to the cathode, which is "closer" to the +310 V rail.

The AF input signal is fed to the grid of the lower triode, V_{1b}. The amplified signal at the anode is used as the input for the upper triode, V_{1a}, and the output of the cascade stage is capacitively taken from the cathode of the upper triode by means of C_4. As the output impedance of this SRPP circuit is relatively low, a cathode follower is not required to increase the drive capacity of the input stage.

It is fair to say that the SRPP-based preamplifier is a straightforward circuit. However, compared with often more intricate and more widely used valve input circuits, it offers quite noticeable features:

- very low distortion;
- good linearity;
- high amplification;
- high overload margin;
- low output impedance (depends on valve type).

All of these advantages make it possible to do without any form of negative feedback—even the cathode resistor of the lower triode is fully decoupled—and

Stereo valve preamplifier

Technical specification:

	MD amplifier	LINE amplifier
Valves	ECC 83 & ECC81	ECC82
Gain	44 dB	22 dB
S/N ratio:	78 dB	86 dB
Deviation from RIAA curve	·0.3 dB	—
Output impedance		2K4
Overall distortion	<0.01% (1 Vpp; 20 Hz – 20 kHz)	

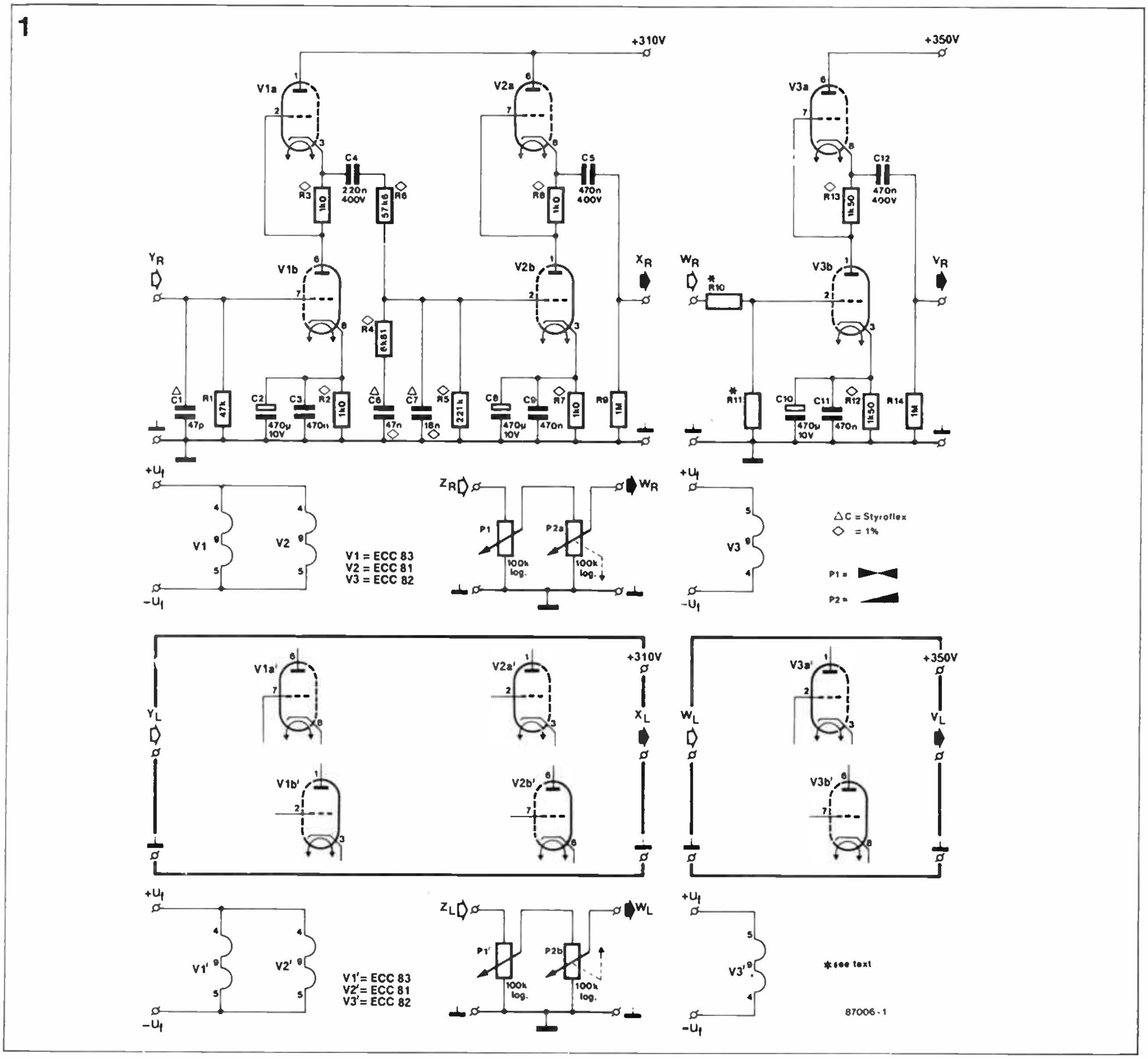
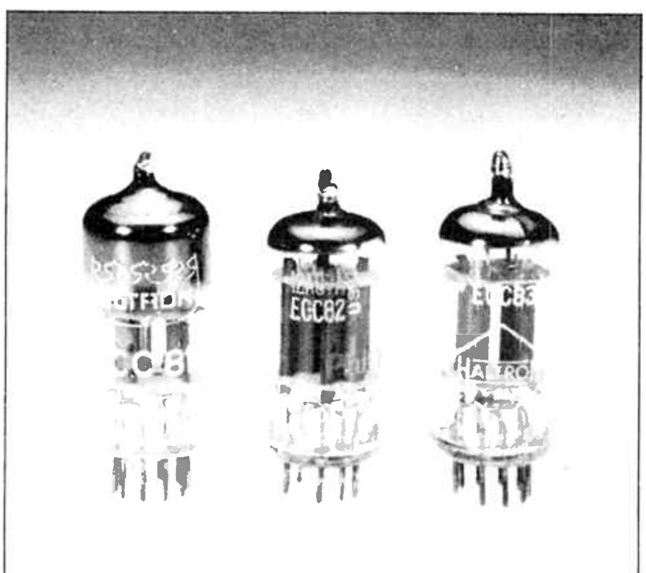


Fig. 1 Circuit diagram of the stereo valve preamplifier.

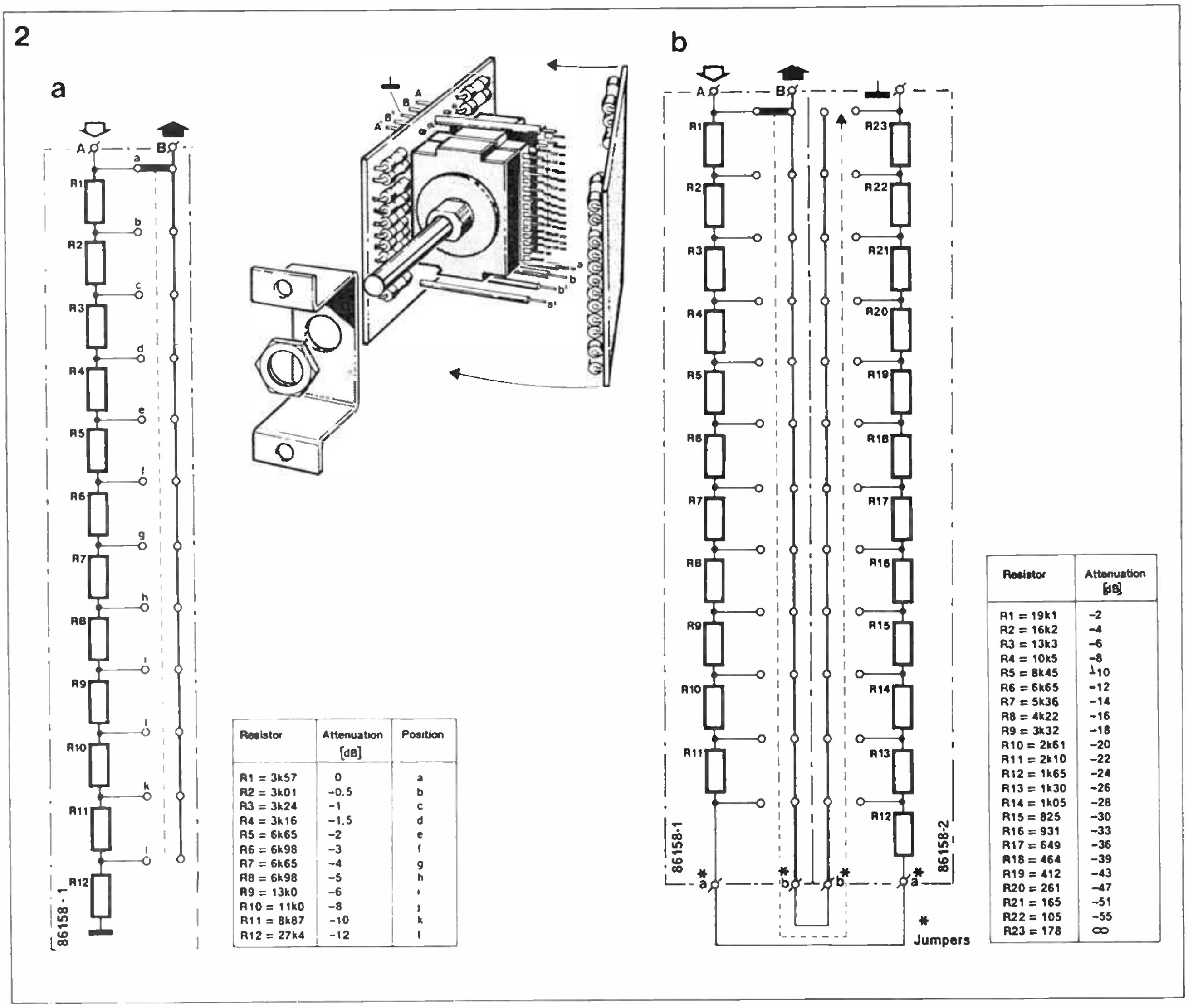
yet ensure a distortion of less than 0.1% at normal output levels. Contrary to many other valve-based designs, the distortion of the SRPP circuit decreases with rising frequency. Furthermore, the low output impedance enables the use of a passive RIAA filter (RIAA = Record Industry Association of America) to lower the overall distortion.

A practical circuit

Fig. 1 shows that the preamplifier essentially comprises three SRPP stages made with six triodes, i.e., three valves per channel. Valves V_1 and V_2 function as the PHONO amplifier. Between them there is the passive RIAA filter composed of R_4-C_6-C_7. The PHONO amplifier has a gain of about 44 dB, and its output signal is applied to an input selector board, whose circuit diagram appears in Fig. 3. Line amplifier V_3 takes its input signal from the volume and balance controls, P_1 and P_2. The volume and balance controls should be of unquestioned quality, and it is strongly suggested to use the ALPS potentiometer stated in the parts list. Alternative circuits for the balance and volume controls appear in Figs. 2a and 2b, respectively. When deciding to use the switch-and-resistor combinations instead of a po-



The triodes used for one channel of the preamplifier.



Resistor	Attenuation [dB]	Position
R1 = 3k57	0	a
R2 = 3k01	−0.5	b
R3 = 3k24	−1	c
R4 = 3k16	−1.5	d
R5 = 6k65	−2	e
R6 = 6k98	−3	f
R7 = 6k65	−4	g
R8 = 6k98	−5	h
R9 = 13k0	−6	i
R10 = 11k0	−8	j
R11 = 8k87	−10	k
R12 = 27k4	−12	l

Resistor	Attenuation [dB]
R1 = 19k1	−2
R2 = 16k2	−4
R3 = 13k3	−6
R4 = 10k5	−8
R5 = 8k45	−10
R6 = 6k65	−12
R7 = 5k36	−14
R8 = 4k22	−16
R9 = 3k32	−18
R10 = 2k61	−20
R11 = 2k10	−22
R12 = 1k65	−24
R13 = 1k30	−26
R14 = 1k05	−28
R15 = 825	−30
R16 = 931	−33
R17 = 649	−36
R18 = 464	−39
R19 = 412	−43
R20 = 261	−47
R21 = 165	−51
R22 = 105	−55
R23 = 178	∞

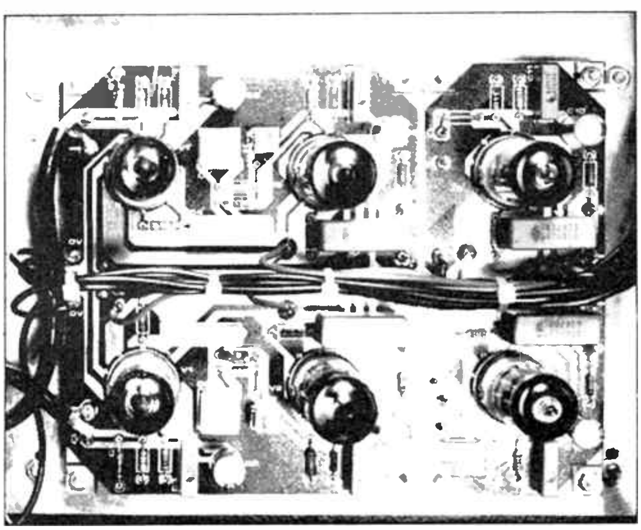
Fig. 2 Alternative versions of the balance (2a) and volume (2b) controls in the valve preamplifier.

tentiometer, make sure that you use the best components available, else the effort at making state-of-the-art controls is useless altogether.

The line output amplifier, V_3, has a gain of about 22 dB. It is possible to bypass it with a switch to enable the driving of a highly sensitive power amplifier direct from the PHONO stage. Note, however, that this requires due attention to be paid to the matching of the V_1-V_2 stage to the power amplifier input impedance. The Type ECC82 valve in the line amplifier ensures an output impedance of the region of 2K4, which is somewhat lower than that of V_2.

The input source selector is shown in Fig. 3.

The selection of the various input signals for the line amplifier is done with the aid of five high-quality relays, controlled from a third PCB that holds the logic circuits to that effect.



Completed preamplifier board

Sound quality

All components in the valve preamplifier should be high quality types to ensure optimum performance. In this context, it is useful to consult *Capacitors: myths and realities*, in *Elektor Electronics*, January 1987, page 35. Extensive testing of this valve preamplifier with the aid of a wide variety of programme material proved beyond doubt that the quality of the valves and resistors also counts rather heavily in the final performance of this design.

While it is realized that any appreciation of a preamplifier's output sound quality is but an attempt to describe basical psycho-acoustic impressions, a test set-up of a prototype of the valve preamplifier gave rise to the following observations regarding the performance:

- there is a high degree of sound neutrality; no part of the AF spectrum is unduly accentuated;

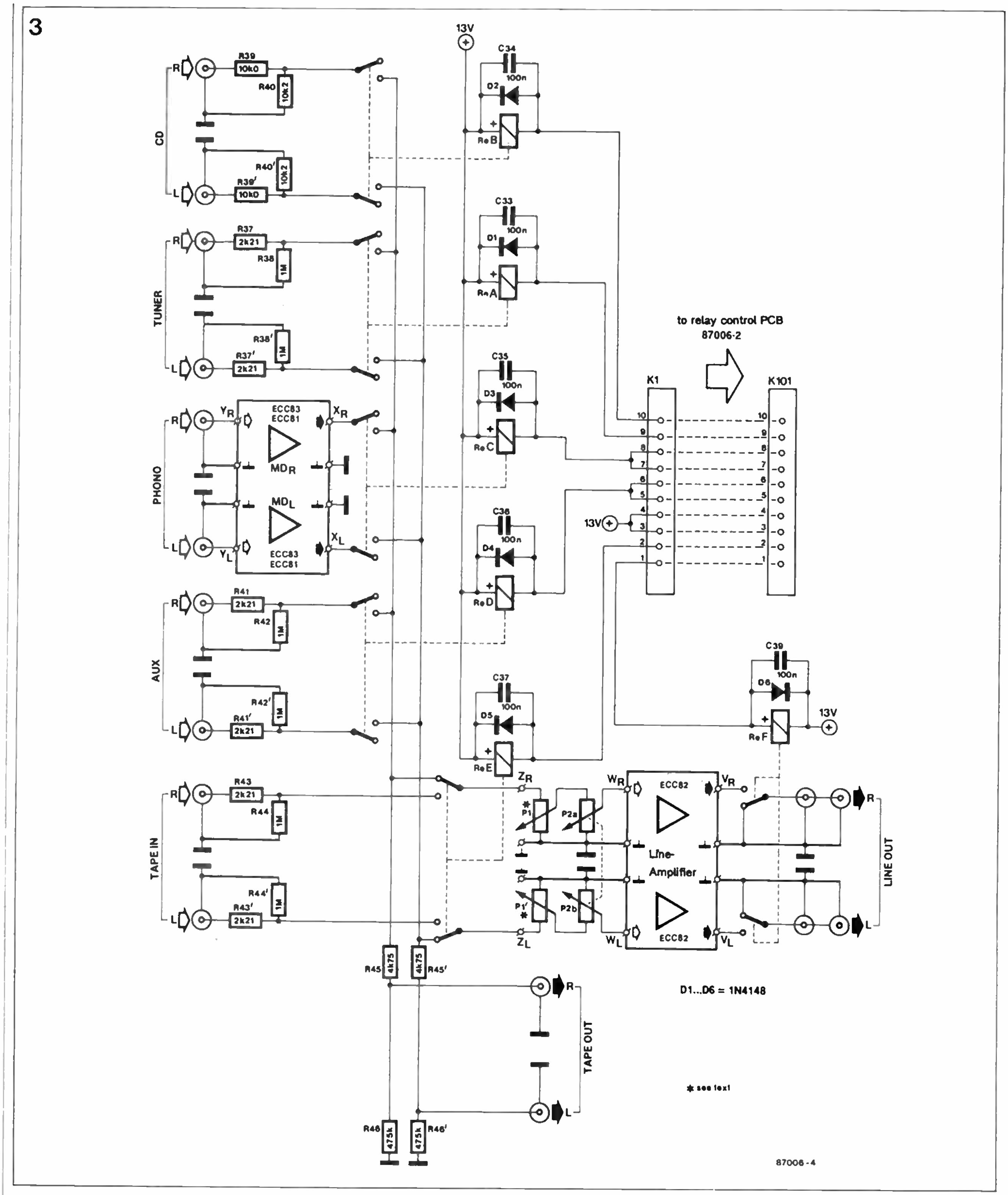


Fig. 3 The input source selector and its connection to the PHONO and LINE amplifiers.

- the dynamic characteristics fully meet the demands of compact discs;
- the transparancy of the output sound is quite remarkable; the amplifier ensures faithful reproduction of the human voice, as well as of percussion instruments.
- individual instruments are clearly audible in the composite spectrum.

Construction

The stereo valve preamplifier is constructed on ready-made double-sided board Type 87006-1. The fitting of parts as per Fig. 4 should not present problems. Make sure that the valves go into the right sockets; although the pinning of all three types is identical, they do have differently rated electrical characteristics! There is no PC board for the construction of the switched resistor volume and balance controls; consult Fig. 2 for a suggested set-up.

Capacitor C_1 may need to be adapted to correctly terminate the magnetodynamic cartridge. Resistors R_{10} and R_{11} are only required if the line amplifier is used as a separate unit; normally, however, R_{10} is a wire link, and R_{11} is not fitted. Resistors R_3, R_8 and R_{13} can be given a slightly different value to obtain the desired output

4

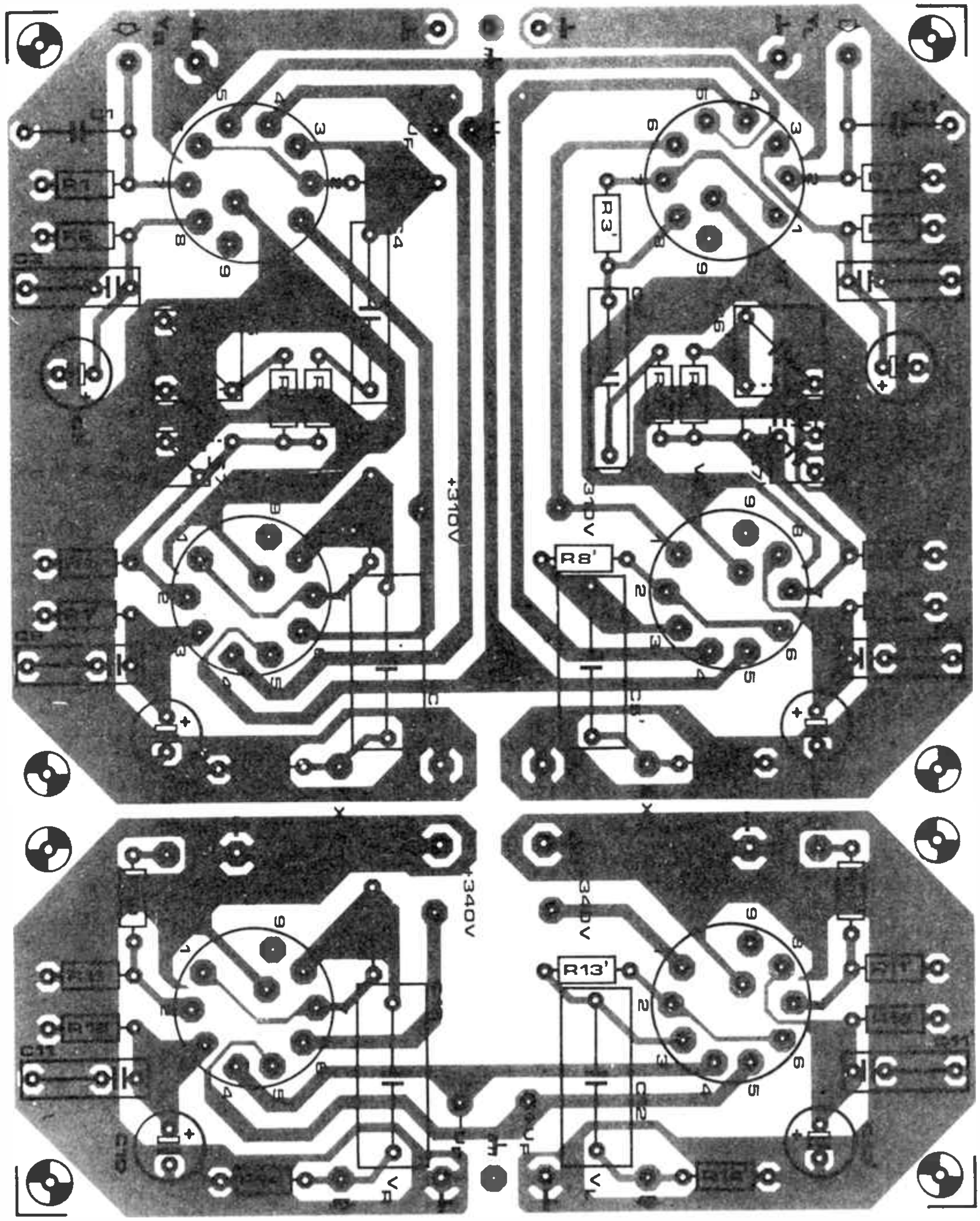


Fig. 4 Component mounting plan for the stereo valve preamplifier.

Parts list
(for stereo preamplifier: 2 off required of every component except P_2)

Resistors: (1% metal film; 0.5 W)
R_1 = 47K
R_2;R_7 = 1K0
R_3;R_8 = 1K0*
R_4 = 6K81
R_5 = 221K
R_6 = 57K6
R_9;R_{14} = 1M0
R_{10};R_{11} = 100K*
R_{12};R_{13} = 1K5*
P_1 = 100K log. potentiometer or switched resistor network shown in Fig. 2b.
P_2 = 100K log. stereo potentiometer, e.g. ALPS K 272A, or 2 switched resistor networks shown in Fig. 2a.

Capacitors:
C_1 = 47p styroflex*
C_2;C_8;C_{10} = 470μ; 10 V
C_3;C_9;C_{11} = 470n
C_4 = 220n; 400 V
C_5;C_{12} = 470 n; 400 V
C_6 = 47n; 63 V; 1%
C_7 = 18n; 63 V; 1%

Valves:
V_1 = ECC83 or E83CC
V_2 = ECC81 or E81CC
V_3 = ECC82 or E82CC

Miscellaneous:
6 off 9-pin (B9A "Noval" miniature) valve sockets for PCB mounting, preferably with gold-plated contacts.
PCB Type 87006-1

* See text

See our 'PROJECT BUYERS GUIDE' this issue for a guide to component sources and kit suppliers.

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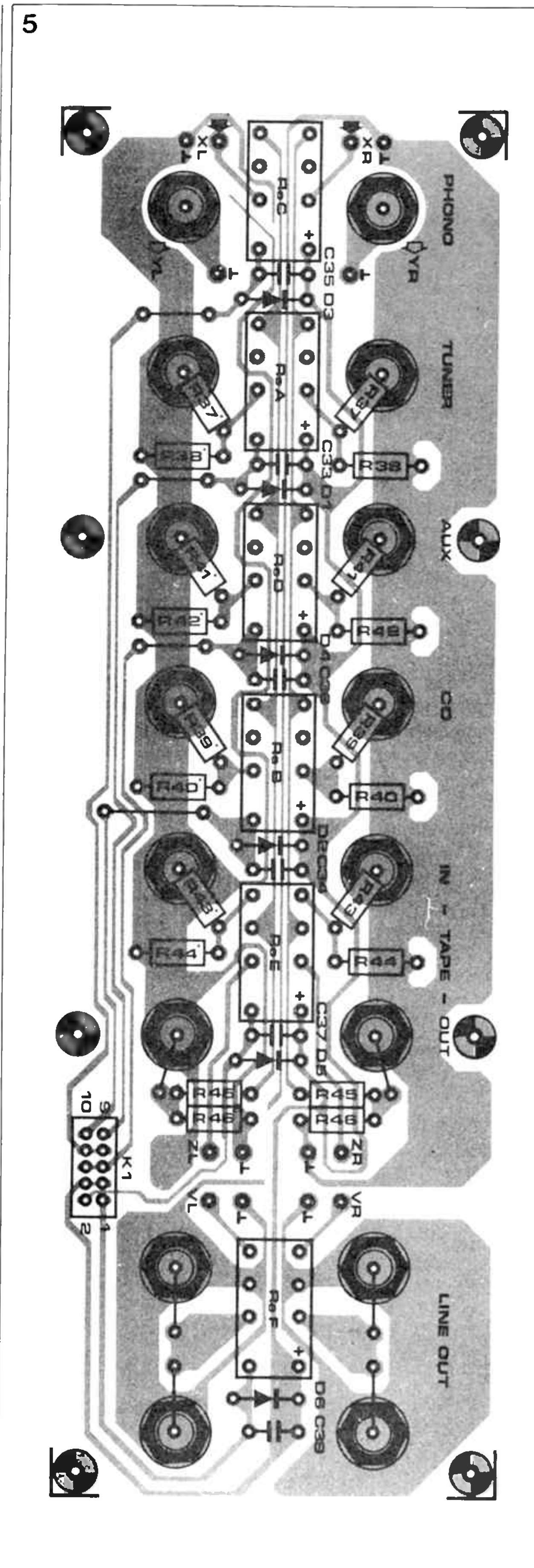


Fig. 5 Component mounting plan for the input source selector.

Parts list
(source selector board)

Resistors (all metal film; 1%):
$R_{37};R_{37}';R_{41};R_{41}';R_{43};R_{43}'$ = 2K21
$R_{38};R_{38}';R_{42};R_{42}';R_{44};R_{44}'$ = 1M0
$R_{39};R_{39}'$ = 10K
$R_{40};R_{40}'$ = 10K2
$R_{45};R_{45}'$ = 4K75
$R_{46};R_{46}'$ = 475K

Capacitors:
$C_{33};C_{34};C_{35};C_{36};C_{37};C_{38}$ = 100n

Semiconductors:
$D_1;D_2;D_3;D_4;D_5;D_6$ = 1N4148

Relays:
ReA;ReB;ReC;ReD;ReE;ReF = sub-miniature PCB mounting relay; 2-pole change-over; 12 V (e.g. Meisei M1-12 or M1B12H; Siemens W11V23102-A0006-A111 + +; Omron G2V-2;SDS DS2E-M12)*

Miscellaneous:
K_1 = 10-way PCB mounted socket*
16 screened phone chassis sockets with mating plugs*
PCB 86111-3a

sound. Suggested values are R_3 & R_8 = 1K1; R_{13} = 1K4. Note that all of the previously mentioned component numbers also apply to the LEFT channel.

The input source selector is constructed in PCB Type 86111-3a—see Fig. 5. For details concerning the design and construction of this part of the valve preamplifier, consult the section *Busboard* on page 44 of *Elektor Electronics*, November 1986. As already stated, the power supply and relay control circuits will be described in Part 2 of this article. *Sv*

Unfortunately the artwork for Elektor project pc boards published last issue and in this issue did not arrive from overseas in time for inclusion. We will publish them in the next available issue following their arrival.

BIPHASER

by W Teder

A sound effects unit that can add a new acoustic dimension to a wide variety of musical instruments.

There are various ways of obtaining the well-known *phasing* or *flanging* sound effect. Most phasers use phase-shifting networks, bucket brigade delay lines, selectively activated L-C networks, comb-type filters, or the like. The present circuit utilizes phase shifting, but has none of the drawbacks generally associated with this type of phaser, since provision has been made to obviate the troublesome amplitude-modulation effect caused by selective filtering at relatively low phaser speed settings. Where this effect is still tolerable—and often expressly sought after—with the rhythm guitar, it all but ruins the sound of numerous solo instruments, whose particular sound is not in any way embellished by appreciable volume variations. The use of a phaser based on the periodic shifting of, say, two stop-band filters results in a very lively effect with input signals relatively rich in harmonics, e.g. those of an acoustic rhythm guitar. The same phaser, however, is practically useless with a solo-instrument, since the played notes are subject to variations in amplitude, rather than in timbre.

When analysing the correlation between phasing effects and pitch of the input sound, it is noted that relatively high frequency components in the input sound typically require modulation with a correspondingly fast phase modulation signal. Similarly, the best effect for low input notes is obtained with slow phase modulation.

The foregoing considerations have been taken into account in the design of this biphaser, so named because of the use of *two* phase shifting circuits, each with its individual centre frequency and phase modulation speed control. These two circuits can be operated in parallel with two phaser speed settings to bring about a very good phasing effect without undesirable amplitude-modulation of the input signal. The circuit as presented here is but the minimum set-up of a versatile phaser unit whose controls offer a considerable variety in output sound. For those who wish to experiment a little further, there are interesting possibilities to extend the circuit to individual needs, as will be seen in the following section.

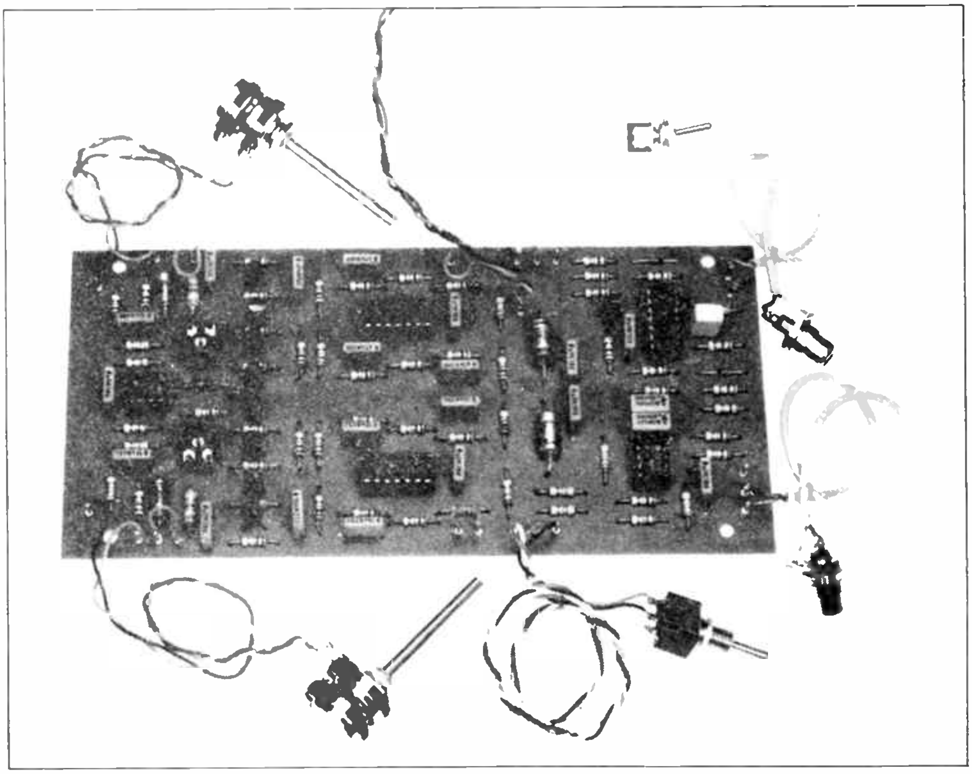
Circuit description

The circuit diagram in Fig. 1 shows that the biphaser contains the usual building blocks of an effects unit. The mono or stereo input signal is raised in amplifier A_1 and fed to two phase delaying circuits via R_{13} and R_{34}. The upper series of opamp-based all-pass filters is dimensioned for a relatively high centre frequency, while the lower series covers most of the lower part of the AF spectrum. Notice that the delay lines are identical but for the four frequency-determining capacitors, C_6-C_9 (high cascade) and C_{11}-C_{14} (low cascade). The circuits around opamps A_{11} and A_{12} are virtually identical, tunable oscillators which output a filtered triangular signal to the gates of the associated line of FETs in the delay chain.

Sufficient phase shift is obtained from both filter lines by controlling the resistances at the + input of the opamps, i.e., the resistance of the FET drain-source junction. Presets P_3 and P_4 enable a precise adjustment of the bias voltage on the gate line. The FETs in this circuit are selected for matching characteristics, to avoid the synchronicity of the opamp sections, and hence the final sound effect of the phaser, being impaired. The output signals of the PM oscillators are integrated with the aid of R_{18}-C_{10} (high) and R_{13}-C_{15} (low) to obtain sinusoidal control signals for the FETs.

Three-way switch S_1 selects the output of either one, or both, phase shifting lines. Mixing of the original input signal with the phased signal is accomplished by R_{28}, R_{49} and R_3. Opamp A_2 is the output buffer of the biphaser. The effect bypass circuit essentially consists of an optional footswitch, T_9, and a network of electronic switches, ES_1-ES_4. Since the footswitch (if used) carries a direct voltage, rather than any AF signal, its connection can be made in a fairly long, unscreened two-way cable.

One possible extension of the biphaser is the fitting of two phasing depth controls, P_5 and P_6, at the outputs of A_6 and A_{10}, ▶



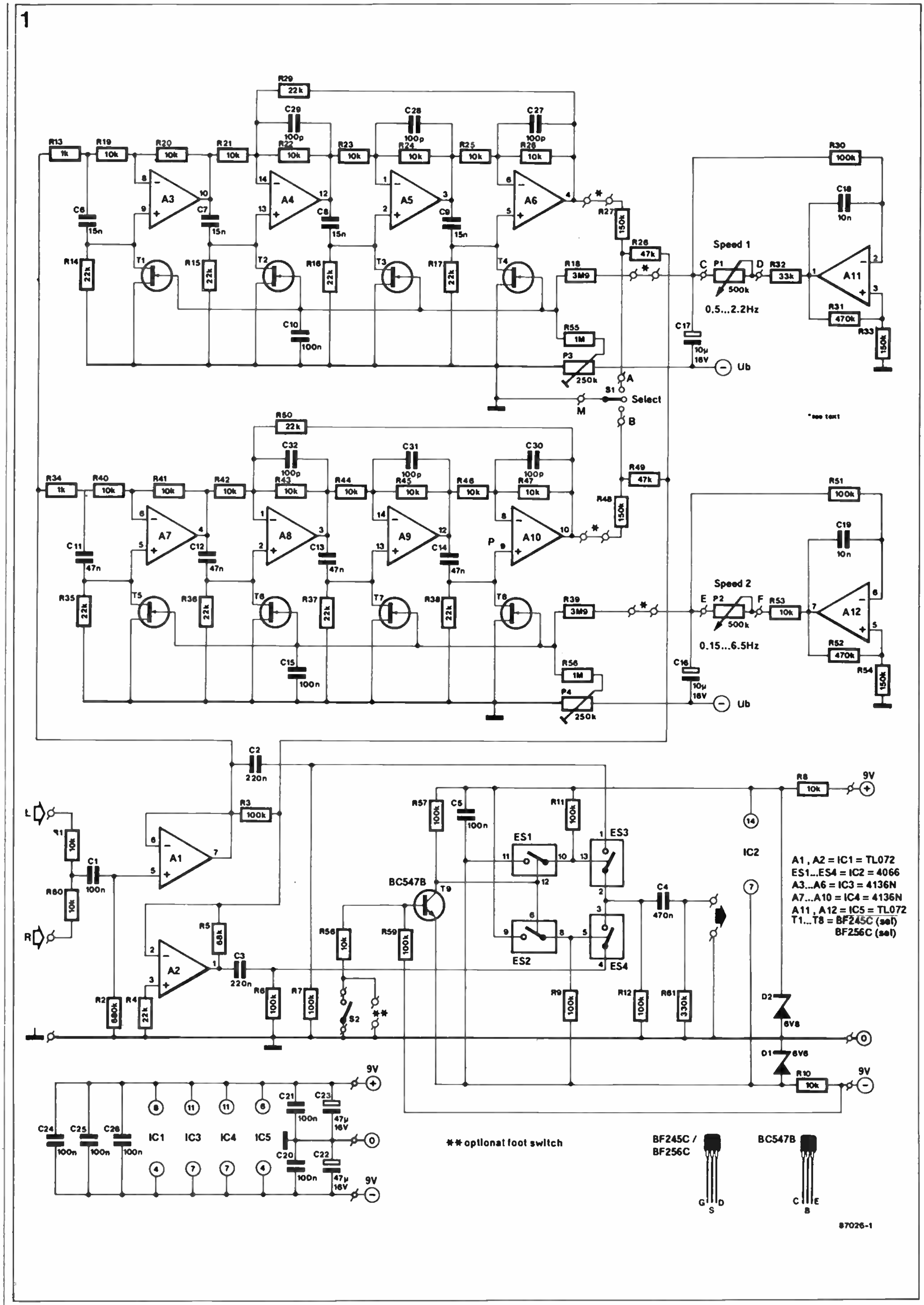


Fig. 1 At the heart of the biphaser are two individually modulated phase delay lines.

Parts list

Resistors (±5%)

R_1;R_8;R_{10};R_{19}...R_{26};R_{40}...R_{47};
R_{53};R_{58};R_{60} = 10K
R_2 = 680K
R_3;R_6;R_7;R_9;R_{11};R_{12};R_{30};R_{51};R_{57};
R_{59} = 100K
R_4;R_{14}...R_{17};R_{29};R_{35}...R_{38};
R_{50} = 22K
R_5 = 68K
R_{13};R_{34} = 1K0
R_{18};R_{39} = 3M9
R_{27};R_{33};R_{48};R_{54} = 150K
R_{28};R_{49} = 47K
R_{31};R_{52} = 470K
R_{32} = 33K
R_{55};R_{56} = 1M0
R_{61} = 330K
P_1;P_2 = 500K linear potentiometer
P_3;P_4 = 250K preset
P_5;P_6 = 100K linear potentiometer *
P_5 = 100K stereo potentiometer *

* Use is optional; see text.

Capacitors:

C_1;C_5;C_{10};C_{15};C_{20};C_{21};
C_{24}...C_{26} = 100n
C_2;C_3 = 220n
C_4 = 470n
C_6...C_9 = 15n
C_{11}...C_{14} = 47n
C_{16};C_{17} = 10µ; 16 V
C_{18};C_{19} = 10n
C_{22};C_{23} = 47µ; 16 V
C_{27}...C_{32} = 100p

Semiconductors:

D_1;D_2 = zenerdiode 6V8; 0.4 W
IC_1,IC_5 = TL072
IC_2 = 4066
IC_3,IC_4 = 4136 (Texas Instruments)
T_1 ... T_8 incl. = BF245C or BF256C *
T_9 = BC547B

Miscellaneous:

S_1 = SPDT with centre position.
S_2 = SPST (or foot switch; see text).
Suitable enclosure.
2 off 9 V batteries, or a mains supply.
3 off 6.3 mm jack sockets

respectively—see Fig. 2a. Alternatively, the two potentiometers can be replaced with a single stereo type as shown in Fig. 2b. The wire links at one end of R_{18} and R_{39} enable both phase shifting lines to be driven from a single PM oscillator. A further, more radical, extension of the circuit could involve the construction of additional phase delay lines, each dimensioned for a specific pass-band, and controlled by an associated oscillator. If you consider trying this out, remember to use matched FETs only, else the effort is useless.

The biphaser is powered from two 9-V batteries or a small sym- ▶

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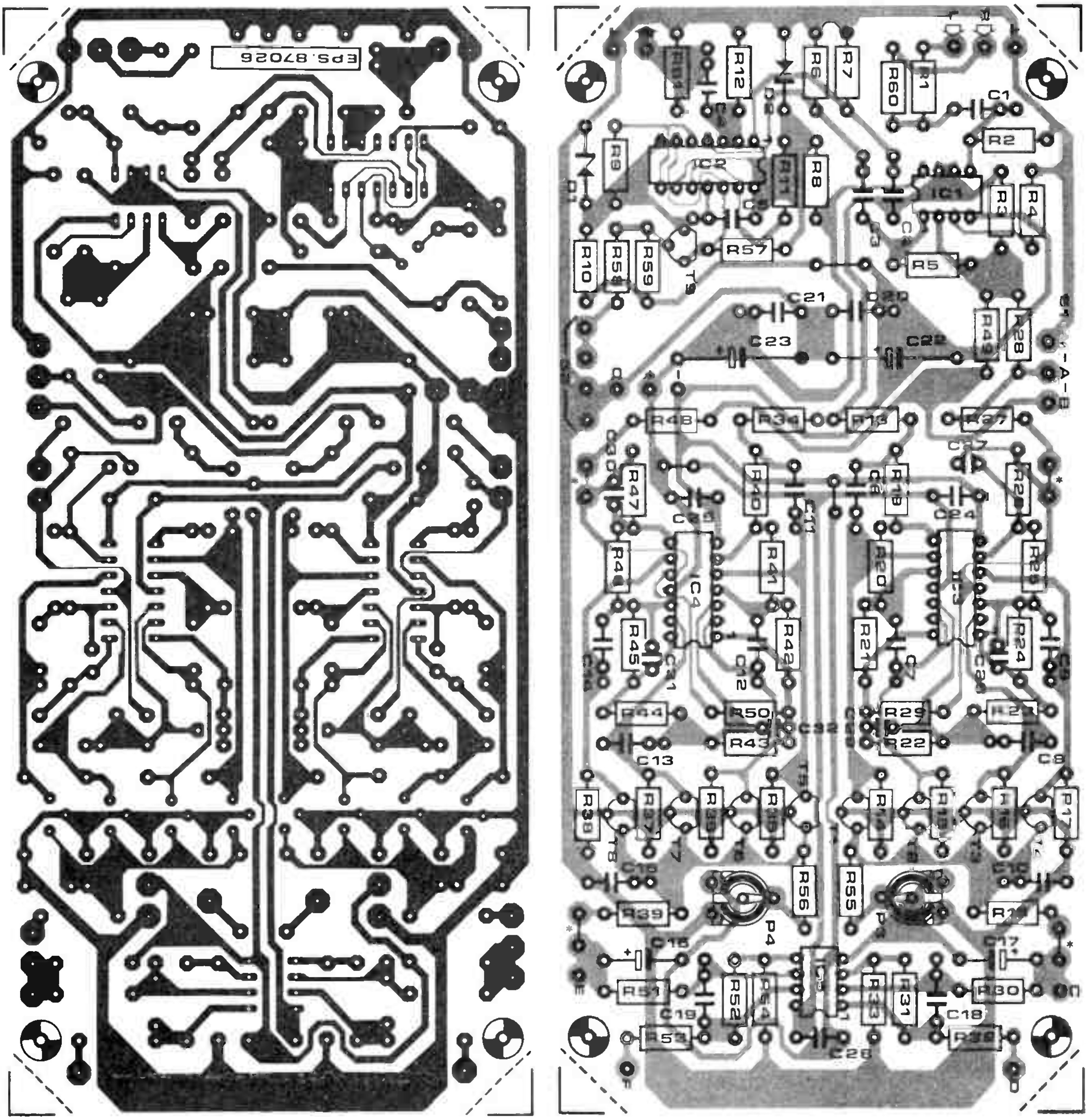

Fig. 3 Overlay diagram and track pattern of the PCB for the biphaser.

SCART ADAPTOR FOR IBM PC

As a growing number of colour TV sets come with a SCART input, many owners of an IBM PC will have toyed with the idea of using a SCART compatible set as a CGA-driven, medium-resolution, RGB display. Well, here is the adaptor circuit to do just that!

Medium and high-resolution RGB monitors with TTL-compatible monitors are generally recognized as costly devices. It is not suprising, therefore, that many an owner of an IBM PC or PC compatible starts wondering about driving the video and sync circuitry in a modern colour TV set with the TTL signals from the CGA (colour graphics adaptor) in the computer. After all, the resolution of the typical TV set should be adequate for the 320 x 200 pixels from the CGA. Considerable difficulty, however, arises from the fact that the CGA composite video output supplies a NTSC signal (American TV standard), rather than a PAL signal as required for most European TV sets.

The solution to the above problem van be found in the use of the SCART input on the TV set; what is required is an add-on interface to convert the TTL levels from the CGA outputs to SCART levels. The vertical synchronization and the horizontal centring adjustments in the TV set will need to be slightly re-aligned to obtain a stable image from the computer. When the TV set is to remain suited for normal broadcast reception, it is suggested to fit a separate set of image adjustment controls aligned for the IBM video standard. A simple switch then makes it easy to select the appropriate setting.

Circuit description

The TTL-to-SCART level converter is shown in Fig. 1.

In the proposed circuit, the level conversion is essentially from digital (Ø=0 V; 1=5 V) to analogue. Three identical level shifters, based around $T_1 \ldots T_6$ provide the SCART-compatible TV set with correctly rated R, G, and B signals with two intensity levels, selected with the I output from the CGA. With presets P_1, P_2 and P_3 set to about the centre of their travel, a logic high I input causes the analogue colour outputs to vary from 0.3 V to 0.6 V, while a logic low I input gives an output range of 0 V to 0.3 V. The toggle voltage should be set at the same level for all three buffers, i.e., P_1, P_2 and P_3 should be adjusted for identical wiper positions. The final alignment of the intensity ratio depends on your personal taste, and some time should be spent in turning the presets for best colour reproduction on the TV screen.

Transistors T_7 and T_8 together form the synchronization mixer-

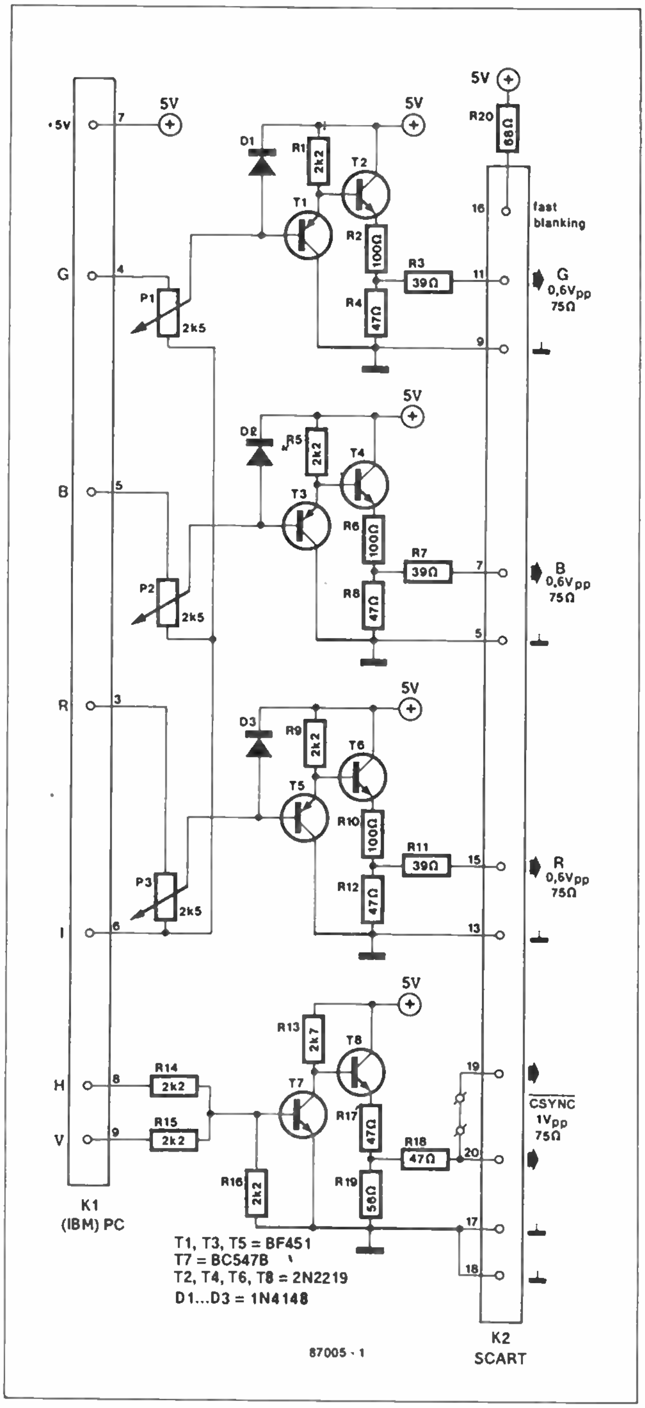

Fig.1 Only a handful of commonly available components are needed to make this TTL-to-SCART adapter for the IBM micro.

Parts list

Resistors (±5%):
R_1;R_5;R_9;R_{14};R_{15};R_{16} = 2K2
R_2;R_6;R_{10} = 100R
R_3;R_7;R_{11} = 39R
R_4;R_8;R_{12};R_{17};R_{18} = 47R
R_{13} = 2K7
R_{19} = 56R
R_{20} = 68R
P_1;P_2;P_3 = 2K5 preset

Semiconductors:
T_1;T_3;T_5 = BF451
T_2;T_4;T_6;T_8 = 2N2219(A)
T_7 = BC547B
D_1;D_2;D_3 = 1N4148

Miscellaneous:
K_1 = 9-way sub-D plug
K_2 = 21-way angled SCART socket

We regret that no ready-made circuit board is available for this project.

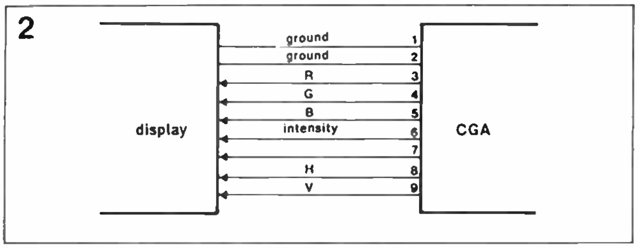

Fig. 2 Connection between CGA and RGB computer monitor.

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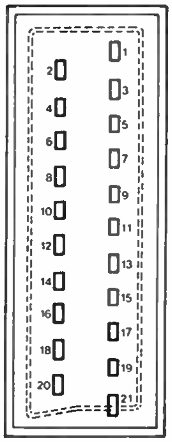

SCART connector

pin	function	nominal amplitude
1	audio output (R)	0.5 V_{rms}
2	audio input (R)	0.5 V_{rms}
3	audio output (L)	0.5 V_{rms}
4	audio ground	
5	B input ground	
6	audio input (L)	0.5 V_{rms}
7	B input	0.7 V_{pp} in 75R
8		
9	G input ground	
10		
11	G input	0.7 V_{pp} in 75R
12		
13	R input ground	
14		
15	R input	0.7 V_{pp} in 75R
16	fast blanking	3 V
17	CVBS ground	
18	fast blanking ground	
19	CVBS output	1 V_{pp} in 75R
20	CVBS input	1 V_{pp} in 75R
21	connector shield	

Fig. 3 Pin assignment and voltage level convention of the standardized SCART connector.

buffer-inverter. The $\overline{CSYNC}$ signal is used to drive the CVBS (composite video, blanking, synchronization) input of the TV set via SCART pin 20. When you use a standard, male-male, SCART cable between the adaptor and the TV set, the $\overline{CSYNC}$ output is applied to connector pin 19.

As the proposed adaptor circuit comprises only very few parts, it is conveniently built into the computer enclosure. The supply voltage can be taken from CGA pin 7, as shown in the circuit diagram. The current consumption of the adaptor is of the order of 150 mA; should this exceed the capability of the CGA board—they come in various forms and are often slightly different from the original IBM version—a separate wire may be run to the +5 V bus line on the mother-board, or a Type 7805 regulator may be used to provide the supply for the SCART adaptor board.

Finally, Figures 2 and 3 summarize the connection between CGA and computer monitor, and the pin assignment of the SCART connector, respectively.

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NTSC = National Television System Committee.
PAL = Phase Alternation Line.

D

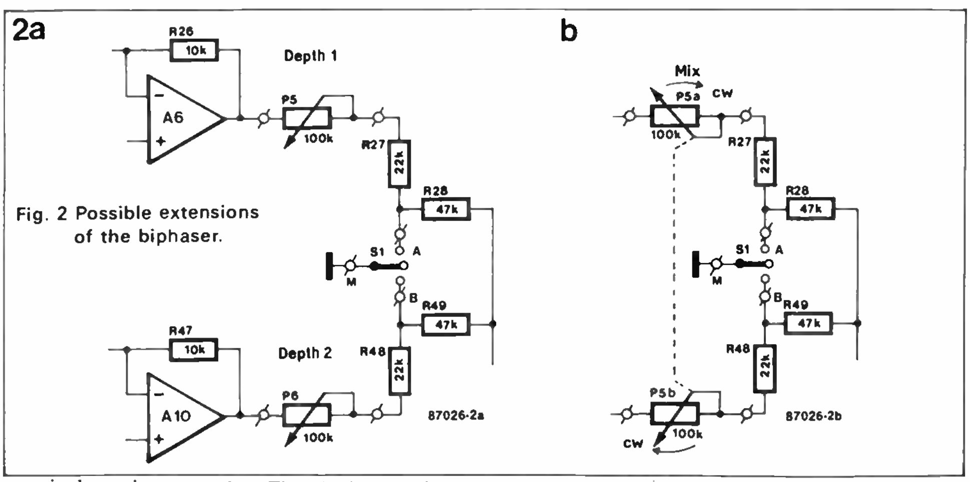


Fig. 2 Possible extensions of the biphaser.

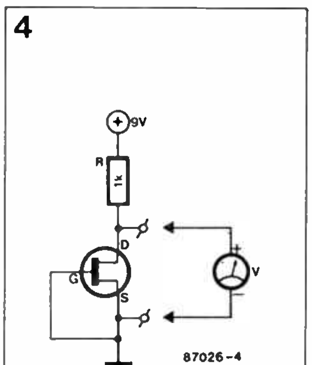


Fig. 4 Perform this current source test to select FETs with matching characteristics.

metrical mains supply. The positive and negative supply rails are adequately decoupled with C_{20}-C_{26} to prevent any likelihood of noise or hum being picked up. Current consumption of the unit is of the order of 40 mA on each 9 V supply rail.

Construction and setting up

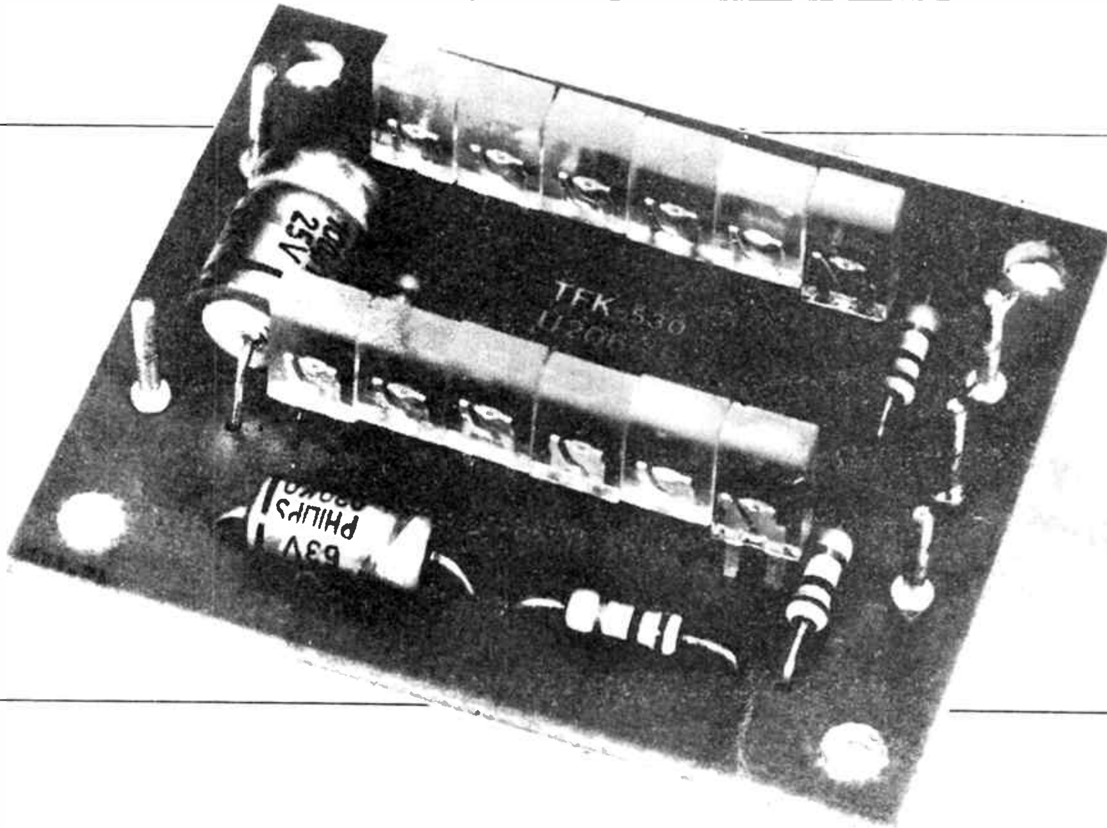
There is virtually nothing to say about the construction of this effect unit. Hardly anything can go amiss if you stick to the Parts List and the component overlay shown in Fig. 3. The AF input and output of the phaser, as well as the foot switch input, are best made with insulated jack sockets, as customary with effect units. The enclosure must, of course, be quite sturdy, and it is recommended to use one of the smaller types of Eddystone diecast boxes, the top lid of which can be used to fit the footswitch and the speed controls. Alternatively, the biphaser can be incorporated in a mains-operated, remote-controlled effects unit, together with a fuzzer, a reverberation/echo unit, and the like, which can all be controlled from a set of footswitches on the stage.

The completed unit requires no alignment other than setting presets P_3 and P_4 for an acceptable phasing rate at a minimum of distortion. This is best done with the aid of an oscilloscope and an AF sinewave generator set to about 1 kHz at 1 V_{pp}. Connect the generator output to either one of the phaser inputs, and use the scope to monitor the phaser output signal. Adjust P_3 and P_4 for optimum amplitude modulation, i.e., the FETs should operate over the full excursion of the sinewave, without appreciable offset and/or clipping. Remove the sinewave input signal and use a voltmeter to check whether all inputs and outputs of the opamps in the phase delay lines are at about 0 V with respect to ground.

Finally, Fig. 4 shows how to select FETs for nearly identical characteristics with the aid of a simple test circuit. The FET under test is connected as a current source, and the drain-source voltage is monitored to find devices dropping the same voltage across the drain resistor.

D

STEREO VU-METER



Although primarily intended for the Mobile Studio Unit described in the March issue of Elektor in AEM, this module is so compact and readily adaptable to individual requirements that it is suitable for incorporation in existing audio equipment as well as new designs.

Strictly speaking, the term *volume unit (VU) meter* is a slightly misleading qualification for what is in essence but a voltmeter with a logarithmic scale. This observation considered, it is logical to propose the use of a VU meter for purposes other than the monitoring of, for instance, recording and playback levels on cassette or tape recorders. The VU meter introduced in this article lends itself like no other to tailoring for incorporation in a wide variety of AF equipment. It is extremely compact, LED-based, and comprises only a handful of components.

A single-chip LED driver

Basically simple integrated circuits lending themselves to a variety of applications are often in danger of remaining unnoticed because more complex chips receive all, or nearly all, the attention. The Types U2066B and U2067B from Telefunken are typical examples of this. None the less, they are interesting devices referred to as *low cost stereo LED scale controllers* by the manufacturers. The following is a brief summary of their essential technical characteristics:

- extensive supply range: U_b = 5—18 V (20 V max.);
- constant current drive for LEDs;
- low dissipation ensured by series-connected LEDs;
- fully configurable for the driving of LEDs in various colours;
- internal operational amplifier for each channel;
- logarithmic scale division;
- two U2066Bs or U2067Bs can drive a 2 x 10-LED scale;
- LED drive intervals:
  5 — 5 — 3 — 3 [dB] (U2066B)
  2 — 2 — 2 — 2 [dB] (U2067B);
- current consumption only 40 mA (typ.).

Table 1

LED no.	U 2066 B V_{in} mV	U 2066 B ΔV_{in} mV	U 2067 B V_{in} mV	U 2067 B ΔV_{in} mV
1	206	± 30	510	± 30
2	364	± 40	644	± 40
3	644	± 50	814	± 50
4	912	± 60	1021	± 60
5	1 289	± 60	1289	± 80

Table 2

LED colour combination	S P 5 0	S P 4 1	S P 3 2	S P 2 3	S P 1 4
5 green	17 V	14 V	11 V	8 V	5 V
5 red	12 V	10 V	8 V	6 V	4 V
4 green & 1 red	16 V	14 V	11 V	8 V	5 V
3 green & 2 red	15 V	13 V	11 V	8 V	5 V
connection diagram (Fig. 4)	a	b	c	d	e

S = Series P = Parallel

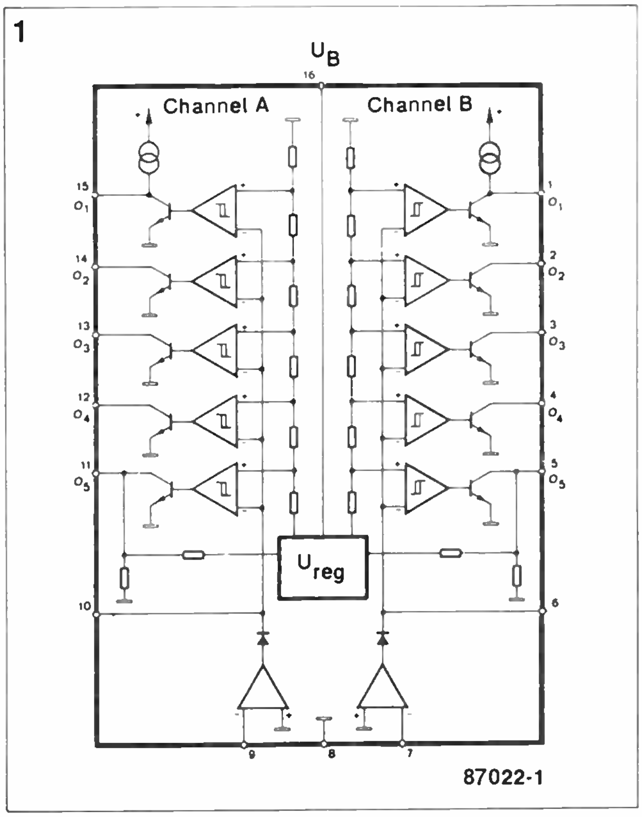


Fig. 1 Pinning and internal organization of the Type U2066 LED VU meter driver.

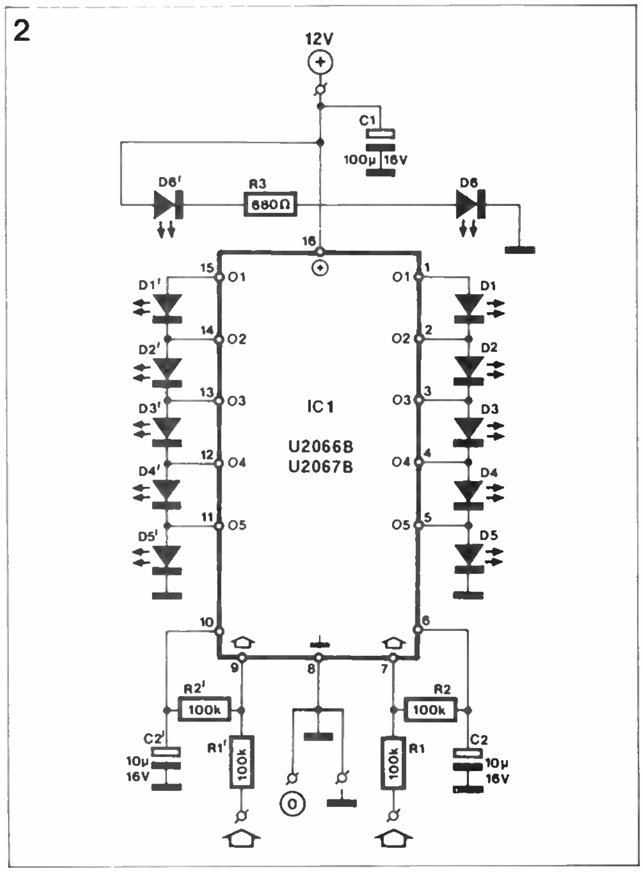


Fig. 2 Circuit diagram of the 12-LED VU meter.

Table 2 shows that the colour of the LEDs connected to these chips determines the minimum supply voltage, as well as the output configuration (series or parallel). A supply voltage of 12 V, for instance, makes it possible to drive four series-connected red LEDs, while a similar configuration with green LEDs requires the chip supply to be at least 17 V.

Fig. 1 shows the internal structure of the Type U2066B. Each channel comprises an opamp-based input amplifier plus rectifier, and a reference voltage divider realized with five comparators driving a similar number of output transistors fed from a 15 mA current source. The reference voltage in the chip is derived from a special regulator circuit.

The fact that the output of the rectifier sections is brought out to pins enables ready dimensioning of the circuit for optimum LED on—off response, as well as input impedance and sensitivity.

The practical circuit of the stereo VU meter is shown in Fig. 2. The input impedance is mainly determined by R_1 and R_1', while the overall gain of the circuit is determined by voltage dividing networks R_2/R_1 and R_2'/R_1'. The large number of possible values for these components enables a wide range of amplification or attenuation factors to be realized. Capacitors C_2 and C_2' serve to define the display response to input signal variations. It is possible to use the chip as a direct voltage monitor by simply grounding the inverting inputs of the opamps, and applying the direct voltage to pins 6 and 10.

The input voltages at which the LEDs light are given in Table 1. It should be noted that the voltage applied to pins 6, 7, 9 and 10 must not exceeed U_b—1.5 V. Two additional LEDs, D_6 and D_6', have been included in the VU meter to indicate the presence of the supply voltage for the board.

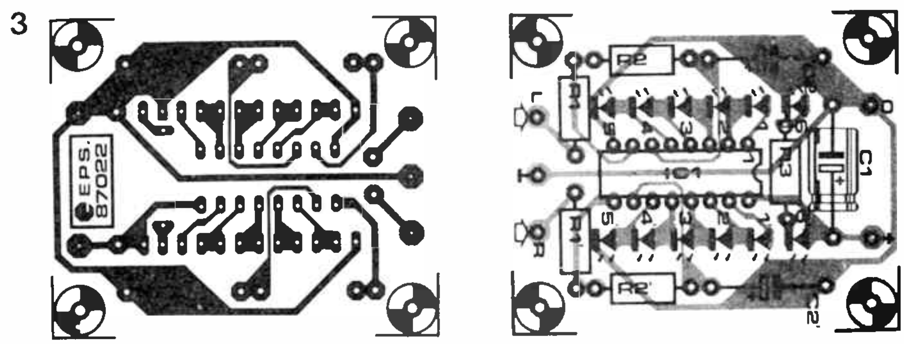


Fig. 3 Component mounting plan and PC board track pattern for the VU meter.

Constructing and tailoring the VU meter

The VU meter is constructed on a small PC board as shown in Fig. 3. All LEDs should preferably be rectangular types to create two 30 x 2.5 mm bars that can protrude from the equipment front panel.

In theory, the minimum supply voltage for the LED driver is calculated as

$$U_{b(min)} = \sum U_D + 2 \text{ [V]}$$

Parts list

Resistors:
$R_1;R_1';R_2;R_2'$ = 100K
R_3 = 680R

Capacitors:
C_1 = 100μ; 16 V axial
$C_2;C_2'$ = 10μ; 16 V axial

Semiconductors:
D_1 . . $D_3;D_1'$ . . . $D_3';D_6;D_6'$ = green rectangular LED
$D_4;D_4'$ = yellow rectangular LED
$D_5;D_5'$ = red rectangular LED
IC_1 = U2066B (Telefunken)

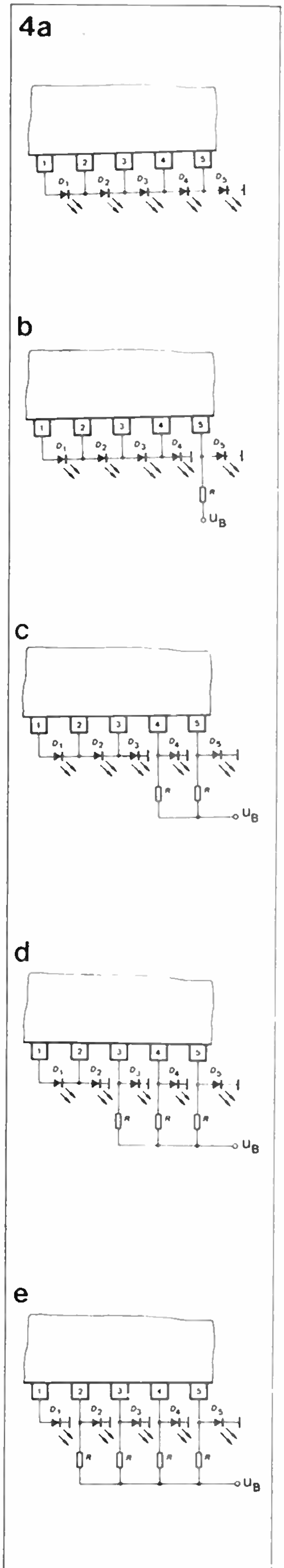


Fig. 4 The LED output configuration depends on the available supply voltage and the LED colours.

Table 3

LED 1	LED 2	LED 3	LED 4	LED 5	LED 6	LED 7	LED 8	LED 9	LED 10	
−20	−15	−10	−7	−4	−2	0	+2	+4	+6	dB
46	81	144	204	288	363	456	574	723	911	mV

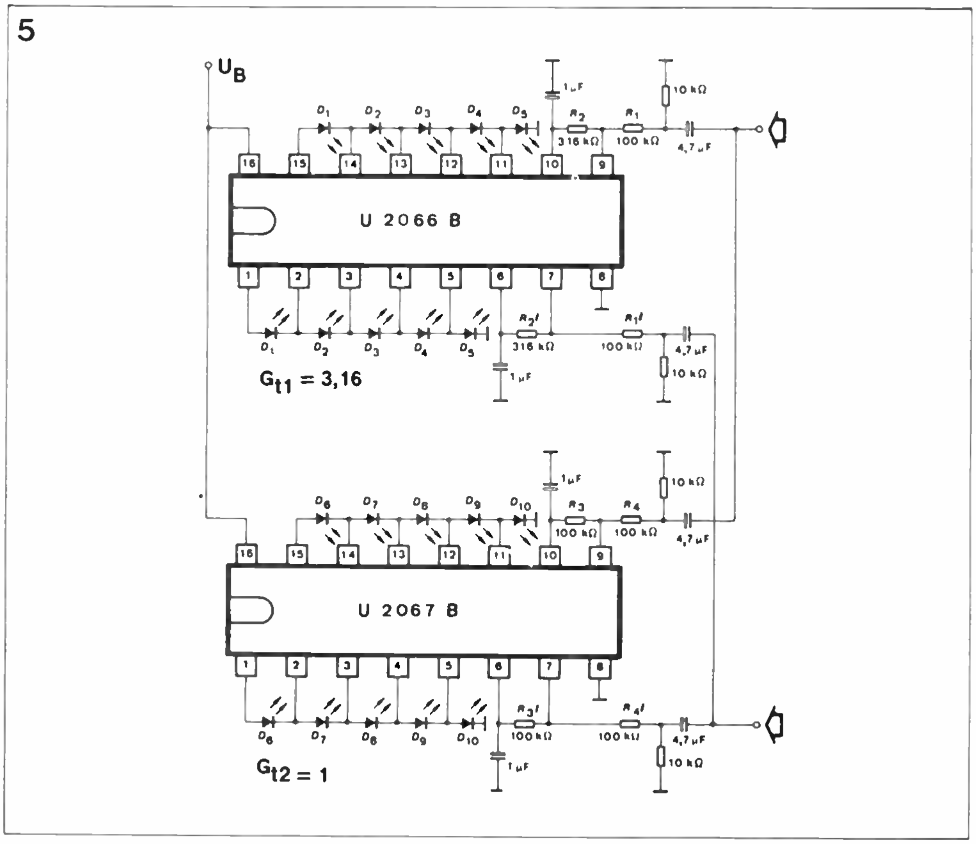


Fig. 5 A Stereo 10-LED VU meter based on two driver chips.

where U_D is the direct voltage required to light the LED in question. Note that $U_D = 2$ V for a red LED, and $U_D = 3$ V for a green type. Comparing the manufacturer's data in Table 2 with the practical circuit of the VU meter would lead to the conclusion that the circuit can work with red LEDs only. Extensive experiments, however, have proved that a supply of 12 V is sufficient for the driving of a series connection of one red, one yellow, and three green LEDs (D_5—D_1/D_5'—D_1') without the slightest problem.

If the supply voltage available in the AF equipment does not allow the use of five series-connected LEDs, consult Table 2 to find an alternative configuration shown in one of the circuits in Fig. 4. It will be seen that more LEDs need an individual current limiting resistor as the available supply voltage decreases towards a minimum of 5 V. The value of R in these circuits is

$$R = (U_b - U_D)/15 \ [k\Omega]$$

The AF input level range that causes the LEDs to light in succession can be established by appropriate dimensioning of the amplification, G_v, of the input amplifier in each channel:

$$G_v = V_{in(D5)}/(V_i\sqrt{2}) = R_2/R_1$$

where $V_{in(D5)}$ can be taken from Table 1, and V_i is the level at which the fifth LED (maximum AF level) should light.

Example; LED no. 5 should light at an input voltage of 212 mV_{rms}: $G_v = 1289/(212\sqrt{2}) = R_2/R_1 = 4.3$ With $R_1 = 100K$, $R_2 = 4.3 \times 100 = 430K$.

A stereo 10-LED VU meter

As already noted, it is possible to build a dual 10-LED scale controller by utilizing a U2066B and a U2067B with appropriate amplification factors—see Fig. 5. The amplification factor, G_{v2}, of the latter is first calculated with the aid of the previously given formula. The fifth LED turn-on level of the Type U2066 is always 10 dB (3.16×) lower than that of the Type U2067B, whence $G_{v1} = 3.16G_{v2}$. Notice that G_{v1} and G_{v2} in the circuit of Fig. 5 are 1 and 3.16, respectively (R_3/R_4 and R_2/R_1). The comparator turn-on threshold levels and associated input voltages are given in Table 3. The previously given calculations may be used to account for the +6 dB level of 911 mV, and the values for R_3 and R_3'. If a different range of input voltages is required, the values of the relevant resistors should be changed as appropriate, but the ratio G_{v1}/G_{v2} should be left at 3.16.

Source: U2066D U2067B data-sheet; Telefunken Electronic.

FIELD-EFFECT OPTOCOUPLER

by W Teder

In this article we will examine a number of possible applications of a recently introduced optocoupler incorporating an infra-red light-emitting diode and a phototransistor made in field effect technology.

In spite of its many interesting applications in the field of audio engineering, the Type H11F3 FET optocoupler from General Electric (GE) has so far passed unnoticed to many hobbyists and professional designers eager to experiment with new semiconductors.

Apart from its use as a fast, electrically isolated switch (solid-state relay), the H11F3 is eminently suitable for quite a number of applications having to do with AF signal processing.
Table 1 shows the maximum ratings of the FET optocoupler, while Fig. 1 shows its pin assignment and its equivalent circuit diagram. The field-effect element in the H11F3 is a non-polarized, photo-sensitive semiconductor layer, comparable to a drain-source junction. This semiconductor essentially behaves like a light-controlled resistor, whose resistance is a function of the current passed through the IR LED in the package. The H11F3 offers a remarkable resistance range of 100 ohms to 300 mega-ohms.

Many applications

In this section we will offer a necessarily brief discussion of a number of application circuits based on the new optocoupler. These applications come under two headings: the use of the H11F3 as a controllable resistive element, and its use as a fast, isolated switch.

Before introducing a number of applications in the first mentioned category, it must be pointed out that the FE element in the H11F3 behaves largely similar to a normal drain-source junction. Therefore, the voltage across R_F must not exceed some 50 mV to avoid distortion. Fig. 2 shows the basic concept of a controlled voltage divider, whose main feature is an unusually low charge injection cross-talk figure. Fig. 3 is a more practical application of the use of the FET optocoupler in a design for a **compressor**, whose attack, decay, and rate of compression are individually adjustable. The **limiter** shown in Fig. 4 is based on the use of a comparator circuit which drives the IR LED in the optocoupler whenever the AF input voltage exceeds a preset value. As with the compressor, the attack and decay times can be defined over a wide range.

When designing circuits incorporating a number of optocouplers driven from a common control line, due account should be taken of the fact that the values of R_F of the individual resistive elements need not be identical, even if the same amount of current is passed through the associated infra-red emitting diodes—see Fig. 5. It is, therefore, not recommended to use H11F3s in tracked VCAs, or synchronously tuned active filters. Fig. 6 shows how adjustable current sources can be used to match R_F of two optocouplers. The cir-

Table 1.

H11F3 Maximum ratings:

IR diode:	
I_{max} (continuous)	60 mA
I_{max} (peak)	500 mA ($t \leq 500$ μs)
	1 A ($t \leq 1$ μs)
Dissipation	150 mW (at T_a = 25° C)
FET:	
U_{RF}	± 15 V
I_{RF} (continuous)	100 mA
Dissipation	300 mW (at T_a = 25° C)

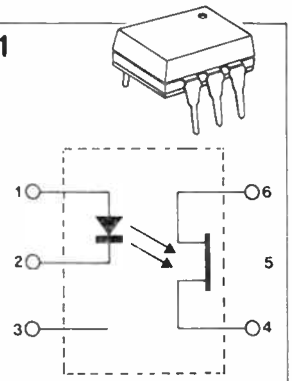
1


Fig. 1 Equivalent circuit and pin assignment of the H11F3 field-effect optocoupler.

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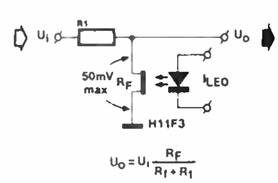

Fig. 2 Rudimentary from of an AF attenuator.

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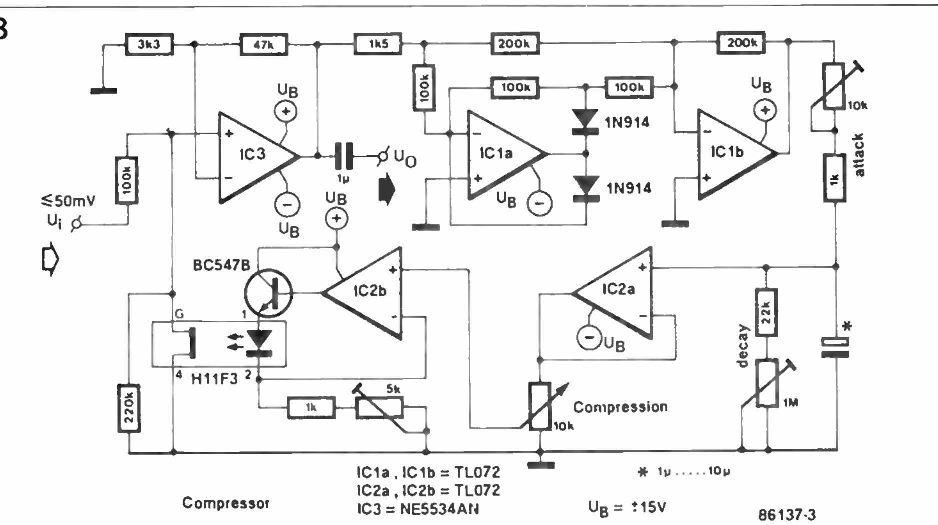


Fig. 3 The new optocoupler as the regulating element in a compressor circuit.

cuit is inadequate, however, to compensate large differences in production tolerance of individual optocouplers. Also, in its basic layout, it can not rule out the effects of differently shaped RF characteristics and device-specific minimum and maximum values of RF.

The use of the new H11F3 as a semiconductor switching element poses less problems than the previously mentioned applications. The typical junction resistance of RF is 100 to 300 ohms at a LED current of 30 mA (60 mA max.) With no current passing through the LED, the FE element reaches an off-resistance of no less than 300 mega-ohms at a stray capacitance of about 15 pF. Figures 7a and 7b show the use of RF as a short-circuiting and a

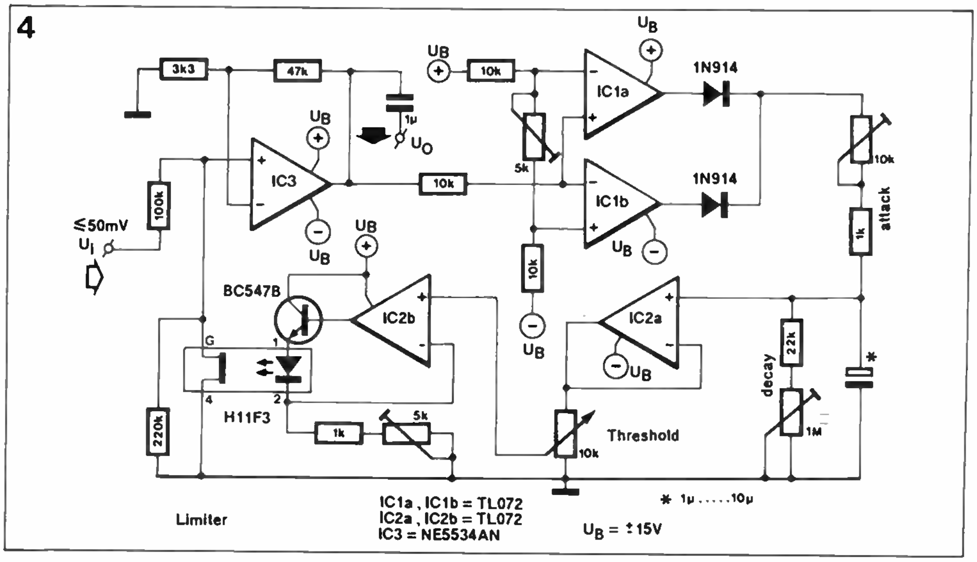


Fig. 4 A variable-threshold AF limiter.

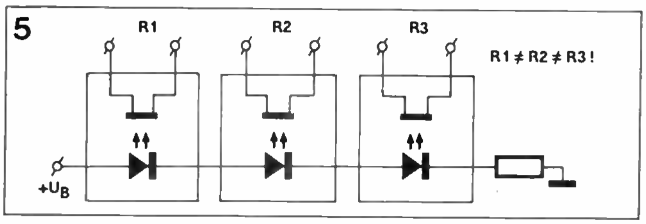


Fig. 5 The IR diodes connected in series for multi-channel regulation purposes.

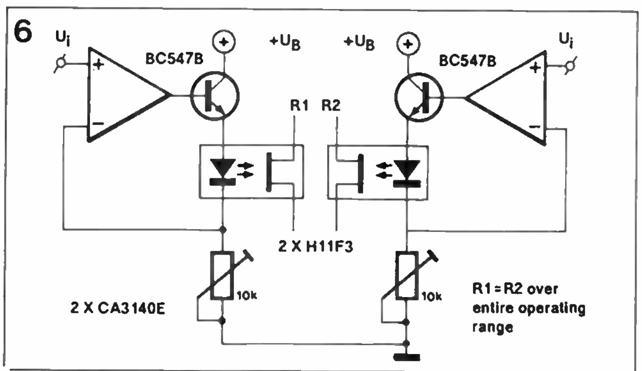


Fig. 6 Adjustable current sources are used to match the ILED-RF characteristics of two optocouplers.

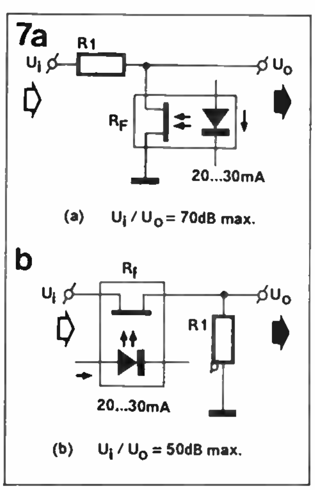


Fig. 7 Basic AF switch configurations.

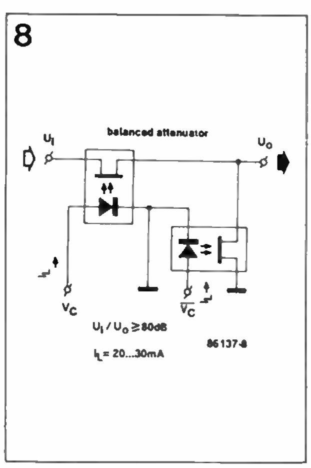


Fig. 8 Improving the Ui/Uo ratio by using a combined series and parallel switch.

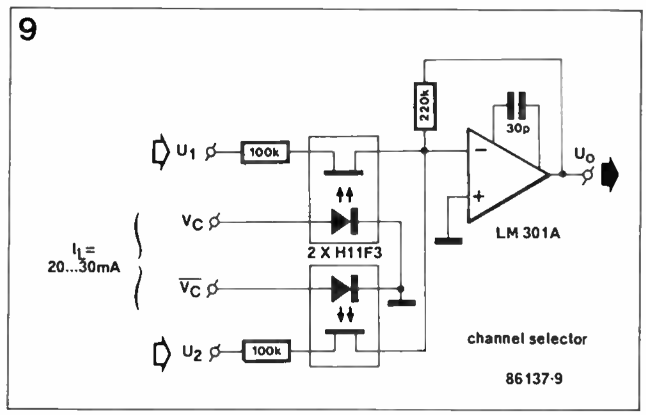


Fig. 9 A click-free two-channel audio input selector.

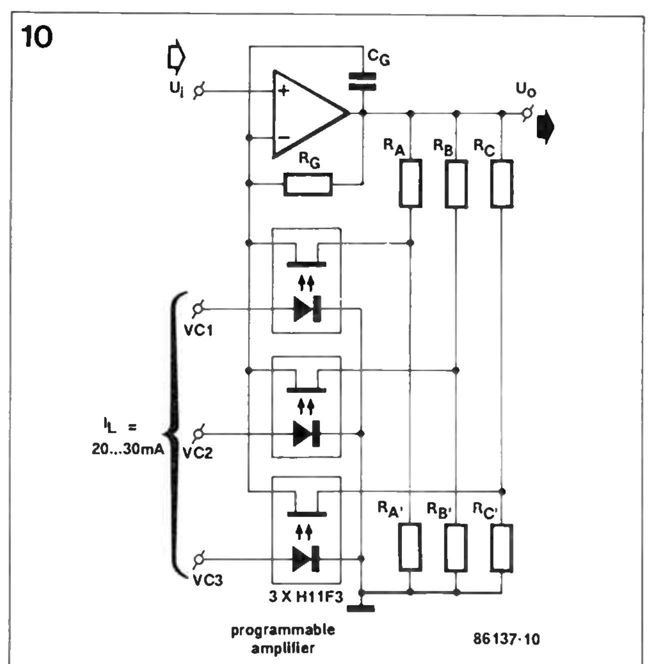


Fig. 10 Using the FE junctions in 3 H11F3s to select a feedback network.

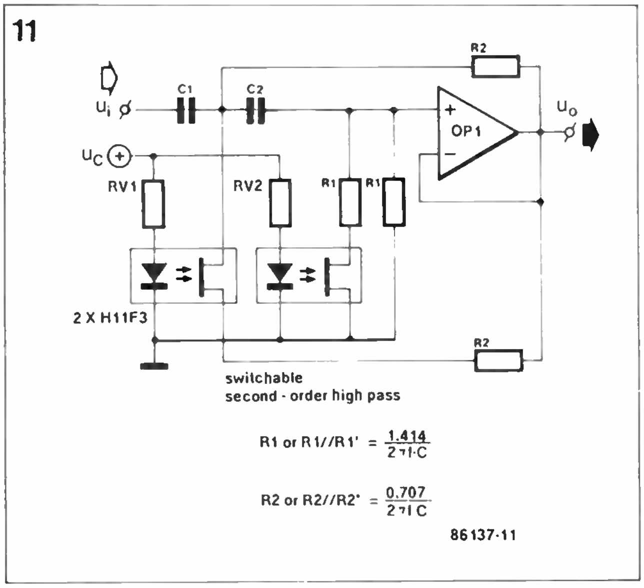


Fig. 11 High-pass filter with a switchable cut-off frequency.

series-connected. AF switch, respectively. The attainable signal attenuation is considerably improved with the combined use of a parallel and a series-connected FE element —see Fig. 8. The control currents applied to the LEDs are in anti-phase, and the entire circuit may be doubled to make a balanced attenuator with very good AF characteristics. Fig. 9 shows the basic layout of an **AF input channel selector**, featuring click- and noise-free operation. The distortion caused by the FE junction is acceptable, as there is a voltage drop of only a few millivolts with the FE element turned fully on. A further development of the circuit in Fig. 9 is the **programmable amplifier stage** shown in Fig. 10. Depending on the levels of VC_1, VC_2 and VC_3, voltage divider R_A-R_A', R_B-R_B', or R_C-R_C' provides the bias voltage for the inverting input of the opamp. Feedback resistor R_G prevents the opamp from being configured for its maximum open-loop gain in the absence of control voltages for the IR LEDs. VC_1...VC_3 should be obtained from a make-before-break rotary switch, or the logic equivalent of it, to prevent the output level of the circuit from varying during the switching over to a different amplification factor. Fig. 11 illustrates the use of the H11F3 in a switchable active filter. This circuit can be dimensioned to function as a click-free rumble or high-frequency noise filter. For relatively low values of the frequency determining resistors, it may be necessary to study the effects of changing the values of RV_1 and RV_2. In conclusion of this miscellany of basic circuits and practical applications, Fig. 12 shows an electrically isolated input amplifier, which is also usable as a safe signal processor for sensors in biological and medical measurements.

EK

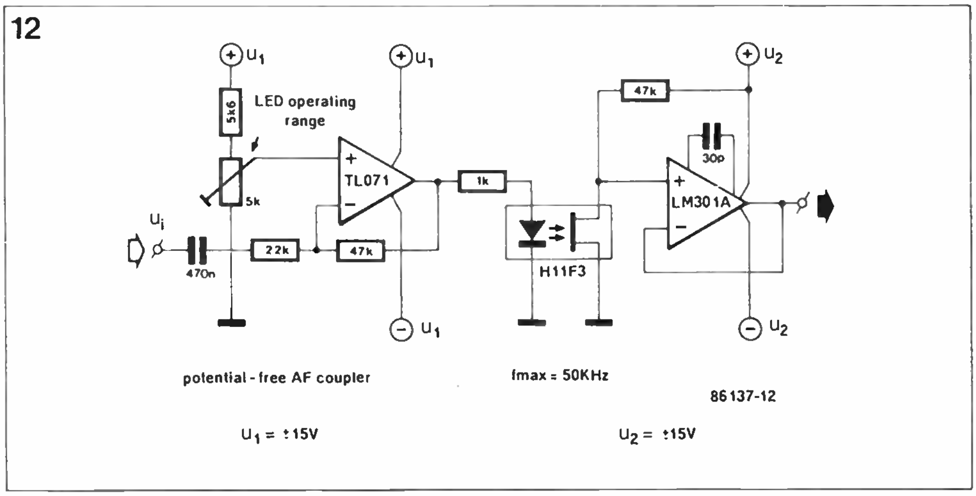
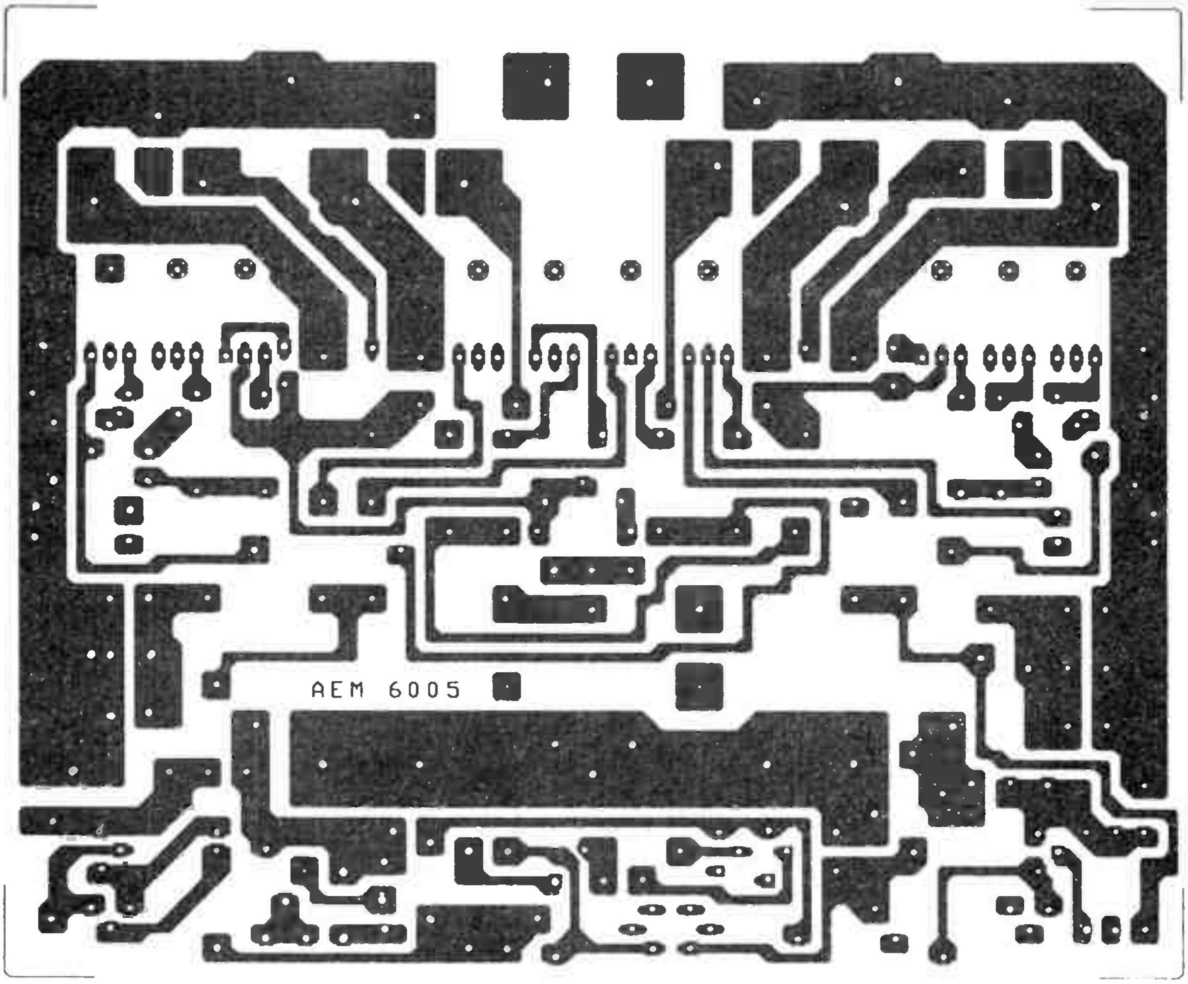


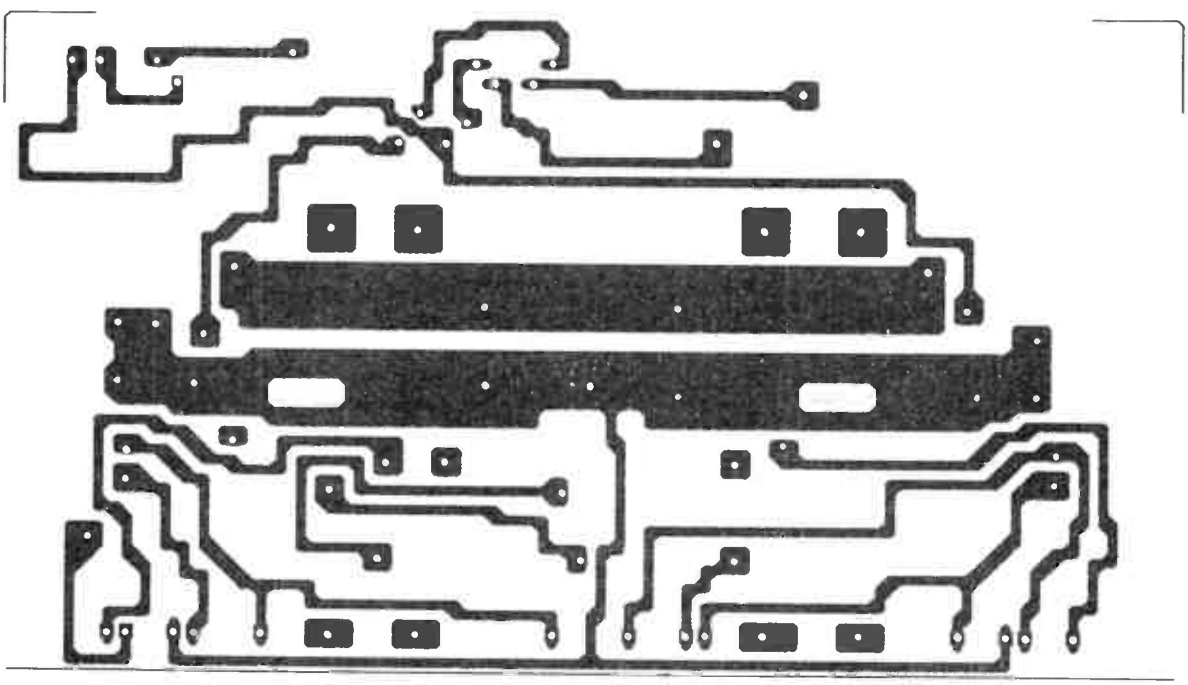
Fig. 12 An electrically safe input amplifier.

CORRECTIONS

True-RMS meter

The correct signal assignment for the contacts on S6c is: S6c contact a = Dp 2; S6c contact b = Dp 1; S6c contact c = Dp 3.


AEM 6005



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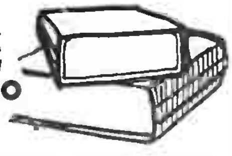

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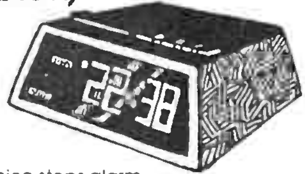

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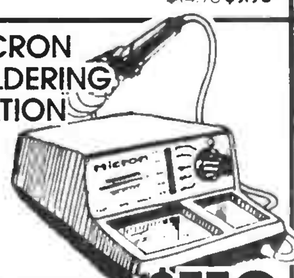

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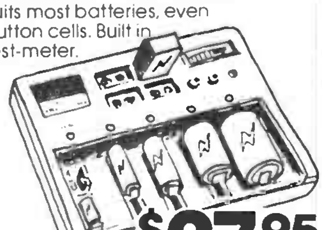

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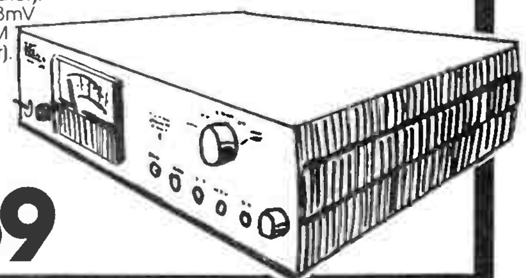

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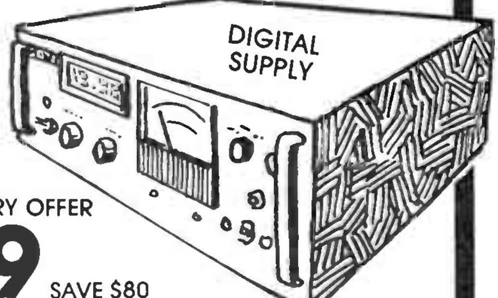

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A true 'laboratory standard' 0-55 V, 10 A max. output power supply

Gerald Reiter

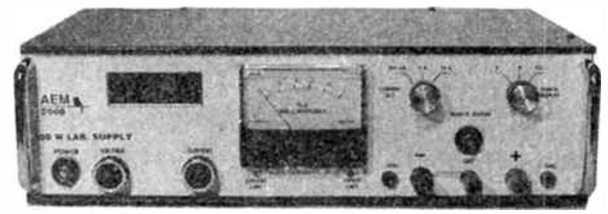
Here's a power supply to meet the fairly exacting requirements often called for these days in many laboratory applications – be it in an engineering R&D lab., a service establishment, an amateur's 'shack', or the home workshop. It features 100 W output (10 A @ 10 V, 2 A @ 50 V) or 200 W output (14 A @ 14 V, 4 A @ 50 V), a switchmode pre-regulator to keep power dissipation low, a linear output regulator, digital and analogue metering, excellent regulation in both voltage and current mode, and very low output ripple and noise.

APPLYING POWER to a newly-built circuit, be it an experimental "rat's nest" or a completed assembly, for the first time can be quite an experience — ranging from disappointing to disastrous! No matter what problems the circuit may have within itself, you need to be able to rely on the power supply to do two things — (i) provide an 'ideal' power source that does nothing to affect the operation of the circuit, and (ii) protect the circuit (and perhaps itself) against destruction should a catastrophic fault occur. The same requirements are demanded when servicing any electronic equipment, or equipment which employs electronics.

So what is an 'ideal' power source? Such a beast does not really exist, but we can come close. As a minimum, it should feature:

- A well-regulated output, variable from zero to its design maximum voltage, with output voltage stable against wide variation in load and mains input voltage.
- Constant current operation, variable from zero to its design maximum current.
- Very low hum or noise, not just on its output terminals but conducted back through the mains or radiated.
- Output power limiting as well as current limiting for load and supply protection. Indicators to warn of both conditions.
- Remote load sensing so that voltage regulation is maintained directly at the load, compensating for voltage drops in the connecting leads.
- Simultaneous and accurate metering of output voltage and current.
- Fast transient recovery.
- 'Floating' output terminals so that either may be grounded.

Having established that, we need to put some numbers to it.



The unit is housed in an all-metal case, locally made by Horwood. The output terminals are 'floating', allowing either to be grounded in an external circuit connected to the supply.

Requirements and decisions

The design maximum output voltage is principally dictated by two things — the general requirements of circuits and equipment one is likely to encounter, and the available transformers. Many applications these days require a 50 V rail, so I settled on having something around 50 V. Fortuitously, the available transformers enabled a 55 V maximum output.

Being able to go right down to zero volts is very necessary in quite a variety of applications. For example, in testing and repairing modern cameras (which I was involved in for some years), one needs a supply to operate at 1.3 volts. Much low power electronics operates from a 1.2-1.5 V supply these days. For fairly clear reasons of circuit economy and thus overall cost, most bench supply projects currently available don't go below 3 V.

Regulation is important as supply voltage variations can adversely affect some circuits. The output voltage varies prin- ▶

FEATURES

- Output voltage range of 0 to 55 volts
- Output power of 100 watts or 200 watts
- Output current of 2 A at 50 V, 10 A at 10 V and below
- Protection against short circuit output and power overload
- LED indicators to show current limit and power limit
- Digital voltage display on 3½-digit panel meter
- Separate current display with analogue panel meter
- 10-turn voltage and current set controls
- Remote sense terminals to maintain regulation at the load
- Isolated output terminals — either may be grounded

This project has been designed by Gerald Reiter for Force Electronics of Adelaide who are marketing complete kits of the unit. See Project Buyers Guide this issue.

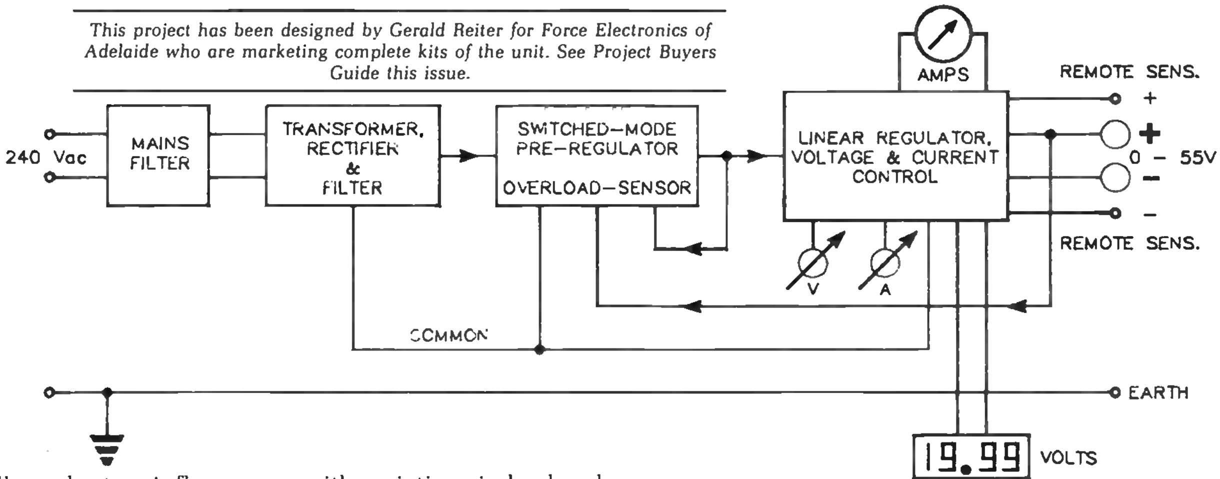


Figure 1. Block diagram of the AEM2000 Laboratory Power Supply.

cipally under two influences — with variations in load and variations in mains voltage. Normally, power supply authorities guarantee to maintain the supply voltage within +/-10% of the nominal 240 Vac (216-264 V), or better. Thus, output voltage must be regulated against mains variations within this range. In addition, the load current may vary from zero to the design maximum and the output must hold close to the set value for such variations. Also, for obvious reasons, the regulation must be maintained over the whole voltage range.

While it has been usual to express regulation as a percentage with respect to full output, a better way is to express it as an absolute variation. A regulation of 0.1% with respect to 50 V is a 50 mV variation, which may mean little to a circuit under test at that voltage. But that 50 mV at 1.5 V, or even 5 V, can have decidely adverse effects on some sensitive circuits. A few years ago, 100 mV regulation represented a 'good' figure for low current output supplies, rated at 50 watts or less. For supplies of 100-200 watts output, 0.4% or 200 mV regulation was considered good, 0.1% or 100 mV was considered excellent. But with the advances in electronics in recent years, regulation figures an order of magnitude (i.e: one-tenth) better than that are expected.

The actual measured regulation on three prototypes with 0-10 A load variation was better than 500 uV. The regulation with a mains variation of 10% was only 100 uV on the prototypes. However, to cover variations that may occur due to component and construction differences, I have quoted the load and mains regulation figures as 2 mV and 1 mV, respectively.

The maximum output current requirement caused me to think a little. Many low voltage applications require high currents — 10 amps, sometimes more. But very, very few high voltage applications require such currents. So it occurred to me that the supply is actually required to deliver something more akin to a maximum power, rather than a maximum current. A 100 watt supply could deliver 2 A at 50 V, 8 A at 12.5 V and 10 A at 10 V. A 200 watt supply could deliver 4 A at 50 V and 14 A at 14 V.

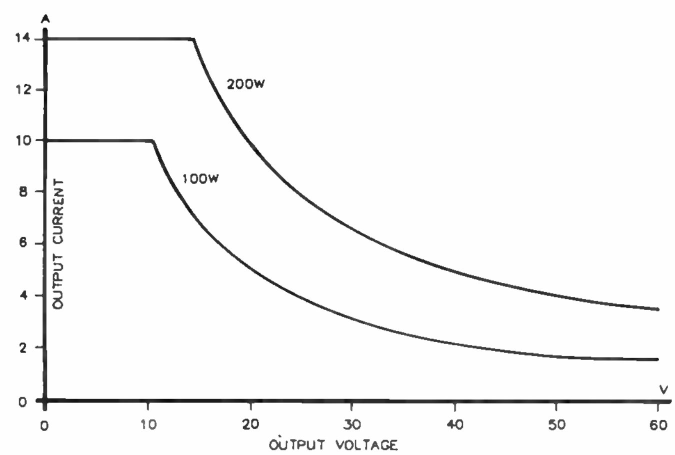
If the supply were required to deliver 10 A right up to 50 V — that's 500 watts — the power transformer would have to be rated at 600 or 700 VA (volt-amps), at least. That's a big transformer! And when delivering high current to a load at low voltage, the regulator dissipation would approach 500 watts — requiring hefty transistors on a hefty heatsink (at hefty prices!) — unless a switchmode regulator were used. But switchmode regulators are inherently noisy, necessitating careful consideration of electrical and electromagnetic filtering to adequately reduce conducted and radiated noise from the regulator circuit.

Principally to keep the costs within bounds, I have opted for the 'maximum power' approach. In order to achieve this and to keep unwanted power dissipation down, I have employed a switchmode pre-regulator followed by a series-pass regulator, as illustrated in Figure 1. This technique permits the supply to deliver high currents at low voltages with high efficiency, yet it only requires small, low-cost, common transformers with series-connected secondaries rated at 2 A for a 0-55 V/100 W supply. Just adding extra transformers and using a higher-rated device in the switching regulator turns the project into a 200 W supply. Figure 2 shows the output current versus voltage curves.

Constant current, or "current limit", operation is a must for protection purposes and in some circuit development and testing applications. In addition, it's great for charging rechargable batteries and measuring zener diodes! Here too, regulation in constant current mode can be important, something I notice which is ignored in many so-called 'lab-standard' supplies. "Fold-back" current limiting is not required as the limiting current can be preset in this design, ranging from zero to maximum available current.

In servicing low-voltage, compact equipment which employs flimsy, flexible printed circuit assemblies with surface-mount components — such as seen in modern cameras, personal cassette players ("Walkmans") and handheld transceiver — a current limit of 100 mA or less is necessary to avoid fatal damage to the 'boards' in case of a fault. I have

Figure 2. Constant power output current versus output voltage curves for the AEM2000 supply.



known a popular "lab. supply" to cause some costly assemblies of this type to go up in smoke at the blink of an eye! Hence a current limit variable down to very low values was seen as a must.

Three ranges of maximum output current may be selected from a front panel switch: 100 mA, 1 A and 10 A. This enables quite fine 'vernier' setting of the output current in current mode operation.

Output current limiting has been incorporated so that currents greater than 10 A cannot be drawn from the supply when the output i set below 10 V. Output power limiting is also incorporated, reducing the current to limit the power delivered when the output is set between 10 and 55 V. To indicate when the supply is running in current limit or power limit mode, I have provided LEDs on the front panel.

As readers would well appreciate, hum or noise on the supply output must be kept well down to avoid adversely affecting any attached circuitry, particularly low noise, high gain amplifiers, for example. A figure of 10 mV RMS hum and noise on the output is considered good, and anything under 5 mV would be considered excellent. The popular "lab supply" mentioned just above had some 100 mV RMS ripple minimum, rising to 300 mV at 3 V/1 A output — hardly lab. standard. The AEM2000 prototypes achieved better than 5 mV at 100 kHz (the switchmode regulator frequency) with either output terminal grounded, and measured better than 1 mV at 50 Hz.

As for RF noise radiated by the unit or conducted back up the mains cable, I had no way to measure it when developing this project. But I can say that, when listening on my shortwave receiver it is noticeably lower than that radiated from a nearby television set or any of my computers.

With circuits that cause a step change in load current, e.g: relay switching, a regulated power supply takes a little time to respond (owing to the speed of the feedback and regulator circuits) and the supply voltage momentarily drops and then recovers. The opposite happens when switching from high (or full) load to low load, the output voltage momentarily 'overshoots' and then recovers. Either way, recovery should happen as quickly as possible. A true laboratory standard supply should have a transient response of less than a millisecond, preferably less than several hundred microseconds. Some (addmittedly, expensive) commercial models have a specified transient recovery of better than 50 us. However, the design I finally arrived at achieved a transient response of better than 120 us, which exceeds the performance of other project designs I have tested.

In both development and service work I have been involved in, I have often required a supply to be set accurately within 20 mV at low voltages. This sort of accuracy requires a digital voltmeter. A 'class 2', or 2% full-scale accuracy, panel meter can provide 20 mV resolution, but only at 1 V full-scale. Hardly practical. Thus, I have incorporated a 3½-digit digital voltmeter. It features auto-ranging for convenience, with two scales of 19.99 V and 199.9 V.

Simultaneous monitoring of voltage and current is essential on a true laboratory supply, so I provided a standard moving-coil panel meter to read current. The current range switching simultaneously sets the full-scale meter reading for ease of use and to obviate "slamming" of the meter needle.

I have also provided switching so that the digital panel meter may be used to read either voltage or current. When the supply is operated in voltage mode, continous monitoring of the output voltage and current is required. But in current mode, only the output current need be monitored in applications where the supply is called upon to deliver a preset constant current. In some applications, however — like measuring zeners — you set the current output and monitor the output voltage. Switching has been provided so that the DVM may also be connected externally, in which case it acts as an autoranging dc voltmeter with two ranges of 19.99 V max. and 199.9 V max.

When a load or item of equipment is located some distance from the supply and you need to maintain voltage regulation at the load, any voltage drop in the leads connecting the load to the supply will degrade the regulation. This is particularly so when high currents are involved. Hence, it is necessary to connect the regulator's feedback connections across the load at the load, rather than having them permanently attached at the supply's terminals. Thus, two 'remote sense' terminals have been provided on the front panel. With the circuitry employed, the maximum voltage drop per lead can be up to 2 V.

The accompanying specifications table summarises the salient characteristics of the project, and shows just why it can truly be called a "laboratory standard" power supply.

Circuit highlights

The switchmode pre-regulator employs a power FET in a 'buck type' circuit, the general arrangement being illustrat- ▶

SPECIFICATIONS — as measured on the prototypes

VOLTAGE MODE	
Output voltage	0-55 Vdc, continously variable with 10-turn pot.
Stability	
• against mains variations	1 mV for 10% mains change
• with load variations	2 mV from 0 to 100% load
Output ripple & noise	1 mV RMS @ 50 Hz 4 mV RMS @ kHz
Drift with temperature	200 uV/Celsius degree from 0 to 40 degrees Celsius
Transient recovery	120 us for a step load change between 20% and 100% of rated load.
CURRENT MODE	
Output current	0-10 amps, continuously variable with a 10-turn pot. N.B.: the maximum output current depends on the output voltage such that the output power doesn not exceed 100 watts. Also, below 10 V, output current is limited to 10 A maximum.
Constant current stability	0.1% from zero to full load current.
Ripple & noise	<20 mA RMS at 10 A load, and under 1 mA at light loads.
Metering	
voltage	3½-digit panel meter, 10 mV resolution to 20 V, 100 mV resolution 20-55 V.
current	moving-coil panel meter, full-scale reading switchable to 100 mA/1 A/ 10 A; or the 3½-digit panel meter with 1 mA resolution to 2 A, and 10 mA resolution 2-10 A.

ed in Figure 3. The pulse-width modulation (PWM) controller switches the FET on and off. When the FET turns on, it charges C via L. When the FET turns off, the collapsing field in L reverses the voltage across the ends of the coil, which now supplies charge to C via the diode, maintaining the voltage across C.

As the load current drawn from the supply increases, the output voltage will tend to fall and so the PWM comparator will turn on the FET for a longer period in order to store more energy in the inductor's field and maintain the charge in C, maintaining the output voltage. The opposite occurs when the output current decreases, the PWM controller only turning on the FET for short periods. The 'natural' LC filter on the output of this type of circuit ensures it has comparitively low ripple and noise on the output.

The controller in this supply does not employ one of the specialised switchmode controller ICs, but discrete circuitry. This was necessary principally because the voltage range over which the pre-regulator is required to operate is wider than such ICs are generally specified for.

The following linear regular employs a MJ15003 power transistors in a complementary PNP-NPN Darlington configuration. This provides high gain while ensuring low input-output voltage differential, keeping dissipation in the series-pass stage to a minimum. This regulator also provides a great deal of filtering for the switchmode pre-regulator output and some isolation between it and the output terminals.

To provide a digital readout, I had to consider costs but not at the expense of necessary accuracy. So I searched for a suitable IC and display. There are a variety of DVM/display-driver chips available from different manufacturers, probably the most widely known being the Intersil 7106 series

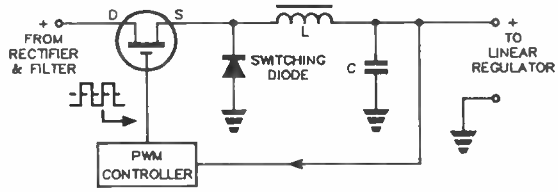


Figure 3. The pre-regulator employs a switchmode 'buck' regulator with a general form like this.

which accommodate a 3½-digit display. Two different types provide for driving either a liquid crystal display or an LED display. Each type of display has its own advantages in particular circumstances, but the LCD display version of the 7106 is the more commonly available type, even though the LCD display itself is generally more expensive than LEDs.

Motorola, however, have a 3½-digit DVM chip, the MC14433, which can drive either an LCD or an LED display and features an input range of +/-200 mV and +/-2 V and an accuracy of 0.05%. With a little extra circuitry, it can be made auto-ranging.

So I chose the MC14433. It is not expensive and good stocks are kept by the distributors. The DVM on the supply provides 10 mV resolution to 20 V and 100 mV resolution from 20 to 55 V output. In addition, you can choose which type of display you want on your supply — LED or LCD — without having to obtain a different DVM chip.

Next month, we get into the full circuit description and construction details.

A 100 watt 'ultra-fidelity' topology MOSFET amp module

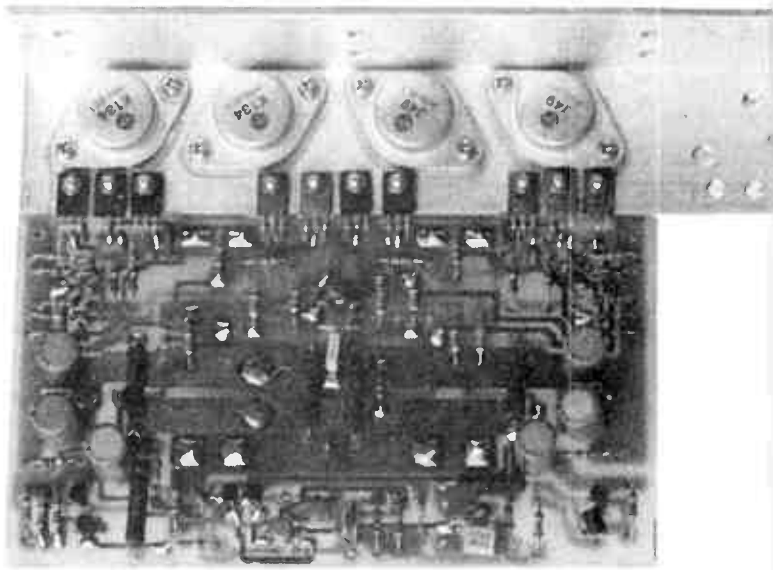
Part 1

David Tilbrook
Technical Systems Australia Pty Ltd

Spawned as a result of considerable reader demand, this amp module employs the 'ultra-fidelity' circuit arrangement of David's 6000 power amp in a lower power, lower cost design that has numerous applications – undoubtedly a popular one being a 'drop-in' replacement for the modules in his legendary Series 5000 stereo amp.

THE AEM6000 Ultra-fidelity Power Amplifier was published in the June, July, August and September 1986 issues. Some of its distinguishing features compared to earlier designs were the use of a JFET/bipolar cascode input stage, a dc-coupled feedback loop, a mixed assymmetric/symmetric topology and a capability to run from 75 volt rails providing a maximum output power of over 240 watts into an 8 ohm load. In order to accommodate the higher supply rails a new type of output power MOSFETs were employed, the Hitachi 2SJ56/2SK176, with significantly higher voltage capabilities than the earlier 2SJ49/2SK134 MOSFETs. Unfortunately, the new devices are significantly more expensive than the earlier types and the requirement for a high voltage power supply tends to make the project more expensive than other kit power amplifiers. It should be emphasised however, that the AEM6000 is very inexpensive when compared to comparable commercial 240 watt power amplifiers. Nevertheless, we have had many requests for a less expensive 100 watt version employing the same topology as that of the AEM6000 but which is simpler to construct and requires a less expensive power supply.

After looking at the problem we decided to design the module so that it could be incorporated within the Series 5000 metalwork so that owners of Series 5000 power amplifiers could upgrade using the new module. The new module is designated the AEM6005 Ultra-fidelity Topoly Power Amplifier as it employs exactly the same topology as that developed for the AEM6000. The values of resistors R6 and R7 have been changed to 22k and the MOSFETs used are also different as discussed above. In this design we have employed the 2SK134 and 2SJ49 devices which we used in the earlier Series 5000 circuit. So if you are converting a Series 5000 power amplifier to a Series 6005, the power MOSFETs can be removed from the old module. The printed circuit board for the 6005 has been designed to be a similar size to the Series 5000 printed circuit board although a different heatsink bracket is required, since in the case of the 6005 module, the drive transistors have been incorporated on the heatsink bracket along with the output devices. This helps simplify construction as well as ensuring the best possible heatsinking for the drive transistors.



Topside view of the completed module, here mounted to a heatsink bracket to take two modules prepared for mounting in a 5000 amp chassis.

The recommended supply voltage for the 6005 module is 50 volts, which means it can be connected directly to the power supply within the 5000 power amplifier. Full details for the installation of two 6005 modules into the 5000 chassis will be dealt with next month, together with drilling details for an appropriate heatsink bracket. The circuit diagram for an alternative dual power supply version will also be dealt with. The drilling details of the heatsink bracket required for a single module are published elsewhere in this article.

The design of the AEM6000/AEM6005 power amplifier modules was based upon a great deal of experimentation to determine an overall circuit topology which would provide the best possible subjective performance. The resulting circuit does not use excessive amounts of overall feedback but derives its low distortion figures by ensuring that each separate voltage amplifier stage is provided with sufficient local feedback and is of such a type to maximise slew rate, for the output stage and the rest of the stages, to minimise the possibility of distortion produced by slew limiting. This provides a further advantage — that of ensuring maximum overall amplifier stability characteristics. ▶

A final and very important characteristic of the topology employed within the AEM6000/AEM6005 power amplifier modules is that of a completely dc-coupled feedback loop. In order to accommodate this, a special cascode input stage was developed which employs both bipolar transistors and a dual JFET in a cascode differential pair configuration. The following discussion covers major aspects of the design and, while many points have been raised in the 6000 articles, their re-iteration is in the context of this design, while the rest of the discussion concentrates on points specific to this project.

The output stage

The output stage for the AEM6005 employs two pairs of Hitachi complimentary power MOSFETs. The N-channel device is a 2SK134, while the P-channel device is the 2SJ49. As mentioned earlier, these are the same power MOSFETs employed in the Series 5000 design and in the AEM6500 general purpose power amplifier modules, the latter being described in the July 1985 issue. The AEM6000 power amplifier module employs the 2SK176 and its complement, the 2SJ56, which are rated for a maximum drain to source voltage of 200 volts. In the case of the 6005 power amplifier module however, the maximum recommended power supply voltage of 50 volts enables the lower voltage MOSFETs to be employed and these are substantially less expensive, as mentioned above.

The 2SK134 and 2SJ49 are rated for use with a maximum drain to source voltage of 140 volts. In a power amplifier employing plus and minus 50 volt rails the maximum instantaneous supply voltage which will expressed across either pair of output devices will be around 100 volts, which is well below the rating for these devices. This condition will occur when the power amplifier is driven into clipping with no load attached.

Like the AEM6000, the 6005 is a class AB power amplifier. The term class A refers to a mode of operation of an active device whereby the device remains in a conductive or on state for both positive and negative half cycles of the amplified signal waveform. The term class B refers to a different mode of operation whereby the active device is turned off by the signal waveform for some portion (generally half a cycle, or 180 degrees) of the amplified signal. In this case, two active devices are necessary to handle each half of the signal waveform. If this is not done, very large amounts of distortion are generated. Where the output device, or devices, conduct for less than half the input cycle, the stage is said to operate in class C. If only part of each input half cycle is amplified, clearly large amounts of distortion are generated.

The lowest distortion output configuration is class A, with class B representing a compromise between the distortion performance of the class A mode of operation and that of the class C. Since the aim of all power amplifier designs, at least for high quality audio applications, is to reduce distortion it would seem obvious to employ the class A mode of operation exclusively. Although there are several pure class A power amplifiers available on the market today, the vast majority of power amplifiers employ a compromise between class a and class B operation which is referred to as class AB.

The reasons for this are best understood by considering the design of a basic output stage such as that shown in Figure 1. This particular output stage uses power MOSFETs as the two active output devices, although bipolar transistors could just as easily have been used. The drain of the N-channel MOSFET is connected to a positive supply rail while the drain of the P-channel MOSFET is connected to a negative supply rail. The sources of the two devices are connected together and form the output terminal of the stage. The gates of the devices are driven from a bias current circuit which maintains a voltage difference between the two gates sufficient to bias on the two power MOSFETs.

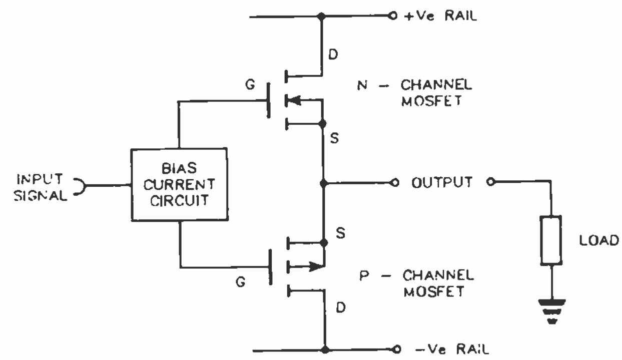


Figure 1. Basic audio amplifier output stage.

If the bias current circuit was set to zero so that the dc voltage on the two gates was identical, then with zero input signal neither the N-channel MOSFET nor the P-channel MOSFET would be on and hence no current flows on the positive rail. This is class B operation. If a positive input signal is applied, the N-channel MOSFET is biased on while the P-channel MOSFET remains in the off state. Current flows from the positive rail via the N-channel MOSFET to the output and then via the load to ground. Similarly, if a negative input signal is applied the P-channel is biased on while the N-channel MOSFET is turned off and the current flows from earth through the load into the output and via the N-channel MOSFET to the negative rail.

Only one of the two power MOSFETs is active at any time and the transition from one device to another, which occurs at the zero crossings of the input signal waveform, generates a distortion known as "crossover distortion". Since the voltage range over which crossover distortion occurs is constant it will occur over a larger proportion of a small output signal than a larger output signal, and hence is more noticeable at lower signal levels.

If a bias current circuit in Figure 1 is now activated so that a dc voltage is produced between the two gates then both the N-channel MOSFET and the P-channel MOSFET will be turned on simultaneously and current will flow directly from the positive rail via the N-channel MOSFET to the P-channel MOSFET and finally to the negative supply rail. This current is commonly referred to as the bias or quiescent current. If the bias current is set sufficiently high so the it exceeds the maximum peak output current which can be pulled by the load then the output stage to be operated in class A. For a 100 watt output stage to be operated in class A, the bias current must exceed the peak current necessary to produce 100 W in an 8 ohm load, i.e: some five amps. Since the rail voltage on the 6005 is 50 volts, the resulting power dissipation in each of the power MOSFETs will be 250 watts!

This is the main reason class A amplifiers are not more widely used since, although their distortion performance is excellent, this level of quiescent power dissipation is impractable for most purposes. If the same power amplifier, for example, were to be rated for operation into a ohm load, the bias current would have to be increased to 10 amps with a consequent increase in power dissipation to 500 watts per MOSFET. The complete power amplifier would dissipate something like 1000 watts in heat which is equivalent to a single-bar radiator.

In order to overcome the heat dissipation problems of pure class A designs and the poor distortion figures of pure class

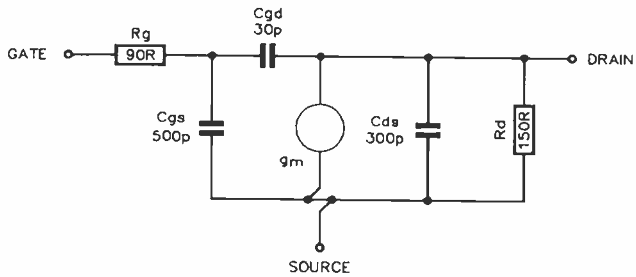


Figure 2. Equivalent circuit of a typical power MOSFET.

B designs, most designers employ a compromise between these two, known as class AB. In this case, the bias current circuit is adjusted so that a relatively small amount of bias current flows through the N-channel and P-channel MOSFETs. Fortunately, even a small amount of bias current has a dramatic effect on crossover distortion. In the 6000 and 6005 power amplifier modules, the output stage drain-source bias current is set at nominally 100 mA and an analysis of the distortion characteristics of the output stage reveals the crossover distortion is completely unmeasurable, being well below the level of noise and other types of distortion mechanisms.

MOSFET versus bipolar

The choice of power MOSFETs in the output stage of an audio amplifier, rather than conventional bipolar transistors, is made because of other of important advantages MOSFETs provide. The first of these is that the power MOSFET provides very high gate impedance at low frequencies. This is illustrated by looking at the equivalent circuit of a power MOSFET which is shown in Figure 2. The gate appears as a 90 ohm resistance in series with a capacitance to the drain of 30 pF and a capacitance of 500 pF to the source. At dc, the input resistance is determined by the resistance of the dielectrics of these two effective capacitances, this being several thousands of megohms. Although the input impedance is very high for low frequencies, the input capacitances become increasingly important as frequency is increased and, although the power MOSFET is capable of switching at very high speeds, these input capacitances must be overcome by the drive stage.

The equivalent circuit also gives us insights into several other important characteristics of power MOSFETs. The high frequency performance of the MOSFET is determined by the RC capacitance Cgs, as shown in Figure 1. The cutoff frequency of a power MOSFET is therefore well in excess of 3 MHz when correctly driven. Furthermore, the absence of an effect which occurs in bipolar transistors called "minority carrier storage" ensures that the power MOSFET is unrivalled in switching speed and is orders of magnitude faster than most bipolar transistors with similar current ratings. The high speed of the power MOSFET enables the output stage of a power amplifier to be as fast if not faster than the voltage gain and differential stages preceeding it and this greatly assists to ensure complete stability of the feedback loop and freedom from slew-induced and other dynamic distortion merchanisms.

Power amplifiers employing slower output devices rely on negative feedback to linearize the high frequency performance of the power amplifier. In this case the amount of overall negative feedback decreases with increasing frequency leading to increased distortion figures at higher frequencies.

One of the most important advantages of power MOSFETs over bipolar transistors for use in the output stages of power amplifiers is not revealed by the equivalent circuit. Bipolar transistors have a positive temperature co-efficient. If the base to emmiter current flowing in a bipolar transistor is held constant, then the resulting collector-to-emitter current will vary proportionately with temperature. If the temperature rises, then so too will the collector-emitter current. The increased current increases power dissipation within the device and the resulting increase in the operating temperature leads to a further increase in collector-emitter current. The resulting effect is called thermal runaway and is the most common cause of output stage failure in power amplifiers employing bipolar output devices. Destruction can be extremely swift.

The power MOSFET, on the other hand, has a negative temperature co-efficient. An increase in drain-source current causing an increase in power dissipation within the power MOSFET will result in an increase in the drain-to-source resistance which tends to oppose any further increase in drain-source current. The power MOSFET is therefore a significantly more robust device than similarly rated bipolar transistors.

The negative temperature co-efficient of power MOSFETs gives rise to yet another advantage over bipolar transistors. The positive temperature co-efficient of bipolar transistors leads to an effect called "secondary breakdown" which limits the area of safe operation within a bipolar transistor when a concentration of current builds up on any part of the chip area. Associated with this increase in current density there will be an increase in power dissipation resulting in a local temperature rise in this region of the chip's surface. The resulting temperature rise causes an even greater increase in current density through this small region of the chip surface resulting in a hot spot which rapidly burns a hole through the chip and destroys the device.

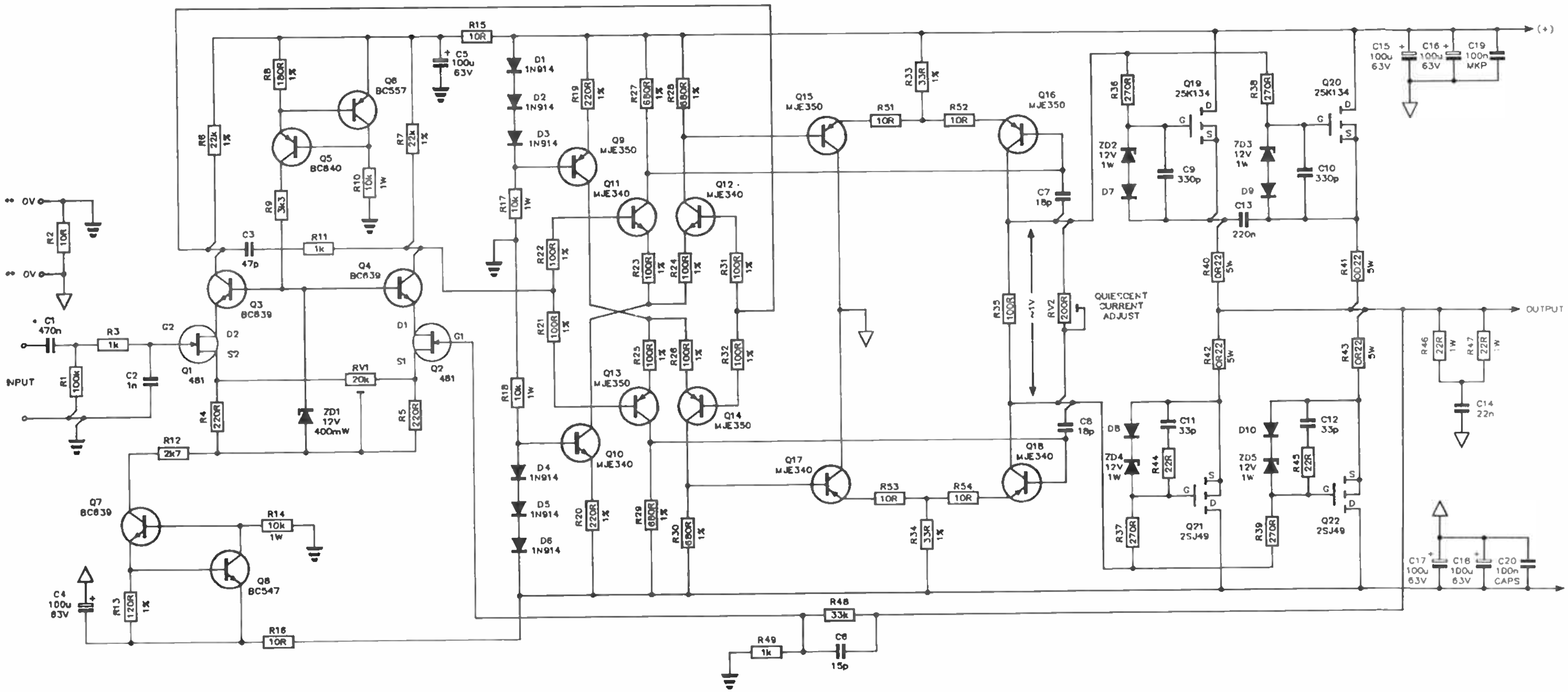
In the case of power MOSFET, however, the negative temperature co-efficient ensures that the current density is spread evenly throughout the chip surface since any increase in current density in a local area will result in an increase in resistance of this area of the chip surface tending to spread the current more evenly over the remaining surface. The absence of secondary breakdown in power MOSFETs is a very important advantage of power MOSFETs over bipolar transistors.

The voltage gain stage

The bulk of the voltage gain of the power amplifier is produced by a fully symmetric differential voltage amplifier which is formed from transistors Q15, Q16, Q17 and Q18 in the main circuit diagram. A fully symmetric voltage amplifier circuit was chosen after experiments into various voltage amplifier topologies showed that the fully symmetric circuit produced the least third harmonic distortion and has the best subjective performance.

This circuit is superior to both asymmetric differential voltage gain stages and symmetric non-differential voltage gain stages. One of the big advantages of the symmetric differential voltage gain stage is that it maximises the linearity of the ▶

LEVEL
We expect that constructors of an
INTERMEDIATE
level, between beginners and experienced persons, should be able to successfully complete this project.



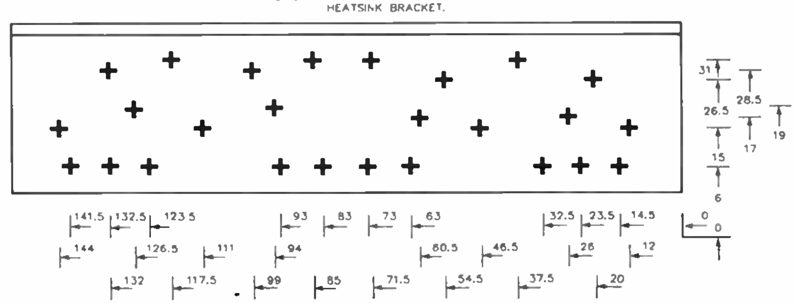
- • C1 IS OPTIONAL BUT RECOMMENDED – SEE TEXT
- •• JOIN TOGETHER ONLY AT POWER SUPPLY
- Q1,Q2 – ECC481 IS A DUAL JFET BY NEW TONE ELECTRONICS (NTE)
- # MOUNTED ON HEATSINK
- D7–D10 ARE 100V 1A FAST RECOVERY DIODES

NOISY EARTH

CLEAN EARTH

N.B. THESE EARTHS MUST REMAIN SEPARATED ON THE P.C BOARD RUN SEPARATE WIRES TO THEM FROM THE POWER SUPPLY FILTER CAPACITORS.

DRILLING DETAILS AEM 6005 MODULE HEATSINK BRACKET.



MATERIAL: 40 X 40 X 3mm ALUMINIUM EXTRUSION

NOTE: ALL DIMENSIONS IN mm

See our 'PROJECT BUYERS GUIDE' this issue for a guide to component sources and kit suppliers.

CIRCUIT OPERATION

The input signal is coupled via capacitor C1 to resistors R1 and R3. This capacitor provides dc decoupling, preventing any dc component of the input signal from being connected to the input of the power amp. With the exception of this capacitor, the entire power amplifier is dc coupled, so the gain of the circuit at dc is the same as that for signals within the audio passband. i.e: around 34 with the feedback components specified. This will be covered in greater detail later, but it implies that the application of 1 Vdc to the input without the dc blocking capacitor installed, would result in roughly 34 Vdc appearing at the output of the power amp and hence to the bass driver of any loudspeaker system connected. This, of course, would result in very rapid destruction of the bass driver. The use of C1 therefore, although still optional, is highly recommended.

Resistor R3 and capacitor C2 form a low-pass first-order RC filter, the purpose of which is to limit the maximum signal slope of the input signal. If it is assumed that the output impedance of the preamp used in conjunction with the power amp is significantly less than the value of R3 (1k), then the -3 dB point for this filter is given by the simple equation:

$$f = 1/(2\pi RC)$$

where f is the -3 dB point
R is the resistance of R3
C is the capacitance of C2.

i.e: $f = 1/2(\times 10^3 \times 10^{-9})$
$= 159$ kHz.

This frequency clearly lies well above the audio passband and therefore has no effect on the frequency response performance of the power amp. Its purpose, as mentioned above, is to limit the maximum signal slope of the input signal. This is necessary to help to ensure complete freedom from slew induced distortion, sometimes referred to as TIM, or transient intermodulation distortion. This type of distortion is analogous to a more commonly understood distortion mechanism, that of clipping. In the case of clipping, distortion is generated when the input signal drives the power amp output beyond the limits of its available supply voltage. In a similar manner, if you attempt to drive the power amp beyond its maximum slew rate, the signal 'clips' or 'hard limits' and gross distortion results with products spreading across the audio spectrum. The solution is to design an amplifier with excellent slew rate figures and then to limit the maximum signal slope by the use of simple high frequency low-pass filter so that the slew rate limit of the design cannot be approached.

The effectiveness of this approach is, to a certain extent, dependent on the quality of the input filter. It is important to ensure that the filter employed introduces minimum signal degradation of its own. It is for this reason that the simple first-order RC is used which seems to introduce negligable, if any, degradation of the subjective or objective performance, provided the right type of capacitor is employed. A ceramic capacitor, for example, should not be used in this application. Ideally, use a polypropylene capacitor if one is available or, alternatively, use a good quality MKT type metallised polyester capacitor. Polypropylene capacitors are, unfortunately, very difficult to obtain in Australia in small quantities and also tend to be expensive, but they exhibit clearly superior characteristics in audio signal applications in comparison to many other types. This is also true for the other capacitors in the power amp, not just the input capacitor, C1, but the two high-frequency power supply decoupling capacitors C19 and C20 as well.

Resistor R1 provides a dc reference for the gate of the first of the JFETs (Q1) which, in conjunction with Q2 (also a JFET), forms the input differential pair. Note that Q1 and Q2 are a dual-JFET contained within a single encapsulation, fabricated on the same substrate to ensure close thermal coupling. Its use is necessary since this power amplifier is entirely dc-coupled and as mentioned above, the gain of the amp at dc is the same as that for signals within the audio passband. If separate transistors are used, each device is free to 'float' at a different temperature (no matter how slight that may be) and a drifting dc offset will result. JFETs are used in preference to bipolar transistors since the JFET requires negligable bias current. If bipolar transistors were used the base-emitter current required produces a dc voltage drop across the bias resistor R1 which, after amplification by the dc voltage gain of the power amplifier, will produce significant levels of dc offset at the output.

The entire input stage actually consists of the dual-JFET described above, in combination with a cascade paid of bipolar transistors, Q3 and Q4. The operating conditions for the input stage are determined by a pair of constant-current sources and the zener diode ZD1. The first current source is formed from transistors Q7, Q8 and their associated resistors R13 and R14. At the moment power is applied to the circuit current flows from the clean earth via R14 through the base of Q7 to the base of Q8 and resistor R13. When the voltage developed across R13 reaches 0.64 V, transistor Q8 is biased on and current flowing through R14 is robbed from the base of Q7. The circuit stabilises so that the current flowing through R13 is such that the voltage across it will be around 0.64 V. This is true regardless of the actual value of resistor R13, so varying the value of this resistor enables the current through it to be varied. Furthermore, once the value of R13 has been chosen, the circuit maintains the current through it at a constant level and the circuit acts as a constant-current source, or actually a constant-current sink in this case. With the value of resistor R13 set at 120 ohms, the current sink will set the current flowing through resistor R12 to 0.64/120 = 5.3 mA.

Resistor R12 is included for two reasons. Firstly, it drops a constant voltage as a result of the constant current flowing through it to decrease the power dissipation in the current sink. Since the current is set by the constant-current sink at around 5.3 mA, a voltage drop of around

$$5.3 \times 10^{-3} \times 2.7 \times 10^3 = 14.4 \text{ volts}$$

will be produced. Secondly, it acts to protect the input stage in the event of a failure of the constant-current sink.

The current set by the constant-current sink flows through the two cascade differential pairs Q1, Q3 and Q2, Q4 as well as through the zenor diode ZD1, which provides a dc reference for the bases of the cascade pair. In order to ensure that the differential pair is fed from a constant current to ensure maximization of the common mode rejection ratio (CMRR), it is necessary to use a second current source specifically for the zener diode. This current source is formed from transistors Q5, Q6 and their associated resistors R8 and R10. This constant-current source works in an analogous manner to that formed from Q7 and Q8 and establishes a current of 0.64/180, or around 3.6 mA. This current flows through the 33k resistor R9, which serves the same purpose as that of R12, and produces a voltage drop of around 11.9 volts. The current available to flow through the differential pair is the difference between the currents set by these two differential pairs, i.e.: around 1.18 mA. This current is shared equally between the two cascade differential stages so that a current of around 900 uA flows through the 22k resistors R6 and R7 producing a voltage drop across these of around 22 V.

The second stage is a fully symmetric differential amplifier employing the bipolar transistors Q11, Q12, Q13, Q14 and their associated resistors R21 to R32. The operating point for this stage is established by a pair of constant-current sources formed from Q9, Q10, R17-R20 and diodes D1-D6. The operation of this type of constant-current source can be understood by considering the negative current source first. The three diodes in series are biased on by current flowing through R18 from the clean earth to the negative rail. The current produces a voltage drop across each of approximately 0.7 V, giving a total voltage drop of 2 V. Since this is applied to the base of Q10, the voltage drop across resistor R20 is also constant giving rise to a constant current through it and hence through the emitter-collector junction of Q10. Since the voltage applied to the base of Q10 is 2 V, around 1.5 volts will be applied across resistor R20, giving rise to a current of 1.5/220 = 6.8 mA.

The current delivered by the constant current sources to the differential voltage amplifier is shared equally between the load resistors R27 and R28, producing a voltage drop across these resistors of around 1.9 V. This voltage biases the final and main voltage amplifier stage comprising Q15-Q18 and their associated resistors R33, R34, R51-R54 and capacitors C7 and C8. The application of 1.9 V to the bases of this stage causes a voltage of around 1.3 V to be expressed across resistors R33 and R34 and establishes the bias conditions for this stage. Since R33 and R34 are 33 ohms the current is set at 1.3/33 = 40 mA. This is a relatively large amount of operating current and is necessary to ensure that this stage has a sufficiently low output impedance to drive the input gate capacitance of the MOSFET final output stage. This helps to ensure very good open loop bandwidth which is essential for amplifier stability and freedom from slew induced distortion.

The final stage of the amplifier is the MOSFET current amplifier formed from the four power MOSFETs Q19-Q22 plus associated resistors and capacitors. The bias current for the output stage is set by adjustment of the preset potentiometer RV2. Since the current flowing through this preset is constant, the voltage dropped across it will be directly proportional to its resistance. As the voltage is increased by increasing the resistance of the preset, the output MOSFET's are biased on and a quiescent current will flow from the positive rail to the negative rail through the MOSFETs. This is necessary to provide an area of class A operation to decrease crossover distortion and other nonlinearities that occur at low signal levels. Resistors R36-R39, in conjunction with the gate-to-source capacitance of the power MOSFETs, produce a low-pass first-order filter with a -3 dB point around 1 MHz which is necessary to ensure stability of the output stage. In addition, capacitor C13 acts to prevent oscillation that can occur because the two 2SK134s and the inductance of the source resistors R40 and R41 form a push-pull Colpitts oscillator circuit.

The source resistors have been included to linearise the transfer characteristics of the MOSFETs and also to assist current sharing between the two sets of MOSFETs. Some recently published designs employing power MOSFET output stages have omitted the source resistors, adopting the approach that the negative temperature coefficient of the MOSFETs makes these resistors unnecessary. The problem with this is that the MOSFETs' temperature coefficient is not constant and is a function of the source-drain current. Also, here the use of the source resistors in combination with the source-gate capacitors C9, C10, C13 and the RC networks R44, C11 and R45, C12 yields an output stage with maximum stability and long term reliability.

The RC network consisting of R46, R47 and C14 serves to ensure that the output stage has a load of high frequencies, again to ensure stability of the power amp output stage. Resistor R48 and R49, and capacitor C6, determine the gain of the power amp. The values shown set the overall voltage gain to 34 for frequencies within the audio passband. At higher frequencies the decreasing impedance of capacitor C6 applies an increasing amount of overall negative feedback, reducing the overall voltage gain.

AEM6005 PARTS LIST

Semiconductors
Q1, Q2 ..... ECG461 or equiv.
Q3, Q4 .... BC639
Q5 .... BC640
Q6 .... BC557
Q7 .... BC639
Q8 .... BC547
Q9 .... MJE350
Q10, Q11, Q12 ...... MJE340
Q13-Q16 .... MJE350
Q17, Q18 .... MJE340
Q19, Q20 .... 2SK134
Q21, Q22 .... 2SJ49
D1-D6 .... 1N914 or equiv.
D7-D10 .... 100 V/1 A fast recovery diodes.
ZD1 ...... 12 V/400 mW zener
ZD2-ZD5 .... 12 V/1 W zeners

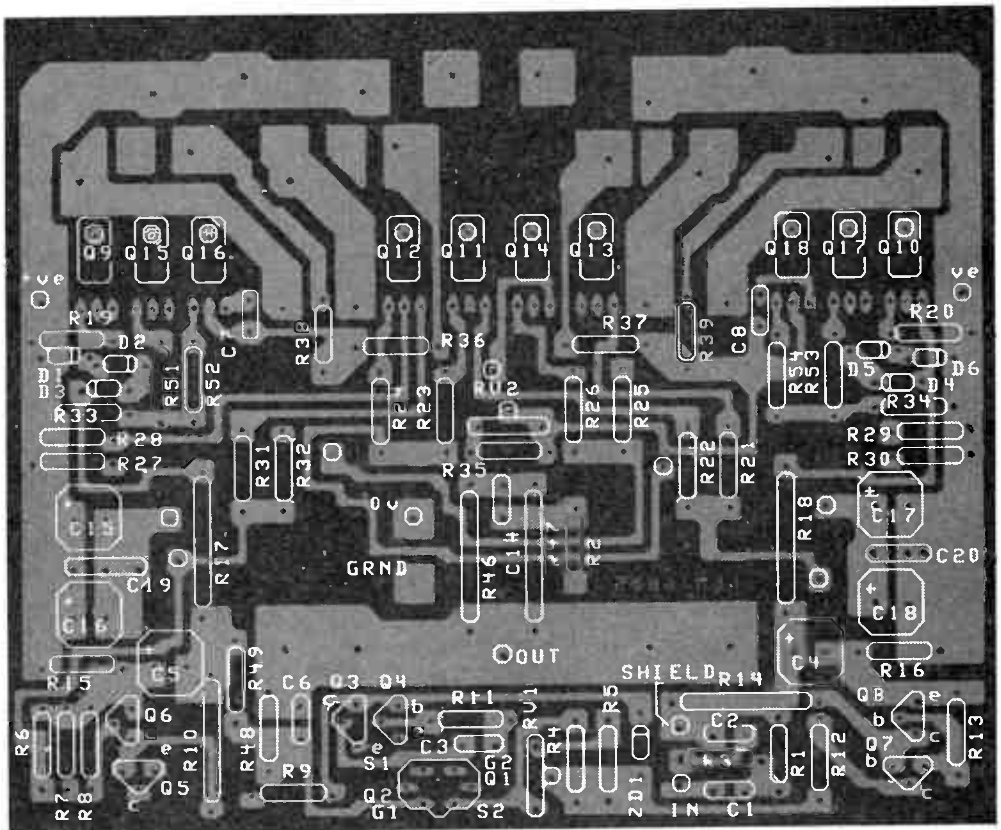
Resistors all 0.25W, 5% unless noted

R1 .... 100k
R2 .... 10R
R3 .... 1k
R4, R5 .... 220R
R6, R7 .... 22k, 1%
R8 .... 180R, 1%
R9 .... 3k3
R10 .... 10k, 1W
R11 .... 1k
R12 .... 2k7
R13 .... 120R, 1%
R14 .... 10k, 1W
R15, R16 .... 10R
R17, R18 .... 10k, 1W
R19, R20 .... 220R, 1%
R21-R26 .... 100R, 1%
R27-R30 .... 680R, 1%
R31, R32 .... 100R, 1%
R33, R34 .... 33R, 1%
R35 .... 100R
R36-R39 .... 270R
R40-R43 .... 0R22, 5W
R44, R45 .... 22R
R46, R47 .... 22R, 1W
R48 .... 33k
R49 .... 1k
R50 .... not used
R51-R54 .... 10R
RV1 .... 20k
RV2 .... 200R

Capacitors
C1 ...... 470n MKP else MKT
C2 .... 1n MKP else MKT
C3 .... 47p ceramic
C4, C5 ... 100µ/63V RB electro
C6 .... 15p ceramic
C7, C8 .... 18p ceramic
C9, C10 .... 330p MKP else ceramic
C11, C12 .... 33p ceramic
C13 ..... 220n MKP else MKT
C14 ...... 22n MKP else MKT
C15-C18 .... 100µ/63V RB electro.
C19, C20 . 100n MKP else MKT

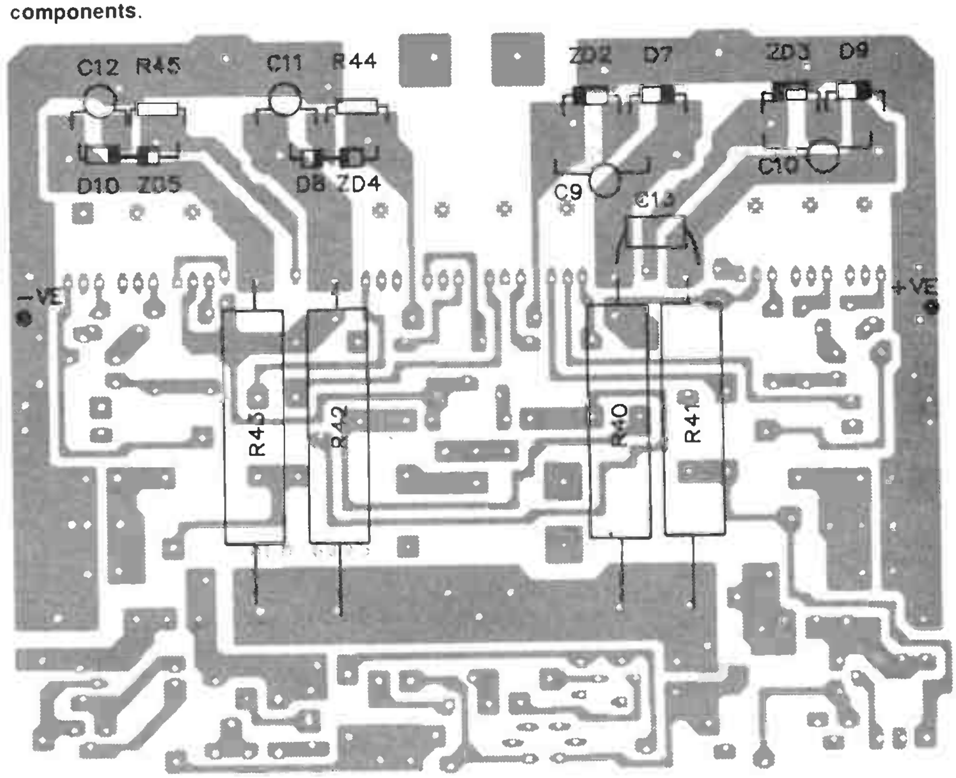
Miscellaneous
AEM6005 pc board; four TO3 mounting kits; 10 TO126 (MJE) mounting kits; thermal paste; nuts and bolts; heatsink bracket, as specified; two nylon bolt insulators.

Estimated cost: $100-$140



Topside component overlay

Rear view of the pc board, showing the rear side components.



voltage gain stage which reduces distortion before the application of any overall negative feedback. In fact, for similar gains a differential symmetric circuit like this is at least an order of magnitude superior in its distortion performance over that of an aysmmetric single transistor.

The input stage

The advantage of the fully symmetric differential pair over an aysmmetric differential pair for large signal voltage levels has already been stated. However, in the case of the voltage amplifier the symmetric differential circuit is used to linearize the transfer characteristic of the voltage gain. The main differential pair at the front end of the power amplifier on the other hand has to perform a slightly different function to that of the voltage gain stage. It must act as a difference amplifier producing a signal at its output which is an accurate difference between the signals at each of its differential inputs. In this application the asymmetric differential pair is superior to the fully symmetric differential pair using the same bipolar transistors.

Another important aspect to the design of input differential pair is its ability to maintain the output dc offset of the power amplifier to a sufficiently low level. In most power amplifiers the gain at dc is reduced to unity by the introduction of a capacitor into the negative feedback loop. Of necessity, this capacitor usuallly must be an electrolytic type which can have a significant effect on the subjective performance of the power amplifier, particularly at low frequencies.

During the development of the AEM6000/AEM6005, a number of test amplifiers were constructed and auditioned. These tests revealed that this dc blocking capacitor tended to cause significant degradation of the subjective performance. In the development of these projects, it was decided to design the input stage with sufficient dc tracking capability so as to enable elimation of this dc blocking capacitor entirely. Accordingly, the input stage was designed using a highly-matched dual JFET, the NTE or ECG 461. This device is available from Stewart Electronics in Melbourne and although there are various alternatives available, this is the preferred device.

The final design for the input differential pair, as can be seen on the main circuit diagram, employs a cascode configuration using the dual JFET and a pair of bipolar transistors. The operating conditions for this cascode arrangement are determined by two constant current sources formed from transistors Q5, Q6, and Q7, Q8. The zener diode ZD1 ensures that the bases of transistors Q3 and Q4 are approximately 12 volts above the sources of the JFETS. In other words, the drain-source voltages of the input JFET are held constant at approximately 11.4 V. The advantage of the cascode pair such as in this circuit, is that it provides excellent isolation of the output of the differential pair from its inputs which provides a more linear and faster voltage amplifying stage. A more detailed description of the operation of the input pair is in included in the Circuit Operation section of this article.

The asymmetric to symmetric converter

To convert from the asymmetric output of the input stage to the symmetric input required by the symmetric voltage amplifier stage and asymmetric to symmetric converter stage has been included. This stage consists simply of four bipolar transistors forming a symmetric differential amplifier fed from two constant current sources formed from Q9 and Q10.

The overall topology of the AEM6005 power amplifier module — that of an asymmetric cascode input stage followed by an asymmetric to symmetric converter, a fully differential symmetric voltage amplifier and a power MOSFET output stage — was found to provide the best subjective performance of the various topologies tried during development. The absence of a dc blocking capacitor in the feedback loop combined with high speed linear stages throughout and lower overall feedback than most MOSFET designs has yielded a power amplifier with exceptional subjective and objective performance.

Construction

In this part we are discussing the AEM6005 module. Details of assembling the modules into a chassis with a power supply will be described in Part 2 of this article. Construction is not difficult due to the fact that the modules are based on the AEM6005 printed circuit board, the artwork of which is published elsewhere in this article. However, when dealing with power amplifiers, care should be taken even with the smallest task.

Commence by preparing the heatsink bracket which is fashioned from a length of L-shaped aluminium extrusion. The drilling details for this bracket are shown elsewhere in this article. If using the 6005 module to incorporate into the 5000 power amplifier, a new bracket will be required as discussed earlier. On completion of the bracket, be sure to check and clear all the holes of burrs that may damage insulating washers used with the devices bolted to the heatsink.

The MOSFETs should be the first components positioned as some manouvering may be necessary which would put undue stress on any other components already positioned. Mount the MOSFETs as shown in Figure 3 with the leads through the bracket and pc board ensuring to insulate the leads from the bracket. Insulating washers with a smearing of thermal paste must be used between the MOSFETs and the bracket as the case of the device is connected internally to the source of the MOSFET which will be shorted to the bracket if not correctly insulated.

The four mounting bolts which are closest to the pc board are used to connect the sources of the MOSFETs to the rest of the circuitry. Therefore, it is essential that these bolts make good electrical contact between both the case of MOSFETs and the track of the pc board. It is also essential to use spaghetti or some other type of insulating material to stop the bolt from shorting to the heatsink bracket. The other four mounting bolts must be insulated from the pc board, bracket and MOSFETs. The simplest method by which to do this is to use nylon nuts and bolts, although care should be taken when using these not to over tighten them and possibly strip the thread from the bolts. Once the MOSFETs have been mounted in position, use a continuity meter to test for any shorts between the MOSFET cases and the heatsink bracket. ▶

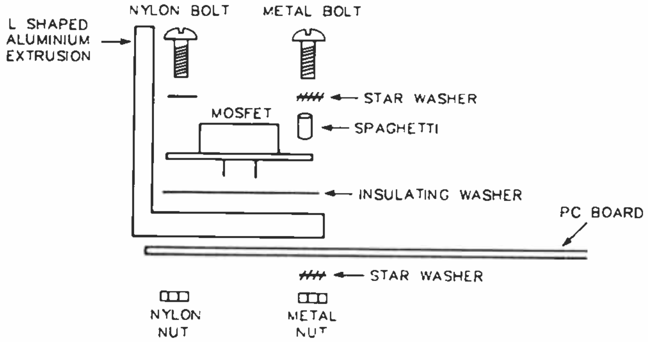


Figure 3. How the heatsink bracket and MOSFETs are mounted to the pc board.

The next components to be positioned should be those on the copper side of the pc board. Be careful to follow the component overlay so as not to confuse their positioning. Several of these components need to be soldered across adjacent tracks so care should be taken to avoid these leads shortening.

Once you have finished this stage, the rest of the pc board can follow. Begin with the passive components such as the resistors and feedthrough links. The feedthrough links are marked on the overlay, so check to ensure that they have all been completed before proceeding. Next, you should position the smaller capacitors as their physical size may interfere with the construction of the rest of the pc board. The diodes, including the zeners, can be soldered into position. These are the first components, other than the MOSFETs, that need to be oriented according to polarity so as to avoid possible damage. To verify their positioning, refer to the component overlay.

Next to be positioned should be the active components. The bipolar transistors, including the MJE350s and 340s, and dual JFET all must be positioned according to polarity so it is essential to follow the overlay precisely. Take great care not to confuse the transistors and this will almost surely result in damage. When mounting the MJE devices you will need to use insulating washers so as not to short the case on the rear side to the heatsink bracket. The rear of the transistor is connected internally to the collector of the transistor. Thermal paste, as used with the MOSFETs, should also be used between the transistors and the heatsink which is essential to the efficiency of the heatsink to reduce the temperature of the transistors. When you have positioned these components check the mounting bolts on the copper side of the pc board to see that they are not shorting to any of the adjacent tracks.

Once you have finally bolted the transistors in, it is wise to check with a continuity meter that the collector is not shorted to the heatsink bracket. This is essential because, if any burrs are remaining on the heatsink bracket they may pierce the insulating washer and hence short the collector to the chasss via the bracket. There is no need to insulate the bolts from the MJEs as they are self insulating.

Finally, it is time to position the larger capacitors and preset potentiometers. The larger capacitors are all electrolytic types and therefore need to be positioned the right way round. If positioned incorrectly a breakdown of the dielectric inside the capacitor will most surely occur at first switch-on. When positioning the presets you will need to be careful of the tracks running beneath them as some presets are not insulated at this point. Sit them slightly proud of the board surface.

The remaining four 5 W/OR22 resistors were placed on the rear side of the pc board due to lack of space on the top side. This was done for compatability of the 6005 module with the 5000 chassis. When positioning these, be sure to space them a couple of millimetres from the board so as to avoid unnecessary heating to the board after prolonged use.

The 6005 module should now be complete. However, you should do a thorough check of the pc board for any unwanted solder bridges between adjacents tracks. Also be sure to check the top side of the board for any of the component's leads shorting to tracks. A final check of the orientation of all components and topside solder joints should be undertaken before first powering-up your module.

An experimenter's modular music synthesiser

Part 4 — envelope generators

Two options for envelope generators are described here, one with voltage controlled parameters and one without. This was felt necessary due to the cost of the voltage controlled version and the panel space required.

John East

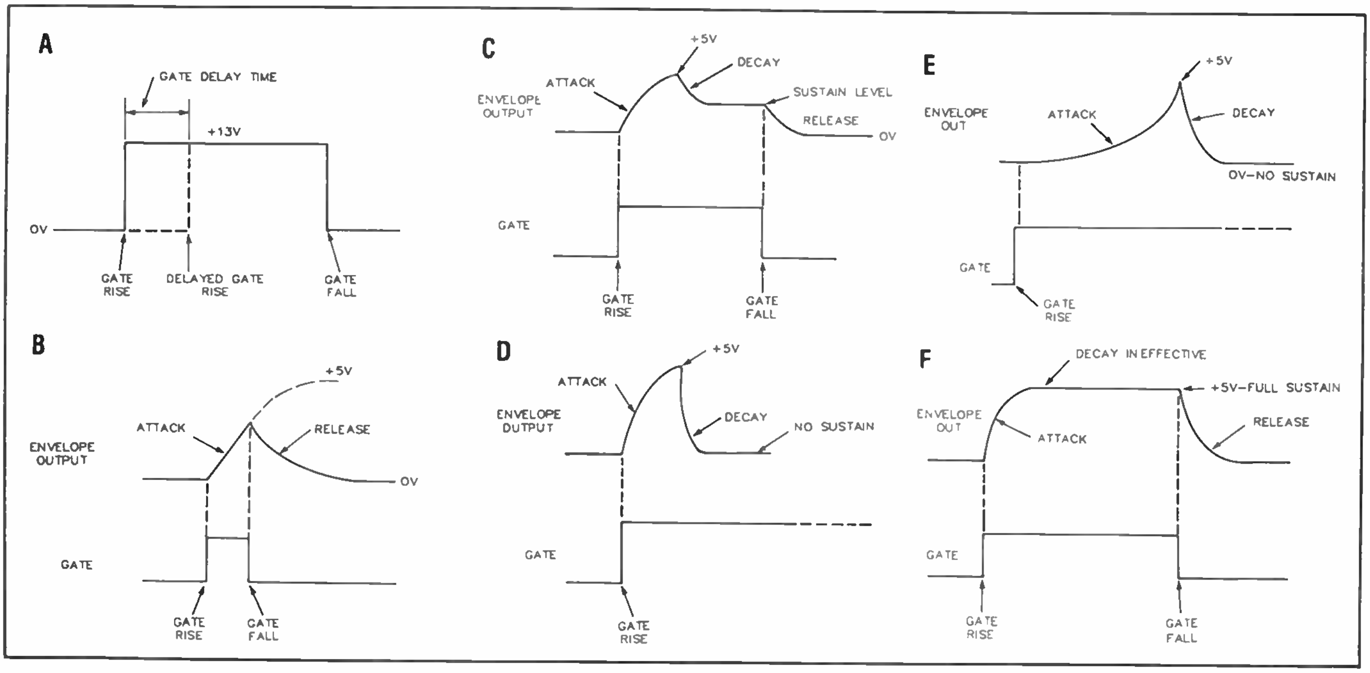
IN MANY acoustical musical instruments the volume contour of a sound, the envelope, is either produced or greatly controlled by the muscular efforts of the musician. This will be easily appreciated by trumpet players! In synthesizers, in order to gain a great variety of envelope shapes from a single controller, such as a keyboard, automated envelope generators are used in which the envelope shape and timings are preset by panel controls before playing a voice. This leads to a kind of rigid inflexibility in much synthesized music, due to the only control over the envelope being at the start and end of the note, defined by the gate rise and gate fall. Predictable results with envelope generator knob manipulation are difficult while actually performing on a synthesizer, so the envelope controls are usually left alone, with the resulting "static, cold" sound so common today.

The voltage controlled envelope generator could do much to alleviate the problem; retaining the variety of shapes possible with automated envelopes, but greatly increasing the possibilities for real-time change in the envelope after initial control setting is done. One simple patch of the keyboard control voltage into say, the attack and decay control voltage inputs of the VCE, can change a percussive sound gradually across the keyboard, with every pitch having a slightly different envelope. Another possibility is to use a two- or three-axis joystick to set a precise range of control of envelope parameters of the VCE, and then to use these in performance.

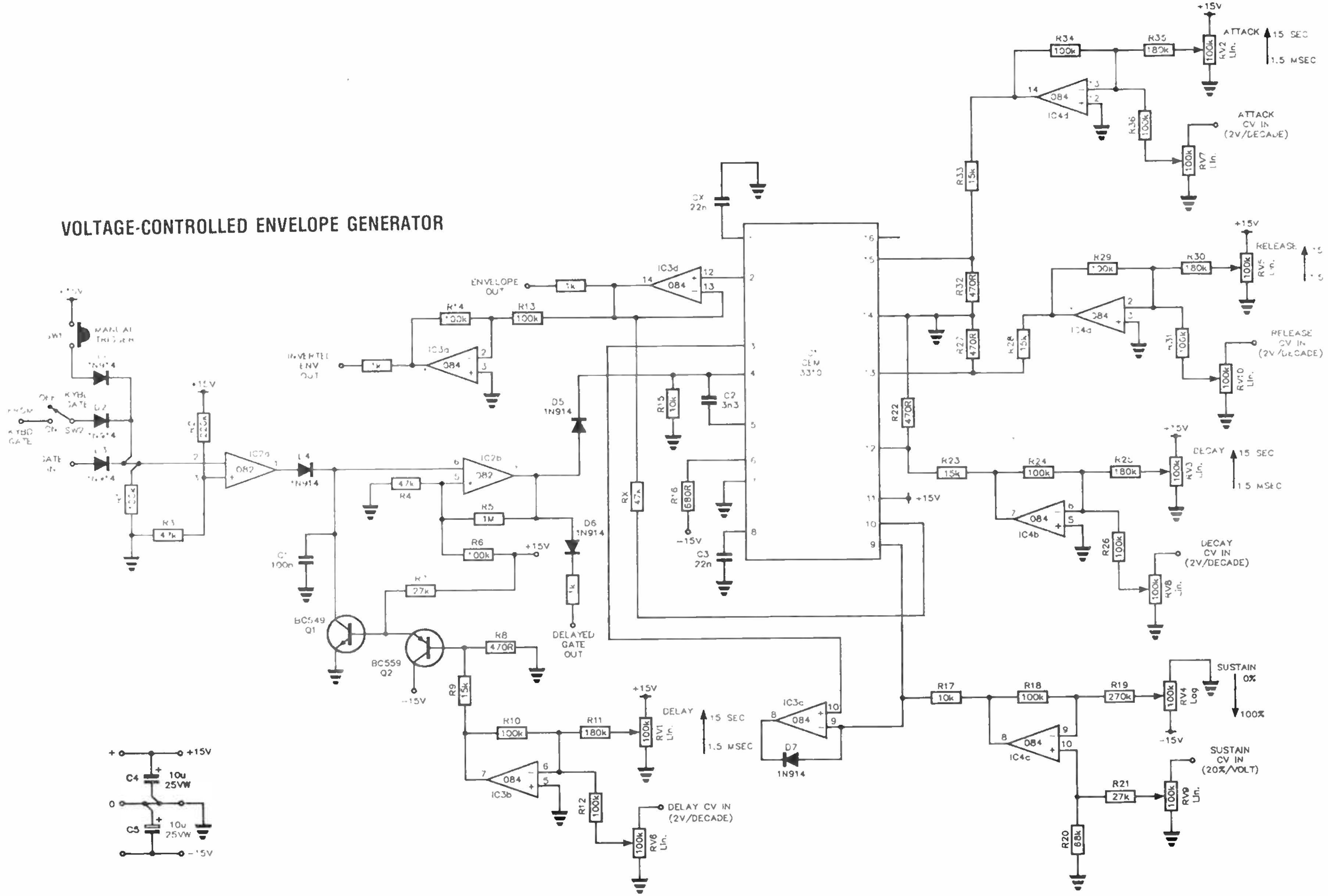
A rather intersting application would be to multiple-control the same parameter in a multiple envelope generator patch. This sort of thing is downright impossible without VCEs and only helps to prolong the problems mentioned earlier. A variation on this is to use the voltage control aspect to completely determine the envelope parameters for a particular voice. This could be of use in a computer-controlled situation, but can be overdone. The perfect example of this is the programmable performance synthesizers which use a microprocessor and VCEs in this way, but fail to make available even one envelope parameter to a left-hand controller or input socket!

Voltage control also helps extend the range of shapes available from the standard ADSR. For instance, the attack segment is a convex exponential shape (see Figure 1d), and to produce the sort of envelope shown in Figure le is therefore impossible in real time. This is the "backwards piano" envelope familiar to "musique concrete" listeners. It can be done with a VCE by setting the Attack control to maximum, the Decay and Sustain to minimum, and simply patching the Inverted Envelope output into the Attack Control Voltage input, and suitably adjusting that input's attenuator. ▶

FIGURE 1.



VOLTAGE-CONTROLLED ENVELOPE GENERATOR



This feedback technique is also implemented in the actual circuit by means of Rx. If Rx were disconnected, the 3310 would generate linear ramps in lieu of the more usual RC envelope shape. Some constructors may wish to experiment with this, but Cx would probably have to be increased to around 100n or so. Note that the time constants of the VCE are proportional to the product of the values of Cx and Rx;' and as individual chips may produce timing variations of ±15% from chip to chip, a preset pot could be used in series with Rx if better tracking is desirable. In a modular system, this would not normally be necessary; the variation is negligible.

The current sources in IC1 are exponential voltage to current converters as in VCOs, VCFs etc. This gives an extremely wide range of time control for the time segments of the VCE. The Delay, Attack, Decay and Release pots all cover a range of four decades, from 1.5 ms to 15 seconds, and the control law at the CV inputs is 2 V/decade. Extremely long envelope times can thus be used, but they are usually of little use. The times increase with more positive control voltages. The Sustain CV input is the odd one out, as the control voltage is used to directly set the sustain level between 0 and +5, and so has a linear relationship. However, a log pot is used at RV4, as the sustain setting usually determines a volume level and is easier to manually set this way.

The Sustain control has rather a drastic effect over its full range. At zero sustain, as in Figure 1d, percussive envelopes of various kinds, some previously mentioned, can be produced. Taking the sustain to full changes the envelope to a sustaining type, useful for organ, brass and other similar instrument imitations. Note that the decay time setting is ineffective under these conditions. (See Figure 1f.)

The Delay section was included as standard, as many useful timing functions are possible when two or more envelope generators are used. An example would be horn blips and noise chiffs. A Delayed Gate output is also included, as a "master" gate delay could be used for timing several subsequent envelopes to this single, initial delay, rather than having to set all the individual delays separately. Also, consecutive delays could be set up for long delays or rhythms.

There are not critical components, as timing variations due to temperature dependences are unlikely to be noticed. Common 5% carbon film resistors and plastic greencaps for C1-C3 and Cx will be okay; C4 and C5 are electrolytics.

The non-voltage controlled envelope generator has similar facilities to the VCE, but lacks voltage control and the inverted envelope output. It is basically the standard ADSR provided on most synthesizers, with the addition of the gate delay. There are many instances where envelopes will be suitable even if not externally controlled, and several of these in conjunction with one or two VCEs, would solve almost anyone's enveloping problems!

The segment times obtainable from this envelope generator will be less than those from the VCE, being limited by the values of commercially available pots. Note that the Delay and Attack controls are 1M; Decay and Release pots are 2M. These values have been found to give the best range of control, and it is hardly worth trying to hunt up 5M pots if the VCE is built. The log. characterstic ensures that the more useful shorter times are available over most of the physical rotation of the pots. Interesting how our perceptions are geared to exponential characteristics, even in this application.

Again, there are no critical components — 5% carbon film resistors, greencaps for C2 and C3, and electros for C5 and C6. Tantalums are used for C1 and C4 as their tolerances are tigher than normal electros. Q1 is a BC549 for the high current gain necessary to discharge C1 properly at the shortest delay times.

Voltage controlled envelope generator

The CEM3310 chip contains all the switching, logic functions and current sources for implementing a standard ADSR, but with all parameters voltage controllable. Gate signals are input to pin 4, and via C2, to pin 5 of IC1. This initiates the standard ADSR output voltage at pin 2 which is buffered by follower IC3d and inverted by IC3a. The attack, decay and release time segments are made voltage controllable by summing control voltages into the summing inputs of the inverters formed by IC4d, IC4b and IC4a. These voltages are attenuated by dividers consisting of 15k and 470 ohm resistors, to drive (at pins 15, 12 and 13) internal current sources in IC1, which are switched internally to charge and discharge capacitor Cx. A differential amplifier IC4c, sums sustain level control voltages which are input to IC1 through RI7 at pin 9. A voltage comparator/clamp circuit, consisting of IC3c and D7, prevents incorrect functioning of IC1 if the sustain control voltage rises above the peak voltage. (Vp at pin 3, about +5 V.)

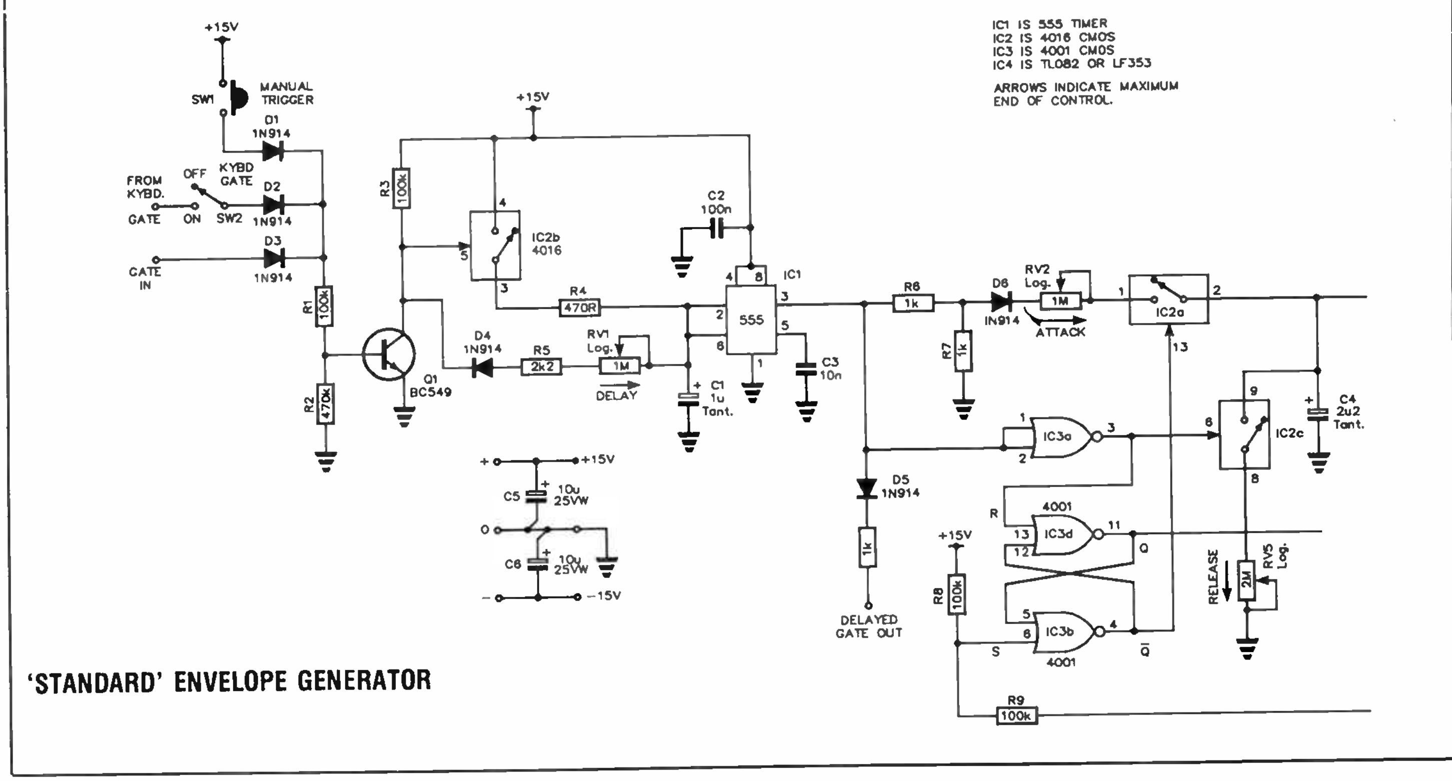
An external circuit is provided to voltage control the gate rise delay time. Gate sources are ORed by D1-D3 and R1 into inverting comparator IC2a. When an input gate exceeds the voltage threshold set by resistive divider R2 and R3 at pin 3 of IC2a, the comparator output goes low, reverse-biasing diode D4, thus allowing C1 to be discharged by the constant current sink Q1. When the voltage on C1 falls to less than about +5 V (set by resistive divider R6 and R4), the output of comparator IC2b goes high and through D5 and RI5 provides a 0 to +13 V gate rise to IC1. When the input gate goes low again, IC2a outout goes high, forward-biasing D4 and forcing the voltage on C1 to return to +13 V almost instantaneously. This forces IC2b output low, thus returning the gate input to IC1 to 0 V.

The gate delay time is determined by the time taken to discharge C1 to +5 V by Q1. This current source is voltage-driven by the temperature-compensating emitter-follower Q2, whose drive voltage is derived from an inverting summer around IC3b, identical to those used for the attack, decay and release time segments.

'Standard' envelope generator circuit

Gate signals are ORed by D1-D3, R1 and R2. Q1 turns on when a gate high state is applied to the base and the collector voltage goes low, turning off CMOS switch IC2b and discharging C1 through RV1, R5 and D4. The settting of RV1 determines this time, which is the gate delay. IC1 is wired as an inverting comparator which goes high when the voltage on C1 falls below +5 V. When the input gate goes low, Q1's collector goes high, reverse-biasing D4 and turning CMOS switch IC2b hard on, which rapidly charges C1 to +15 V through R4. (See Figure 1a.)

A high gate output at pin 3 of IC1 is applied to resistive divider R6 and R7, which then starts charging C4 through D6, RV2 and CMOS switch IC2a . The gate is inverted by IC3a, thus turning off IC2c, simultaneous with the rising gate. If the gate falls before C4 charges to +5 V, the voltage at pin 3 of inverter IC3a goes high, turning on switch IC2c and discharging C4 through RV5, which sets the release time. Diode D6 is reverse-biased at ths instant also, preventing C4's discharge through this path. This is the normal resting state of the circuit. (See Figure 1b.) ▶



'STANDARD' ENVELOPE GENERATOR

If, however, C4 is allowed to charge to the peak voltage of + 5 V, the attack phase is completed, the time being determined by RV2. Capacitor C4's voltage is buffered by follower IC4b, and compared with the peak sustain voltage at the junction of R12 and RV5. If this is exceeded, comparator IC4a goes high. This "sets" the bistable flip-flop consisting of NOR gates IC3d and IC3b. Thus, CMOS switches IC2d and IC2a are turned on and off respectively. This disables the attack charging circuit and allows C4 to discharge through RV3 to the sustain voltage set by the wiper of RV4. The time taken to do this is the Decay time, set by RV3. If now the gate goes low, the inverter IC3a resets the flip-flop and enables C4 to discharge through the Release time pot RV5, as before. The flip-flop simultaneously reverses the condition of the CMOS switches, turning IC2d off, and IC2a on, restoring the normal "rest" state. (See Figure 1c.)

There is a snag, however. At the envelope peak, the comparator output is high for a short time. (It normally goes low as the decay phase begins, due to C4's voltage falling below + 5 V.) If the gate goes low while the comparator is high, a "disallowed" state arises due to logic 1 states on both set and reset inputs of the flip-flop. The NOR gate implementation solves this problem, as both flip-flop outputs go to O. This allows C4 to discharge to release phase, and thus IC4a goes low, returning the flip-flop to its normal rest state. (Q output at 0, $\overline{Q}$ at 1.)

Construction

There are a fair number of connections between the VCE and its panel controls; it would be exceedingly confusing if any of the control voltage inputs were wrongly wired so watch this. Don't forget an earth strap from the circuit common to a mounting bracket bolt. A socket for IC1 is a good investment.

Points common to both units are as follows: 1k resistors are to be mounted on the envelope and gate delay output sockets. The diodes in series with the 1k output resistors on the gate outputs allow gates to be ORed by plugging them all into a multiple, which is then plugged into a gate input. Sort of a logic signal "Mixer". SW1 is a pushbutton type, SW2 is a miniature toggle. Note that only two diodes at the gate inputs. If all three inputs are used, simply wire in the D1 diodes betwen SW1 and circuit. Front panel pots should be wired so that envelope segment times *increase* with clockwise rotation, thus satisfying the convention that any parameter should increase with clockwise rotation and/or positive-going control voltages.

Note that IC2 and IC3 of the plain, vanilla-flavoured envelope generator are CMOS and due care should be taken. Finally, here's a list of panel controls for both envelope modules.

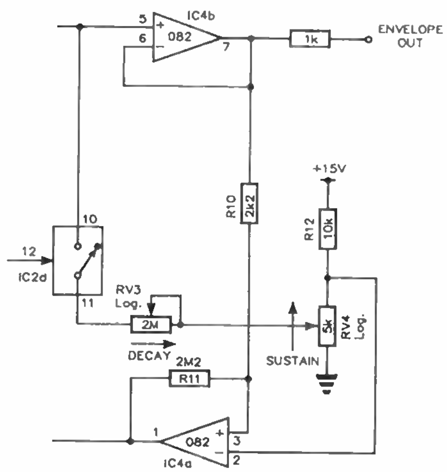
PANEL CONTROLS

VCE

KNOBS	SWITCHES	SOCKETS
Delay	Manual Trigger	Gate Input
Attack	(SW1)	Delayed Gate Output
Decay	Keyboard Gate On/Off	Envelope Output
Sustain	(SW2)	Inverted Envelope Output
Release		Delay CV Input
Delay CV Attenuator		Attack CV Input
Attack CV Attenuator		Decay CV Input
Decay CV Attenuator		Sustain CV Input
Sustain CV Attenuator		Release CV Input
Release CV Attenuator		

ENVELOPE GENERATOR

KNOBS	SWITCHES	SOCKETS
Delay	Manual Trigger	Gate Input
Attack	(SW1)	Delayed Gate Out
Decay	Keyboard Gate On/Off	Envelope Out
Sustain	(SW2)	
Release		



Setting Up

There are no adjustments for either of these modules, and they should work from turn-on. It is a good idea to check the output levels of the envelopes are about +5 V with full sustain and a gate applied, and that the delayed gate output is present. Checking the contour shapes can be done by using the envelope to control a VCO, resulting in the "audible oscilloscope" described in Part 1.

A full checkout of the envelopes in patches controlling other modules would at this stage be an instructive and rewarding lesson. The next article will present a keyboard controller, the obvious choice for use with the envelope modules.

Cutris Electromusic Specialties ICs are available in Australia through Chris Short of NRG Keyboards & Computers, 135 Rae St, North Fitzroy 3058 Vic. (03) 481 8995

CEM 3310 Circuit Block & Connection Diagram

Features

- Low Cost
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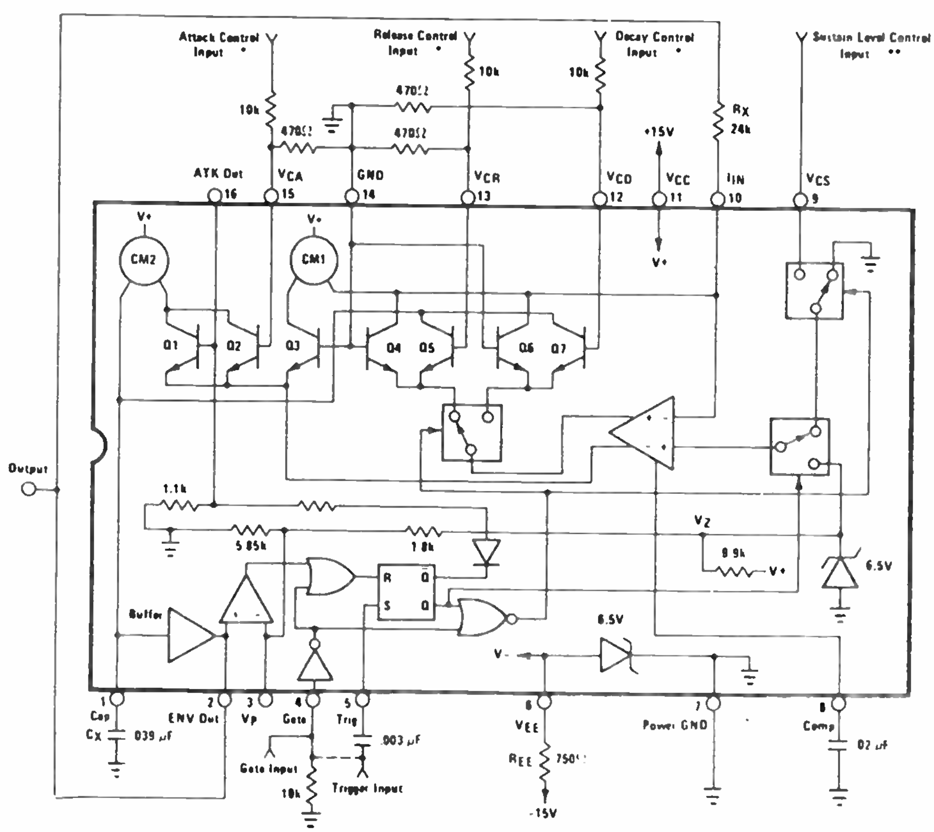
- Full ADSR Response
- True RC Envelope Shape
- Exceptionally Low Control Voltage Feedthrough: 90µV max
- Accurate Exponential Time Control Scales
- Isolated Control Inputs
- Good Repeatability and Tracking Between Units Without External Trim
- Independent Gate and Trigger
- ± 15 Volt Supplies

* Zero to −5V Varies the Times from 2mS to 20S

** Zero to +5V Varies the Sustain Level from 0 to 100%



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22,000uF	25v	18-3506	$ 9.00
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SR48	G5	393	WL6	$1.60
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SR726	G2	396		$1.30
Alkaline				
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LR43		186		$0.80
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Adapting the EPB electronic ignition to electronic points systems

Mark Hurry & Dino Ius
Chipspeed Electronics

So you'd like to install an EPB Electronic Ignition, but your car's got one of those fancy electronic points systems? Well, here's how to do it. It's simple, as provision was made to accommodate the extra components on the pc board from the start.

THE EXTENDED PULSE BURN (EPB) ignition system described as a Star Project in the February '87 issue has proved to be a popular unit. The EPB system has a number of advantages over other electronic and conventional ignition systems but as published, did not cater for vehicles which use one of the fancy new electronic points systems. Well fear not!, you have not been forgotten. In this article we will describe the steps necessary to adapt the system to those opto/Hall Effect/variable reluctor points systems and, as you will see, it only involves the addition of a few extra components to the existing printed circuit board.

The EPB circuit board was designed to accommodate any one of three options for an alternative to the basic points system. The actual mechanism installed in the distributor is left up to the individual constructor who may have one of the three systems already installed in the car or who may be considering upgrading from the conventional points system.

Each option consists of two basic stages; a constant current source to allow for variations in the car's supply voltage, and a sense circuit followed by an inverting driver stage so that the signals are of the correct polarity and sufficient amplitude to drive the EPB control circuitry. The configurations were chosen to minimise the number of wires required between the EPB unit and the car's distributor as well as eliminating all non-essential electronics from within the harsh environment of the distributor itself.

Optical points

In this configuration the constant current source of about 80 mA supplies the LED. A phototransistor senses the LED output as a chopper disc passes between the two devices and the EPB unit triggers when the light is broken (i.e: on the leading edge of the chopper. Optical points are the most difficult in terms of availability and reliability. High temperature optical devices are expensive and uncommon. Normal distributor temperatures and vibration make these devices marginal in the long term and may explain why there are not many commercially available optical systems around.

Figure 1 shows the placement of the additional parts to be fitted on the pc board. Component values only are shown as we felt it may cause some confusion if we were to label them R1, R2 etc., especially if a constructor is fitting one of the options at the same time as constructing the main unit.

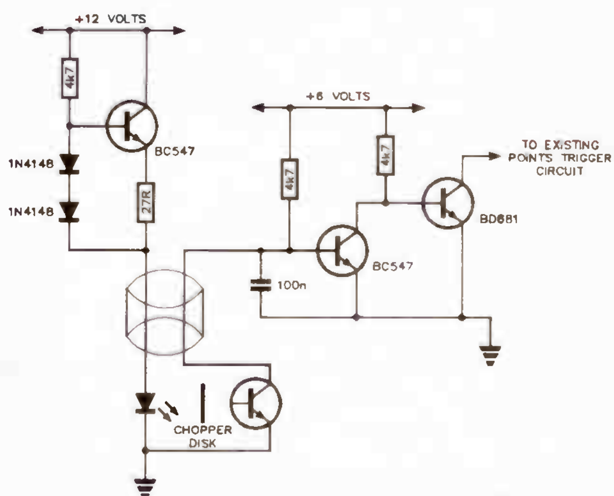
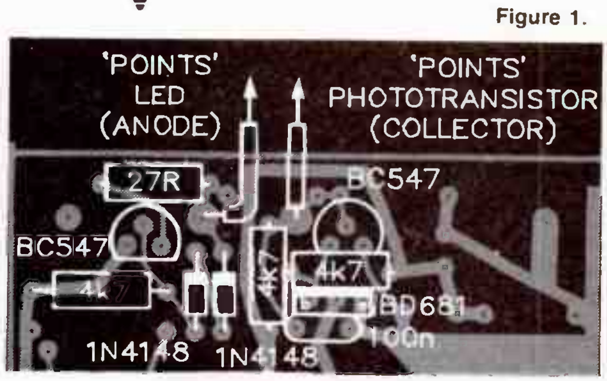


Figure 1.



There are only ten parts involved so there should not be any difficulties encountered. You will require the following parts for this option:

- 1 × 27R, 0.25 W resistor
- 3 × 4k7 0.25 W resistor
- 1 × 100n greencap capacitor
- 2 × 1N4148 silicon diodes
- 2 × BC547 transistors
- 1 × BD681 transistor

▶

The parts can be fitted to the circuit board in any order, although it is usually easiest to start with the resistors and capacitors. Take care to orient the two diodes and three transistors correctly. Solder the components and then check your work. Connection to your optical points system is via the two flying leads. Make sure that the "anode" lead goes to the correct end of the "points" LED and similarly, that the "collector" lead goes to the collector of the "points" phototransistor.

Hall Effect points

This option is designed to allow use of the "Sparkrite" Hall effect points system as supplied by Jaycar. The constant current source provides about 30 mA to bias the Hall effect device at about 7 V when in it's "unswitched" state, and 4.5 V when in its "switched" state. A 5.6 V zener diode ensures that no current flows into the base of the BC547 transistor when the Hall Effect device is switched on.

When the leading edge of one of the poles of the ring magnet causes the device to switch to it's "high" state, the zener will conduct. This provides base current to turn on the BC547 which will shunt the base of the BD681 to ground, turning it off. When the Hall Effect device goes from "low" to "high" it simulates a set of contact points going from closed to open.

Fitting this option is accomplished in a similar manner to the optical points above and most of the points made there will apply here. This time, eleven components are required and they are a little different to those used in the optical points system. Figure 2 shows how the components are placed and once again, to avoid possible confusion, we have only shown the component value. The components required for Hall Effect points systems are as follows:

- 1 × 18R 0.25 W resistor
- 3 × 4k7 0.25 W resistor
- 1 × 100n greencap capacitor
- 2 × 1N4148 silicon diodes
- 1 × 5.6 volt zener diode
- 1 × BC547 transistor
- 1 × BC548 transistor
- 1 × BD681 transistor

Fit the parts to the PCB as indicated in Figure 2, taking care to get the diodes and transistors the right way around. Connection to the "Sparkrite" points is made by a single flying lead so, provided you adhere to the instructions supplied with the points, you should experience no problems.

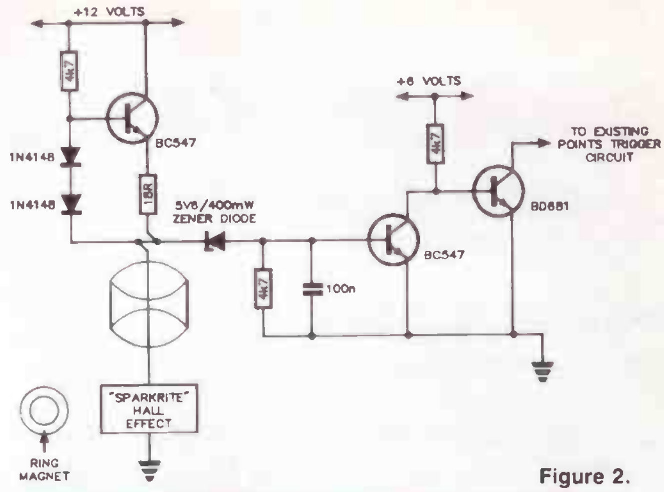
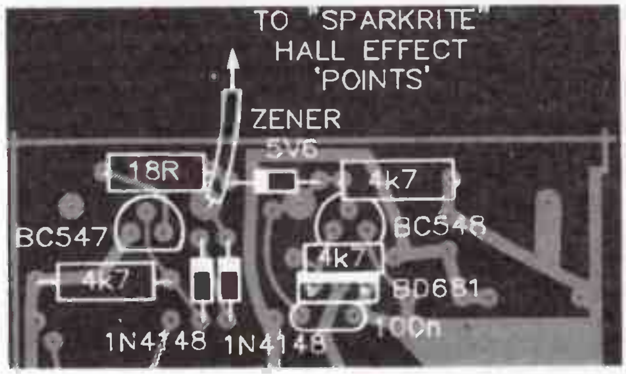


Figure 2.



Variable Reluctor systems

The variable reluctor is the only system which actually generates a voltage as its operation involves a magnet and a moving pole piece which sets up a moving magnetic flux as the poles move past an iron core. With this system the constant current source simply sets the bias on the pickup coil and the voltage sensed by the BC547 transistor is either the sum or the difference of the bias voltage and the voltage produced by the coil itself. The bias is arranged so that when the voltage produced is the difference, the voltage at the base of the BC547 falls below 0.7 V thus turning it off. When the vol-

EFFECTS OF ALTERING SPARK DURATION

Understanding the meaning and effects of spark duration, or the time that the spark is maintained, can enable you to fully utilise the benefits of your EPB ignition. A spark duration of 1.6 ms is generally considered to be a figure which will suit most petrol engines subjected to a wide range of conditions. In other words, if you drive in the city or the country with your vehicle loaded or not, this figure would be best for your engine. If R8 is 100k, then the spark duration should be close to 1.6 ms.

If you use an engine for race or rally, then you should shorten the spark duration to about 1.2 ms to allow for a higher number of sparks per minute. Use a value for R8 of 82k to obtain this figure.

Spark duration can be made shorter than 1.2 ms and higher rpm achieved, but there is a limit to how far you can go. A point will be reached where the spark will not be present in the combustion chamber for long enough to ensure reliable combustion. It should be noted that combustion chamber dynamics vary with different engine designs and modifications. These characteristics, which include the varying effects of mixture "squish" and "swirl" result in a different minimum spark duration requirement for each type of engine.

If spark duration is made too short, like under 0.7 ms, your engine will probably simply misfire. Using a spark duration of between 0.7 ms and 1 ms may result in a mild misfiring condition under light throttle. When cruising at, say, 80 km/h with the throttle just slightly open, a "buffeting" effect will be felt as though a strong headwind was blowing at the vehicle. This condition exists because a short spark duration can't reliably ignite the leaner mixtures which occur under light throttle/high inlet manifold vacuum conditions. If your engine is used for competition, this condition will be masked because of large throttle openings and can be tolerated to achieve high spark rates so long as spark duration is not so short that mid to high rpm combustion is incomplete.

At the other extreme, if your engine can't rev very high or you never drive it that way, you can extend the spark duration beyond 1.6 ms by making R8 100k.

The two waveforms relating to automotive ignition can be viewed on an oscilloscope or engine analyser. The primary (12 V side) can be viewed by hooking a 10X probe onto the 'earthy' side of the coil. You can see the pulses of the EPB if you do this. The secondary (high tension side) can be viewed by using a clip-on type capacitive pickup, connected to the CRO input, on the HT lead you wish to view.

If you only view the primary waveform, you can approximately calculate the spark duration by adding 0.2 ms to the time that the pulse group takes. If you view the secondary waveform you will see a very large initial spike at the start of the spark and then a lower amplitude 'plateau' period. The large spike is the kilovolts required to ionise the gas between the spark plug electrodes and the pulse amplitude during the plateau period is the kilovolts being delivered to maintain the spark during combustion. Spark duration is the time from where the spike occurs to where the plateau finishes.

tage produced is the sum ,the base of the BC547 will be above 0.7 V and the transistor will remain on. Whether the sum or the difference is produced will depend on the polarity of the pickup coil and whether the rotor is moving towards or away from the pole-piece. Some experimentation may be required to get everything phased correctly.

Once again, this option is fitted in a similar manner to the other systems. Ten components and one wire link are required and Figure 3 shows where to put things. The parts required are as follows:

- 1 × 150R 0.25 W resistor
- 1 × 15k 0.25 W resistor
- 2 × 4k7 0.25 watt resistors
- 1 × 100n greencap capacitor
- 2 × 1N4148 silicon diodes
- 2 × BC547 transistors
- 1 × BD681 transistors

Take care with component orientation and don't forget the wire link. Connection to the pickup coil is by a single flying lead so there is little possibility of confusion.

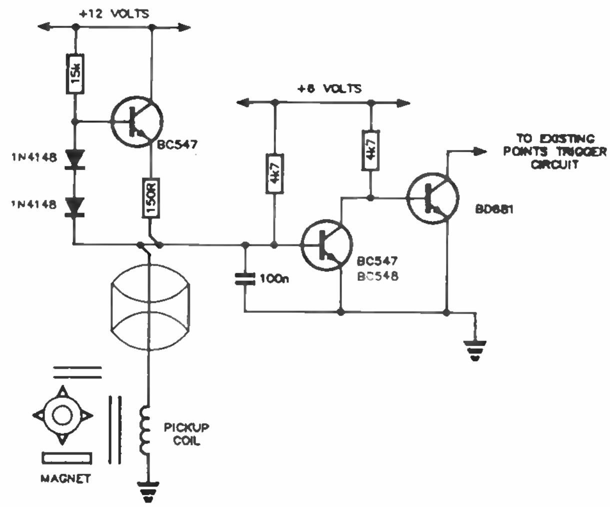
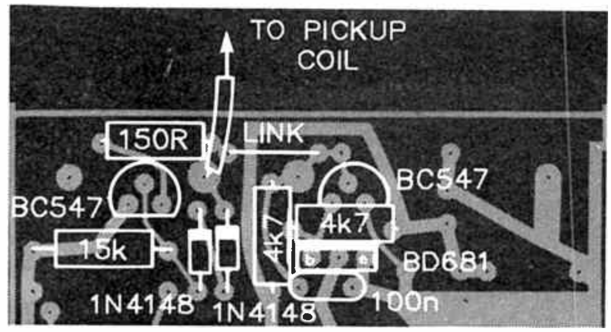


Figure 3.



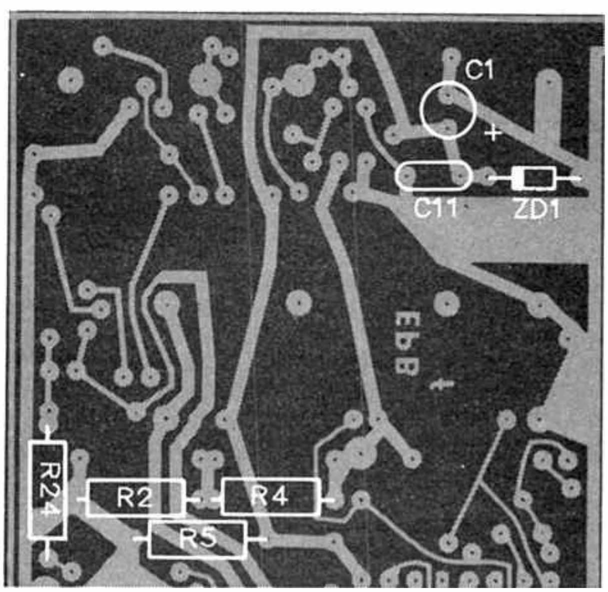
NOTES & ERRATA

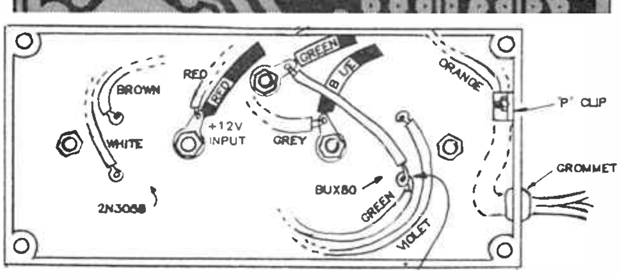
A few errata crept through from the documentation unnoticed in the February Star Project article. Firstly, the heavy duty red, blue and green wires to the ignition coil and chassis (respectively) were missed out on the wiring diagram. They terminate inside the die-cast box as shown in the diagram here.

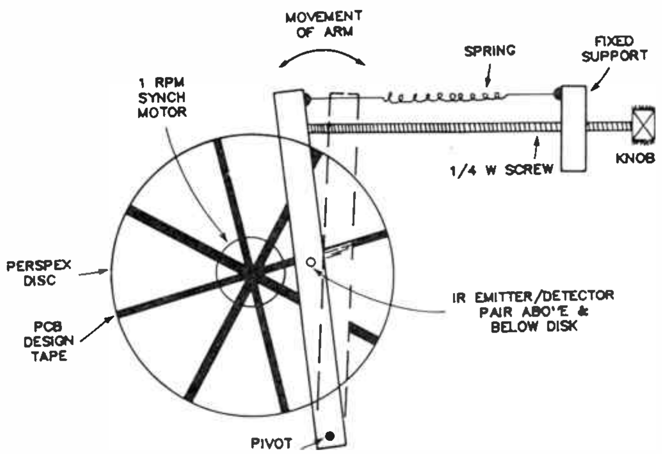
Secondly, C1 and C11 were incorrectly positioned on the overlay, and R5 was omitted. The accompanying revised overlay shows the amendments.

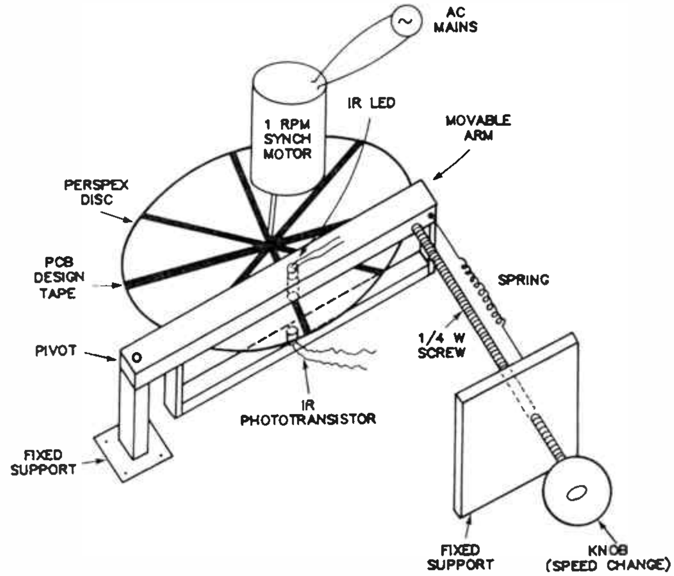
Thirdly, R18-23 comprises 2 × 3R9, 0.6 W AND 4 × 4R7, 0.6 W resistors, not the combination specified in the parts list. (It's obvious from the pc board how many resistors are required). Lastly, R14 is 4k7, not 47k. The parts list shows it correctly.

So much for the errata. Now, Q1 and Q5 — both specified as BC548s, may be replaced by BC547Cs. The value of R8 depends on your application. For 'normal' running, a value of 100k is recommended, but for rallying or racing, a value of 82k is recommended. For extra long spark duration, a value of 120k is suggested.









Variable rate telescope drive

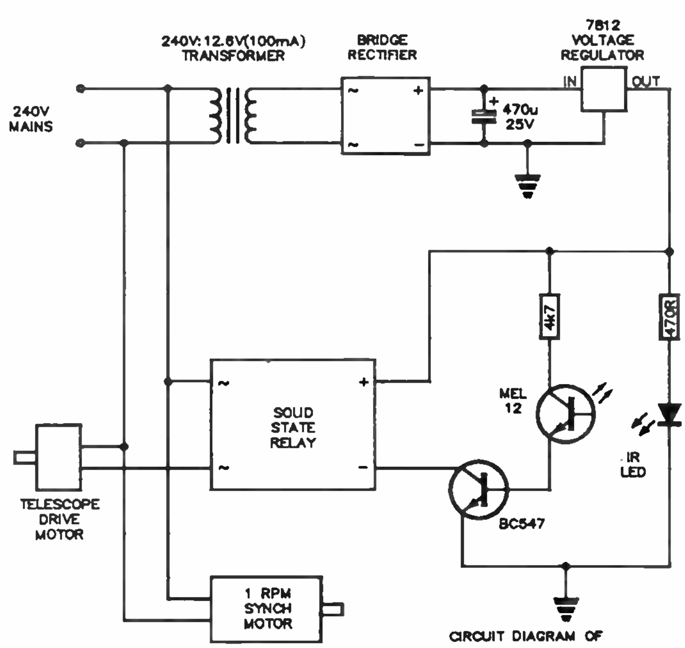
The telescope drive described in *Benchmark* AEM January 1987, is an elegant and simple solution to the problem of small telescope control. It solves one of the basic problems — stability. However, several very important requirements are not fulfilled with this drive. Because a star moves across the sky at varying altitudes its apparent speed changes due to the bending of light as it enters the Earth's atmosphere. Thus any practical drive must not only be stable but its rate must be able to be varied. The power limitation of 5 W is also too restricted for large amateur or professional telescopes.

While considering these problems a few years ago, I came across a low cost solution to these problems which no doubt has many industrial applications.

Constant rates of motion can easily be produced by using synchronous motors and locking the motors to the mains. But if one wishes to deviate from this speed, as is often required, then the usual solution is to provide a low voltage oscillator and then transform the voltage back to 240 V. This is where the problems usually occur since the requirements for astronomical photography, for example, are stabilities of the order of one part in 10 000 and an adjustment sensitivity and repeatability of the same order.

A solution is to design the telescope to drive at the correct rate when the synchronous motor receives a frequency of say, 49 Hz. The motor receives the mains voltage at 50 Hz but is interrupted for 2% of the time thus producing the correct average speed. The stability of this interruption need only be to one part in 200 since it is the *difference* from 50 Hz rather than the 50 Hz which is being regulated.

In my system, the interruption takes place every 10 seconds and is provided by radial stripes on a circular perspex disk which interrupts an infrared emitter/detector pair as the disk rotates. The IR pair controls a solid state relay which switches the mains off for 0.2 sec intervals. The disk is direct driven by a small synchronous timing motor operating directly from the mains. The variable speed is provided by moving the emitter/detector pair radially giving a ± 2% speed variation while retaining the high stability. A speed change of one part in 10 000 is achieved by 1/10 turn of a 1/4" BSW screw which is used to move the emitter/detector pair with respect to the disk.



CIRCUIT DIAGRAM OF SIMPLE TELESCOPE DRIVE.

The power limitations are only those of the solid state relay which switches the synchronous motor; in my case 15 kW! The stability is that of the mains and there are no temperature sensitive components which affect the speed. Apart from the time when the motor is being interrupted, the waveform feeding the synchronous motor is perfectly sinusoidal. Best of all, it is simple and cheap to make.

G.K.G. Moore
Keiraville, NSW

Benchbook is a column for circuit designs and ideas, workshop hints and tips from technical sources of the staff or you — the reader. If you've found a certain circuit useful or devised an interesting circuit, most likely other readers would be interested in knowing about it. If you've got a new technique for cutting elliptical holes in zippy boxes or a different use for used solder, undoubtedly there's someone — or some hundreds — out there who could benefit from you knowledge.

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An audio show formula to watch

The America's Cup is over, but Fremantle lives on. And to prove that there is life after the cup, Perth hi-fi mar keters are putting on a hi-fi show and festival of sound.

In an imaginative concept, the Hi-Fi Retailers Association of WA is staging a hi-fi show in the Fremantle Esplanade Hotel against a back drop of live music in the first weekend of April.

What the America's Cup activities pointed up is that people like activities in the streets. The committee organising this show has addressed that very fact and plans to have the show as much in the streets as in the confines of the hotel. And the Fremantle City Council is enthusiastically backing the project.

The Hi-Fi Association has booked the complete first floor of the Esplanade Hotel, and of the 47 available rooms all but six were let six weeks before the show.

The committee approached the Fremantle Council to seek permission to extend some of the show activities onto the grassed area opposite the hotel. It is expected that exotic cars, with even more exotic car sound fitted, would be ideally set in the park.

One of the major manufacturers even spoke about a marquee as part of this outdoor exercise.

As a backdrop to this hi-fi show, which is being sponsored by local station 96FM and the Western Mail Newspaper, there will be a Battle of Jazz Bands of Perth, and classical recitals. The Channel Seven Concert band is scheduled to play on the grassed area outside the hotel on Friday and Saturday nights, and the 60-member WA Mandolin Orchestra will play as a curtain raiser on the Saturday lunchtime. During Saturday morning string quartets will play in the Fremantle streets promoting the fact the hi-fi show is on.

Then on Sunday morning comes the musical highlight — a battle of Perth's leading jazz bands. They are to be launched from the recently completed $5.5 million St John's Square just before 11 am.

They will march back and forth through the town, visiting a number of pubs and restaurants as they march. The six bands will trace their own individual routes through the town, attempting to out-blow each other as they cross paths, eventually all reaching the grassed area outside the Esplanade Hotel around 1.30 pm for a grand mass bands finale.

The bands are being sponsored by different hi-fi manufacturers who will dress their bands for the biggest effect. There has even been talk of a busker competition. Many of the ideas for this sound festival have been inspired by the Berlin Electronics Show.

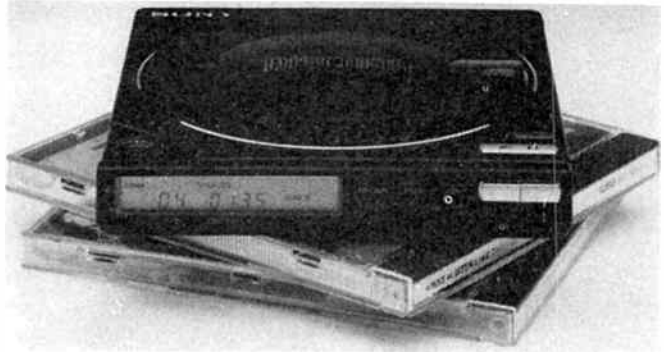
A local electronics journalist who helped establish the Perth Electronics Show saw the concept in Berlin and Germany and is working with the committee on this hi-fi show. He is organising this musical backdrop. In fact, a number of the original committee members who launched the Perth Electronic Show are working on this committee.

In coming years, this weekend is to be known as The WA International Hi-Fi Show and Fremantle Festival of Sound. It could grow to become as big as the current Perth Electronics Show because it is a street music festival as well as an audio show.

Chairman of the committee, Peter Robinson, said: "The Hi-Fi Show and Festival of Sound is being launched to complement the Electronics Show. The upmarket hi-fi dealers and manufacturers find it difficult to demonstrate esoteric equipment at the Electronics Show because of the crush of the crowds and lack of sound lounge facilities.

"We will continue to be part of the Perth Electronics Show, but we needed an alternative show that, although it will appeal to less people, will enable us to demonstrate hi-fi in a proper environment.

"We see this show as a listening show. There will be 47 sound lounges where people will be able to listen to the best sound available, and talk quality audio. That is the reason for launching the new hi-fi show. And as music is what hi-fi is about, we thought integrating live music would add a new exciting and fun dimension to the weekend."



New Discman from Sony

From the company that brought us the world's first portable CD player comes the release of the Discman D-100, which is a staggering 80% smaller than the original unit and weighs approximately 420 grams.

It has all the features of the original D-50 and D-50 MK II, with automatic music sensor, two-speed search function, versatile music repeat and random music sensor which enables one to program up to 21 individual tracks in any preferred order.

In addition, it has a hold switch feature which protects the selected playing function against accidental change by over riding all other modes.

The D-100 has a digital filter that prevents the generation of jitter and suppresses unnecessary residual signals, Sony claim.

Another major feature of this unit is an inbuilt track memory which, in the event of the player being knocked or bumped, will return to the precise playing position once stability has resumed.

An impressive list of optional extras is also available for the D-100, including: an infra-red remote commander with 10 key direct music select pad, keys for the major player select functions and the CPA 1 car cassette adapter allowing the user to connect to most stereo car cassette systems.

The Discman D-100 is available through the Sony dealer network at the recommended retail price of $699 and comes supplied with an over the shoulder carry case.

Consumer to win in the DAT versus CD battle

Dennis Lingane

Recent publicity about digital audio tape has set the CD hardware and software manufacturers scurrying to the defence. Disc prices will drop dramatically soon and CDs with video clips will appear on the market shortly.

THE DAT SCARE has put a rocket under the proponents of CD. This year we will see a cranking up of the marketing of CD with price cuts on the discs and new, complementary, technologies introduced. The most exciting will be the much talked about and long-awaited CD Video.

Under the title "CD Maxi-single", this new carrot to would-be CD buyers will be unveiled in Chicago at the annual US Consumer Electronics Show, according to Philips' CD marketing chief Ian Weathers and Polygram's new Marketing and Sales director, Paul Dixon. It will also be unveiled in September at the Berlin Show (Europe release) and then in October in the Japanese Audio Fair. Market availability is expected to be in early 1988.

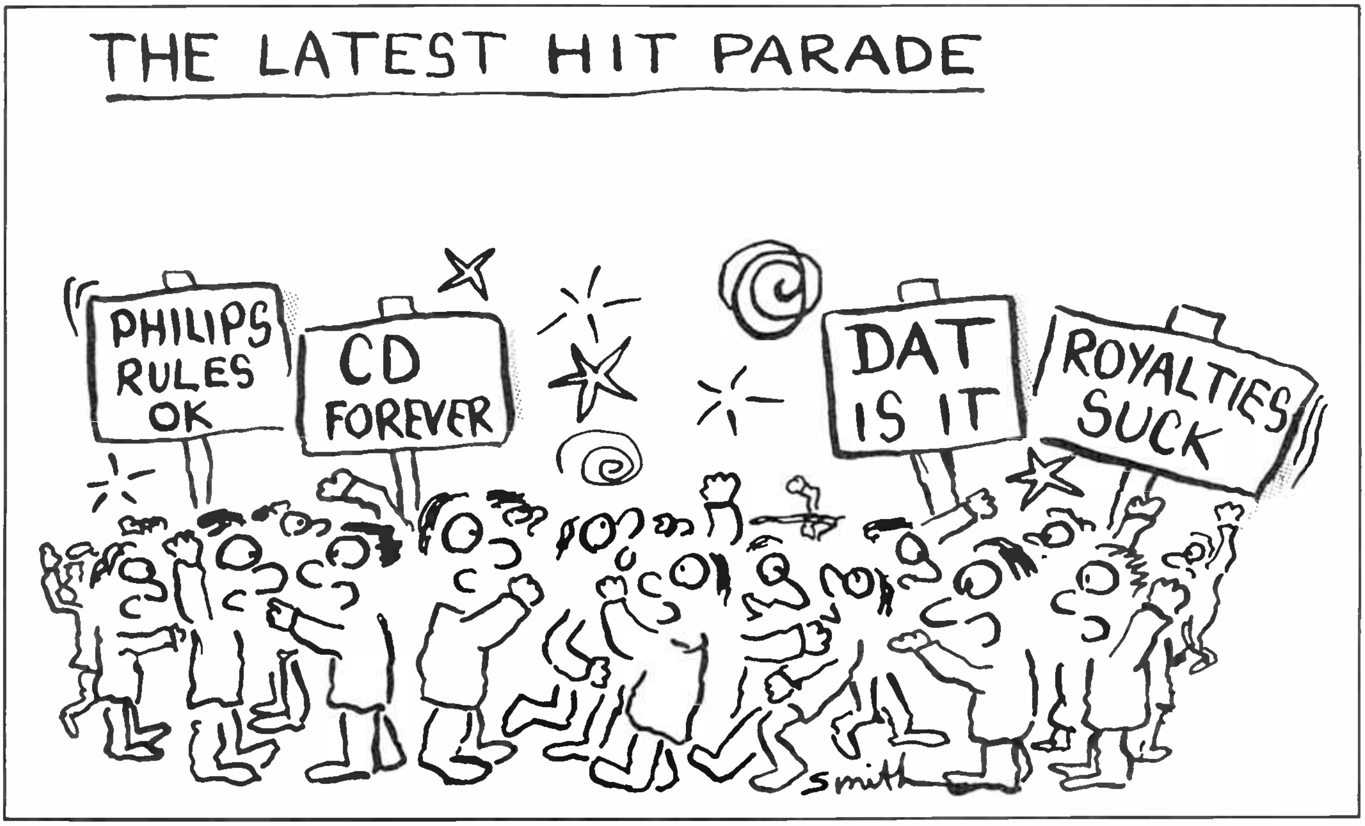
Meanwhile, Philips has signed a deal with DuPont to press ahead with CD-ROM for computers and electronic publishing. And Polygram will introduce two new price points for CDs, one at around $22, and later a budget label for around $16!

Why all this sudden activity? In a word — albeit an acronym — DAT.

Industry scared

Frankly, the industry is shit-scared of what the Japanese may do to this new technology CD as they crank up the promotional activities for DAT. To try and compare the two technologies is nonsense, of course. CD has more to offer than DAT, such as video pictures and random access, while the tape can only offer linear access.

Furthermore, the recording industry has said it will not allow its software on DAT, and, because of a standards agreement, you cannot record CD onto DAT digitally. The two have been made incompatible. If you want to transfer your favourite CD tracks onto DAT you can only do it via the analogue route. And if the consumer is really that keen on digital recording tape, why haven't they taken to the 8 mm (video) tape system which offers 18 hours of recording on one tape which is roughly the size of the current compact audio cassette? It may not be the technical equivalent, audio wise, of the new DAT but any ordinary audio enthusiast would be hard pressed to pick the difference.



Fighting back

So this year the Philips-led CD camp will be fighting back with actions rather than words, and several of the CD technologies that we have talked about will now be rushed into production to shore up the system.

For the last two years the demand for CD software has far outstripped supply and the result has been somewhat inflated prices. "It is the first opportunity we have had in 10 years to make money and we are going to make it," one international Polygram executive told me in the early days of CD.

The demand stayed ahead of supply, despite the fact that sales of discs and players virtually doubled each year for the last three years. Last year there were 112 000 players sold in Australia, and 2.2 million discs. This year, the industry conservatively predicting 150 000 players and three million discs.

Despite these VCR-style sales, CD has been losing ground in recent months. The glamour has slipped because of the high cost of software, and because of the DAT marketers' scare tatics. When a record is available on cassette or LP for around $12 it's hard to argue one should pay $28 for a compact disc.

Now unless the Philips/Sony-backed group can really crank up the marketing, the DAT seeds of doubt sown by the Japanese, who, if they get DAT up and running over CD will save billions of dollars in royalities to Philips, could win out. As was shown in the VCR war, the best system doesn't necessarily win at the end of the day. Consumer technological ignorance coupled to big advertising budgets is a powerful persuasive force.

The major string to the new CD bow will be CD-Video which the Polygram and laser proponents (Philips, Sony Yamaha, Pioneer, and Marantz) will launch this year. To be called a Maxi-single, this new disc will offer buyers five minutes of video clips, plus 20 minutes of music. It will be coloured gold to differ from the current silver audio CD. Furthermore, the 20 minutes of audio can be played on current CD players.

But to watch the video clip you will need a CD player with a digital output (usually up-market players offer this) and a new 'black box' to view the video output on your TV set. Ian Weathers of Philips says the black box will be called a 'video player' and will conform to a world standard. Although nobody can tell us how it works, we are told that the video clip will play on PAL, SECAM and NTSC TV sets.

Broaden the base

This CD Video Maxi-single will be aimed at the young market that has still to take to CD. They have been brought up on a diet of music video, thanks to the TV pop shows, and are primed for the new technology.

Says Polygram's Paul Dixon: "The idea is to broaden the base of CD as quickly as possible and the next obvious target is the young market that is the biggest buyer of records. "It will be to CD what the EP is to the LP in the vinyl record market."

Because of the size of the compact disc it is not possible to put more than five minutes of video on a CD. But if CD Video is successful, it could open the door to PAL Kombi players — that is, a player that will play both CD and Video discs. These are aleady sold in Japan and the USA. Then owners will need only one machine to play the 5" CD, 5" CD-Video, 8" Video disc, and 12" Video disc, all on the same machine.

Meanwhile, on another front we will see CD-ROM rushed through. This interacts with a home computer and can carry a complete encyclopaedia, and other educational programs. It is the first step in 'true' electronic publishing.

ERRATA MARCH '87 ISSUE.

A last-minute re-shuffle caused the parts list for the AEM3504 CAT Yaesu Interface to disappear beneath the pc board artwork! The parts list is reproduced here. Apologies for that.

On the AEM2505 components overlay, p.77, the label for capacitor C31, to the right of pin 9 of IC9, fell off the artwork it seems, so it appears unlabelled.

AEM3504 PARTS LIST

Semiconductors

IC1	4050
IC2	LM311
Q1	BC548

Resistors
all 0.25 W, 5% unless noted

R1	4k7
R2	33k
R3-R8	4k7
R9	120k
R10	1k
R11-R20	4k7
Rv1	10k vertical trimpot

Capacitors

C1	100n greencap
C2	10n greencap

Miscellaneous
AEM3504 pc board; aluminium instrument case to suit, about 125 x 40 x 65 mm, e.g.: Jaycar HB-5494; 5-pin DIN socket, chassis-mount type; 5-pin DIN plug, line type; connector to suit receiver; connectors to suit computer; bolts, nuts, washers and spacers, hookup wire.

Estimated cost: $20-$30
(depending on connectors)

PRIZE WINNERS!

Here are the happy winners of the major prizes in our last Birthday Contests, run over July-August-September last year.

The photographs here, taken from the top, show Michael Springett of S.A. receiving his Philips Australian-made stereo colour TV from Bryan Loftes (on the left), S.A. Manager for Philips Consumer Products.

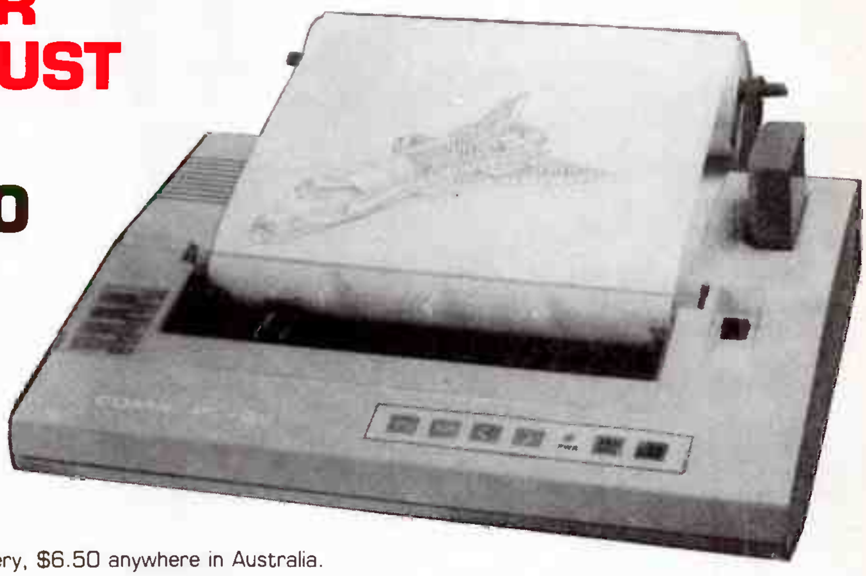
Bruno Celotto (on the left) of Victoria was presented with his PM 3055 dual-trace 50 MHz CRO by Graham Adams of Philips Scientific & Industrial, Victoria.

Cathy Foley was presented with her Multitech computer at Dick Smith Electronics' North Ryde NSW headquarters by Howard Needleman, Marketing manager of Dick Smith Electronics. Even the computer said congratulations!

Special AEM Reader Offer

A FOUR-COLOUR PLOTTER FOR JUST $399.00!

COMX PL-80



As an introductory offer for a limited period, the distributor of the COMX PL-80, Mike Boorne Electronics, is offering this remarkable machine to AEM readers at $100 under the recommended retail price!

That's right, a $499 plotter for only

$399.00! Delivery, $6.50 anywhere in Australia.

USER FRIENDLY AND ACCURATE

The PL-80 is designed to have both the printing and plotting modes selectable by the user, it can work as a plotter or a normal ASCII character printer with four basic colours: black, red, green and blue. The PL-80 plots up to 92mm per second with a resolution of 0.2mm per step. The friendly control panel can help you perform functions instantly even before looking into operational details of the user manual.

HIGH-LEVEL COMPATIBILITY WITH MOST SOFTWARE PACKAGES

The PL-80 has a standard built-in Centronics Parallel Interface. It is compatible with most micros including IBM PC series, Apple, Commodore, and many others. The PL-80 can easily operate on a handful of popular graphic packages such as AutoCAD, Lotus 1-2-3, Supercalc . . . etc. For the user who wants to write a program by himself, standard graphic and text command sets are provided.

COMPREHENSIVE USER MANUAL

The PL-80 users manual is designed for both hobbyists and professionals. It covers a great variety of graphic functions written in standard BASIC, so that you can tackle almost any graphic tasks required.

FILL OUT THE COUPON NOW AND RUSH IT TO:

COMX PLOTTER OFFER
Australian Electronics Monthly
PO Box 289, Wahroonga 2076 NSW

Please rush me . . . . . COMX PL-80 plotter(s), priced at $399.00, plus $6.50 for delivery.

TOTAL: $ . . . . .

I enclose payment by:

Money Order ☐ Cheque ☐ Visa ☐
Bankcard ☐ Mastercard ☐ American Express ☐

Credit Card No: . . . .

Expiry date: . . . .

Cheque or Money Order No: . . . .

[Please make cheques or Money Orders payable to 'Australian Electronics Monthly']

Name . . . .

Address . . . .

. . . . Postcode . . . .

Signature: . . . .

[Unsigned Credit Card orders cannot be accepted]
Please allow for normal postal and bank clearance delays

The PL-80 is no match for high-speed flat-bed plotters or the like. But the price is unmatched! The PL-80 performs most of the basic functions that only the flat-bed plotters can do. It can print on ordinary A4, letter size or foolscap paper and paper roll, as well as transparencies.

LOOK AT THESE FEATURES:

Plotting area	: 192mm x 13000mm
Paper size	: Cut sheet — 215.9mm x 279.4mm (letter size) 210.0mm x 300.0m (A4 size) Roll paper — 214mm width 50mm core dia. (max.)
Max. plotting speed	: 92mm/sec.
Step size	: 0.2mm
Pen types	: Ballpoint type (water soluble) OHP type (oil soluble)
No. of pens	: 4 (black, red, green, blue)
Panel Control	: Up, Down, Left, Right, Pen Select, On line
Indicators	: Power, On Line
Interface	: Centronics parallel interface
Power supply	: DC 10V/1.3A adaptor
Power consumption	: 10W typ.
Dimensions	: 320mm(W) x 234mm(D) x 56mm(H)
Weight	: Approx. 1.2Kg (without adaptor & accessories)

AutoCAD is a trademark of Autodesk, Inc.
SuperCalc 3 is a trademark of SORCIM Corp.
Lotus 1-2-3 is a trademark of Lotus Development Corp.

Apple II, IIe are trademarks of Apple Computer Inc.
IBM PC, PC XT are trademarks of International Business Machine Corp.
Commodore is a trademark of Commodore International.

OFFER CLOSES LAST MAIL 31 MAY 1987

XT/AT motherboards "with the lot"

Australian electronics manufacturer Pulsar Electronics has released two PC compatible motherboards claimed to have the highest on-board functionality and flexibility, and the greatest Australian content of any similar products.

The Pulsar PC/XT and Pulsar PC/AT motherboards have been designed for low power consumption, high speed operation, and to eliminate the need for additional function cards.

They have been totally designed, developed and manufactured in Australia with a total Australian content in excess of 40%. Systems built upon them can achieve Australian contents in excess of 70%, according to the manufacturers.

Each has EGA monochrome text and graphics, Hercules, CGA, EGA and Plantronics video standards on board, software selectable between modes, auto-detection of connected monitor types, 256K-bytes Dual Port Graphics RAM on board, and flicker-free scrolling in all modes.

Communications is equally well catered for with twin RS232 ports, one parallel Centronics port, one floppy controller port capable of reading disk formats from 360K to 2M, a games port for dual joysticks and a keyboard port.

Both systems are seen to be ideal as the heart of low-power industrial controllers, commercial stand-alone PCs, or as diskless workstations. Each has an on-board audio driver and battery-backed calendar-day-date real time clock.

The Pulsar PC/AT has an Intel 80286 processor running at software selectable 10 MHz and 5 MHz and 1M of 100ns dynamic RAM on board with no wait states. A socket is provided for a 10 MHz 80287 arithmetical processor.

The AT has three AT standard expansion slots and one XT standard expansion slot.

The Pulsar PC/XT has an Intel 8088-1 processor, with software selectable speeds of 4.77 MHz, 7.15 MHz, and 9.45 MHz, and a socket for the 10 MHz 8087-1 processor; on-board memory is 786K of dynamic RAM (100 ns) with no wait states.

Each board is available as 'board alone' or built-up, and is backed with a full 12 month guarantee. For further information, contact **John Rearden, Pulsar Electronics, Lot 21 Catalina Drive, Tullamarine Vic. (03) 330 2555**

Amiga User Assoc.

The Australian Amiga User Association was formed in 1986 by Commodore Amiga users to cater for the interests of owners of the new Amiga range of computers.

The aims of the Association are the interchange of knowledge on hardware, software, education, business and all related applications, so as to promote full and further development and use of the Amiga range of computer systems.

The Association has extensive connections with both Commodore and overseas Amiga user groups.

Open days are held periodically by the Association consisting of discussions on news, demonstrations/reviews of the latest in hardware and software, as well as talks and lectures on programming or many other Amiga related subjects, all held in the atmosphere of a social function for members and their families.

Association members are posted bi-monthly newsletters.

A 24-hour multi-mode (V21, 22, 23) bulletin board service is operated by the Association on (047) 58 8006 which is accessible to subscribing members with limited access to visitors. This BBS features full facilities for private and public messages, Association news and the exchange of public domain software.

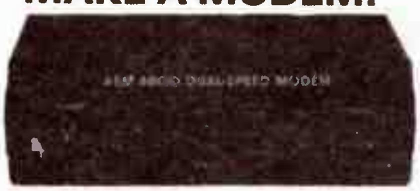
For further information or details on membership etc, please write to: **Australian Amiga User Association, C/- Post Office, Penrith 2750 NSW.** Alternatively, the Association can also be contacted via Viatel message page 473534880.

Illawarra BBS

John Simon, sysop of the Illawarra BBS, advises that their new phone number is (042) 61 8230. Although the system has only been running for approximately eighteen months, it has built up a good following in the Illawarra area.

The system runs 24 hrs a day on a Commodore C64 and two SFD1001 drives (with a third about to be added) and an Avtek auto-answer modem.

The IBBS caters for many types of computers not just the Commodore C64 as there is downloadable software for some six popular computers online for full access users. A fee of $15/annum to cover power, phone etc, is now charged.



Using your Amstrad CPC 464/664/6128 as a frequency meter

Peter Lukes

So you've got a computer! Why not put it to 'a good use'? Here's a simple little interface project and program that enables you to use your Amstrad as an audio frequency meter. Why not build it this weekend?

IF YOU'RE into electronics and have recently purchased a computer, no doubt, like many enthusiasts, you're looking for ways to combine the two interests. Likewise, if you're a computing enthusiast and have recently gained an interest in electronics, undoubtedly you're looking for electronic adjuncts to go with your computer. This project is an ideal place to start.

An often-useful item of test equipment to have around the home workshop or the science classroom (if you're a teacher!) is a digital frequency meter. But 'real ones' can be expensive — especially if they spend most of their time idle. In addition, one often only wants to measure signals at audio frequencies, and eight digit accuracy is unnecessary. A simple computer frequency counter interface unit and a program to suit the Apple // series computers, designed and written by Roger Graham, was published in the December '86 issue (Project 4506). This comprised a "squarer-upper" circuit employing an op-amp connected as a Schmitt trigger to change the waveform of the signal being measured into the sort of signal the computer can deal with. The approach is disarmingly simple, low in cost and the computer does most of the work.

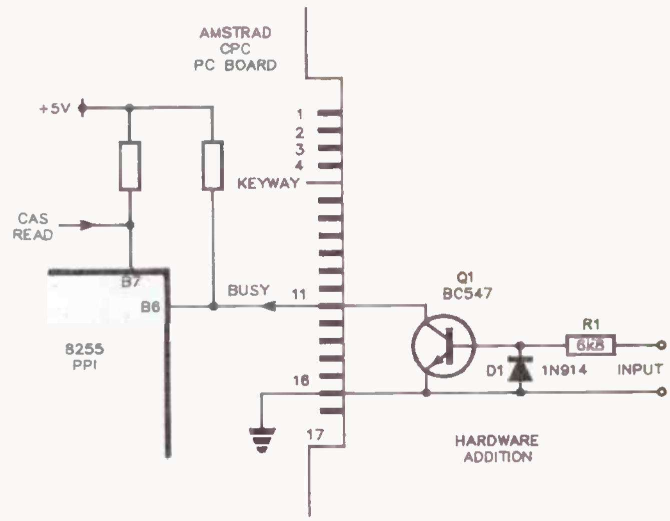
The interface circuit presented here takes advantage of the internal circuitry of the Amstrad CPC series computers.

The CPCs have two input/output ports which are readily accessible in software and require minimal hardware additions, if any, to make them usable. The first is the printer port, which can be used as a 1-bit input and 8-bit output port. The second is the tape port, with 1-bit input and output. On my very early 464, I have used both as serial ports, driving a serial printer and reading/writing tapes in the Kansas City format (as used on the Microbee). The circuitry in the 664 and 6128 are identical, so this interface and program should work with them, too.

The interface

The interface and software employ the printer port, using the 'BUSY' line as a 1-bit input. The CPCs employ an 8255 'parallel peripheral interface' (PPI) chip, the inputs of which are 'pulled' high by a resistor. Any input from the 'outside world' must be *active-low* and pull down the input line.

The circuit presented here employs a transistor as a switch. The transistor's collector-emitter junction switches the printer port's 'busy' line, the port B/line 6 (hence, B6) line of the 8255 PPI. The incoming signal is 'clipped' into pulses by the diode and the base-emitter junction of the transistor. Simple, and effective.



Counting

For those who like reading software listings, the program works as follows: The software 'reads' the line every 22 microseconds, which allows coverage of the audio frequency range beyond 20 kHz, for a period of quarter of a second. The count is then multiplied by four and displayed on the screen. The routine runs until the ESC key is pressed twice in succession.

The count is kept in register HL of the Z80 by adding the CARRY flag to it on every pass. The flag is set by comparing the current and previous states of the port: the flag is set when the port bit changes from ON to OFF, otherwise it is reset. The port is accessed by the IN r, (C) instruction: the address must be in register B; the value in C is immaterial and is not changed by the instruction.

Timing is obviously critical. The firmware manual states that each machine cycle is stretched to a multiple of 4T cycles: in working out the timings, I took instructions such as ▶

```
10 PRINT"AMSTRAD CPC as Audio Frequency Counter. LKS 870109"
20 PRINT"Uses port B of the 8255 PPI: bit 6 PRINTER BUSY, bit 7 CAS READ"
30 PRINT"P.LUKES, 26 Noll St., TOOWOOMBA, Q 4350"
40 DIM freq%(58)' Store for routine: must be integer
50 x$="LO:  di  ld hl,0000: disable interrupts, clear counter":DATA f3, 21,00,00
60 x$="ld de,passes (1/4 sec)":DATA 11,64,2c
70 x$="ld b,f5: port address":DATA 06,f5
80 x$="in a,(c): read port":DATA ed,78
90 x$="and 40: bit mask: 40 for bit 6, 80 for 7":DATA e6,40
100 x$="ld c,a: initial state of port":DATA 4f
110 x$="L1: in a,(c)":DATA ed,78
120 x$="and 40: see above":DATA e6,40
130 x$="cp c: CARRY set on change from 'on' to 'off'":DATA b9
140 x$="ld c,a: save":DATA 4f
150 x$="ld a,0  adc a,l  ld l,a":DATA 3e,00, 8d, 6f
160 x$="ld a,0  adc a,h  ld h,a":DATA 3e,00, 8c, 67
170 x$="dec de  ld a,d  or e":DATA 1b, 7a, b3
180 x$="jr nz, L1":DATA 20,ed
190 x$="ex de,hl: save count":DATA eb
200 x$="ld h,7 ld l,9 call txt_set_cursor:locate 7,9":DATA 26,07,2e,09,cd,75,bb
210 x$="ex de,hl: recover count":DATA eb
220 x$="add hl,hl  add hl,hl: count*4":DATA 29,29
230 x$="ld bc,1e4d  xor a: divide by 10000d":DATA 01,10,27, af
240 x$="L2: sbc hl,bc":DATA ed,42
250 x$="inc a  jr nc,L2  add hl,bc":DATA 3c, 30,fb, 09
260 x$="add a,2f: convert to ASCII digit":DATA c6,2f
270 x$="call txt_output":DATA cd,5a,bb
280 x$="/ 1000d":DATA 01,e8,03, af, ed,42, 3c, 30,fb, 09, c6,2f, cd,5a,bb
290 x$="/  100d":DATA 01,64,00, af, ed,42, 3c, 30,fb, 09, c6,2f, cd,5a,bb
300 x$="/   10d":DATA 01,0a,00, af, ed,42, 3c, 30,fb, 09, c6,2f, cd,5a,bb
310 x$="ld a,l  add a,30  call txt_output: units":DATA 7d, c6,30, cd,5a,bb
320 x$="ld a,42  call km_test_key : test for ESC":DATA 3e,42, cd,1e,bb
330 x$="jr z,LO  ret : continue if not pressed, else return":DATA 28,8b, c9
340 FOR a=0 TO 58:READ x$,y$:PRINT SPC(2)x$ SPC(2)y$;
350 freq%(a)=VAL("&"+y$+x$):NEXT a
360 PRINT:INPUT"Press ENTER to start. Press ESC to exit",a
370 ' Cassette port may require CALL &bc6e to turn on relay, CALL &bc71 to turn
it off
380 MODE 0:LOCATE 3,6:PRINT"Frequency (Hz)"
390 CALL @freq%(0)
```

Using the Microbee in your amateur station

G.J. Wilson.

1) Producing a log

RECENTLY I wrote a long BASIC program to produce an Amateur Radio log. It is designed for use with a 32K Microbee and printer. While the entire program (approximately 30K) is too large to reproduce here, some of the ideas used may be of interest to others contemplating something along similar lines.

There appears to have been very little material published for the Microbee specifically related to Amateur Radio applications. If programs are being written, the authors seem reluctant to share their work with other hams. This is a great pity as the 'Bee can be quite a useful addition to any shack, in a number of areas, given suitable software to drive it.

The outline below describes a simplified version of the original program, the full version also includes provision for contest operation which adds greatly to the overall complexity.

The log is printed on continuous-form sheets. At the top of each page a heading gives the station callsign and page number. Below this a column heading indicates: QSO No.; Date: Time UTC; Callsign; Frequency, MHz; 2× Mode; Report sent; Report received; QSL sent; QSL received; Name & QTH of operator worked and/or Remarks.

To list all this information on a single line requires the use of condensed printing rather than the normal pica size. The number of lines per page is optional but about fifty (plus the page heading) can be printed on a standard 8.25″ × 11″ sheet. The lines are counted as they are printed until the preset limit is reached, after which the current page is rulled off prior to commencing the next one. A margin is placed on one side of the page so that the sheets may be punched and filed using a ring binder or simlar system.

Data is called-for sequentially for each column of each line of the log. The number of modes is deliberately limited to CW, FM and SSB to keep things as simple as possible, although others could easily be added if needed.

The input is arranged to accept numerous variations such as "C", "c", "CW" or "cw" for CW. Unless input data is received which fits the criteria selected for the program, the question is asked again until a suitable answer is supplied.

For signal reports, if "9" is entered the printout will be either "5×9" or "599" depending upon the mode in use. Other report variations will print as entered.

The answer to QSL (S or R) may be "Y". "y". "-", "N" or "n". Any of these options will be accepted as valid.

Within certain limits, the input data can be fairly crude yet still produce the full detail needed.

To prevent errors being printed, each entry is presented on the video display as it is typed in and the entire data for ▶

LISTING

```
00001 REM SIMPLE LOG PRINTING PROGRAM FOR MICROBEE AND EPSON RX-80.
COPYRIGHT G.J.WILSON 1987.
00010 GOSUB 70: PRINT CHR$(27);"@";: PRINT CHR$(27);"G";: GOSUB 80: A0$=KEY: A1=
0: A2=0: A3=0: A4=0: B1$=KEY: B2$=KEY: B3$=KEY: B4$=KEY: B5$=KEY: C0$=KEY: GOTO
190
00020 REM IF STARTING PART WAY DOWN A PAGE, INITIALIZE YOUR PRINTER AT THE TOP E
DGE OF THE PAGE AND ADVANCE THE PAPER TO THE DESIRED STARTING POINT USING THE LI
NE FEED BUTTON.
00030 REM FAILURE TO FOLLOW THIS PROCEDURE WILL FORCE A FORM FEED FOR ONE PAGE L
ENGTH AFTER THE END OF THE PARTIAL PAGE TO THE START OF THE NEXT PAGE.
00040 REM THE NEW STARTING POINT WILL THEN BE UNRELATED TO THE TOP OF THE NEW PA
GE AND ALL SUBSEQUENT PAGES WILL BE OFFSET.
00050 REM TO OPERATE WITHOUT PRINTER PLACE "CLS: RETURN: REM " AT START OF LINE
70.
00060 PLAY 24; 0; 24: RETURN
00070 OUT#0 OFF: CLS: OUT#1 ON: RETURN
00080 OUT#1 OFF: CLS: OUT#0 ON: RETURN
00090 GOSUB 70: PRINT CHR$(15);: GOSUB 80: RETURN
00100 PRINT "  -------------------------------------------------------------------
---- -----------------------------------------------------": RETURN
00110 PRINT: PRINT "  ===========================================================
=============================================================": A4=1: RETURN
00120 GOSUB 70: IF A4=0 THEN 140
00130 PRINT CHR$(12);
00140 PRINT CHR$(27);"E";: PRINT CHR$(27);"4";
00150 PRINT " LOG OF AMATEUR RADIO STATION: VK0AAA                    Page No." A
1: PRINT
00160 PRINT CHR$(27);"5";: PRINT CHR$(27);"F";: GOSUB 80
00170 GOSUB 90: GOSUB 70: GOSUB 100: PRINT "  QSO No.!   Date   !Time UTC!  Call
sign  !Freq. MHz.! 2x Mode : Rpt. S. : Rpt. R. !QSL S.!QSL R.! Name  &  QTH / Re
marks": GOSUB 100
00180 GOSUB 80: RETURN
00190 CLS: CURS 1,8: INPUT "ARE YOU STARTING A NEW PAGE ? ( Y / N )",A0$
00200 IF A0$="Y" OR A0$="y" THEN LET A0$="Y": GOTO 240
00210 IF A0$="N" OR A0$="n" THEN GOSUB 90: GOTO 220 ELSE GOSUB 60: GOTO 190
00220 CLS: CURS 1,8: INPUT "WHAT IS THE CURRENT PAGE NUMBER ?",A1
00230 CLS: CURS 1,8: INPUT "HOW MANY ENTRIES ARE THERE ON THE CURRENT PAGE ?",A2
: IF A2=>50 THEN GOSUB 60: GOTO 10 ELSE GOTO 250
00240 CLS: CURS 1,8: INPUT "WHAT IS THE NEXT PAGE NUMBER ?",A1
00250 CLS: CURS 1,8: INPUT "WHAT IS THE NEXT QSO NUMBER ?",A3
00260 IF A0$="Y" THEN GOSUB 120
00270 CLS: CURS 1,1: UNDERLINE: PRINT "LOG OF AMATEUR RADIO STATION: VK0AAA
      PAGE No." A1: NORMAL: CURS 1,3: PRINT "QSO No.": CURS 1,4: PRINT A3
00280 CURS 16,3: INPUT "DATE OF QSO ?:",A5$: CURS 28,3: PRINT " "
00290 IF A5$="" THEN CURS 30,3: PRINT [A9 32]: GOSUB 60: GOTO 280 ELSE CURS 31,3
: PRINT A5$
00300 CURS 16,4: INPUT "TIME U.T.C. ?:",A6$: CURS 28,4: PRINT " "
00310 IF A6$="" THEN CURS 30.4: PRINT [A9 32]: GOSUB 60: GOTO 300 ELSE CURS 31,4
: PRINT A6$
00320 CURS 16,5: INPUT "CALLSIGN    ?:",A7$: CURS 28,5: PRINT " "
00330 IF A7$="" THEN CURS 30,5: PRINT [A9 32]: GOSUB 60: GOTO 320 ELSE CURS 31,5
: PRINT A7$
00340 CURS 16,6: INPUT "FREQ. MHz.  ?:",B0$: CURS 28,6: PRINT " "
00350 IF B0$="" THEN CURS 30,6: PRINT [A9 32]: GOSUB 60: GOTO 340 ELSE CURS 31,6
: PRINT B0$
00360 CURS 16,7: INPUT "2x MODE     ?:",B1$: CURS 28,7: PRINT " "
00370 IF B1$="C" OR B1$="CW" OR B1$="c" OR B1$="cw" THEN LET B1$="CW": GOTO 400
00380 IF B1$="F" OR B1$="FM" OR B1$="f" OR B1$="fm" THEN LET B1$="FM": GOTO 400
00390 IF B1$="S" OR B1$="SSB" OR B1$="s" OR B1$="ssb" THEN LET B1$="SSB"
00400 CURS 31,7: PRINT [A9 32]: IF B1$="CW" OR B1$="FM" OR B1$="SSB" THEN CURS 3
1,7: PRINT B1$: GOTO 410 ELSE GOSUB 60: GOTO 360
00410 CURS 16,8: INPUT "REPORT SENT ?:",B2$: CURS 28,8: PRINT " "
00420 IF B1$=CW THEN 430 ELSE 440
00430 IF B2$="9" THEN LET B2$="599": GOTO 450 ELSE 450
00440 IF B2$="9" THEN LET B2$="5x9"
00450 IF B2$="" THEN CURS 30,8: PRINT [A9 32]: GOSUB 60: GOTO 410 ELSE CURS 31,8
: PRINT B2$
00460 CURS 16,9: INPUT "REPORT REC. ?:",B3$: CURS 28,9: PRINT " "
00470 IF B1$=CW THEN 480 ELSE 490
00480 IF B3$="9" THEN LET B3$="599": GOTO 500 ELSE 500
00490 IF B3$="9" THEN LET B3$="5x9"
00500 IF B3$="" THEN CURS 30,9: PRINT [A9 32]: GOSUB 60: GOTO 460 ELSE CURS 31,9
: PRINT B3$
00510 CURS 16,10: INPUT "QSL S. Y/N  ?:",B4$: CURS 28,10: PRINT " "
00520 IF B4$="Y" OR B4$="y" THEN LET B4$="Y": GOTO 550
00530 IF B4$="N" OR B4$="n" THEN LET B4$="N": GOTO 550
00540 IF B4$="." THEN 550 ELSE CURS 30,10: PRINT [A9 32]: GOSUB 60: GOTO 510
00550 CURS 31,10: PRINT B4$
00560 CURS 16,11: INPUT "QSL R. Y/N  ?:",B5$: CURS 28,11: PRINT " "
00570 IF B5$="Y" OR B5$="y" THEN LET B5$="Y": GOTO 600
00580 IF B5$="N" OR B5$="n" THEN LET B5$="N": GOTO 600
00590 IF B5$="." THEN 600 ELSE CURS 30,11: PRINT [A9 32]: GOSUB 60: GOTO 560
00600 CURS 31,11: PRINT B5$
00610 CURS 16,12: INPUT "NAME        ?:",B6$: CURS 28,12: PRINT " "
00620 IF B6$="" THEN CURS 30,12: PRINT [A9 32]: GOSUB 60: GOTO 610
00630 CURS 16,13: INPUT "QTH / REM.  ?:",B7$: CURS 28,13: PRINT " "
00640 IF B7$="" THEN CURS 30,13: PRINT [A9 32]: GOSUB 60: GOTO 630
00650 CURS 1,14: UNDERLINE: PRINT "
                  ": NORMAL
00660 CURS 49,3: PRINT "To ENTER press": CURS 52,4: PRINT "[RETURN]"
00670 CURS 49,6: PRINT "To ERASE press": CURS 52,7: PRINT "[E] then": CURS52,8:
PRINT "[RETURN]": CURS 54,10: INPUT ":",C0$
00680 IF C0$="E" OR C0$="e" THEN 270 ELSE GOSUB 70
00690 PRINT TAB (2) A3 TAB (11) A5$ TAB (24) A6$ TAB (33) A7$ TAB (45) B0$ TAB (
58) B1$ TAB (68) B2$ TAB (78) B3$ TAB (87) B4$ TAB (94) B5$ TAB (99) B6$ TAB (10
9) B7$
00700 GOSUB 80: A2=A2+1: A3=A3+1: IF A2=50 THEN LET A1=A1+1: A2=0: GOSUB 70: GOS
UB 110: GOSUB 120: GOSUB 80: GOTO 270 ELSE 270
```

LOG OF AMATEUR RADIO STATION: VK0AAA *Page No. 500.*

QSO No.	Date	Time UTC	Callsign	Freq. MHz.	2x Mode	Rpt. S.	Rpt. R.	QSL S.	QSL R.	Name	& QTH / Remarks
25000.	01.02.1987	0645	VP8BLQ	14.220	SSB	5x8	5x7	Y	.	Harry	Falkland Is.
25001.	02.02.1987	0923	KA2IJ	14.253	SSB	5x9	5x9	Y	.	Joe	Ogasawara
25049.	05.02.1987	0748	A61AB	14.189	SSB	5x6	5x7	Y	.	Khalid	Abu Dhabi

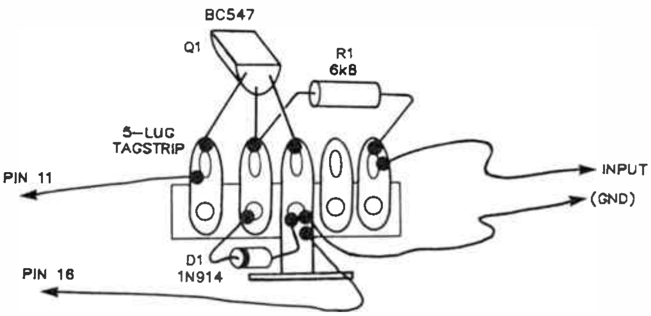
each line is shown when complete, prior to printing. If an error is found the entry can be erased by typing "E" or "e" as shown, then rewritten before proceeding further. Unless a mistake is overlooked it should not reach the printing stage using this system.

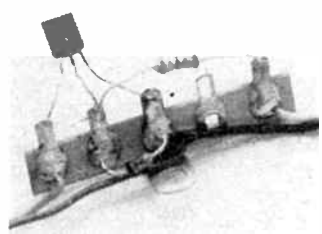
QSO numbers increment by one with each entry and page numbers increment by one after each fifty entries. The log can be commenced at any desired QSO or page number.

The end result is a very neat log produced by what is virtually an electric typewriter with correction facilities.

The listing must be copied exactly as given if the program is to work successfully. The original program was written for use with a 32K Microbee and an Epson RX-80. Other equipment may require some program modifications.

aem project 4507





AEM4507 PARTS LIST

Semiconductors
D1 .... 1N914
Q1 .... BC547

Resistors 0.25 W, 5%
R1 .... 6k8

Miscellaneous
1 × 5-lug tagstrip; small jiffy box (if required); bolt and nut or screw; hookup wire.

Estimated cost:
$15.00-$20.00
(depending on connectors)

DEC DE as 8T, instead of 6T as given in the specifications. The results were reasonable when tested against an ancient valve AF generator, but I cannot claim that the program was calibrated. It can be calibrated by adjusting the number of times the loop is executed, varying the value in register DE.

The machine-language part of the program is stored in an integer array. This is a convenient way of including m/l with BASIC, provided the routing is re-locatable. However, note how the data is stored: it appears and is read as X Y, is converted into hex as Y X, but the operating system stores it in the integer element as X Y, in the correct order.

Construction

The circuit is really too trivial for a printed circuit board, but it's ideal for construction on a small 5-lug tagstrip. The accompanying diagram shows the general arrangement.

The assembly may be mounted in a small jiffy box with suitable connectors bolted in either end. Or you could mount it on a small square of chipboard, screwing the tagstrip down. If mounting the unit in a jiffy box, it's best to solder the components to the tagstrip before mounting the assembly in the box.

Take care with the orientation of the diode and the transistor when assembling the components. If you get either or both the wrong way round, the unit will not work.

The input and ground (GND) leads are long, 'flying' leads with test hooks or alligator clips in the business end of each. The leads should be twisted together for most of their length so as not to pick up stray hum fields which may interfere with the operation of the interface.

You will need to get a 34-way edge connector for the CPC's printer port as it is not advisable to solder directly to the board!

Getting on line

DURING the last month I have been dabbling in the 'mystical' world of data communications with my PCW and while my efforts focus on that machine, the majority of the column also applies to the CPC series and the PC 1512.

The items you will need to purchase to enable you to enter the data communications age are listed as follows:

(a) The Amstrad CPS8256, a combined Centronics parallel and RS232C serial interface that plugs into the 50-way edge connectors at the rear of the PCW. For the CPC series you will need the RS232C serial interface, while for the PC, the RS232C interface is built-in.

(b) A modem. Mitsubishi Electric AWA supply an Avtek Minimodem which is compatible and very easy to use. I am trying to find an intelligent modem for those that would prefer to use one. I hope to report on that in a later issue.

(c) Most importantly, you will require some form of communications software so that your computer will be able to interpret the information being received from the modem and the computer you're "talking" to understands what your computer is transmitting.

MAIL232 for the PCW is a basic, but effective, communications program. The important thing with MAIL232 is to set your Serial Input/Output (SI/O) parameters everytime you use it. The reason being that on initial loading of the program, the transmit/receive baud rates are set to 9600 bps.

The manual provided with the CPS8256 gives clear instructions for the use of MAIL232 for all types of data transfer, except viewdata systems (Viatel). There are also descriptions to enable the redirection of printer output to either the serial or the parallel output ports.

The RS232C interface for the CPCs includes ROM software for a simple text terminal, a full-colour Viatel emulator, software selection of baud rate, number of bits, parity, etc. Also, commands are present for the redirection of printer output to the RS232C. The manual included descriptions for the use of the interface in BASIC and CP/M complete with examples and descriptions of the 32 extrernal commands which support the above-mentioned functions.

I am led to believe that the PC1512 will support an internal modem allowing access to a wealth of public domain software written specifically for MS-DOS (PC-DOS) computers (e.g. Pro-Comm, probably the best of the lot. — Ed.)

Whilst doing the research for this month's column, I made contact with several bulletin boards. The more notable of them being the OMEN RTRS and PROPHET RBBS. Also, I contacted several of the FIDOnet-type boards.

Take care when you contact a bulletin board. Don't abuse the services offered by them or they may discontinue visitor access. One BBS I contacted was cluttered with aimless garbage through people abusing the freedom of access offered.

If you download programs or data, be aware that it would help other users if you upload programs to pay in kind for what you use. If problems arise with what you download and you debug it for an Amstrad, put the modified version back in the public domain to help your fellow Amstradders.

If anybody has a version of Xmodem, modem7 or Kermit for any of the Amstrads I'd appreciate a copy so I can give it wider dissemenation through the column.

On loan to me from Mitsubishi Electric AWA was a copy of Sage Soft's Chit-Chat program that enables PCW owners to use Viatel. The program has extensive capabilities apart from Viatel. There are useful functions like the phone directory; this includes a page and a quarter of English bulletin boards, electronic mail services, PRESTEL (the mother of Viatel) and their respective telephone numbers. Not a lot of use to us down under.

A list of current bulletin boards is available from PROPHET AED on (02) 628 5222.

With the 'phone directory, when you add an entry the configuration required to use the new BBS, Viewdata service or Electronic mail system is also entered and the software handles configuration of the RS232C interface, making communications just that little bit easier.

Chit-Chat can also be configured to work with an intelligent modem, you can configure the software to work with Hayes standard commands and a variety of British-made modems. It also handles auto-logon and password transmission to the source terminal.

Available at any time is HELP for the page you are using. It is generally helpful, but at times can be vague. The draw back I found was with downloading files it does not provide any of the now standard protocols for this purpose. Neither does MAIL232.

I have had enquiries from Amstrad users with a view to establishing a bulletin board system. I'd like to hear from more readers and/or groups on this matter. (Write to 'Amstradder', AEM, PO Box 289, Wahroonga 2076 NSW).

News some of you may already be aware of is that there are now 10 and 20 megabyte hard disks available in the UK for the PCWs. I am trying to locate an Australian distributor for them and will make the details available as soon as they come to hand.

I would like to hear from all the Amstrad user groups throughout Australia so that I can put new converts in safe hands.

Supermodem and V.22 update

A VERSION 7 ROM for the AEM4610 Supermodem has been released, containing several minor changes. As before, the update costs $20 (plus postage and return of the old EPROM) and is available from Maestro Distributors (see the end of this column for location). The seven changes are detailed below:-

1. The + + + (Return from On-line mode to Command Mode) instruction has been made user-definable. Register S2 holds the decimal value for the character (e.g: decimal 43 for the "+" character, decimal 37 for the '%" character etc.)
2. Modem Parity Selection. The manner in which the Supermodem sets the parity has been modified. In the Command Mode, the Supermodem will always follow the parity setting of the host computer. In the On-line Mode, the Supermodem defaults to 8 data bits with no parity. The reason for this is to accommodate some rather unusual BBSs and modem programs (YAM is an example of this).
3. Ring Detect — The manner in which the Supermodem detected a Ring Tone on a remote system was unreliable, due to the "funny" ring tones of some PABXs. This has been corrected.
4. The MAESTRO> prompt that was returned by the Supermodem when returning from the Data Link to the Command Mode was giving problems when used on the MAC with RED RYDER V1.0 as the comms package. There is no prompt now when returning from the Data Link to the Command Mode.
5. The manner in which the Supermodem operates on Register S10 (Disconnect on Loss of Carrier) has been modified. A value of 1 in this register now produces the shortest possible delay (in the order of milliseconds). All other values remain unchanged. Some noisy 'phone lines were giving problems with disconnect after the carrier dropped out.
6. The Break Key is now supported. Register S9 (a bit-mapped register) has Bit 1 dedicated to break key support. If this bit is set (a value of 2) then the break is supported. If the bit is not set (any decimal number providing a zero in bit 1 — e.g: 0, 1, 4, 5) then break is not supported. The latter setting is the default.
7. The V.22 section has a test sequence for the telephone line, to determine the signal-to-noise ratio. This was done in order to make the Supermodem less fussy about the quality of the line being used. This however, does bring about some comms problems, in that file transfers may require large amounts of re-transmission, or that comms may be interspersed with random "garbage". The sign that a 'phone line is either good or bad can be visually determined by watching the characters that the Supermodem uses as the test sequence. If the characters are consistent (all the same e.g: all "u"s or all spaces), then the 'phone line is good. If the characters are interspersed with random garbage, then either the 'phone line is suspect, or the remote system is using some weird "handshaking" protocol. Some BBS systems have been known to produce this form of "random garbage" as they establish the handshaking at either end. In the event of a suspect 'phone line, I usually hang up and try again.

General communications

The topic for general discussion this month is multiplexing. Whilst the use of multiplexers is usually confined to business applications, a number of BBSs are using multiplexers to improve user throughput. Very simply put, a multiplexer is a device for allowing a single communication line to handle a number of terminals/modems, whilst remaining totally transparent in operation.

There are two main transmission methods which the multiplexer uses to accomplish its task, frequency division multiplexing (FDM) and time division multiplexing (TDM). The latter method of operation is by far the most popular and will be discussed first. The main feature of TDM is the merging of several low speed comms channels into a single high speed channel. This means, of course, that the multiplexer MUST be connected to a high speed modem and that the communication line (internal PABX or external Telecom line) must be capable of supporting the high speed transmission.

A typical example of TDM would be the merging of four 300 bps lines into a single 1200 bps line, or eight 300 bps lines into a single 2400 bps line. The TDM takes a single character in turn from each terminal/modem and transmits that character, followed by one from the next in line, until each modem/terminal has had one character assembled into the transmit cycle. At the receiving end, a TDM de-multiplexer can be used, or, alternatively, the merged data stream can ▶

be fed directly into the computer and software may be used to extract the individual characters and re-assemble the data stream. In all but the simplest of cases, it is usually more cost effective to use hardware rather than software for the re-assembly process. Like modems, multiplexers come in 57 varieties, ranging from the very simple, (handling only asynchronous transmission) to the very complex (read costly), which simultaneously handle both synchronous and asynchronous transmission.

FDM is usually used in conjunction with public telephone lines which have been dedicated as data lines (and as such must be separately leased from Telecom). Each modem/terminal to be connected to this line is assigned a unique frequency band and then the multiplexer transmits all of the information simultaneously over the 'phone line. At the receiving end, the de-multiplexer filters out each separate frequency band and passes the individual data streams to the computer for processing. The necessity of having a leased line should be fairly self-evident. If we have eight terminals communicating via an FDM multiplexer, there must be eight different frequency bands allocated to the one 'phone line, which must be capable of handling all eight lines simultaneously, without permitting "crosstalk" (signal from one channel leaking into another) to occur. This places quite a strain on voice grade lines and consequently a leased data line becomes necessary.

In all of the above cases, the receiving computer must have:

(a) The processing speed;
(b) the high speed I/O channels;
(c) suitable multi-tasking software.

to handle the separate streams of data arriving at its input ports.

Letters

Most of the letters we received this month were on the topic of the Novix Forth chip and the proposal to build a computer based on this chip. **Dr Webster** of Tamworth, N.S.W. and **Mike Dixon** of Stratford, Victoria have indicated their interest and the Darling brothers have started roughing out some initial designs. The board would probably be designed as a stand-alone unit, with a high speed serial port to enable it to be driven from a terminal/computer. Because of its high speed, off-line mass storage would have to be an integral part of the project (3.5" floppy drives with 720k of storage seem to be the ideal form). One US company, Silicon Composers (1), already has a board available for plugging into the IBM PC. Their PC4000 board contains the Novix NC4000 with a 4 MHz clock and produces speeds of four to five MIPS (million instructions per second). This is a fair downgrade of the performance specs of the NC4000, which is already capable of operating at 6 MHz and 9 MHz versions are in production. A C compiler for the board is already available and Prolog and BASIC compilers are in the works. LISP and LOGO also have been mentioned as possible compilers for it. This is one very powerful board.

Another letter from **David Stafford** of Balaclava, Victoria, mentioned problems of using the Supermodem with comms packages on the Microbee. It is possible that David is not using the correct dialling string (don't forget that capital letters must be used for the AT command) or possibly, the string is not being terminated with a carriage return. Another possibility is the need to make a hardware patch to the serial cable as follows, details courtesy of Jamye Harrison.

The patch is best effected on the RS232 connector, on the inside of the modem. Connect pins 8 and 20 together and disconnect pin 22. If using TELCOM, make sure the ECHO is OFF.

In my column next month, I hope to commence a series of articles dealing with the various communications protocols, starting with a summary of error checking procedures and then continuing with the ever popular XMODEM protocol developed by Ward Christensen. I will also mention one of the latest stages in the push for parallel processing.

REFERENCES

1) *Electronics*, Jan. 8, 1987, pp 32-33 (published by McGraw-Hill).

Maestro distributors are located at: Calool St, South Kincumber NSW.

Making the most of your C64

Part 2 Ian Jellings

Part 1 (Jan. '87) introduced a handy routine, dubbed 'DATAPOKE'. In this part, as promised, Ian explains assembly language listings and their mysteries, but the foreshadowed disk interface program has been deferred to Part 3 owing to space limitations.

ASSEMBLY LISTINGS look very complex to the uninititated, but they are really quite easy to understand. If you look at the sample listing elsewhere on these pages, you will see a small program assembled at address 828 (cassette buffer) which changes the colour of the screen and the colour of the background without changing any of the processor's registers. If you are learning, or interested in learning about, assembly language programming, this is the way to start. It saves on gallons of midnight oil. Anyhow, down to business.

Fields

A listing is arranged in a number of fields. I will use line 50 to explain what the different fields mean.

Field 1 is the instruction address. This is the hexadecimal (remember?) address at which the machine code is stored.

Field 2 are the hexadecimal (there's that word again) values of the actual machine code.

If we had DATAPOKE, and a printout of fields 1 and 2, would we have sufficient information?

Keep reading!

Field 3 is the line number field. This is completely ignored by the 'ASSEMBLER' and is only for the benefit of the programmer. (How else would you tell your text editor that you would like it to list a certain line in your program . . . 'LIST SOMETHING' perhaps ?).

Field 4 is the 'LABEL' field. A label in assembly language programming performs the same (well almost the same) function as a line number in BASIC.
In BASIC we can say:

GOSUB 1000

But without extra programs we cannot say:

GOSUB WHATJEMECALLITS

In assembly language we can say

JSR WHATJEMECALLITS

Where JSR and GOSUB are essentially the same function! But we cannot say:

JSR 1000

if we mean it to go to line number 1000. We can, however, tell the assembler to go to:

JSR LINE1000

Where LINE1000 is a label!
To illustrate:

```
1230          JSR LINE1000

1240          RTS                    ;return

1250;

1260 LINE1000

1270;

1280          LDA #L,$0300

1290          STA $1022

1300          RTS
```

This is a very useful way of translating a BASIC program into an assembly language file! Provided you retain your BASIC listing, you can easily trace which part of the program does what.

Field 5 contains two kinds of information which are:

1) Pseudo OPs

2) Assembly language instructions

Pseudo OPs. In our demonstration program the following are Pseudo OPs:

.BA .OS .BY .DE and .EN

We will not go into the meaning of these as this is not meant to be a tutorial on assembly language programming. Pseudo OPs give instructions to the assembler (tell the assembler what to do).

Assembly language instructions are the 'working' statements of the code. This is the actual language which generates the code. Here you will find the statements which make up your program. It is really an English translation of the numbers in Field 2! ▶

BASIC LISTING
(Requires DATAPOKE program)

```
10 X=X+1:IF(X<2)AND(PEEK(49152)+PEEK(49153)<>285)THENLOAD"DATAPOKE.BIN",8,1
20 SYS49152,1
9000 DATA@1,800009800980C3C2CD3830A2008E16D020A3FD18A2FFA07F208DFD2015FD205BFF20
9002 DATA@1,802053E420BFE3A2FB9AAD8A0209808D8A02A9008D06858D07858D04858D0585A993
9004 DATA@1,804020D2FFA90E20D2FFA000A90C8D20D08D21D0A9068D86029900D89900D99900DA
9006 DATA@1,806099E8DAC8D0F1A000B94A84F00620D2FFC8D0F5A2FB9A206B82201F83AD00CFC9
9008 DATA@1,80805DF0034C6483A001B900CF8D0685C957F028C947F024C952F020C958F00BC923
9010 DATA@1,80A0F018C940F0144C648320A383A2FB9AA2008D00022042A66C02A0203C83AD0685
9012 DATA@1,80C0C957F00FC952F00EC923F00DC940F00C4C91814C47814CBD814C07814CDF8020
9014 DATA@1,80E05482A6B820C6FFA92020D2FF20E4FFC90DF00620D2FF4CEC8020CCFFA9008D06
9016 DATA@1,8100858D07854C7680A002B900CFC920F0034C6483C8C02790F1A92020D2FFA92420
9018 DATA@1,8120D2FFAD0585202384AD0485202384A93D20D2FFAD0585AE048520CDBDA9008D06
9020 DATA@1,8140858D07854C7680AD04858D4784AD05858D48842075838D40CFA2012074839D40
9022 DATA@1,8160CFE8E00890F5205482A6B820C9FFA000B9448420D2FFC8C00690F5A000B940CF
9024 DATA@1,818020D2FFC8CC498490F4A6B820CCFF4CD680205482AD04858D3C84AD05858D3D84
9026 DATA@1,81A0A6B820C9FFA000B9398420D2FFC8C005D0F520CCFFA6B820C3FF4C7680205482
9028 DATA@1,81C0A6B820C9FFAD04858D41841869088D0485AD05858D428469008D0585B93E8420
9030 DATA@1,81E0D2FFC8C00690F520CCFFA6B820C6FFA20020E4FFB00F9D40CFE8EC438490F220
9032 DATA@1,8200CCFF4C08824C6483A000A92020D2FFB940CF202384C8C00890F0A91220D2FFA0
9034 DATA@1,822000B940CFC9209014C93C9012C93DF00EC93FF00AC9419004C95B9002A92020D2
9036 DATA@1,8240FFA5D3C927B00AC8C00890D5A99220D2FF4C7680A90F20C3FFA90F85B885B9A9
9038 DATA@1,82600885BAA90085B720C0FF6020A383A90D20D2FFA95D20D2FFAD0785F00FAD0685
9040 DATA@1,8280C952F00BC957F007C947F0034C1183AD068520D2FFA92020D2FFAD0585202384
9042 DATA@1,82A0AD0485202384A9004C118320BCF620E1FFD00C2015FD20A3FD20A3834CA98020
9044 DATA@1,82C0E4FFF0FBC98DD002A911C911D00AA9008D0785A90D4CDF82C90DD0038D0785C9
9046 DATA@1,82E093F0DC20BB8320CA83C90DD00160C99DF004C914D008A4D3C00290AFB013C911
9048 DATA@1,8300F00FA4D3C01F900948A01E84D3206CE5684820A3836820D2FF20AC834CAB82A0
9050 DATA@1,832000B1D1297F85FB06FB24FB1002098070020940990CFC8C02890E660AD0685C9
9052 DATA@1,834023F006C940F002D0016020748380585207583 8D048520A383A90785D3206CE5
9054 DATA@1,836020AC8360A93FC891D1A9008D06858D07854C7380C8A900850220888306020602
9056 DATA@1,838006020602208883 60C8B900CF38E930C90A900BE907C910900585034C64836502
9058 DATA@1,83A0850260A4D3B1D1297F91D160A4D3C01F9002A01EB1D1098091D160C991F00160
9060 DATA@1,83C0A4D6C005900160A90060A4D6C014B00160C911F005C90DF0016020DE836020A3
9062 DATA@1,83E083A210A97885FDA90485FEA02718A92865FD85FD9003E6FE18692885FBA5FE69
9064 DATA@1,84000085FCB1FB91FD8810F9CAD0DEA92091FBC8C02890F9A99120D2FFA91D20D2FF
9066 DATA@1,8420A90D60484A4A4A4A202E8468290F0930C93A900269064CD2FF4D2D4500004D2D
9068 DATA@1,8440520000084D2D5700000812202020202020202020204449534B204452495645204D
9070 DATA@1,84604F4E49544F52202020202020202020202020202020202020202020202020284329202 0
9072 DATA@1,8480492E4A454C4C494E47532031393836202020202020202020202020200D0D0D0D0D
9074 DATA@1,84A00D0D0D0D0D0D0D0D0D0D0D0D0D0D0D0D0D0D434F4D4D414E445320122028232 93D50
9076 DATA@1,84C0525420504320284029 3D44534B53542028572952495445 0D1220202020202020
9078 DATA@1,84E020202020285229 3D5245414420202020285829 3D455849542020202847293D474F2013
9080 DATA@1,85000D0D0D00000000
```

The right-most field (preceded by a semicolon) is the comment field. Here we write comments (like REM statements) that will allow us to remember why we did what, or so others may understand why something was done a certain way.

Now you are able to read a listing, load up your DATAPOKE program from the Part 1, and try to enter the demo program into data statements.

Still a little confused? Try:

```
10 Ifx = othenx = 1: load "datapoke.bin", 8, 1
20 sys 49152, 1: rem activate datapoke
25 sys 828: rem activate routine
40 data@1,033c 4c 41 03
50 data@1,033f 00 06
60 data@1,0341 48 08 ad 3f 03 8d 20 d0
70 data@1,0349 ad 40 03 8d 21 d0 28 68
80 data@1,0351 60
```

Can you understand why I separated the code at line 50? Top of the class!

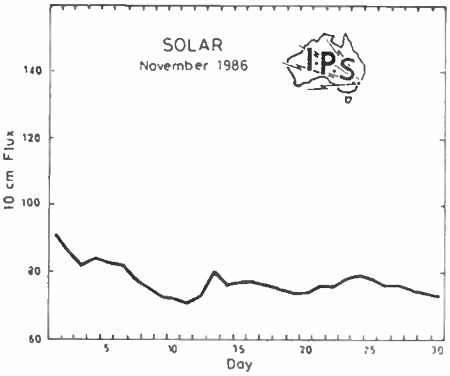
These are the values of the colours. Run your program, see what it does, and change line 50 to read:

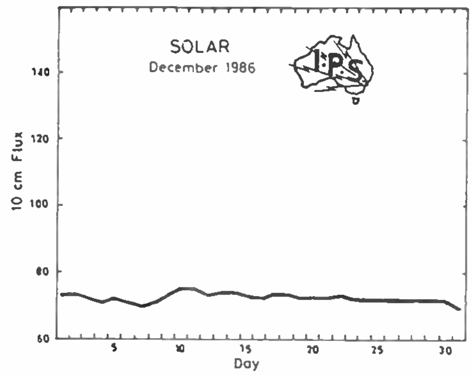
```
50 data@1,033f 01 07
```

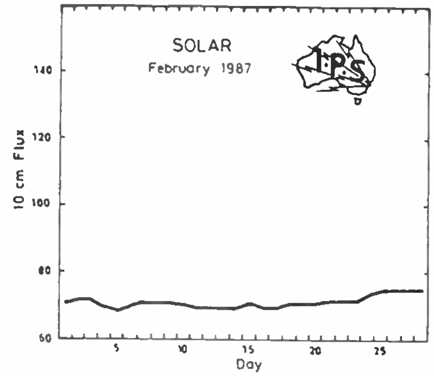
Did you see the colours change from black and blue to white and yellow? Play around with it and see what you can achieve. If you do something wrong, you can always switch your computer off and try again. You cannot hurt anything!

DEMO PROGRAM

```
                    0010                .BA 828         ;ADDRESS FOR MC
                    0020                .OS             ;PUT PROGRAM IN MEMORY
                    0030 ;
033C- 4C 41 03      0050 START          JMP GO          ;JUMP OVER COLOURS
                    0060 ;
033F- 00            0070 BACKGROUND .BY 0               ;BLACK
0340- 06            0080 FOREGROUND .BY 6               ;BLUE
                    0090 ;
                    0100 BACKREG        .DE 53280
                    0110 FOREREG        .DE 53281
                    0120 ;
                    0130 GO
0341- 48            0140                PHA             ;SAVE ORIGINAL CHARACTER
0342- 08            0141                PHP             ;SAVE STATUS REGISTER
0343- AD 3F 03      0150                LDA BACKGROUND  ;GET BG COLOUR
0346- 8D 20 D0      0160                STA BACKREG     ;CHANGE COLOUR
0349- AD 40 03      0170                LDA FOREGROUND  ;GET FG COLOUR
034C- 8D 21 D0      0180                STA FOREREG     ;CHANGE COLOUR
034F- 28            0181                PLP             ;REGET STATUS REGISTER
0350- 68            0190                PLA             ;REGET ORIGINAL CHAR
0351- 60            0200                RTS             ;RETURN TO CALLER
                    0210 END
                    0220                .EN             ;ASSEMBLER NEEDS THIS
```







Sunspots bottom-out, new cycle on the rise!

Cycle 21 is dead! It seems the sunspot minima was passed late last year, according to reports from IPS Radio and Space Services, and now sunspot regions appearing on the solar disc appear to be all 'new cycle' regions.

Solar activity has been very low for many months, during November last, the solar disc was without spots for five days, in December it was without spots for 18 days, and without spots for 15 days in February.

Sunspot regions observed during November were a mixture of old and new cycle regions (old cycle regions arising near the solar equator, new cycle regions arising near the poles), while those appearing in February were all new cycle regions.

The 10 cm flux (radio power emitted by the Sun at 2800 MHz) — a good indicator of solar activity widely used in place of the sunspot number — dropped to a monthly average of 71.5 in February, the lowest since September last year.

The 10 cm flux ranged from a maximum of 91 on 1 Nov. to 71 on 11 Nov., with an average in the high 70s. In December it peaked at only 75 (on 11 Dec.), while the low was recorded at a value of 70 on 7 Dec.; monthly average was mid-70s. In February this year it ranged from a low of 69 (5 Feb.) to a high of 75 (25-28 Feb.).

While the sunspot number may drop to zero, the 10 cm flux never does, having a minimum of around 67 even with a spot-free solar disc.

Now Cycle 22 is on the rise, the next maximum will come relatively quickly because the rise is shorter than the decay, generally taking around four years of a typical 11-year solar cycle. Get ready for 1991!

Mt. Gambier amateur convention

The South East Radio Group (SERG) will be holding its popular Annual Convention again in June this year. This is the 23rd Convention held by the group in Mount Gambier.

The convention attracts much interest due to the many interesting trade displays kindly staged by the various companies involved in the retail of amateur-related equipment.

There are of course the ever-popular competitions, such as fox hunts, hidden transmitter hunts and scrambles to name a few, available for those interested in competing for excellent prizes and the perpetual trophy.

Of course, it should not be forgotten that the renewal of old acquaintances and the meeting of those faces behind the microphone is to some the most important part of all.

The convention starts on Saturday 6th June with Registration and a few events. The Sunday sees most of the serious competitions and of course the famous Lunch and Tea.

It really is a must to come along to Mount Gambier on this weekend and join in the fun, SERG says.

Mount Gambier is situated on the side of an extinct volcano (the Blue Lake), about halfway between Adelaide and Melbourne.

Accommodation is normally plentiful, but as the city plays host to many sporting events on this weekend it is a good idea to book early.

For a full programme, accommodation guide and any other queries, please write to the **SERG Inc., PO Box 1103, Mount Gambier SA 5290.**

Low noise amps

Mitsubishi Electric Austra lia has released the model 12H180A low noise amplifier and the mode 12H200A low noise block converter for use as the receive front end in AUSSAT Ku-band earth station terminals.

Utilizing the latest GaAsFET devices and microwave integrated circuit technology, the extreme compactness of these uncooled untis ensures their inherent reliability, which is required for unattended operation in remote locations where many earth stations will be located, Mitsubishi claim.

The LNB has a low 2.3 dB noise figure and a minimum gain of 50 dB across its input frequency range of 12.25 GHz to 12.75 GHz.

An IF output frequency range of 950 MHz to 1450 MHz ensures compatibility with existing TVRO receivers.

Supply voltage for both the LNA and LNB is +15 V to +25 V dc.

For further information, contact **Mitsubishi Electric Australia, PO Box 1567, Macquarie Centre 2113 NSW. (02) 888 5777.**

Build this simple switched RF attenuator

Dick Smith Electronics
Technical Products Division

Here's a simple, but highly useful, project for RF enthusiasts. This 50 ohm switched attenuator exhibits good characteristics well into the UHF region and provides a total of 63 dB attenuation in seven steps, with intervals of 1 dB, 2 dB, 4 dB, 8 and 16 dB.

A 50 OHM STEPPED ATTENUATOR is very useful in many RF applications — in RF development work, communications test and measurement, radio equipment servicing, antenna measurements, etc. This inexpensive unit employs common slide switches and quarter watt metal film resistors, each of which give remarkably good performance well into the VHF region.

The project employs some seven 'stages', with five different attenuation steps of 1, 2, 4, 8 and 16 dB, to provide up to 63 dB of total attenuation in 1 dB increments. While primarily intended for use over the HF region to around 30 MHz, this attenuator has quite adequate accuracy for use well into the VHF region and would still prove useful in many applications in the UHF region. With quarter watt resistors employed in the attenuator sections, the project is unsuitable for use in transmitting applications unless the power level is kept below +25 dBm.

The attenuator sections are all 'pi' networks. The symmetrical layout of the switch sections, interstage shielding and maximisation of 'ground' area all contribute to the linearity of attenuation and insertion loss across such a broad frequency range.

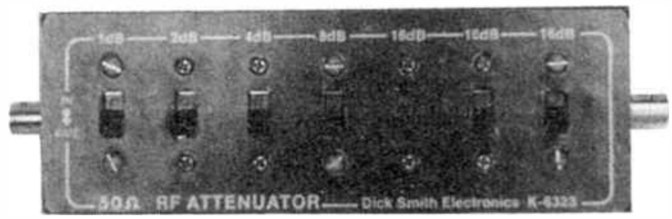
Construction

The unit is constructed from precut and painted printed circuit laminate soldered together, three-pole double-throw slide switches and metal film resistors. To assemble the unit, it is suggested you construct the box first and prepare the switches separately.

A soldering iron of at least 50 watts rating will be required for soldering the edges of the box together. It should have a bevelled or wedge tip 4-6 mm across. The diagrams here show the general construction. The pc board pieces are soldered together to form a segmented box. All the copper sides face inwards.

Building the box

The first step is to clean the copper sides of the precut printed circuit laminate. This makes for ease of soldering and hence better earth conduction. You can get a good idea of the final construction tolerances by manually holding the side and end pieces in position against the front panel placed front-down on a bench or table. It should be stressed that, during construction of the box, it is essential to start with accurate right angles between the front panel and its side and end pieces.

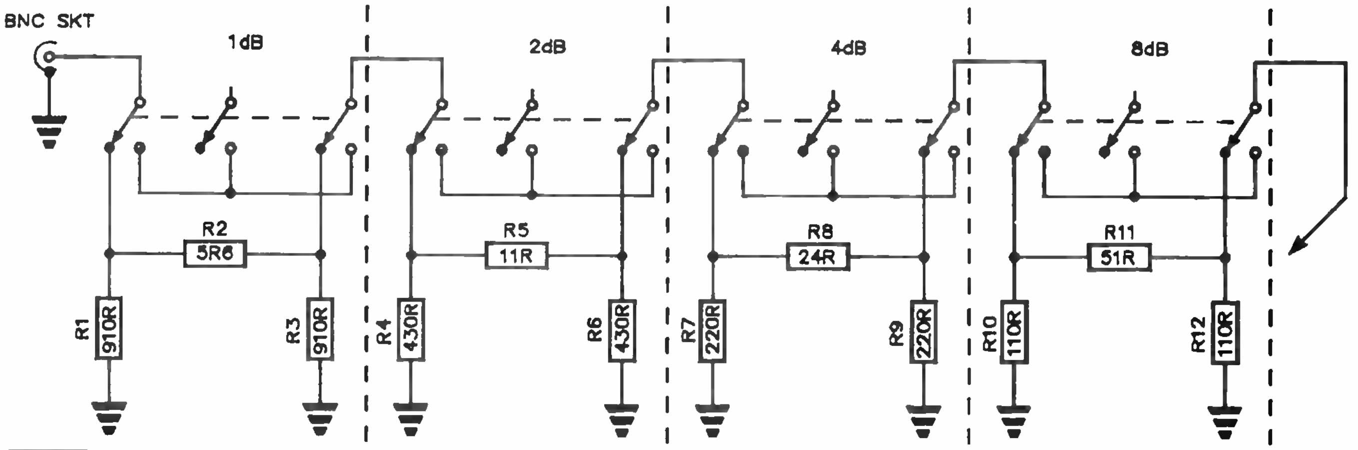


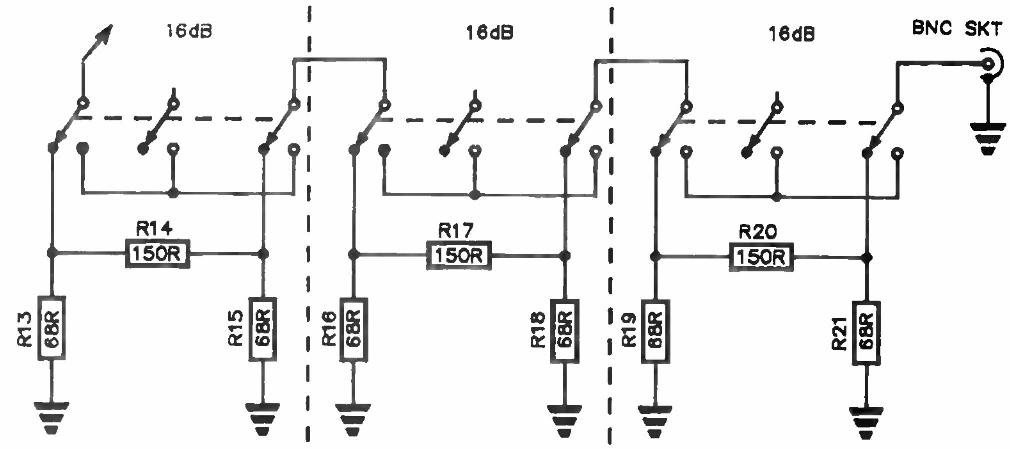
View of the completed attenuator box.

Start by placing the front panel face down and holding an end piece in position at right angles to it. The side pieces can be placed in position and temporarily soldered in place. The technique for soldering the side pieces is to place a small spot of solder adjacent to the switch screw holes, this will ensure that the mid-pieces can be inserted afterwards, without interfering with this solder, at the edge of the front panel and side edge. The side pieces can be soldered more permanently once the unit is near completion. The end pieces can be temporarily soldered to the side pieces and front panel, note that the hole in the end pieces should be closer to the back panel than the front panel. At this stage the box can be checked for symmetry and minor adjustments made if necessary.

SPECIFICATIONS — as measured on the prototype

Impedance	50 ohms
Attenuation steps	1 dB, 2 dB, 4 dB 8 dB and 3 x 16 dB
Accuracy	
overall	<+/- 0.5 db to 450 Mhz
1 dB	–0, +0.25 dB to 470 Mhz
2 dB	–0, +0.25 db to 400 MHz
4 db	–0, +0.25 db to 180 MHz
8 dB	<+/- 0.5 db to 520 MHz
16 dB	<+/- 0.5 db to 600 MHz
Insertion loss	<0.1 dB to 40 MHz 0.5 dB or better to 100 MHz <1 dB to 300 MHz
Nominal power rating	+25 dBm max.





PARTS LIST
RF ATTENUATOR

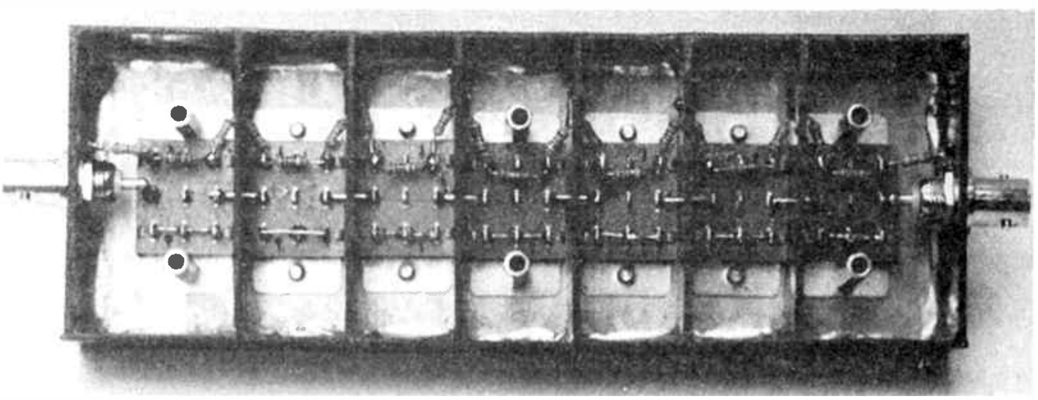
Resistor.........all 0.24 W, 1% metal film

R1	910R
R2	5R6
R3	910R
R4	430R
R5	11R
R6	430R
R7	220R
R8	24R
R9	220R
R10	110R
R11	51R
R12	110R
R13	68R
R14	150R
R15, R16	68R
R17	150R
R18, R19	68R
R20	150R
R21	68R

Miscellaneous

7 x 3PDT slide switches; 2 x BNC panel sockets; 20 x 3mm screws, 6mm long; 6 x 25mm spacers, tapped 4mm; 6 x M3 'inside' shakeproof washers; 1 x pcb front panel, 1 x pcb rear panel, 2 x pcb side pieces, 2 x pcb end pieces, all single-sided board; 6 x pcb mid-pieces, double-sided board; 200 mm of tinned copper wire.

Kit price: $37.95



Internal view, showing the general construction.

Before including the mid-pieces, temporarily screw the switches in position. This will ensure the mid-pieces are correctly spaced and will not interfere with the switches later on. Also note that the mid-pieces are to be orientated so that the hole is closest to the centre switch terminals in order for the links between the switches to be included later. After all sections are in place, withdraw the switches and solder more thoroughly around the perimeter edge of the box. The mid-pieces should not be soldered directly to the front panel, but only to the side-pieces at this stage, as the solder may interfere with the switch seating. Alcohol or meths and an old toothbrush can be used to remove any excess flux from inside the box, but take care not to damage the paint or front-panel artwork.

This month's ★ Star Project ★ is from Dick Smith Electronics who will be marketing kits through their stores and dealers; cat. no. K6323, $37.95. Mail order enquiries to PO Box 321, North Ryde 2113 NSW. (02) 888 3200

Switch preparation

The switches are prepared by soldering the 'series' resistors in place between the two outer switch lugs on one end, followed by soldering a straight-through link of tinned copper wire joining all three lugs on the opposite end. The resistor leads must be as short as possible. Then the switches are screwed into the box. Note that three of the switches are secured with 25 mm tapped spacers instead of nuts. It is these ▶

spacers which secure the bottom plate and provide a common earth connection for it. Then mount the two BNC sockets.

With all the switches and the two sockets secured in place, the shunt resistors for each attenuator section are soldered between their appropriate switch lugs and ground with the shortest leads possible. Note that the shunt resistors at the first and last attenuators have their 'earthy' ends soldered directly adjacent to the BNC sockets. The through-links joining each section must then be soldered in place. Finally the BNC sockets can be linked to the switches with short lengths of tinned copper wire and the back panel screwed into place.

Testing and performance

The attenuator box can be checked by terminating one end with a load of exactly 50 ohms. This can be made up by connecting two 100 ohm, 1% resistors in parallel. As this is a dc test, lead length is uncritical. Now, with your multimeter set to the low ohms range, connect the leads across the opposite end of the attenuator box. Any switch setting, or combination of switch settings, should result in a measurement of 50 ohms. With digital multimeters, the reading should be within plus or minus one ohm.

Testing the prototype with RF signals, the worst-case tolerance was found to be on the 16 dB sections, which measured +0.5/–0.4 dB from 1 MHz to 600 MHz, the mean attenuation being about 16.3 dB. The prototype was virtually flat (within +/– 0.2 dB) up to 100 MHz for all sections.

Insertion loss was measured at 0.5 dB or less up to 50 MHz, then +0.5 dB between 50 MHz and 300 MHz. The accompanying chart shows overall measured performance of the unit.

It should be noted that the effects on attenuation accuracy of long hookup cables, or any impedance mismatch the attenuator box may contribute, is going to worsen as frequency increases. At 500 MHz, a quarter wavelength is 150 mm, so normal VHF-UHF precautions should be observed when connecting up the unit — use short leads.

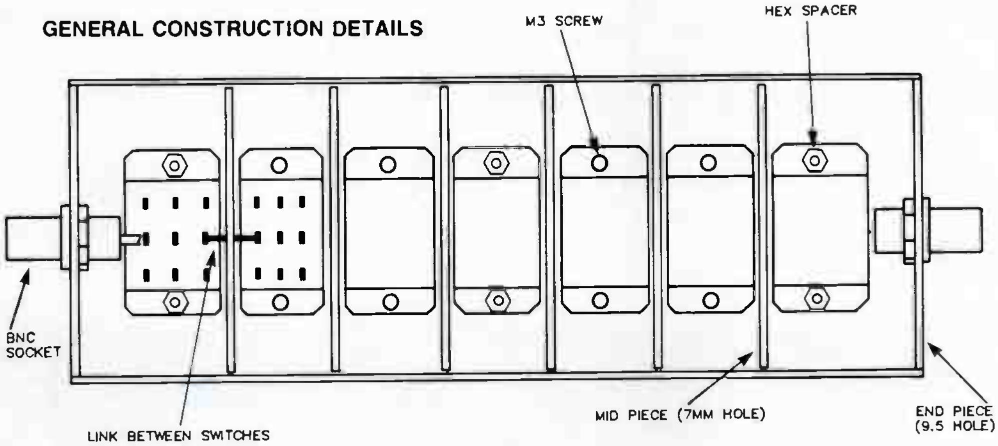
Details of test and measurement techniques and applications may be found in the references cited here

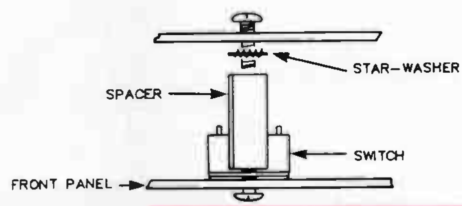
REFERENCES

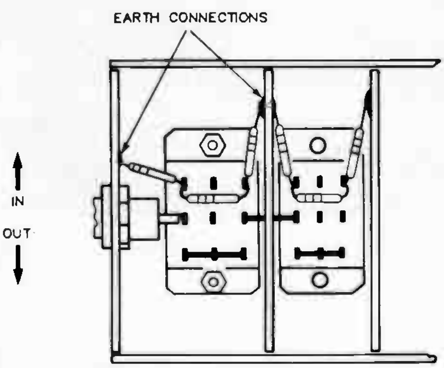
The Radio Amateur's Handbook 1986, Chapter 25, "Test *Equipment and Measurements*". Published by the ARRL.

The ARRL Antenna Book, Chapter 15, "*Antenna and Transmission Line Measurements*".

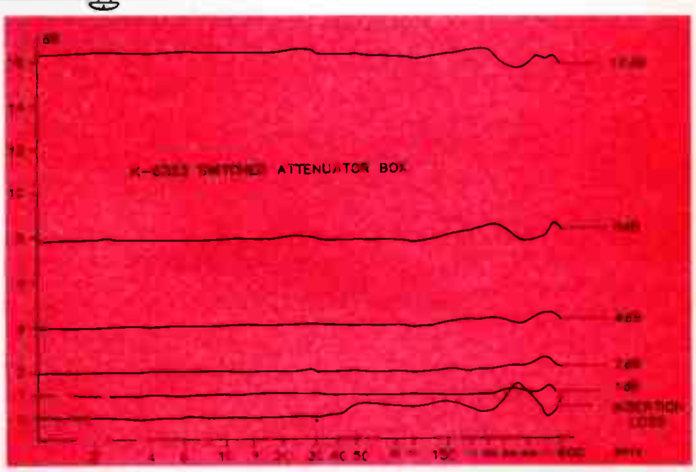
GENERAL CONSTRUCTION DETAILS



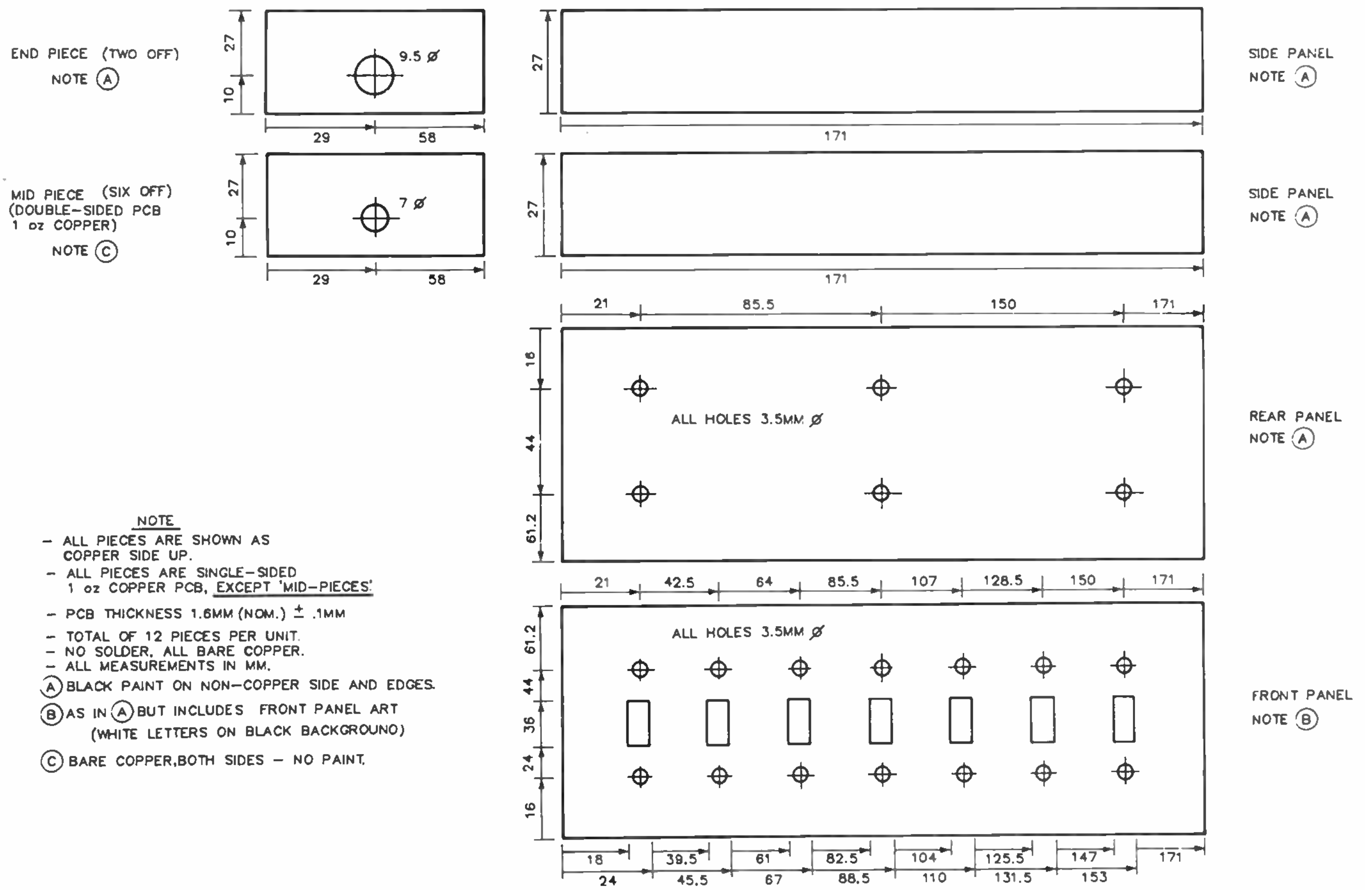




RESISTOR CONFIGURATIONS



LEVEL
We expect that hobbyists who are
BEGINNERS
in electronics construction should be able to successfully complete this project.



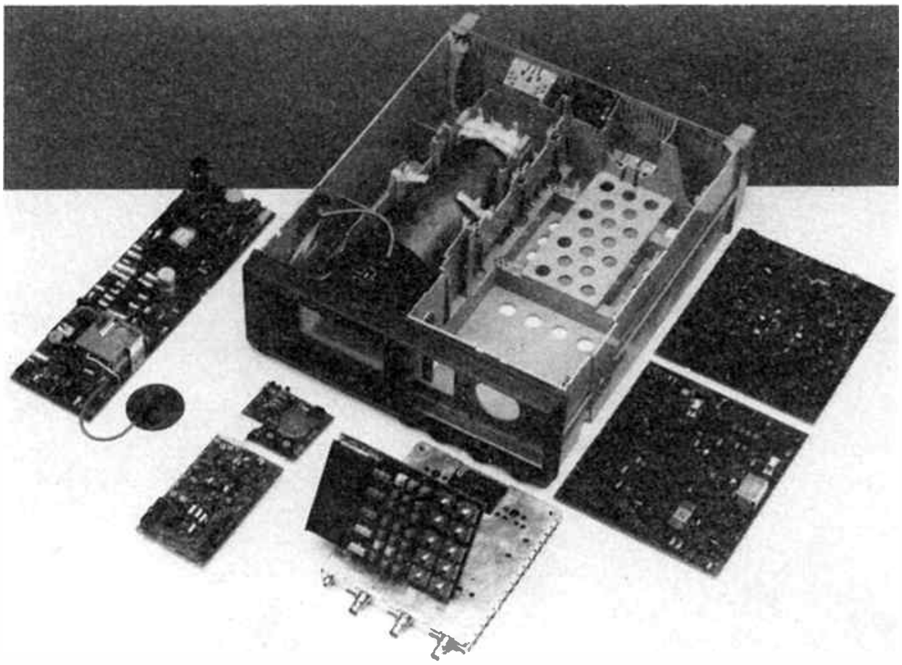
— from page 26

gineering grade" plastic and is clearly very sturdy. If you have to service the unit yourself, the chassis design makes it relatively fast and simple. Modular construction is employed, there being five subassemblies. The pc boards are readily accessible, with the exception of the input stages which are housed in a shielded compartment. Boards are interconnected via flat ribbon cables. The power cable plugs into an IEC line connector in the rear panel and may be stowed away in a special recess provided. Hard rubber strips on either side of the rear panel permit the instrument to be stood on end, while four rubber feet on the cabinet underside allow for normal bench or shelf standing. The carry handle also acts as a tilt stand.

The documentation is of a high standard. The owners manual is clearly written, well organised and easy to follow. A service manual is obtainable also.

Conclusion

Overall, the PM 3055 is a fine instrument. Its design and features, particularly Autoset, panel design and its construction, set it apart from all other CROs in this class. I have little hesitation in recommending it for general service and development work.



Further information on the PM 3050/55 can be obtained from Philips Scientific & Industrial, 25-27 Paul St, North Ryde 2113. (02) 888 8222.

— Roger Harrison

Weather FAX transmissions and RTTY news services on shortwave

Wayne Whiteway

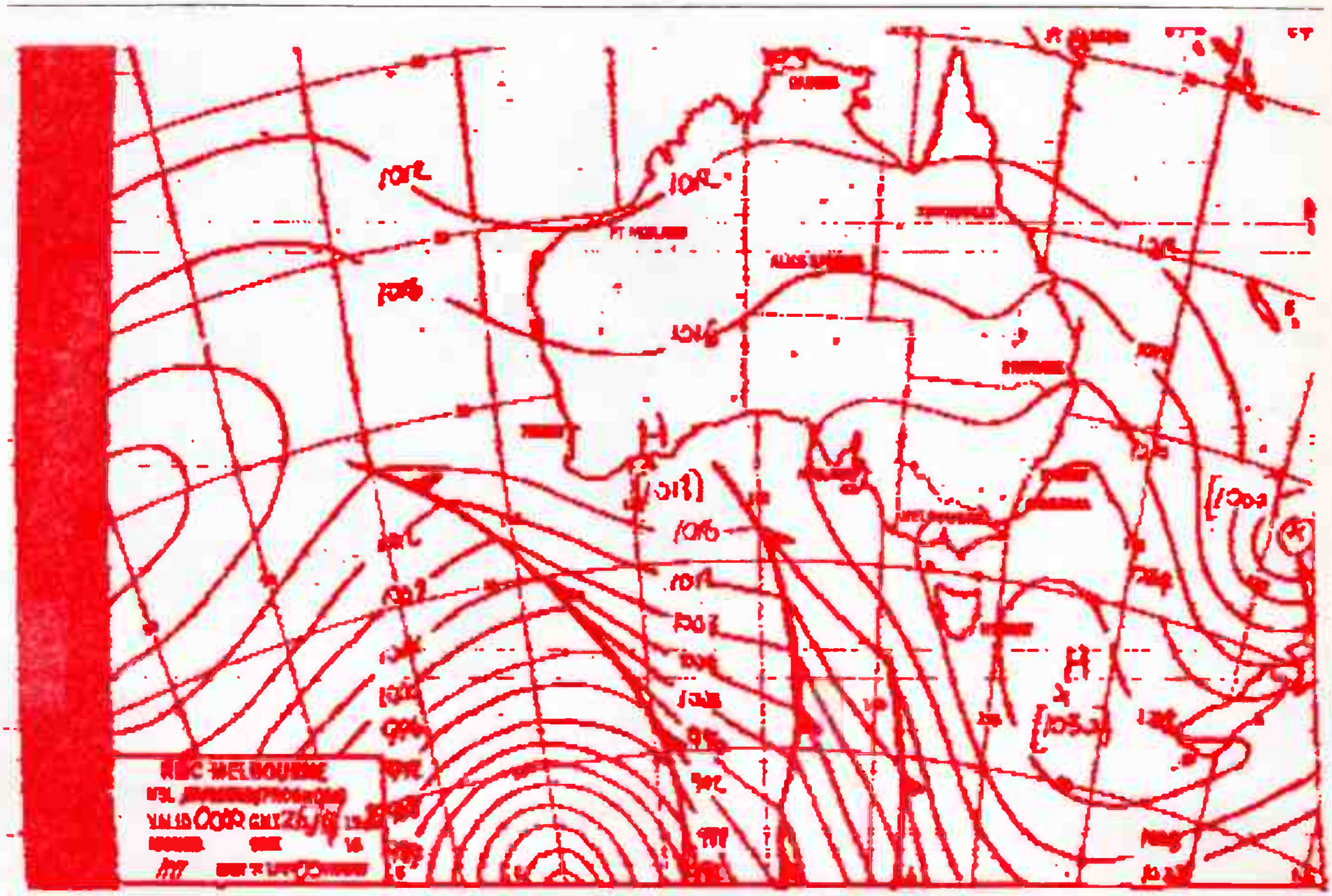
Searching for weather FAX stations to decode weather maps transmitted? Or are you looking for international news agency broadcasts? For AEM3500 Listening Post project users, here's a list of some transmission frequencies that may be useful.

IT IS OFTEN difficult to get lists of frequencies for utility transmissions on shortwave. In fact, when I completed construction of my first RTTY decoder about two years ago, the only lists of frequencies to try were included in the article accompanying the construction details of the unit. Unfortunately, as many of you know, the author and designer of the Listening Post, RTTY Decoder and FAX Decoder projects, Tom Moffat, is from Tasmania. Needless to say, due to the nature of propagation, frequencies heard well in Tasmania are seldom heard in Brisbane or areas further north. So started my search for the elusive and exotic RTTY, FAX and CW transmissions. For the benefit of listeners who do not have the time to search the spectrum, I have compiled a list of some of the stations I received in February this year.

Reception

I have not sent reception reports to any of the stations in the above list. There are two reasons for this. First, I have no addresses for any of the FAX or weather RTTY stations. Second, although I do have addresses for the News Agencies, I believe they are not keen to receive reception reports from non-subscribing listeners. However, if anyone would like to try, I have included some addresses elsewhere in this article. Good luck!

The receiver I use is a Sony ICF 2001D in conjunction with a Listening Post decoder and a Microbee IC computer. Although the Microbee generates quite a deal of RF noise, very little seems to get into the receiver. The antenna, a 5.8 MHz dipole, is located at least 30 metres from the computer and is fed with coax via an aerial tuning unit. The ATU is built inside a diecast aluminium box. The receiver is on the desk only a metre from the computer. Given these conditions, I would have expected noise to be a much greater problem than is in fact the case.



In the print-out, frequencies listed are as they were on the digital readout on the Sony when the station was being successfully decoded. If you have a digital receiver and dial up a frequency but hear nothing, first check that you have switched to the correct sideband, then tune carefully plus and minus 3 kHz. If you still do not hear a signal, try another listing. And if that doesn't work either, then you may have to think about moving to Brisbane! In any case, tune up and down 50 kHz and most likely you will get some we cannot hear in Brisbane.

Station addresses

For those listeners who would like to write to news agencies, perhaps to send a signal report or even to get a transmission schedule you might like to try the following addresses:

RTTY, FAX AND MORSE CODE STATIONS RECEIVED FEBRUARY, 1987

Date	kHz	Time	Mode	Baud	Call Sign	Notes
10	15644.8	1220	LSB	50	KUNA	KUWAIT NEWS AGENCY
10	08173.5	1230	USB	50	KYODO	KYODO TSUSHIN NEWS SERVICE
10	14572.8	1233	USB	50	MAP	MAGHREB ARABE PRESSE
10	18494.6	1237	USB	50	MAP	MAGHREB ARABE PRESSE
10	19179.8	1244	LSB	50	IINA	
10	15708.4	1256	USB	50	TASS	
10	17508.4	1300	USB	50	TASS	
10	18383.3	1303	USB	50	UNKNOWN	
10	17568.5	1314	USB	50	TASS	
10	14365.2	1323	USB	50	XINHUA	
10	16132.4	1324	USB	50	MAP	MAGHREB ARABE PRESSE
10	09084.2	1341	USB	75	Y7A20	PROBABLY ZID
10	09088.1	1343	USB	50	CNA	CENTRAL NEWS AGENCY
10	14461.7	1345	LSB	50	Y7A34	PROBABLY ZID (TESTING RYRYRYRYRYRYRYRY)
10	15964.6	1347	LSB	50	Y7A58	PROBABLY ZID
10	13536.4	1350	USB	50	ZID	
11	13561.5	1404	USB	50	CNA	CENTRAL NEWS AGENCY
11	09079.6	1408	LSB	50		GERMAN (Tx in CYPHER)
11	10816.8	1417	LSB	50	ANSA	
11	06970.3	1940	USB	50	JNA	JORDAN NEWS AGENCY
11	08025.4	1930	LSB	50	AFP	(FTF-84B/H3)
11	09354.7	1944	LSB	50	CTK	
12	10544.7	1245	LSB	50	ADN	ALLGEMEINER DEUTSCHER NACHRICHTEND
12	09968.2	1300	USB	50	ADN	ALLGEMEINER DEUTSCHER NACHRICHTEND
12	10552.4	1305	USB	50	ADN	ALLGEMEINER DEUTSCHER NACHRICHTEND
12	11534.3	1308	LSB	50	ATCC	
12	12076.5	1310	LSB	50	KUNA	KUWAIT NEWS AGENCY
12	12313.3	1315	USB	50	TASS	
16	17068.0	0100	USB	FAX		JAPAN (60 LINES/MINUTE)
22	13777.4	2300	USB	50	BCA95	UNKNOWN TESTING "RYRYRYRYRYRYRYRYRYRYRY"
23	17596.0	0241	USB	50	KYODO	KYODO TSUSHIN NEWS SERVICE JAQ57
23	18353.8	0250	USB	50	UNKNOWN	UNKNOWN (WEATHER DATA eg 21116 48110)
23	18986.3	0254	USB	50	JAX78	UNKNOWN (QRA DE JAX78 RYRYRYRYRYRYRYRYRY)
23	19273.4	0255	FAX		UNKNOWN	UNKNOWN
23	19527.2	0300	USB	50	UNKNOWN	WEATHER SUMMARY FOR N. HEMI. IN ENGLISH
23	16902.1	0600	FAX		UNKOWN	120 LINES/MIN PROBABLY CHINESE
23	17149.5	0145	FAX			NATIONAL WEATHER SERVICE SAN FRANSISCO

MAP Maghreb Arabe Presse
Zanka
El-Yamana No 10
Rabat
KINGDOM OF MOROCCO

KUNA Kuwait News Agency
B.P. 24.063
Safat
KUWAIT

KYODO Kyodo Tsushin News Service
2, Akasaka Aoicho
Minato-ku
Tokyo
JAPAN

IINA International Islamic Republic News Agency
P.O. Box 5054
Jeddah
SAUDI ARABIA

JNA Jordan News Agency
P.O. Box 6845
Amman
JORDAN

ANSA Agenzia Nazionale Stampa Associata S.C.
Via della Dataria, 94
I-00187 Roma
ITALY

AFP Agence France-Presse
B.P. 20, F-75061 Paris
Cedex 02
FRANCE

ADN Allgemeiner Deutscher Nachrichtendienst
Hollstrasse 1
Postfach 1219
DDR-1020 Berlin
GERMAN DEMOCRATIC REPUBLIC

ATCC Agence Telegraphique de Coree
Pyongyang
DEMOCRATIC PEOPLE'S REPUBLIC OF KOREA

ZID Zentraler Informationsdienst
Thaelmannplatz 8/9
DDR-8 Berlin
GERMAN DEMOCRATIC REPUBLIC

CTK Ceskoslovenska Tiskova Kancelar
Opletalova 5-7
CS-11144 Praha 1
Nove Mesto
CZECHOSLOVAKIA

CNA Central News Agency Incorporated
209 Sunkiang Road
Taipei, Taiwan
REPUBLIC OF CHINA

TASS Telegrafnoie Agenstvo Sovietskavo Soyusa
Tverskoi Bulvar 10-12
Moskva
U.S.S.R.

XINHUA New China News Agency
30 Hsuanwumen Hsi Chieh
Beijing
PEOPLE'S REPUBLIC OF CHINA

Probably the most reliably received agency in the Brisbane area is Kyodo, from Japan, which can be copied from start of transmission about 12.30 pm local time until well after 4.00 pm on 17 596 kHz. Listeners who like reading the financial pages of the newspaper will find Kyodo's items very interesting.

For a more general news content you could try the MAP Agency. Maghreb Arabe Presse was the original name given to this private agency when it was founded in 1959. In 1975, the Moroccan Government took control and since then has tended to become a mechanism for spreading the views of King Hassan. There has been a name change, too, since 1975, to Mutual African Press. At least the initials have remained unaltered. In any case, MAP often retransmits items from AFP, REUTER and AP which can make for some interesting reading. I have noticed that MAP seems to transmit an extra line feed with each carriage return, resulting in a double-spaced printout.

The Last Laugh

Further research openings

I RECENTLY travelled on a long commercial aircraft flight back to Australia. It is some years since I have been subject to overseas travel and I am sorry to say that things haven't improved much for the passengers.

Again, I must draw attention to the gap that exists between known technology and the application of such technology (see Last Laugh, Oct.'86) to relieve the stress and strain of modern living, or, in this case, modern travelling.

After take-off, at the command of the Flight Controller, the cabin crew go through a form of mime, designed to tell you where the toilets are and the escape hatches and so on. They also, at the appropriate moment, point to the ceiling of the aircraft and produce an oxygen mask. Such a mask (so the man says), is concealed above each passenger and in the unlikely event of loss of cabin pressure, will fall gently from its hiding place. The oxygen is turned on as the mask is moved towards the passenger's face.

An elegant piece of technology; not new, but elegant and worthy of further comment.

Having finished their demonstration, the cabin crew's next job is to serve drinks. To do this they unleash a metal tray-mobile thing loaded with drinks and sharp corners. This machine of war is pushed around the aisles getting in everybody's way and slowly dispensing drinks.

Such an archaic dispensing method screams out for the application of known technology. As a system has already been developed for automatically providing oxygen to passengers who will probably succumb if they don't get it, why cannot a similiar system be developed in the interests of passengers who think they too will succumb if they don't get a drink? If this elaborate oxygen technology has been set up to cater for an occurrence that is rated as 'unlikely', what about something similiar to cater for a situation that is bound to occur the instant the wheels of the aircraft leave the ground; namely, that I shall develop a raging thirst.

Why not pipe the life-saving liquor to each passenger, as is already done with the oxygen and, of course, the music? Please don't raise any objection as to how you get on if one passenger wants a gin and tonic and another wants a scotch and soda. Surely if we can arrange for six different music programmes and a couple of comedy shows to be piped to each passenger and selected at his seat, our technicians can also work out how to cope with that little problem!

I imagine a dial, similiar to that used to select the music programmes, in the arm of each seat, with, say, six settings: scotch and soda, gin and tonic, orange juice, beer and perhaps a couple of cocktails. There may be some difficulty getting the olive into the Martini, but I am sure that a dedicated team would soon develop the necessary technique.

There is some possibility of using the existing piped music system for dispensing the grog. This would, however involve the risk of the passenger getting an earful of Vodka instead of Vivaldi in the event of a malfunction!

Mention of the piped music brings me to my next point.

The headphones that you are given are more like a doctor's stethescope. They consist of two plastic tubes and you are meant to put one end of each into your ears and plug the other ends into a fitting on the arm of your seat.

To make the ear ends less uncomfortable, each is fitted with a little white plastic mushroom and these brutes of things will not stay put. Just as you think you have it fitting properly on the end of the tube and you are ready to insert it in your ear, off it pops. Considering that scientists have developed adhesives that will stick ceramic tiles to the exterior of space craft to withstand re-entry temperatures, you would really think that someone could develop something to stick a little white plastic mushroom to the end of a piece of plastic tubing.

The only way I could get the thing to work was to put a mushroom in each ear first and then try to get the tubing into the mushroom.

I made a mental note to tell someone about it.

Before we landed, and under instructions from the Flight Controller, I carefully examined the seat pocket in front of me in case I had left something in it.

It was full of little white plastic mushrooms!

They were no doubt put there by management to save passengers scrabbling about under their seat when the originals shot off the tube. So they knew all about it all along and their only answer was to provide more mushrooms. How will Australia ever progress!

I firmed in my resolve to make an issue of the matter.

After we had landed and I had gathered my belongings together I made my way to the cabin exit. One of the crew was farewelling the departing passengers.

'Good-bye sir,' she said, 'Do you have any complaints?'

I knew there was something but I couldn't remember it. I shook my head.

A little white plastic mushroom shot out of my ear and rolled across the cabin floor.

'Ah yes,' I said, 'Now, about those headphones . . .'

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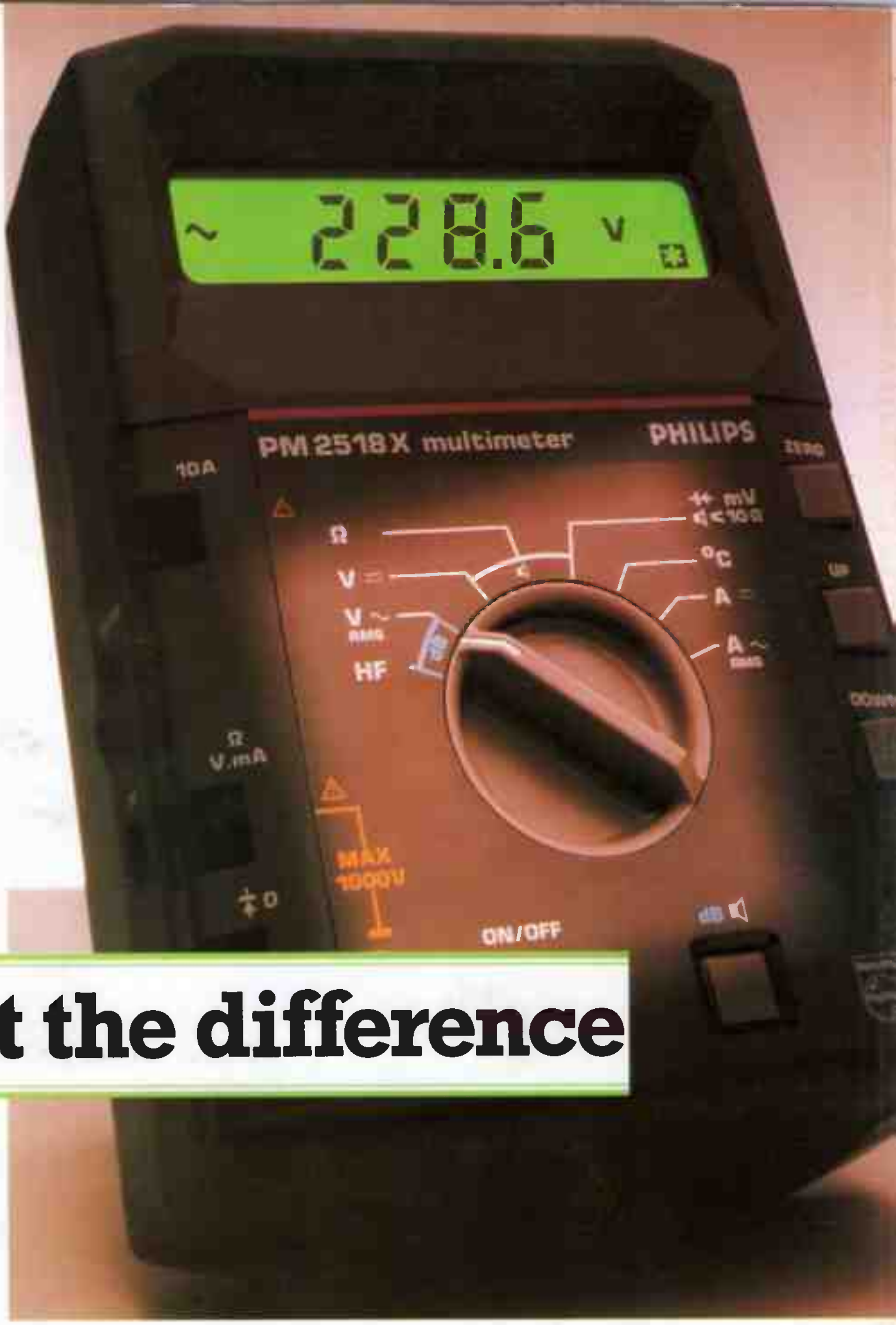
Highlight on multimeters



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