AUSTRALIA'S TOP ELECTRONICS MONTHLY
NOV. 1986 $4.75 NZ$6.50

The AUSTRALIAN ELECTRONICS Monthly

Incorporating Elektor Electronics

HEATHKIT ARRIVES AT DICK SMITH!

PROJECTS:
- Guitar Equalizer
- Pink/White Noise Gen.
- Atari ST Video Interface
- Darkroom Exposure Meter
- VHF Filters & More!

NEW: AMSTRAD COLUMN!

The Marantz 'digital monitor' PM-94 — how good?

audio • video • computing • communications • projects • engineering • technology

World Radio History

How to beat the high cost of cheap meters.

You get what you pay for.
So get the Fluke 70 Series.

You'll get more meter for your money, whether you choose the affordable 73, the feature-packed 75 or the deluxe 77.

All of them will give you years of performance, long after cheaper meters have pegged their fishhook needles for the last time.

That's because they're built to last, inside and out. So they're tough to break. They don't blow fuses all the time. You don't even have to replace batteries as often.

And they're backed by a 3-year warranty. Not the usual 1-year.

Of course, you may only care that the world-champion 70 Series combines digital and analog displays with more automatic features, greater accuracy and easier operation than any other meters in their class.

You may not care that they have a lower overall cost of ownership than all the other "bargain" meters out there.

But just in case, now you know.

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Analog/digital display	Analog/digital display	Analog/digital display
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World Radio History

Australian Electronics Monthly

Elektor Electronics

A FEW SHORT YEARS AGO it was widely believed that satellites would take the bulk of world communications traffic then burdening the HF radio spectrum which depended in large part on ionospheric propagation to cover the required distances. But it didn't happen. Communications via the ionosphere is now more popular than ever, by all reports! The greatest attractions of HF communications are the low cost and simple equipment requirements. Its greatest drawbacks lie in man-made noise cluttering the HF spectrum and its variability. The attractions have not escaped the notice of third-world nations, who have joined the HF melee with gusto. And these days, the drawbacks can be greatly minimised for many users.

Knowledge of the ionosphere and radiowave propagation has grown in substantial strides over the past decade, enabling improved usage of the available HF spectrum. Even satellite communications is affected by the ionosphere well into the UHF region. This month we feature a special report on the ionosphere and radiowave propagation, summarising an important international conference held in Australia early last year, which I was privileged to attend. There's more to the "short waves" these days than many realise, I'll warrant. I recommend you read the report, which starts on page 16.

Roger

Roger Harrison
Editor

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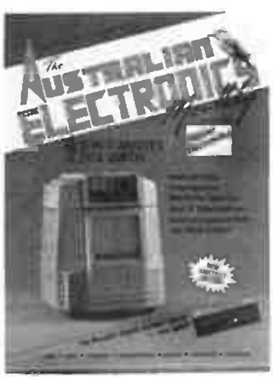
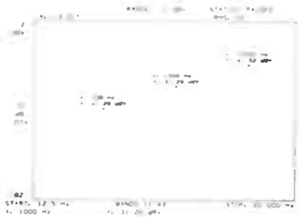
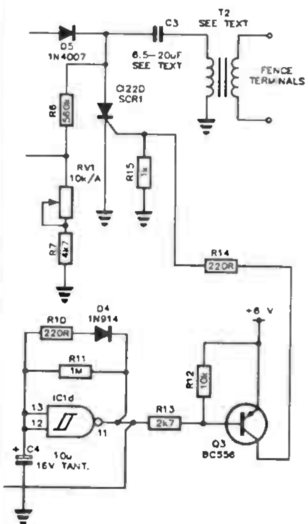


COVER

Heath's Hero Junior robot, a great kit now available through DSE! (Picture courtesy DSE). Inset is the new Marantz PM-94 amp. (Picture by Mark Rowland). Design by Val Harrison.

PROJECTS TO BUILD





CIRCUITS & TECHNICAL

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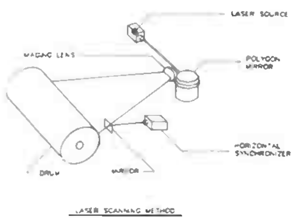
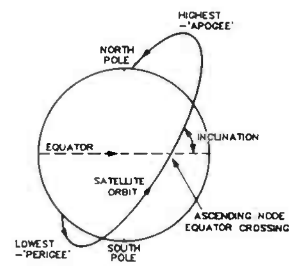


PRACTICAL COMPUTING



World Radio History

NEXT MONTH!

AN ALL-MODE UHF POWER AMPLIFIER
This project provides a typical power output of 50 watts for a 2 W input in the 70 cm amateur band. It features operation from 12 Vdc, a 10 MHz bandwidth at the 0.5 dB points, spurii at -60 dB, third-order and IMD products below -35 dB and an overall efficiency of 40%. It's great for boosting transmitters ranging from low power handhelds to 10 W output mobile or base rigs.

12 V NICAD FAST CHARGER
Have you noticed how fast the NiCad batteries on Christmas toys go flat? With this project you can save the day, charging your NiCads from any handy 12 Vdc source — from your vehicle battery or a mains supply.

BUILD A SLAVE STROBE
Remember the AEM9500 Beat-triggered Strobe Project? Build our low-cost flash-triggered slave strobe unit and have multiple strobes spread around your party or disco, triggered by the flash of one main strobe unit.

ALL ABOUT MEMORY MAPPING AND COMPUTER NUMBER SYSTEMS — USING THE VZ200/300
Getting 'inside' a computer is half the fun of owning one! Here Bob Kitch explains what memory mapping is all about and shows how computer number systems work.

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

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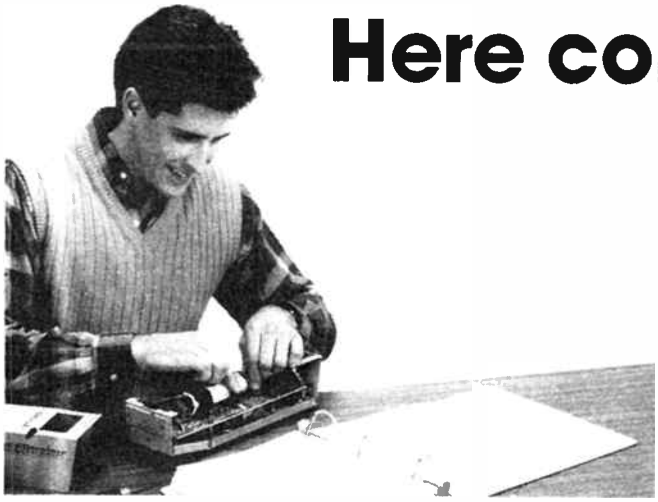
You lucky enthusiasts. Here comes Heathkit!



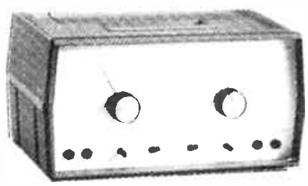
For more than fifty years, the Heath Company of Benton Harbour, Michigan, has given hobbyists and enthusiasts build-it-yourself kits which are at least as good — and sometimes much better — than commercially available units.

More than that, and possibly what has given Heathkits their well-respected name, is the highly detailed, step-by-step construction manuals that Heath meticulously prepare for each kit.

Add to this the huge range of kits — everything from AM transistor radios, through all types of test equipment, right up to the amazing Hero Robot you see on the front cover. Kits for the home, the car, for education, amateur radio . . . you name it, there's one or more in the Heathkit range.

Until now, Heathkits have been readily available through most of the western world — ex-

cept Australia. Now that's all changed. Dick Smith Electronics has recently been appointed Heathkit distributor for Australia and New Zealand. Initially, some 20 kits have been selected as "off-the-shelf" lines in major Dick Smith Electronics stores (some stores may have to order for you).



Of the other hundreds of products in the Heathkit catalog, Dick Smith Electronics will order for you, on an indent basis against a firm deposit, direct from the USA. Some kits are obviously not suitable for Australia (such as NTSC colour TVs, etc) and other kits are not available for licensing reasons (such as computers).

Among the kits to be stocked off-the-shelf are the Hero Junior robot, a low power CW transmitter for amateurs, an active antenna for shortwave listeners, several digital multimeters, an ultrasonic cleaner, an RF signal generator and a laser trainer.

Heathkits are not cheap. But then nothing of top quality ever is! When you buy a Heathkit, Dick Smith say you're buying the best kit available. And when you tell your friends "I built it myself" they'll have to believe you — it's a Heathkit!

Intel wins in microcode Copyright suit

Intel Corp. emerged as the victor in the most significant issue in its copyright infringement case against NEC Corp., the California-based company claims.

In the first of a two-part decision, US district Court Judge William Ingram today ruled that a microprocessor's "microcode" is a software program and is therefore protectable under US copyright law. Microcode interprets high level language commands into language recognised by the microprocessor hardware.

The ruling provides an important precedent for the entire US electronics industry, which in the past has seen unauthorised versions of its innovative products copied by competitors at a fraction of the original development cost.

"We are very pleased with Judge Ingram's decision," said F. Thomas Dunlap, Intel General Counsel. "Once again, a US Court has ruled against attempted piracy of software programs," Mr. Dunlap added.

"We were convinced all along that microcode is as copyrightable as any other computer program. This decision establishes beyond a doubt that microcode is copyrightable, and will provide US microprocessor developers protection for their intellectual property and a means of protecting their investments in development against the predatory practice of copying," Mr. Dunlap continued. Development costs for products such as 32-bit microprocessors can exceed $100 million.

Judge Ingram also ruled in Intel's favor on an NEC defense that Intel failed to protect its copyright through inadequate marking.

The remaining issues to be decided by Judge Ingram concern whether or not NEC infringed Intel's copyright on its 8086 microprocessor microcode and various NEC defenses.

Philips and Siemens pool resources

Conversion of the world's national and international telephone networks to digital operation is already well under way. By 1990, about 500 million US dollars will have been spent on complex integrated circuits to connect the voice, data and video communication services of some 10 million subscribers to an Integrated Services digital Network (ISDN).

The investment and effort needed to design and manufacture ICs for these applications is being provided by two leading multinational electronic component manufacturers, Philips in the Netherlands and Siemens in West Germany.

Philips and Siemens have standardised an ISDN-Orientated Modular architecture (IOM) for the integrated circuits which will form the all-important interfaces between the equipment at both ends of the digital subscriber lines.

The modularity of the IOM architecture minimises the number of different VLSI-circuits required and reduces their individual complexity so that they can be more quickly brought to market.

It also assures equipment designers of the flexibility they need to connect a wide variety of subscriber terminals to telecommunication networks which accord with present and future ISDN specifications.

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12 MONTH WARRANTY

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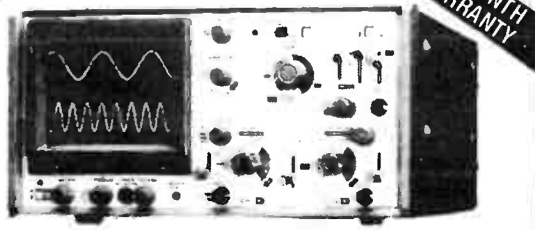
$ 732 EX TAX

$855 inc tax

Compact and easy to operate for hobbyists and professionals



CHECK TRANSISTORS, CAPACITORS AND CURRENT TO 10A

One multimeter does the lot - Vdc from 200mV to 1000V, Vac from 200mV to 750V, Adc from 200uA to 10A, Aac from 20mA to 10A, Ohms from 200ohm to 20Megs, Diodes, Continuity beeper, Capacitance from 2nF to 20uF. Plus measure hFE for PNP and NPN transisitors from 0 to 1000. Single rotary dial for unambiguous range selection. Auto-polarity 3½ digit display. Bright yellow case so you won't lose it! **EDM1111A $118.88 inc. tax ($103.03 ex tax).**

HANDY POCKET MULTIMETER

Measures only 126mm x 70mm x 24mm yet incorporates full 3½ digit multimeter including a continuity buzzer. Single rotary switch for fast convenient operation. Checks diodes too. Measures Vdc from 200mV to 1000V, Vac 200 and 750V, Adc from 200uA to 2A, Ohms from 200ohm to 2Meg. Special 1.5V battery test range with 1mV resolution and a continuity range which beeps when resistance is below 100ohm. Bright yellow case so you can't mislay it!! **EDM-70B $64.40 inc. tax ($55.52 ex tax).**

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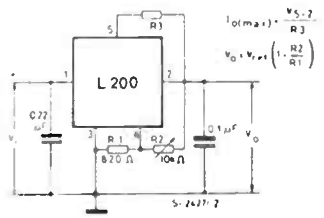
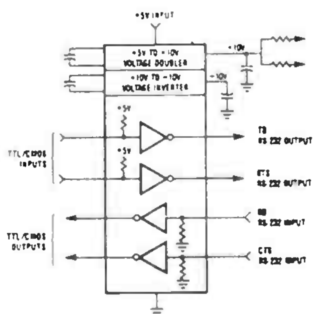


Programmable voltage regulator with current limiting

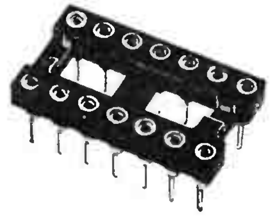
5V POWERED DUAL RS232 TRANSMITTER/RECEIVER MAX232

Yes it meets all RS232C specs but only needs a 5V supply because it has built-in converters for the +10V and -10V power supplies. Can also be used as a voltage quadrupler for input voltages up to 5.5V.

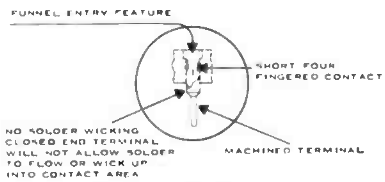
Also contains 2 drivers and receivers. Uses low power CMOS. Handles 30V input levels and provides a +9V output swing. Ideal for battery powered systems. **$12.96**



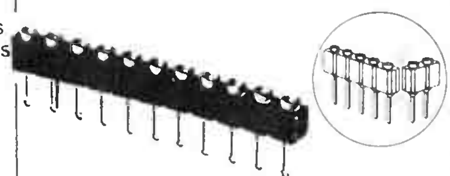
OPEN FRAME LOW PROFILE IC SOCKETS



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



SINGLE IN-LINE SOCKETS & ADAPTORS



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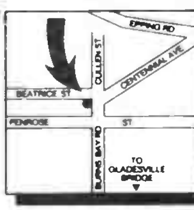

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As described in May '84 EA

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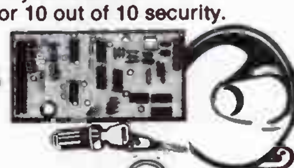
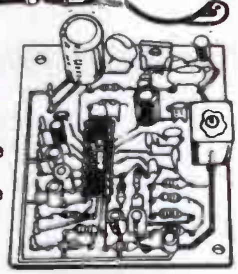


Stereo Decoder...



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As described in Oct '84 EA

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Here's a popular communicator! 1W, 3-Ch 'safety' transceiver that's compact enough for bushwalkers, etc. Fitted with 27.620 frequency with remaining 2 frequencies open for your choice. DOC approval: 242H0108 **$99**
Cat D-1102

Uniden MC-480 Marine Radio Telephone

ONLY **$449**

The best of both worlds: Access to 55 international VHF marine channels PLUS OTC's Seaphone facility for contacting land phone network. Immediate Ch.-16 access, switchable 1W/25W output. DOC approved. Cat D-1400

* Stingray - No 1 In Marine Communications

HF Marine Transceiver

Powerful 100W SSB rig for all HF marine frequencies... handles emergency, club and chatter over 2-30MHz range. Plug-in frequency cards for simple single knob frequency selection. DOC approved. Excellent value for a fine unit! **$1795**

BONUS 2182kHz Emergency channel Card included!

ONLY THE BEST

Cat D-1410

Forget Antenna Tuning Hassles!

Stingray tuning unit matches antenna to transceiver quickly and easily for maximum performance and minimum risk of high SWR damage. Covers 2-23MHz range. **$429**
Cat D-1412

Noise Blanking Mute Cord

Fitted in your transceiver to prevent ignition noise and other forms of pulse type interference. D-1414 **$139**

2182kHz Whip (emergency frequency)

Just the thing for those smaller craft going off shore. Complete with base and lead. D-1418 **$129**

Economy Marine

10 Channel, 27MHz transceiver that won't sink the budget! Yet provides max. legal output on all channels, auto noise limiter and ceramic filter. LED freq. display and squelch. Doubles as PA amp with optional power horn. DOC Approval: 2440040 **$139**
Cat D-1717

There's a bigger, better choice at... DICK SMITH ELECTRONICS

* These products available at selected stores on the coast — please phone your store for availability.

World Radio History

THE BEST KITS IN THE WORLD!

Ask any "old timer" in electronics who makes the best kits in the world and the answer would be, without fear of contradiction, "Heathkit."

And they'd be right.

For the past fifty years, Heath Company has earned its reputation as the world's leading electronic kit manufacturer.

Heath kits are the best in the world. Not only are they outstanding in design and function, they look good! In fact, most people find it impossible to tell apart a Heathkit product and a commercial equivalent.

Of course, the builder can tell them apart: not only has he/she saved money by building it themselves, they also have the satisfaction of knowing they've built it themselves! And, along the way, probably learnt a little more about the fascinating hobby of electronics, and developed new skills in construction techniques.

But Heathkits are much, much more than just a collection of electronic bits and pieces.

As anyone who has ever built a Heathkit will tell you, it's the manuals that set Heathkits apart from the rest.

Some idea of the importance that Heath places on the manual can be gained from the time it takes to prepare them: on average, Heath spends four times as long writing, editing, re-writing and drawing the manual as it does in actual kit design.

That's right, four times as long. Heath know that any competent engineer can design a circuit that works,.. they also know that the kits are normally built by hobbyists without the degrees or even the experience. They know that nothing is more frustrating than not being able to identify a component, or not knowing how to align or adjust a project.

Therefore nothing is left out. Every piece of information even the most novice constructor could need — even things like how to bend resistor pigtails.

Not only that, but everything you need to know to get the product to work — including comprehensive trouble-shooting and service notes.

And even then, Heath has a technical help service: in the unlikely event that your project doesn't work, there's always help available.

Hence Heath's motto: "We Won't Let You Fail"

HEATHKITS IN AUSTRALIA

Despite their international reputation, Heathkits have not been easily obtainable in Australia.

They've been around — but not so you could walk into a store and buy them.

Until now.

Dick Smith Electronics have, for many years, recognised the potential of Heathkits if made freely available.

As the leading kit supplier in this country for nearly two decades, DSE has had many requests for Heathkits. When the opportunity arose for DSE to import and sell Heathkits, we naturally said "Yes!"

Sure, we recognised that Heathkits were more expensive than most other kits. But they were worth it!

We also knew that there was a demand for the quality of Heathkits — particularly from retired people who had time on their hands — and knew of Heathkit's reputation.

DSE's dedication to the electronics hobbyists and enthusiasts of Australia and New Zealand meant that Heathkits would be one more service we could offer. And a top-of-the-line service at that.

So a selected range of Heathkits has been chosen and will become available through DSE almost immediately.

We've picked almost twenty kits which we have had demand for in the past. These will be available "off the shelf", many of them through your local DSE store.

Some may need to be ordered through the central computerised DSXpress Centre in Sydney (24 hour despatch to anywhere in Australia.)

We're deliberately not trying to stock the whole range in Australia or New Zealand: look at the Heathkit catalogue and you'll see it's immense! It's simply not possible to hold this amount of stock in a small market such as Australia/New Zealand.

This doesn't mean, however, you cannot get other Heatkits: we will order any kit in the Heathkit range against a firm deposit, with the exception of computer kits or learning/training aids.

You should keep in mind that some kits are specifically American in nature — such as NTSC colour TV's. Of course, if you specifically want an NTSC colour TV, we can order one for you.

Because of the rapidly fluctuating dollar, we cannot print firm prices on these kits: however, one phone call to our Heathkit Information Line will get you the current price.

SPECIAL INSTRUCTION MANUAL OFFER:

It's difficult to order from a catalogue, sight unseen. So here's our special deal:

If you're interested in a particular kit, you can buy the instruction manual alone. It tells you all about the kit, how to put it together, how to adjust/align it, and so on.

You'll be able to judge whether or not it's the kit for you.

Then, if you go ahead and buy the kit, we'll refund 50% of the price you paid for the manual. What could be fairer than that?

You can't lose — no outlay for a kit you might not want — and you'll be assured it's the right one when you order it!

THEY LOOK SO GOOD...

DSE takes pride in the kits we produce. Remember our slogan: They look so good your friends won't believe you built them...

We admit it! Heathkit does it better.

They look so good you won't believe you built them...

Heathkit — available from

DICK SMITH ELECTRONICS PTY LTD

World Radio History

Just a few of the Heathkits you'll find at Dick Smith Electronics. (Not all these kits will be stocked in all stores, but should be available same day in all capital cities).

Deluxe Antenna Tuner

Exactly match your antenna system to your transceiver: minimise losses, maximise efficiency. The Heathkit Antenna Tuner features very high power handling (1kW CW) over the full HF bands, with roller inductor, dual watt-meters and built-in 4:1 balun.

Cat G-3000 **$799**

Active Antenna

Just right for the SWL with no room! HF preamplifier with its own inbuilt whip antenna and provision for external 50 ohm antenna. Operates from 300kHz to 30MHz.

Cat G-3005 **$199**

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Cat G-2010 **$299**

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Work with FM? You need this one. Deluxe deviation meter accurately and quickly checks deviation from 2 to 75kHz, over the range of 25 to 1000MHz. No more reports of "over deviation, om!" — you can even leave this in line for continuous checks.

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Economical test gear — that really works well! Modulated and unmodulated signals from 310kHz to 110MHz — with calibrated harmonics to 220MHz. A must for every service shop — or for the serious hobbyist

Cat G-4005 **$149**

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Check out RF, IF even audio circuitry quickly and easily. Trace through until you find the fault. A must for the work bench.

Cat G-4015 **$149**

Digital Readout of Unknown Components

Imagine: just plug in any unknown L or C and get an instant readout. Why throw away components? Also ideal for tolerance sorting, checking losses & dissipation, and so on. Range is massive: 1pF to 2000uF; 1uH to 2000H.

Cat G-4020 **$699**

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Schools, colleges, clubs: here's the perfect way to find out all about the laser. The laser trainer includes a HeNe gas laser with modulator, also includes a receiver for detecting the beam and amplifying sound.

Cat G-2020 **$799**

(Tax Free price for schools, etc only $649)

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QRP transceiver just right for the novice or avid CW enthusiast. CW coverage on 80, 40, 20 and 15 metres with RF output up to 4 watts. Ideal for portable/battery operation too.

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Accessory Band Pack for QRP transceiver

Allows operation on WARC bands — 30, 17 and 12 metres plus 10 metres.

Cat G-3021 **$75**

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The Ultimate Weather Station

Get better weather information than the weather bureau gives! Famous world-wide, the Heathkit computerised weather station gives wind speed and direction, wind chill factor, temperature, barometric pressure (and whether its rising or falling)... everything! If your business is knowing the weather, the Heathkit weather computer is for you! Everything supplied — including sensors and cable.

Cat G-2000 **$999**

Everybody's HERO!

The robot of the future is here today. It's Hero Jr — from Heathkit, of course. More than just a robot, Hero Jr will become a real member of your family. He (she?) is pre-programmed: Hero Jr will wake you up (even listen to make sure you're awake!), remember dates and anniversaries, walk, talk, protect you and your home (even activate your security system for you!) and much, much more. You can re-program Hero Jr via its own keypad or with your home computer (needs RS232C link). Of course, Hero Jr is battery operated and comes with an AC recharger.

Cat G-1005 **$1395**

(Also available built up: Cat G-1000 @ $1995)

Accessories:

Infra Red Motion Detector
(for security applications) **$399**
Cat G-1010

RS232 interface
(re-program hero from your own computer) **$179**
Cat G-1030

Cartridge Adaptor
(for plug-in command cartridges) **$179**
Cat G-1050

Special Occasions cartridge **$69**
Cat G-1045

BASIC Cartridge
(Robotics Oriented BASIC Language — use when reprogramming with your own computer). **$179**
Cat G-1080

Spare Batteries
(set of 2 rechargeable) **$69**
Cat G-1040

Terms and conditions of sale:

For items stocked in DSE stores or the DSXpress centre, normal DSE terms and conditions apply.

For items from the Heathkit catalogue other than those normally stocked, DSE will order these for you on the following conditions:

(1) Price must be confirmed via the Heathkit Information Line — Sydney (02) 888 2105.

(2) A 25% non-refundable deposit must be made on any order (this can be done with your credit card as per normal sales).

(3) Normally delivery time from the US via seafreight is 8 to 10 weeks from order. Air freight is available (approx 10% extra) and this reduces the delivery time to approximately 4 weeks.

(4) Items ordered from the US do not qualify for our normal 14 day satisfaction guarantee or for refund: if in doubt about the kit you would like, take advantage of our special assembly manual offer.

(5) Quotations given for Heathkit products, whether written or verbal, are valid for 7 days only. This is because of the volatile nature of international currencies.

(6) Orders may be made by phone (toll free 008 226610), mail, fax, telex or any other of our normal order methods. If using phone, we suggest the order form overleaf be filled out to confirm the details of your order and retained by you.

Did you miss out on a Heathkit Catalog?

Some issues of this magazine did not contain the Heathkit Catalogue (it is in very short supply world-wide!)

Or it may be that some light-fingered larrikin has lifted, purloined or pinched it before you saw it...

Don't panic: send this coupon to The Heathkit Information Service, Dick Smith Electronics, PO Box 321, North Ryde — and we'll send you one free of charge.

Or if you talk nicely to your local DSE store manager he/she might be able to find one for you (just give them this coupon).

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World Radio History

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G-1010	Hero Jr I/R Detector	$399		
G-1030	Hero Jr RS232 Interface	$170		
G-1040	Hero Jr Spare Battery Set	$69		
G-1045	Hero Jr Special Occasions Cartridge	$69		
G-1050	Hero Jr Cartridge Adaptor	$179		
G-1080	Hero Jr BASIC Cartridge	$179		
G-2000	Computerised Weather Station	$999		
G-2005	The Most Accurate Clock	$629		
G-2010	Ultrasonics Cleaner	$299		
G-2020	Laser Trainer	$799		
G-3000	Deluxe Antenna Tuner	$799		
G-3005	Active Antenna	$199		
G-3015	Cantenna Dummy Load	$49.95		
G-3020	Amateur CW Transceiver	$499		
G-3021	Accessory Band Pack G-3020	$75		
G-4000	FM Deviation Meter	$435		
G-4005	RF Generator	$149		
G-4015	Signal Tracer	$149		
G-4020	Digital L/C Bridge	$699		

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World Radio History

Scanning & Marine Bonanza! The best value in communication around.

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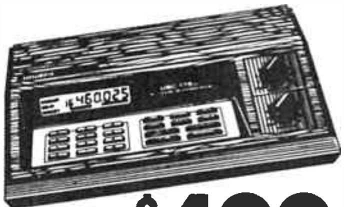
New! Uniden Bearcat 16-Ch. Scanner

UBC-175XL

Here's what scanning is all about! 16 Channels over 11 ranges - including aircraft and weather. 8-Digit display: freq., Lockout and Priority. Direct channel with manual up/down scanning or auto search ... and much more.



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Cat D-2812

Frequencies Covered
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- 136-174MHz • 406-512MHz

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- 136-174MHz
- 406-512MHz

Packs all the best features into a compact, go-anywhere unit just 74x35x179mm. Covers 9 freq. bands with direct channel access and auto search. Enjoy selective scan delay, priority and auto lockout. Includes carry case, ear plug, (AC adaptor and battery optional). Cat D-2813

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27MHz Helical

Superb whip for all hull types ... wood, cement, fibreglass ... and it doesn't require a ground plane! Complete with mounting base, cable and simulated ground plane.

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All just $9.50 pair

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Campbelltown Mall Queen St	**Campbelltown**	(046) 27 2199
Shop 235, Archer St Entrance	**Chatswood Chase**	(02) 411 1955
147 Hume Hwy	**Chullora**	(02) 642 8922
164 Pacific Hwy	**Gore Hill**	(02) 439 5311
315 Mann St	**Gosford**	(043) 25 0235
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450 High Street	**Maitland**	(049) 33 7866
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818 George St	**Railway Square**	(02) 211 3777
125 York St	**Sydney City**	(02) 267 9111
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VIC		
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260 Sydney Rd	**Coburg**	(03) 383 4455
1150 Mt Alexander Rd	**Essendon**	(03) 379 7444
Nepean Hwy & Ross Smith Ave	**Frankston**	(03) 783 9144
Shop 9, 110 High St	**Geelong**	(052) 43 8522
291-293 Elizabeth St	**Melbourne City**	(03) 67 9834
Bridge Rd & The Boulevarde	**Richmond**	(03) 428 1614
Springvale & Dandenong Rds	**Springvale**	(03) 547 0522
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Dear Customers,
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.

MAJOR DICK SMITH ELECTRONICS AUTHORISED RESELLERS

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Offer concludes 31/11/86 or until stocks last. Prices can be increased without notice due to fluctuations in currency, high interest rates, government taxes and imports.

World Radio History

A real knocker!

Dear Sir,

I enjoy reading AEM for its editorial approach.

In Septembers' AEM I noted your search for a novel doorbell sound. My search for the ideal doorbell ended some years back, though I have yet to do anything about it. On pressing the bell button, it gives the sound of three thumping great knocks on an imaginary large oak door.

If, after a while, one finds this electronic knuckle too much, it could always be toned down to a moderate rapping. Guaranteed to have the button pushing debt collector smiling as you open the door!

Of course, if you leave your residence there is a third option, say a loud bark followed by sinister scratching which could deter those who take delight (and your possessions) in an empty house or flat. A symbolic blow to those electronic ding-dongs!

Ned Ludd,
Bardon, QLD

Corrections to 'The Mindless Mouth'

Dear Sir,

Your "Mindless Mouth" speech synthesis feature (February '86, page 20) has some errors which should be corrected for the sake of people wishing to follow the arithmetic presented.

On page 21, beneath Figure 4, the text should read as follows: "... 128 possible values), it can be represented by a 7-bit (digital) binary number. One second's worth of speech would require 6000 samples. To store those 6000 samples would require a total of 6000 × 7 = 42000 bits, or 5.25 kilobytes ... 20 minutes ... 6.3 megabytes."

This assumes that there is no polarity bit but just seven amplitude bits to represent the 128 levels and that 8-bit bytes are used with the 7-bit samples packed "serially" into sequential memory address, i.e: can have eight samples in seven bytes.

I liked the DOS article in SoftTalk in the same issue.

Graham Goeby,
Greensborough, VIC

A peculiar FAX problem

Dear Sir,

I have a problem with FAX reception on my Listening Post project (AEM3500). The problem specifically lies with FAX, since it works perfectly in the RTTY/CW modes.

The problem with FAX can be seen from the map I have included (reproduced here). It appears that every alternate line or so is deleted, producing discontinuity (note the text on the side and isobar lines etc). The vertical lines however, produce a clear grid pattern. This was achieved by entering "AA" at address OB84 to minimise slope.

The signals were recorded on 12.675 MHz, however exactly the same problem is experienced with AXM signals. (12.675 MHz is a far stronger signal where I live).

I am currently using a Yaesu FRG 7700 and a CP-80 'parallel' printer coupled to the Microbee via an RS232-to-Centronics Interface (ETI project 675) from the serial port. Everything else appears to be pretty well 'standard' apart from the interface, could this be the problem? I've run numerous graphics screen dumps etc, successfully with the interface without any hitch, so where does the fault lie and could you suggest a possible solution?

Nicholas Drewitz,
Busselton, WA

Can anyone assist?

Apple //c and the Listening Post

Dear Sir,

I have just completed your Listening Post project and find it will not work on my Apple //c. I have worked out what the problem is but ask your advice on modifications to the Listening Post to make it work on the //c.

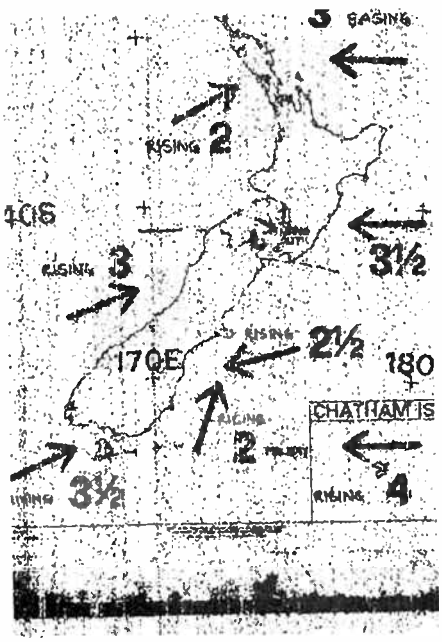
The problem with my //c is that the logic 1 on the joystick fire button needs to be 4 V, or greater, at 8 mA to trigger the program. On my Listening Post the maximum voltages to fire buttons 0 and 1 are about 3 V maximum, when each frequency is tuned for peak output.

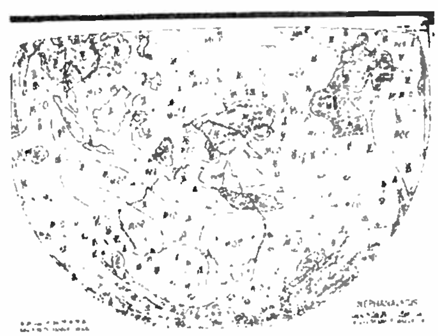
I have checked all the components several times and everything checks out OK.

Bryan Wilson,
Grovedale, VIC

The problem is that the pull-up resistors R6 and R12 will not source the current required by the //c's joystick port. You could lower the value of R12 to around 100-120 ohms, but you can't do the same for R6. The CW output comes from pin 6 of the XR2211 which is a common emitter transistor with a maximum collector current rating of 5 mA. You might drop R6 to 1k, but no lower, and see if the //c responds. Have any other //c owners successfully used the Listening Post; if so, have you run into the problem and how did you solve it?

Roger Harrison





Listening Post and the Tandy CoCo

Dear Roger,

Find enclosed weather maps I have received using the AEM3500 with my Tandy 64k Color Computer and FAX software from Locus Technical in Victoria. I use a serial-to-parallel interface to run a FAX120 printer.

Bryan Buckingham,
Potts Point, NSW

World Radio History

The ionosphere and radiowave propagation — an update

John Kennewell

Learmonth Solar Observatory,
IPS Radio and Space Services

Why do we need to consider the ionosphere, and radiowave propagation? Surely we know already all there is to know about the subject. And anyway, isn't HF radio virtually obsolescent nowadays? Sure, radio amateurs use the HF spectrum, but doesn't all commercial and military traffic go by satellite in this day and age?

THE ANSWER to all but the first question is a resounding NO! And it is for that reason that we still have a long way to go in learning more about the ionosphere; how to make use of it where we can, and how to minimize its effects on our systems where we must live with it.

The ionosphere has traditionally been used to provide transglobal communication. Broadcasts of news, views and entertainment are made by shortwave transmitters located in practically every country in the world. Two-way communications use ionospheric reflections to provide circuits for military, government, private and amateur stations in just as many nations. Until the advent of the geosynchronous communication satellite, submarine cables and HF circuits were the only means of real-time international comunication. And while it is true that much traffic is now handled by satellite, it has also been found that satellite circuits are not themselves immune to ionospheric effects.

There are many reasons why HF propagation will continue to be vitally important for a long time to come. Some of these reasons are economic and some relate to new uses to which the ionosphere may be put. In tropical and mountainous countries HF broadcasting is the only way to economically reach all the population. Medium wave ground-wave transmissions would simply not penetrate into all the valleys and plateaus without an enormous number of transmitters. Shortwave broadcasting likewise is the only way that one country can reach the population of another with its 'message'. [International radio broadcasting from satellite has been proposed, but this will involve nuclear reactors to provide sufficient power and immense antenna structures — available to only a very few select nations — and is also still subject to the vagaries of the ionosphere.]

In most nations, HF communications are the only feasible way to provide mobile communications. The US Department of Defence some 10 years ago was of the opinion that HF communications were almost a thing of the past — that is, until it was realised that two one-megaton nuclear devices exploded at appropriate altitudes above the atmosphere could probably wipe out close to 100% of all military satellite communication capability.

The last 10 years has since seen a great revival of interest in HF communications by US DoD forces (and no doubt others). New uses for and problems with the ionosphere have surfaced with transionospheric propagation (both with regard to satellite communications and satellite tracking) and with new developments such as over the horizon radar, and precision navigational aids. The space shuttle travels through the ionosphere which can cuase considerable perturbation in delicate measurements carried out from the cargo bay.

The ionosphere, as part of our near-space environment, will thus be of vital importance to us whilst we remain a technological society. It is for this reason that continued study and research of this environment is essential to our understanding and application in the field. Results of such research, and new techniques available to measure and exploit the

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URSI-IPS CONFERENCE ON THE IONOSPHERE AND RADIO WAVE PROPAGATION

From the 11th to the 15th of February 1985, the third Australian conference on the Ionosphere and Radiowave Propagation was held at the School of Electrical Engineering, University of Sydney. The conference was jointly sponsored by the International Union of Radio Science (URSI) and the Australian IPS Radio and Space Services, and was attended by about 100 delegates from Australia and overseas. Countries represented included Indonesia, India, the UK and the USA, New Zealand, France, the Federal Republic of Germany, Fiji and South Africa.

During the five days of the conference about 70 papers were presented under the headings of five symposia:

- **New techniques**
- **Experimental and theoretical studies**
- **Models and their applications**
- **Forecasting and specification of the ionosphere**
- **Practical application**

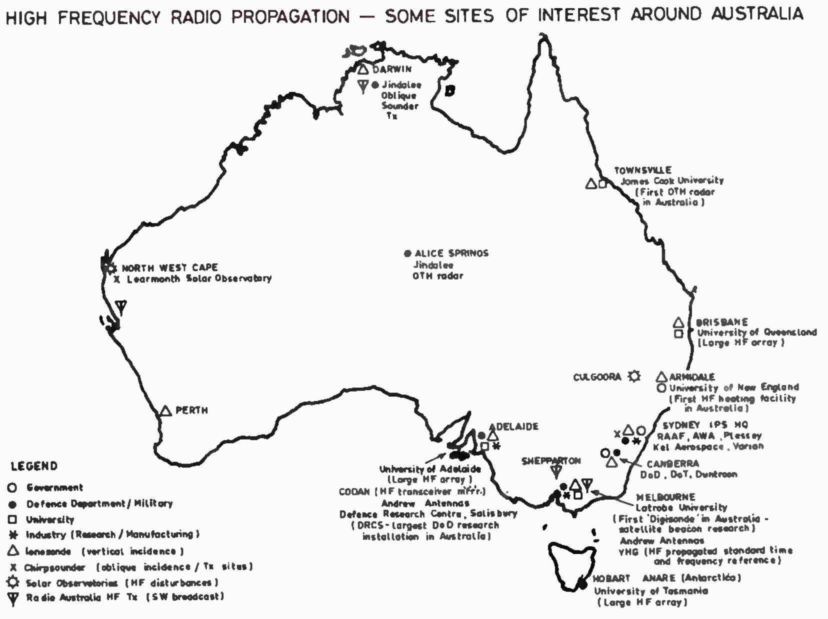
Interests covered thus ranged from pure ionospheric research, through directed research and equipment development to specific applications and technology employed in areas ranging from the military to the needs of developing countries.

While it is obviously not possible to list the titles of all papers presented, a few titles of interest are mentioned below:

- **Remote sensing with the Jindalee Skywave Radar**
- **Ionospheric forecasting for specific applications**
- **Use of HF radio by the Australian defence force and the DOD**
- **The theoretical and experimental investigation of the ionosphere**
- **Search and rescue using HF DF techniques**
- **The relationship between marginal HF communications and man-made noise**
- **HF noise measurements — the Jindalee surveillance system**

The complete proceedings of this conference may be obtained as IPS Technical Report TR-85-04 for $12 including postage within Australia from the **Assistant Secretary, IPS Radio and Space Services PO Box 702, Darlinghurst, NSW 2010.**

World Radio History



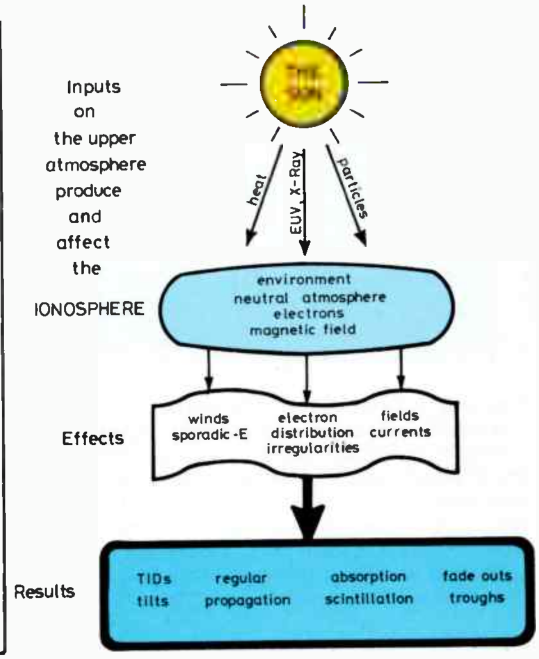


Figure 1. The ionospheric system (D. G. Cole).

ionosphere were discussed at an international conference held in Sydney early last year (see box for details). This article aims to present in very condensed form some of the ideas presented at this conference — a status report on the ionosphere and radiowave propagation.

There are three sections: *Knowledge* of the ionosphere — what is new in our understanding, and what still remains to be explored: *Techniques* — to help us explore further: and *Applications* — the new (and old) uses to which our increased knowledge of the ionosphere has contributed or made possible. We will find however, that as we explore these areas that they are interlocked. Research suggests new applications, and the applications in turn reveal new knowledge of their environment.

Knowledge

The ionosphere is the result of solar inputs acting upon the netural (i.e: un-ionised) gases that comprise the Earth's upper atmosphere (Figure 1). These inputs are heat, extreme ultraviolet (EUV), x-ray and particulate radiation. The primary effect of these inputs is to ionise some of the gas

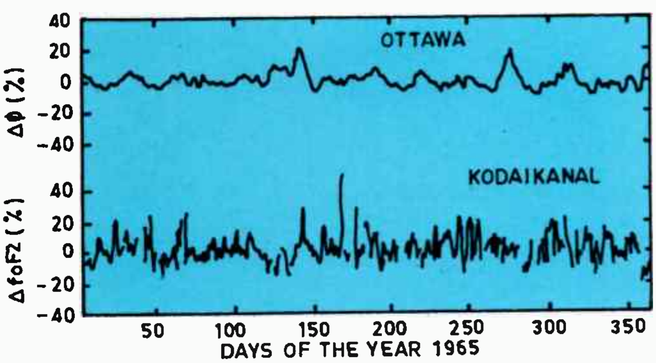


Figure 2. Graph showing the unresolved (and thus unpredictable) component in ionospheric critical frequencies. The top plot represents the percentage deviaton of the 10 cm (3 GHz) solar radio flux (a good index of solar UV output) from corresponding monthly means. The bottom plot is a similar deviation for an foF2 value at a station in India. If the ionosphere was dependent only on the solar radiation, the two plots would be very similar. This is obviously not the case. The ionosphere has a much higher frequency content in its deviate behaviour than does the Sun. These variations are thought to be due to changes in the neutral atmosphere. (S. Aggarwal).

molecules or atoms, producing ions and electrons. The electrons, being very light are very responsive to any radio frequency energy that happens by. The electrons are set into oscillation by the RF energy, and thus absorb and reradiate this energy. The net result is refraction and/or absorption depending upon the density of the surrounding neutral gas. Thus while refraction occurs in the high F-layer (where the gas density is very small), mostly absorption occurs in the low D-layer where the neutral atmosphere is more dense.

There are other environmental parameters which tend to complicate the situation. At any one point in the atmosphere the solar zenith angle changes with the rising and setting of the sun. Not only does this lead to a diurnal change in the density of ionisation, but the varying heat input also leads to strong winds which blow the ionisation around from the daytime to the nighttime sector. The solar output is not constant and this leads to changes in the ionisation density with timescales varying from minutes to decades. The ionisation layers within the atmosphere are now always uniform and are not always flat. Patches or clouds or intense ionisation may form.

The Earth's magnetic field plays a big role in the motion of the free electrons once they have formed. It also controls the motion or entry of solar particles into the Earth's environs. Particles are funnelled into the polar regions, and are also trapped high in space to form the Van Allen radiation belts. The presence of electron distribution anomalies leads to temporary charge imbalances which give rise to electric fields and in turn various currents. All these phenomena have an effect on electromagnetic energy being reflected from or passing through the region.

Observation of the ionosphere using radio waves over the last few decades has elucidated many of the variations that occur. Because of the world distribution of technologically inclined societies, the mid-latitude ionosphere has received the greatest amount of attention. It also happens that the mid-latitude ionosphere is better behaved and less subject to disturbances than either the equatorial or polar regions. As a result, the behaviour of the mid-latitude ionosphere is reasonably well understood. Monthly median predicted critical frequencies are now quite accurate. However deviations of individual days still present a problem. That these deviations are not related to changes in the solar output can be seen quite clearly in Figure 2. The ionospheric critical frequencies show a more rapid fluctuation than does the solar ▶

World Radio History

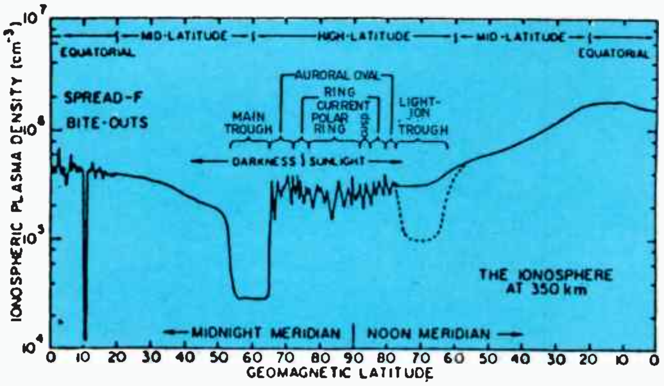


Figure 3. A perspective of phenomena in the ionospheric F-layer. The diagram is an idealised representation of ionospheric behaviour along a great circle path starting at the midnight equator, travelling north or south through the pole and returning to the noon equator. It represents the typical disturbances found along this path. The mid-latitude region is fairly well behaved, but both the equatorial and polar ionospheres suffer considerable fluctuations. (E. Szuszczewicz et al).

output of x-rays. It is thought that this variation is related to changes in the density and content of the upper atmosphere — the thermospheric weather if you like. It has so far proven difficult to develop a 'barometer' to monitor and predict these changes which result in MUF variations.

The mid-latitude problems however, pale into almost insignificance compared to the variations that are encountered in both the equatorial and polar regions. The problems are shown in an idealised fashion in Figure 3. The equatorial ionosphere is subject to large electron density irregularities. It is believed that bubbles (depleted regions) form in the lower layers, become unstable and rise up to the F-layer. These irregularities and other effects produce the phenomenon known as spread-F which leads to distortion of HF signals passing through the region. Multiple closely-spaced reflection points spread the wavefront of a signal in time and thus limit the speed at which data may be transmitted. Spread-F also appears to be associated with transequatorial propagation (TEP) whereby much higher frequencies than normal may be supported along paths crossing the equator. Intense "bite-outs" (electron density depletions) tend to form and change rapidly in time and space in the equatorial region, making prediction of useable frequencies a forecaster's nightmare.

Intense study of this region has been underway for the last 10 years in an attempt to unravel the variations that occur and to develop more accurate predictions schemes for and models of the equatorial ionosphere. One of the most interesting points to come out of satellite studies, is that the concentration of electrons existing above the normal HF reflection heights (the 'topside' ionosphere) has been seriously underestimated by past ionospheric models.

The polar ionosphere is likewise subject to even more extreme variations. Magnetospheric coupling (for this is where the magnetic field lines disappear into the bowels of the planet) and particle precipitation effects (the solar and cosmic particles spiral down the same magnetic field lines) cause frequent problems. This region is also probably the least studied simply because of the lack of population in these areas. Again, satellite techniques are providing vital additional data.

Both the forecaster and the researcher require accurate mathematical models of the global ionosphere. Deficiencies in current models are steadily being identified and improvements made as more and more data becomes available. Attention is also being paid to the development of simplified models for computational and prediction efficiency. At one extreme is the work of the Naval Ocean Systems Center (NOSC) at San Diego, California in the development of the MINIMUF type of program. MINIMUF is an ionospheric prediction program that can be run in very limited memory on practically any microcomputer. It must be realised however, that consistent with its very simple physical model of the ionosphere (which does not take into account the very important effects of the geomagnetic field) the errors involved in prediction must necessarily be quite large (see Figure 4). However, microcomputer development now has almost reached the point where the larger and more accurate prediction systems (such as the empirical model used by IPS) can be readily accommodated.

Travelling ionospheric disturbances (TIDs) are still an area of research where conflicting data has given rise to interpretation problems. Do clouds of higher electron concentration really move large distances through the ionosphere, or are most effects observed due to turbulent motion and rotation of the cloud? This question was forcefully put to the conference by Professor Whitehead from the University of Queensland.

There was universal agreement at the conference on the need for an intensive and concentrated global ionospheric study period to obtain simultaneous and continuous geographically distributed ionospheric measurements. It is anticipated that such an effort would be a designated year toward the end of the decade (or early in the next) where maximal use would be made not only of the new techniques developed, but also of the whole range of older equipment and low cost satellite studies employed and in use throughout many nations. Might it not be possible that the amateur and SWL community worldwide could concurrently conduct a mini-GIS? Coordination and comprehensive data reduction are the clues to the success of any endeavour of this kind. ▶

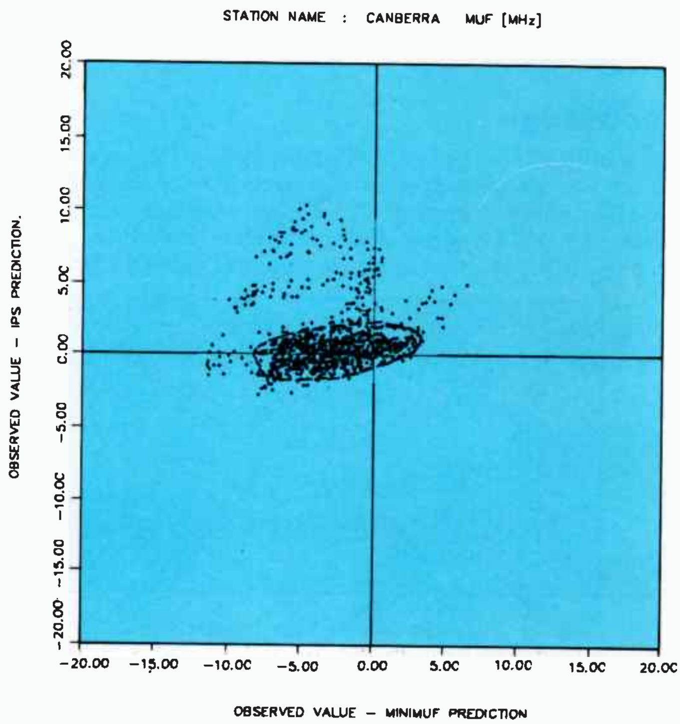


Figure 4. A comparison of MINIMUF and IPS prediction. The dotted line encloses about 90% of the data. The dots outside this area are most probably due to non-normal (i.e: disturbed) conditions. The scatter in the IPS predictions is thus about 4 MHz uniformly distributed either side of the actual value (i.e: ± 2MHz). The scatter in the MINIMUF predictions is about 15 MHz and consistently overestimates the MUF values.

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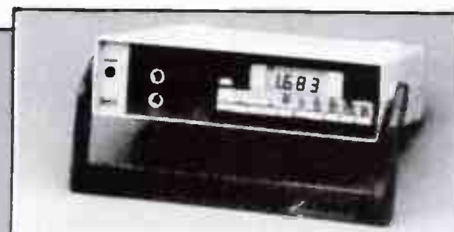

EDM-2347

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EDM-2347 SUMMARY
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EDM-2116

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EDM-2116 SUMMARY
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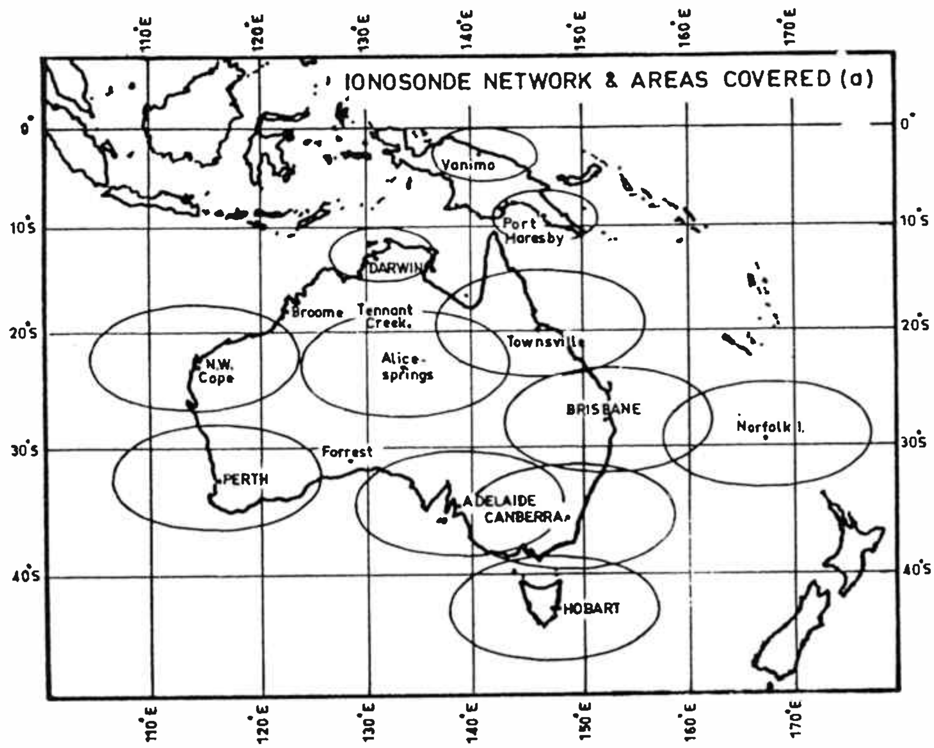

Figure 5. IPS Radio and Space Service plans to establish a network of ionsondes (IPS 5A) that will be remotely interrogated from Sydney to provide real-time ionospheric data to customers. The proposed distribution of ionosonde sites is shown here together with the geographical coverage achieved (G. K. Webster).

Techniques

New instruments and techniques have been developed not only to satisfy the needs of more intensive research programs, but to support the needs of data communicators who require increasingly more frequent evaluation of the ionospheric circuit over which their signals are transmitted.

Ionosondes have traditionally been the device through which information about the state of the ionosphere has been determined. These have been joined by other devices as listed below:

TECHNIQUE	FREQUENCY
Partial Reflection	1.8 – 6 MHz
Ionosondes	1 – 30 MHz (swept)
Coherent Radar	10 – 100 MHz
Incoherent Radar	10 – 500 MHz

An ionosonde is essentially a pulsed vertical incidence radar that produces a record of ionospheric virtual height versus frequency. Until recently, the output of an ionosonde was recorded on film which then had to be developed and manually scaled to obtain the required information. Provision of real-time data from these units was thus out of the question. Ionosondes produce useable signals only from ionospheric layers that give strong reflection. Information about the absorbing D-layer is thus not available. The technique of partial reflection uses high power transmitters to measure the attenuation of a signal in the D-layer and provide information about the electron density in the lower reaches of the ionosphere.

Large HF antenna arrays with narrow and steerable beams enable radars to map the spatial variation of ionised clouds, and to follow their movement.

VHF and UHF very high power radars are used to obtain information about small ionospheric irregularities that do not produce a return signal on HF radars. These instruments are able to provide a three dimensional map of ionospheric electron density. The VHF radars require irregularities with some degree of order, such as small areas (on the order of a wavelength) that have been aligned by the magnetic field. UHFG radars will produce returns from even smaller ionised structures, although they require immensely high powers to do so. Only five UHF incoherent radar facilities have been built so far, and unfortunately none are located in or near Australia.

To overcome the deficiencies of the conventional ionosonde a new class of digital ionosonde has recently been designed. These not only provide significantly more information about the ionosphere, but do so in digital format that can be transmitted in real-time. Some of these instruments even do the job of actually analysing the ionogram and providing estimates of the normally required parameters for prediction purposes. A comparison of the data provided by the conventional and newer ionosondes is given below:

OBSERVABLES	CONVENTIONAL IONOSONDES	DIGITAL IONOSONDES
Range	yes	yes
Amplitude	sometimes	yes
Phase	sometimes	yes
Polarisation	no	yes
Angle of arrival	no	yes
Doppler shift	no	yes
Data access	after processing film and manual scaling	immediate dial-up

The ability to provide angle of arrival information can be used to give an indication of ionospheric tilts. Layer tilts produce path asymmetry in propagation ('one-way' propagation effects). Local tilts increase the probability of multipath propagation and thus produce fading and errors in direction finding. For both direction finding and OTH (over the horizon) radar it is very useful to be able to predict ionospheric tilts.

Real-time ionosonde networks are being developed for short term forecasting and now-casting modes of operation. One network will be established by IPS in Australia with site locations as shown in Figure 5. This will provide a good geographic coverage of the continent, and each ionosonde will be remotely interrogated from Sydney at 15 minute intervals if required. Data will be processed immediately and will be available to support most customers' needs. This type of serv- ▶

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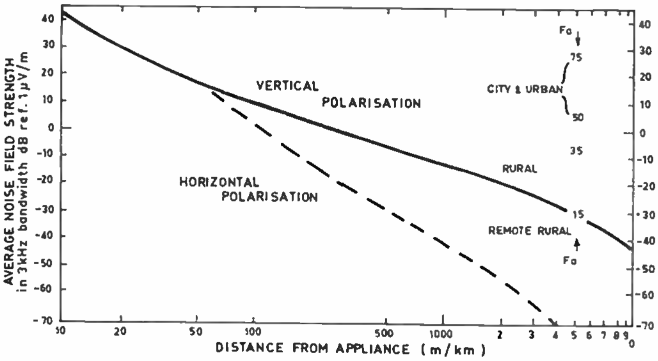


Figure 6. The variation of man-made noise with distance and antenna polarisation. Measurements were made at 5.5 MHz. Note the significant advantage offered by horizontal polarisatin with increasing distance from the interfering source. (R. T. Rye).

ice is essential to keep pace with the increasing use of the ionosphere to support high speed data links.

When the above service is not adequate, real-time channel evaluation procedures are now available that allow direct frequency management of the users' HF circuits. This type of evaluation is conducted by transmitting a pilot tone together with the data (usually in some form of time-division multiplex) on the channels in question and performing measurements at the receiving end of the time and frequency spread in the received signal. In this way a continuous check on channel quality is achieved, and this can be used to control what channels should be used from moment to moment. All this however, is very costly, and in general would only be used by an organisation with large traffic requirements between fixed sites.

In the research line it is now possible to perform a relatively controlled ionospheric experiment. Instead of waiting around for a TID to occur a very large (multimegawatt) HF transmitter can be used to heat up the ionosphere and produce a controlled irregularity. Such a heating facility, as with a UHF scattering radar, is very costly and usually requires multi-national cooperation. It has been proposed that Australia consider the construction of a heating facility to take advantage of the excellent ionospheric diagnostic equipment that already exists here.

In spite of the plethora of new instruments available it was emphasized that the ionosonde is still central to ionospheric research and prediction. Although labour intensive, the older ionosondes can also provide much more information than is usually reduced from the ionogram records. Their relatively low cost thus makes them ideally suited in applications where finance is not available for the more expensive technology.

Finally, a large number of papers, particularly from the Indian sub-continent showed the power but simplicity of satellite beacon studies. The technique involves monitoring of CW beacons from geosynchronous satellites. Records of either or both the amplitude and polarisation of the beacon signal may be made. The polarisation measurement reveals the changes in the electron content of the ionosphere, whereas the amplitude measurement, through the detection of scintillations, monitors the presence of ionospheric irregularities. This technique can even be responsibly used to predict some disturbances to HF propagation up to a few hours in advance.

The equipment involved, particularly the amplitude measurement, is quite minimal. A large number of low cost satellite beacon stations, together with a few ionosondes can provide a very comprehensive and economical ionospheric monitoring network.

Applications

The present use and interest in HF radio propagation was made abundantly clear at the last symposium (Practical Applications) held on the Friday of the conference when the lecture theatre was filled beyond capacity.

Emphasis was made of the fact that HF is still very important for easy low-cost general communications. This is even more true in developing countries where HF may be the only communication available. A case mentioned in point was the South Pacific Islands. The military also places great importance on HF for the reasons of mobility, economics, and as a vital backup.

Because the military regard HF as a satellite alternative, it is essential that methods be developed to transmit digital signals over an ionospheric channel at considerably higher speeds than have formerly been used. With real-time channel evaluation coupled with direct frequency management it is now possible to employ HF digital communication at speeds of up to 2400 baud. It is hoped that even greater speeds will be attainable with further development. At the present, most data is sent using parallel tone modems, but work is

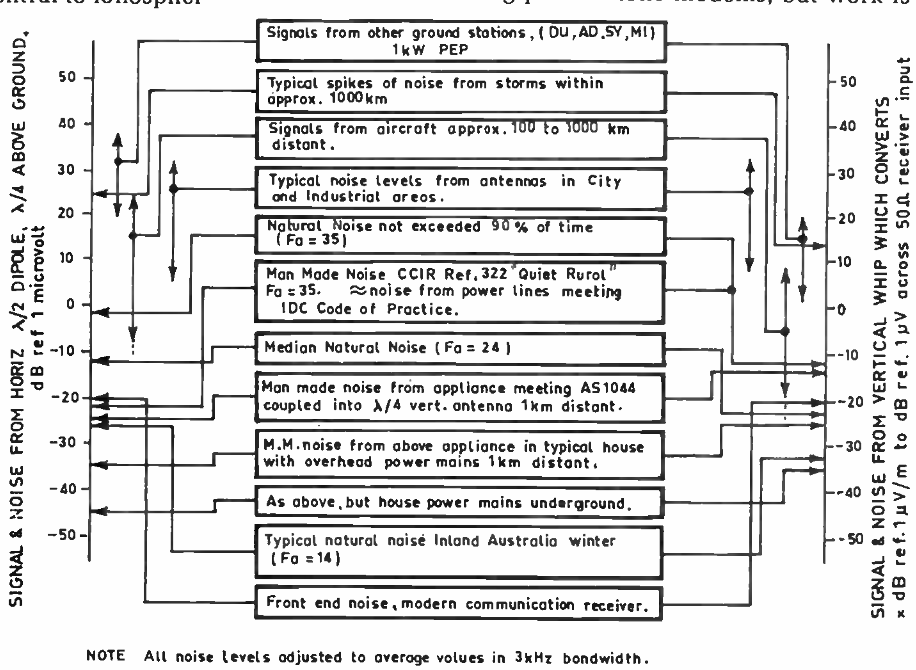
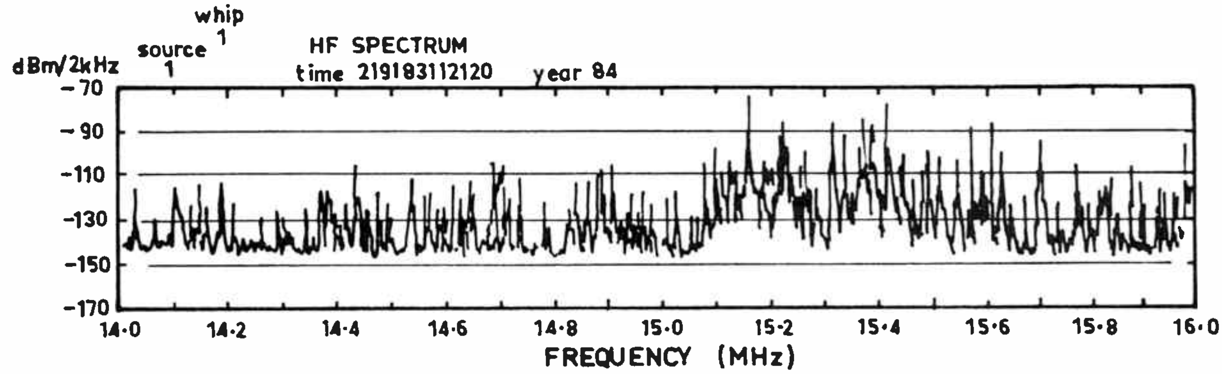


Figure 7. Comparative noise and signal levels measured at Melbourne airport on 5.5 MHz at midday. Note that signals from distant aircraft are below the noise levels experienced from antennas located in city and industrial areas. (R. T. Rye).

World Radio History



Figures 8. Signal levels in a 2 MHz segment of the HF band. This frequency range from 14 to 16 MHz covers both the 20m amateur band (14.00 to 14.35) where the average signal is low, and the 19m shortwave broadcasting band (15.10 to 15.45) where signals levels are as high as for any other single allocation class. (B. D. Ward).

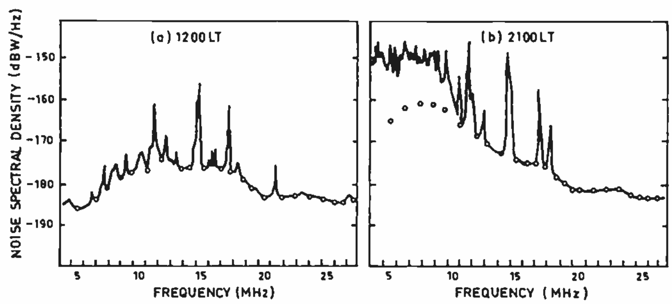


Figure 9. Background noise measurements across the HF spectrum made from a quiet receiving site near Alice Springs. The open circles are estimates of the true atmospheric background noise (contributed mainly from distant thunderstorms around the world). At noon the peaks are primarily due to shortwave transmitters broadcasting on the allocated freqeuncy bands (e.g: the 13, 16, 19 and 25 metre bands are prominent). The night record shows the enormous worldwide usage of the HF spectrum (e.g: below 10 MHz) where there is virtually no unoccupied 2 kHz channel (B. D. Ward).

rapidly proceeding to evaluate and adapt serial modems to ever higher data rates.

Microwave (low GHz) satellite communications (trans-ionospheric) and space-track radars are affected by ionospheric disturbances. Both the range of a spacecraft, and its apparent position in space is dependent upon the electron content of the ionosphere. Satellite beacon measurements are here invaluable for providing correction factors. VLF navigation systems (such as OMEGA) are also affected by changes in the ionosphere, and it was shown that diurnal phase changes can introduce position errors, if not corrected, of up to 25 km.

Noise is a great problem in all HF communications, especially in urban environments. Two very interesting papers were presented relating to both the man-made and the 'natural' noise background in the HF spectrum. Ron Rye, of the Department of Transport, presented two graphs that illustrate the influence of distance and antenna polarisation on interfering signals (Figure 6), and also show the various factors that contribute to the radio noise environment (Figure 7).

Dr Ward, of the Jindalee project, presented spectral views from one of the quietest locations in Australia. Figure 8 will be of interest to the radio amateur as it shows channel occupancy over a 2 MHz range covering both the 20m amateur allocation and the 19m broadcasting allocation. Figure 9 illustrates the typical background noise across the majority of the HF spectrum.

IONOSPHERIC MEDLEY

- The moon has a tidal effect on the ionosphere which can change values of the critical frequencies (e.g: for F2) by up to 0.5 MHz.
- Patches of ionization in the D-layer have been observed to move with speeds around 100 m/s. This is the expected speed of the atmospheric winds at these heights.
- Tilts of sporadic-E layers exceeding 10° are very common and the tilt can be as much as 30°.
- Both spread-F and spread-Es conditions appear to be related, and are thus most probably produced by the same or similar disturbances.
- Waves travelling in the ionosphere (TIDs) can produce changes in foF2 for up to 1 MHz.
- Even in geomagnetically quiet conditions unpredictable (as yet) variations in mid-latitude foF2 values are on the order of ±0.5 MHz. These are not due to solar effects, but are most probably due to changes in the neutral atmosphere characteristics.
- The error rate in HF digital communications is dependent on the signal to noise (S/N) ratio for S/N 30 dB. For S/N 30 dB, the error rate is also dependent upon the doppler spread and time-delay spread of the received signal.
- Partially reflecting sporadic-E consists of ionization clouds varying in size with the smallest dimension between a few kilometres and 25 km horizontally.
- F-region travelling disturbances display rapid changes after moving only relatively small distances (e.g: 100 km).
- Recent sophisticated signal processing techniques have made it possible to detect HF communication signals 20 dB below the noise level, together with providing coarse directional information.
- Ionospheric irregularities monitored between Macquarie Island and Melbourne appear to have travelled with speeds of between 200 and 1000 metres/second.
- Westward propagation of VLF signals at mid-latitudes suffers more attenuation than eastward propagation. This, and similar velocity differences are due to effects of the Earth's magnetic field.
- Apparent motion detected in ionospheric irregularities may be due to random turbulent motion rather than bulk horizontal motion.
- There exists an enormous amount of satellite ionospheric data in World Data Centres that awaits someone to analyse it.

Looking at these graphs it becomes obvious that the international short-wave broadcasters radiate more power than any other single user class. Figure 9(b) shows the tremendous world-wide usage of the HF spectrum. If you had any doubts

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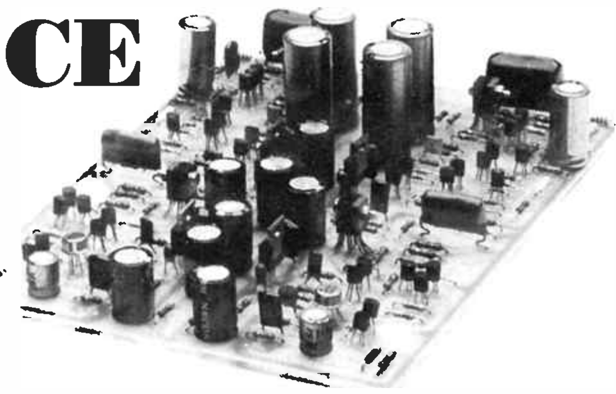
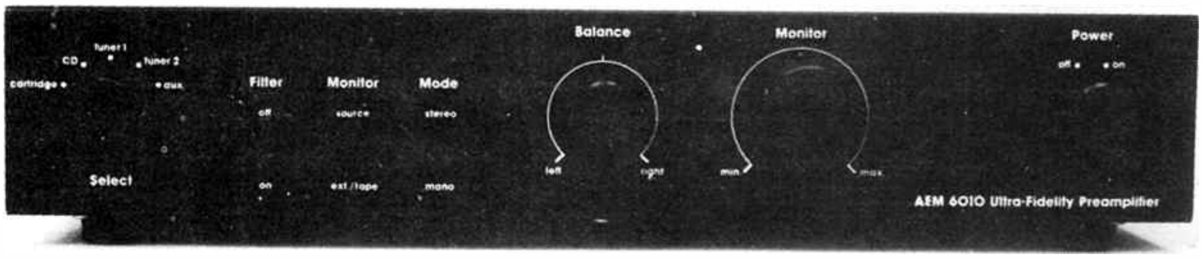
AEM KIT CONSTRUCTION SERVICE





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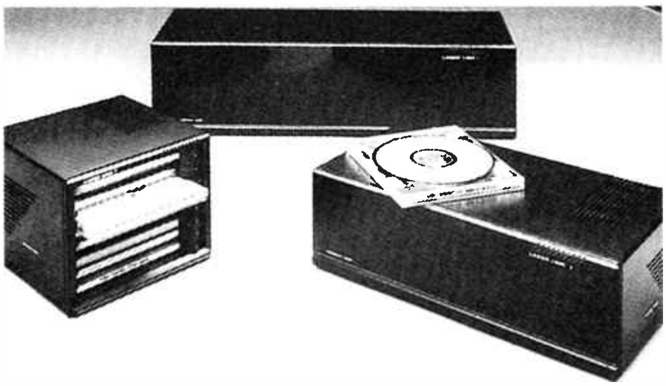
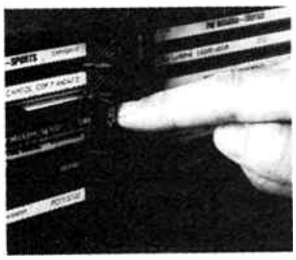
Modular CD storage system

A newly-released storage system for compact discs has been launched here through local audio accessories distributor, Communications Power Inc.





Made by Creative Point of the USA and going under the brand name of "Laserline", the CD storage units feature a special Securing-Release Mechanism (or 'SRM', as they call it).

The special mechanism simply requires a slight push to release the selected disc cartridge, which is pushed forward by a spring mechanism for easy removal. A cartridge is stored by simply sliding it into a vacant slot where it is securely locked into place by means of the SRM.

The modular units come in three models: the CD-800, which holds eight CD cartridges, the CD-1200 which holds 12 cartridges, and the CD-2400 which holds 24.

Further details are available from **Communications Power Inc., PO Box 246, Double Bay 2082 NSW. (02) 357 2022.**

NEW TAPES FROM JVC

A new range of audio tapes from JVC has been announced by Hagemeyer Australasia, comprising four models in both C60 and C90 formats.

The F1 series, JVC claim, provides improved frequency response at low cost. This is a Type 1 (normal position) tape with a plain polyester film base material. Apparently, it's a reformulated version of an earlier product.

The UF-I and UF-II series are entirely new formulations, designed to take advantage of the growing demand for an analogue tape capable of recording from a digital source. Both feature a stylish, transparent 'smoked' plastic, heat resistant shell. The UFI is a Type 1 tape, featuring a maximum output level (MOL) of +4.0 dB at 315 Hz and -6.0 dB at 10 kHz. The UFII, a Type II tape, features a MOL of +3.0 dB at 315 Hz and -8.0 dB at 10 kHz.

Having been at the forefront of metal tape developments earlier this decade, JVC continues their tradition with the introduction of the ME-PII metal tape. This new metal tape offers extended frequency response and dynamic range, according to JVC, making it ideal for recording digital sources, for mastering and first generation copies. The MPE-II features a MOL of +7.0 dB at 315 Hz and +1.5 dB at 10 kHz.

Full details on the range are available from **Hagemeyer (Australasia) B.V., 5-7 Garema Circuit, Kingsgrove 2208 NSW. (02) 750 3777.**

New Sony CD

Sony Australia has released the CDP-203ES CD player, a new system designed to give the audio enthusiast the high-quality sound of CD in a logical easy-to-use format.

In this model, Sony has made an attempt to assure 'complete' bass sound reproduction, an area of importance to the true enthusiast, by the use of large capacitance power transformers, high-speed diodes and large value filter capacitors.

This system incorporates functional features like complete search, 20-key direct music select, index and manual search, automatic music search and one-touch random music search programming allowing up to 20 music selections.

The full-function display includes a music calendar and six-mode time keeper function which indicates the total playing time, remaining time of the total disc and programmed selections, time elapsed and remaining time of current selection.

All major functions can be operated with the included remote control commander including, the 20-key random music selector.

The suggested retail price of this unit is $999 and is available through the Sony dealer network now.

Joint venture in car audio

Philips Netherlands and the Gold Peak Industries group of Hong Kong have signed an agreement to form a joint venture for the production and marketing of car audio equipment.

The joint venture, called *Car Audio Electronics (Hong Kong) Ltd (CAE)*, will be established in Hong Kong. It is envisaged that actual production will be done in the People's Republic of China by a company to be formed by CAE together with a local organisation.

Philips will supply the marketing know-how. Management and industrial know-how will be supplied jointly by Philips and Gold Peak.

Participation in the new joint venture, CAE (Hong Kong) Ltd, will be 51 per cent Philips and 49 per cent Gold Peak. Production is planned to start by the end of 1986.

Philips is one of the world's major car audio manufacturers and Gold Peak in Hong Kong's leading car audio producer.

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Imaging Wars:
Reports from several fronts

Malcolm Goldfinch

While the 8 mm video camp returns fire from the VHS-C video broadside (see Sept. AEM), JVC lobs them a bombshell amidships with a "VHS Brownie" video camcorder. Meanwhile, Japanese manufacturers are pushing R-DAT digital audio tape closer to the market but the European hardware and software manufacturers are calling "whoa boy". And in the background, 'optical memory' – a variant of the compact disc – makes a run on the computer front.

I REMEMBER, in England during WW II, sitting one night in a cold waiting room on a country station. It was snowing outside. I had 48 hours leave and had walked for an hour in the slush with a suitcase to catch a London train. It was cancelled. The next was at 0100 next morning. During my three hour freezing wait at the station, I sat before a poster that said, simply, "Is Your Journey Really Necessary?".

As I sit in front of my VDU with a pile of press releases about 'would-be' new formats for audio, video and computer imaging, the bleak wisdom of that wartime poster flashes vividly on the screen in my imagination. (Then I remembered — she wasn't worth the trip, anyway!)

In the imaging wars (featured in AEM September last), there are a number of suggestions I'd class as "Is Your Journey Really necessary" regarding 8 mm video and digital audio tape (both rotary-head and stationary-head formats). Reading editorials in recent overseas issues of magazines and papers covering imaging products, I find a general and openly confessed confusion about what is happening to the whole imaging industry. There appears to be a headlong rush into digital technology taking place with little thought given to the consumers who will ultimately foot the bill.

Missing the catch

A New York Times story in the May 4th edition, by Hans Fantel, faint-praised VHS-C compared to 8 mm video. The article was accompanied by a cartoon showing two similar VC figures racing along a railway track, the leader has an 8 mm flag. The caption below reads, "In performance, the revamped VHS-C lags behind its 8 mm competitor." The gist of the article is encapsulated in Fantel's jibe at the VHS-C camp, charging ". . . a deliberate effort by certain commercial interests to head off the progress of 8 mm format before it reaches universality." Fantel also makes mention of the claimed high performance of 8 mm and the limited record/play time of VHS-C.

What Fantel, and many other writers, miss I think, is that to play back your 8 mm format tape, you must use the camcorder plugged into your TV using an RF converter — and a power supply if it runs longer than just a short time. Alternatively, you must buy a new 8 mm VCR and replay using that. If you opt for 8 mm, you pretty well have to go *wholly* 8 mm. Most people likely to purchase a camcorder will have a VCR already and would prefer to use a camcorder in conjunction with that.

There are currently some 110 million VHS VCRs in homes around the world. Any VHS or VHS-C cassette made in the ten years the VHS format has been in existence may be played back perfectly, even on the latest machines. With VHS-C technology, the consumer with a VHS VCR does not have to buy a second VCR to play his or her tapes made with a VHS-C camcorder.

Now the wildcard

At this point, enter the wildcard of video, just released. Where? — Japan! Guess who? JVC, again! If JVC played its joker in the video imaging conflict at the Chicago CES this year ("VHS plays its Joker at Chicago CES", AEM September) then their latest release — a VHS camcorder equivalent to Kodak's enormously popular "Box Brownie" camera of yesteryear — must rate as the wildcard (a card that takes the place of any card you nominate in the pack).

Kodak's Brownie box camera was a low-cost simple-to-use product. Just a box with something to wind the film past the shutter, a single lens and simple shutter mechanism tripped by a lever; no focusing, no exposure to adjust and a simple viewfinder. The consumer loved it, while the experts scorned it. The Betamovie and more recently the Sony handycam (8 mm) video camcorders largely parallel the Brownie concept and consumers (or those that could afford such) have liked them.

The whole reason for the development of 8 mm video was to make a *much lighter and smaller* unit than possible using either the Beta or VHS formats with half-inch tape.

The chart here (Table 1) first appeared in AEM September last ("Imaging Wars" feature), except that now I've added the 'bust measurements' of the latest JVC camcorder, the GRC-9 "Mini" VideoMovie.

JVC's GRC-9 Mini VideoMovie is smaller and lighter than the Sony V8 Handycam. Now here is the video Brownie in VHS-C format! I expect it will appeal to a huge number of those 110 million VHS owners because using just the cassette adaptor they can get instant playback of shots using the existing equipment, no attachments or extras necessary.

In a minute package, the GRC-9 features JVC's HQ (for high quality) picture improvement circuitry (see the review of the JVC HRD565EA VCR in AEM April '86, p.14) and a solid-state charge-coupled device (CCD) imaging chip having a minimum light level rating of 10 lux. Add to this pan-focus, a focus field of one metre to infinity; so who wants auto-focus? Automatic white balance completes the virtually fool-proof formula. JVC predicts (hopes? — Ed.) it will become the world's foremost means of audio/video communication.

Hans Fantel sums up the position, in his May 4th New York Times article, "Leaving aside technical quibbles, it is the public who will ultimately decide the outcome of these trade

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JVC's GRC-9, just released overseas, is a VHS-C camcorder, smaller and lighter than any on the market. It looks set to become the 'Box Brownie' of video!

wars. Unfortunately, as the case of VHS versus Beta has shown, the public's choice is not always an informed one and sometimes permits inferior offerings to emerge triumphant." Well, well! I lean towards the view that it's the public who knows best.

When I contemplate the future of the 8 mm video format, I cannot escape the deja vu of the cold wartime train waiting room, and the question in my inner mind echoes the poster. Only time will tell if the 8 mm video camp's 'journey' was really necessary.

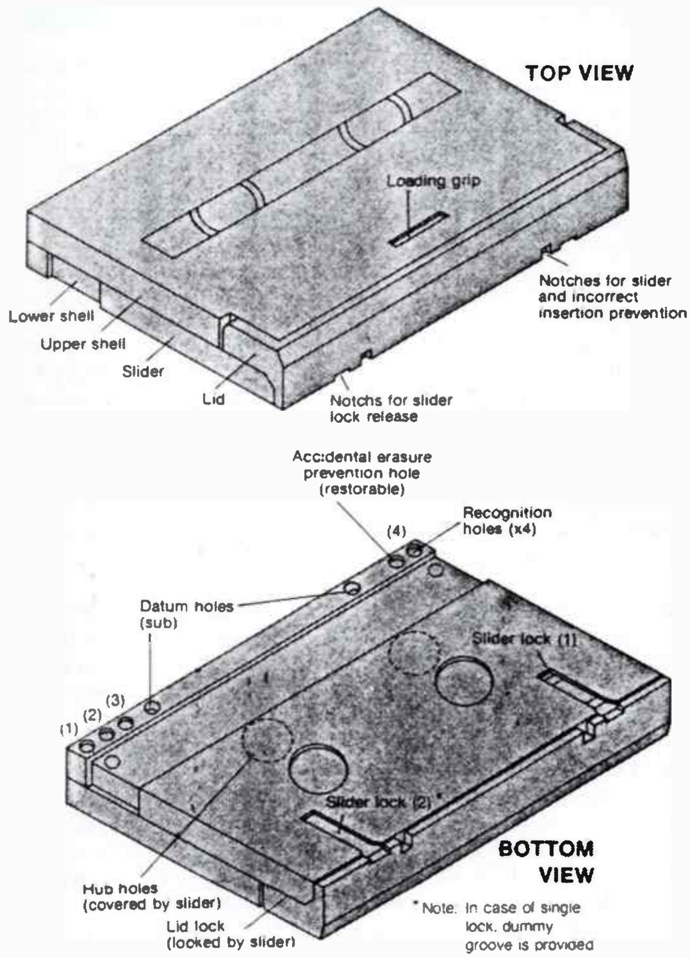
On the digital audio front

If it is not enough to have all these cassette format problems in video, audio now faces similar problems. I am not a racing man but I regard with fascination those loud commentators on TV who pick the winners. Why don't they just shut up, back the winners themselves and make a fortune? In my case, I am an infallible loser by picking winners years ahead of their time. In extreme youth, I picked that the bright emitter valve was for the chop, even though the experts said that a dull-emitter valve with only a red-glowing filament could never do a proper job of flinging electrons at an anode. Later, I picked losers like metal aircraft when wood and fabric was the vogue. ("They will never fly", said my uncle); superhet receivers over Reinartz; Baird's whirling-disc TV I saw losing to EMI's cathode ray TV; I had doubts for a while about stereo records but they improved them; quadrophonic I picked as a loser at first hearing; eight track endless cartridges versus the Philips compact cassette I saw as another disaster.

The next hex I am feeling hovers over DAT (digital audio tape) cassettes. When I was in Japan last year, the dreaded letters D — A — T were hurriedly whispered late at night after libations of sake and Suntory. There have since been more people saying what is wrong with DAT than what is right, but it has all been based on whisper and innuendo format details. (Refer AEM September "Imaging Wars" Audio section).

JVC recently took the bold step of issuing a press release announcing their development of "R-DAT" the rotaryhead option adopted by a section of the international DAT cassette consortium. This is a VCR-type (rotary head) system for audio use with digital encoding/decoding. The fact that the tape is also 8 mm wide begs us to ask why the industry is trying to foist onto the consumer two very similar tape cassettes and systems doing almost the same thing. "Vastly improved sound quality . . . easier to use . . . longer recording time . . . quicker access . . ." are the claimed advantages. But CD has all this and more, except recording well, not just yet. The release ends, "As the final specifications and merchandise have yet to be finalised it is expected that the audio tape as it is known today will be around Australia for many years yet." Yea and verily!

But now, at last, we have an open and authoritative explanation of the DAT mystery from TDK's Dr Fukuzo Itoh in his house magazine, in an article headed, "Home-use digital recording technology gets set to leap from the drawing-board to marketplace. Versatile DAT shows promise galore." Those words "gets set" and "shows promise" are cautions qualifications. The intro is the frankest statement yet made publicly on the DAT format. "As consumer oriented recordable digital audio tape (DAT) nears marketability it's critical to settle on a single hardware format in order to eliminate ▶



Construction of the R-DAT cassette.

TABLE 1: Current camcorders in weight order from specs. (battery and tape inc.)

MAKE & MODEL	TAPE	FORMAT	DIMENSION, cubic cm	WEIGHT kg	SPECIAL FEATURES
Sony Betamovie	½"	Beta	146 x 177 x 374 = 9665	3.1	With AF, no EVF Replay
National M3	½"	VHS	155 x 192 x 324 = 9642	3.1	With Autofocus
Sony CCD-V8AS	8 mm	V8	126 x 191 x 350 = 8423	2.63	With Autofocus
JVC GRC-1	½"	VHS-C	176 x 136 x 340 = 8138	2.5	Not Autofocus
JVC GRC-2	½"	VHS-C	123 x 142 x 317 = 5537	2.4	With Autofocus
JVC GRC-7 CCD	½"	VHS-C	121 x 165 x 223 = 4452	1.7	With Autofocus
Sony CCD-M8	8 mm	V8	107 x 109 x 215 = 2507	1.37	Not AF, EVF, Replay
JVC GRC-9	½"	VHS-C	111 x 95 x 208 = 2193	0.99	Not AF, EVF, Replay

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Chart 1

DAT S and R systems

S-DAT

- Compatible with multi-track systems.
- Still under development.
- Hopeful future prospects.

R-DAT

- Simple.
- Long playing capability, miniaturised, low priced.
- Compatible with both HiFi audio and general audio systems.
- Technology based on simplified conventional VCR technology.
- Specifications easily implemented within a short time.

Chart 2

DAT characteristics

S: Stationary head type
R: Rotary head type

	Cassette dimensions (mm)	Tape speed (cm/s)	Writing speed (cm/s)	Linear recording density (KBPI)	Transmission rate (MBPS)
S	86 × 55.5 × 9.5	4.76 4.37	4.76 4.37	64	2.4 2.2
R	73 × 54 × 10.5	0.72 0.90	313.4 313.3	61	2.46

Chart 3

Principal properties of consumer digital audio tape

Tape width	3.81 ± 0.02mm
Tape thickness	Several kinds, all less than 13μm
Coating thickness	Approx. 2μm
Base material	Polyester or equivalent
Transparency	May be the same as 8mm videotape
Suggested coercivity	1400 ∿ 1600 Oe for S-DAT 1400 ∿ 1500 Oe for R-DAT
Back coating	No for S-DAT Yes for R-DAT
Cassette	Two kinds under consideration

Chart 4

Digital videotape

Recording track width	40μm max.		
Non azimuth recording	Guard band 5μm		
Tape speed	286.588 mm/sec. (525/60) 286.875 mm/sec. (625/50)		
Nominal bit rate to be recorded	227 Mb/sec.		
Shortest wave length	0.9μm		
Writing speed	40m/sec.		
Cassette	S	M	L
Size (mm)	172 × 109	254 × 150	366 × 206
Playing time (min)	11 (16μ tape)	34 (16μ tape)	64 (16μ tape) 94 (13μ tape)

Chart 5

Principal properties of digital videotape

Tape width	19.010 ± 0.015mm
Tape thickness	16μm max.
Base material	Polyester or equivalent
Tensile strength	Greater than 1.5kgm
Transparency	Less than 5% measured with a 750 Nm ± 5 Nm
Suggested coercivity	Approx. 850 Oe
Coating thickness	Approx. 2μm
Back coating	Yes

TABLE 2.

Beta/VHS type confusion . . . or so say marketers. But some R&Ders beg to differ. The DAT Conference, a group of 81 recording hardware and software firms (21 of them non-Japanese) that has convened regularly in Tokyo since 1983, narrowed the format choices to two — stationary head (S-DAT) recorders and rotary head (R-DAT) ones — and pinpointed R-DAT for initial commercialisation. But will S-DAT follow?"

The article may be digested as follows:

1. In July '85, the DAT Conference resolved to consider items in Chart 1 (Table 2, here). Using front-mounted thin film heads in S-DAT, with 22 tracks in eight micron track pitches makes it ideal for multi-track use. problems in thin film technology remain. By comparison, R-DAT looked simple and economical with proved, long-run low-cost operations and is compatable with both analogue and digital hi-fi. By comparison, 13 micron R-DAT VC can run 120 min; the same S-DAT VC 90 min.

2. A year later, thin film head technology has made enormous strides while S-DAT's assumed simplicity has been snagged by the precision called for in the smaller scale of 8 mm tape. The decision to commercialise R-DAT first still stands with S-DAT on the back burner.

3. The fact that tape for R- and S-DAT must be different presents another standardisation problem. Although both tapes are super smooth, R-DAT tape can be a little rougher and cheaper. In analogue recording, characteristics of the tape are crucial. Error rate, tolerable in R-DAT tape, would be a disaster in S-DAT's slow speed. Chart 2 shows the dramatic difference in writing speed. TDK suggest that these differences may be a way out of what must be a terrible dilemma for the DAT members; confine S-DAT to the professionals and let the consumers have R-DAT. The S and R cassettes are different. S was to be the size of a compact audio cassette but has shrunk to the size of a credit card. R is slightly thicker and smaller.

4. Only the R-DAT cassette form and dimensions have been frozen. It has two slider locks in a torsion bar system. When they open, the tape is exposed for use in the deck. Accidental erasure protection and data recognition holes are at the rear and bottom of the cassette.

Dr Itoh concludes, "The near future is expected to see the launch of R-DAT hardware products by several manufacturers. DAT's advent should be a shot in the arm for the audio business since it encourages consumers to upgrade their recording systems."

Since, we have heard that major music software houses, like Polygram, have told DAT members no software will be licenced. Philips have also proposed the postponement of marketing DAT and some of Japan's most prestigious hardware manufacturers are canvassing DAT opinions from their international operators and getting back negative vibes.

The situation is largely the product of uncertainty about the future of audio without video. The "videoclip" has become the equivalent to the hot platter of the record industry. In February this year, the SMPTE (Society of Motion Picture and TV Engineers) fixed a D-1 Format for digital broadcast-quality standard. From Charts 4 and 5 in Table 2 will be seen that there are three ¾" tape cassettes, from VHS dimensions to briefcase size; not consumer items.

The question is, should not any new consumer playback, and record format cater for video/audio? Just as VHS-C was a sleeper for its first two years and is now looking like a second VHS success story, the video/hi-fi VCR with depth modulation audio recording over video may now take off. The VHS-C cassette at ⅓-speed, already accepted, would be an excellent solution to the consumer demand for less formats rather than more. Sony's 8 mm VCRs have shown how such a system can go digital or analogue.

Variations on a compact disc

Composers have always used a good tune for many variations and CD is the hum of the moment. The fact that it is both digital and analogue in use bridges the narrowing gaps between the audio-video-computer systems of imaging.

I have often written about CD digital record/play and CD-ROM as the immediate future. It now appears that the time has arrived for the format to be frozen; hopefully there will be one only, but I apprehensive. There are two development groups, one straddling the Pacific, one straddling the Atlantic. The Japan/West-US group view CD-ROM as a permanent, pre-recorded mass distributed product, while the East-US/Europe group view it as a blank media, write-once read many times, product for individual use. The logic of cost seems to make it mandatory to use the technology, tooling and duplication investment in the audio CD for the cheapest computer

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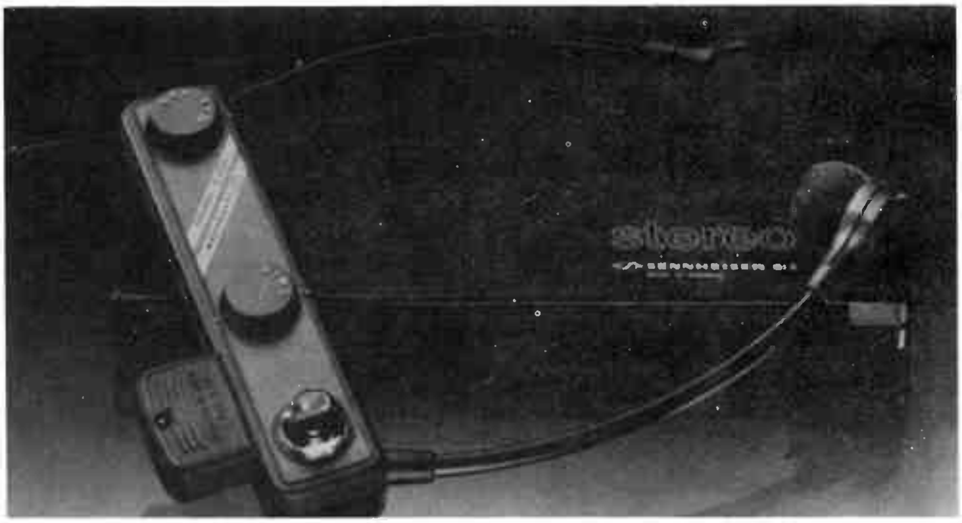

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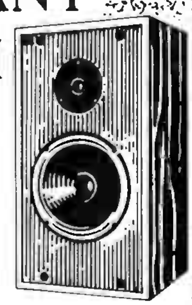

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The Marantz PM-94 'digital monitoring' amplifier

Robert Fitzell AAAC

Here's a hot contender in the amplifier fashion stakes for the digital era. Marantz's new integrated amp features a MOSFET stage with class A/class AB operation and over 250 watts per channel output.

TO FOLLOW UP some of our earlier reviews of high quality audio equipment we review here, and I might say with some pleasure, the flagship of the current Marantz amplifier range — the model PM-94 'digital monitoring' amplifier. The amplifer front panel declares that this is a MOSFET power amplifier and includes the unusual designation of "Quarter A". The label is there to indicate that the circuitry provides pure class A operation for the first quarter of the power output, switching to class AB above about 35 watts.

marantz have, along with most manufacturers over recent years, been diversifying their marketing strategy. As a result, perhaps unfairly, the brand was becoming identified with budget priced glossy packages, marketed in department stores rather than the quality equipment hich many happy owners expect of them. Whilst this has been more likely a response to market trend rather than a marketing decision, I for one welcome the visible presence on the market of a high quality power amplifier bearing the well respected name of Marantz.

For some years now I have contended that the power amplifer is the component least likely to compromise the audio quality of your system. I do still believe that to be true, although the incredible clarity achievable from compact discs has put a lot more pressure on amplifiers than theyhave had for years. One of the catches of CDs, as I have more than once said, is that they need power and lots of it. The simple reason for this is that the dynamic range of CDs is so large that the power peaks — the cymbal crashes, drums, brass etc — are many decibels above the average level. If any of these peaks are sustained, the result is that the amplifier cannot handle the input power, is driven into clipping and usually damages your loudspeakers. In fact, you are probably as likely to damage loudspeakers from using an underpowered amplifier as you are from an overpowered amplifier.

Marantz, I suspect, would have no argument with me over theneed for power. In the PM-94 they have offred close to the ideal amplifier — one which provides ultra low distortion Class A performance at normal listening levels, heaps of power headroom, most of the facilities that one can think of plus a few more, all packaged in the ever popular black-with-gold-lettering box.

Features

The PM-94 is a very high quality, high powered amplifier offering all the features normally required for domestic users and many of those sought by professional equipment users. The physical appearance of the amplifier is trendy — another black front panel with gold lettering — but really well finished and does convey its class. The side panels of the amp are finished in a mirror lacquered timber and rack mounting does not appear to be an option. The Marantz engineers clearly intend the amplifier to be up on display and have put a deal of effort into its' appearance.

For a number of reasons the PM-94 encourages installation as a stand alone component. For those, such as myself, who don't really like to see hi-fi equipment spread across the

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REVIEW ITEM:	Integrated power amplifier
MANUFACTURER:	Marantz
MODEL:	PM-94
FORMAT:	Integrated preamplifier/power amplifier
PRICE:	$2699 rrp
WARRANTY:	Two years parts and labour
SUMMARY:	A hot amplifier!

sideboard, the amplifier could offer problems in deciding where to really sit it.

The input-output options provided on the amplifer are quite extensive. RCA-type input sockets are provided permitting moving coil and moving magnet phono cartridge, compact disc, tuner, two auxiliary input jacks, two tape recorder input jacks and a hi-fi VCR input jack. Screw type output terminals enable connection of two loudspeaker systems for an impedance range of 4 — 16 ohms.

For those who wish to play with their systems a little more than normal the amplifier has an excellent feature in providing an interconnection point between the pre amplifier output and main amplifier input. For normal operation these are connected by a short bar to give a direct short circuit. However, if you wish to connect a graphic equaliser, or any other signal processor, the bar may be simply removed and RCA-type connection for the signal processor then made. Whilst this facility will probably not be used by the majority of users, there will be many semi-professional users who will see a useful application and one which extends the market for the amplifier into the areas which normally require separate amplifier equipment.

The front panel is fairly well laid out although, like all equipment, needs some familiarisation. A rather odd feature is separate bass and treble controls for left and right channels. These would allow some improved balance between loudspeakers if used in a room with uneven room acoustics, but I think it would have made more sense to provide separate tone control for loudspeaker systems 1 and 2 rather than between channels. I am sure there will be many readers who think the opposite.

The operation of the amplifier controls is very comfortable with centre detent on tone controls, positive double action push buttons and switches, and clear function labelling. Front panel controls comprise source selector switch with LED indication, volume treble and bass controls, a phono selector switch to provide for moving magnet and high or low output moving coil cartridge, balance control, tone defeat switch, 20 dB muting, tape monitor switches permitting a replay of tapes 1 and 2 as well as the hi-fi VCR and speaker outputs switches. Amongst the less common facilities offered on the front panel are a CD direct switch which provides signal processing with the minimum of amplifier circuitory, a subsonic filter switch providing a high low frequency roll off below 16 Hz, and a tape copy switch.

The "extras" not provided on most amplifiers are:

1. Sensitivity control for moving coil cartridge input, effectively guaranteeing that performance of your cartridge selection can be optimised,
2. Tape copy switch, permitting dubbing from the selected input to a tape recorder (great for those few who just happen to have a live recording of themselves that they want to copy),
3. Input facility for two tape recorders and a VCR, plus two auxiliaries, an attractive feature for those who have semiprofessional interest in the amp,
4. Tone defeat switch, more useful than it sounds, particularly where more than one family member uses the equipment and one (young?) member likes fairly coloured sound,
5. Muting, becoming more common but great when the telephone rings,
6. Subsonic filter, often not used since the effects are frequently inaudible, but can have dramatic effects if you listen to records regularly,
7. CD Direct, more than just a selector switch although functionally that is what it achieves, minimises the amplifier circuitry during replay. This switch is interesting, since it is also possible to listen to a CD player by selection from the normal selector switch and to thereby use the full amplifier circuitry, tone controls etc. This is a good comparison test for those who think amplifiers do not colour audio sound, since even for the class A PM-94 the difference is clearly audible, the direct CD processing being cleaner and more transparent.
8. Output to two pairs of loudspeakers.
9. Two years parts and labour warranty.
10. Lots of heat.

▶

TABLE 1: Test results summary

Frequency response:		20 — 20 kHz ± 0.25 dB 10 — 36 kHz +0/–3 dB
Power output:	(both channels driven) (one channel driven)	260 W/channel into 8 ohm 303 watt/channel into 8 ohm
Signal-to-noise:	at 1 watt output	87 dB linear 101 dB(A)
THD:	better than — 77 dB at test frequencies of 100, 1 kHz, 10 kHz at all powers up to 100 watts.	
dc on output:	left channel right channel	+27 mv –10 mv
Input for 1 watt output at full system gain:	phono MM phono MC high phono MC low aux 1, 2; tape Tuner CD CD Direct	212 microvolt 20 microvolt 11 microvolt 12.5 millivolt 12.5 millivolt 12.5 millivolt 11.7 millivolt
Temperature:		55° Celsius (amp on idle)

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That's not a bad list of extras is it? and I haven't talked about how it performs yet. I will talk more about the last item later, at this stage it is sufficient to say that the potential problems of heat from the amplifier are considerable if you are not aware of it. High heat output is probably not such a new thing in the eyes of owners of other class A amplifiers or professional equipment, but if you are considering upgrading and hope to poke the new amp in where you have previously had the old one, don't. At least not before you have thought about it fully.

Performance

In a word — excellent. The amp is wasted if you are thinking of driving through anything less than top grade loudspeakers. At $2700 purchase price, by the time you add loudspeakers and at least one input device, don't allow yourself to get excited unless you are ready to spend big money.

One of the real signatures of quality for audio equipment is to be untiring and non-intrusive. These qualities are probably more dependent on the loudspeaker than the amplifier, but from my own listening tests the PM-94 performs superbly. Evaluation requires a long listening time and is a major reason why you should not jump at buying a sound system the first time you hear it, particularly where you are auditioning in a noisy store without your own choice of music.

It perhaps sounds an odd criterion but an uncoloured sound system at a moderate listening level, music selection apart, does not intrude into conversation and other similar activities. If you're attempting a frontal lobotomy using a sound system incision then intrusion and colouration are perhaps desirable features, and for those who take their listening hard the qualities of clarity attainable from amplifiers such as the PM-94 are wasted. If your musical interests are wide, and particularly if you want both loud and soft performance, the PM-94 is an excellent amplifier.

Test results bear out the subjective performance. Frequency response (Figure 1) is within 0.5 dB from 20 Hz to 20 kHz, whilst the -3 dB bounds are 10 Hz to 36.25 kHz. Figures 2 and 3 show high frequency roll-off for a random noise source on a log frequency scale — the balance in roll-off between channels cannot be faulted. Also shown on Figure 1 are tone control effects, giving maximum boost and cut for bass and

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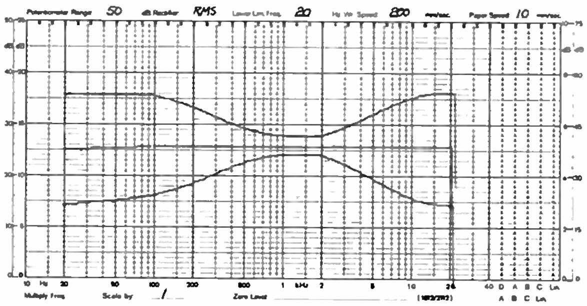

Figure 1. Frequency response runs with bass and treble controls at flat, max. and min.

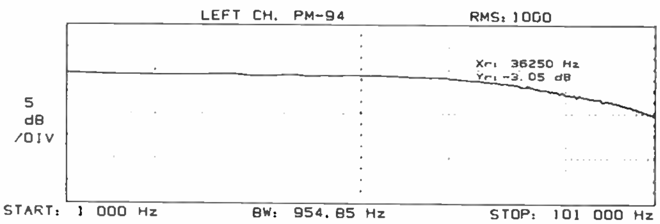

Figure 2. Left channel top-end roll-off.

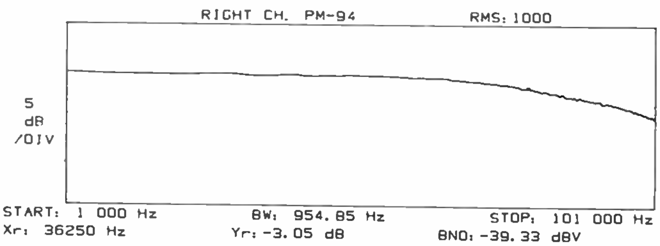

Figure 3. Right channel top-end roll-off.

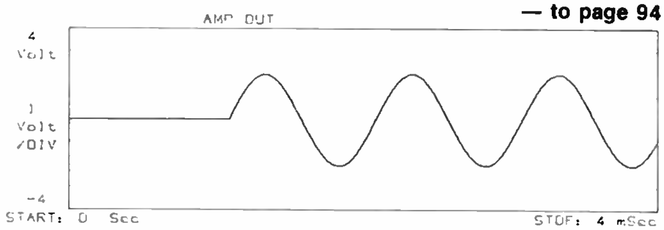

Figure 4. Amp output on tone-burst; compare to Figure 5.

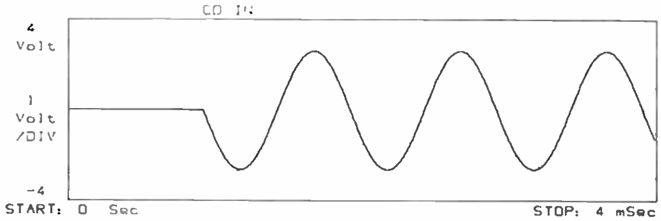

Figure 5. Tone-burst source; compare to Figure 4.

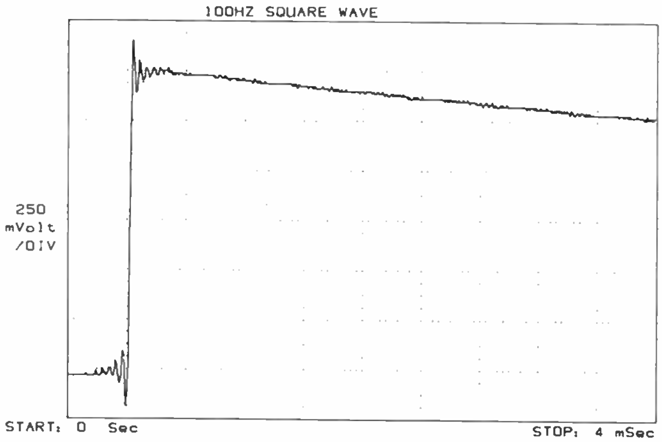

Figure 6. Square wave response at 100Hz. Some ringing at 25 kHz is evident.

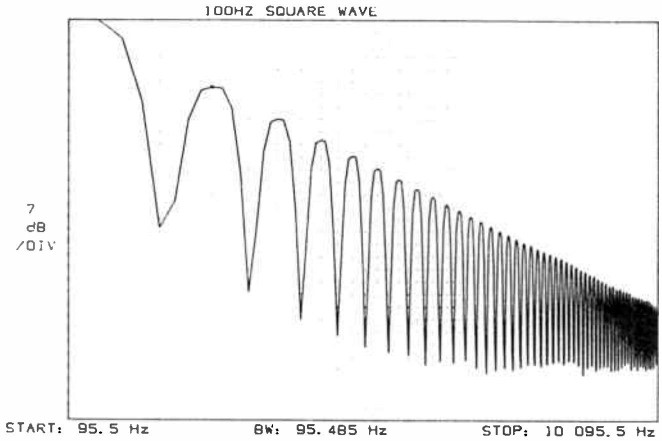

Figure 7. Spectrum produced by 100 Hz square wave passed through the PM-94.

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Elektor Electronics in AEM

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EQUALIZER FOR GUITARS

by W Teder

Equalizers are used to change the normal sound of an instrument by filtering certain frequencies or bands of frequencies. Graphic equalizers are the best for this, but they are difficult to construct and fairly expensive. Fortunately, a parametric equalizer is a satisfactory alternative, more easily constructed, and far less expensive. That described here is intended primarily for use with guitars.

A parametric equalizer consists of a so-called state-variable filter or filters, whose centre frequency, Q(uality) factor, and cut-off profile are variable. If only a relatively narrow band of frequencies is to be controlled, one filter will do, but to cover the entire audio band, several filters are connected in parallel.

The present equalizer consists of four filters: LOW; LOMID; HIMID; and HI. The first and last of these are standard low-pass and high-pass filters respectively, while the other two are state-variable filters. The centre frequencies of the two standard filters are fixed, but those of the parametric filters can be varied with the aid of switch-selected resistances.

Guitarists will find the following properties of interest.

- The spacing between the centre frequencies of the state-variable filters is divided into fourths. The LOMID filter operates more or less over the range of fundamental frequencies, while the HIMID filter covers the range from the upper fundamentals well into the harmonics. It is thus possible to calibrate the relevant scales on the front panel in musical notes (see Fig. 2 and Tables 2 and 3).
- The Q factors can be preset at intervals corresponding to a fourth, a major third, or an octave plus a fifth.
- The cut-off profile of the filters can be varied in 1.5 dB steps at the front panel.

Circuit description

In Fig. 1, switches S_1 to S_4 are the filter profile selectors, while S_7 to S_{10} enable the filter response to be

Table 1. Correlation between resistance and attenuation.

Table 1

Resistance	Attenuation (dB)
R_a = 1k//12 k = 920 Ω	1.5
R_b = 680//6k8 = 620 Ω	3.0
R_c = 1k//1k5 = 600 Ω	4.5
R_d = 470//6k8 = 441 Ω	6.0
R_e = 470//4k7 = 430 Ω	7.5
R_f = 560//1k8 = 424 Ω	9.0
R_g = 330//15k = 322 Ω	10.5
R_h = 390//1k = 283 Ω	12.0
R_i = 270//1k8 = 233 Ω	13.5
R_j = 220//2k2 = 202 Ω	15.0

Table 2. Correlation between musical notes (orchestral pitch), their frequencies, and required resistance for the LOMID filter section.

The musical notes are shown here in international electro-acoustic notation, i.e. they are given inferior or superior exponents to indicate how many octaves they are below or above their namesake in the octave commencing with middle C (261.63 Hz).

Table 2

Note	Freq. (Hz)	Resistance
A_2	110	R_r = 6k8//7k5 = 3570 Ω
D_1	146	R_s = 3k3//16k = 2741 Ω
G_1	195	R_t = 2k2//33k = 2065 Ω
C	261	R_u = 1k6//56k = 1551 Ω
F	350	R_v = 2k2//3k3 = 1320 Ω
B	493	R_{15};R_{16} = 3k3//150k = 3229 Ω
		R_{19};R_{20} = 3k3//150k = 3229 Ω

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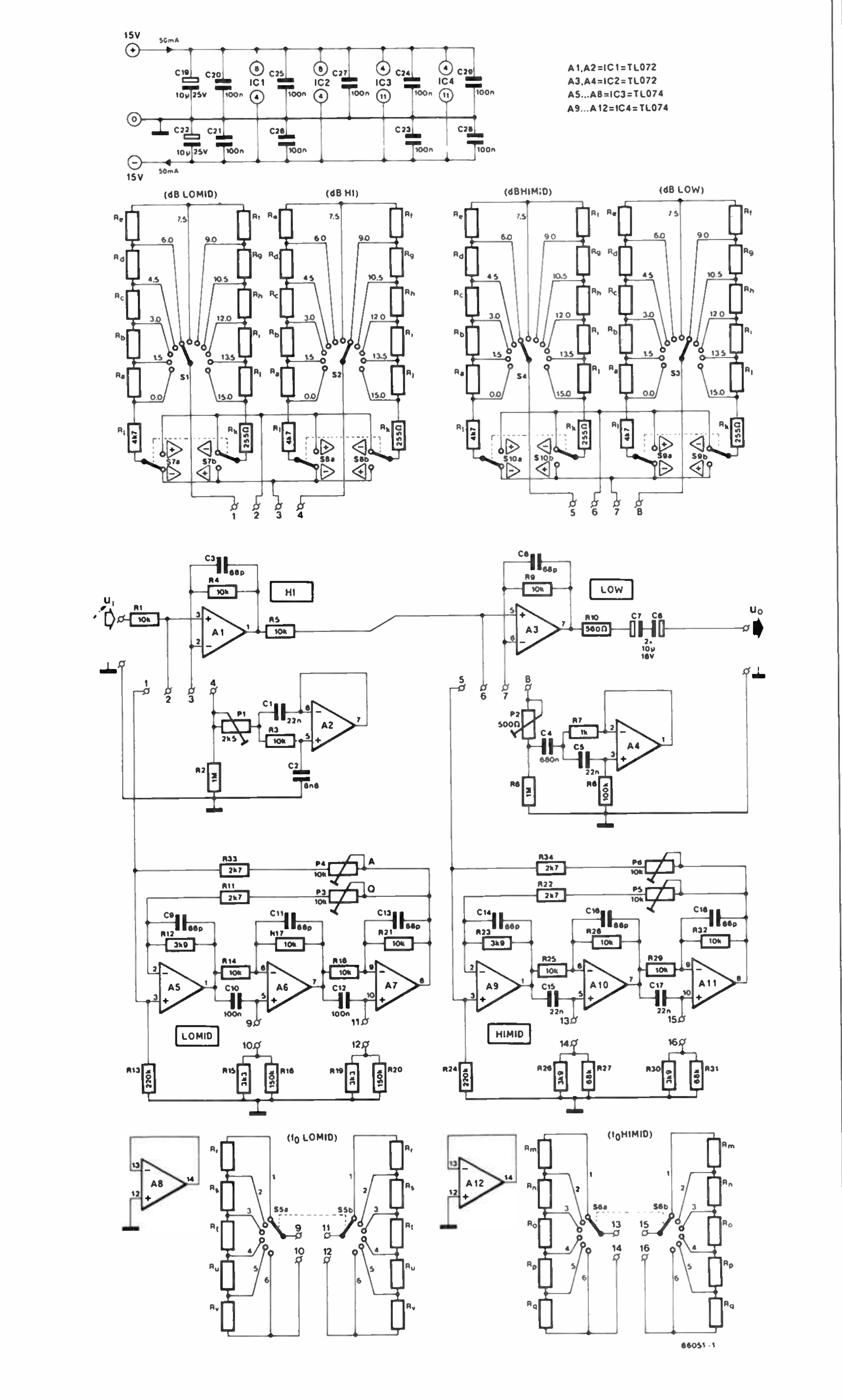

Fig. 1. The circuit diagram of the equalizer. The values of R_a to R_j are given in Table 1; those of R_m to R_q in Table 3; and those of R_r to R_v in Table 2. Note that R_k = 270//4k7 = 255 Ω

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boosted. Switches S_5 and S_6 serve to vary the centre frequency of the state-variable filters.

Stages A_1 and A_3 work in conjunction with switches S_1 to S_4 and S_7 to S_{10} and operate either as amplifiers or attenuators, depending on the setting of the switches. The inputs of these stages are fed by gyrators A_2 and A_4 to form the HI and LOW filters.

For practical purposes, these gyrators present the large inductances required in this application. The cut-off frequencies of these fixed filters are 100 Hz (A_2=HI) and 5 kHz (A_4=LOW) respectively.

Presets P_1 and P_2 serve to set the internal impedance of the gyrators at maximum amplification and attenuation respectively.

The centre frequencies of the state-variable filters, A_5-A_6-A_7 (LOMID) and A_9-A_{10}-A_{11} (HIMID), are determined by the resistors selected by switches S_5 and S_6 respectively. Presets P_4 and P_6 in the positive feedback loop vary the internal impedance of these filters, while presets P_3 and P_5 in the negative feedback loop determine the Q factor.

Construction

It is best to start with soldering all the resistors R_a to R_v to the six control switches. Note that each of these resistors appears in the components list twice, because, although the circuit diagram in Fig. 1 shows them as single components, they are actually parallel combinations in all cases, except for R_1. It is wise to check the value of each set with Tables 1, 2, and 3 before and after soldering each combination to the relevant switch. It is very difficult to find a wrong combination once everything has been

2

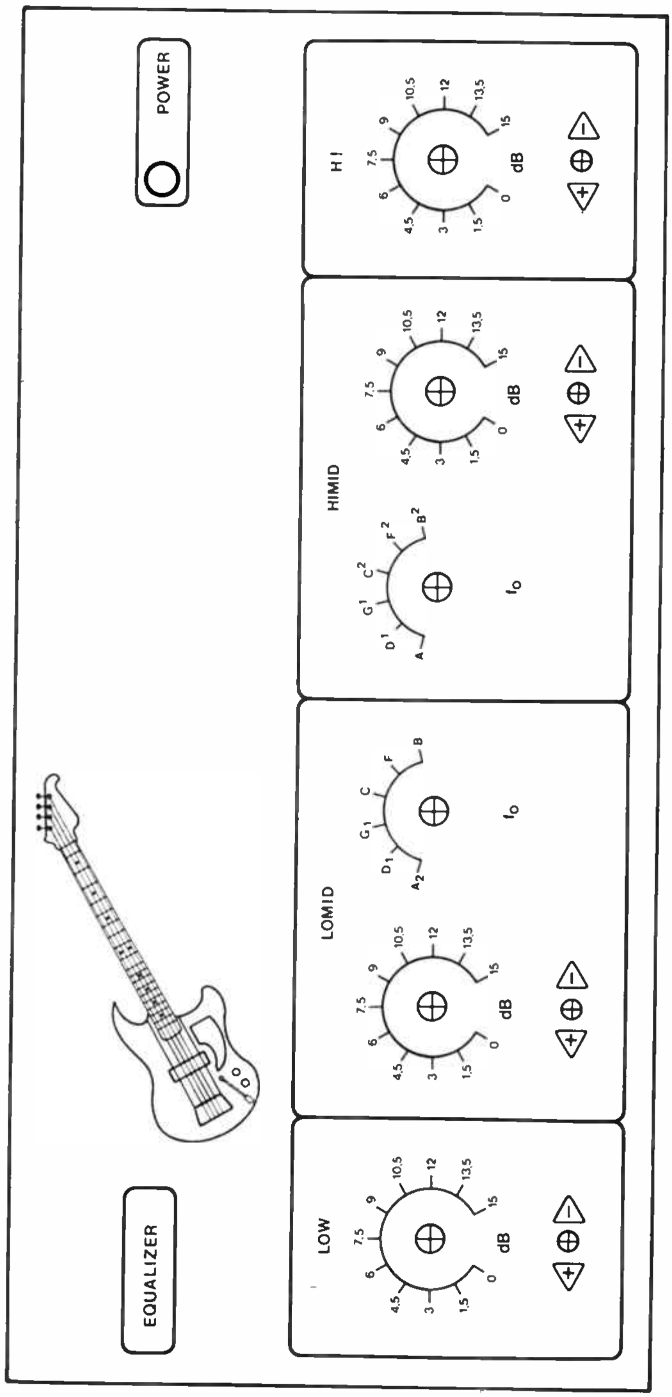

Fig. 2. Suggested front panel layout: the front panel is not available ready made.

Fig. 3. The printed-circuit board of the equalizer

Table 3. Correlation between musical notes (orchestral pitch), their frequencies, and required resistance for the HIMID filter section

The musical notes are shown here in international electro-acoustic notation, i.e. they are given inferior or superior exponents to indicate how many octaves they are below or above their namesake in the octave commencing with middle C (261.63 Hz)

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soldered!

The remainder of the unit is built onto the printed-circuit board shown in Fig. 3.

A mains power supply has not been included here, since any small, dual supply will suffice: all that is required is ±15 V at ±50 mA.

Finally, all the switches are mounted on a front panel as suggested in Fig. 2, and the remainder fitted into a case of about 250×110×100 mm (W×H×D).

Calibration

Ideally, three instruments are required: a signal source (sine wave or function generator); oscilloscope or millivoltmeter, and a frequency counter. At frequencies up to about 440 Hz, a digital multimeter may take the place of the oscilloscope or millivoltmeter.

First, the LOMID filter is calibrated, for which S_5 is set to position 1 (A_2); switch S_4 to position 11 (15 dB); S_7 to +; and S_2, S_3, and S_4 to 0 dB. The position of the remaining switches is irrelevant.

Inject a 110 Hz sinusoidal signal at a level of 138 mV into the input of the equalizer, and measure the amplitude at the output.

Adjust P_4 until an output of 775 mV (=0 dBm=1 mW into 600 Ω) is obtained.

With the intervals between successive centre frequencies arranged at fourths, the bandwidth, B, is related to the centre frequency, f_o, by $B=f_o/2.5$; so that in this case $B=110/2.5=44$ Hz.

Shifting the frequency by ±½B should reduce the output to about 550 mV (=−3 dB). If not, both P_3 and P_4 should be adjusted until around 550 mV output is obtained both at 88 Hz and at 132 Hz.

Adjust the HIMID filter in a similar manner with the centre frequency at 440 Hz (which gives a bandwidth of 176 Hz). The switches should be set as follows: S_6 to A (=440 Hz); S_4 and S_{10} to 15 dB and + respectively; and S_1, S_2, and S_3 to 0 dB.

The HI and LOW filters are calibrated by setting S_2 and S_3 respectively to 15 dB.

Still with a 110 Hz sinusoidal signal at a level of 138 mV (=−15 dB) injected into the input of the equalizer, adjust presets P_1 or P_2, as appropriate, for 775 mV output at any of the frequencies shown in Tables 2 and 3.

(Sv)

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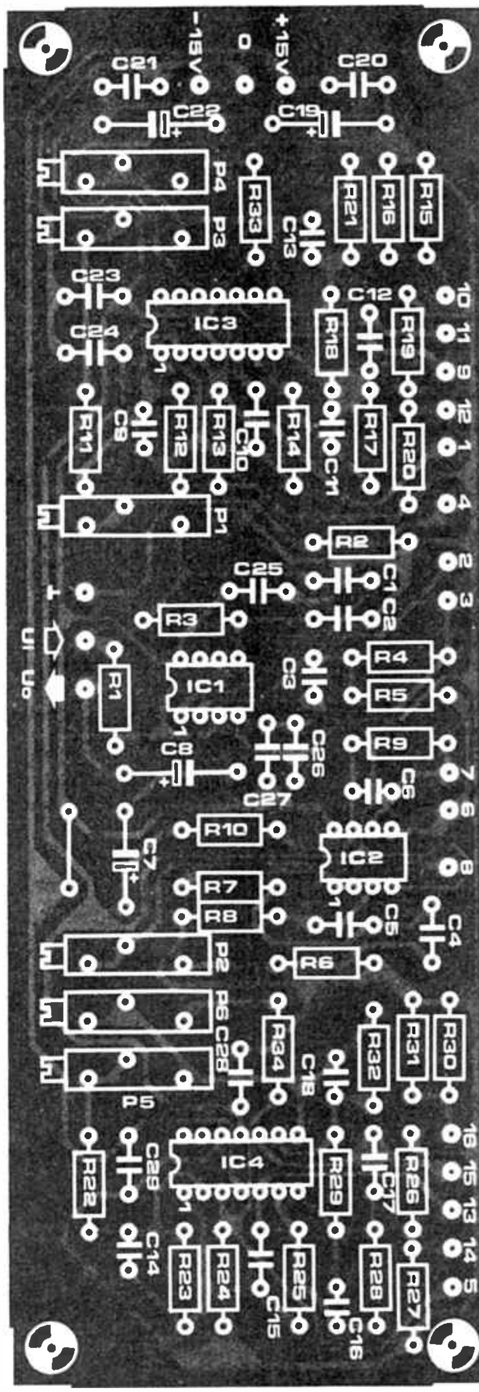

Table 3

Note	Freq. (Hz)	Resistance
A	440	R_m = 4k7//33k = 4119 Ω
D'	587	R_n = 3k3//47k = 3087 Ω
G'	784	R_o = 3k9//5k6 = 2324 Ω
C'	1046	R_p = 2k2//8k2 = 1735 Ω
F²	1397	R_q = 1k8//10k = 1520 Ω
B²	1975	R_{26};R_{27} = 3k9//68k = 3664 Ω
		R_{30};R_{31} = 3k9//68k = 3664 Ω

Parts list

Resistors (10%):

R_1;R_3;R_4;R_5;R_9;R_{14};R_{17};R_{18};R_{21};R_{25};R_{28};R_{29};R_{32} = 10 k
R_2;R_6 = 1 M
R_7 = 1 k
R_8 = 100 k
R_{10} = 560 Ω
R_{11};R_{22};R_{33};R_{34} = 2k7
R_{12};R_{23} = 3k9
R_{13};R_{24} = 220 k

Resistors (2%):
(4 each are required of R_a to R_v incl)

R_{15};R_{19};R_n;R_s;R_v = 3k3
R_{16};R_{20} = 150 k
R_{26};R_{30};R_o = 3k9
R_{27};R_{31} = 68 k
R_a;R_c;R_h = 1 k
R_a = 12 k
R_b = 680 Ω
R_b;R_d;R_r = 6k8
R_c = 1k5
R_d;R_e = 470 Ω
R_e;R_k;R_l;R_m = 4k7
R_f = 560 Ω
R_f;R_i;R_q = 1k8
R_g = 330 Ω
R_g = 15 k
R_h = 390 Ω
R_i;R_k = 270 Ω
R_j = 220 Ω
R_j;R_p;R_t;R_v = 2k2
R_m;R_t = 33 k
R_n = 47 k
R_o = 5k6
R_p = 8k2
R_q = 10 k
R_r = 7k5
R_s = 16 k
R_u = 1k6
R_u = 56 k

Multiturn presets:
P_1 = 2k5
P_2 = 500 Ω
P_3;P_4;P_5;P_6 = 10 k

Capacitors:
C_1;C_5;C_{15};C_{17} = 22 n
C_2 = 6n8
C_3;C_6;C_9;C_{11};C_{13};C_{14};C_{16};C_{18} = 68 p
C_4 = 680 n
C_7;C_8 = 10 μ/16 V
C_{10};C_{12};C_{20};C_{21};C_{23};C_{29} = 100 n
C_{19};C_{22} = 10 μ/25 V

Semiconductors:
IC_1;IC_2 = TL072
IC_3;IC_4 = TL074

Miscellaneous:
S_1;S_2;S_3;S_4 = 12-position rotary switch (make before break contacts)
S_5;S_6; = 2×6 position rotary switch
S_7;S_8;S_9;S_{10} = double-pole change-over switch
PCB 86051
Enclosure 250W × 110H × 100D mm (approx)

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RF CIRCUIT DESIGN — 2

Do you get annoyed from time to time (or more often) by your favourite FM radio programme being interrupted when a strong out-of-band signal blocks the receiver? If so, read this article and find out how to design and construct a filter that may ban this irritation for ever.

VHF FILTERS

by A Bradshaw
&
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Elektor Electronics has presented its readers with comprehensive articles on theory and practice of VHF aerial amplification before; see, for instance, the February 1980 issue of this magazine. The conclusions reached in those articles may be summarized as follows:

1. A well-designed aerial amplifier can only compensate for cable loss if it is mounted in the immediate vicinity of the aerial (masthead mounting).
2. To be of any beneficial use at all, this booster must have appreciably lower self-generated noise than the receiver.
3. The first active device in the receiver RF signal chain determines to a large extent the total receiver system noise figure and thus its sensitivity for weak signals.
4. A good directional aerial is the best booster because it generates no noise, is absolutely intermodulation-free and functions as a selective device at the same time.

As evidenced by the article on the wideband aerial booster with Type BFT66 transistor, low noise, good intermodulation ratio and high signal gain are generally appreciated characteristics of active devices in VHF aerial amplifiers. However, it was also pointed out that only one of these characteristics may be favoured over the others given a certain transistor working point; the three are never optimum for one bias setting.

It is for this reason that many wideband amplifier designs use two identical, cascaded *high fr* type transistors; the first (aerial side) set for low noise, the second (receiver side) for high overall gain. It will be fairly obvious that intermodulation characteristics of such a design are far from ideal, simply for lack of suitable DC setting and appropriate filtering. To increase bandwidth and reduce the intermodulation products, these transistors are usually direct-coupled, and every effort has been made to keep booster gain as high and constant as possible over a frequency range as large as 50. . . .800 MHz.

It will stand to reason that this type of amplifier can not be used for reception of weak FM band signals, because the odds are that a far stronger RF signal present outside the receiver tuning range will wreak havoc with the booster transistors. Even if the aerial features some attenuation for this out of band signal, booster input voltages may be as high as 100 mV with a powerful transmitter in close proximity. Even a very selective and intermodulation-free receiver can not do anything towards improvement of reception in this case, simply because it sees a mess of interference and intermodulation products at its input.

To keep strong out-of-band signals away from the base of the VHF preamplifier stage, some filtering device is called for. Conflicting design considerations contend for the upper hand, however, and a basic knowledge of filter operation and construction is required to find

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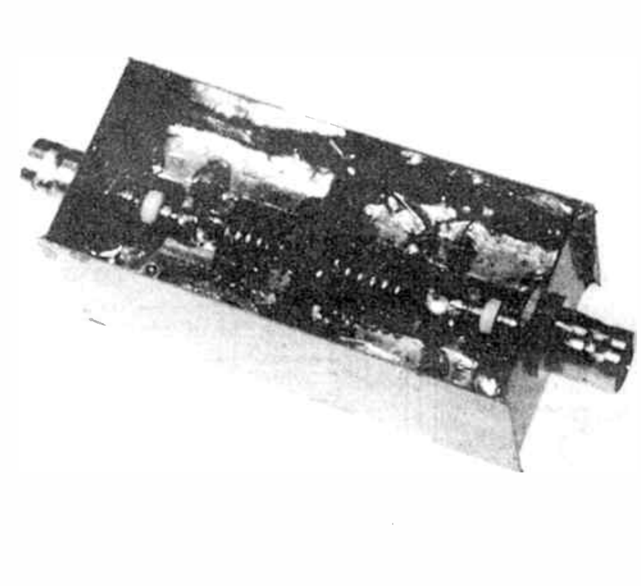

Photograph 1 Practical realization of the VHF roofing filter LPF section. Though its characteristics are not ideal, it provides a good starting point for more advanced filter construction. Note the two capacitors at the input, their total capacitance should be about 44 pF

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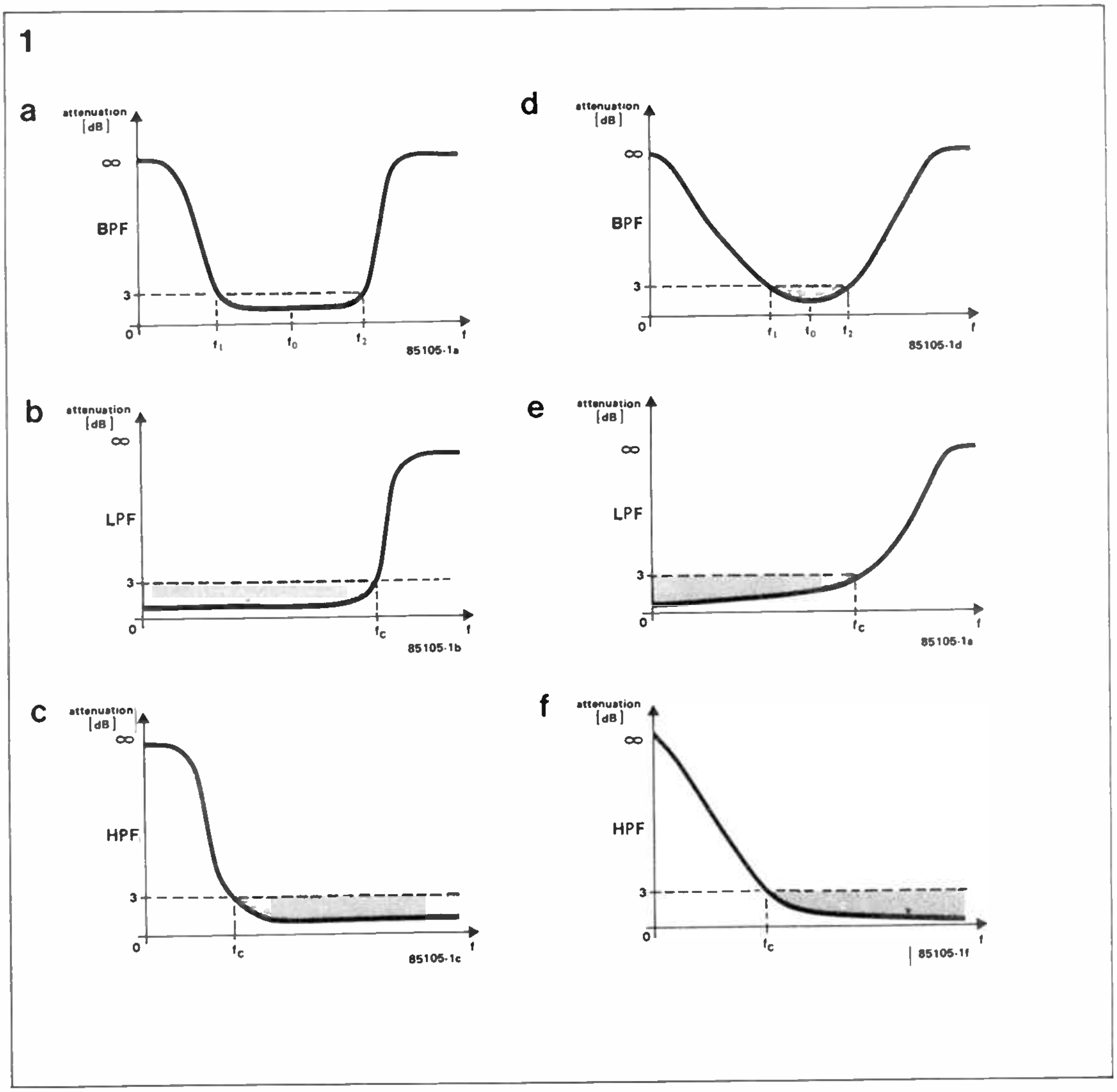

Fig. 1. Typical curves showing that a band-pass filter (BPF) profile is obtained from adding curves of constituent low pass (LPF) and high pass (HPF) sections.

the right compromise for a given situation.

VHF filters; a crash course

For a basic understanding of filter operation, it is useful to think of it as a sieve; depending on the diameter of its holes, it will pass the desired liquid and block large particles, however many. In electronics, such a sieving device is generally referred to as a **band-pass filter**; it has a high **attenuation** for all signals outside its **pass band**.

A typical frequency vs attenuation curve of a bandpass filter (BPF) is shown in Fig. 1a. The shaded area is referred to as the filter **3dB bandwidth**. Note that Fig. 1d also shows a BPF curve, but this time with lower **skirt steepness** than that of Fig. 1a, and a reduced 3dB bandwidth. From this comparison of filter curves it should be evident that the term **filter selectivity** it not related direct to 3dB bandwidth.

Although the band-pass filter type is a suitable starting point for introducing filter theory, it must be mentioned here that it is basically a combination of two constituents: a low-pass filter (LPF) and a high-pass filter (HPF), the curves of which are shown in Figures 1b and 1c respectively. Note that skirt steepness of both LPF and HPF may be less, as shown in corresponding Figures 1e and 1f. It will be evident that the BPF curves of Figures 1a and 1d may be obtained by adding Fig. 1b to 1c and Fig. 1e to 1f respectively.

To define the 3 dB bandwidth of the BPFs, it will be seen that

BPF f_1 = HPF f_c and (1)

BPF f_2 = LPF f_c (2)

where f_c is the **cut-off frequency** of LPF or HPF, or the frequency at which the filter output, U_o, falls to

$U_o = 0.708 U_i = ½\sqrt{2} U_i = 3$ dB attenuation (3)

Thus, the 3 dB bandwidth of a BPF may be calculated from

$bw_{3dB} = f_2 - f_1$ <Hz> (4)

The curves shown in Fig. 1 are theoretical and therefore idealized; depending on component tolerance and construction method of the filter, it may feature far less smooth characteristics, as will be seen later. Neither need band-pass curves always be symmetrical like those of Fig. 1; depending on skirt steepness of constituting LPF and HPF, the low and high side **roll-off characteristic** of a BPF may have quite different profiles.

To come to a conclusion about suitable electronic components for use in filters, the low-pass setup shown in Fig. 2a may be examined; it is also known as a 'pi type' (note its visual similarity to π).

Assuming that the circuit is at resonance, that $R_i = Z_i = Z_o = R_o = Z$ and that Q (quality factor) is fairly high, then the basic design equations for this filter are as follows:

$Z \approx \sqrt{\frac{L}{C}}$ (5)

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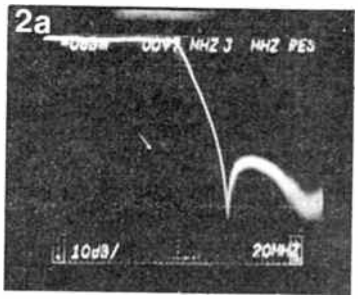
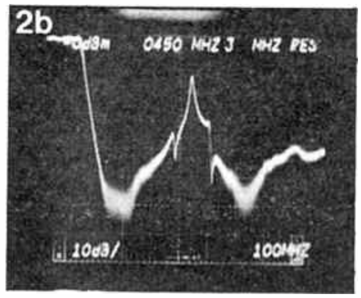
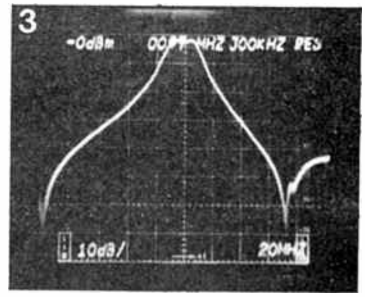




Photograph 2. Roll-off characteristic of the VHF roofing filter LPF section (2a) and response of the same when swept over several hundred Megahertz (2b). Note that low attenuation corresponds to a high point in the curve, as opposed to the curves in Figures 1 and 2.



Photograph 3. Band-pass profile of the VHF roofing filter, sweep centre frequency at 97 MHz.

$$L=\frac{R}{\pi f_c} \qquad (6)$$

$$C=\frac{1}{\pi R f_c} \qquad (7)$$

$$f_c=\frac{1}{2\pi\sqrt{LC}} \qquad (8)$$

where
R = filter termination resistance <Ω>
L = inductance in filter <H>
C = capacitance in filter <F>
f_c = 3 dB cut-off frequency <Hz>
Z = filter impedance <Ω>

For VHF applications, these equations are adapted as follows to calculate with nH (nano Henry, 10^{-9} H), MHz (mega Hertz, 10^6 Hz), and pF (pico Farad, 10^{-12}F):

$$Z\approx\sqrt{\frac{1000L}{C}} \;<\Omega> \qquad (9)$$

$$L=159.2R/f_c \;<nH> \qquad (10)$$

$$C=318\,000/Rf_c \;<pF> \qquad (11)$$

Example: if a filter of this type were to be constructed for f_c = 100 MHz, and Z = 50 Ω, the following component values are found: C = 63.6 pF, L = 79.6 nH.

To improve the filter skirt steepness, several of these sections may be cascaded provided they have been designed for the same termination impedance. However, so-called m-derived sections at both LPF input and output may be a more efficient way to get the desired curve shape; see Fig. 2b for the basic arrangement. With L and C calculated from (9), (10), and (11), the component values for these additional sections are computed from

$$L_1 = mL \qquad (12)$$

$$C_1 = \frac{1-m^2}{4m}C \qquad (13)$$

$$C_2 = mC \qquad (14)$$

To understand how m is determined, refer to Fig. 2c which shows the frequency vs attenuation curve of the filter proposed in Fig. 2b. To be noted are the 'humps' which appear above f_c; at f_∞, the filter attenuation seems to be infinite, and this is repeated at regular intervals as f increases. The points of infinite attenuation are called **poles** and, generally speaking, the more filter sections, the more poles will appear; this also goes for high-pass sections, and, consequently, for band-pass filters which will feature poles at either side of the curve. The value of m is calculated from

$$m = \sqrt{1-f_c^{\,2}/f_\infty^{\,2}} \qquad (15)$$

where f_∞ is the frequency of the first pole. Most designers, however, use the value 0.6 for m, which gives us

$$L_1 = 0.6L \qquad (16)$$
$$C_1 = 0.27C \qquad (17)$$
$$C_2 = 0.6C \qquad (18)$$

for the three-stage LPF of Fig. 2b.

There are several types of m-derived sections, and some of them are shown in Fig. 3. To go into the design calculations for the components in these sections would be beyond the scope of this article, and interested readers are referred to the numerous handbooks on this subject.

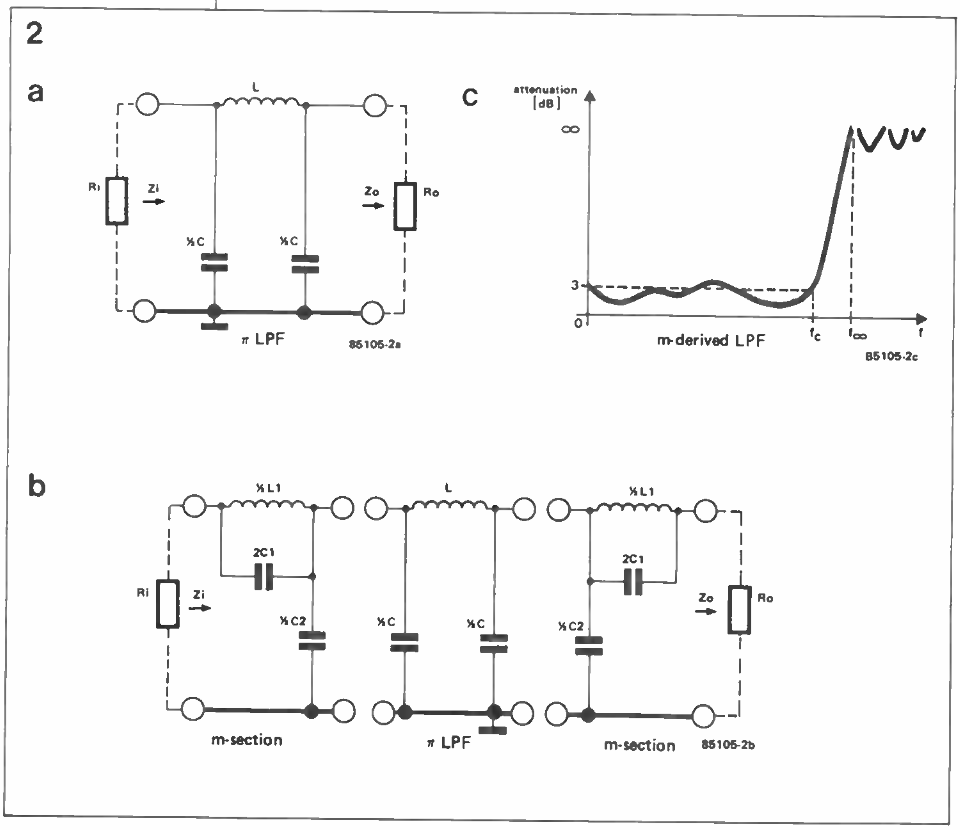


Fig. 2. Starting from the basic pi-LPF (Fig. 2a), m-derived sections may be added (Fig. 2b) to obtain a low pass profile as shown in Fig. 2c.

VHF roofing filter

A practical example will no doubt be quite helpful at this stage; if only to get an idea of the practical problems involved in filter design and construction.

Figure 4 shows the circuit diagrams of precisely calculated filters with m-derived sections shown in Fig. 3. If the proposed LPF and HPF are cascaded, a band-pass filter may be obtained with suitable characteristics for selective VHF reception (85. . . .110 MHz). Note the component values in LPF and HPF; they are, of course, theoretical. The term **roofing filter** is used to refer to the protec-

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tive (i.e. selective) character of this device, which is intended to keep strong out-of-band signals away from the first active device in the aerial booster, for reasons outlined above. Prototypes were made of these sections, and the LPF is shown in Photograph 1. Note the RF-tight construction in a brass enclosure and the short capacitor lead lengths to avoid stray inductance. The frequency curves of this LPF were examined with an RF sweep generator; Photograph 2a shows the roll-off characteristic and the first pole at about 130 MHz. Skirt steepness looks quite acceptable, and so does the pass-band attenuation; so far, so good. Sweeping the filter over a larger frequency range, however, reveals a quite unexpected peak in the UHF area; at 490 MHz, filter attenuation is only 13 dB, or about 5 times. As this frequency lies within TV band 4, there may still be trouble with a local transmitter despite the fact that the filter 'looks good' when swept over its target frequency range.

The rather disappointing results of these measurements, however, are still useful because we should be on our guard when looking at beautifully symmetrical curves of filters with low pass-band insertion loss, high Q factor, and near-perfect input and output matching; there are bound to be ugly peaks at frequencies well removed from the filter design frequency.

To finish this paragraph, Photograph 3 shows the impeccable band-pass curve of the roofing filter consisting of cascaded LPF and HPF to the designs of Fig. 4. Note the near-symmetrical profile and 3 dB bandwidth of about 25 MHz. Finally, it must be mentioned that the undesirable out-of-band peaks are mainly caused by the rather unpredictable, complex impedance of the filter for frequencies outside its pass-band range. Furthermore, the choice of capacitors plays an important role, so constructors who have read the following paragraphs may use the information given to produce a better version of this filter.

Filter matching

Filter design theory generally assumes ideal impedance matching at input and output. However, effects like out-of-band peaking can hardly be calculated because there are too many unknown variables involved. For a strong out-of-band signal, a four-element VHF Yagi type aerial has a very unpredictable impedance, and so has the filter input.

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Phtograph 4. A look at some filter components: upper row: BNC type socket and plug; BNC plug for 10 mm diameter coax cable; home-made N-to-BNC adapter. Middle row: split stator (butterfly) trimmer; ceramic tubular trimmers — chassis and PCB mount types; VHF coil. Lower row: leadless capacitors (chip types).

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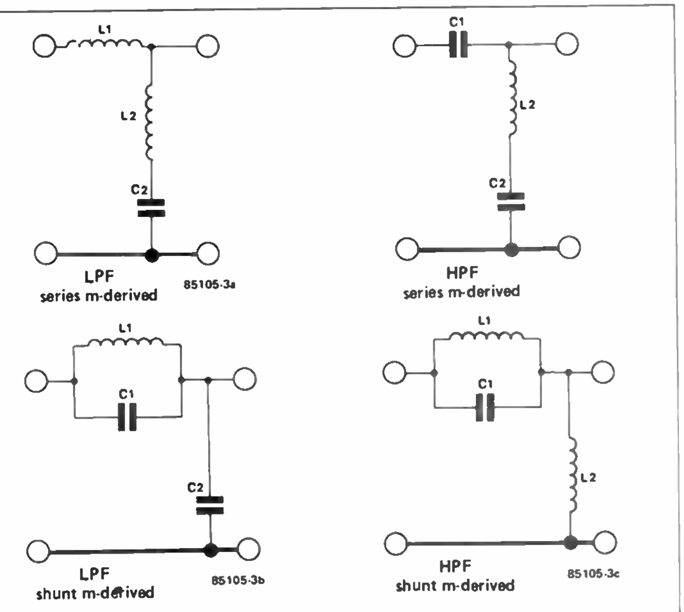

Fig. 3. These are some of the simpler configurations for m-derived sections.

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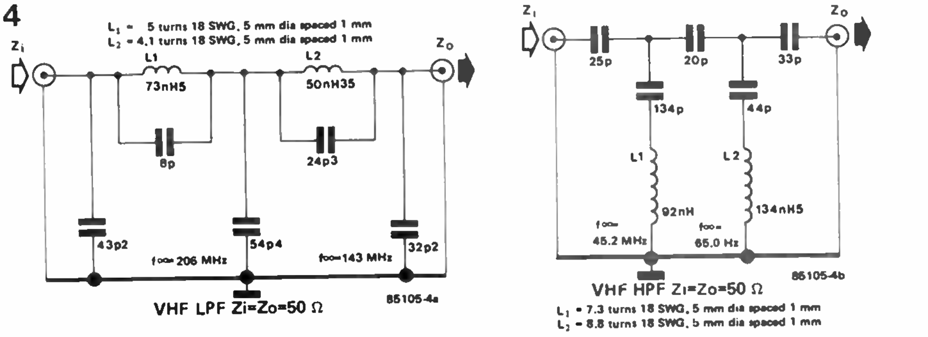

Fig. 4. Circuit diagrams and coil winding data for LPF and HPF which, when cascaded, form a VHF roofing filter. Note that the filters use m-derived sections shown in Fig. 3.

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The only known and stable impedance in the receiver RF chain is provided by the coaxial cable (50 or 75 Ω).

The undesired signal, then, will find the filter input as highly unmatched, and a large part of the signal will be reflected into the cable, only to be reflected again by the aerial. The delaying effect of the coax cable added to the unavoidable phase shift and reflection cause a so-called **standing wave**. It will stand to reason that the filter input must be as **reflection-free** as possible for the desired frequency band, simply because a large part of the RF signal would else be lost to the active device. Furthermore, **filter insertion loss** must also be as low as possible, but, as we have seen, good band-pass profiles require many filter sections and thus many components to pass the signal, and neither of these has ideal (low-loss) characteristics.

A total filter insertion loss of 0.5 to 1 dB is already a good figure, but it should be kept in mind that **any** insertion loss adversely affects the optimum noise figure of the active device coupled to the filter output.

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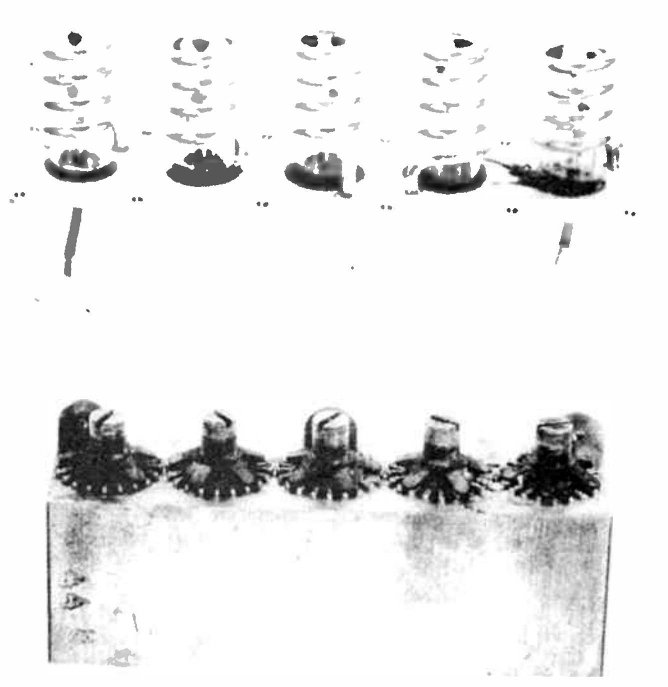

Photograph 5. This is a 5-stage helical filter for use in the 400 to 500 MHz frequency range. Coils are inductive-coupled and tuned with brass precision screws. Note the low-impedance tap at input and output coil

Filter construction

To conclude this article, some useful suggestions will be given for the choice of filter components and mechanical construction, because it ought to be clear by now that good filter calculation may be useless if the practical realization is not up to the 'VHF standard'. As these are mostly unwritten laws, it is very instructive to have a look at some of the established VHF construction methods in, for instance, a discarded VHF/UHF TV tuner.

Coils: Use 20 SWG or thicker silvered copper wire (CuAg) for the self-supporting, air-cored coils, and make sure that coils in separate filter sections can not 'see' each other to avoid unwanted stray coupling. In case the coils are PCB mounted, coupling can be avoided by positioning them at an angle of 90°. There are, however, also filter types that are based on inductive or capacitive coupling of coils to achieve a suitable bandwidth, e.g. helix type narrow band slot-coupled filters, in which case the above rule does not apply.

Capacitors. To arrive at the calculated cut-off frequency, the capacitors must be close tolerance types (1 or 2%) with good high frequency characteristics (NP0 or silver mica). Keep leads as short as possible to avoid introducing stray inductance in the circuit; where available, ceramic chip capacitors are the ultimate solution. Trimmers, if used, are preferably tubular glass or ceramic types with extremely low end capacity (1 pF or less); older types of TV tuner still contain them in abundance, but they are not easy to get out intact.

Connectors. Use standard 50 Ω plugs and sockets such as those in the UHF series (PL259-SO239), BNC or N types are even better, however, and much to be preferred. Do not ask for trouble by using the cheap coax connections as used with modern TV sets and FM tuners.

Housing. The filter should be fitted in a stable metal housing (diecast box) to prevent strong signals from bypassing. If at all possible, fit the amplifier in a separate housing and connect it to the filter output with a short length of low-loss coax cable fitted with BNC or N plugs; this also goes for the aerial-to-filter connection. Phograph 4 shows some preferred parts for VHF filter construction, and, finally, Photograph 5 shows a UHF type band-pass filter for professional use.

Next time

A further instalment in this series will concentrate upon an up-to-date VHF preamplifier stage constructed on the universal HF board. JB:JB

Literature:

Radio Communication Handbook vol. 1, publ. the Radio Society of Great Britain (RSGB)

The Radio Amateur's Handbook, publ. the American Radio Relay League (ARRL)

Elektor Electronics, February 1980 issue

Reference data for Radio Engineers 4th edition, pp 164-182, publ. ITT

UKW Berichte 3-75, R. Lenz DL3WR: 'Rauschen in Empfangsanlagen'

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RF CIRCUIT DESIGN

Third in the series, this article discusses aspects of good VHF preamplifier design, before proposing a practical circuit that enables reception of FM broadcast signals hitherto lost in noise.

VHF PREAMPLIFIER

Some of the important aspects in aerial amplifier design have already been covered in *Elektor Electronics*, March 1986 issue, along with the prerequisites for successful VHF filter realization. While the points discussed in that article remain fully valid, the present article aims to look at the most important technical characteristic of any VHF preamplifier stage: its noise figure.

While many of today's FM tuners have very sophisticated tuning control systems and excellent stereo demodulation, the design of up-to-date RF amplification and first mixer sections often deplorably lags behind. Since it is certainly not advisable to embark upon a complete reshuffle of the proprietary RF parts in the receiver front end, an add-on preamplifier stage of good design may prove helpful in updating the receiver performance to a considerable degree. Moreover, as the above mentioned article already pointed out, a VHF aerial booster should not be mounted in the receiver, but at the other end of the downlead coax cable, at the one and only place where it is effective; direct at the aerial connections (masthead mounting).

Noise

There are a number of basic considerations to go with design and construction of an RF preamplifier stage, if this is to operate in the very high frequency (VHF) range, generally referred to as 50...300 MHz. A section of this band is of special interest for this article, namely the FM broadcast band, which extends from 88 to 108 MHz; while being quite crowded with local stations in most built-up areas, only few stations may be received in rural districts. This is due to the straight line propagation characteristics of the RF waves at these frequencies, which makes it impossible to receive over-the-horizon stations, except during special weather conditions.

A typical daytime FM-band spectrum (= survey of signal strengths within a certain frequency band) may look very much as sketched in Fig. 1a; there are a number of very strong transmissions, as well as relatively weak and also nearly invisible (i.e. inaudible) ones, sometimes quite close to one another. This spectrum is purely hypothetical, however, since it is a representation of relative signal strengths at the aerial connections, i.e. without noise caused by any active electronic device. Obviously, the spectrum analyser itself would feature a certain amount of self-generated noise, but this has been disregarded for the sake of clarity. The low noise level N_i in Fig. 1a is, however, present at any

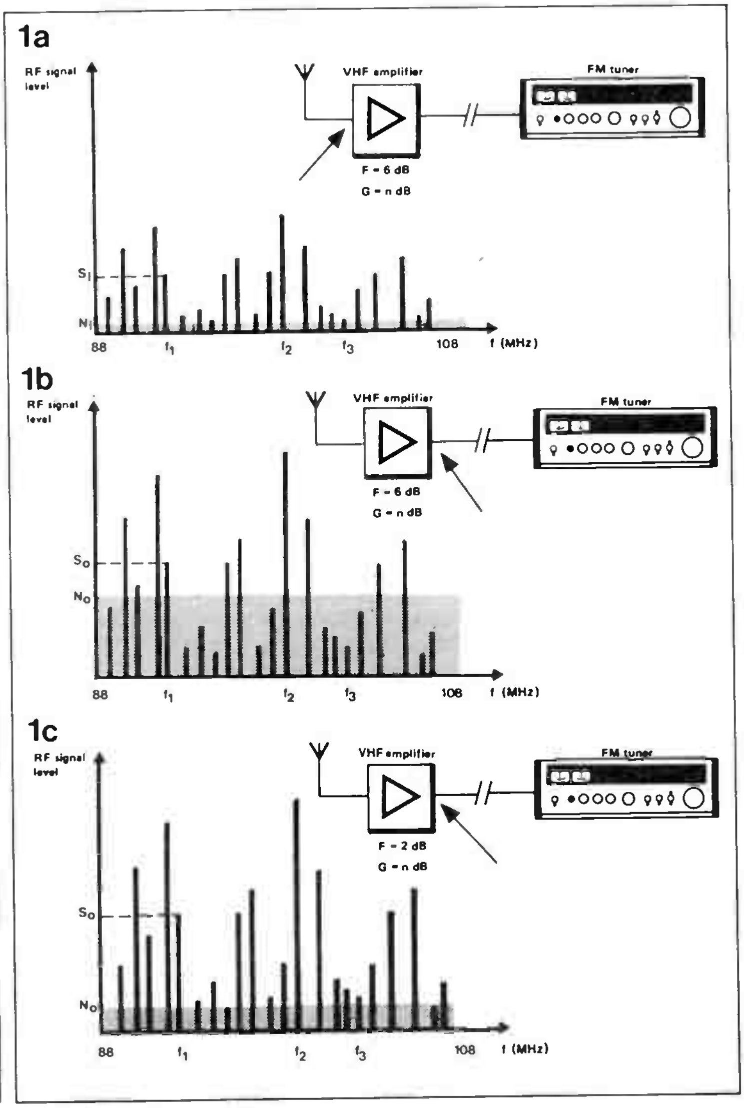

Fig. 1. Representation of FM band spectrum analyses showing that the noise factor of the preamplifier stage determines to a large extent the number of stations that can be made audible in the FM receiver.

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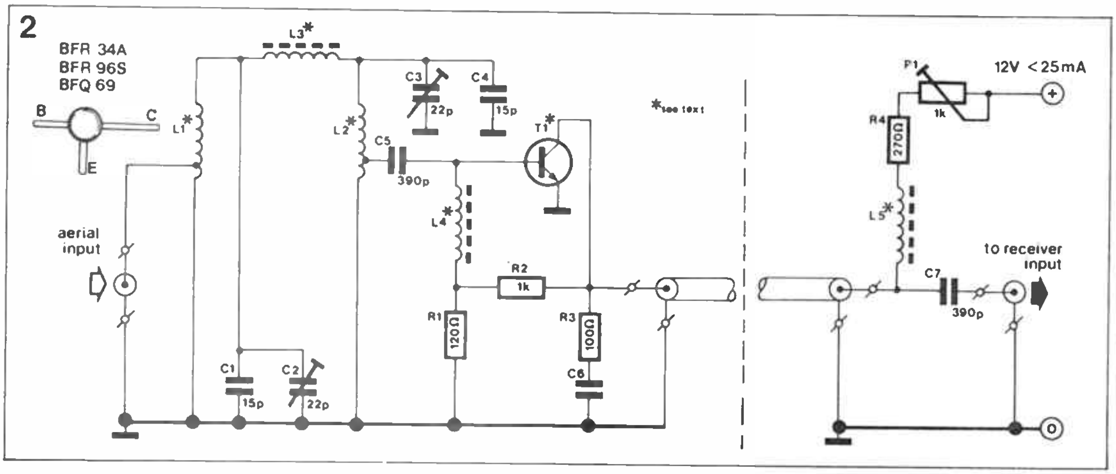


The value of capacitor C_6 should be 1n.

Fig. 2. Circuit diagram of the low-noise aerial amplifier with receiver-mounted supply parts.

VHF aerial, since this picks up a certain amount of atmospheric noise; the nature of this effect would lead us into theoretical physics, which is beyond the scope of this article. Spectrum analysis of the preamplifier output signal (Fig. 1b) reveals that while all signals have been amplified, a certain amount of additional noise is introduced by the aerial booster, to the effect that some signals have got lost underneath the noise threshold N_o and are, therefore, inaudible in the receiver. Since the amplifier noise output is not caused by amplification of the atmospheric noise level N_i (compare the signal levels of f_3 in Fig. 1a and 1b), level N_o must needs be generated by the amplifier itself; clearly, this is an undesirable effect. If we consider the effective signal strengths of, for instance, the transmission at f_1 in Fig. 1a as opposed to Fig. 1b, the total **noise factor** of the amplifier stage may be defined as the overall ratio of the output signal/noise ratio to the input signal/noise ratio, or

$$F = (S_o/N_o)/(S_i/N_i) \qquad (1)$$

the **noise figure** may be calculated from F using

$$F_{dB} = 10\log_{10}F \qquad (2)$$

Clearly, S_o/N_o for f_1 is worse (lower) than the original S_i/N_i and this arises from the extra amount of noise generated by the amplifier. Were this device ideal, then

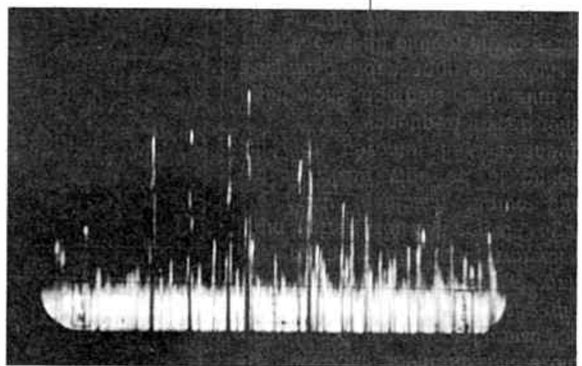
$$S_o/N_o = S_i/N_i \text{ or } F=1, \text{ or } F_{dB}=0\text{dB} \qquad (3)$$

Unfortunately, no electronic device has been developed as yet for use in the ideal preamplifier, nor will it ever be developed, due to some basic laws of physics. However, modern SHF transistors are now readily available with noise figures as low as 1.5 dB at 1000 MHz, while Gallium Arsenide (Ga-As) FETs have been designed to achieve 2.8 dB at 12 GHz; however, the cost and circuit design complexity of these devices puts them well beyond the reach of the average home constructor.

The importance of a low preamplifier noise figure is evident after a comparison of Figures 1b and 1c; while its signal gain (amplification factor) is still ndB, the amplifier of Fig. 1c has a noise figure improved by 4 dB, which enables reception of signals that were inaudible with the F=6 dB amplifier of Fig. 1b. We may, therefore, establish the general rule that reception is improved with a lower preamplifier noise figure. Thus, designing for low noise should be a high priority issue.

So far, only the active device in the preamplifier has been held responsible for the noise addition, but it should be pointed out that this device can only attain its minimum noise contribution when supported by passive components that ensure thermal stability and low signal insertion loss at the amplifier input. It will stand to reason that any mismatch at the booster input will adversely affect (i.e. increase) the transistor noise figure as given in the manufacturer's data sheets.

No preamplifier stage, however low its noise figure, will be capable of reception improvement if the signals at the target frequency have been considerably attenuated before being applied to the first active device, either by downlead cable losses or a severe mismatch at the booster input. As the above mentioned article pointed out, however, the preamplifier input necessarily consists of a low-loss filter, which serves the dual function of an out-of-band signal attenuator and signal source to transistor input impedance transformer (source matching). It should be fairly obvious by now that the actual gain of the booster is far less important than its noise figure; if the former is some 10 dB higher than the downlead cable attenuation, adequate results are usually obtained; a gain of 15...20 dB is common for a single-transistor preamplifier stage.



Practical circuit

The circuit diagram of the present VHF preamplifier is shown in Fig. 2. The RF signal at the input is passed to the base of T_1 by a capacitance-tuned, inductive top-coupled, low insertion loss and source matching bandpass input filter with a −2 dB bandwidth of 20 MHz (88...108 MHz). This is quite a mouthful for a basically simple filter that performs the functions outlined above. Note the taps on L_1 and L_2 to obtain impedance matching of the cable and the transistor respectively. Any of the listed transistor types may be used in the circuit, but the Type BFQ69 is preferable because of its extremely low noise figure. Since this transistor has been introduced only quite recently, however, it may prove difficult to get hold of.

The amplifier is fed by the receiver power supply over the downlead coax cable; the parts to the right of the dotted line are, therefore, mounted in the FM tuner. Decoupling parts L_5 and C_7 ensure that no RF signal is lost in the power supply. The amplifier bias setting is effected with P_1; depending on the transistor in use, this preset may be adjusted to find the right compromise between

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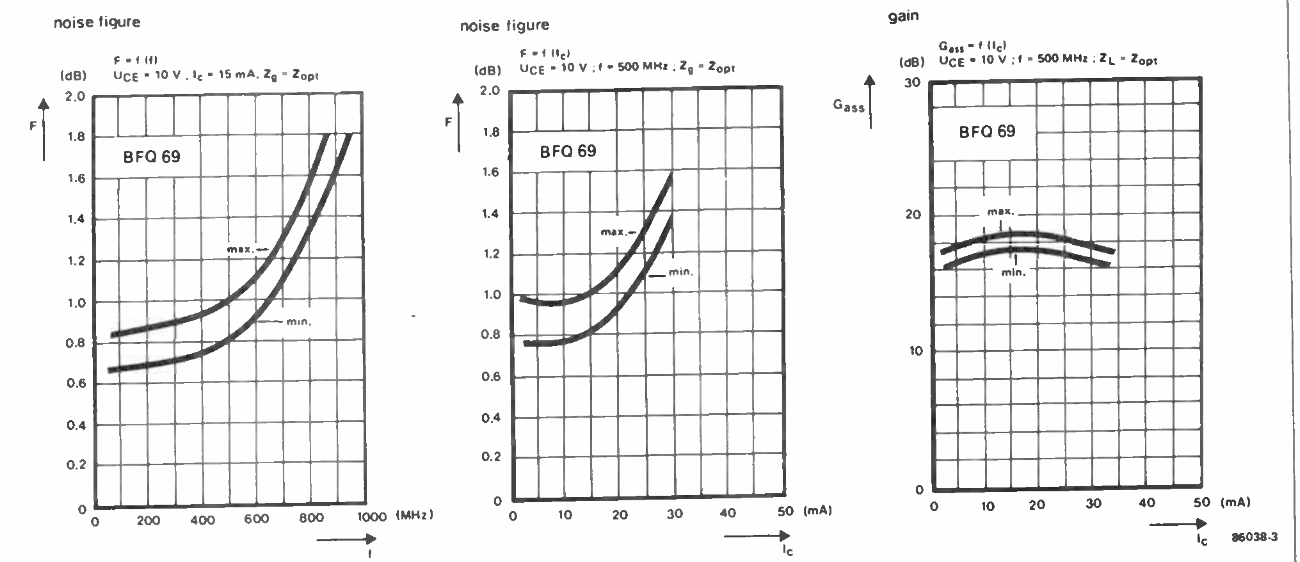
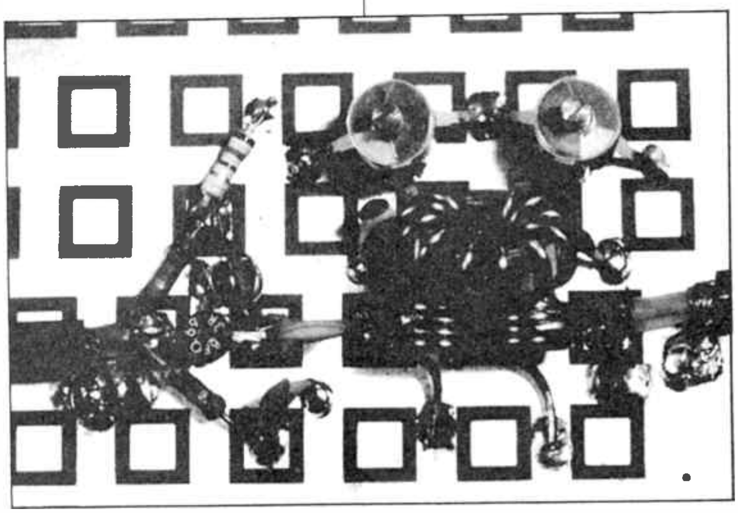


Fig. 3. Curves showing the characteristics of the new BFQ69 transistor. Note that the curves in Figures 3b and 3c refer to a test frequency of 500 MHz and not to the design frequency of the present pre-amplifier. (Siemens)

Fig. 4. This RF design is also fitted on the universal prototyping board 85000.

optimum noise figure (low current) or maximum amplification with acceptable intermodulation response (high current). For further details on the bias setting of RF preamplifier transistors, refer to *Elektor Electronics*, February 1980 issue. Fig. 3 shows three curves relevant to the novel BFQ69; a collector current of 15 mA appears to be suitable for a minimum noise figure of about 1 dB, which will bring the total noise figure of the present design in the 1...2 dB range with a Type BFQ69 fitted and the filter tuned to optimum input matching. However, the Types BFR34A and BFR96S will also ensure a noise figure that is usually far better than the average FM tuner specification in this respect.



The coils and chokes for the present design are wound as follows:

L_1 = 4 turns 20SWG (ϕ 1 mm) enamelled wire, close wound on dia. 6 mm, tap at 1.5 turns from earth.

L_2 = identical to L_1, but tap at 2.5 turns from earth.

L_3 = 11 turns 20SWG enamelled wire on toroid core Type T50-12 (Amidon).

L_4; L_5 = 4.5 turns 30SWG (ϕ 0.3 mm) enamelled wire through 3x3 mm ferrite bead.

For more information on inductor calculations and specifications, refer to last month's issue of *Elektor Electronics*.

Construction and alignment

The present amplifier is fitted on the universal RF board 85000 as shown in Fig. 4; not shown are the bias setting parts, since these are mounted in the receiver. After completion, the unit may be tested by tuning the receiver to a weak transmission at about 95 MHz and adjusting C_1 and C_2 for optimum reception. The collector current setting should be fairly uncritical; its precise effect on the amplifier performance can only be judged when a very stable and yet sufficiently weak transmission is being received and the input filter has already been correctly tuned. Finally, the preamplifier may be fitted in a suitable water-resistant case for masthead mounting, equipped with suitable coaxial sockets, and fixed to the aerial mast.

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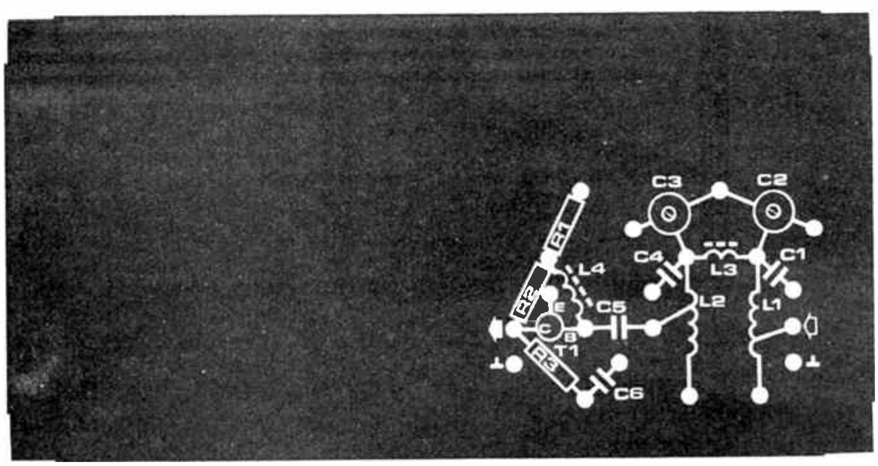

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* The first three appeared in the February, March, and April issues of *Elektor Electronics*.

The fourth in this series on RF circuit design describes a superregenerative short-wave receiver that can be coupled to a frequency counter for an accurate read-out of the frequency of the received signal.*

superregenerative short-wave receiver

A superregenerative receiver is provided with ample positive feedback so as to be capable of oscillation at the desired radio frequency. It is also provided with a means by which oscillations can be stopped or started at will. During normal operation, the relevant circuit is just oscillating.

Block diagram

From the block diagram in Fig. 1 it is seen that the RF signal intercepted by the aerial is fed to an RF stage, which not only serves to amplify the signal but also to decouple the aerial from the remainder of the receiver. The amplified signal is fed to a buffer and a detector stage. The output of the buffer may be used to drive a frequency counter to give a read-out of the received frequency. The demodulated output from the detector is passed through a low-pass filter with a cut-off frequency of 5 kHz and then applied to an AF amplifier. The audio output is sufficient to drive a pair of headphones, but may also be used to drive a more powerful AF amplifier.

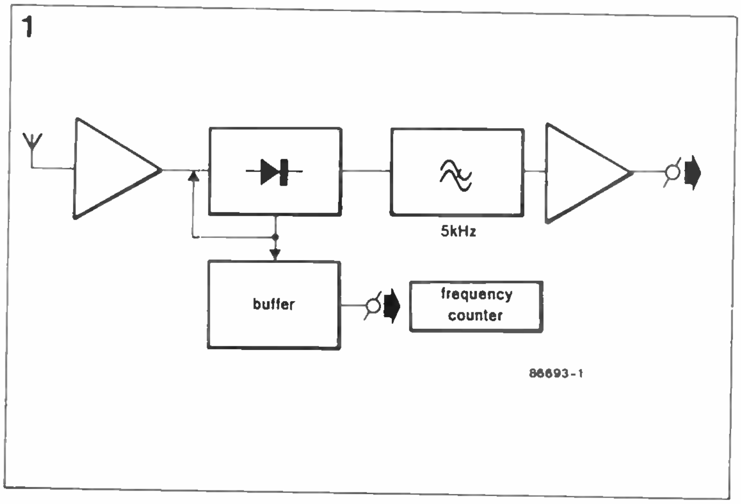

Fig. 1 Block diagram of the short-wave receiver

Table 1 Winding data for L_2

Band	L2A (turns)	tap at (turns)	L2B (turns)
120 m	132	12	7.5
90 m	99	9	5.5
75 m	82,5	7.5	4.5
60 m	66	6	3.5
49 m	54	5	3
41 m	45	4.5	2.5
31 m	34	3.5	2.5
25 m	27	2.5	2
19 m	21	2	1.5
16 m	18	1.5	1.5
13 m	14	1.5	1
11 m	12	1	1

The core is a Type T50 6 RF toroid, while the winding wire is 0.3 mm dia. enamelled copper.

Circuit description

With reference to the circuit diagram in Fig. 2, the aerial signal is applied across potentiometer P_1, which enables the signal to be set to the correct level, as will be explained later.

MOSFET T_1 amplifies the input signal and decouples the aerial circuit. The amplified signal is applied to a detector, the G_1-S junction of T_2, via circuit L_2-C_7-C_8-C_9-C_{10}, which is tuned to the frequency of the incoming signal.

Part of the RF signal is applied to the G_2-D junction of T_2 from where it is fed back inductively to the tuned circuit. As this feedback is positive, oscillations tend to be set up in the tuned circuit at the frequency of the received signal. These oscillations are quenched by the resistance of P_2, depending on its setting, so that this potentiometer affords a means of bringing the tuned circuit just into oscillation.

The demodulated output at the source of T_2 is applied to low-pass filter L_3-C_{13}-C_{14}-C_{15}, which has a cut-off frequency of about 5 kHz. Since many short-wave stations operate at 5 kHz channel separation, the filter provides effective adjacent-channel suppression.

The audio signal is then amplified in T_4 and T_5 whose gain is sufficient to enable a pair of high-impedance headphones to be driven from the AF output across C_{18}-C_{19}. If the audio output is used to drive an additional AF amplifier, the value of C_{19} should be reduced to 1 μF.

The signal at the drain of T_2 is also fed to buffer T_3, whose output may be used to drive an external frequency counter. This is a very useful means of obtaining a read-out of the frequency of the received signal, which makes operation of the receiver immeasurably easier.

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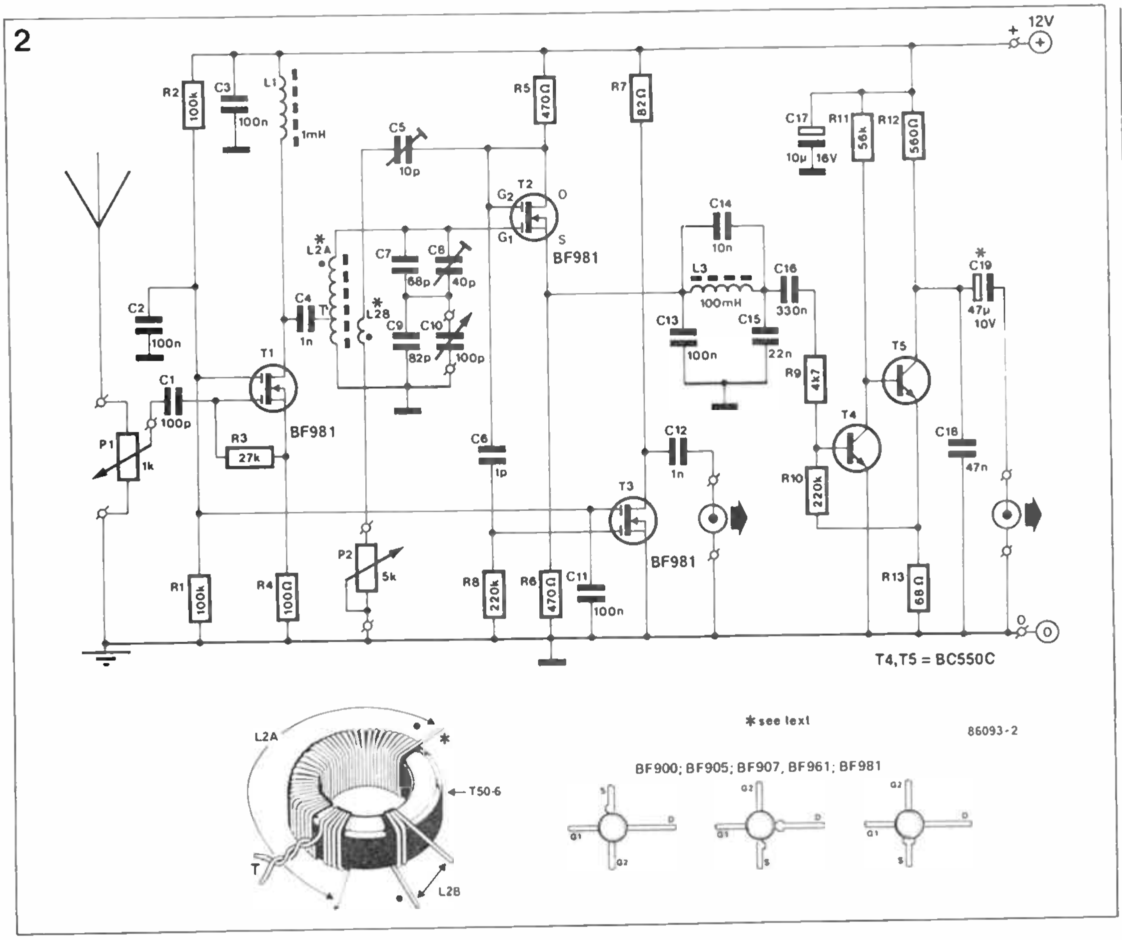

Fig. 2 Circuit diagram of the short-wave receiver

Parts list

Resistors:
R_1;R_2 = 100 k
R_3 = 27 k
R_4 = 100 Ω
R_5;R_6 = 470 Ω
R_7 = 82 Ω
R_8 = 220 Ω
R_9 = 4k7
R_{10} = 220 k
R_{11} = 56 k
R_{12} = 560 Ω
R_{13} = 68 Ω
P_1 = 1 k linear potentiometer
P_2 = 5 k linear potentiometer

Capacitors:
C_1 = 100 p
C_2;C_{11};C_{13} = 100 n ceramic
C_3 = 10 n ceramic
C_4;C_{12} = 1 n ceramic
C_5 = 10 p trimmer
C_6 = 1 p
C_7 = 68 p NPO
C_8 = 40 p trimmer
C_9 = 82 p NPO
C_{10} = 100 p variable capacitor
C_{14} = 10 n
C_{15} = 22 n
C_{16} = 330 n
C_{17} = 10 μF; 16 V
C_{18} = 47 n
C_{19} = 47 μF; 10 V (see text)

Semiconductors:
T_1;T_2;T_3 = BF981 (= BF900 = BF905 = BF907 = BF961)
T_4;T_5 = BC550C

Miscellaneous:
L_1 = 1 mH
L_2 = see text and Table 1
L_3 = 100 mH
AF output socket
RF output socket
RF board 85000
Metal case of about 135 × 150 × 75 mm

Construction

The receiver is constructed on the Universal RF Board Type 85000, which is available through our Readers' Services. As it is an unpierced copper-clad board with fifty-seven isolated islands and three isolated tracks, it is also available from most electronics retailers. A suggested component layout is shown in Fig. 3.

Chokes L_1 and L_3 are commercially available components, but inductor L_2 must be wound as shown in Fig. 2. The number of turns for the various short-wave bands are given in Table 1. It is imperative for correct operation of the receiver that the coils are wound in the direction shown and that correct polarity is observed (this is facilitated by the large black dots in the circuit and on the coil drawing).

Operation

For optimum performance, the G_2-D section of T_2 should just oscillate. This is achieved by setting P_2 to roughly its centre of travel and adjusting C_5 till oscillations just occur: this is indicated by a whistle in the headphones or loudspeaker.

The input level is then set with P_1: if this is too high, cross modulation occurs, i.e. apart from the wanted station, others are also audible. If the aerial signal is too weak, the detector does not operate correctly, and the signal is hardly audible.

It may be necessary to adjust P_2 slightly before optimum performance is achieved: only when this is so, does the frequency counter indicate the frequency of the received signal.

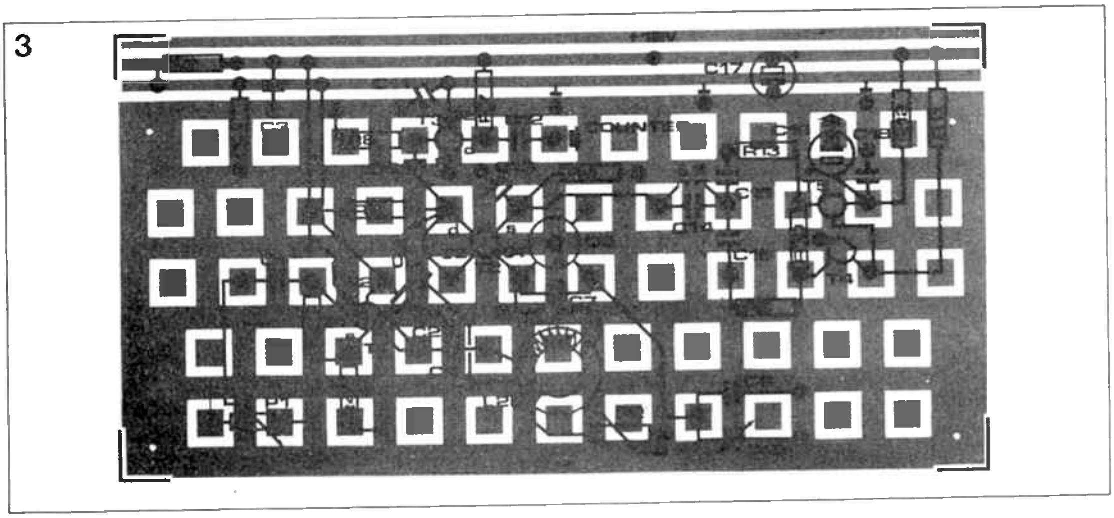

Fig. 3 Suggested component layout of the short-wave receiver

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DARK-ROOM EXPOSURE METER

No photographer can work properly in his dark-room without some sort of light meter. The instrument proposed here is not expensive, easy to build, and, apart from the exposure time, it indicates the contrast in relative light values.

In spite of its simplicity, the meter is accurate enough for virtually all requirements. Moreover, it is constructed from standard components throughout, with the possible exception of the Type BPW21 photodiode. Operation of the meter is simplicity itself: a push button for normal exposure measurement; another push button for constrast measurement; and a microammeter for the readout.

Circuit description

The first notable aspect of the circuit diagram in Fig. 1 is that three different levels of supply voltage are required: +2 V; +5 V; and +9 V. At first sight this may seem extravagant, but it is not really as will be seen later. Moreover, the three levels are obtained relatively easily. The +9 V is provided direct by the battery; since the total current consumption does not amount to more than 15 mA, a standard PP3 will do nicely. The +5 V supply is derived from the battery via a Type 7805 voltage regulator, while the +2 V supply is provided by a voltage divider (R_{19}-R_{20}) and an opamp (IC_5).

The exposure meter is based on a well-known principle: the photovoltaic effect. This effect causes certain semiconductor diodes to produce a forward voltage when they are illuminated. This voltage changes in direct proportion to the logarithm of the causative change in light flux, provided the diode is terminated in a high impedance. This proviso is met in the present circuit by terminating the photodiode, D_1, into opamp IC_2.

It should be noted that the spectral sensitivity of the BPW21 is very similar to that of the human eye. The maximum sensitivity of the diode and the human eye are about the same, but the BPW21 has a somewhat larger bandwidth.

The diode voltage is amplified and inverted in three opamps: IC_2; IC_3; and IC_4, and then applied to the series combination of the meter, M_1, resistor R_{18}, and preset P_3. In this application, the meter should have a logarithmic scale (see Fig. 2).

It should be noted that this exposure meter works in an exactly opposite way from that in a camera, because the present meter should not indicate the amount of light, but the required period of illumination. Therefore, when the light flux is large, the diode voltage is high, and the voltage across the meter is low. Conversely, if there is but little light, the meter will deflect strongly.

Diodes D_2 and D_3 serve to compensate for the variation of the diode voltage with temperature. In the prototype the variation resulted in a difference of only half a stop for every 7 °C: a perfectly satisfactory value, the more so when it is remembered that the temperature in a darkroom must be kept fairly constant. As long as the three diodes are not heated unnecessarily when the instrument is handled, all will be well.

Potentiometer P_1 affords compensation for different paper sensitivities,

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because, in conjunction with R_4-R_5-R_6-R_7-D_4-D_5, it can add a small direct voltage to the measured voltage. Since the meter scale is logarithmic, this added voltage manifests itself as a multiplication of the indicated time. The effect of P_2 is the same as that of P_1, but this control is only set during the initial calibration of the instrument.
Contrast measurement is effected with the aid of electronic switches ES_1, ES_2, and ES_3. When the contrast push button, S_2, is open, ES_1 will also be open, while ES_2 and ES_3 will be closed (situation as shown in Fig. 1). The circuit operates as an exposure meter as described. In this state a light section of a negative should be measured.
When S_2 is pressed, ES_2 and ES_3 open and ES_1 will close for a short time (at the instant—after ES_3 has opened—that C_5 is charged via R_{13} and R_{14}, junction C_5-R_{14} will go high, which causes ES_1 to close; once C_5 is charged, junction C_5-R_{14} will go low, and this causes ES_1 to open again).
During the time that ES_1 is closed, C_4 is charged to the potential then present at the output of IC_3. The voltage across the microammeter then drops to zero, so that the pointer does not deflect at all. Even when ES_1 opens again after a short while, the potential across C_4 is maintained.
With S_2 still depressed, hold the photodiode under a dark part of the negative: the meter will deflect again, but the voltage across C_4 is now deducted from the measured value. In other words, the meter now indicates the contrast (in LV) between the first and second measurements, i.e. between the light and dark parts of the negative.
Since a difference of one LV (light value) corresponds to a doubling (or halving) of the light flux, the contrast scale of the meter is calibrated linearly as shown in Fig. 2.

Construction

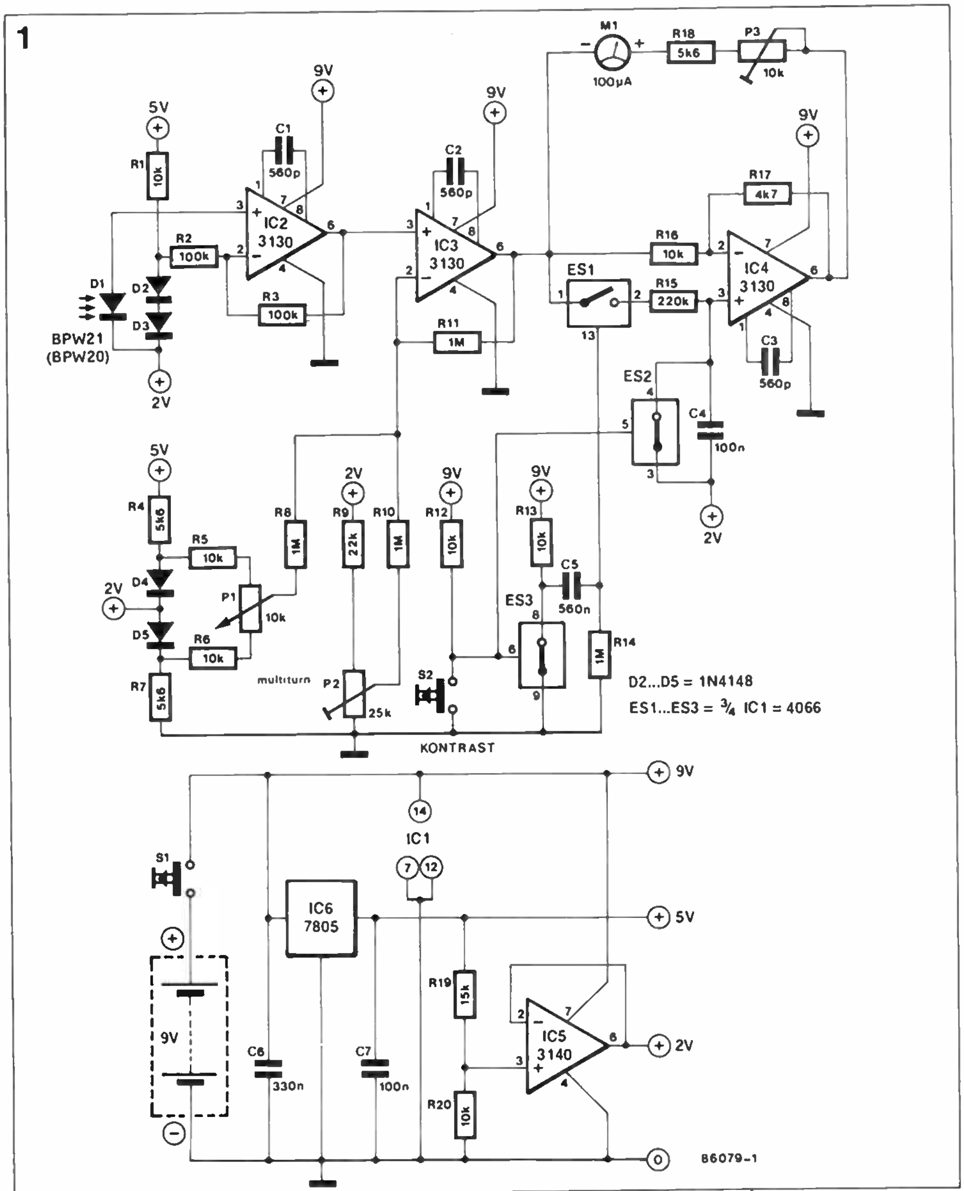
The circuit is best constructed on a small piece of single-sided Veroboard. As far as the enclosure is concerned, any small one will do, as long as the board, microammeter, and operating controls can be fitted neatly. The controls should, of course, be easy to reach and operate. The photodiode should be mounted in a manner which ensures that the light from the enlarger reaches it freely. Diodes D_2 and D_3 should be placed as close as possible to the photodiode, so as to keep temperature differences between the three as small as possible.

Setting up

Set P_1 to the centre of its travel.
Using photographic paper of average sensitivity, make a test strip that is correctly exposed with an exposure time of 2 seconds. The lowest stop number should be used, and the correct illumination obtained by adjusting the height of the enlarger. Place the exposure meter on the base of the enlarger and disperse the light, for instance, by holding a piece of opaque paper in front of the lens.
Adjust P_2 until the microammeter indicates 2 s.
Select the fourth lowest f-stop and adjust P_3 until the microammeter reads 32 s (=contrast of 4 LV).

Finally

A calibrated scale needs to be made for P_1 corresponding to the sensitivities of different types of photographic paper. This requires the making of a lot of test strips, but such a scale will be found very useful in practice for a long time to come.
For contrast measurements, the position of P_1 is irrelevant (as long as it is not changed between the two measurements).



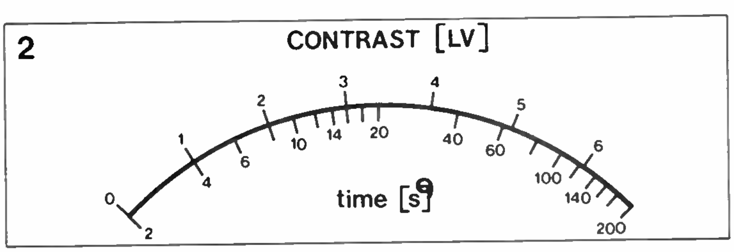


Fig. 1. The circuit diagram of the dark-room exposure meter.

Fig. 2. Suggested scale for the microammeter: logarithmic for time, and linear for contrast.

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COLOUR VIDEO INTERFACE FOR ATARI ST

by T Scherer

The Atari ST is one of the most significant new computers introduced in the past few years. Unfortunately, one of its advanced features—the SCART video output—makes it impossible in many cases for the machine to be readily connected to a colour TV set or monitor. The interface presented here is aimed at overcoming this problem.

Computers in the Atari ST series provide a comprehensive set of output signals via a SCART socket. Although it was decided some years ago that this type of socket should become a European standard, there are still only few TV sets fitted with it. The name is an acronym of Syndicat des Constructeurs d'Appareils Radiorécepteurs et Téléviseurs, the French association of radio and television manufacturers who proposed the 21-way plug-and-socket arrangement.

Unfortunately, it is not as simple as it may seem to build up a composite video (colour) signal from the Atari ST output. However, a combination of Type LM1886 and LM1889 ICs offers a perfect means to synthesize a PAL video signal from computer data.

The LM1886 is a fast digital-to-analogue converter with three 3-bit inputs for the three basic colours. The total of 9 bits enable the 512 colours provided by the Atari ST to be reproduced.

The LM1889 is a PAL encoder with composite video and RF output in the VHF band.

Regrettably, the Atari ST computers provide only three colour outputs on the SCART socket: the digital 9-bit data are only available direct at the printed-circuit board. This is the reason that some work has to be done in the computer before the interface can be connected. This interference is completely harmless as will be explained later on.

Circuit description

To form a composite video signal, the following signals are needed: colour information; a combined field and line sync(hronization) signal (which is not generated in older 520-ST models); a blanking signal; an audio signal; 0 V; +5 V; and +12 V.

From these inputs, the interface produces a video signal at a level of 1 V_{PP}; an RF signal that covers the VHF bands 1-3; and an audio signal.

The circuit diagram in Fig. 1 shows that, apart from the two ICs already mentioned, three more ICs, three transistors, and a quartz crystal are required.

The crystal provides the 4.433619 MHz chrominance subcarrier, which is modulated in the LM1889 with the colour information from the LM1886. The colour burst signal (see Fig. 2) is also derived from the crystal frequency.

Circuits IC_3, IC_4, and IC_5 serve to process the $\overline{sync}$ and $\overline{BL}$ (blanking) pulses. The PAL bistable, FF_1, divides the frequency of the line sync pulses by 2 to ensure that, in accordance with the PAL standard, each burst is shifted by 180° with respect to the preceding one.

A monostable, MMV_1, in IC_4 with a pulse duration of 48 μs prevents spurious triggering of FF_1 (line duration = 64 μs).

Monostable MMV_2 in IC_5 ensures the exact onset of the colour burst signal, i.e. 1 μs after the end of the line sync pulse, which is the mono period of 6 μs minus the width of the line sync pulse (5 μs). If the interface produces black-and-white pictures only, tolerances in the computer or interface components are almost certainly to blame. Increasing R_9 to 22 k will normally cure the fault.

Monostable MMV_2 in IC_4 prevents triggering of MMV_2 in IC_5, and thus the generation of colour burst signals, during the field sync pulses.

Capacitor C_{11} and inductor L_1, in conjunction with the LM1889, form the RF oscillator.

Transistor T_1 buffers the video output signal from IC_2, while T_2 and T_3 form a buffer and impedance converter for the audio signal, whose level is preset with P_1.

Finally, switch S_1 enables selection of the VHF or the video output.

Construction

Construction on the printed-circuit board (86103) follows the usual pattern: first wire links, then resistors, ICs, capacitors, and the remainder, in this case, L_1. This is a hand-made, air-cored inductor of six turns enam-

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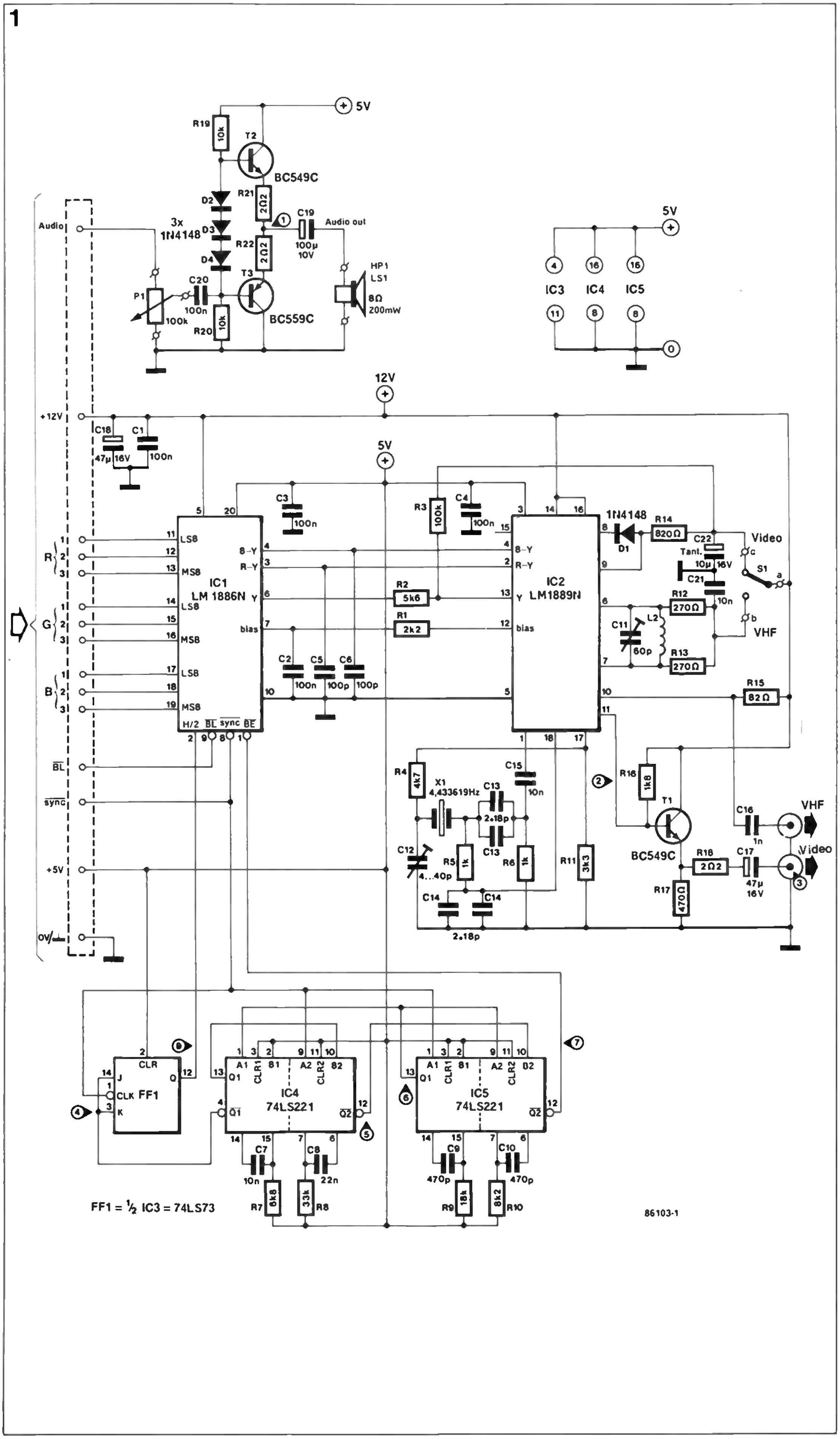

Fig. 1. Circuit diagram of the colour video interface.

Typical test values

1 2.5 V
2 6-10 V
3 1 Vpp (video)
4 48 µs
5 500 µs
6 6µs
7 2.5 µs
8 7.813 kHz

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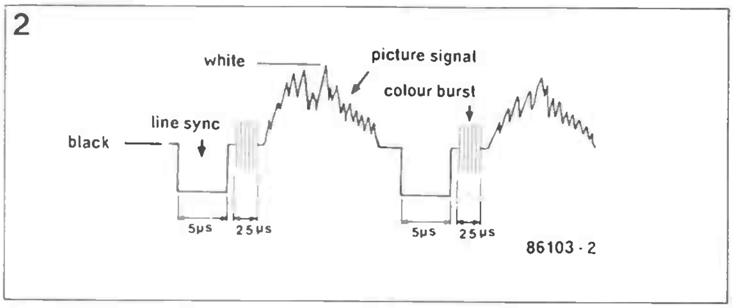
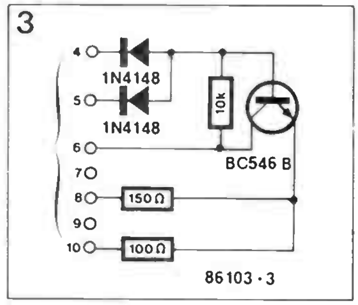
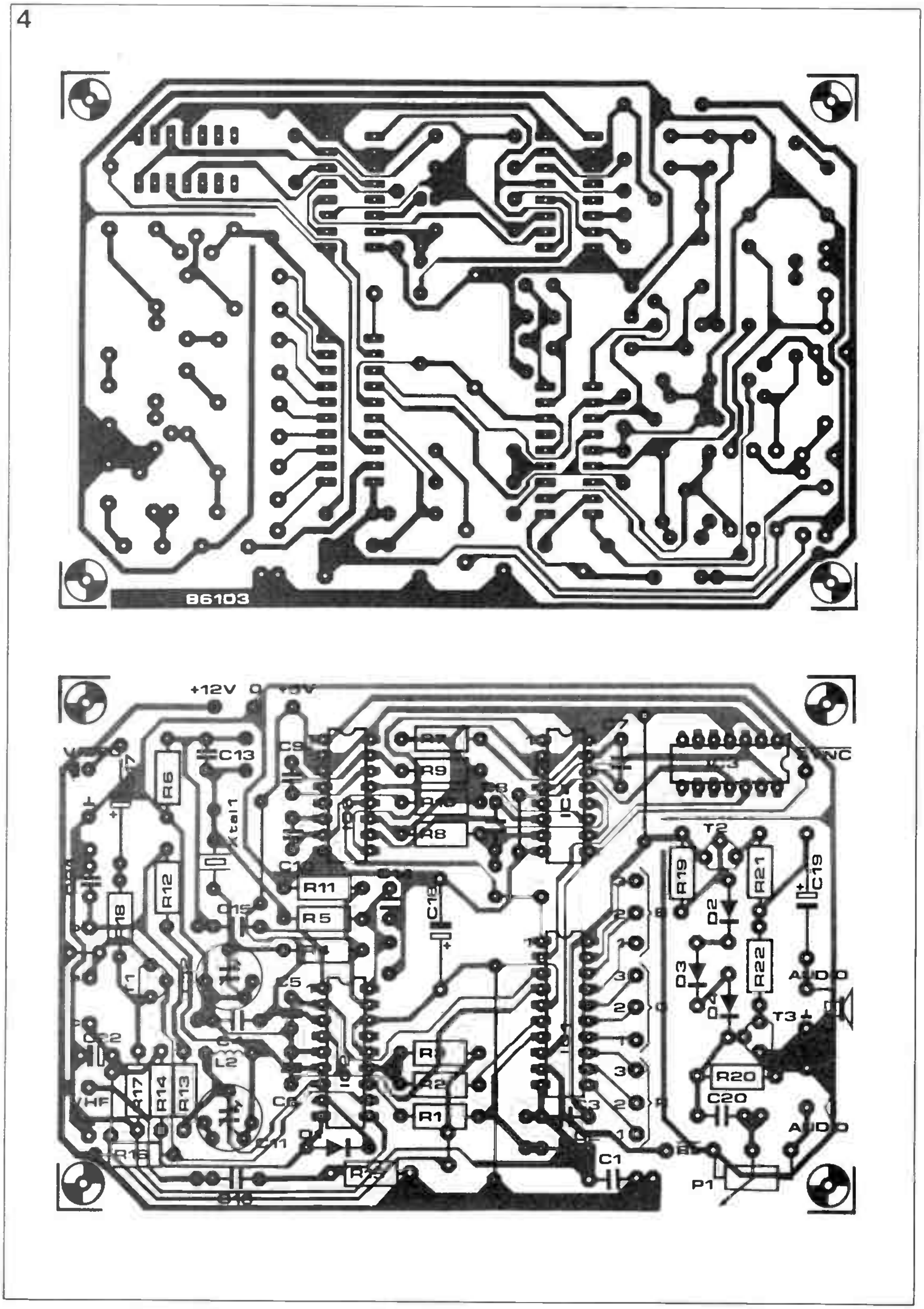
Fig. 2. Composite video signal with line sync and colour burst pulses







Parts list

Resistors:
R_1 = 2k2
R_2 = 5k6
R_3 = 100 k
R_4 = 4k7
R_5;R_6 = 1 k
R_7 = 6k8
R_8 = 33 k
R_9 = 18 k (see text)
R_{10} = 8k2
R_{11} = 3k3
R_{12};R_{13} = 270 Ω
R_{14} = 820 Ω
R_{15} = 82 Ω
R_{16} = 1k8
R_{17} = 470 Ω
R_{18};R_{21};R_{22} = 2Ω2
R_{19};R_{20} = 10 k
P_1 = 100 k preset

Capacitors:
C_1 - C_4;C_{20} = 100 n
C_5;C_6 = 100 p
C_7;C_{15};C_{21} = 10 n
C_8 = 22 n
C_9;C_{10} = 470 p
C_{11} = 10 . . . 60 p trimmer
C_{12} = 7 . . . 40 p trimmer
C_{13};C_{14} = 33 p
C_{16} = 1 n
C_{17};C_{18} = 47 μ; 16 V
C_{19} = 100 μ; 10 V
C_{22} = 10 μ; 16 V, tantalum

Semiconductors:
D_1 - D_4 = 1N4148
T_1;T_2 = BC549C, BC550C
T_3 = BC559C, BC560C
IC_1 = LM1886 (National)
IC_2 = LM1889 (National)
IC_3 = 74LS73
IC_4;IC_5 = 74LS221

Miscellaneous:
S_1 = single-pole change-over switch
X = crystal, miniature, 4.433619 MHz
L_1 = see text
Small piezo-electric loudspeaker (optional)
Metal case as required
VHF socket
Video socket
Two D subminiature sockets for chassis mounting
Two D subminiature plugs for cable mounting
Length of 10-way ribbon cable
PCB 86103

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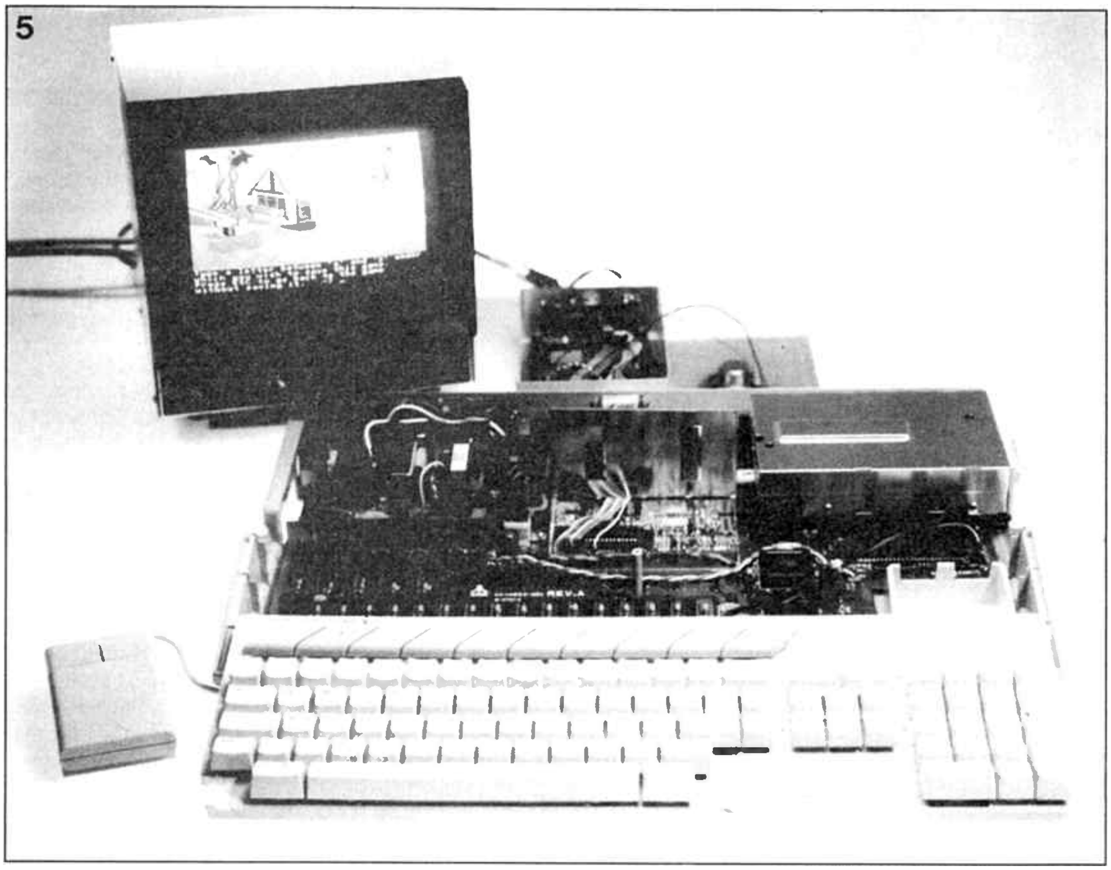

Fig. 3. Circuit for obtaining the sync signal in Atari 520-ST models that do not provide this signal.

Fig. 4. Printed-circuit board of the colour video interface.

Fig. 5. Atari 1040-ST with top lid removed.

elled copper wire of 0.6-1.0 mm dia. wound around a 6-mm dia screw-driver shaft or pencil. Spacing between the turns should be about the same as the diameter of the wire.
The board should then be mounted in a small metal case, into which S_1; P_1; loudspeaker (unless an external amplifier and loudspeaker are used, in which case an AF socket should be fitted); VHF socket; video socket; and a 15-way D subminiature socket should also be fitted. The wiring of the D socket is shown in Table 1.

Modifying the Atari 520-ST

- Remove the 6 cross-slotted screws at the underside of the computer, and remove the lid.
- Disconnect the keyboard by removing the plug at the right-hand side of the PCB. Mark which way the plug is located!
- Remove the copper-coloured adhesive foils.
- Using a pair of flat-nose pliers, straighten the ten lugs retaining the screening cover at the underside.
- Remove the cross-slotted screws that fasten the screen to the PCB, and remove the screen.
- At the centre right of the PCB is another screen that must also be removed. Under this screen is the video section of the computer: the large IC denoted U31 is the video shifter.
- Cut an appropriately sized hole in the back panel of the computer to receive a 15-way D subminiature socket.
- Adjacent to the video shifter IC, at the side facing the keyboard, is a row of resistors and diodes.
- From above, solder a 10-way ribbon cable to the terminals of these components facing the U31, starting with R_{53} (3k6, coming from B_3), with the ninth core to R_{61} (15k, coming from R_1), and the tenth core to the cathode of diode CR_1 (coming from BL). The ten cores are soldered to the 15-way D socket as shown in Table 2.
- The remaining connections to the D socket are made as follows.
  - (a) The sync connection (pin 11) is made to the emitter of the transistor located immediately beneath the screen of the video section. The emitter is the pin to which two resistors are soldered.
  - (b) On the PCB, behind the power socket, is a toroidal choke, from which (facing the video section) four wires are soldered to the PCB. From right to left, these carry +5 V; +12 V; −12 V; and ground. Of these, the +5 V and +12 V are connected to the D socket (pins 12 and 13 respectively). The ground connection to the socket (pin 14) is soldered to the screen of the video section.
  - (c) Behind the SCART socket is a parallel row of seven times three soldering tags. The centre row carries the audio output of the computer and this is, therefore, soldered to pin 15 of the D socket.

In older 520-ST models, there is no sync signal available. Fortunately, this may be obtained by soldering the small circuit shown in Fig. 3 to the row of soldering tags, numbered 1 to 10, located behind the screen of the video section. The sync signal is taken from the emitter of the transistor and connected to pin 11 of the D socket.

Modifying the Atari 1040-ST

- Remove the six cross-slotted screws from the underside of the computer. These are short screws: the longer ones retain the floppy disk drive.
- Remove the lid of the computer (see Fig. 5).

Table 1.

Pin	Signal	
1	B3	
2	B2	
3	B1	digital
4	G3	colour
5	G2	information
6	G1	
7	R3	
8	R2	
9	R1	
10	$\overline{BL}$ (blanking)	
11	sync(hronization)	
12	+5 V	
13	+12 V	
14	earth	
15	audio in	

Table 1. Pin connections of the D subminiature socket on the video interface.

Table 2.

Pin	Connected to	Signal
1	R_{53}	B3
2	R_{54}	B2
3	R_{55}	B1
4	R_{56}	G3
5	R_{57}	G2
6	R_{58}	G1
7	R_{59}	R3
8	R_{60}	R2
9	R_{61}	R1
10	CR_1 (K)	$\overline{BL}$
11	Tr-E*	$\overline{sync}$*
12	Choke*	+5 V
13	Choke*	+12 V
14	Screen*	earth
15	See text	audio

* see text

Table 2. Pin connections of the D socket on the Atari 520-ST.

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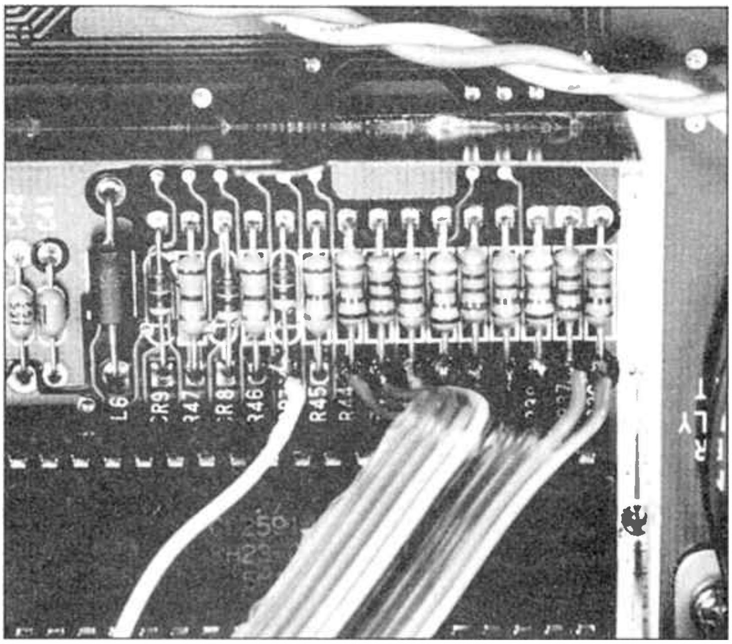

Fig. 6. How to tap the colour signals in the Atari 1040-ST.

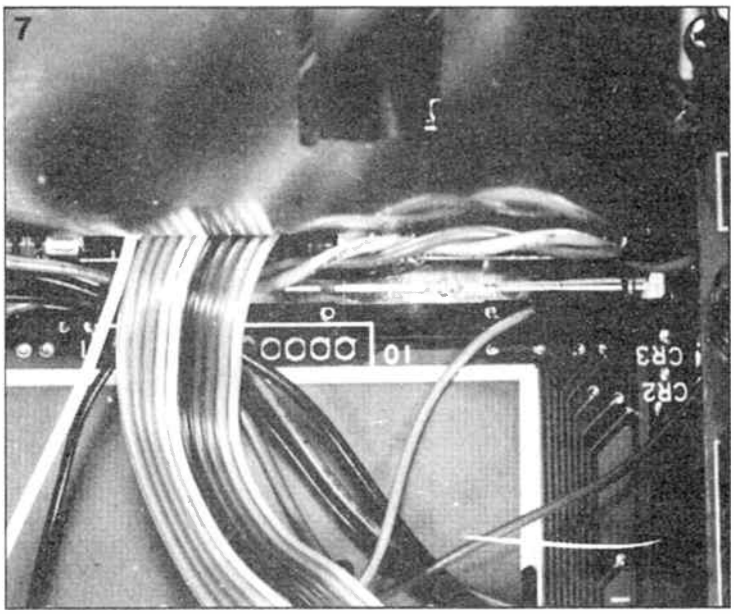

Fig. 7. The colour signal lines can pass under the cover of the video section screen.

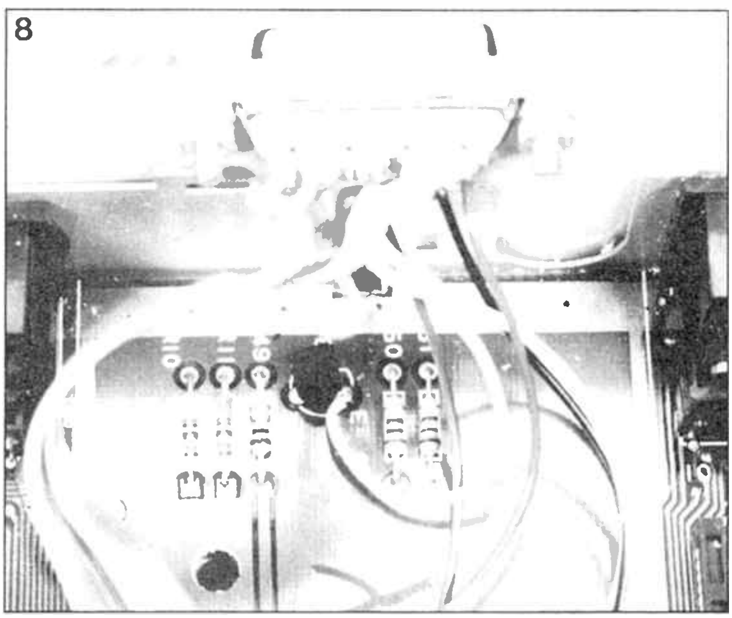

Fig. 8. Tapping the $\overline{sync}$ signal off the emitter of Q_8. (Atari 1040-ST only).

Table 3.

Pin	Connected to	Signal
1	R_{36}	B3
2	R_{37}	B2
3	R_{38}	B1
4	R_{39}	G3
5	R_{40}	G2
6	R_{41}	G1
7	R_{42}	R3
8	R_{42}	R2
9	R_{44}	R1
10	CR_7-K	BL
11	Q_8-E	$\overline{sync}$
12	C_{33} (C_{34})	+5 V
13	See text	+12 V
14	Screen*	earth
15	See text	audio

* see text

Table 3. Pin connections of the D socket on the Atari 1040-ST.

- Disconnect the keyboard from the computer.
- Using a pair of flat-nose pliers, straighten the lugs retaining the screen.
- Remove the cross-slotted screws that fasten the screen to the PCB.
- Remove the screen from above the power supply.
- Remove the power supply.
- Remove the three long screws retaining the floppy disk drive from the underside of the computer.
- Remove the large screen.
- Cut a suitably sized hole in the back panel of the computer to receive a 15-way D subminiature socket.
- Using a pair of flat-nose pliers, straighten the lugs retaining the lid of the video section (centre of PCB) and remove the lid.
- Solder nine cores of a length of 10-way ribbon cable to resistors R_{36}-R_{45} (at the side facing U_{31}) as shown in Fig. 11 and 6. The other side of the cores are connected to pins 1-9 of the D socket in accordance with Table 3. The cable can pass under the cover of the screen (see Fig. 7).
- Solder the tenth core of the ribbon cable to the cathode of diode CR_7, i.e. the side facing U_{31}. The other side of this core is soldered to pin 10 of the D socket.
- Towards the rear of the computer, outside the video section is transistor Q_8 (see Fig. 8). Connect the emitter of this transistor (indicated by E on the PCB) with pin 11 of the D socket.
- Connect pin 12 of the D socket to the terminal of C_{33} (or C_{34}) facing the front of the computer (see Fig. 9).
- Four supply wires run between the video section and the rear of the computer, coloured blue, black, black, and red. Where the blue wire emerges from the PCB is a figure 4: follow the PCB track in the direction of the video section, where a soldering pin is located. Connect this pin with an additional wire to pin 13 of the D socket.
- Connect pin 14 of the D socket to the screen of the video section.
- Behind the SCART socket for the Atari monitor are a number of soldering pins (see Fig. 10). Connect the pin beside the figure 4 to pin 15 of the D socket.

Test

Reassemble the computer in reverse order to that given under *Modifying the Atari 520-ST (1040-ST)*.

Connect the interface to the computer by a cable (max. length of

World Radio History

20 cm) terminated at both ends in a D subminiature plug, and switch on both units.

There should be no plug inserted into the SCART socket on the computer. A colour monitor or TV set should be connected to the interface.

If the interface is connected to the aerial input of a TV set (which can not be done in the case of a modern UHF only set), set the receiver to (VHF) channel 3, and tune C_{11} in the interface for best-quality picture.

If the interface is connected to the video input of a TV set or monitor, a good-quality colour picture should now appear on the screen. If not, carefully adjust C_{12} in the interface (this tunes the chrominance subcarrier to exactly 4.433619 MHz).

If the picture cannot be held still, the 60 Hz synchronization of the Atari is at fault. Your Atari dealer will be able to provide you with a (free!) copy of a small program that converts the field frequency from 60 Hz to the correct 50 Hz.

9

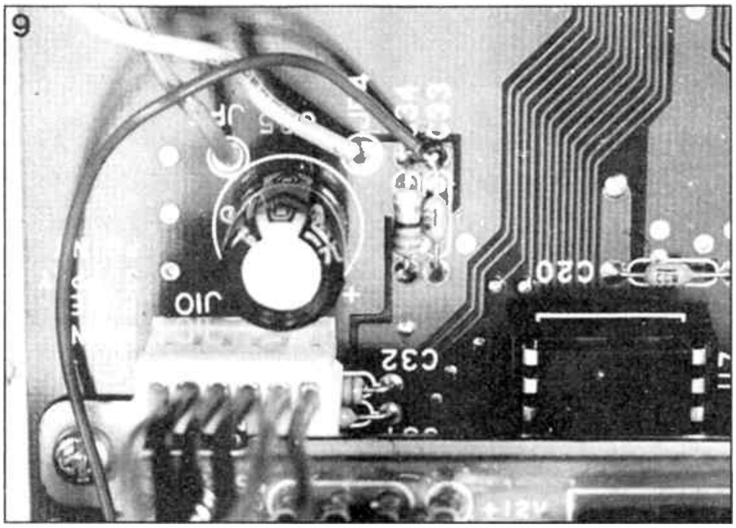

Fig. 9. Where to tap the +5 V supply for the interface. (Atari 1040-ST only).

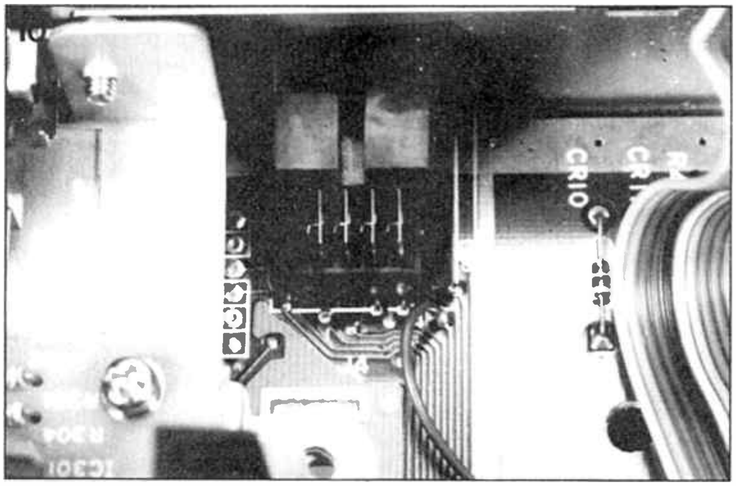

Fig. 10. The audio signal is taken from right behind the SCART socket on the Atari 1040-ST.

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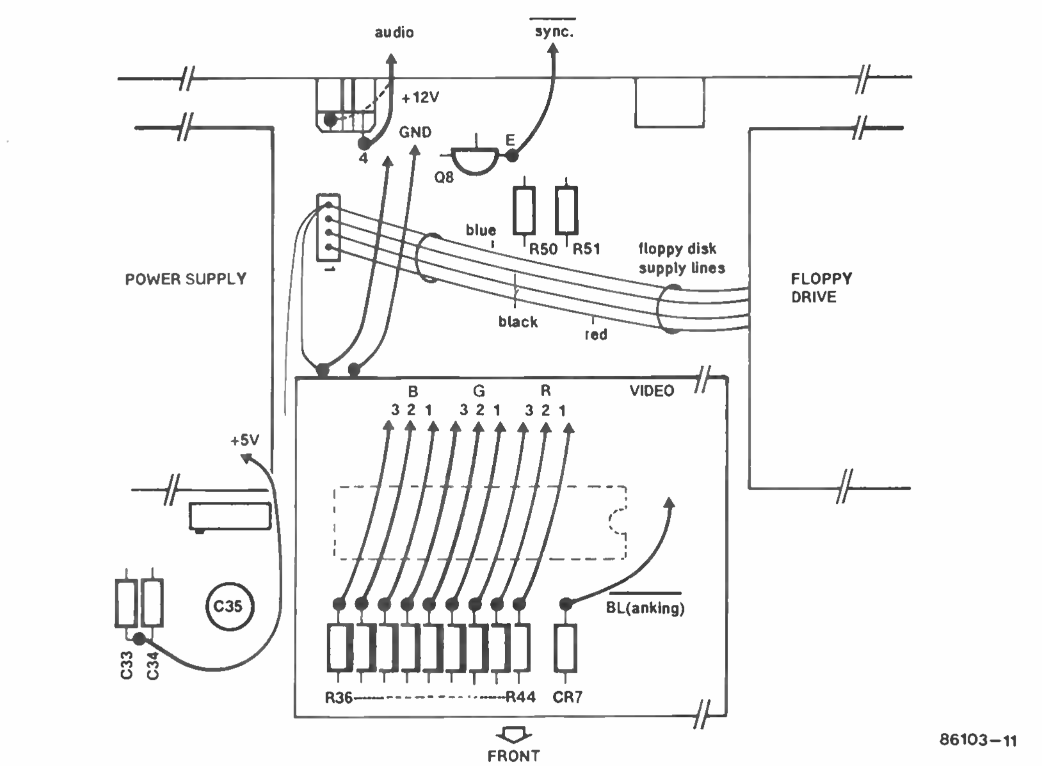

Fig. 11. Summary of all connections to be made in the Atari 1040-ST.

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HOW MUCH LONGER WILL SILICON BE USED?

It sounds rather strange, against the background of the present development of microelectronics, to ask how much longer silicon will be used. The first quantities of one-megabit dynamic memories using existing silicon technology have been announced recently while four-megabit dynamic memories are expected in 1988. These are the most outstanding current examples of the state of the art of silicon microelectronics. These developments in large-scale integration (LSI) have been due to process technology or, to put it the other way around, it was mastery of process technology that made this progress in large-scale integration possible.

A reduction in costs per bit on an integrated device went hand in hand with this large-scale integration.

This is demonstrated by Fig. 1, which shows the evolution of costs per bit for the various generations of dynamic RAMs as "learning curves". The learning curves for one-megabit and four-megabit dynamic RAMs are estimated values. Before turning to the question of the limits of silicon technology and its replacement by gallium arsenide, we shall first briefly outline the development of silicon technology.

By the standards of microelectronics, silicon technology is a "very old" technology. It was 25 years ago, in 1961, that the first IC was developed by Kilby in germanium and one year later in silicon.

This process led in only 25 years from a small number of transistors on a chip to more than one million transistors in regular logic devices on the one hand and to more than a hundred thousand transistors on a chip in non-regular logic devices on the other hand. In other words, the complexity of the circuitry has increased by more than a hundred thousand times in this period of time.

After these developments, is a competitor now appearing on the horizon in the form of gallium arsenide? The worldwide market potential of gallium arsenide is estimated at 3.2 billion dollars for 1992, a considerable amount when one considers that, e.g., the German microelectronics market was worth about one billion dollars in 1985.

Against this background, one might after all be justified in asking how much longer silicon will be used. In order to answer this question we shall consider the following points:

- the mechanisms of substitution which result in the replacement of a technique or technology by another;
- the limits of silicon;
- the limits of integration techniques;
- the development of the market for silicon and gallium arsenide.

Mechanisms of substitution

A technique or technology is only replaced by another under the following conditions:

- Techno-economic limitations of a technique become apparent, i.e. substitution results in cost savings.
- A faster evolution of an alternative technique is expected and at the same time a tendency towards greater efficiency. In such a case a substitution is frequently made as a future investment.
- As well as the actual replacement of the existing technique, a new technique promises completely new applications. A substitution is made with a view to innovative potential.

Limits of silicon

In order to assess the limits of silicon and possibilities of the alternative material gallium arsenide, it is first necessary to consider the physical properties and also the technological status of the two materials.

A comparison of the physical properties of the two basic materials reveals three salient factors:

- the much greater electron mobility of GaAs, which means that considerably faster circuits can be realized with GaAs;
- the much greater thermal stability of GaAs and greater resistance to radiation, which would be of particular advantage with very fast and highly integrated memories;
- a worse ratio of electron mobility to defective electron mobility in the case of GaAs, which also means that complementary electronics can be less easily used in GaAs than with silicon.

The physical properties

1

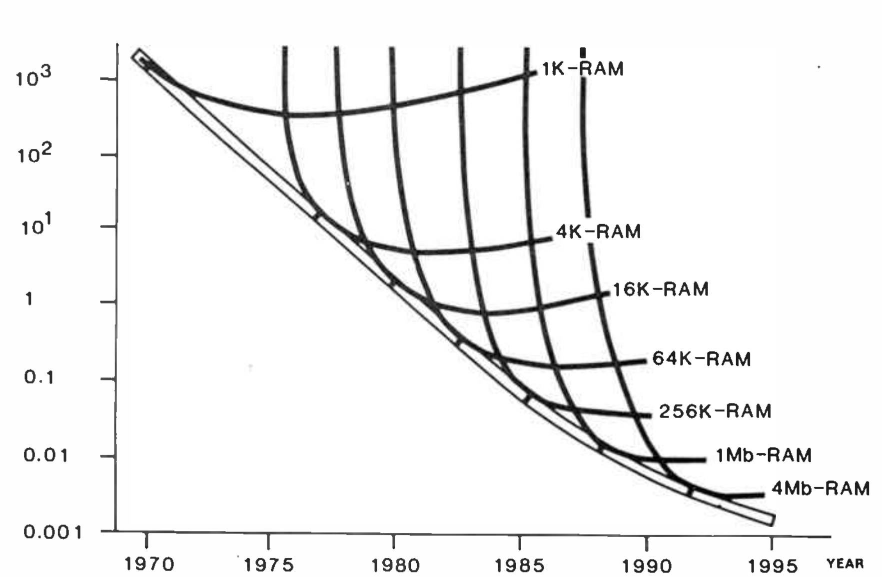

Fig. 1. The evolution of relative costs per bit for dynamic MOS-RAMs.

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Table 1

Technological status

	Si	GaAs
Chip diameter	6"	3"
Fault density – chip uniformity – chip purity – surface smoothness	< 10 / cm^2	> 10^4 / cm^2
Chip surfaces	> 50 mm^2	10 - 15 mm^2
Components / IC	10^6	10^4

only represent one side, however. In order to make a final judgement we also have to take into account the state of the art in the two technologies. This has been done for silicon and GaAs in Table 1.
If we look at this table, we see that the fault density for silicon chips is more than a thousand times less than for GaAs. This is due to a considerably greater uniformity, purity, and surface smoothness in the case of silicon chips; in other words, as a starting material silicon can be much better controlled than GaAs, which in turn results in far greater efficiency. We can also see that silicon chip surfaces are now more than 50 mm^2 in size, compared with 10-15 mm^2 for GaAs, in other words considerably larger and more complex ICs can at present be fabricated with silicon.
On the basis of this table, it can be said that GaAs is at present technologically about a hundred times behind silicon in complexity, or more than two generations of components behind. The same conclusion is reached if one considers the evolution of the complexity of integrated circuits, as shown in Fig. 2. The thick line represents the evolution of the complexity of silicon circuits and the thin line the evolution of GaAs circuits.
We can see how silicon has evolved to the four- and 16-megabit dynamic RAM, while GaAs has developed to the four-kilobit RAM. Fig. 2 does not show the production status of these circuits but the time at which the first design models were presented.
If we look at the two curves for silicon and GaAs, we have to conclude that, even if we assume a more rapid development for GaAs than for silicon, it will not attain the degree of complexity of silicon until 1995. Such a rapid development of GaAs is not to be expected and we should assume that the broken line with shorter strokes is more probable, so that even in the year 1995 we can expect a difference in complexity of more than ten between silicon and GaAs. If GaAs is not going to catch up with silicon in the next ten years as regards complexity, what about the advantage of greater speed which components constructed on GaAs have?
An indication is provided by the evolution of the gate delays of integrated circuits based on silicon technology. As an example, Table 2 shows how gate delays in MOS processes in the Valvo plant (part of Philips GmbH in W-Germany) have developed from 1979/80 to 1986, together with the expectations for 1988.
Along with the reduction in the smallest geometries and the associated reduction in gate delays we can also observe a simultaneous increase in the size of the chip surface and in the number of components per chip and per mm^2. This means, therefore, that not only the individual components on the chip have become faster, but that the total chip sizes and number of components have grown very rapidly. At present chips are produced which are 40-50 mm^2 in size, while chips up to 100 mm^2 are being developed and will be produced in 1987. This implies that from 1988 chips between 50 and 100 mm^2 will represent the state of the art. At the same time, the length of the circuit on such chips will also increase, so that a length of 10 mm on a chip of approximately 80 mm^2 will not be exceptional. If, however, we wish to determine the propagation delay on a circuit which is 10 mm in length and assume a value of 10^{10} cm/s for the signal propagation, we obtain propagation delays of 0.1 ns. This means, therefore, that with chips whose geometry is smaller than 1 μm and with chip surfaces of 100 mm^2 the speed of the components and the propagation delay between the components are in the same order of magnitude.
From the above observations, it can be deduced that with highly integrated circuits it is no longer the properties of the components on the ICs which determine the speed of signal processing, but that the arrangement of the circuitry has a major influence. This also applies to GaAs. If, therefore, we substituted GaAs for all the silicon

2

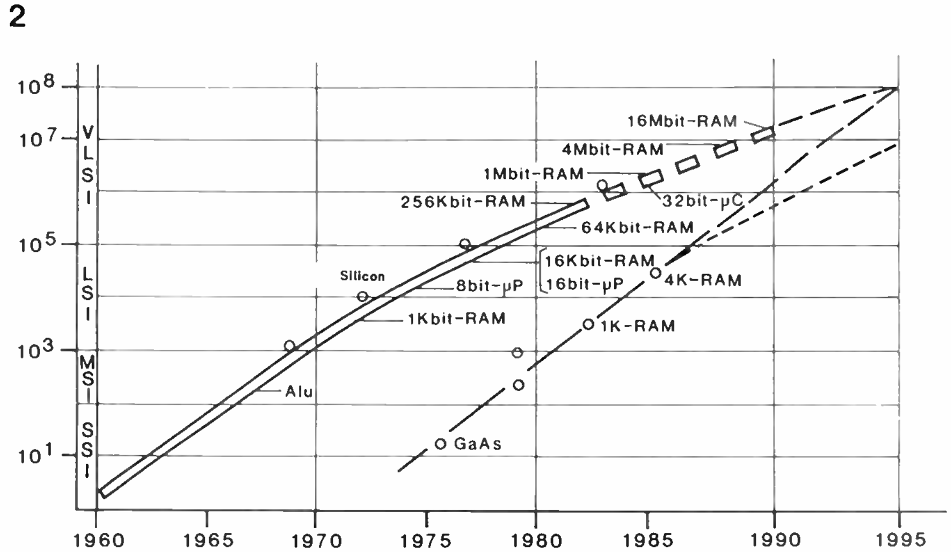

Fig. 2. The evolution and complexity of integrated circuits.

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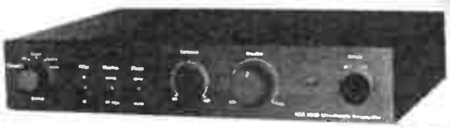

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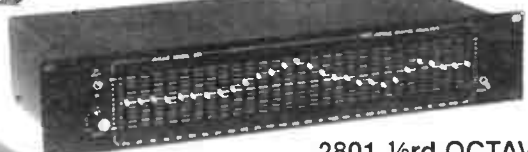

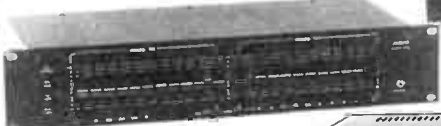

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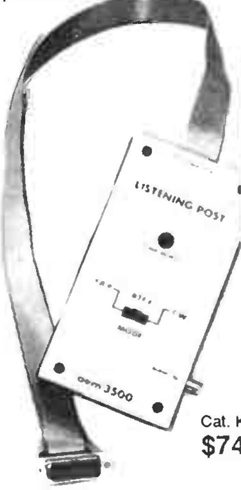

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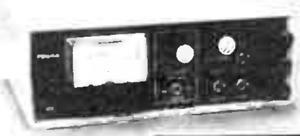

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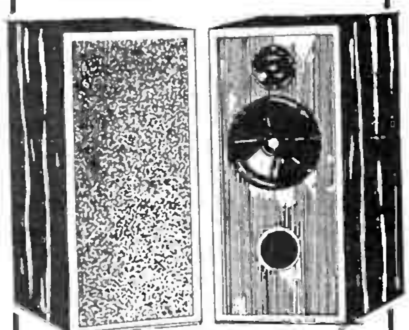

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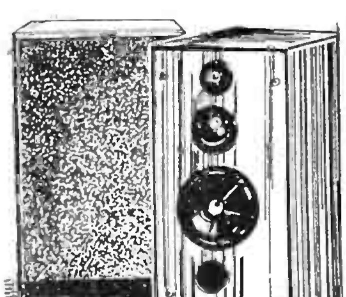

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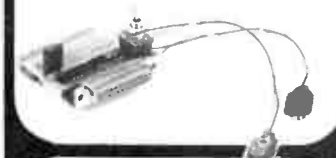

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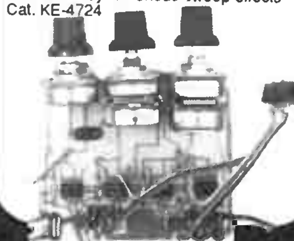

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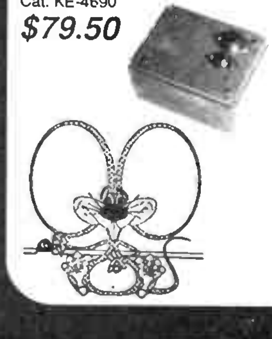

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components on a highly integrated circuit of this kind, we would scarcely alter their speed, as this is largely determined by the propagation delays between the individual components.

Limits of integration techniques

These observations show that in highly integrated circuits the speed cannot be the decisive factor for a changeover from silicon to GaAs and hence for the replacement of silicon technology. Hence, an assessment of whether silicon is likely to be replaced can only be made if we first answer the question concerning the limits of silicon technology. We must first clarify, therefore, whether silicon is more likely to come up against technological limits than GaAs. The question concerning the limits of silicon technology raises, however, questions concerning the general limits of integration techniques, which basically exist independently of whether one uses silicon or GaAs as the starting material. They do very much depend, however, on the smallest geometries that can be used and on the process technology required for these.

If, for example, we consider the yield loss in 64 K dynamic memories, approximately 70 per cent is due to random defects, i.e. defects which are caused by the lithographical and deposition processes. About 10 per cent is correlated to the structure, in other words is due to geometrical tolerances, and only about 20 per cent is connected with device parameters, i.e. directly linked with the processing of the silicon. The physical limits for vertical and lateral structures are approximately 0.05 µm for bipolar transistors and approximately 0.1 µm for MOS transistors. The limits are set by the minimum dimensions of the space charge regions of the pn junctions, which at room temperatures and voltages of 1 V are approximately 0.03 µm.

For the limits that can be reached in practice, we can make the following estimates. For lithography and etching techniques it is not possible in terms of production to go below structures of 0.1 µm. Insulation requires geometrical distances of about 0.5 µm. In order to keep the contact resistance at a tolerable level for components of less than 100 ohm, the contact holes should likewise have a diameter of more than 0.3 µm. For the pitch, by which is meant the line width plus the spacing between it and the next line, it will not be possible to go below 1.0 µm, above all for reasons of reliability. The limits that one can expect in practice are thus higher than the physical limits. It is not the physical properties of silicon which set the limits for integration techniques, but the processing limits in lithography, insulation, contact diameter and pitch.

How, then, is silicon technology expected to develop in the years 1990 to 1995?

Table 3 gives an estimate of what is expected in 1990 to 1995 on the basis of present technological knowledge. For the year 1990 structures of 0.3 µm are expected in the second generation, with chip surfaces between 100 and 200 mm^2. The difference between the first and the second generation can be seen in the lithographical process. While light-optical processes and steppers are still used for the first generation, the second generation will be based on processes that use X-ray lithography, as structures of 0.3 µm can no longer be realized with light optics. The limit for light-optical processes is put at about 0.5 to 0.6 µm. Below this limit it will be necessary to use new processes such as X-ray lithography. Developments in this direction are already taking place and it is to be expected that they will be available for production in 1990.

These are projections for MOS devices. It is also interesting, however, to take a look at the right-hand side of Table 3, which shows the expected development of bipolar devices. We see here that geometries of 0.9 µm in the first generation and 0.5 µm in the second generation are expected. In the first generation this results in limit frequencies for bipolar silicon components of 12 GHz and of 40 GHz in the second generation.

This means that on the basis of bipolar silicon technology with devices of the first generation, it is possible to construct systems with transmission speeds of 2.4 Gbit/s and up to 10 Gbit/s with devices of the second generation. The degree of integration, however, will be considerably lower than with MOS circuits. Silicon elements will, therefore, also be suitable for the construction of very rapid signal processing systems.

If we now return to the question which was posed initially, namely how much longer silicon will be used, and the related question of substitution, we should consider the three points:

1. substitution in order to save costs;
2. substitution as a future investment and
3. substitution for the purpose of innovation.

Point 1: costs per bit for silicon were reduced by more than a thousand times between 1970 and 1985.

Point 2: integration techniques, and not the properties of silicon devices, will set the limits.

Table 2

Development of gate delays

Example: MOS processes Valvo valve and semiconductor plant

Year	1979/80	1982	1984	1986	1988
Process	1100	700	500	300	"100"
Gate oxide thickness (nm)	110	70	50	30	10
Smallest geometry (µm)	6	3.5	2.5	1.5	< 1.0
Power delay product (pJ)	2.5	1.0	0.5	0.25	
Gate delay (ns)	3.0	1.0	0.4	0.20	< 0.10

Propagation delay

Length of circuit $L = 10$ mm
Signal propagation $V_s = 1 \times 10^{10}$ cm/s
Propagation delay $t = 0.1$ ns

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Table 3

Expectations for 1990-1995

Master product level	Memory 1st gen.	Memory 2nd gen.	MOS logic 1st gen.	MOS logic 2nd gen.	Bipolar 1st gen.	Bipolar 2nd gen.
Width of structure	0.7 μm	0.3 μm	0.7 μm	0.3μm	0.9 μm	0.5 μm
Chip sizes	100 mm^2	< 200 mm^2	100 mm^2	200 mm^2	–	–
Transistor functions	5×10^6	10^8-10^9	10^6	10^8	10^5	10^7
Wiring levels	4	<6	<6	<10	<5	<8
Limit frequency	–	–	–	–	12 GHz	40 GHz
Access time	40 ns	<40 ns	–	–	–	–
Data transmission rate	–	–	–	–	2.4 Gbit/s	10 Gbit/s

Point 3: GHz devices have already been developed with silicon. Further possibilities will open up after 1990/95.

Markets

Where, then, are the applications and markets for GaAs devices? The applications of GaAs are in those areas where on the one hand increased thermal resistivity, high resistance to radiation, and optical-electrical applications are called for. These are physical properties in which GaAs is clearly superior to silicon or properties which silicon does not possess. This means that the main area of application for GaAs is the military sphere, aviation, and the aerospace industry. In 1984, these applications covered approximately 46 per cent of the market share of GaAs, and it is expected that this market share will be extended to 56 per cent in 1992. These circuits will not be highly integrated circuits. In other words, they will be MSI circuits rather than VLSI circuits.
Alongside this area of application, GaAs is also expected to be used for small-scale integration circuits as interface circuits in the communication engineering industry for optical-electrical interfaces. The areas of application will require medium and small-scale integrated circuits, but not system integration with corresponding VLSI circuits. But then are the figures given at the beginning reliable, namely that the market potential for GaAs in 1992 will be worth about 3.2 billion dollars? These figures are right according to the information available at present. They show that GaAs will only account for a small share of IC consumption, while silicon will continue to dominate and provide the basic material for large-scale integration.

Conclusion

To sum up, we can say that GaAs will not become a substitute for silicon in large-scale integration or in system integration. It will be possible to realize some individual functions better in GaAs than in silicon. These functions, however, will have to be very critically examined, as realizing certain functions in a different technology always raises questions concerning interfaces. For example, the position of the interface between silicon and GaAs in systems for optical communications will very much determine the success or failure of a new system. Not only physical properties will necessarily play a decisive role in this, but also the technological practicability of the whole system. The transition from a technology that is mastered to a new and relatively difficult technology always involves a large number of technical risks. It may thus be a better prospect to use a familiar and perfected technology, even perhaps at the cost of "technical elegance", and only to use the other technology where it is absolutely necessary for making a system more efficient and more rapid.
The choice of technology or the question of the interface between two technologies will thus be decisive for the success of complex systems. Realizing functions in GaAs which cannot be realized in silicon does not represent substitution. Questions of this kind are of course excluded from any consideration of the question of substitution.

Philips Report No. 10.759E (from a speech by Dr Peter Draheim, Valvo, Philips GmbH, Federal Germany).

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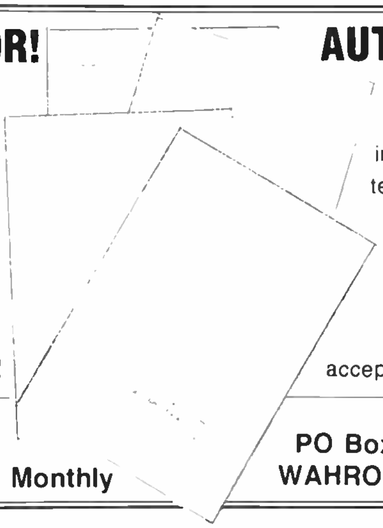

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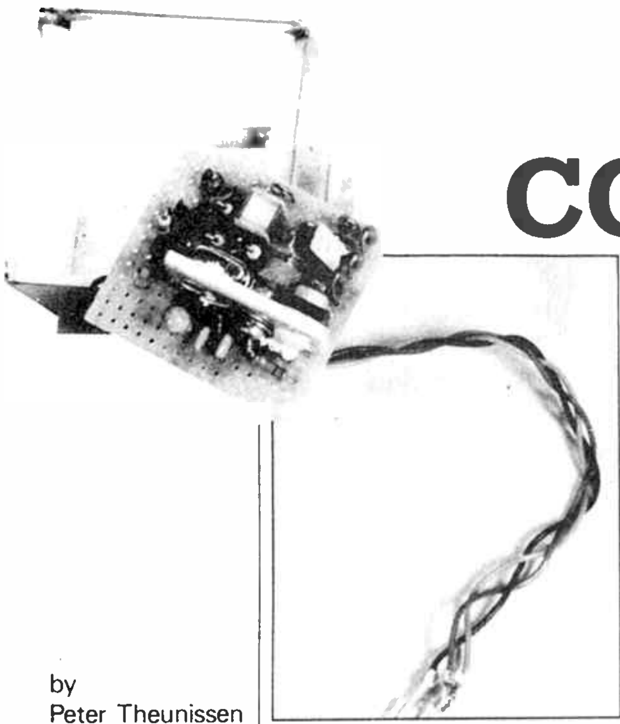
WAHROONGA 2076 NSW

World Radio History



OVEN-COMPENSATED OSCILLATOR

Of all the factors affecting the stability of crystal oscillators, temperature variation is the most detrimental. Therefore, where very good stability is required, the crystal is invariably fitted in a temperature-controlled oven.

by
Peter Theunissen

The Q(uality) factor of any resonating circuit is the ratio of the inductive reactance to the resistance: in an *LC* circuit it may vary from 100 to 500, whereas in a crystal, which has a very low series equivalent resistance, values of up to 100 000 can be achieved. With a properly cut crystal, the resonant frequency is independent of ambient temperature over a reasonable range. As a result, frequency stabilities of the order of 100 p.p.m. can be achieved. However, in many cases, much greater accuracy is required and this can be attained by keeping the temperature surrounding the crystal at an even level. This can, for instance, be done by placing the crystal in a temperature-controlled oven. Note that, although variations in ambient temperature have the most pronounced effect on crystal frequency stability, there are other factors as well, for instance, ageing, supply voltage variations, and loading of the oscillator circuit.

Fig. 1 shows the relative frequency drift in p.p.m. as a function of temperature for a typical AT cut crystal. Note that the drift may be positive or negative.

Fig. 1 Relative frequency drift as a function of temperature for a typical AT cut crystal.

Fig. 2 Block schematic of the oven thermostat.

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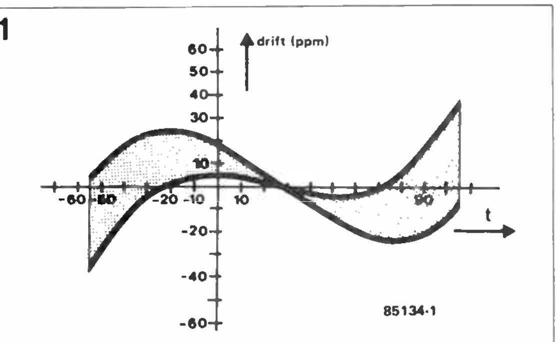

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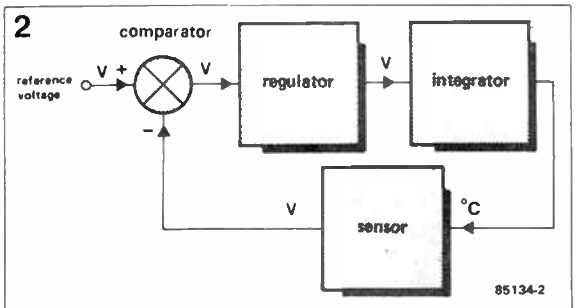

Temperature control

Inside the oven, the crystal, together with a heating element and a temperature sensor, is fitted on a small metal block, which affords a large measure of heat inertia. The sensor output is compared with a reference voltage, and the comparator is arranged to control the supply to the heating element.

At some time after the heating element has started to heat the metal block, the sensor output and the reference voltage will be identical: the comparator will then switch off the heating element. None the less, the temperature of the metal block will continue to rise for a little while because of inertia. Eventually, however, the block has cooled off to an extent sufficient for the sensor output to drop below the reference voltage, and the comparator then arranges for the supply to the heating element to be switched on again. It is clear that, just as in a domestic central heating system, there is some delay between cause and effect. The temperature of the block will, therefore, vary within a narrow band. The width of this band is in direct proportion to the volume of the block. Unfortunately, it cannot be made very narrow by reducing the mass of the block, because this would also seriously decrease the heat inertia factor.

Fortunately, this problem can be solved by a so-called proportional integration regulator — see Fig. 2. Such a regulator simultaneously amplifies and integrates its input signal, which results in high DC amplification. One requirement of this type of regulator is that the integration time constant for a certain step response must be equal to 3.3 times the delay time; at the same time, the amplification must not be so high as to affect the stability of the regulating system.

Circuit description

Regulator

The regulator system, the circuit of which is shown in Fig. 3a, uses a Type LM335 temperature sensor, which provides an output of 10 mV/K. The reference voltage at the non-inverting input (pin 3) of IC_1 is arranged at 2/3 of the supply voltage by divider R_1-R_2-R_3. Note that these resistors should be high-stab (1%) types to ensure correct operation of the regulator. It is also advisable to stabilize the supply voltage: this is done with a 7805 regulator as shown in the inset circuit diagram.

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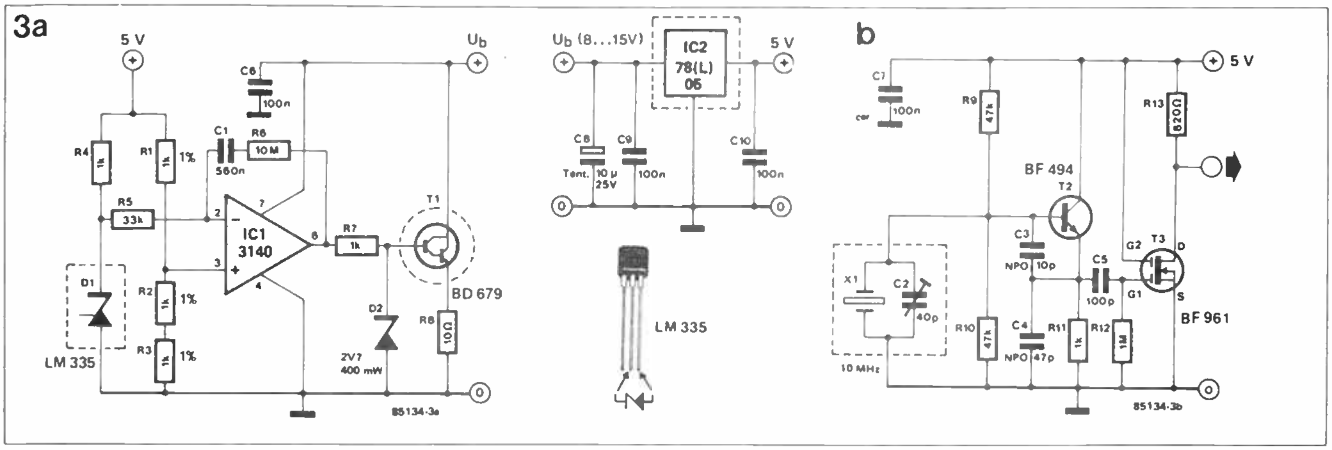


Fig. 3 The circuit in two parts: a shows the regulator and b the oscillator circuit. The parts within dotted lines are mounted on the aluminium plate.

Note: 0 K = −273 °C; one kelvin is equal to one degree Celcius.

The 3140 will toggle when the output of the LM335 equals or exceeds the reference voltage of 3.330 V. For the sensor to provide this potential, the ambient temperature must be 60 °C (0 K + 333 K). When the opamp toggles, it switches off transistor T_1, a variable current source functioning as the heating element.

As long as the ambient temperature is below 60 °C, the output level of IC_1 (pin 6) is such that T_1 is driven hard. The base potential of this Darlington is limited to 2.7 V by zener diode D_2 to prevent run-away. In this arrangement, the collector current cannot exceed about 200 mA.

Oscillator

The oscillator circuit shown in Fig. 3b is arranged for the crystal to operate in its parallel mode. This is based on the assumption that most readers will use a crystal for operation in the temperature range −10 °C to +45 °C. If, however, a crystal for operation in ovens is used, trimmer C_2 will have to be connected in series with the crystal.

Capacitors C_3 and C_4 form the capacitive load of the crystal; it is imperative that they are of the ceramic NPO type, i.e., have a zero temperature coefficient.

Field-effect transistor T_3 forms a buffer between the oscillator and the loading circuit.

Construction

The crystal, trimmer C_2, and current source T_1 are mounted on one side, and voltage regulator IC_2 and temperature sensor D_1 on the other side, of a 30×50 mm plate made of 3 mm thick aluminium alloy, as shown in Fig. 4. All other components are mounted on a similarly sized piece of vero board.

The aluminium plate should be provided with a bolted-on soldering tag for the earth connection.

Heat conducting paste should be used for all components; transistor T_1 should additionally be fitted by means of an insulating washer.

After the necessary connections between the plate and board have been made, the completed assembly should be fitted into a small — earthed — metal box of suitable dimensions and lined internally with 50 mm thick expanded polystyrene for thermal insulation. The box should be provided with two small holes: one for the connecting wires, and the other for adjusting C_2.

Calibration

First, check with a moving-coil voltmeter that the potential between pin 6 of IC_1 and earth lies between 1.5 V and 2.0 V. It will take some minutes for this voltage to stabilize after the supply has been switched on.

Once an even temperature has been reached, the frequency can be adjusted to exactly 10 MHz, and this is, of course, most conveniently done with the aid of a good-quality frequency counter.

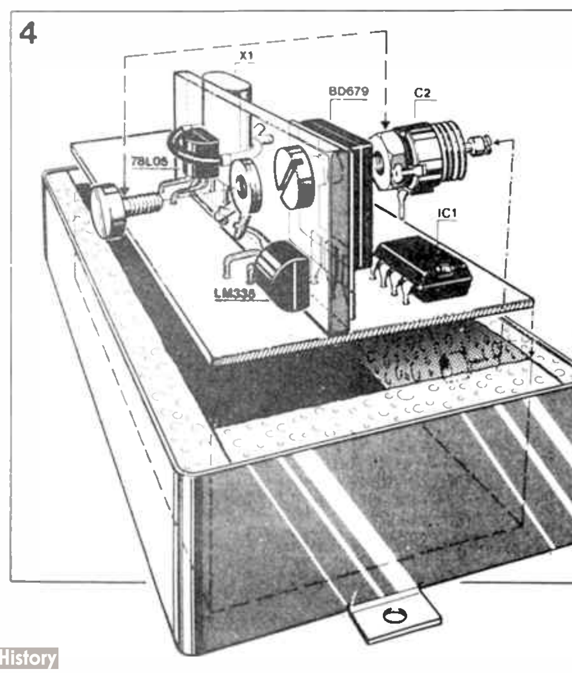
Where a counter is not readily available, two other possible methods may be used. In the first, divide the oscillator output by 200 000, and use this to drive a digital clock. Run the oscillator and clock for 24 hours. Set the clock to the exact time as given, for instance, by British Telecom's Speaking Clock or the BBC time signal, and run the oscillator and clock for 24 hours. After this period, check the clock against the same time signal, and adjust the oscillator as appropriate. Note that a 1 second error in 24 hours is equal to a frequency deviation of 120 Hz.

The second method is far less tedious, but for this an oscilloscope and a special, yet simple, long-wave receiver are needed. The receiver must operate at 200 kHz (BBC Radio 4), and output the carrier and its 90° component. These two outputs are connected to the X and Y inputs of the oscilloscope, and result in a circle on the screen. Now, divide the oscillator output by 10 and apply the resulting 1 MHz signal to the Z input of the oscilloscope. If the oscillator is adjusted correctly, the screen should continue to show a true circle or an ellipse with five stationary breaks.

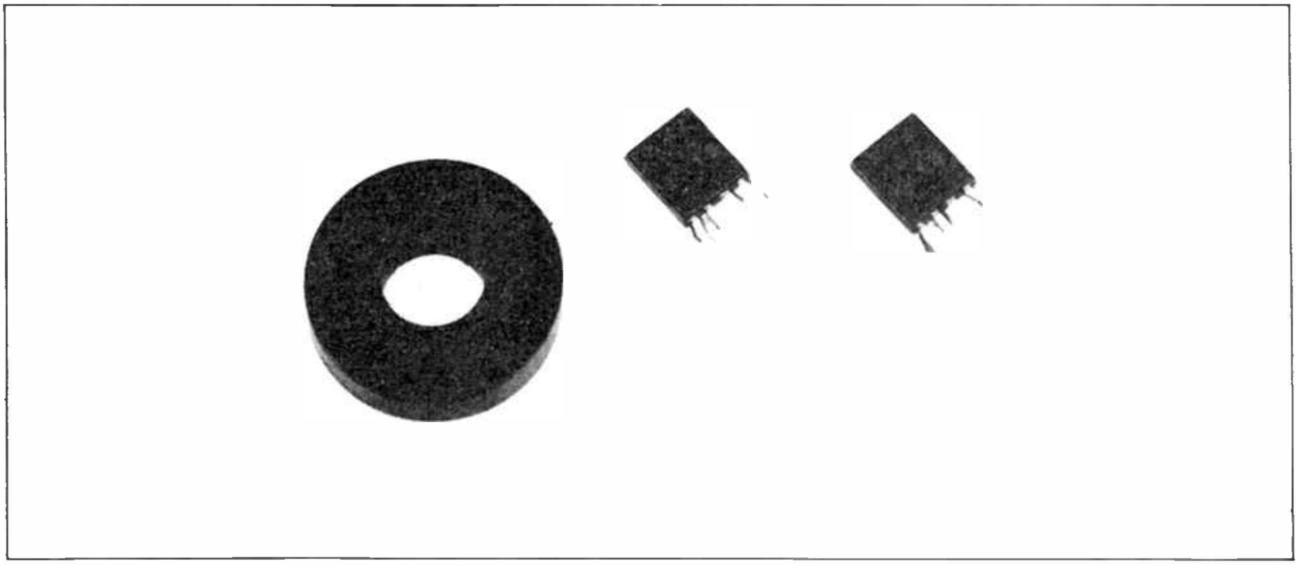
Finally

The oscillator may be used, for instance, as the reference frequency source for the *Microprocessor-controlled frequency counter* featured in the January 1985 issue of *Elektor Electronics*. This is done by connecting the present circuit to the 10 MHz bus inside the counter: the oscillator output goes to the 10 MHz input; Ub to U~; and the earth connection to GND.

Fig. 4 A practical suggestion for the construction of the aluminium plate which holds a number of components.



MAGNETIC-FIELD SENSORS



Announced as being more sensitive than Hall-effect elements, magnetoresistive sensors (MRS) have recently been introduced by leading manufacturers of electronic components. This introductory article examines their fundamental characteristics and possible applications.

The physical operation of magnetic sensitive resistors is based on the Gauss-effect, which may be summarized as follows: a magnetic field with lines of force perpendicular to a current carrying conductor forces charge carriers to travel along the surface of that conductor; the magnetic field 'pushes' the current into a thin layer, which results in a diminished cross-sectional area for the current to pass along, or, in other words, an increased resistivity of the conductive material. Figure 1 illustrates this effect which has been known for quite some time, but has re-

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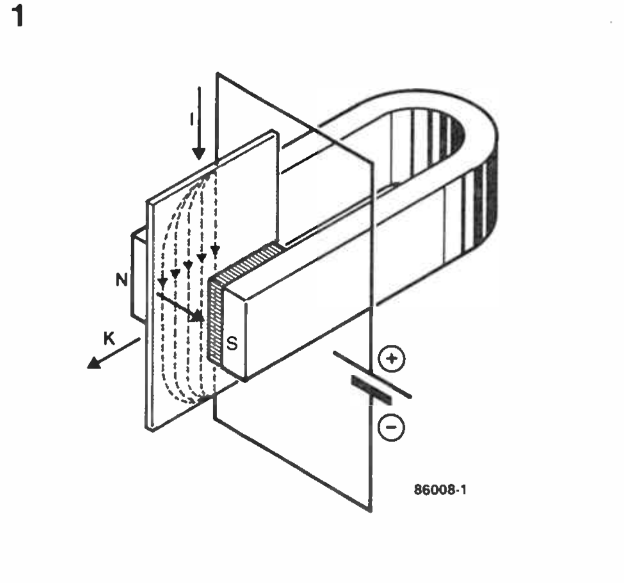

Fig. 1 The magnet pushes the electric current out of the area with maximum magnetic field strength.

Fig. 2 A sufficiently high total resistance can only be obtained by means of a long conductor path.

Fig. 3 Gold stripes have been applied to the resistor track, which make it look like a barber's pole.

Fig. 4 The four resistive elements in a Wheastone bridge configuration.

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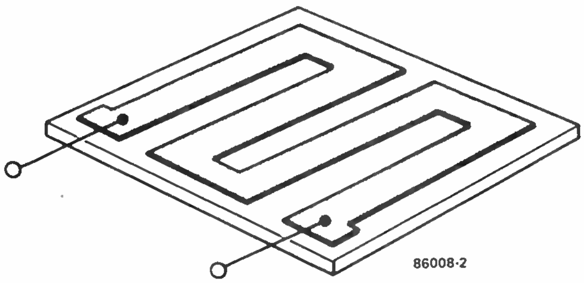

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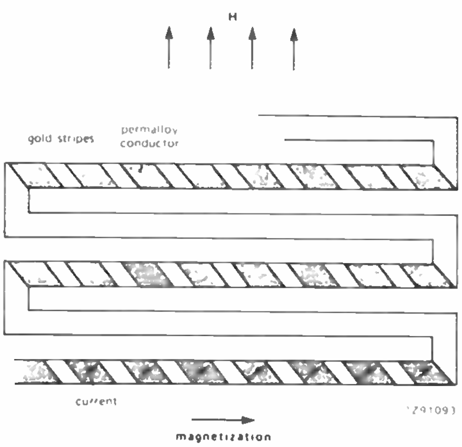

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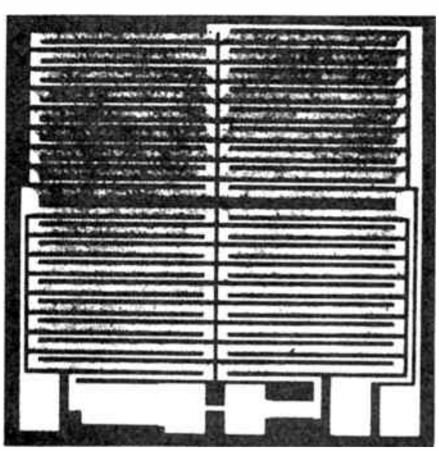

mained disregarded by the electronics industry until quite recently, when suitable alloys were developed to put the effect to practical use.

The increase in resistivity caused by the Gauss-effect is minimal with pure metal conductors, with the exception of bismuth (Bi), which is a so-called diamagnetic metal with poor conductivity. However, certain alloys have been developed which are more sensitive to the presence of a magnetic field.

Siemens, for instance, use a semiconductor with antimony (Sb) based alloys, such as indiumantimonid-nickelantimonid (InSb-NiSb). This material has semiconductor properties and may be glued onto a permeron, ferrite, ceramic or plastic substrate. The magnetic sensitive resistor is usually realized in the form of a meander path as shown in the sketch of Fig. 2; this is done to achieve a maximum-length current track within the encapsulation.

While Siemens manufacture single, flat type resistive elements, Philips have developed complete Wheatstone bridges in a standard transistor case. These devices are made from a thin permalloy layer on a silicon substrate. Permalloy is a 20% iron, 80% nickel ferromagnetic alloy without semiconductor properties. The resistivity of a polycrystalline alloy such as permalloy varies in direct proportion to the angle between magnetic field lines and the direction of the current in the conductor. In order to obtain a maximum operational linearity for these devices, Philips have come up with a special arrangement for the permalloy track: a regular pattern of gold stripes is applied onto the conductive track, at an angle of 45° with respect to the current flow direction. For reasons made clear by Fig. 3, this layout is referred to as a 'barber's pole'. Since gold has a much higher conductivity than permalloy, the gold stripes effect a net current turn of 45° with respect to the conductor axis; this causes the current to travel zigzag through the flat, conductive track.

A complete sensor device of this type contains two resistive elements that feature an increase in resistance with an increase in magnetic field strength, and another two elements with precisely the inverse property: their resistance decreases in a stronger magnetic field. These four resistors have been connected in a Wheatstone bridge setup, with the same resistor types arranged diagonally, as illustrated by Fig. 4. The diagonal configuration offers a high element sensitivity while minimizing bridge unbalancing by changes in ambient temperature.

One of the most important advantages of magnetic sensitive resistors is the ease of device sensitivity definition by means of the manufacturing process.

The new Philips magnetic sensitive Wheatstone bridge devices come in a TO92 style case with four leads: two for the bridge supply voltage and two for the bridge output voltage. Applications are found in any electronic field involving magnetic force detection or measurement. A revolution counter, for instance, may be constructed by mounting a MRS device between a permanent magnet and a cogwheel, driven by the engine; every passing cog will unbalance the Wheatstone bridge and cause an output voltage which may be applied to equipment for further signal processing. Similarly, these devices may be used to determine the angular position of a spindle. If placed close to a current carrying conductor, a magnetic sensor may even perform the function of current transformer.

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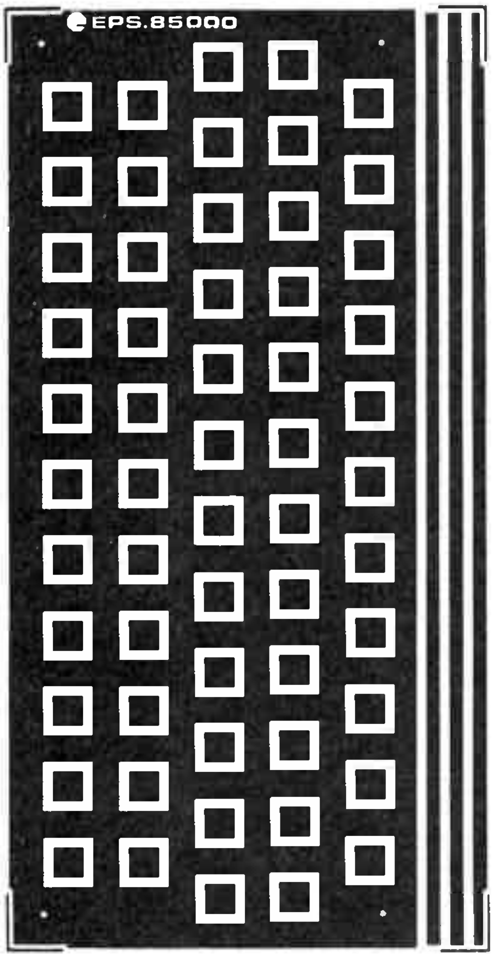
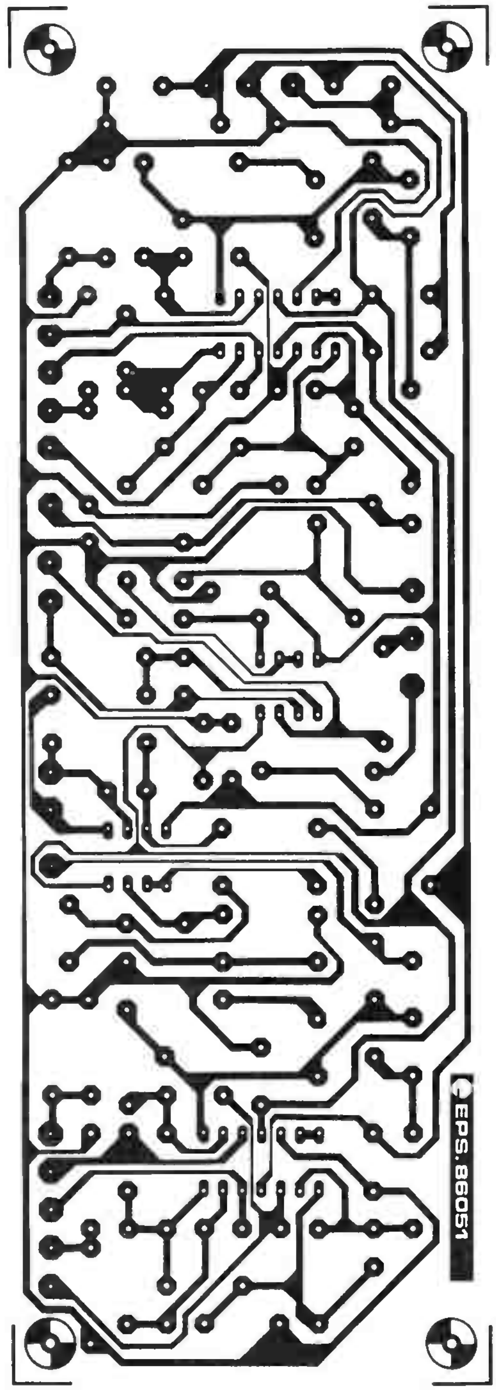
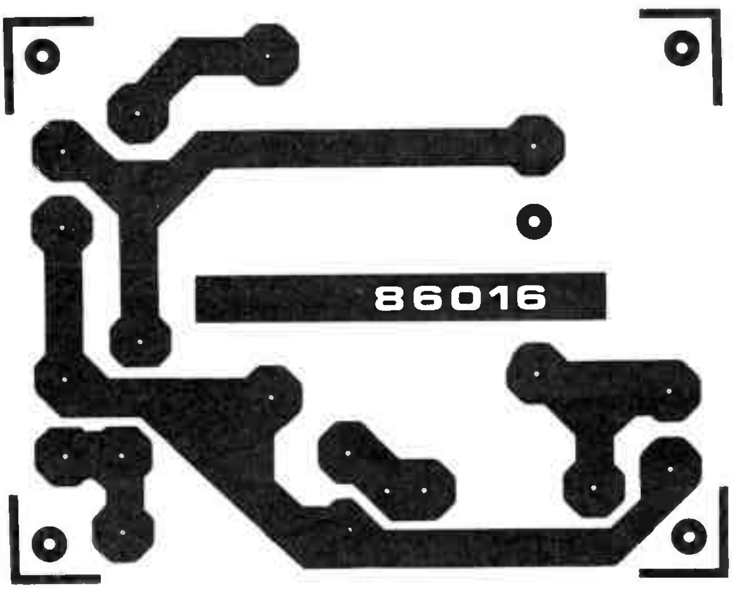
Elektor Electronics PCBs







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IC regulator features full protection, adjustable V and I

Geoff Wood Electronics stocks a versatile little dc regulator IC from SGS, type L200C, that features adjustable voltage and current limits plus thermal overload and input over-voltage protection.

The L200C provides adjustable output currents up to 2 A and an output voltage range of 2.85 V minimum to 36 V maximum. Voltage setting and current limiting are each programmed simply by resistances. The input is over-voltage protected to 60 V. Safe operating area is limited to a dc power curve of 40 watts.

SGS suggest the L200 can be used to replace fixed voltage regulators when high output voltage precision is required and eliminates the need to stock a range of fixed voltage regulators.

Dropout voltage (input to output) of the L200 is typically 2-2.5 V at a load of 1.5 A, and voltage regulation is typically 0.15% at 2 A output current. In current regulation applications, typical load regulation is 1% at one amp.

The L200 comes in a variety of packages: TO3 with four pins, and "pentawatt" five-pin vertical and horizontal TO220 type package.

Geoff wood is stocking the L200C in the pentawatt horizontal package for a meagre $3.50, which seems not bad value for the features offered. He also has data books and applications manuals available. Flash over to **Geoff Wood Electronics, 229 Burns Bay Rd, Lane Cove West 2066 NSW. (02) 427 1676**

Coax stripper

A tedious and frustrating job, always, is stripping coax. You have to be quite careful because the task requires delicacy to avoid nicking the braid or the centre conductor which can lead to faulty joints.

A tool to help this fiddly operation can be obtained for the paltry sum of $2 from Pre-Pak in Sydney. contact them at **1a West St, Lewisham NSW. (02) 569 9797.**

1% capacitors

Low tolerance 1% and 2% capacitors are relatively scarce at the best of times, not to mention expensive. You can pay up to $4 each for values around 100n!

Jaycar currently ha packs of 20 in seven values, two each per value, with most 1% and some 2% tolerance. Values range from 220 pF to 220n. These would normally set you back around $60, but they're on special for $12.50 the pack!

Call in to your local Jaycar store, five in Sydney and one in Brisbane, or call head office on **(02) 747 2002.**

PROJECT BUYERS' GUIDE

If you're contemplating construction of the **AEM9502 Electric Fence**, then you'll find several sources of supply for parts. The 6.5 uF/250 Vac paper capacitors widely used in disco and party strobes are sold by **Dick Smith Electronics** all over Australia and New Zealand, **Jaycar** in Sydney and Brisbane, and **Altronics** in Perth. Other suitable paper capacitors, such as — or similar to — the Plessey ones mentioned, may be obtained from **Geoff Wood Electronics** in Sydney, **All Electronic Components** and **Radio Parts** in Melbourne. The FX2243 potcore assembly may be obtained from **Jaycar stores, Geoff Wood Electronics, Altronics** and perhaps **All Electronic Components**. The JT349 transformer is obtainable from **Geoff Wood Electronics** in Sydney and possibly **All Electronic Components** in Melbourne. **Jaycar** and **Altronics** may stock it over-the-counter, so it's worth asking. All the other components are fairly standard items in most retailers' inventories. If the BD679 is hard to get, you may substitute a BD681, which you'll find somewhat more common. The pc board is available through our Printed Circuit Service. Call for pricing.

Components for the **AEM2501 Pink/White Noise Generator** you'll find widely stocked so you shouldn't experience any difficulty obtaining them. As usual, the pc board will be available through our Printed Circuit Service.

In our **Elektor Section** this month, the **Guitar Equalizer** will find a few fans, no doubt. Well, you'll find components quite easy to source as they're stock items at most electronics retailers, with the exception perhaps of a two E48-series resistors, a 1k6 and a 7k5. Some firms do carry the E48 range, however (e.g: as **RS Components** in Perth and Sydney, or **Stewart Electronics** in Melbourne). Lorlin make rotary switches which would be suited to the project and you'll find these stocked by **Jaycar** in Sydney and Brisbane, **Altronics** in Perth and **Active** in Melbourne. The semiconductors are all commonly stocked. Finding the right case may prove problematical, but it's not a critical item, so long as you get something with adequate room internally as well as a suitable front panel format.

The simple **Superregenerative SW Receiver** on page 46 makes a nice weekend project. The BF981 dual-gate FET (or BF-900 series FETs) is a high performance Philips device and not a common item. However, in this circuit reasonable substitutes could be used, but expect some variation in performance. You might try the more common MFE131 dual-gate MOSFET, which is widely stocked by retailers, or the 3N201 stocked by **RS Components**. The Amidon T50-6 toroid may be obtained through Amidon ferrite components retailers **Geoff Wood Electronics** in Sydney, **Electronic Components** at Fyshwick in Canberra, **Truscott Electronics** at Croydon in Melbourne and **Willis Trading** in Perth. The 100p variable capacitor may need some hunting out, but try **All Electronic Components** in Melbourne and **Sheridan Electronics** in Sydney. Pretty well everything else is readily obtainable.

For the photographically inclined, the **Darkroom Exposure Meter** may hold some attractions. The sensor, a BPW20/21, is a Siemens device. Siemens semiconductors are distributed by **Promark** in Sydney and Melbourne, and by **Protronics** in Adelaide. 'Phone for pricing.

Atari ST owners will have a keen interest this issue in the **colour interface** starting on page 50. The heart of this project is the pair of the chips, the LM1886N and the LM1889N. National Semiconductor stockists may carry it, or be able to order it in. In Melbourne, try **Radio Parts** on the west side of the city, but in Sydney, try **Geoff Wood Electronics** in Lane cove. The other components are widely stocked and constructors should experience little difficulty with this one. The 4.433 MHz crystal you may find stocked by **Hi-Com Unitronics, Geoff Wood Electronics** and **Jaycar** in Sydney. In Melbourne, try **All Electronic Components** and **Rod Irving Electronics**.

Lastly, the **oven-compensated oscillator** circuit may well prove fruitful for some. The 78L05 is relatively widely obtainable and constructors should experience little difficulty with this one. The BD679 Darlington control transistor may be substituted by a BD681, which is more common. The 3140 op-amp is a very common device, but the National LM335 is only stocked by a few firms. Try **Geoff Wood Electronics** and **Hi-Com Unitronics** in Sydney, **Radio Parts** in Melbourne. The oscillator is a fairly conventional Colpitts type. The BF494 transistor is stocked by many retailers, including **Altronics** in Perth, **Jaycar** in Sydney, **All Electronic Components** and **Stewart Electronics** in Melbourne. The BF961 dual-gate MOSFET is not common, but other dual-gate MOSFETs may be substituted here with only minor variation in circuit characteristics. Try the common MFE131 or the 3N201 (from **RS Components** in Perth and Sydney).

Printed circuit boards for these projects will be offered through our normal Printed Circuit Service. 'Phone first for details.

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AEM PRINTED CIRCUIT SERVICE

Our printed circuit boards are all manufactured on quality fibreglass substrate and feature rolled-tin over copper tracks and silk-screened component overlays.

5501 NEG-ION GENERATOR
Clear the air! Our negative ion generator provides around 8 kV output. Simple and low-cost. (Sept. '85)
$18.35

AEM1500 METRONOME
A simple, low-cost project with variable beat from 'presto' to 'largo'. Operates from 9 V battery. (Aug. '85)
$4.70

AEM3500 LISTENING POST
Our most popular project, by far! It decodes the audio from a SW receiver and, with software, allows your computer (Apple II/BBC/C64/Microbee) to decode RTTY, FAX and Morse. (July '85)
$12.20

AEM6500 MOSFET AMP MODULE
A 'universal' amp module using the Hitachi MOSFETs and able to deliver 60 W with one pair or 120 W with two, into 8 ohms. (July '85)
$9.70

6504 POWER AMP STATUS MON.
This project prevents dc fault conditions or excessive clipping from exterminating amps and speakers alike. Handles amps up to 300 W and powers from the amp's supply rails (Aug. '86)
$19.40

5505 MAINS FILTER
This project, dubbed the "Hash Harrier", is a truly effective mains filter that copes with both common mode and differential mode noise, including spikes. It is rated for loads totalling up to 5 A. (April '86)
$26.00

2600 PEAK RF POWER METER
This simple, low-cost project features a 10-LED bar display and can be made for power ranges from 5 W peak to 400 W peak. (April '86)
$10.50

2500 AUDIO OSCILLATOR
A simple sine/square signal generator for the bench. It covers to 100 kHz and has output amplitude ranges from 30 mV to 3 V, fully variable. Separate sine and square outputs. (Dec. '85)
$9.65

6010 ULTRA-FIDELITY PREAMP
The 'digital era' preamp, featuring low-level cartridge input, CD input, two tuner inputs and one aux. input. There are four boards in the set — 6010LL (cartridge pre-preamp), 6010f, 6010r and 6010ma — the front, rear and main boards. (Oct-Nov-Dec. '85).
6010LL — $19.10
6010f — $16.40
6010r — $16.40
6010ma — $23.10
Set of four $74.90

5502 MICROWAVE OVEN LEAKAGE DETECTOR
Anyone who owns a microwave oven needs one of these! Simple to build and low cost. (Dec. '85)
$9.15

6503 ACTIVE CROSSOVER
Here's a high performance four channel (use as many as you need) active crossover that's just right for that active speaker project! (Feb. '86)
$34.40

5504 ELECTROMYOGRAM
This is a 'muscle activity' monitor, sensitive enough to detect muscle activity that cannot be detected by eye. Can be used for relaxation training, biofeedback, migraine relief etc. (Mar. '86)
$15.90

4600 DUAL-SPEED MODEM
A great little modem that provides 300/300 baud full duplex and 1200/75 half duplex operating modes at the flick of a switch. It features simple RS232 interfacing. (Dec. '85, 7910 data sheet, same issue)
$33.70, or $15.00 (faulty tracks, no overlay)

6102 2-WAY CROSSOVER
Crossover board for our popular 2-ways using the Vifa drivers. (Aug. '85)
$21.75

5503 BED-WET-ECTOR
This is a simple, safe battery-operated alarm that may be used to help overcome bed-wetting problems. (Mar. '86)
$9.20

4610 SUPERMODEM
An intelligent modem with Hayes-compatible command set, for any computer with a serial port. It is capable of all V.21 and V.23 modes and features an expansion bus for later add-ons. Price includes necessary EPROM with resident software. (Apr-Aug. '86)
$139.00

4505 CODE-TO-SPEECH SYNTH.
Taking ASCII text input from a serial port, Centronics port or IBM slot, this versatile project will 'speak' text files. Double-sided, thru-hole plated board. (June-July '86)
$55.00

4504 LOW-COST SPEECH SYNTHESISER
This simple to build project employs the GI speech chip SPO256-AL2 which allows you to put together 'word parts' to make electronic speech. It employs 8-bit parallel interfacing. ('Bee interface — Feb. '86, with data sheet; C64 interface — July '86)
$17.30

3502 SIGNAL-OPERATED CASSETTE CONTROLLER
Just the thing for taping signals picked up on your SW receiver or scanner while you can't attend. Simple to build, powers from 10-15 V. (Mar. '86)
$9.20

4501 8-CHANNEL RELAY INTERFACE FOR COMPUTERS
Get your comptuter to control something! Hooks up to 8-bit parallel port or data bus. ('Bee — Oct. '85, C64 — Sept. '86).
$13.00

6501 4-INPUT MIXER
A versatile mixer/preamp for a guitar amp or stage amp. Select resistors to select the input impedance of the channels (Sept. '85)
$20.40

4502 REAL TIME CLOCK
This project plugs into the Microbee's parallel port and gives accurate date/time etc. Battery-backed. (Nov. '85)
$10.50

8500 VEHICLE COURTESY LIGHT EXTENDER
Don't get caught in the dark! This project 'holds' your vehicle's courtesy light on for some 30 seconds after you leave or enter it. (Nov. '85)
$9.90

4500 MICROTRAINER
Take the mystery out of micros. A great project for learning the 'guts' of microprocessing, without having to build a microcomputer. (Sept. '85)
$28.50

6000 ULTRA-FIDELITY POWER AMP
A low-distortion amp module that delivers over 200 W into 8 ohms, featuring the high power 2SK176/2SJ56 Hitachi MOSFET output devices. (June-July '86, data sheet in June).
$31.20

9501 DUAL-RAIL SUPPLY
A utility power supply module that can deliver dual rails from 2.6 V to 26 V at currents up to 560 mA — depending on choice of 5 VA pc-mount power tranny. (Aug. '86)
$19.30

9500 BEAT-TRIGGERED STROBE
Just the thing for discos and parties! Project can act as a manually variable strobe or, coupled to an audio source, flash in time with the beat. (July '85)
$11.30

ELEKTOR BOARDS

86090 SERIAL DIGITISER
The project can attach to any computer sporting an RS232 port and features one to eight multiplexed analogue input channels, conversion time less than half ms, variable ref. voltage to 4 V and modular construction. The main board is 86090-1, input boards (up to four) are 86090-2. (Oct. '86)
$21.10 — 86090-1
$6.40 — 86090-2 each

86086 HEADPHONE AMP
Featuring the TEA2025 stereo amp chip, this project has ample output for headphones from 30 to 600 ohms. Uses a 12 V supply. (Oct. '86)
$15.50

86016 SATELLITE SPEAKERS
This is the crossover board for a set of two-ways featuring the Dynaudio 17W75 and D-28AF drivers. (Oct. '86)
$8.35

86041 SPEAKER Z-METER
This simple instrument measures the resistance and inductive reactance of woofers and 'wide-range' drivers with a range to 18 ohms resistive and 5 ohms reactive. (Oct. '86)
$17.60

86002 BATTERY CHARGER
This dc-operated battery charger is designed to charge 9, 12 or 15 volt NiCads from a 12 V car battery. (Oct. '86)
$15.75

86462 RMS-TO-DC CONVERTER
A great add-on for your multimeter. It features a response to 100 kHz above 1 V input, 6 kHz at levels below 100 mV. A x1 and x10 attenuator is included. Needs supply of 5-15 V. (Oct. '86)
$3.25

86490 RODENT DETERRENT
An ultrasonic 'screamer' to annoy rats, mice and maybe even cockroaches. Simple, cheap. (Oct. '86)
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85000 RF BOARD
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World Radio History

Digital pink/white noise generator

David Tilbrook

When testing loudspeakers or room acoustics one of the most useful pieces of test equipment is a noise generator. The AEM2501 is a simple but effective unit which produces both white and pink noise outputs.

MOST frequency response tests carried out over the whole audio range are plotted on a linear-logarithmic (lin-log) scale. The vertical axis of most frequency response graphs is a linear scale usually expressed in dB, for decibels. A decibel is, by definition, a unit which is related logarithmically to the ratio of two linear quantities. For example, if the frequency response of an amplifier was under test the horizontal axis of the graph would be used to represent frequency while the vertical axis would be used to plot information regarding the output voltage from the amplifier. This information is usually plotted in the form of dB where, in this case, dB is defined by the equation

$$dB = 20 \log (V1/V2) \quad (1)$$

Where log is the log to the base 10 and V1/V2 is the ratio of the two voltages V1 and V2. Notice that the decibel is related to the *ratio* of two quantities and is therefore a dimensionless quantity. This is important because it implies that the decibel can be used to represent the ratio of any two quantities which have the same dimensions. For example, dB can be used to express the ratio between two power levels. In this case the equation is

$$dB = 10 \log (P1/P2) \quad (2)$$

The factor 10 is used in this case instead of the factor 20 used in the voltage ratio case so that the decibels defined by these two equations will be the same size. If the ratio of two voltages was, for example, 10 then by equation (1) we would say that V1 is 20 dB greater than V2. At the same time we know that power is related to voltage by the simple equation

$$P = V^2/R \quad (3)$$

Where R represents the resistance across which the voltage V is expressed. The important point arising from this equation is that power varies proportionately with the square of the voltage. So if the voltage ratio in the example above is 10 then the ratio of the powers when these voltages are applied to a load will be 100. If this ratio is used in equation (2) then once again we would say that P1 is 20 dB greater than P2.

If one of the two quantities expressed in the ratio in equations (1) and (2) above is held constant then the concept of a decibel takes on a slightly different meaning. It still represents a ratio of two quantities, of course, but because one of these two is held constant then dB can be used to represent particular levels.

In this case we have a slightly different type of decibel and to distinguish these an additional letter is placed after the "dB" such as "dBV" or "dBm" or even "dB SPL". In the case of dBV, the voltage V2 is set equal to one volt. Hence a voltage of 9.5 V for example could be expressed in decibels by using equation (1):

$$dBV = 20 \log (9.5/1) = 19.55dBV$$

Similarly, a voltage of 2V can be expressed as 6 dBV.

In the case of dBm, voltage V2 is replaced by a different reference voltage. In this case the reference voltage is defined to be that voltage which will give rise to a power dissipation of 1 mW in a perfect 600 ohm resistor. Applying equation (3) above shows that this voltage level is approximately 0.775 volts. In the case of dB SPL, decibels are used to represent Sound Pressure Level. The reference level is a pressure of 0.0002 millibars.

Since the vertical axis of most frequency response graphs is expressed using decibels it is effectively a logarithmic scale. In the case of the horizontal axis frequency is plotted on an actual logarithmic scale. In this way the entire audio spectrum can be represented in such a way that the low and midrange frequency region occupies more of the scale than the high frequency region does. Graphs showing the range from 20 Hz to 20 kHz usually have frequencies around 1 kHz approximately half way up the scale.

When plotted on a graph employing a logarithmic frequency response the ideal frequency response will be one that ▶

LEVEL

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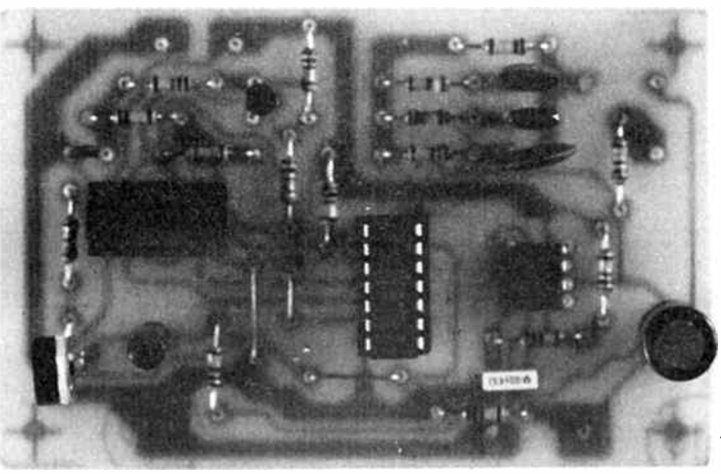
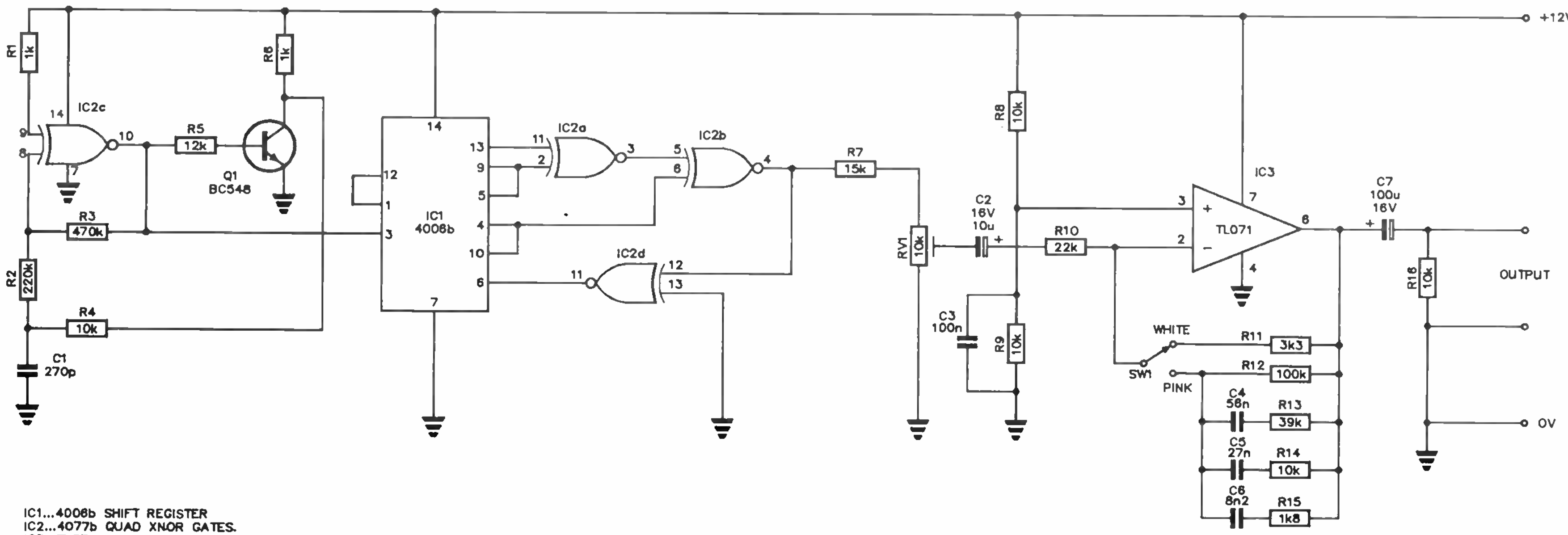
BEGINNERS

in electronics construction should be able to successfully complete this project.



World Radio History



IC1...4006b SHIFT REGISTER
IC2...4077b QUAD XNOR GATES.
IC3...TL071

CIRCUIT OPERATION

IC2c and transistor Q1, together with associated resistors and capacitors, form a clock oscillator set to a frequency around 80 kHz. With pin 9 of IC2c taken high via resistor R1, input signals applied to pin 8 appear on pin 10 non-inverted. Resistors R3 and R2 provide positive feedback around the gate converting the gate to a Schmitt action buffer with a dead-band of around 8 V.

If the output of IC2c happens to be high, i.e: its input is also high, then Q1 will be biased hard on via the current limiting resistor R5. The voltage on the collector of this transistor will therefore be low which will discharge capacitor C1 via resistor R4. The voltage across C1 will continue to decrease until it reaches the lower Schmitt level of IC2c when the output of IC2c will also be taken low. This low biases Q1 off, allowing its collector to go high which then begins to charge C1 via R4. This continues until the upper threshold of the Schmitt buffer is reached when the process repeats itself. The frequency of oscillation is therefore determined by the size of the Schmitt dead-band and the values of R4 and C1.

The output from the clock oscillator is taken from pin 10 of IC2c and fed to the clock input of the 4006B static shift register. This is an 18-stage shift register which is configured by the use of three exclusive nor gates to provide a complex sequence of high and low voltages which has a spectral distribution approximating that of white noise. In reality, the pattern is not completely random but repeats every few seconds.

The output from the white noise generator is taken from pin 4 of IC2b and is supplied to the input of an output buffer amplifier formed from the TL071 op-amp. Resistor R7 forms a potential divider in conjunction with preset RV1 to limit the maximum signal voltage that can be supplied to the input of the buffer stage.

Resistors R8, R9 and capacitor C3 bias the non-inverting input of the op-amp at around 6 V so that the op-amp operates symmetrically around this voltage. Capacitor C2 provides dc isolation between the two stages.

When operated in the white noise output mode, resistor R11 provides feedback around the op-amp which therefore forms a flat gain buffer. When operated in the pink noise output mode feedback is provided by the frequency dependent RC network formed by R12, R13, R14 and R15 and capacitors C4, C5 and C6. This network provides increasing negative feedback as frequency increases which decreases the gain of the stage as frequency increases.

Capacitor C7 provides dc isolation from the output of the op-amp which sits at approximately 6 V. Resistor R16 provides the necessary dc ground reference at the output to ensure that the output dc voltage is 0 V.

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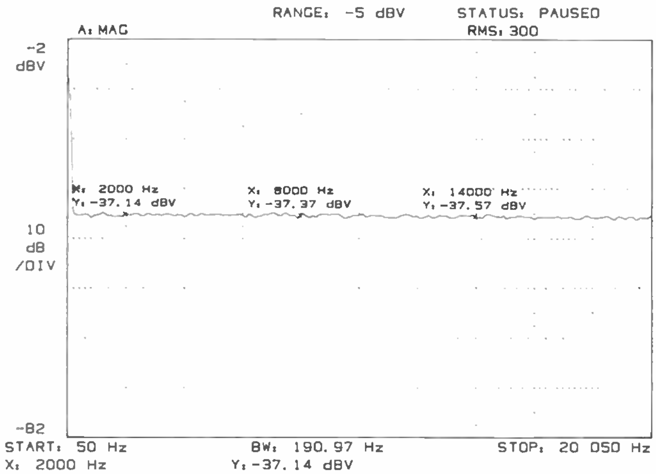


Figure 1.

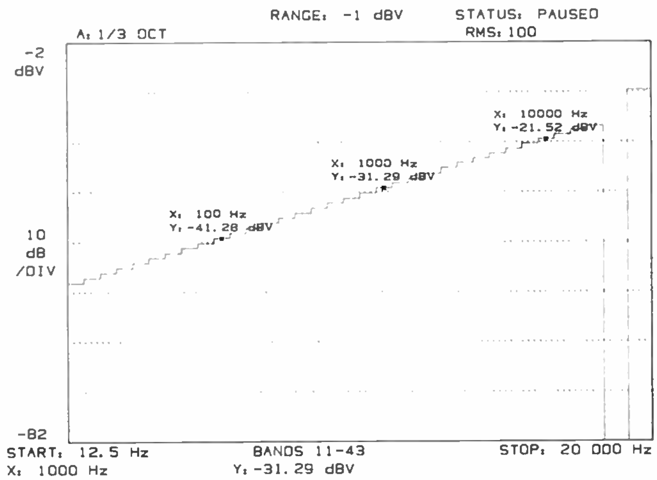


Figure 2.

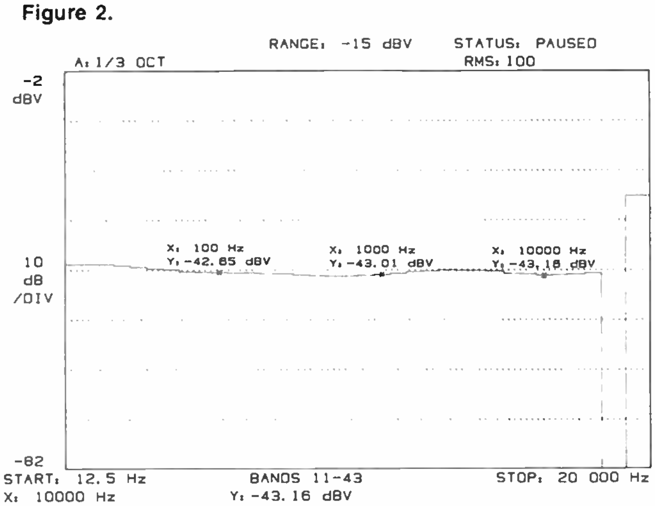


Figure 3.

results in a flat straight line indicating that the device under test will reproduce all frequencies equally. In order to facilitate measurements of frequency response we need a generator which will produce a signal with equal amplitude at all frequencies then any deviation from this ideal can be attributed to the device under test. One means to accomplish this is to use a swept sine-wave. A sine-wave generator is used, the frequency of which can be varied over the entire audio range and in this way the frequency response of the device can be determined.

An alternative approach is to design a generator which will produce a large number of sine waves simultaneously so that the frequency response can be measured using a set of filters or a device called a Fourier Analyser. Devices which generate large numbers of sine waves are commonly called noise generators.

Design considerations

The design of noise generators can be based around any component which generates electrical noise such as a transistor, a diode or even a resistor. The problem with most of these sources is that they provide noise outputs with amplitude and spectral distributions which can differ widely between different devices. To overcome this problem the AEM2501 noise generator uses a digital technique to generate the noise. A 4006B CMOS shift register is used in conjunction with 4077B exclusive NOR gates in such a way that a complex sequence of high and low voltages are generated. The spectral distribution of this complex signal is similar to that of a completely random noise source. In Figure 1 the frequency response of this noise source has been plotted on a graph using a *linear* frequency response axis instead of the more usual logarithmic type. This graph was obtained by the use of an HP3561A Dynamic Signal Analyser and the graph shown is the result of taking 300 measurements and averaging them. The analyser shows that on this scale the output from the shift register generates a remarkably flat response.

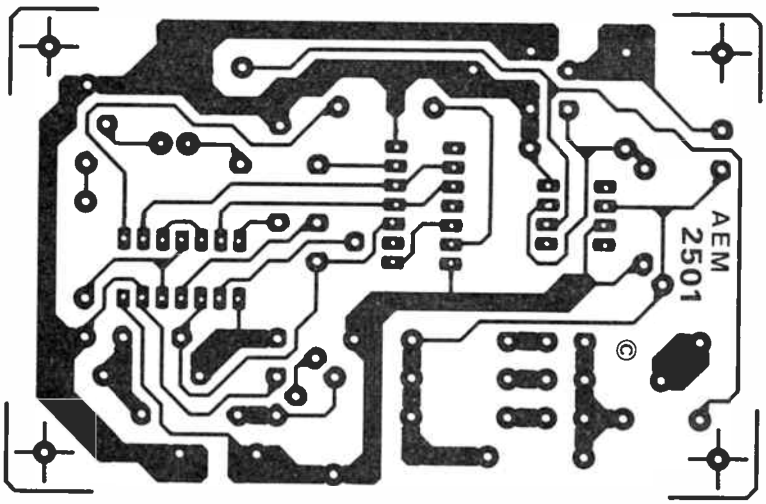
Noise with a spectral distribution like that shown in Figure 1 is called "white noise". The flat response on the linear frequency scale graph arises because this type of noise is characterised by a spectral distribution with equal amounts of electrical energy in each frequency interval over the frequency range of interest. This type of noise would be perfect for frequency response graphs using a linear frequency scale. However, as discussed above, most frequency response graphs employ log frequency scales.

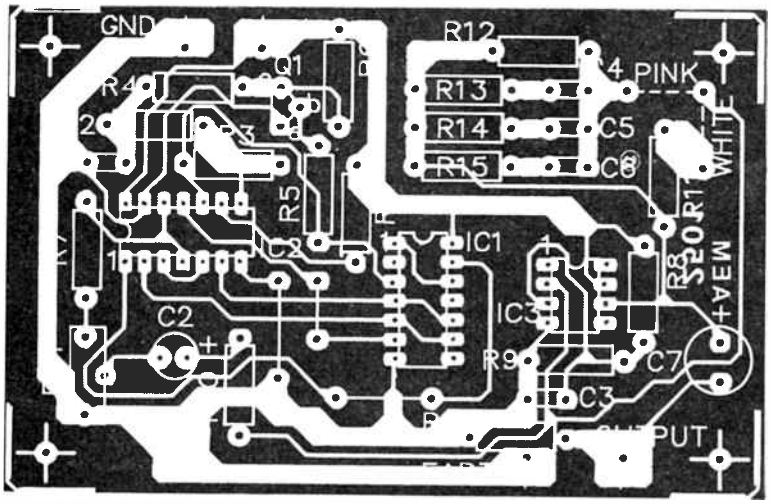
We need a different type of noise for use with logarithmic frequency scales, one which is characterised by a spectral distribution with equal electrical energy in successive frequency intervals the width of which increase logarithmically. In other words *we need equal energy in each octave or part octave over the frequency range of interest.* Noise with this type of spectral distribution is called "pink noise".

In Figure 2, we have plotted the spectral distribution of the same white noise signal as that used for Figure 1 except that in this case we have used a logarithmic frequency scale and we have summed signals in each successive one-third octave interval. The graph shows an overall sloping straight line indicating increasing energy in each octave as frequency increases. A perfect pink noise source, on the other hand, would display a spectral distribution characterised by a flat line on this graph.

To convert the white noise signal to the required pink noise a filter is used which introduces increasing attentuation for increasing frequency. In the AEM2501 this is achieved by the use of a simple op-amp filter employing a capacitor-resistor feedback network. The resulting noise spectral distribution is shown in Figure 3. Note that the curve remains within about 1 dB of the flat response required of a true pink noise source so this is a good approximation. In practice it is difficult to achieve a more accurate pink noise source as long as 5% tolerance components are employed, but the response generated by the 2501 makes it suitable for the vast majority of applications requiring a pink noise generator. ▶

World Radio History





AEM2501 PARTS LIST

Semiconductors
IC1 . . . . 4006B
IC2 . . . . 4077B
IC3 . . . . TL071
Q1 . . . . BC548

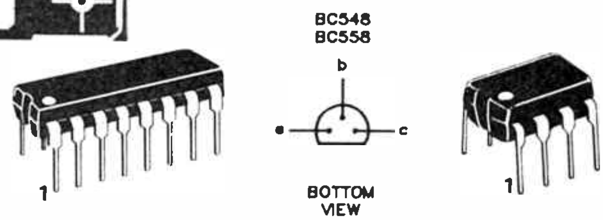
Resistors all ¼W, 5%

R1 . . . . 1k
R2 . . . . 220k
R3 . . . . 470k
R4 . . . . 10k
R5 . . . . 12k
R6 . . . . 1k
R7 . . . . 15k
R8, R9 . . . . 10k
R10 . . . . 22k
R11 . . . . 3k3
R12 . . . . 100k
R13 . . . . 39k
R14 . . . . 10k
R15 . . . . 1k8
R16 . . . . 10k
RV1 . . . . 10k preset

Capacitors
C1 . . . . 270p ceramic
C2 . . . . . . 10µ/16 V RB electro.
C3 . . . . 100n greencap
C4 . . . . 56n greencap
C5 . . . . 27n greencap
C6 . . . . 8n2 greencap
C7 . . . . . . 100µ16/V RB electro.

Miscellaneous
AEM2501 pc board; SW1-SPDT toggle switch (optional); IC sockets (optional).

Estimated cost: $17-$23



Construction

Construction of the project is not difficult, particularly if the AEM2501 pc board is used. As usual, solder all passive components first being careful to ensure that the polarised components, such as electrolytic capacitors, are inserted with the correct orientation, then solder the transistor in place. The two ICs employed are CMOS types and should therefore be handled with the usual precautions required by these devices. The very high input impedance makes CMOS somewhat more susceptible to damage from static electricity and although the inputs are protected by reverse diodes, some precautions should be taken. It is wise to use a soldering iron with an earthed tip and be careful not to overheat the leads. IC sockets can be used if required and in this way the ICs can be removed easily if necessary.

The project can provide both pink and white noise outputs according to the setting of a link on the pc board. If the application does not require the option to provide both types of noise then the appropriate points on the pc board can be linked together. If the option to supply both types of noise outputs is required then the three points can be taken to an optional toggle switch which can be mounted on the front panel of the unit in which the noise generator is mounted.

The preset potentiometer RV1 provides the facility to adjust the output level to match that required by the input of a preamplifier used in conjunction with the noise generator.

Using the noise generator

We plan to describe projects in the future which employ the noise generator, but the device is very useful on its own. Pink noise is a particularly good source for use during A/B testing of loudspeakers and will highlight the differences betweeen the frequency responses of different loudspeakers far more dramatically than most music sources.

Pink noise is also very useful when testing the acoustics of different listening rooms. The broad spectrum of frequencies will excite room resonances making them considerably easier to hear. To use the device for these applications simply connect its output to one of the line level inputs on your preamplifier such as the aux. input and adjust the preset potentiometer on the noise generator so that the output level is similar to the levels heard when other sources are used. The main volume control on the preamp can then be used to set the required listening level.

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DB-25PL	3.80	25 Pin D-Range plug
DB-37SL	4.90	37 Pin D-Range socket
DB-37PL	5.90	37 Pin D-range plug
SB-02	0.30	2 Pin short plug jumper
396-12	1.00	12 Pin power socket
SR-40	2.50	40 Way r'angle S header
SH-40	2.50	40 Way single header
DR-80	4.50	80 Way r'angle dual header
DH-80	4.00	80 Way dual header

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PC0028	0.40	28 Pin
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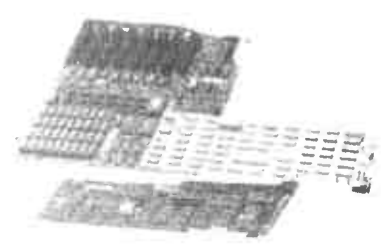

IBM PC/XT AT COMPATIBLE PCBS

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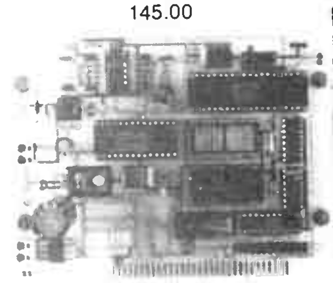

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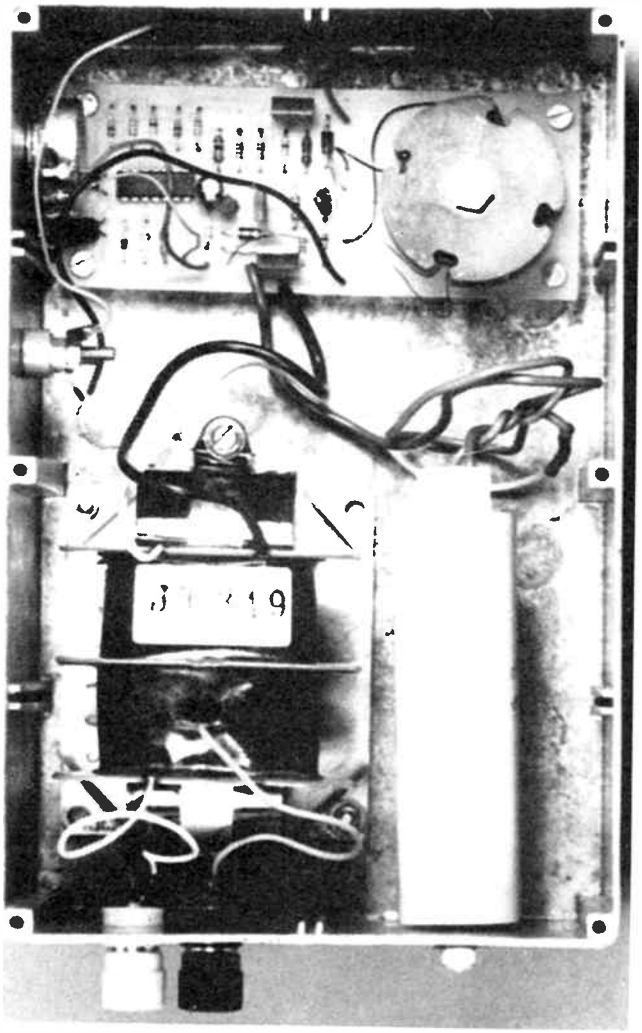
World Radio History

An electric fence controller with variable output

Part 2

Graeme Teesdale

This part concludes with description of the circuit and construction details.



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

HAVING COVERED some of the background problems faced by any electric fence controller in Part 1, and looked at the design considerations for electronic controllers, now we get down to the real thing.

The final circuit is shown in Figure 5. A 4093 CMOS quad Schmitt NAND-gate IC provides the inverter oscillator, 0.8 sec switch and 'overvoltage switch'. A regulated 8 V supply is derived from the 12 Vdc input by a three-terminal regulator. This supplies the IC and SCR gate drive transistor. The arrangement of driving the SCR gate was adopted so that a wide variety of insensitive, high current SCRs (or even triacs) could be used.

IC1a comprises the inverter oscillator, driving a Darlington driver, Q2. T1 is the inverter transformer, and D5 can charge the discharge capacitor, C3, to some 250 Vdc. Transistor Q1 shorts the base drive to Q2 when the overvoltage switch, comprised of gates IC1b-c, operates. Diode D3 couples the overvoltage switch and the 0.8 sec switch ensuring Q2 is held off when the SCR is fired so that Q2 does not drive what is effectively a short circuit at that time.

Potentiometer RV1 provides the output peak voltage control. Reverse polarity protection for the circuitry is provided by D2 in series with the positive dc input.

The discharge capacitor, C3, has to be a paper type, which are superior in pulse applications such as this. A variety of values are available and you can choose something to suit your requirements (and maybe your pocket!). The circuit shows values ranging from 6.5 to 30 μF. The 6.5 μF types are widely used in "disco strobes" (e.g: our AEM9500 Beat-Triggered Strobe, July '85). They come with flying leads and are rated to withstand 250 Vac and will happily withstand some 400 Vdc. They are the least expensive of those available. To obtain more discharge energy, you may find it more economical to use several connected in parallel. Plessey distribute a number of high value paper capacitors manufactured for fluorescent lighting ballast applications and values up to 15 μF may be found available, with a little shopping around. Plessey also manufacture (in Australia!) paper capacitors specifically for electric fence controllers and we obtained one rated at 30 μF/440 Vac/1000 Vdc from Geoff Wood Electronics in Sydney. These have automotive-type spade terminal lugs, so you'll need to remember to get them with it.

The output transformer, T2, needs to be specially wound to comply with the Australian Standard as well as to provide low output impedance. Jones Transformers of Sydney manufacture and distribute an electric fence transformer, model JT349, which we also obtained from Geoff Wood Electronics. ▶

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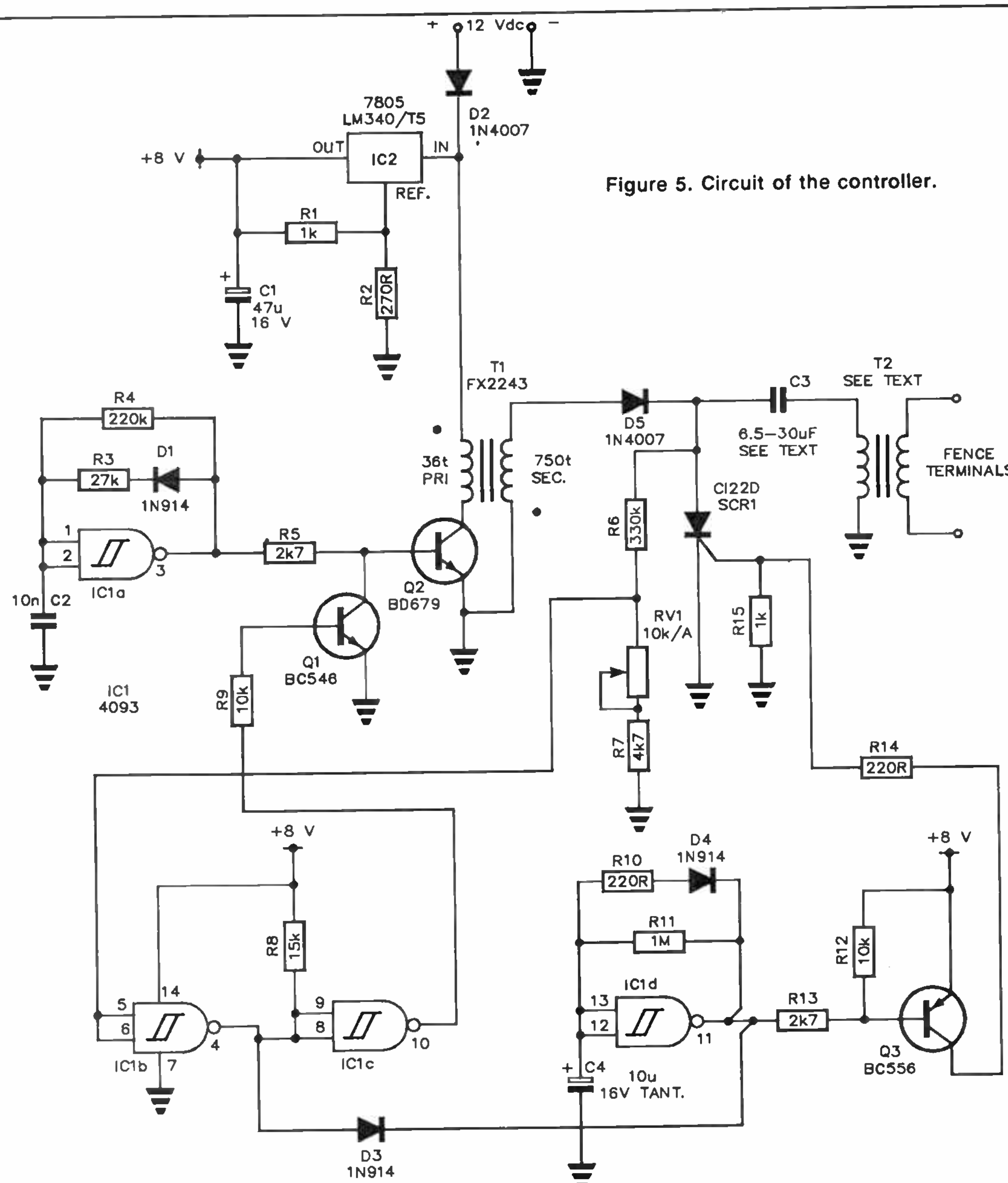


Figure 5. Circuit of the controller.

CIRCUIT OPERATION

The design is based around a quad two-input Schmitt NAND gate IC, the 4093. IC1a is connected as an astable multivibrator. Capacitor C2 is initially discharged. When power is applied IC2 provides 8 V to IC1 and associated circuitry. Pins 1 and 2 are low, driving the output (pin 3) high. C2 starts to charge through R3/R4 from the high on pin 3. This continues until the upper hysteresis threshold voltage is reached. The output then goes low and C2 discharges through R4, diode D1 being reverse-biased at this stage. When the voltage on C2 drops below the lower hysteresis threshold of IC1a's inputs, pin 3 switches high again and the cycle repeats. The circuit oscillates at a frequency in the high audio range.

The oscillator output drives the base of Q2 via R5. Q2 is a Darlington-pair switching transistor. Resistor R3 determines the period for which IC1a's output is high, and thus determines the on time of Q2. The collector current of Q2 pulses the primary of T1, developing a voltage of around 250 V at the secondary. This is half-wave rectified by D5 which charges C3 via the primary of T2, the output transformer.

Each time SCR1 fires, it connects to the fence load. At the same time, the SCR also shorts the output of T1 and rectifier D5.

IC1d is the 0.8-second trigger. This is also an astable multivibrator, in the same manner as IC1a. However, the oscillator time constants are much longer here. The output pulse is a short duration, low-going pulse repeated every 0.8 seconds. Pin 11 of IC1d biases on the base of Q3 via R13 every time it goes low. When Q3 turns on, it supplies an 8 V pulse to the gate of SCR1 via R14, turning it on. This arrangement of driving the SCR from the 8 V supply was adopted so that a wide variety of insensitive high current SCRs or triacs could be used. Resistor R15 across the SCR gate is included to reduce the possibility of false triggering when Q3 is off.

The output voltage is determined by an 'over-voltage switch' comprising IC1b-c and the network R6-R7-RV1. The latter form a potential divider across the rectified output of T1. When the voltage at the inputs to IC1b (pins 5, 6) exceeds the gate's input threshold value, pin 4 goes low, driving the output of IC1c (pin 10) high. This switches Q1 on via R9, the collector of which clamps the base of the Darlington Q2 to 0 V. This stops any further increase in the voltage developed across C3.

In addition, Q1 is also switched on when the SCR is fired. When pin 11 of IC1d goes low, D3 pulls the input of IC1c low, driving pin 10 high, turning on Q1. This prevents Q2 driving into the short circuit on the secondary of T1 presented by the conducting SCR.

World Radio History

AEM9502 PARTS LIST

Semiconductors

D1 .... 1N914
D2 .... 1N4007
D3, D4 .... 1N914
D5 .... 1N4007
IC1 4093
IC2 .... 7805, LM340/T5
Q1 .... BC546
Q2 .... BD679, BD681
Q3 .... BC556
SCR1 .... C122D

Resistors all 1/2W, 5%

R1 .... 1k
R2 .... 270R
R3 .... 27k
R4 .... 220k
R5 .... 2k7
R6 .... 330k
R7 .... 4k7
R8 .... 15k
R9 .... 10k
R10 .... 220R
R11 .... 1M
R12 .... 10k
R13 .... 2k7
R14 .... 220R
R15 .... 1k

RV1 .... 10k/A pot.

Capacitors

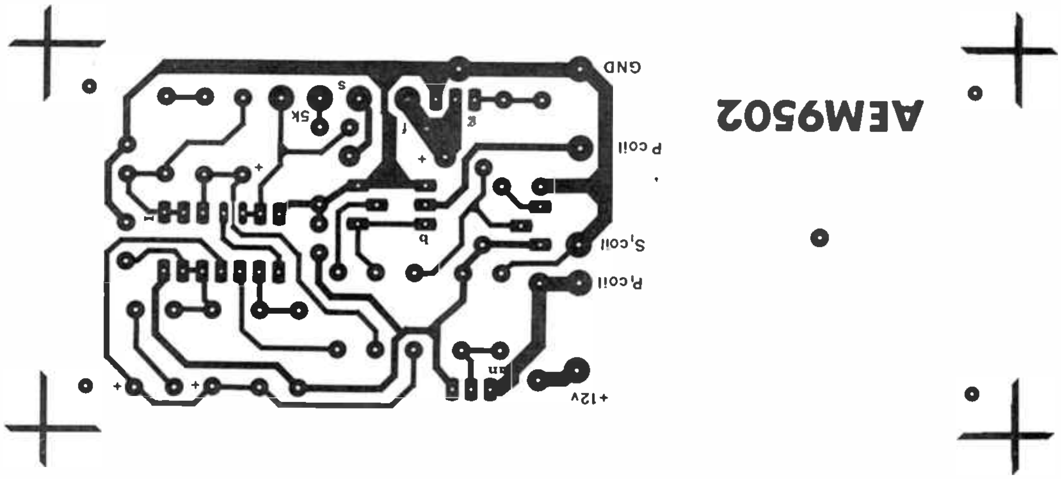
C1 ...... 47μ/16 V RB electro.
C2 .... 10n plastic (MKT)
C3 .... 6.5-30μ paper cap., rated at 400-1000 Vdc
C4 .... 10μ/16 V tant.

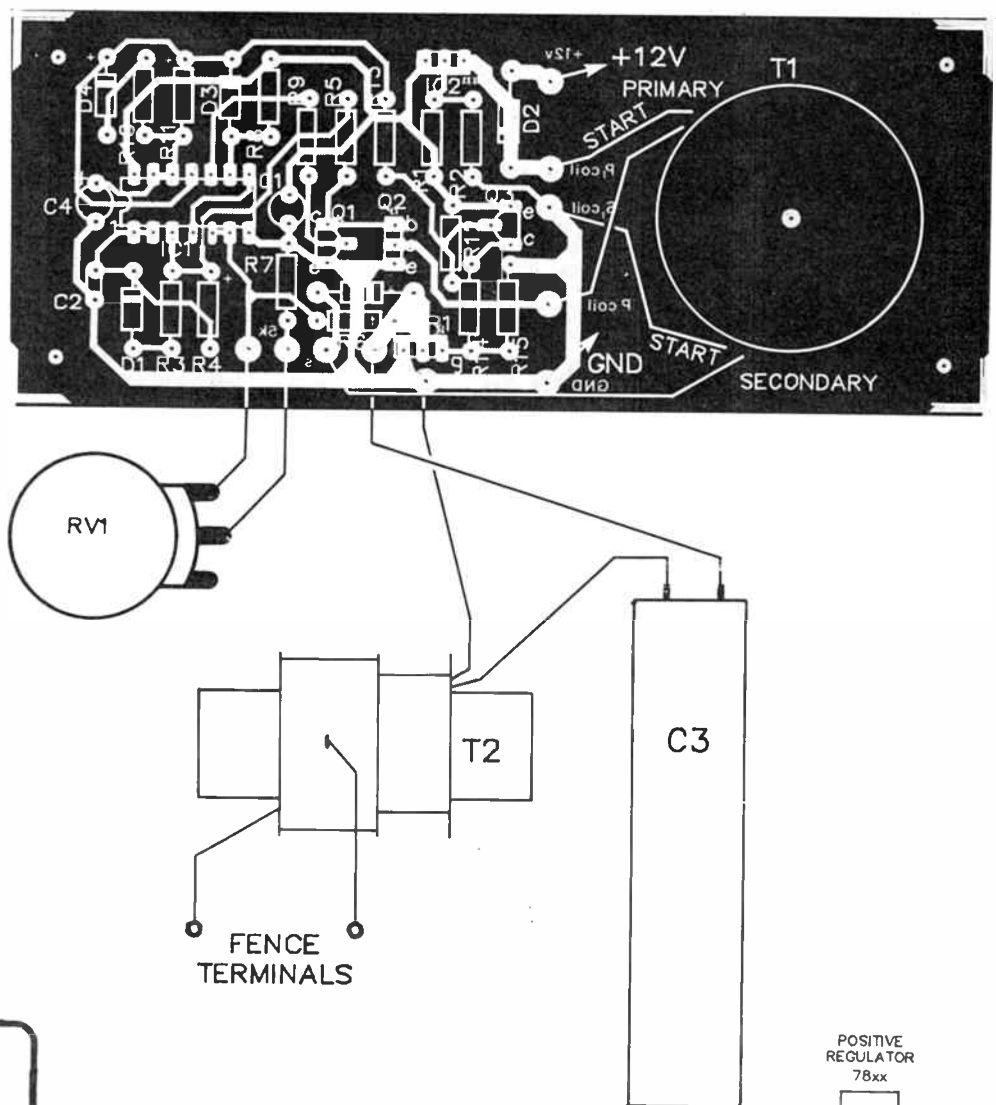
Miscellaneous

T1 .... FX2243 potcore and former, wound as per text.
T2 .... JT349

AEM9502 pc board; Scotchcal panel; weatherproof housing to suit; output terminals to suit (see text); battery leads and alligator clips; four insulated 12mm standoffs; hookup wire, 30g and 22g enamelled copper winding wire, nuts, bolts, solder etc.

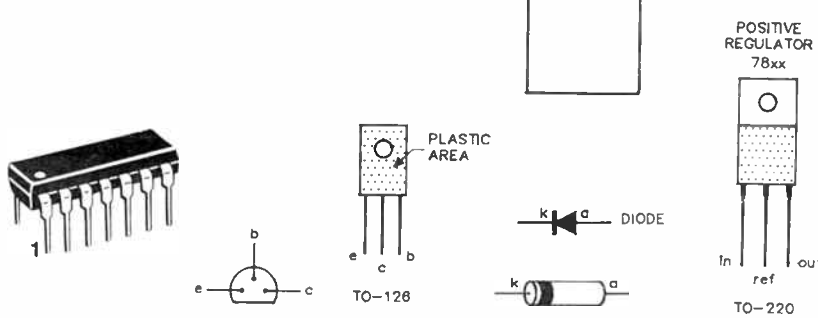
Expected cost: $75-$90





AEM9502

WARNING! ELECTRIC FENCE



World Radio History

Construction

The minor electronic components, including T1, are mounted on a small pc board, assembly of which is quite straightforward. The pc board, potentiometer, discharge capacitor (C3) and output transformer (T2) will need to be housed in a suitable weather-proof case if the controller is to be mounted outdoors. Here, you can suit yourself, just so long as the case is large enough inside to comfortably accommodate all the major components and the pc board. Layout is relatively uncritical, so long as the leads from the output of T2 to the fence terminals are kept short and away from the pc board and other components.

An ideal case for the unit is a diecast box. They are rugged, easily weather-proofed, reasonably priced and widely available. Anything mounted through the walls of the box must provide a seal, or be sealable, to prevent the ingress of moisture which can spell disaster for the internal electronics. Begin by laying out the positions of the components which mount to the case. A soft-lead pencil is ideal for this.

For the fence terminals, common 4 mm 'binding post jacks' were used. While not ideal, they provide a seal, are common, low in cost and serviceable. They should be mounted on one end of the case and the case mounted so that the terminals face downwards. This prevents any precipitation collecting around them and adding to the losses. It may be an idea to shroud the terminals with an open-ended plastic box bolted to the end of the diecast box for added protection. Make sure this is large enough to allow access to the fence terminals.

The potentiometer should be mounted on one side, with the 12 Vdc input terminals mounted below (i.e: toward the fence terminals end). Again, common 4 mm binding post jacks provide a sealable, serviceable connector.

Position the pc board, output transformer and discharge capacitor(s) in the box, moving them around in several trial layouts to determine the best overall layout. Transformer T2 must mount near the fence terminals, as explained earlier. The output winding is terminated with one flying lead (white wire) and a solder lug. Position the transformer such that the white wire will reach one of the terminals.

The blank pc board may be used as a template to mark out the mounting holes. Use insulated stand-off spacers to mount it. The 6.5 µF discharge capacitors have an integral mounting bolt at the end of the plastic case. Others need a mounting strap. You might find a suitable cable or conduit 'saddle', or you could make one from a strip of aluminium.

Note that, when mounting anything that passes through the box wall, seal the hole and surrounding area with a gasket material such as 'Silastic'.

Next step is to wind transformer T1. This is wound on an FX2243 45 mm diameter ferrite potcore assembly which comprises two potcore 'halves' and a plastic bobbin-type former. The secondary is wound on the former first. This requires 750 turns wound with 30 gauge enamelled copper wire. Leave some 100-150 mm of wire for a lead. Mark it with tape or something as you'll need to identify the start lead later. When this winding is completed, wind one layer of thin insulation tape or sticky tape over it to hold it in place. Now wind the primary. This requires 36 turns of 22 gauge enamelled copper wire. As before, leave 100-150 mm of lead at the start and mark it in some way. Note that, it's a wise idea to bring out the primary leads on the opposite side of the former to the secondary leads. Wind a layer of sticky tape or thin insulation tape over the completed windings. Set the assembly aside for now.

WARNING: THE DISCHARGE CAPACITOR WILL "BITE". ALWAYS SWITCH OFF AND DISCHARGE THE CAPACITOR WITH A LOW VALUE RESISTOR BEFORE WORKING ON THE UNIT.

The pc board assembly may be tackled next. First, quickly check the pc board, whether it's a 'bought one' or homemade, to see that all holes are drilled and of the correct diameter. You'll find the job easier if you solder all the resistors in first, followed by the five diodes (take care which way round you put them, they are polarised). Then solder IC1, the transistors and the SCR in place. Here too, take care which way round they go. Now the three on-board capacitors can be soldered in place. C1 and C4 are polarised and must not be inserted the wrong way round.

Now make a careful check of the board. Look for poor joints and solder bridges between closely-spaced pads, particularly around IC1. Fix any problems now.

The potcore may now be mounted on the board. It is secured with a bolt through the centre of the ferrite 'cups'. Use a flat washer under the nut and a rubber of fibre washer between the flat washer and the cup. If you tighten it too much, you're likely to crack the cups and the transformer will not work correctly.

Now, solder the wires from T1 in place after first cutting them down so that they reach without large amounts of slack lolling about. The **start** of the primary winding goes to the cathode of D2 (marked 'P1 coil' on the board), while the end goes to the collector of Q2 ('P coil' on the board). The secondary **start** lead goes to the board GND track ('S1 coil' on the board), while the end lead goes to the anode of D5 ('S' on the board).

Attach leads for connection to the potentiometer, T2 primary and the 12 Vdc input. Use medium duty hookup wire. Now you can mount the board in the box along with the other components, and wire it all up. Check your wiring.

Power-up

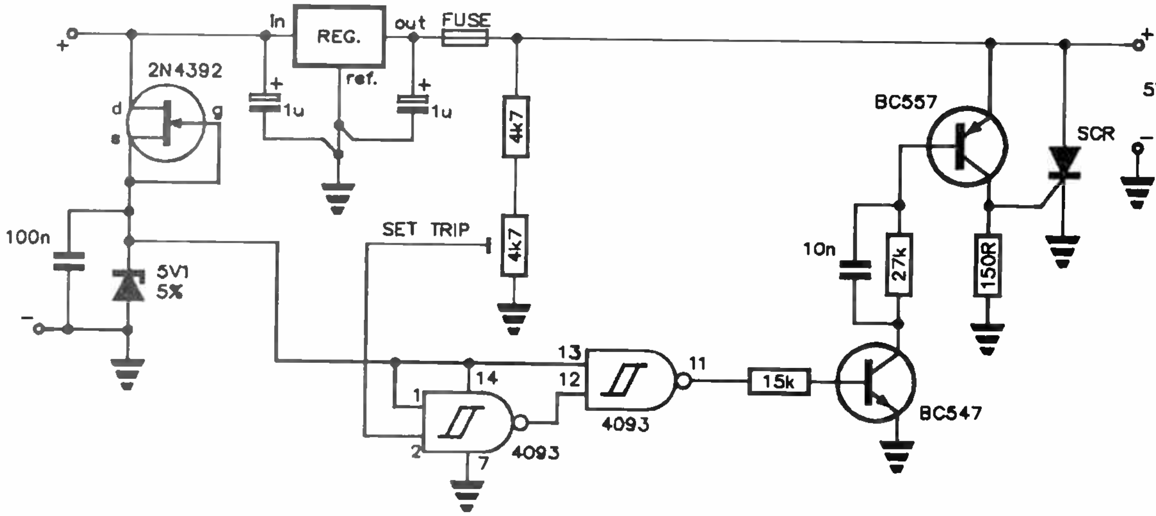
To test the unit, connect a multimeter or dc ammeter in series with the positive supply lead. Set your multimeter to read around half amp, or use a 0.5 A ammeter. Set the output control to minimum. Leave the lid off the box. Switch on. The meter should indicate very low current until the SCR fires, when the meter should 'kick up' sharply. It will take five to ten seconds perhaps before this happens, first. Listen for a high-pitched 'singing' sound from T1. When the SCR fires, a distinct 'tick' may be heard.

If you don't get these indications, switch off and carefully check wiring and the pc board assembly. See that all the semiconductors are correctly orientated. Check that there's +12 Vdc on the cathode of D2. If not, either your hookup is incorrect or D2 is reversed. Check the 8 V regulated supply, it should be within ±1V. Check R1 and R2 values if not. If all's well here, you can check that the oscillator's OK by using a high impedance earpiece or audio signal tracer on pin 3 of IC1. It should produce a loud, high-pitched sound. If not, check IC1, D1 and the values of R3, R4 and C2.

A multimeter may be used to check the 0.8-sec trigger. Check at pin 11 of IC1. You should get a short pulse at intervals slightly less than a second, but remember it takes a few seconds to fire initially. If this stage isn't working, check D4 and C4 are correctly oriented and that R10 and R11 are the right values. You may try replacing C4.

Check that the cathode of D5 rises to about 250 Vdc. The voltage at the inputs of IC1b (pins 5 and 6) should rise to about 3.5 V minimum and about 10.5 V maximum, depending on the setting of RV1.

World Radio History



Precision overvoltage protection

Failure in a three-terminal regulator, which applies the raw dc input to the output terminal, can spell disaster for circuitry supplied by it that is sensitive to overvoltage — 5 V digital logic, for example. This circuit applies an 'electronic short circuit' to the supply rail should the voltage rise above a precisely set, predetermined limit.

Two gates from a 4093 CMOS Schmitt NAND gate provide a stable, precision threshold which may be set by means of the 4k7 trimpot. The 4093 is supplied via a 5V1 zener from the dc input. The 2N4392 JFET provides a constant current source for the zener, while the 100n capacitor is simply a bypass.

Should the regulator fail and short circuit its input and output terminals, the rising output voltage will trip the pin 2 input of the 4093, driving pins 3 and 12 low and pin 11 high. This will turn on the BC547 which, in turn, will turn on the BC557, immediately tripping the SCR gate which conducts, shorting the output and blowing the fuse in series with the regulator's output.

The trip level may be set by first removing the fuse and applying a variable, current limited dc supply to the output side of the fuse. Wind up the "set trip" trimpot to maximum ('top' end of the trimpot). Using a digital multimeter, set the variable dc supply output to the required voltage, then wind back the "set trip" trimpot until the dc supply's current limit operates.

G. Wilmot,
Canberra, ACT

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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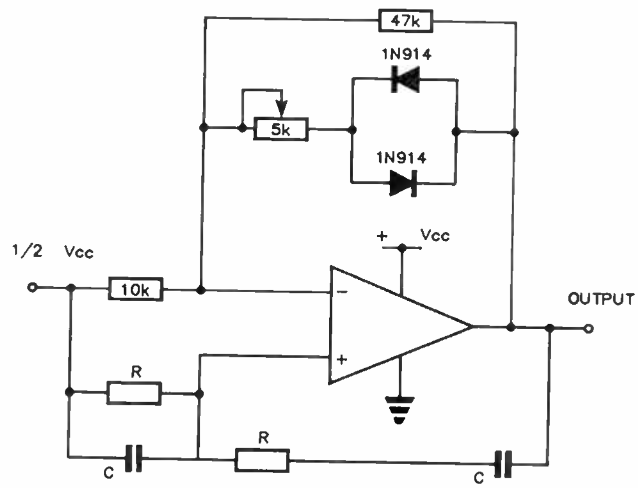


fo = 1 \ 2πRC

"Quickie" Wien bridge oscillator

A good standby in a myriad of audio oscillator applications is the Wien bridge circuit. However, most show some sort of thermistor in the feedback for amplitude stabilisation. But if you're after a quick audio oscillator one afternoon, it's unlikely you'll have the right thermistor on-hand.

This circuit is as simple as thermistor-type Wien bridges, but employs back-to-back silicon diodes and a trimpot in the feedback. It doesn't produce lowest distortion, but its performance is acceptable in many applications.

You can set the output frequency by choosing suitable values and substituting them in the equation with the circuit. For a 1 kHz oscillator, typical values would be 12n for C and 15k for R. The ½ Vcc point should be supplied from a well-bypassed, low impedance source. You could use a dual op-amp and use the other half as a "supply rail splitter" voltage follower.

N. Webster,
Fitzroy, Vic.

World Radio History

EFG7515 CMOS

SINGLE CHIP DPSK AND FSK MODEM

(BELL 212A - BELL 103 - V22 A/B)

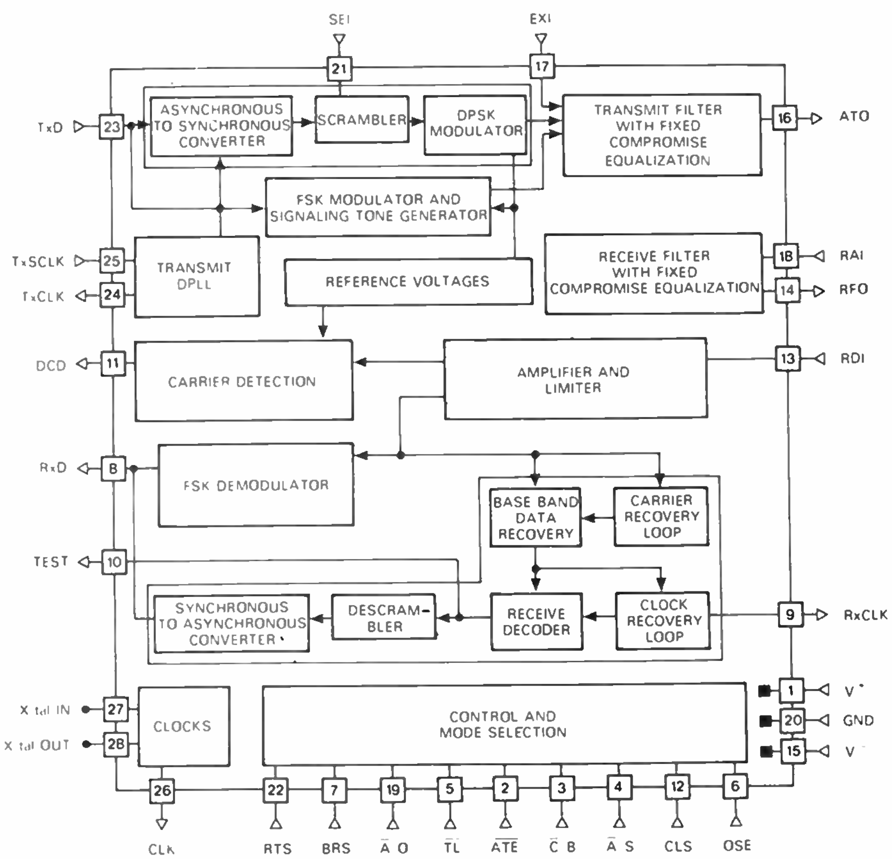
The EFG7515 is a single chip DPSK and FSK voiceband modem, compatible with the applicable BELL and CCITT recommended standards for 212A sets including BELL 103 and V22 A-B type modems.

- Monolithic device includes both transmit and receive filters.
- Mixing analog and digital technics.
- Standard low cost crystal (4.9152 MHz).
- Available clock for microprocessor at 4.9152 MHz.
- Low power consumption - CMOS technology.
- Sharp adjacent channel rejection.
- Fixed equalization in transmitter and receiver.
- Test loops.
- Carrier detect output.
- CCITT and BELL signaling tone.
- 1200 bps and 600 bps bit synchronous format in DPSK.
- 1200 bps and 600 bps +1%, −2.5% or +2.3%, −2.5% character asynchronous format (8, 9, 10 or 11 bits) in DPSK.
- 0 to 300 bps in FSK.
- Break signal supervision.
- External voice band tone filtering available (i.e. 550 Hz or DTMF).
- CMOS and TTL compatible.
- Direct interface to THOMSON SEMICONDUCTEURS microprocessor family.
- Special line monitoring facility.

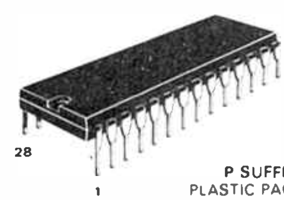
MAIN OPERATING MODES

- Standard selection (BELL 212A/BELL 103/V22).
- Answer tone selection.
- Low speed mode selection.
- Channel selection (Answer/Originate).
- Synchronous/Asynchronous mode selection.
- 8 bits to 11 bits word length selection in character asynchronous format mode.
- Overspeed selection in character asynchronous format mode.
- Scrambler selection.
- 1800 Hz guard tone selection in V22.
- Test loop selection (Digital/Analog).

BLOCK DIAGRAM

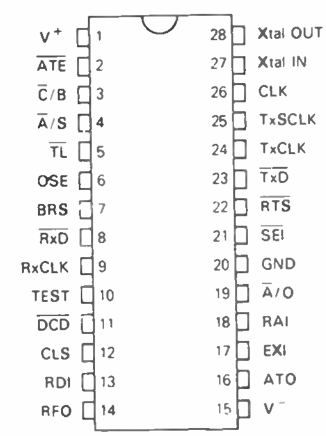


CASE CB-132



P SUFFIX
PLASTIC PACKAGE

PIN ASSIGNMENT



SUMMARY OF THE DIFFERENCES BETWEEN BELL 212A AND V22 A-B

Feature	BELL 212A	V22
Low speed mode	0-300 bps FSK	600 bps DPSK
Guard tone	No	1800 Hz optional*
Answer tone	2225 Hz	2100 Hz
Character length in asynchronous mode in DPSK	9, 10 bits	8, 9, 10, 11 bits**
Over speed mode in asynchronous mode in DPSK	No	Yes**
64 spaces detection	No	Yes

Table 9

* 550 Hz may be externally generated and added to the transmit signal through EXI
** Features of V22 are available in BELL 212A on the chip

All these differences are taken into consideration inside the EFG7515

GENERAL DESCRIPTION

The EFG7515 is a general purpose monolithic DPSK and FSK modem implemented with double poly CMOS process. It is capable of generating and receiving phase modulated signals at data rates of 1200 bps or 600 bps as well as frequency modulated signals at data rates up to 300 bps on voice-grade telephone lines. It is offered in a 28 pin package capable of operating full-duplex according to three pin selectable standards :

- CCITT V22 A-B.
- Bell 212A with its low speed mode.
- Bell 103.

All filtering functions required for frequency generation, out-of-band noise rejection and demodulation are performed by on-chip switched capacitor filters. In phase modulation the modem provides all data buffering and scrambling functions necessary for bit synchronous format and asynchronous character format modes of operation. Internal frequencies are generated from a 4.9152 MHz crystal reference. ▶

World Radio History

PIN DESCRIPTION

Common section (supply, clock, handshaking and mode selection)

Name	Pin Type	No	Function	Description
V⁺	I	1	Positive power supply	+5 V
V⁻	I	15	Negative power supply	−5 V
GND	I	20	Ground	0 V
XIN	I	27	Oscillator input	This pin corresponds to the input of the oscillator. It is normally connected to an external crystal but may also be connected to a pulse generator. The nominal frequency of the oscillator is 4.9152 MHz.
XOUT	O	28	Oscillator output	This pin corresponds to the output of an inverter with sufficient loop gain to start and maintain the crystal oscillating.
CLK	D	26	Clock	This pin delivers a clock signal, the frequency of which is the crystal frequency. It may be used as a buffered clock for a microcontroller.
C̄/B	I	3	CCITT/BELL selection	This three-state input selects the features corresponding to CCITT or BELL recommandation.
Ā/S	I	4	Synchronous/asynchronous selection	This three-state input selects the synchronous bit format or the asynchronous character format mode in DPSK transmission. This input allows also character length selection (refer to table 7).
CLS	I	12	Character length	This input selects the character length in conjunction with Ā/S input (refer to table 7).
DSE	I	6	Over-speed selection	This input selects the over-speed in asynchronous character format mode required by CCITT recommandation (refer to table 7).
BRS	I	7	Binary rate selection	A logic "0" on this input turns the chip on 1200 bps rate. A logic "1" turns the chip on 600 bps or 0-300 bps according to C̄/B selection.
Ā/O	I	19	Answ./Orig. selection	A logic "0" on this input turns the chip on answer mode. A logic "1" turns the chip on originate mode.
T̄L̄	I	5	Test loop selection	This three-state input, selects the test loops mode (refer to table 5)

Transmit section

Name	Pin Type	No	Function	Description
T̄x̄D̄	I	23	Transmit data	Data bits to be transmitted are serially presented on this input. A mark corresponds to a logic "1" and a space to a logic "0". This data determines which phase or frequency appears at any instant at the ATD pin in DPSK or FSK modes.
ATO	O	16	Analog transmit output	The analog output is the modulated carrier or the answer tone to be conditionned and sent over the phone line mixed with the filtered signal from EXI.
EXI	I	17	External tone input	This analog input allows external tone to be filtered by an internal low-pass filter. Filtered signal appears at ATO whatever RTS.
ĀT̄Ē	I	2	Answer tone enable	A logic "0" on this input instructs the chip to enter answer signaling tone mode according C̄/B selection. A logic "1" turns the chip on transmit data mode (refer to table 8).
S̄Ē Ī	I	21	Scrambler enable input	A logic "0" on this input enables the internal scrambler. A logic "1" instructs the chip to bypass the scrambler.
TxCLK	O	24	Transmit clock from modem	This output delivers a transmit bit clock generated by the chip in synchronous mode. This output generates a logic "1" in asynchronous mode. When TxSCLK is used, TxCLK is locked on TxSCLK.
TxSCLK	I	25	Transmit clock from terminal	This input receives a bit clock supplied by the DTE. This clock synchronizes the internal transmit clock of the chip in synchronous mode.
R̄T̄S̄	I	22	Request to send terminal	When a logic "0" is present on this input, the chip delivers on ATD a modulated signal or a signaling tone and the filtered signal from EXI. When a logic "1" is present on this input, ATO delivers only the filtered signal from EXI. When a logic "-1" is present on this input, the receive section may be used for line monitoring and ATO delivers only the filtered signal from EXI.

Receive section

Name	Pin Type	No	Function	Description
RAI	I	18	Receive analog input	This input receives the analog signal from the hybrid. It corresponds to the input of the receive filters.
RFO	O	14	Receive filter output	This analog output is the signal received on RAI once filtered. The receive filter also equalizes the signal for adaptation to most existing lines. This output must be connected to RDI through a capacitor to meet the level detection conditions.
RDI	I	13	Receive demodulator input	This pin is the input of the carrier detection logic and of the demodulator.
D̄C̄D̄	O	11	Data carrier detect	A logic "0" on this output indicates that a valid carrier signal is present on RAI. A logic "1" means that no valid signal is being received. The hysteresis meet standards recommendation.
R̄x̄D̄	D	8	Receive data	Data bits demodulated are available serially at this output.
RxCLK	O	9	Receive clock	This output delivers a receive bit clock generated by the chip. In asynchronous mode this clock is 16 times the modulation rate. In synchronous mode the clock is equal to the bit rate.
TEST	O	10	Test	This output is an intermediate demodulator output intented for handshake and test purposes.

FUNCTIONAL DESCRIPTION

TRANSMITTER

The transmitter consists of two analog signal generators followed by switched capacitor and continuous filters. In phase modulation operation mode the DPSK signal generator is preceded by a selectable scrambler and an asynchronous to synchronous converter is included in character asynchronous format mode.

Tone allocation: the modem on the end of the line which initiates the call is called the originate modem. In normal transmission operation it transmits in low channel and receives in high channel. The other modem is the answer modem which transmits in high channel and receives in low channel.

Modulators

DPSK modulator: the phase modulation type is differential quadrature four phase shift keying (see table 1). The 1200 bps data stream to be transmitted is converted into two 300 dibits per second streams which modulate alternatively two independant carriers. Consequently the base band shaping is included is a 5 bit address ROM which generates samples for a 8 bit switched capacitor DAC at a frequency equals to 8 times the carrier frequency.

FSK modulator and tone generator: a frequency synthesizer provides accurate clocks to a switched capacitor sine wave generator (see table 3). Phase continuity is maintained when a frequency shift occurs.

Transmit filters

To avoid unwanted frequency components to be echoed by the hybrid in the reception path, to maintain the level of spurious out-of-band signals transmitted to the telephone line below the limits specified by administrations (see figure below) and to complete statistical amplitude and phase equalization, the analog signals are processed by ten poles sharp pass-band switched capacitor filters. The response of these filters depends on the selected channel (Answer/Originate) and the selected standard (BELL 212-V22/BELL 103). A continuous filter eliminates parasitic sampling effects. An additional low-pass filter input is provided. This allows to mix and filter such tones as DTMF signals or special guard tones (550 Hz) to the transmitted signal.

Scrambler

The scrambler used during phase modulation ensures the transmission of a continuously changing pattem. This avoids the receiving modem to drop out of lock on certain continuous repetitious data patterns. This scrambler may be disabled during handshaking procedures. In V22 a special unlocking sequence is performed on 64 spaces pattern at scrambler output.

Asynchronous to synchronous converter

The DPSK signal is synchronous in nature but the modem has both an asynchronous as well as a synchronous mode of operation in DPSK. So a data buffer is necessary to convert variable rate asynchronous character data to an equivalent bit oriented synchronous data stream. This is done by inserting or deleting stop bits. In addition this converter is able to recognize and format the break signal.

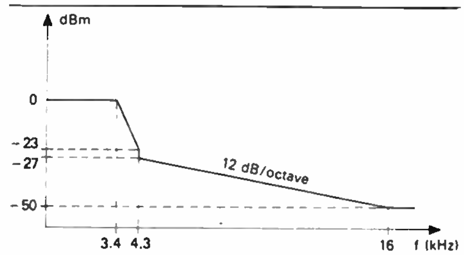


Figure 1: Transmit filters charecteristics

BRS	TxD n − 1	TxD n	Phase shift
0	0	0	+90°
		1	0°
	1	0	+270°
		1	+180°
1		0	+90°
		1	+270°

Table 1: DPSK modulation

Ā/O	T̄x̄D̄	Standard frequency
0	0	2025 Hz
	1	2225 Hz
1	0	1070 Hz
	1	1270 Hz

Table 3: FSK modulation (BELL 103)

World Radio History

RECEIVER

The receiver includes two band-pass filters followed by an amplifier and a hard limiter. Depending on selected standard, the detector output is passed through a DPSK demodulator or a FSK demodulator. The DPSK demodulator is followed by a descrambler and a selectable synchronous to asynchronous converter. In addition a carrier detector monitors the level of the received signal.

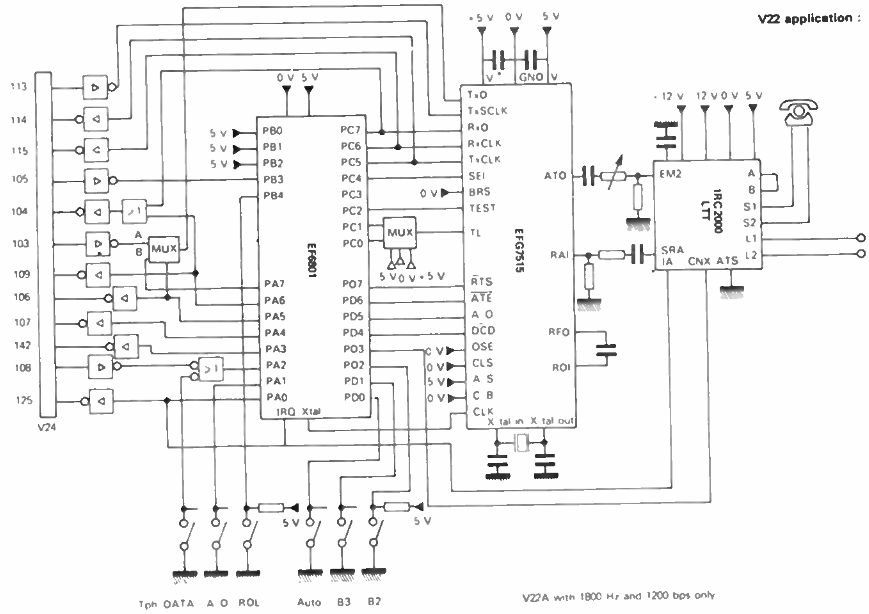
Tone allocation: in normal transmission operation the originate modem receives in high channel and transmits in low channel. The answer modem receives in low channel and transmits in high channel.

Receive filters

The signal delivered by the hybrid to the receive analog input is a mixture of transmitted signal, received signal and noise with a level in the range from −48 dBm to −6 dBm. Depending on the operating mode and the selected standard the 20 poles receive switched capacitor band-pass filter selects the frequency band of the low channel or the high channel. A ratio of 14/15 is applied on the sampling clock frequency between FSK and DPSK in the same operating mode (Answer/Originate). These filters reject out-of-band transmission noise components and undesirable adjacent channel echo signals which can be fed from the transmit section into the receive section. Fixed equalization is included in order to assure low error rate.

Amplifier and hard limiter

Once filtered the received signal is amplified and fed to the carrier detector. In order to limit analog parts in the design all the demodulator techniques used in the EFG7515 are based on zero crossing detection. So the received signal is just limited before entering demodulator.



Demodulators

DPSK demodulator: a DPLL is used to recover the carrier signal. This DPLL has a lock range of ± 2 Hz but as the incoming carrier may present an offset of ± 7 Hz a second loop allows the first DPLL to lock on the exact frequency of the carrier with an accuracy of ± 1 Hz and to follow its slow variations. Then the limited received signal is mixed through exclusive-Or with the recovered carrier and with the 90 degrees phase shifted recovered carrier. The results are processed through four poles Bessel filters which provide a good amplitude propagation time compromise. The received sampling clock is recovered from these base band data with a simple DPLL. The received data are sampled by this clock and then converted into a serial synchronous bit stream.

FSK demodulator: the zero crossing detector output is passed through a shift register whose length depends on the operating mode (Answer/Originate). The output of the shift register and the detector are mixed into an exclusive-Or. Then they are processed through a four poles Bessel filter and a slicer.

Test output

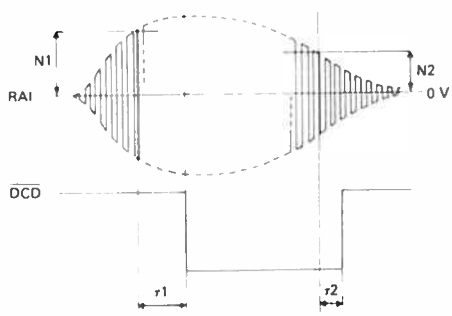
Once demodulated DPSK data are generally processed (cf next paragraph) but during call set-up procedures or data set testing it is of importance to monitor the demodulator output. So in DPSK mode demodulated data are available on TEST pin.

Descrambler and synchronous to asynchronous converter

Data coming from the DPSK demodulator are unscrambled. In V22 the unlocking sequence is detected at descrambler input and the original data are decoded before descrambling. In asynchronous character format mode of operation a data buffer is able to detect missing stop bits and reinsert them. The converter is able to recognize the break signal and transmits it without modification.

Carrier detector

Whenever valid signals are being received at the input of the demodulator and are acceptable for demodulation, carrier detect output is pulled down. A delay is timed out before the carrier received or carrier lost signal changes carrier detect output to provide immunity against noise bursts. The modem also provides at least 2 dB of hysteresis between the carrier ON and the carrier OFF thresholds (see diagram below).



In DPSK mode 105 ms < t1 < 205 ms 10 ms < t2 < 24 ms
In FSK mode 215 ms < t1 < 315 ms 25 ms < t2 < 75 ms

Standard frequency	Frequency using 4.91 MHz	% deviation from standard	Mode
1070 Hz	1066.7 Hz	−0.3%	BELL 103 Originate
1200 Hz	1200 Hz		BELL 212A or V22, Originate
1270 Hz	1269.4 Hz	−0.05%	BELL 103 Originate
1800 Hz	1807.1 Hz	+0.4%	Guard tone V22
2025 Hz	2021 Hz	−0.2%	BELL 103 Answer
2100 Hz	2104.1 Hz	+0.2%	Answer tone CCITT
2225 Hz	2226.1 Hz	+0.05%	BELL 103 Answer or Answer tone BELL
2400 Hz	2400 Hz		BELL 212A or V22, Answer

Table 2: Output frequency deviation

A/S	C/B	BRS	TxCLK	RxCLK	Mode
−1 ou 0	−1 ou 0	0	1	19.2 kHz	V22 asynchronous
		1	1	9.6 kHz	
	1	0	1	19.2 kHz	BELL 212A asynchronous and BELL 103
		1	1	4.8 Hz	
1	−1 ou 0	0	1200 Hz	1200 Hz	V22 asynchronous
		1	600 Hz	600 Hz	
	1	0	1200 Hz	1200 Hz	BELL 212A synchronous and BELL 103
		1	1	4.8 kHz	

Table 4: Clocks operation

LOOP TESTS

LOOP 3

This loop is called the analog loop. When it is selected the receive filters and the demodulators are configured to process the same channel as the transmit section. The transmit carrier has to be looped back externally to the receive analog input. This loop allows the user or the DTE to check the satisfactory working of the local DCE.

LOOP 2

This loop is called the digital loop. When it is selected received data, receive clock and data carrier detect signals are respectively and internally looped back on transmit data, transmit clock from terminal and request to send. This loop allows the user or the DTE to check the satisfactory working of the line and the remote DCE.

CLOCKS

In synchronous mode of operation TxCLK, TxSCLK and RxCLK are respectively working as the V24 circuits C114, C113 and C115. In asynchronous mode of operation RxCLK can be used as baud rate clock to synchronize the transmit and the receive sections of a UART. See table below.

OSCILLATOR OUTPUT

The buffered master clock (4.9152 MHz) is made available at output CLK. It can be used as a clock for a microcontroller.

VOLTAGE REFERENCE

A temperature compensated voltage reference build with a zener is included in the chip. This voltage is used to calibrate transmit levels and to generate the carrier detection thresholds.

LINE MONITORING

A special mode has been included in the EFG7515 to monitor the line during an automatic call. When this mode is selected receive filters clock is directly derived from TxSCLK which allows the user to precisely observe broad frequency bands. Furthermore the DCD performs a fast carrier detection equivalent to an envelope detection. As the center frequency of the receive filters is proportional to TxSCLK frequency in this mode it is possible to tune the passband according to the frequencies to be detected (see next table).

We would like to acknowledge the kind permission granted by Promark Electronics to reproduce this data sheet.

APPLICATIONS INFORMATION

In a typical application a microcontroller provides control and interface to the Data Terminal Equipment (DTE), and a Direct Access Arrangement provides connection to the telephone line. Then the EFG7515 can communicate with the most popular modems (BELL 103 and BELL 212A) in countries under BELL standards and popular modems (V22) in countries under CCITT recommendations.

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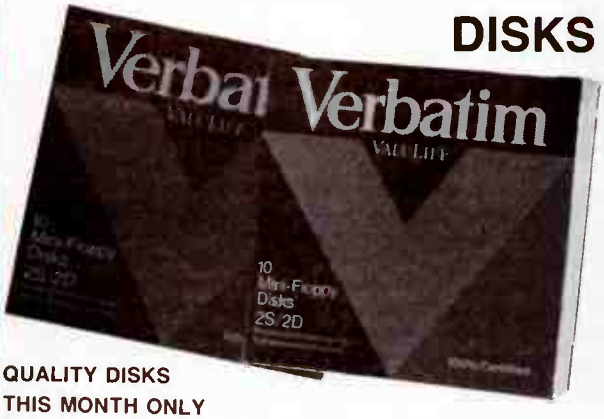

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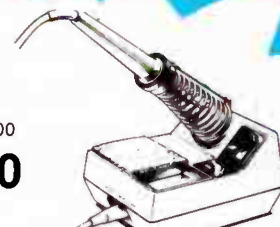

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C2520	10µF 63V	.18	.14	.11
C2525	22µF 25V	.15	.10	.08
C2528	22µF 63V	.17	.12	.10
C2531	33µF 25V	.17	.12	.10
C2535	47µF 16V	.15	.10	.09
C2536	47µF 25V	.16	.10	.09
C2540	100µF 16V	.16	.14	.10
C2541	100µF 25V	.22	.19	.14
C2543	100µF 63V	.26	.22	.16
C2545	220µF 16V	.18	.16	.12
C2546	220µF 25V	.23	.20	.15
C2548	220µF 63V	.42	.31	.27
C2555	470µF 16V	.24	.22	.18
C2556	470µF 25V	.49	.45	.42
C2560	640µF 16V	.52	.44	.35
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New Avtek modem features Hayes SM300 and SM2400 emulation

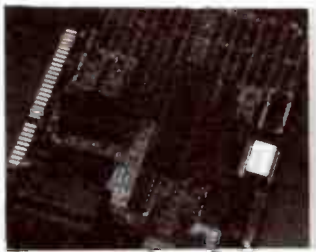
Avtek Electronics, who describe themselves as "Australia's leading manufacturer of modems", this month launch the 'Megamodem', claimed to outperform other modems offered at up to four times its $499 price tag.

The Megamodem emulates the Hayes SM300 and SM2400 standards and features an easy-to-drive menu mode. Avtek claim it will work intelligently with the vast majority of PC software, straight out of the box.

In addition, the Megamodem will recognise both outgoing and incoming baud rates and adjust automatically. So connection is pretty well idiot-proof! Phil Gleeson, of Avtek, says this feature is of great benefit when training business people to use data communications software. "The modem takes care of all the tricky stuff", he says. "Modems that could do this previously used to fall into the $2000-plus price bracket — out of reach of all but the most well-heeled data comms fanatics!".

Sophisticated auto-answer facilities are also provided and the Megamodem accommodates communications using the complete V21/V22/V23 standards, according to Avtek. Applications include low or high speed data comms, plus videotex service accessing, such as Viatel.

Further details from **Avtek, PO Box 651 Lane Cove 2066 NSW. (02) 427 6688.**



A panoply of ports!

Hypertec, Australian designer/manufacturer of PC add-ons, has released the "Hyper-Port", a low-cost short board that provides your PC or clone with:

- one parallel port
- one serial port
- a clock/calendar, and
- printer spooling

The latter provides for independent spooling on any or all of the parallel and serial ports of the machine as well as the choice of being driven from interrupts or standard communications drivers.

For details, contact **Hypertec Pty Ltd, Suite 404, Henry Lawson Business Centre, Birkenhead Point, Drummoyne 2047 NSW. (02) 819 7222.**

"SCRAM" KEEPS TRAFFIC MOVING

The introduction of SCRAM (Signal Co-ordination of Regional Areas in Melbourne) to Melbourne's major arterial roads is providing motorists with a 20% reduction in travelling time, 40% reduction in number of stops and a fuel saving of up to 12%. Ultimately 2000 sets of traffic signals within the Melbourne metropolitan area will be computer controlled under the SCRAM system introduced by Victoria's Road Traffic Authority.

Melbourne has been a challenging city for traffic engineers. Its road network forms one of the worlds largest urban grids with over 40 000 intersections and currently 1800 sets of traffic signals. Victorians, in fact, have double the number of cars per head of population than does Japan or Great Britain, for example.

SCRAM operates by linking traffic signals to provide green lights at successive intersections in order to allow traffic to flow smoothly. SCRAM determines the most appropriate timing of green lights for each intersection, varying dynamically with vehicle, public transport and pedestrian requirements. Successive intersections are computer linked to allow groups of vehicles to move through the intersections with minimum interruption.

Monitoring and fine tuning the operations of SCRAM is a continual process. As traffic patterns alter, and in order to further streamline the system, it is necessary to make minor adjustments from time to time to SCRAM's operational parameters. Early in the system's evolutionary stage is was found advantageous to have a surveillance helicopter with the ability to go live on-line to SCRAM's central computer in order that timing changes could be made with the operator being able to immediately observe their effect on traffic flow.

The necessity to have a completely error-free data path between the helicopter's terminal and ground-based central computer was essential. A locally designed, secure error correcting smart radio data modem was chosen to perform the task. Known as the model CPU-100 it is manufactured in Mitcham, Victoria by GFS Electronics and simply connects between RS-232 ported data equipment and a UHF/VHF or HF voice frequency bandwidth radio system. Its small size, light weight, portability, error correction and ability to handle the full ASCII character set made it ideal for the job, GFS say. The makers claim the modem, available in a number of different versions, is suited to and used in many other applications where data communication or collection is necessary from mobile or remote sites, particularly when land lines are not available or just too expensive to use.

Further information on the CPU-100 smart radio data modem can be obtained from **GFS Electronics, PO Box 97, Mitcham 3132 Vic. (03) 873 3777.**

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World Radio History

Amstradder

with Steve Holland

WELCOME to the Amstradder column! With the popularity of Amstrad computers on the increase I was suprised to see that no major electronics magazine had a column catering for people who own these well-priced and easy to use machines. But then all good things take time and here we are with an Amstrad column in the best (from my point of view) electronics magazine in Australia! On with the column.

As some of the readers of this column may only be giving it a cursory glance because it is new to the magazine. I commence with a brief overview of the entire Amstrad range. First Amstrad off the production line was the CPC464 (CPC stands for Colour Personal Computer). It is a Z80A-based computer, consisting of a monitor with built-in power supply and a keyboard unit comprising a 74-key QWERTY-style keyboard having built-in data cassette recorder. The computer comes with 64k of RAM of which 42K is available to the user. There is a choice of either a hi-res green screen or an RGB colour monitor.

The next computer off the rank was the CPC664, the difference being that instead of a datacorder there was 3″ disk drive in the keyboard unit. Amstrad's next release was the CPC6128. It had many of the features of the '464, but again there was the built-in 3″ disk drive plus an extra 64K of RAM. The price of the CPC6128 was almost the same as that of the CPC664, which spelled the death nell for the '664. Of the 128K RAM on board, 41K is available to the user in BASIC, whilst there is a 61K transitory program area (TPA) available in the CP/M + operating system. Packaged with the system are two disks containing CP/M +, CP/M 2.2, D-R Logo and CP/M system utilities.

Amstrad then went into business. That is, business computing. The product was the PCW8256 (PCW — Personal Computer Wordprocessor). Like the previous releases, it had a Z80A CPU. Amstrad pulled out the big guns with this one. In the one package they included a lot of so-called 'extras':

(a) A 90 x 32 column monitor (50% more than a popular 16-bit PC).

(b) A 3″ disk drive (180k per side).

(c) A dot matrix printer capable of NLQ printing (20 cps) or draft mode (90 cps).

(d) A powerful Wordprocessor (the 82 key keyboard, has 17 dedicated workprocessing keys).

(e) Also included are CP/M + GSX, DR Logo, and Locomotive Software's Mallard BASIC.

(f) 256K of RAM, of this, 61K is used as TPA, CP/M + occupies about 80K of RAM, the rest being configured as a RAM disk (normally more than 100K).

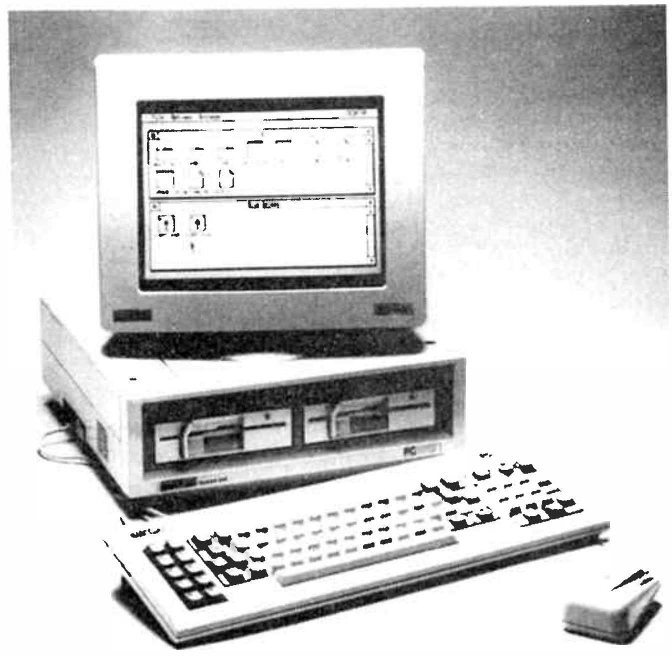
In fact, what you have with the PCWs is a completely functional, ready-to-go wordprocessor for approximately the same price as a reasonable electric typewriter. The PCW has more than just business applications. I know of writers who bought them purely for the wordprocessing abilities.

Amstrad made a controversial decision in using Hitachi's 3″ disks, rather than Sony's 3½″ disks that Apple, HP, Atari, Microbee and others have opted for. When asked about this their answer is that, with over 500 000 unit sales of the PCW series alone, they have the right to establish their own standard.

The Amstrad computers have a lot of software and hardware add-ons available. All can be expanded with peripherals such as disk drives; printers, modems, light pens etc.

I have found that all the instruction books are easy to understand and the novice should have no trouble in becoming aquainted with a new purchase, in my view.

The PCW series are of rather unusual manufacture. When you take a peek inside you will notice a large square hole in



The Amstrad PC1512, just released by AWA.

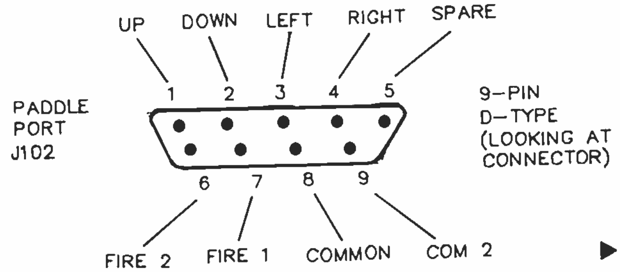
the circuit board filled by an equally large 80-pin flatpack IC. This appears to be one of the new breed of gate array devices. This chip controls all the functions of the computer. The Z80A does all the computing work but all addressing is through the gate array. The 16 memory chips are easily replaced as they are socket-mounted. In the 8256 only half the space is used. I will endeavour to procure the correct method for expanding to the full 512K of memory and present it in an up-coming column.

In late August, Amstrad released the PC1512 IBM compatable in London, and it will be released here this month. In the design of the PC compatible, Amstrad made great use of LSI (large-scale intergrated circuit) chips to keep the total chip count down to around 20 devices.

Amstrad are using he Intel 8086 CPU at 8 MHz, instead of the standard 4.77 MHz. This does not however make it as fast as the IBM AT. The price for the base model will be around $1300 for this, you get 500K of memory, a single disk drive, a monochrome monitor, printer and communications ports — but sadly, no printer — and Digital Research's DOS Plus operating systems with the GEM interface program.

The top of the range model gives the user dual drives, colour monitor etc for around $2300. Whilst a 20M hard disk edition with colour monitor will retail for $3000 or thereabouts.

As often as possible, I'll attempt to include some technical details of one or other of the Amstrad computers. This month, it's the 464's connector details.



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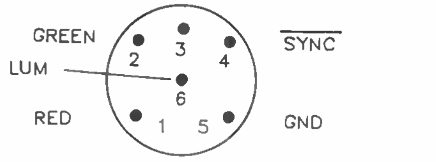

VIDEO OUTPUT CONNECTOR J101

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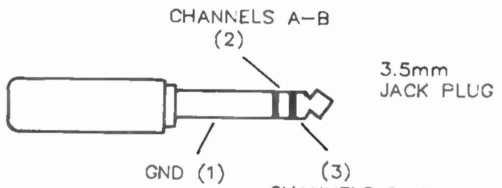
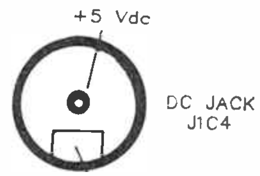


SOUND OUTPUT J103



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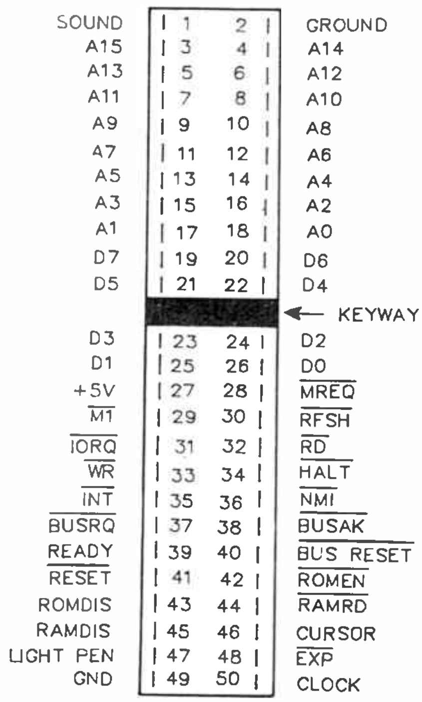

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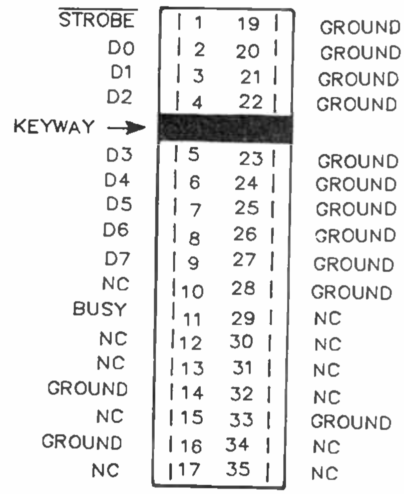

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World Radio History

dial-up

with Roy Hill

WELCOME to the second issue of our monthly computer communications feature. The first item of interest for this month's column is the release of a new Viatel pacakge for the IBM PC and-compatibles. This new package supports the full Viatel colour set (i.e: 8 colours + flash), but because it uses the IBM text page for display, graphics rendition is not perfect. However, I have never seen Viatel look so good — a colour monitor is well worth having, just for Viatel. The cost of the package is quite reasonable — $39, from Maestro Distributors (Calool St, South Kincumber 2256 NSW).

There are now a large number of people using the AEM4610 Supermodem on a variety of computers — Macintosh, IBM, Apple *//e*, Commodore/Amiga, Microbee, Atari, Tandy CoCo, Osborne and more that we are probably unaware of. The V.22 prototype board has been received and several small errors have been corrected (inevitable on first runs!). The design is based on the 28-pin Thomson-CSF EFG7515 Singe Chip DPSK/FSK modem (DPSK Stands for "dual phase-shift keying" and FSK stands for "frequency-shift keying"). A partial data sheet for this chip is provided elsewhere in this issue. The board also contains a 6821 PIA, a 6850 ACIA, an LM1458 op-amp and three 74-series ICs. These, plus a half dozen passive components are all that is required to implement V.22. The board measures approximately 120 × 160 mm and will fit quite neatly inside the Supermodem box.

The Videotext decoder discussed inthe last issue is also progressing well. It will be driven by the Supermodem and will have the capacity to interface to either composite/RGB monitors, or to a standard TV set via an optional modulator. Once again, a Thomson-CSF chip (in this case the EF9345 Screen Controller) is integral to the circuit. This chip is a dedicated Videotext screen controller chip, containing in-built graphics handling and a Videotext character set. I believe that literally millions of these chips are in use throughout Europe. Details of this will appear very soon now.

General communications

There are two items that I would like to discuss as general topics this month. Firstly, I would like to clarify the difference between the two terms *transmission speed* (measured in bits per second — bps for short) and *baud rate*. The two term used to be considered synonymous (and in fact they were in earlier technological times), but they now have slightly different meanings.

Baud rate refers to the number of events or changes occurring in one second and for very simple forms of transmission, such as V.21 (300 bps), is still the same as the bps rate. Things become more complicated under V.22 where phase-shift keying (DPSK — see Figure 1) is used rather than frequency shift keying (FSK). It becomes possible under DPSK Transmission to encode two bits of data (called 'dibits') onto one single 'event'. In this case then, the transmission speed — bit rate (bps) is now *twice* the baud rate (see Figure 2). 'Quadbits' are also used and the bps transmission rate then becomes *four* times the baud rate. Unfortunately, this also means that the poor old Telecom line has to cope with far more. For this reason high speed (i.e: greater than 1200 bps) transmission over 'phone lines usually requires the installation of a specially leased data transmission line from Telecom. A summary of points to remember is shown in Figure 3.(2). Housley (3) sums it very nicely by saying "Because confusion can arise, and because the term bps is more meaningful, I try to discourage the use of the term baud, and it does not appear again in this book (except in the index!)." He also includes quite a good discussion on the above definitions which are a bit too lengthy to include here.

Secondly, a large number of first-time modem users find themselves in trouble when it comes to wiring up an RS232 cable to connect the modem to their computer. The main reason being that even experts have trouble with the RS232 standard, in that it is the most un-standard standard that was ever perpetrated upon an unsuspecting public. The most common problem is the configuration of the ▶

Modulation Methods

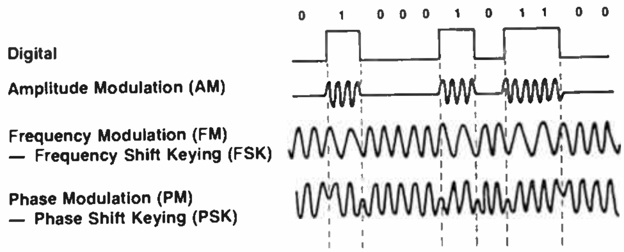
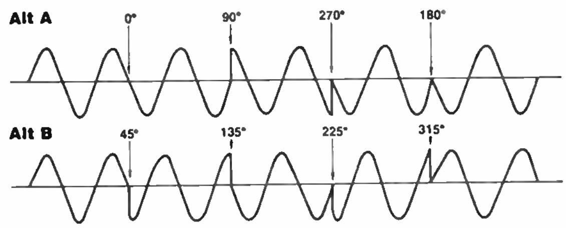


Figure 1. Showing the various modulation methods employed in modems. FSK and PSK are widely used.



Data Encoding — 2400 bps

Dibit	Phase Change: Alternative A (V.26A)	Phase Change: Alternative B (V.26B)
00	0°	+ 45°
01	+ 90°	+ 135°
11	+ 180°	+ 225°
10	+ 270°	+ 315°

Data Encoding — 1200 bps

Bit	Phase Change
0	+ 90°
1	+ 270°

Figure 2. An example of phase-shift encoding.

Points to Remember

- Modulation Impresses Data On a Voice Frequency Carrier Wave
- The Data is Coded Into Symbols
- Each Symbol Spans a Fixed Time Interval
- The Number of Symbol Intervals Per Second is Defined By the Baud Rate
- The Number of Bits Per Symbol Multiplied By the Baud Rate Equals the Data Rate in bps
- Baud Rate Determines Bandwidth Required
- Bit Rate Determines Susceptibility to Errors Induced By Other Channel Characteristics

Figure 3. Keep this table in mind.

World Radio History

two data lines (from the modem to the computer and from the computer to the modem). By convention, these two lines are usually crossed when two 'intelligent' pieces of equipment communicate. On the Supermodem, we have imlemended what is called 'straight-through' connection. This means that every pin used on the computer's serial port connector (normally pins 2, 3, 5, 7, 8 and 20), is connected to the corresponding pin on the Supermodem, with no crossing of wires required. One of the greatest devices ever sold to assist would-be RS232ers is the 'break-out box'. This little device uses LEDs to indicate the state of various RS232 lines and can be bought for as little as $30 to as much as $900 for all-singing, etc versions.

New devices

An exciting new device by Thomson-CSF (the seem to have the modem world covered, don't they?) is the 68950/1/2 Modem Analogue Front End (MAFE) chip set. This set of three chips is capable of handling any communications protocol (including those of your own invention) at any speed up to 9600 bps. However, at this stage design and implementation costs are prohibitive (the three chip set costs about $500 and would require a $30,000 software development investment). More details later.

I have been asked by Maestro to survey readers for interest in a rather ambitious kit project. For some time now, both Chris Darling and I have had a great interest in Forth (the Supermodem Viatel software was written in it). The designer and implementer of the language, Charles Moore, has spent the last five years designing and producing a FORTH dedicated microprocessor (called the Novix NC4000). Prototypes of this chip, running an 8 MHz clock, have already appeared and run at the astounding speed of 10 million operations/second. The Forth language is actually microcoded (not in EPROM) onto the chip. The chip features a parallel, bit-slice architecture and the prototype version ran the 'Sieve of Eratosthenes' program in 0.3 seconds, whilst a 68000 coded in assembly language ran the same number of primes in 0.5 seconds (1). Even these figures do not show the true speed of the chip, which is capable of performance equal to that of a VAX 11/750. It is hoped that the next release (with improved architecture and a far higher clock speed) will improve these figures by an order of magnitude.

Chris and Dan are considering designing a computer (in kit form) based on this chip. Is anyone out there interested in such a kit? Bear in mind that this sort of kit would be a major project of the magazine, running over an extended period and would probably cost a lot more than the average Z80-based computer. There would also be a limited supply of software — prospective kit purchasers would be supplied with all of the authors' development software — and persons becoming involved with such a kit would have to become conversant with FORTH. Please feel free to drop me a line, or contact Maestro on Viatel. Their number is 436929130. My Viatel number is 434147010, but as I still don't have a full-time modem (I've gone to 490th on the list), it may be a fair time before I'm able to look at messages. Maestro are also interested in obtaining readers' contributions for viable projects. Let's hear your ideas!!

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Addendum and errata

1. The gremlins appear to have struck my computer — in the third part of the construction article (AEM June 86, p92, Step 6) the third paragraph should have read "now type the letter 't' . . . . ." (Note the lower case 8 this will cause the AT ERROR message to be generated).

2. R14 of the Supermodem is shown on the circuit diagram to connect pin 3 of IC21 to +5 volts. The correct location of this resistor is from pin 3 of IC20 to ground.

3. C34 was shown as 100 nF bypass capacitor. This in fact should be a 10 uF/25 V electrolytic capacitor, with the negative electrode facing the rear of the board. Note that the overlay diagram is also incorrect.

4. Both IC11 and IC12 show pin 11 connected to A0. Each of these pins should be shown connected to A2.

5. C37 has now been replaced by a 125 ma fuse and holder in the latest versions of the Supermodem. The 2 uF/440 V isolation capacitor was becoming very difficult to obtain and Telecom has modified its specifications to permit the use of a fuse, rather than a capacitor.

6. On some early versions of the circuit board, the junction of ZD3 and ZD4 was incorrectly connected to ground. This does not affect the operation of the modem, but does affect the isolation properties of the interface. If your version has the junction of th two zeners connected to ground, simply cut the track.

7. R5 is incorrectly shown on the circuit diagram as 4k7. It should be 470R.

The battery back-up facility has been modified to make use of the latest technology. As an optional extra, the Supermodem can be supplied with a Dallas Semiconductor DS1213 'SmartSocket', which contains in-built lithium cells capable of retaining data for over ten years. You can 'phone Maestro for for the latest prices as this is an optional extra.

REFERENCES:

1. Electronic Design — March 21, 1985 "*FORTH Language Shapes the Structure of a 10-MOPS Chip*" — published by Hayden.
2. figures 1, 2 and 3 are reproduced from Rockwell seminar material through kind permission of the Australian distributors — Energy Control, Goodna, Qld.
3. "*Data Communications and Teleprocessing Systems*", Trevor Housley, Prentice-Hall, 1979, p.89.

World Radio History

Codex: *A wooden tablet; a system of secret writing; a set of signals for sending messages.*

A weather satellite 'finder'

Paul Butler
Head of Science,
Mentone Girls' Grammer School

USERS of Tom Moffat's Satellite Picture Decoder (AEM3503, July 1986) will by now have found that one of the major problems of working with weather satellites is finding the spacecraft in the first place! Lying in wait in the hope of NOAA 9 appearing over the horizon quickly loses its attraction, while the use of a squelch-operated tape recorder assumes the possession of the appropriate electronics (AEM3502, March '86) and a receiver which does not drift in frequency over long periods of time.

The program presented here represents one way of finding satellites. It, and others, have been used over the last few years by girls at Mentone Girls' Grammar School in their study of satellite mechanics, tracking and signal processing. It was written to provide information about any polar-orbiting circular orbit satellite, given basic satellite parameters and a reference orbit. Users will find it valuable for predicting the orbits of NOAA and Meteor weather satellites, as well as the circular orbit amateur satellites, details of which are given later.

The program was written on an Apple IIe with an 80-column card but is readily transportable to other microcomputers. It is self-documented and easy to follow in its operation. Calculations are based on formulare found in any standard text on satellite tracking.

Most of the program is involved with formatting the output to produce useful tables. It is a fairly slow program because it was designed to cover all types of circular orbit satellites. Enterprising programmers could make improvements in the areas of speed of operation, output format and error trapping. Such modifications were not implemented at Mentone Girls' Grammar School because it was important to keep the program simple enough to be understood by school students and also because the program works very well as it stands.

Reference orbit data are included here for several satellites, together with a sample printout for NOAA 9. Potential users should type the program into their own microcomputer, then run it using the NOAA 9 data to confirm correct operation. Changes may then be made to the values for observer latitude and longitude or the program used for other satellites. ▶

```
]LIST

1  REM
2  REM  CIRCULAR ORBIT TRACKER
3  REM
4  REM  BY PAUL BUTLER
5  REM
6  REM  MENTONE GIRLS' GRAMMAR SCHOOL
7  REM
8  REM  MELBOURNE VIC 3194
9  REM
10  REM  CONSTANTS & DEFINITIONS
20  DIM A(130)
30 PI = 3.14159
40 RE = 6371: REM  EARTH'S RADIUS IN KM
50 Q1 =  - 37.8: REM  OBSERVER'S LATITUDE
55 Q1 = Q1 * PI / 180
60 Q2 = 215: REM  OBSERVER'S LONGITUDE
65 Q2 = Q2 * PI / 180
70  DEF  FN AS(X) =  ATN (X /  SQR ( - X * X + 1))
80  DEF  FN AC(X) =  -  ATN (X /  SQR ( - X * X + 1)) + 1.5708
99  REM
100  REM  CHOOSE SATELLITE, GET DATA
101  REM
105  HOME
110  RESTORE : READ N
120  DIM SN$(N),IN(N),P(N)
130  FOR I = 1 TO N
140  READ SN$(I),IN(I),P(I)
150  PRINT I;"    ";SN$(I)
160  NEXT I
170  INPUT "TYPE THE NUMBER OF THE SATELLITE WANTED ";NS
175  IF NS < 1 OR NS > N THEN 170
180 SN$ = SN$(NS):IN = IN(NS):P = P(NS)
199  REM
200  REM  CALCULATIONS FOR THIS SATELLITE
201  REM
210 CC =  COS ((450 - IN) * PI / 180)
219  REM
220  REM  ORBIT RADIUS FROM PERIOD
221  REM
230 RA = ((P / 84.41) ^ .66)
240 AL = RA * RE - RE
250 HS = AL + RE
259  REM
260  REM  LONGITUDINAL INCREMENT
261  REM
270 LW = (360.9856473 + 9.97 / RA ^ 3.5 *  COS (IN * PI / 180)) * P / 14
40
279  REM
280  REM  PRECESSION
281  REM
290  IF IN > 90 THEN PR = 1: GOTO 300
295 PR =  - 1
299  REM
300  REM  DISPLAY SATELLITE DATA
301  REM
310  HOME
320  PRINT SN$
330  PRINT "SATELLITE ALTITUDE (KM)   ";AL
340  PRINT "LONGITUDINAL INCREMENT (DEG.W)   ";LW
350  PRINT "INCLINATION (DEG.)   ";IN
360  PRINT "PERIOD (MIN.)   ";P
399  REM
400  REM  INPUT REFERENCE ORBIT
401  REM
410  PRINT : PRINT
420  INPUT "JULIAN DAY ";DY
430  INPUT "ORBIT NUMBER ";OB
440  INPUT "TIME OF EQX (HR., MIN., SEC.) ";H,M,S
450  INPUT "LONGITUDE OF EQX (DEG.W) ";LX
455  INPUT "PRINT OUT FROM JULIAN DAY ";JD
460 T = H * 3600 + M * 60 + S
499  REM
500  REM  LATITUDE & LONGITUDE TABLE
501  REM
510  FOR I =  INT (P / 2) TO  INT (P) STEP 2
520 LA =  FN AS(CC *  SIN (6.28318 * I / P))
530 A(I -  INT (P / 2)) = LA
540 SL = LA
550  IF SL < 0 THEN SL =  ABS (SL) + PI:FL = 1
570 LO = PR *  FN AC( COS (6.28318 * I / P) /  COS (SL)) + I / 229.2
580  IF FL = 1 THEN LO = LO + PI:FL = 0
590 A(I -  INT (P / 2) + 1) = LO
595  NEXT I
999  REM
1000  REM  START NEW DAY
1001  REM
1010 DF = 0: REM  DAY FLAG 1=NEW DAY
1025  PRINT : PRINT
1030  PRINT SN$;"  DAY ";DY
1099  REM
1100  REM  START NEW ORBIT
1101  REM
1105  IF DY < JD THEN 3000
1109  REM
1110  REM  TIDY UP TIME FOR PRINTOUT
1111  REM
1120 H$ =  STR$ ( INT (H)):M$ =  STR$ ( INT (M)):S$ =  STR$ ( INT (S))
1130  IF  LEN (H$) < 2 THEN H$ = "0" + H$
1140  IF  LEN (M$) < 2 THEN M$ = "0" + M$
1150  IF  LEN (S$) < 2 THEN S$ = "0" + S$
1160 T$ = H$ + M$ + ":" + S$
1199  REM
1200  REM  PRINT EQX DATA
1201  REM
1205  PRINT : PRINT
1210  PRINT "ORBIT ";OB;
```


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A list of useful references is also included. Much of this material is available from retail book shops, while some of it must be obtained from overseas.

Reference orbits (EQX — equator crossings) will be usable for a few months for most satellites, within the accuracy required by amateur satellite watchers. Perhaps AEM will find the space to publish updated reference data each month, so that readers can keep up-to-date on satellite activity.

Note — thanks must go to Mike Kenny, bureau of Meteorology, and Dr Graham Pearman, CSIRO Division of Atmospheric Physics, for their invaluable help and encouragement during the development of the satellite programme at Mentone Girls' Grammar School.

REFERENCES

The AMSAT Newsletter, available from AMSAT Australia, GPO BOX 1234, Adelaide 5001 SA.

The Satellite Experimenter's Handbook, by M. R. Davidoff, published by the American Radio Relay League, 1984.

Satellite Tracking software for the Radio Amateur, by John Branegan, published by AMSAT UK, London E12 5EQ, 1982.

Teacher's Guide for Building and Operating Weather Satellite Ground Stations, by R. J. Summers and T. Gotwald, published by the Educational Programs Branch, Office of Public Affairs, NASA Goddard Space Flight Centre, Greenbelt MD 20771, USA, 1981.

The Weather Satellite Handbook, by R. E. Taggart, published by 73 Publications, Peterborough NH 03458, USA, 1981.

NOTES: Line 1510 is written for eastern Australian Standard Time (UT plus 10 hrs). For eastern summertime, 1510 reads TH = H+11. Users in other states should correct for local time zone. In line 2010, "DEG.W" should simply read "DEG.".

REFERENCE EQX DATA

Julian Day 213 (August 1, 1986)

	NOAA 6	NOAA 9
Orbit	36822	8416
Time of EQX	0116.35 UTC	0102.40 UTC
Long. of EQX	101.38W	153.13W
Frequency	137.50 MHz	137.62 MHz

Julian Day 250 (September 7, 1986)

	RS-5	RS-7
Orbit	20772	20835
Time of EQX	000744 UTC	005508 UTC
Long. of EQX	285.56W	304.14W
Frequency	29.331 MHz	29.341 MHz
	29.452 MHz	29.501 MHz

Julian Day 250 (September 7, 1986)

	UO9	UO11
Orbit	27346	13432
Time of EQX	001029 UTC	004728 UTC
Long. of EQX	94.15W	41.84W
Frequency	145.825 MHz	145.825 MHz
	435.025 MHz	

Note: The Julian Day is the number of the day in the year. e.g: January 1 is JD1. August 1 is JD 213. etc. EQX data is usually given in this form.

The NOAA series are US weather satellites, the RS series are Russian amateur satellites, and the UO series are University of Surrey (UK) amateur satellites.

```
1220  PRINT " EQX ";( INT (LX * 100)) / 100;" DEG.W";
1230  PRINT " AT ";T$;" UTC"
1299  REM
1300  REM  BEGIN PASS
1301  REM
1310  FOR I =  INT (P / 2) TO  INT (P) STEP 2
1320 LA = A(I -  INT (P / 2))
1330 LO = A(I -  INT (P / 2) + 1) + LX / 57.3
1340  IF LO > 6.28318 THEN LO = LO - 6.28318
1349  REM
1350  REM  CALCULATE HALF GREAT CIRCLE ANGLE
1351  REM
1360 DL = LO - Q2
1370  IF DL > PI THEN DL = DL - 6.28319
1410 D =  FN AC( SIN (Q1) *  SIN (LA) +  COS (Q1) *  COS (LA) *  COS (DL
    ))
1419  REM
1420  REM  CALCULATE ELEVATION
1421  REM
1430 E = PI / 2 -  ATN (HS *  SIN (D) / (HS *  COS (D) - RE))
1440  IF E < 0 OR E > PI / 2 THEN  GOTO 2500
1449  REM
1450  REM  CALCULATE AZIMUTH
1451  REM
1460 Z = ( SIN (LA) -  SIN (Q1) *  COS (D)) / ( COS (Q1) *  SIN (D))
1470  IF Z > .9999 THEN Z = .9999
1480  IF Z <  - .9999 THEN Z =  - .9999
1490 AZ =  FN AC(Z)
1495  IF LO > Q2 THEN AZ = 6.28318 - AZ
1499  REM
1500  REM  FIND TIME AEST
1501  REM
1510 TH = H + 10
1520 TM = M + I
1530 TS = S
1540  IF TM >  = 120 THEN TM = TM - 120:TH = TH + 2
1550  IF TM >  = 60 THEN TM = TM - 60:TH = TH + 1
1560  IF TH >  = 24 THEN TH = TH - 24
1599  REM
1600  REM  TIDY UP TIME
1601  REM
1610 TH$ =  STR$ ( INT (TH)):TM$ =  STR$ ( INT (TM)):TS$ =  STR$ ( INT (
    TS))
1620  IF  LEN (TH$) < 2 THEN TH$ = "0" + TH$
1630  IF  LEN (TM$) < 2 THEN TM$ = "0" + TM$
1640  IF  LEN (TS$) < 2 THEN TS$ = "0" + TS$
1650 TT$ = TH$ + TM$ + ":" + TS$
1999  REM
2000  REM  PRINT OUT PASS
2001  REM
2005  PRINT
2010  PRINT "AZIMUTH "; INT (AZ * 57.3);" DEG.W";
2020  PRINT ", ELEVATION "; INT (E * 57.3);" DEG.";
2030  PRINT " AT "TT$;" AEST"
2500  NEXT I
2999  REM
3000  REM  CALCULATE NEXT EQX
3001  REM
3010 T = T + P * 60
3020  IF T > 24 * 3600 THEN T = T - 24 * 3600:DF = 1:DY = DY + 1
3030 H =  INT (T / 3600)
3040 M =  INT ((T - H * 3600) / 60)
3050 S = T - H * 3600 - M * 60
3060 LX = LX + LW
3070  IF LX > 360 THEN LX = LX - 360
3080 O8 = O8 + 1
3090  IF DF = 1 THEN  GOTO 1000
3100  GOTO 1100
5000  REM  SATELLITE DATA
5001  REM
5010  DATA  16: REM  NUMBER OF SATELLITES
5020  DATA "NOAA 6",98.49948,101.1140
5030  DATA "NOAA 7",98.97856,101.9802
5040  DATA "NOAA 8",98.60766,101.1477
5050  DATA "NOAA 9",99.00654,102.0796
5060  DATA "METEOR 7",81.2705,102.2425
5070  DATA "METEOR 8",82.5408,104.1273
5080  DATA "METEOR 9",81.25,101.9896
5090  DATA "METEOR 30",98,96.44531
5100  DATA "METEOR 31",98,97.57900
5110  DATA "UO9",97.6545,94.602772
5120  DATA "UO11",98.1440,98.4907788
5130  DATA "RS4",82.9603,119.3943
5140  DATA "RS5",82.9629,119.5554
5150  DATA "RS6",82.9542,118.7167
5160  DATA "RS7",82.9629,119.1957
5170  DATA "RS8",82.9570,119.647
```

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Versa Tuner II matches almost all

According to GFS Electronic Imports, MFJ's Australian distributor, the latest MFJ-941D Versa Tuner II will match almost any piece of wire presented to it as an antenna over a frequency range of 1.8 to 30 MHz.

Additionally, GFS claim, it offers the versatility of an accurate built-in SWR/power meter which combines two ranges, 0-30 and 0-300 watts.

For those with more than one antenna to worry about a front panel mounted six-position coaxial switch allows easy selection. For folded dipoles and other balanced line fed antennas the MFJ-941D incorporates a 4:1 balun.

Rated up to 300 watts, two wide-spaced 1000 volt rated tuning capacitors are used in the MFJ-941D. GFS claim that with all its in-built facilities, it is suitable for use on a wide variety of antennas including dipoles, inverted-vee's, random wires, verticals mobile whips, beams, plus any others using balanced line or coaxial cable feeds.

Housed in an all metal cabinet the MFJ-941D is just 255 x 76 x 1770 mm in size. At the time of writing its price was $495 plus $18 P&P.

If you would like further information, contact **GFS Electronic Imports, 17 McKeon Road, Mitcham 3132 Vic. (03) 873 3777.**

Amateur packet bird flies

Wednesday, August 13th had amateur radio operators around the world listening anxiously for the first signs of life from the latest amateur radio satellite.

Launched by the controlling body of amateur radio in Japan, the Japanese Amateur Relay League, the JAS-1 satellite was due to blast into space from the Tanegashima Space Centre at 2031 hours UTC (6.31am EAST).

The satellite was carried as payload on the test launch of Japan's H-1 launcher and, as such, did not attract the many millions of dollars fees commanded by other methods of launching. Even so, the satellite itself had to be funded entirely by amateur operators.

With a separation from the launch vehicle over Chile at one hour and ten minutes after launch, the first pass over Sydney should have been at 2248 hours UTC (8.48am).

Amateurs employed by Dick Smith Electronics' head office in Sydney set up a special station using the DSE Amateur Radio Club's callsign VK2DRS to listen out for the telemetry signals from JAS-1 indicating all had gone well.

The JAS-1 satellite includes a beacon which continually transmits Morse Code data on approximately 435.795MHz in the 70cm amateur band. Operators at VK2DRS had some anxious moments as 2248 hours came and went with no sign of signals from space.

Then, some eight minutes later, at 2256 hours, came the sound everyone was waiting for: HI HI, in Morse (laughter!) followed by groups of numbers, as the spacecraft transmitted data back to earth. The laughter from space was echoed on the ground as the amateurs realised all was well.

Within a month or two, JAS-1 will become the first satellite "packet" radio repeater, allowing fully automatic, unmanned communication between amateur stations having the necessary computer equipment.

The equipment used at VK2DRS/P was a Yaesu FT726R all-mode VHF/UHF transceiver with 70 cm and satellite options, and an RF Aerospace SAT7018GR 18 element 70 cm Yagi antenna. Also used was a Yaesu FRG7700 receiver to monitor AMSAT's information service from the US on 20 metres.

Australia in front line of packet radio development

The Sydney Amateur Digital Communications Group has been involved in the task of implementing the CCITT X.3 Terminal Interface Protocol (TIP) into the existing Amateur Packet Radio AX.25 Protocol.

The SADCG is the first group in the world to do this, the Vancouver Amateur Digital Communications Group (VADCG) had implemented the X.3 TIP into the Vancouver Protocol.

The implementation of X.3 TIP into the AX.25 protocol puts Australia in the front line of world wide amateur packet radio development, as up to now, the US and Canadian amateur radio groups have dominated development.

Currently, the AX.25/X.3 version is only available to users of VADCG Terminal Node Controllers (TNCs), but it is expected that TNC manufacturers will adopt the X.3 TIP standard, which will be commonly known as AX.3 TIP, as it features some extra commands that are only found in an amateur radio environment. The CCITT X.3 TIP Recommendation is most commonly used in commercial packet systems.

Further details from the **SADCG, PO Box 231, French's Forest 2086 NSW.**

PL259 plug secures in seconds

Brilliant Australian design does it again, according to Captain Communications who're marketing the new "Teflock" PL259 connectors.

The Teflock is designed to fill the need for a high quality UHF and HF connector for RG58 cable.

Unlike older designs, the Teflock can be secured in seconds, without soldering and without any risk of shorting, it is claimed. The centre conductor can be crimped or soldered, enabling quick, easy fitting away from the workshop. The braid and outer sheath are held to the connector by the shield lock. David Gill of Captain Communications challenges anyone to part connector from cable!

For the novice, or anyone who is not expert at making up cables, the Teflock is the only conector worth looking at, Gill claims. Its high temperature Teflon insulator will not surrender, even when attacked by monster soldering irons!

Being Australian designed and manufactured, the Teflock is not only better, but is actually cheaper than imported conventional PL259 plugs, says Gill. And the Teflock is re-usable.

For further information and pricing, call **David Gill, Captain Communications, 28 Parkes Street, Parramatta NSW. (02) 633 4333.**

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about the significance of HF at the beginning of this article, they should all be dispelled by this point.

HF direction finding can be very important for search and rescue teams in operations at sea, or far from any VHF facility. A new proposal of location combining data from distant ground stations together with a local airborne rescue unit was described with reference to ionospheric effects. Figure 10 shows the devastating effect that tilts can have on the perceived direction of a signal. The team involved with the development of the method are from Andrew Antennas in Australia, and are claiming signal detection at levels well below the ambient noise. The method involves examination of the probability distribution function of signal phase.

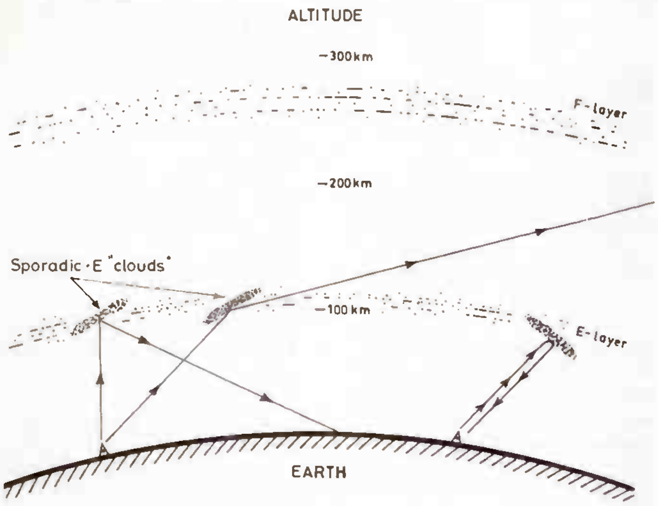

Figure 10. Effects of Es-layer tilts on HF-propagation depending on orientation and position of the layer relative to the transmitter. (A. K. Paul).

Lastly, but certainly not least, are the exciting developments from the Project Jindalee OTH radar team. This system is not only capable of long-range surveillance to the northern half of Australia, but as a necessary adjunct it is capable of providing high resolution information about the ionosphere (in effect, a super-ionosonde), remotely sensing the state of the ocean in the cyclone formation areas around the coast, and acting as an exotic meteor radar able to monitor the influx of very small particles entering the Earth's atmosphere from various directions in space.

The paths by which the Jindalee project may monitor the ionosphere are shown in Figure 11. The system has both a main radar and a mini-radar. The mini-radar is used to provide details of the ionosphere that can be used to best advantage by the main radar. Oblique sounding from Darwin, or vertical incidence sounding (as per a conventional ionosonde) may be monitored at the Alice Springs location.

The ability to sense the state of the ocean lies in the Doppler shift that the radar signal undergoes when reflected from

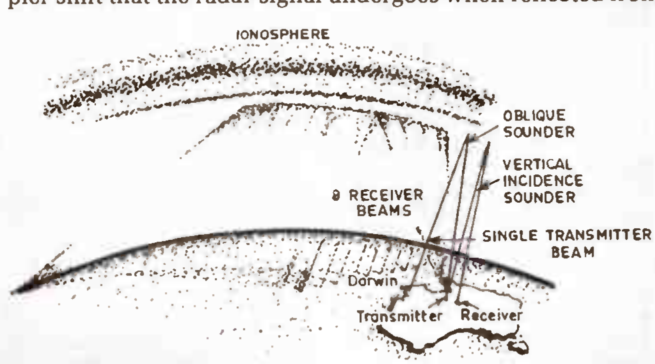

Figure 11. Project Jindalee Geometry (G. E. Earl) showing ionospheric sounding system.

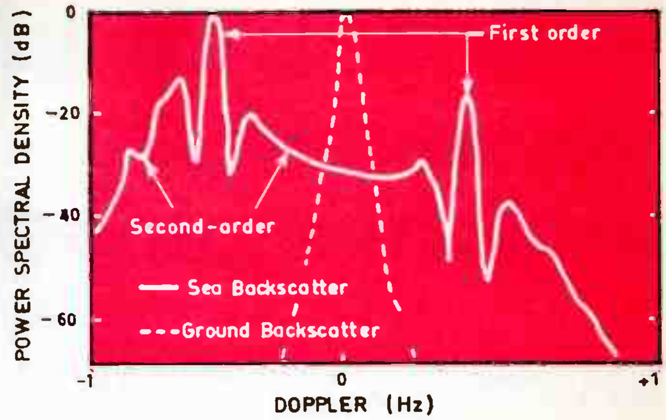

Figure 12. The Doppler spread of a returned or backscattered signal undergoing reflection from the gound and the sea. The ground, with all reflection points at zero velocity with respect to the transmitter, shows very little broadening. However the sea, with reflection from points having a range of velocities shows a complex broadened spectrum. Measurements of this spectrum provide information on surface wind direction and magnitude and wave height. It is important to be able to obtain clean single mode propagation with little ionospheric 'contamination' of the desired signal. (B. D. Ward).

its target (in this case the sea). Figure 12 indicates the sort of Doppler shift that is encountered. For a ground reflection, the returned signal is narrow, showing little Doppler spread. However, a reflection from the sea surface produces a much more complex spectrum. The form and displacement of the spectrum from the originating frequency can reveal the surface wind direction and magnitude, and even the average wave height. The last two measurements however, require a very stable ionosphere, otherwise ionospheric contamination of the Doppler spread renders it impossible to extract the appropriate information. In general, single mode propagation using a uniform, untilted layer is required. A solid sporadic-E layer is ideal for this purpose. Unfortunately these are not always predictably available. Figure 13 shows a surface wind direction map produced by the Jindalee radar. ▶

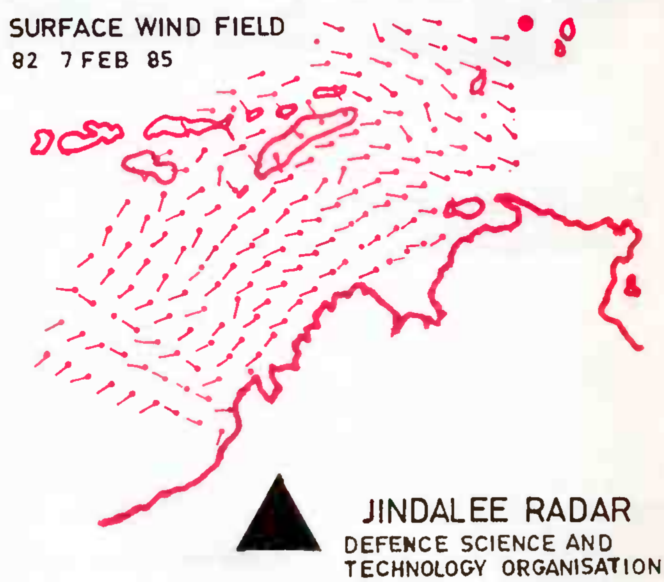

Figure 13. Surface wind direction map for North Western Australia computed from the Jindalee OTH radar backscattered signals. This was the first such map transmitted from the Jindalee project to the Bureau of Meteorology and represents a world first in providing a national weather service with access to HF radar synoptic remote sensing data. (S. J. Anderson).

World Radio History

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Terry Kelly of Kel Aerospace (of Hornsby, NSW) provided the conference with a practical demonstration of a portable dial-up system to access ionosondes world-wide. Data was obtained from Boulder Colorado with equal ease to that from a local ionosonde in Sydney.

The conference was terminated with an appreciation talk from Dr Reddy, Deputy Director of the National physical Laboratory in New Delhi. Dr Reddy, a very entertaining and informative individual kept the organisers and attendees guessing as to his arrival at the start of the conference due to a slightly suspicious delay at Bangkok. He also was renowned for exceeding his allocated speaking time. However, his summary was very apt, referring to the continued need to pursue our knowledge of the ionospheric environment, and the importance of continued government funding around the world to accomplish this aim.

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```
]RUN
1   NOAA 6
2   NOAA 7
3   NOAA 8
4   NOAA 9
5   METEOR 7
6   METEOR 8
7   METEOR 9
8   METEOR 30
9   METEOR 31
10   U09
11   U011
12   RS4
13   RS5
14   RS6
15   RS7
16   RS8
TYPE THE NUMBER OF THE SATELLITE WANTED 4
NOAA 9
SATELLITE ALTITUDE (KM)  851.496571
LONGITUDINAL INCREMENT (DEG.W)  25.5184475
INCLINATION (DEG.)  99.00654
PERIOD (MIN.)  102.0796


JULIAN DAY 213
ORBIT NUMBER 8416
TIME OF EQX (HR., MIN., SEC.)
?REENTER
TIME OF EQX (HR., MIN., SEC.) 01,02,40
LONGITUDE OF EQX (DEG.W) 153.13
PRINT OUT FROM JULIAN DAY 215


NOAA 9  DAY 213

NOAA 9  DAY 214

NOAA 9  DAY 215

ORBIT 8444 EQX 147.64 DEG.W AT 0040:53 UTC

ORBIT 8445 EQX 173.16 DEG.W AT 0222:58 UTC

AZIMUTH 133 DEG.W, ELEVATION 1 DEG. AT 1349:58 AEST

AZIMUTH 118 DEG.W, ELEVATION 5 DEG. AT 1351:58 AEST

AZIMUTH 100 DEG.W, ELEVATION 8 DEG. AT 1353:58 AEST

AZIMUTH 79 DEG.W, ELEVATION 8 DEG. AT 1355:58 AEST

AZIMUTH 61 DEG.W, ELEVATION 5 DEG. AT 1357:58 AEST

AZIMUTH 47 DEG.W, ELEVATION 1 DEG. AT 1359:58 AEST


ORBIT 8446 EQX 198.68 DEG.W AT 0405:03 UTC

AZIMUTH 165 DEG.W, ELEVATION 6 DEG. AT 1530:03 AEST

AZIMUTH 164 DEG.W, ELEVATION 17 DEG. AT 1532:03 AEST

AZIMUTH 162 DEG.W, ELEVATION 37 DEG. AT 1534:03 AEST

AZIMUTH 137 DEG.W, ELEVATION 81 DEG. AT 1536:03 AEST

AZIMUTH 349 DEG.W, ELEVATION 45 DEG. AT 1538:03 AEST

AZIMUTH 347 DEG.W, ELEVATION 21 DEG. AT 1540:03 AEST

AZIMUTH 346 DEG.W, ELEVATION 8 DEG. AT 1542:03 AEST

AZIMUTH 345 DEG.W, ELEVATION 0 DEG. AT 1544:03 AEST
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data process storage ever. So far, no one in CD-ROM manufacture seems to have made money due to the lack of recognised format. The adoption of the CD could help clear this up quickly. A lot of manufacturers are waiting in the wings for this to happen.

The Atlantic group are talking about 400 megabytes of storage capacity (120 000 print pages or about 1000 floppies). The uses visualised boggle the mind and if the ecologists are interested, millions of trees that would have been cut down for the paper war will be spared. These CD/ROMS are permanent records, non-tamperable and court acceptable.

Just as IBM brought a degree of standardisation to the computer industry, it is hoped IBM will announce their format and crystalise the imaging solution; for the moment.

In the Pacific group, TDK has announced tape, floppy discs, rigid discs, and optical discs as their four cornerstones supporting TDK's future as a manufacturer of comprehensive data storage media. TDK's technical MD, Hideki Hotsuki says, "As it was in the past, the products will shrink physically while their data storage capacity balloons tenfold every five years." Referring to new coating technologies he said, "Within ten years, a vacuum deposited system will be introduced for maximum packing density and smoothness — a real improvement over binders . . . we've also come up with a 2" video flopy disc with a one megabyte storage capacity that can be used with either a still camera or a mini floppy disc drive."

Miniaturisation is one thrust in the computer sphere; burgeoning memory capacity is another. TDK's sputtered rigid disc responds the the latter. From its 40 mbyte capacity now, the next five and ten yers will see 60 mbyte and 80 mbyte capacities, respectively.

"But," Mr Hotsuki concluded, "optical discs are the pinnacle of data storage capacity. TDK's future holds deletable magnetic optical discs that store an extraordinary 600 megabytes of data — within a ten year target, ten times greater, or 6000 megabytes!"

With CDs that are ROMs concealing up to 6000 M, just around the corner, dis of DAT, VHS-C or V8, no wonder that the whiztronic exec through to the poor consumer, 'WAIT-NC' (wait-and-see!) is likely to be the best format for the moment.

WE WANT YOUR WORDS!

— and circuit sketches, and ideas, and news, and views, and letters.

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if you have a completed, or part completed article outline — 'phone, write or call us. You might get your words of wisdom in print! And a little cash in your hand.

CONTACT: The Editor, Roger Harrison
Australian Electronics Monthly, PO Box 289, Wahroonga 2076 NSW (02) 487 2700.

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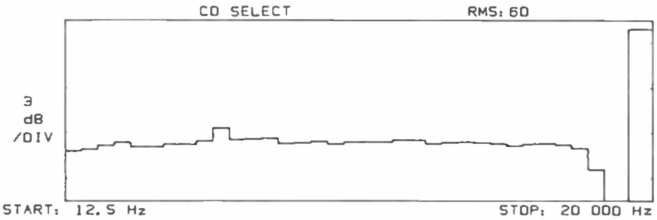


Figure 8. One-third octave pink noise response via 'CD select' input.

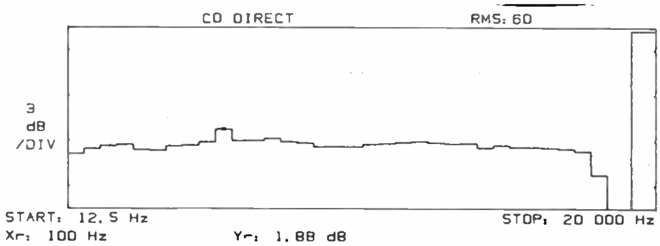


Figure 9. One-third octave pink noise response via 'CD Direct' input.

treble at ± 11 dB, centred of 1500 Hz. Bass boost is a little less smooth than cut, whilst treble control operation cannot be faulted.

The results of tone burst testing are shown in Figure 4 (the amp output) and 5 (the source) and again cannot be faulted. There is some evidence of ringing at about 25 kHz with the 100 Hz square wave tests shown in Figure 6, a result which suggests capacitance in our dummy load. The frequency analysis of the square wave shown in Figure 7 is as expected and, for all interested students, clearly shows square waves to be the summation of odd harmonics.

Harmonic distortion testing proved a little frustrating, since the amplifier clearly exceeded the resolution of our testing. In all instances our tests were limited by test equipment electronic noise, although in one test at 100 watt/10kHz there was evidence of third harmonic distortion at about 86 dB down. In general, however, all we can say is that the THD clearly exceeds minus 80 dB for all power and frequency tests.

As a comparison of amplifier performance with a compact disc signal selected using the CD direct button versus CD selected from the input selector, we ran a frequency response in one-third octave bands for pink noise source from a test disc. The two traces are shown in Figures 8 and 9 and, whilst the differences between the traces are slight only they are there — direct gives about 1.9 dB higher output and relative output across the bands varies by about ± 1 dB. It is likely that more significant differences exist in transient performance.

Figure 10 shows the amplifier performance with and impulse limited to 20 kHz, on a linear frequency scale. Don't be tricked by the sidebands associated with the Fourier transform appearing as low amplitude impulses leading and following the main pulse. They are not really there at all. Although one expects such linear performance from all good quality amplifiers, it is none the less good to see it.

Amplifier input sensitivities were found to be quite normal, while power output was found to be stunning at 260 watt/channel into 8 ohm with both channels driven — well over the manufacturers claims, and well into the region of interest to semi-professional and professional users.

One aspect of amplifier performance that we have not previously bothered to measure is temperature. With the PM-94 measurement of temperature became mandatory. To Marantz credit the instruction books does warn that the amplifier runs hot, although I must say a stronger warning

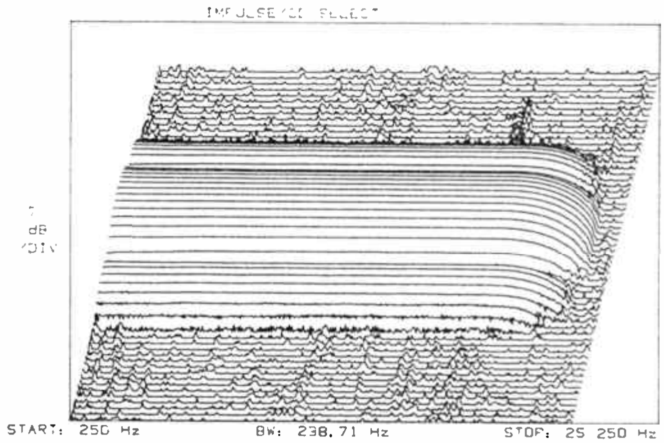


Figure 10. Impulse response of the PM-94. For an explanation, see the text.

would not be out of place. During our tests, with the amplifier on idle, the top panel reached 55 degrees celsius, plenty hot enough to warp records and to interfere with the electronics of other items of equipment — tape decks, CD's etc.

At 50 watt output, the temperature dropped to 44 degrees. This apparent anomaly is no error, but evidence of the switch over between Class A and Class B operation. The amplifier simply runs too hot to enclose in any way, or to locate below other system components, unless ventilated with a fan. Also, whilst it might make friends as a heater in winter, I am sure there will be some silent lounge rooms on tropical summer nights in Sydney.

Professional use?

Overall, the excellent performance of the Marantz is probably more typical of professional equipment that it is of domestic hi-fi, although the use of higher powered amplifiers will, with the pressure from CD's, become more common. The main drawbacks of the amplifier for professional use are the lack of rack mounting, the lack of level or clipping indication, the lack of a cooling fan, and the use of RCA Type input sockets.

The amp is also perhaps too complicated for professional use, since many of the facilities would not be required. For semi-professional users the equipment could be ideal, particularly for disco use where multiple input is required and some equalisation to suit individual spaces.

Summary

I found the amplifier outstanding. One problem with amplifiers is that, for all our objective testing, test results do not really home in on the differences. The Marantz performance is top of the range, but subjectively it is probably the best amplifier we have tested. I found I could hear superb detail, and I could listen to it all day.

It is hard to find anything with the Marantz to cause complaint. On a range of music from classical and chamber music to rock the amp displays delightful transparency. There is ample power for stunning performance with transients on CD recordings, and even at low level I found the use of tone controls to be quite unnecessary, a good measure of non-coloured sound. With FM radio and compact disc sources the PM-94 provides the utmost clarity, it is really up to the speakers to try to keep up.

Further details on the PM-94 and other Marantz products may be obtained from Marantz Aust. Pty Ltd, 19 Chard Rd, Brookvale NSW. (02) 939 1900.

World Radio History

Low-cost LF generator features low distortion

A compact, low-cost RC oscillator offering distortion of less than 0.03 per cent over the 300 Hz to 20 kHz audio range is now available from Philips Test & Measurement.

The PM5110 RC generator provides both sine and square waves from 10 Hz to 100 kHz on a front-panel BNC connector; maximum output is quoted as 6 V peak-to-peak with a choice of 20 dB fixed and 40 dB variable attenuation at 600 ohm impedance. A separate rear-mounted TTL output is also provided. A useful feature for crosync inputs of digital frequency display.

Simple frequency setting is possible on the new instrument by a variable dial and four push-button selectable ranges; setting accuracy is specified better than four per cent.

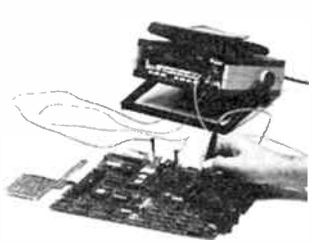
A yellow LED behind the transparent dial indicated power-on and the frequency setting. A choice of fast settling or low distortion output is switch-selectable on the rear panel.

Selection of RC oscillator design for this new low frequency generator is intended to meet the growing need for high purity signals in audio service work, Philips say.

The simplicity of operation and robustness of the instrument also make it very well suitable for educational training applications. The price of the instrument is aimed at the high volume market, we're told.

The PM5110 is part of Philips' comprehensive range of signal sources consisting of RC, function and synthesizer/function generators. The new instrument measures 160 x 65 x 160 mm and runs on both 220 and 110 Vac supplies.

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



No more short circuit frustrations

Emona has announced a pcb fault tracer that instantly detects and locates short circuits, devices loading down V_{cc} and bus and multilayer circuit faults. It's useful for both analogue and digital circuits, the makers claim.

The Toneohm 700 combines the milli-ohmmeter (100 micro-ohm resolution) and current probe capabilities of the existing Toneohm 550 and 580 instruments, with an additional microvoltmeter sensitive enough to measure the voltage drop along a pcb track.

For track short location using the milli-ohm range, probing the shorted tracks with the toneohm 700 produces an audio tone which rises in frequency as the probes are moved nearer the short.

The point of highest frequency output will be within two to three mm of the physical short. Special 'Kelvin needle' probes, and a maximum probe tip voltage of 60 mV, ensure high resolution and no danger to components.

For multilayer and bus faults, the toneohm has a sensitive magnetic field probe, working with an on-board drive source, which can detect current flow inside an IC, or shorted capacitor (tantalum!), or within the layers of a multilayer pcb, the makers claim.

The Toneohm 700 provides rapid and logical techniques of short circuit location which results in lower troubleshooting time, less rework and fewer scrapped boards, says Emona.

Details from **Emona, 1st Floor, 720 George Street, Sydney 2000 NSW. (02) 212 4599.**

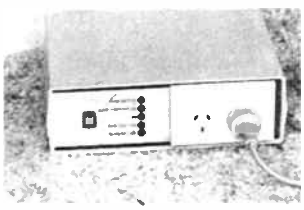
Ultra-lightweight, dc-ac sine wave inverter

Using new technology, the makers claim, has enabled the assembly of a dc-ac inverter of 300 watts weighing 2.5 kg with a case size of 260 x 190 x 80 mm.

The unit has an autostart feature which senses the exact nature of the load, say the makers, Modulite. Other features include full current limiting, input reverse polarity protection, battery under-voltage cutout, reactive power overload cutout, full voltage regulation, full transient suppression and protection.

The Power Converter is short cicuit proof, has thermal overload cutout and twin power points.

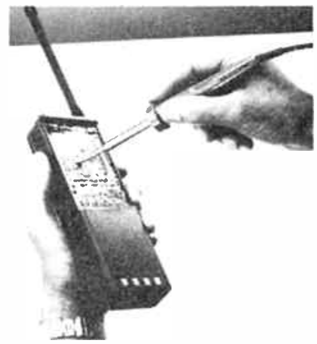
The output wave shape is sinusoidal — less than 5% distortion, and the inverter has efficiency equal to or greater than 82%, Modulite claim.



The Power Converter is available in a plastic case or in a rugged, water-resistant, higher rating metal unit. Both are a similar price to ordinary square wave inverters.

New 800 watt, 1000 watt, 1500 watt and 3000 watt sine wave Power Converters will be available soon, the company says.

For further information, contact: **Modulite Pty Ltd, Factory 6, 42 New Street, Ringwood 3134 Vic. (03) 879 2825.**



New Weller portable

Cooper Tools has released an innovative addition to their line of Weller soldering tools, a portable 12 volt iron rated at 30 watts, known as the SP30.

The Weller SP30 is supplied with non-polar battery clips so there's no concern about positive or negative battery connections. With a long 4.5 metre lead, the SP30 is ideal for use at some distance from the battery power source.

A range of four 4mm wide Weller tips are available for it, in cone, screwdriver, chisel and spade types.

For further information, contact: **Cooper Tools Pty Ltd, PO Box 366, Albury 2640 NSW. (060) 21 5511.**

World Radio History

Laser printers — writing with light

Roger Harrison

Low-cost laser printers put a staggeringly powerful technological tool in the hands of everyone owning or using a personal computer - a tool likely to revolutionise publishing like no other machine since *The Times* was printed on Konig & Bauer's steam-driven printing press in 1914.

EVER SINCE wordprocessing became available on personal computers, and comparably low-cost printers appeared to provide on-the-spot hard copy output, users have wanted to have every aspect of hard copy output under their total control, untrammelled by constraints on the font (i.e: the actual typeface used), the line spacing, page make-up etc, placed on them by the mechanical or electro-mechanical limitations of the printer employed. For all the facilities they provide, and their versatility, common dot-matrix, daisywheel and similar printers do not offer the degree of control over the finished output users really want.

With the advent of programs that provided high resolution graphics make-up and output, the demand for a printer to match (or complement) the software's abilities rose sharply. Enter the low-cost laser printer.

Laser printers had been available since the late 70's, but only in the $20 000 to $100 000-plus price range suited to large corporations and government departments. In 1983 Canon introduced a low-cost laser "printing engine", the LBP-CX, the basic component that paved the way for the explosive development of desktop laser printers, and with it so-called "desktop publishing".

A marriage of technologies

The laser printing engine is a marriage of technologies: Xerography (i.e: photostatting!), optical scanning and microcomputing.

The Xerographic process was invented in 1938 by Chester F. Carlson, a physicist who worked for a patent firm in New York, USA. The word Xerography comes from xeros, meaning dry, and *graphein*, to write. Prior to Carlson's invention, document copying involved photographic processes or methods which involved causing a chemical change through the action of light on specially prepared papers, both 'wet' methods.

Xerography involves inducing an electrostatic charge on a photoconductive surface — on a cylindrical drum — in darkness. This drum is rotated and the surface exposed to light reflected from the original document. Just the white areas on the original document reflect light to the photoconductive surface of the drum, none is reflected by the black (written) portions. The light impinging on the drum virtually 'wipes off' the charge on that portion of the surface on which it falls.

This pattern of charge on the drum is then 'dusted' with a (usually black) powder — the "toner" — which is also charged. The powder thus adheres to those areas where the light did not fall. The toner pattern so formed now represents the image on the original document and is then transferred to the blank copy paper, which is also charged. The toner is 'fixed' to the copy by fusing with heat and pressure.

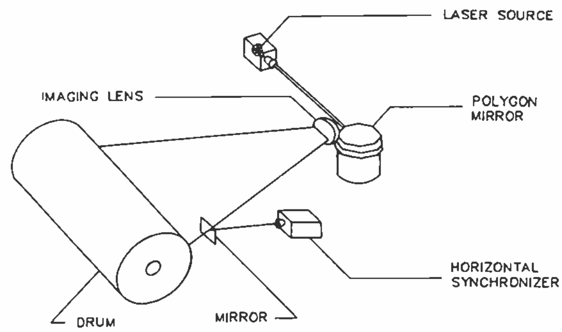


Figure 1. How the laser beam is scanned across the 'xerographic' surface of the drum. (Courtesy Impact Systems).

In the laser printer engine, almost exactly the same arrangement is employed. A drum with a photoconductive surface is first charged. The charge is then selectively wiped off by a narrow light beam from a laser which is scanned rapidly across the surface. The beam is turned off at intervals where toner needs to adhere to form a tiny 'pixel' (picture element) of the desired image, just as the electron beam that is swept across a VDU screen is turned on during a line where portion of a letter or image is required to appear, the image being built up line by line.

A laser is employed because it provides an intense, extremely narrow, well-defined beam of light. The beam is swept across the drum by means of a 'polygon mirror', a many-sided cylindrical mirror. Figure 1 shows the general arrangement. The laser shines on the polygon mirror which spins rapidly. Each plane mirrored surface deflects the beam through an increasing angle as the mirror rotates, effectively scanning the laser beam across the width of the drum. An 'imaging lense' maintains the focus as the beam traverses the drum width.

A small mirror at the commencement of the scan momentarily deflects the beam into a 'horizontal synchroniser' which maintains the system in step. The drum rotates beneath the scan and thus the beam scans the drum's surface area in a series of lines, just like the lines on your TV or VDU screen which are scanned by the picture tube's electron beam. In general, laser printers provide a scan of some 300 lines per inch.

This method of optical scanning is employed in weather satellites where light from the Earth's surface is reflected onto a photosensor, the area 'seen' being scanned by a rotating polygon mirror, which provides the 'horizontal' scan while the satellite's movement provides the 'vertical' scan. Its great virtues are simplicity and reliability.

Figure 2 shows the general schematic arrangement of a laser printer engine along with the paper feed system. The

World Radio History

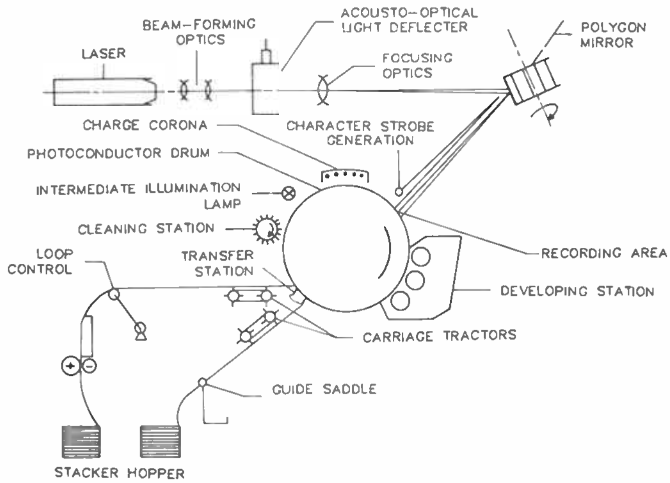


Figure 2. Schematic diagram of the laser electrophotograph process. (Courtesy Impact Systems).

optical system is there to maintain the laser's "spot" on the drum surface as finely focussed as possible, the acousto-optical light deflector swings the beam off-line, effectively turning it off.

A corona unit atop the drum assembly imparts charge to the photoconductive drum surface, the optical system scans the drum, leaving a charge pattern of the desired image. This passes through the developing station which applies toner to the drum. The 'developed' image than passes over the surface of the copy paper at the transfer station where toner is transferred to the copy paper, effecting the transfer of the image. What toner might be left on the drum is removed by the cleaning station and the surface discharged by the intermediate illumination lamp.Copy paper is picked up from the 'hopper' and passes through to the output 'stacker' following transfer of the image.

The developing station/drum assembly is a disposable unit. Once the toner runs out, you remove the disposable cartridge and insert a fresh one. Typically, they last around 3000-4000 A4 pages.

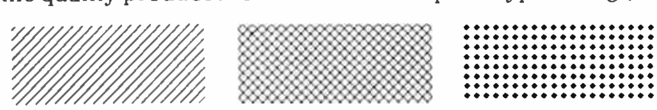
It is the power of microprocessing that really makes the laser printer so attractive. As the image is formed by turning the laser beam on and off, this action is ideal for microprocessor control. Just as a character generator within your microcomputer puts letters and numerals on your VDU screen, so characters can be formed by controlling the laser beam.

Typically, these laser engines can provide a resolution of some 300 dots per inch, which allows quite fine detail and provides enormous flexibility. Characters can be stored in ROM and their 'pattern' called-up at will. Hence, a 'font' (or typeface) can be made up in software and specified for use as required. In addition, 'standard' sets of graphics patterns may be stored in ROM, called up and placed on a page in a specified position. What's more, text and graphics may be mixed.

With plug-in ROM cartridges then, one could obtain many of the advantages offered by a typesetter, with the availability on-line of a wide variety of typefaces and font sizes, special characters, logos etc created for individual use. However, the quality produced is not the same as phototypesetting (as used by AEM). One would need a resolution of at least 1200 lines per inch horizontally and vertically before that situation could be truly approached, according to Andrew Mowatt of Impact Systems, who manufacture laser printers in Australia (and *export* them).

Inside your average laser printer you'll find virtually a complete microcomputer — with maybe even two microprocessors! Typically, they'll have one to two megabytes of RAM — it literally takes 1M of memory to completely fill an A4 page with graphics at 300 lines per inch horizontally and vertically. The 'front end' comprises an interface that may be configured to emulate a wide range of existing printers, allowing the laser printer to be immediately slotted into your existing computer system. Some have the ability to emulate a plotter, making them useful with CAD software.

With all that 'intelligence' on-board, manufacturers generally provide an escape-code command set so that users may vary printing parameters under software control.



@ A B C D E F G H I @ABCDEFGHI

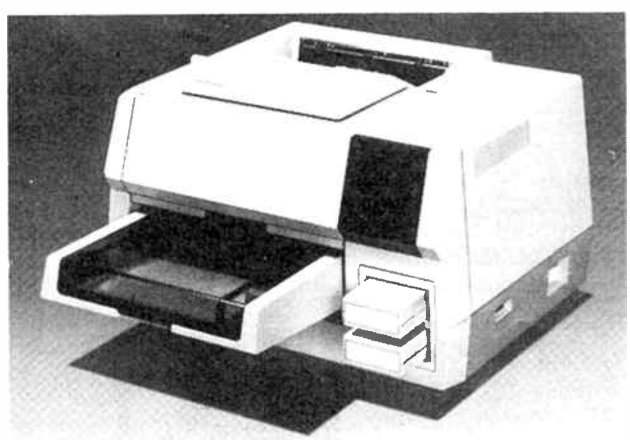
` a b c d e f g h i `abcdefghi

Some typical print examples from a laser printer. Impact 800. (Courtesy Impact Systems).

The possibilities

With sophisticated graphic design programs now becoming widely available at prices readily affordable by small businesses, desktop publishing as a means of quick, effective communications on a manageable scale has ballooned rapidly thanks to the availability of relatively low cost laser printers. The possibilities now afforded by the technology are now very much broader than conventional printer technologies offer. According to Andrew Mowatt of Impact Systems, the laser printer stands somewhere between conventional printers, with their limited hardware and software facilities, and phototypesetters which afford the best quality but have relatively limited facilities (when compared to laser printers) and are high in cost.

For a great many people, that plugs a hole long left to gape unattended.



Mitsui released the Ricoh LP4080M Laser Printer recently, which boasts a life duty cycle of 600 000 pages compared to most other laser printers' life duty cycle of 100 000 pages, Ricoh claim, greatly reducing overall cost of ownership.

The LP4080M comes standard with Diablo 630, HP 7470 Plotter, Epson-MX, IBM Graphics, and HP LaserJet Plus emulations. In addition, 12 fonts and up to 16 special effects per font are also supplied. With both parallel and serial interfaces, the LP4080M is compatible with virtually all computers, say Ricoh.

Mitsui supplies, at no extra charge, customised printer drivers for MulitMate, WordPerfect, Displaywrite 3, MS-Word, as well as providing lots of handy tips in its manual. The Ricoh LP4080M is compatible in both text and graphics with all of the leading spreadsheets such as Lotus 1-2-3, Framework, Symphony etc. Under its plotter emulation, the LP4080M is compatible with CAD/CAM packages such as AutoCad and ProDesign etc.

World Radio History

The Last Laugh

BACK IN the late '70s, we went on an overseas "journo's junket" touring research laboratories in various locations around the world as the guest of a multinational research-funding foundation. After six stops in ten days across south-east Asia and Europe, having toured some 20 establishments (up to three a day) we arrived in New York, USA, rather jaded and suffering brain cell techno-overkill.

So it was in this frame of mind we were all trooped to an establishment over the border in Canada a day later, to see the work of a unique specialist who called himself an archeo-acousticologist. For those unfamiliar with the term, he was looking into sounds entrapped in historic artefacts by perhaps unknown means. Our tour guide (we called him "warden", for we seemed but mobile prisoners) promised us "something different".

This scientist, whom we shall call "Pierre" for the purposes of this story, was exploring an hypothesis that the grooves etched in ancient clay pots as they were 'thrown' on a pottery wheel may have been modulated by sounds occurring in the vicinity at the time, acting as 'natural' gramophone-type recordings. He had an elaborate setup on which to spin any intact ancient clay pots he could obtain, with a special pick-up arm to follow the surface undulations and a versatile high compliance pickup cartridge to track the grooves.

Now, it all sounds a little far-fetched, but in our jaded state the touring party found this exercise so totally at variance with the more-or-less conventional lines of research seen at the techno-whizz establishments visited the past while that we all took keen interest. Our tour guide didn't let us down!

Naturally, we demanded a demonstration. Pierre eagerly obliged. Selecting a large-ish pear-shaped vessel, he carefully positioned it on the contraption, hooked up an amplifier and we stood expectantly around.

What greeted our ears was a sound not unlike what you would expect from a badly worn 78 shellac record played on a turntable suffering from severe rumble! Pierre beamed at our dumbfounded expressions.

"Now gentlemen," he said at length, "replace your disappointment and think of the archeologist who seeks ancient artifacts amid mounds of rubble or beneath centuries of silt! That noise you hear is merely the 'acoustic rubble' through which I have to search to find my acoustic artifacts".

At that stage I was reminded of the joke about the couple who had two children of opposite temperaments. One was a pessimist, the other an optimist. Each Christmas time, they asked each child what he wanted as a gift. One Christmas they each requested a horse. Comes Christmas eve and the couple tethered a horse outside the pessimist's window, then laid a huge pile of horse manure in the optimist's bedroom, almost filling it.

On Christmas morning, they looked in on the pessimist to see him glumly sitting on the edge of his bed, sadly contemplating the magnificent stallion outside. "It's terrible", he said to them. "I'll probably fall off and break my leg and have to miss Christmas dinner."

Looking in on the optimist, they found him furiously digging through the pile of manure. "With so much of this stuff around, there's gotta be a horse in here somewhere!", he said.

See what I mean about Pierre?

Well, I largely forgot about Pierre and his laboratory after the tour, except for some dinner party fun, in the ensuing years. Recently, however, I was in Canada on business and happened to be in the same area as Pierre's lab. I enquired of my business host about Pierre, who excitedly told me the man had met with some success.

An appointment was made.

Pierre had made numerous recordings with his contraption employing the latest in digital equipment and had then subjected these to some very sophisticated digital signal processing to 'bring out' any naturally recorded sounds.

"I have had good success with this vessel", he said, holding aloft a soccerball-sized vessel with a flat bottom and open-lipped orifice on top. "Listen," he said excitedly, pressing the play button on his digital playback gear.

What I heard was, at first, puzzling. It sounded like — "spppttt ..... dingk!" Then it dawned on me: it was a spittoon!

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