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Monthly



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— communications and the First Fleet Re-enactment

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AS YOU'VE NO DOUBT GATHERED from last month's announcement on this page, we've moved premises. This was engendered by the need to find adequate space and a more convenient and efficient working environment. Travelling to Wahroonga from Balmain (literally half-way across Sydney), and travelling anywhere in Sydney from Wahroonga (except, perhaps, to North Ryde industrial estate and maybe Gosford) became increasingly inconvenient, although it was a convenient arrangement when we started the magazine back in 1985 as we shared premises and facilities with the 'trade' publishers, Westwick-Farrow.

The harbourside suburb of Balmain has been 'home' for us since 1971, which was when the stirrings of a "renaissance" of inner-city suburbs began in Australia. We first lived on the northern side, in Birchgrove, then in the mid-70s we purchased a modest terrace in the heart of the suburb and became part of the renaissance of Balmain. I use the term renaissance, really, with a capital R, referring to that period in European history when there was a tremendous rebirth and re-enervation in art, literature, architecture, engineering and science; for that's just what has happened here. Balmain is a vigorous, intellectually stimulating place and we're tremendously excited about being based here.

As our new premises boasts a balcony with a commanding view of the harbour and the bridge, we had a 'box seat' view of the Australia Day celebrations. With such close access now to venues in the city and surrounds, and a little more time, we can once again enjoy a little real hi-fi. viz: live music!

With improved facilities and room for expansion, we look forward to 1988 with great enthusiasm. We have a few exciting plans to implement and some refreshing new ideas to explore.

This month we kick off with a new project design team who will be designing projects for the magazine on a contract basis. While the firm is known as 'BSR', the guys who'll be doing the work are Jonathan Scott and Colin de Kantzow. Jonathan will be known to many of our readers, he was one of the designers who produced our very popular "Hash Harrier" mains filter project. Both Jonathan and Colin are practising hobbyists as well as being qualified engineers! A rare combination indeed. We have some exciting project plans in-hand and you'll shortly see the fruits of their labours.

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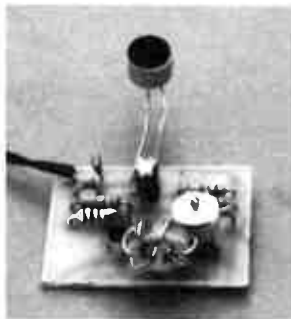
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PROJECTS TO BUILD



AEM1502 The "Minder" FM Wireless Mic. 56

Here's a simple, low-cost one-transistor radio mic. that is easy to get going and works very well. Dozens of uses! Lots of fun! Use it to 'mind the baby', keep an 'ear' on the action in the pool, etc.

AEM4000 Build A Super Computer! 28

Part 3 - powering up for the first time and getting it going; troubleshooting hints included, plus full circuit description.

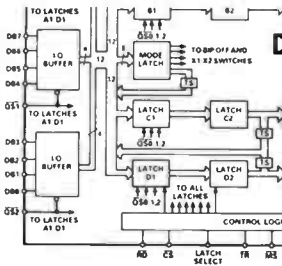
AEM3106 Build the "Flat Dwellers" Dipole 94

Here's an antenna that's easy to build and erect for the enthusiast keen on receiving signals on the shortwave bands but confined to a flat, unit or apartment.

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Add-on extends the frequency range.

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We review a stack of smart modems currently on the market. If you're on the lookout for Hayes compatible modem, check out this lot.

Build A Super Computer! 28

Experience the leading edge of electronics and computing technology with this fantastic project!

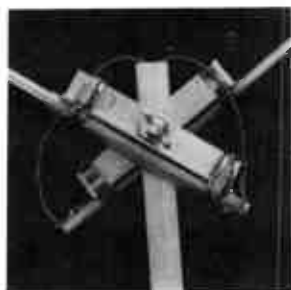
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Get yourself a kit for this phenomenal project!

SPECIAL OFFER A Real Time Clock Add-in for IBM PCs and Compts - \$49.95! 97

Here's a versatile, low-cost add-in that takes minutes to install. Data and description was published in the Feb. issue.

COMMUNICATIONS SCENE



The "Flat Dwellers" Dipole Antenna 94

If you're keen on listening to signals on the shortwave bands, but are confined to a flat, unit or apartment, here's a simple to build and erect dipole that really gets results.

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Sony bows to market pressure and will add VHS VCRs to its line of Beta video equipment.

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NEXT MONTH!

"ULTRA-GRAPHICS" ADAPTOR FOR THE VZ200/300

Sick of graphics and text restrictions on your VZ200/300? This Project is for you! Offering 256 new characters, including upper and lower case, Greek, DATA70, mathematical and other symbols, as well as graphics up to six times the normal resolution, this Ultra-Graphics Adaptor is a must for the serious VZ200/300 owner.



HANDHELD MULTIMETERS 1988 SURVEY

If you're looking to buy a handheld multimeter — here's your MM supermarket! Our feature gives a rundown on what's available, who sells it and how to evaluate your needs in a handheld multimeter. Don't miss it!

ASSEMBLING YOUR WEATHER SATELLITE GROUND STATION

Held over from last month owing to lack of space. Here's advice on how to get your VHF satellite ground station together, from the antenna on down.

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

FEATURE

Radio on the Bounty! 8

Communications and the 1st Fleet Re-enactment. Mike Davidson tells how radio and modern electronics technology played a part in this historic event.



New OTC satellite link opens in Sydney

A new satellite earth station was opened by OTC late in November last, to carry telephone, television, text and data traffic between Australia and New Zealand, Papua New Guinea, Asia, Japan and North America.

Developments in communications technology has permitted performance increases in both satellites and Earth stations such that the Earth station can now be located close to business and population centres, reducing the costs of land-line links.

Forty percent of the complex's \$26 million dollars worth of building and equipment was supplied by Australian industry – worth some \$11 million for 26 Australian companies.

Located at Oxford Falls, some 17 km north of Sydney's central business district, the complex currently operates three dishes – an 18 metre "Standard A" working to one Intelsat satellite, and 8 m dish for testing and a 7 m dish for digital business service demonstrations. The 18 m dish and the transmission power monitoring equipment were designed and built in Australia.

OTC's 32 m antenna, previously located at the Moree satellite centre in central NSW, is presently being erected at the new site. This will provide service to a second Intelsat satellite. When installation is completed, the new station will carry almost one-third of Australia's total international communications traffic.

Aging OSCAR still a hit

With the return of the aging amateur satellite OSCAR 10 to service on November 16 last, interest in satellite operation has been rejuvenated. Mode B being the only mode available (435 MHz uplink, 145 MHz downlink).

As the satellite is in a highly elliptical orbit, coverage from the southern hemisphere to the northern hemisphere is possible with only modest equipment.

Operators have been reported working into the UK, Germany, Italy, Japan, Scandinavia and New Zealand.

Unisys B25 workstations from Wordplex

Wordplex has joined forces with Unisys to distribute the Unisys B25 workstation family, manufactured under licence from Convergent Technology.

Wordplex handle the Norsk Data range of computer equipment and a gateway will be provided from the Norsk data range to the B25 family.

Wordplex managing director, Mr Maurice Hayes, said the agreement placed Wordplex in the box seat to take advantage of moves in the Australian market towards larger computer systems. All service support for the B25 family would be brought onshore to Australia.

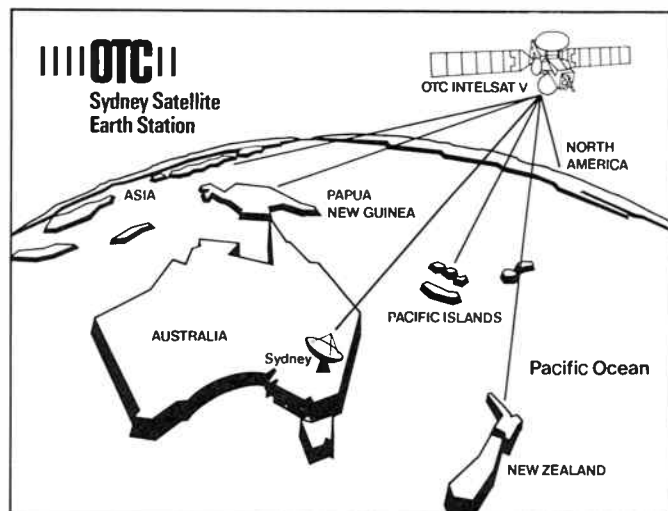
Training committee for S.A.

A new South Australian Industry Training Committee (ITC) in the electronic and electrical industries was set up in January by the Federal Minister for Employment, Education and Training, Mr John Dawkins.

The Commonwealth Government will provide \$55 000 for the ITC's first year of operation with a further \$10 000 coming from industry.

The new committee will promote and develop structured training at all industry levels and provide training advice to governments, the Minister's media release stated.

The ITC will merge with the existing Training Advisory/Curriculum Committee, established under State legislation, to avoid duplication in providing government policy advice. The committee is made up of representatives from industry, State and Federal governments, and the unions.



Laser pioneer granted patent after 30 years

American inventor, Gordon Gould, won a 30 year battle late last year to receive a patent for the gas-discharge laser that he first described in 1957.

He was granted US Patent 4 704 583 early in November, the third in a series issued to him following protracted legal wrangling.

Gould thought of the idea and spent two days describing it in a notebook which was officially recorded in November 1957. It was Gould who coined the term, laser. He applied for a patent in 1959.

Townes and Schawlow, then

of Bell labs, published an article on laser theory at that time and later applied for patents on an "optical maser". Both later won Nobel Prizes in Physics for their work.

Schawlow and others at Bell Labs tried to make a laser, but it was Theodore Maiman working by himself at Hughes research labs who succeeded. Because Townes and Schawlow were first with a published account of the laser principle, they are often credited with "inventing" it.

Gould is now vice chairman and chief scientist of Patlex Corp., of California, who secured the rights on his patents. Patlex demands about 5% royalties on lasers covered by the patents, which accounts for most of the laser industry's sales. Patience pays.

NOTES & ERRATA

Filter design – Parts 1, 2 & 3. Jack Middlehurst has noted the following errata in the first three parts of his article

Part 1 – Figure 1.3, line 130 should read:

```
IF N=1 THEN PHASE=-ATN(R/XC)*180/PI ELSE
PHASE=ATN(XC/R)*180/PI
```

In Figure 1.4, the sign of the phase of the LP filter should be negative, and that of the HP filter should be positive.

Part 2 – Figure 2.4, line 370 – replace (-S) with ABS(S).

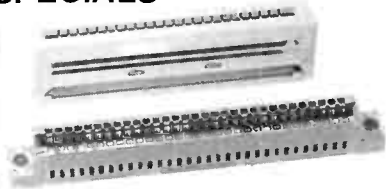
In the caption for Figure 2.9, the second line should read: "cutoff 10 kHz, having an attenuation of 30 dB at 15 kHz, and . . ."

Part 3 – Figure 3.13, line 440 – replace (-S) with ABS(S).

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

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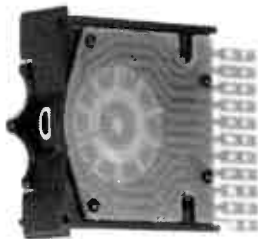


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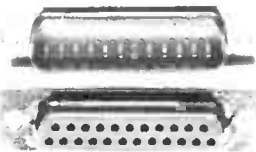
These are genuine C&K high quality Available in decimal or BCD format. PCB edge connector or solder leads on directly Both types are \$6.85 each. End plates are \$3.80 a pair and screws are \$1.40 a pair They come in sizes depending on number of wafers 1- 3 or 3 to 7 Please specify when ordering.

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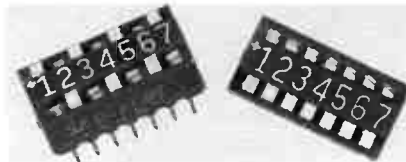
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Ideal for programming and test linking on circuit boards, these links have a standard 0.1" spacing. Contact is partially exposed for touching a probe on. Packet of ten \$2.95.



23 PIN 'D' CONNECTORS

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



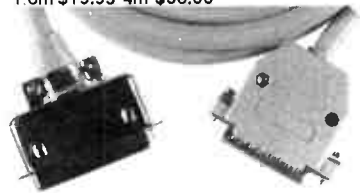
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 1.8m \$19.95 4m \$36.00



NATIONAL 32000 DESIGNER'S KIT

Geoff has had to order two consignments of these kits in since we advertised them. They are only suitable for advanced computer hobbyists and professionals.

Two versions - one with 32016, the other with a 32032. Both have a 32082 Memory Management Unit, a 32201 Timing Control Unit, a 32081 Floating Point Unit, 1 32202 Interrupt Control Unit and two "Tiny Development Systems" (TDS) PROMs. That's seven chips altogether.

There's a massive pack of literature including a databook 40mm thick, a 20mm thick instruction set reference manual, a TDS user guide, a programming reference guide, application notes on UNIX, 32 bit architecture and even a PASCAL listing to aid development of 32000 code using a PC. To top it all off there's an article reprint from the US on a UNIX co-processor for under \$US400!!

These are definitely not for beginners but what a great buy - 32016 kit is just \$132. The 32032 costs \$180. (P&P \$6.00 local or \$15.00 airmail - it's a big pack!)

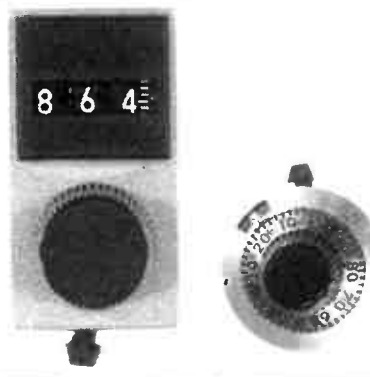
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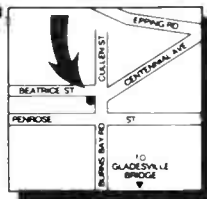


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Communications and the First Fleet Re-enactment

Mike Davidson

An important and, until now, unsung contribution to the triumph that was the First Fleet Re-enactment was the role played by the communications and electronics equipment on board the vessels. Our correspondent, who sailed on the *Bounty*, tells the story.

WHEN THE First Fleet Re-enactment sailed through Sydney heads on the morning of January 26, 1988, it marked the end of an extraordinary operation in logistics and support systems as well as its more obvious achievements. Paradoxically, however, these very support systems prevented the fleet from sailing as a fleet, as it did in Captain Arthur Phillip's original version.

Let me explain. The First Fleet Re-enactment was first and foremost a profit-making venture. Historian Jonathan King as long as 10 years ago dreamed up the idea of a fleet of authentic replicas – 11 of them – that would retrace Capt. Arthur Phillip's path to Australia. When it became clear that a project of that scale was too ambitious, he scaled it down to the point where the flagship, *Sirius*, was to be built. Plans were quite advanced for *Sirius* when King and travel entrepreneur Ken Rosebery, then of Australian Himalayan Expeditions, discovered the *Bounty* was for sale. She had been built in New Zealand for the latest re-make of the classic *Mutiny on the Bounty*, this time starring Mel Gibson, and director David Lean had specified he wanted an exact sailing replica rather than a sophisticated film prop.

When a consortium involving King and Rosebery bought the *Bounty* in lieu of building a *Sirius*, the focal point for the re-enactment fleet was laid. As a full working model, *Bounty* not only had diesel engines and generators, she had sophisticated communications and navigation systems as well. It was a triumph of the camouflager's art that throughout *Bounty's* life as a film prop she sported a 48" radar scanner in her rig, but even when you knew where it was you couldn't see it.

With *Bounty* in the stable and undergoing a refit for her new role, the First Fleet Re-enactment company began chartering other suitable vessels. The criteria for suitability was that they had to be square-rigged on at least one mast (square rig means that the sails are held aloft on horizontal beams called yards, as opposed to more modern yacht rigging which has them fore and aft on vertical beams, masts). They also had to have all appropriate survey conditions to take passengers to sea. This includes HF SSB and VHF radio systems, but not necessarily radar or satellite navigation.

Having secured the fleet, the company appointed a fleet communications officer, David Iggulden, who was also second mate on the flagship *Soren Larsen*. He has a wireless telegraphy ticket and well as telephony and set up the skeds the fleet would adhere to throughout the 24 000-mile voyage from Portsmouth to Sydney.

Seven ships left Portsmouth after a farewell by the Queen last May. They were: *Bounty*, *Soren Larsen* from Britain, *Amorina* from Sweden, *Anna Kristina* from Norway, *Our Svanen* from Canada, *Tradewind* from Holland and *R. Tucker Thompson* from New Zealand. The Australian ship *One & All*



Spot the radar scanner! (It's the rectangular black box above that platform up the mast in the foreground).

joined in Cape Town and the *Eye of the Wind*, another British ship that had been working in the Pacific, joined in Fremantle.

From the onset, the fleet maintained four single-sideband (SSB) "skeds" (regularly scheduled communications) a day at 0815, 1215, 1615 and 2015. Beforehand, the flagship made a general announcement over the international distress frequency on 2182 kHz that all ships should transfer to the fleet frequency, which, initially, was 2301. Then each ship reported her position in latitude and longitude, derived for the most part from satellite navigation readouts, then if there were any problems.

The fleet that wasn't

I will go into the skeds in more detail later, but for the moment want to come back to my original contention that the

*(The author, a Sydney journalist, was radio officer aboard HMAV *Bounty* from Rio de Janeiro to Fremantle).*

radio prevented the fleet from sailing as a fleet. To understand this we need more background.

The First Fleet under Captain Phillip comprised 11 ships and until they split into two groups in the southern Indian ocean, sailed within sight of each other. Position finding was still in its infancy 200 years ago, and while each fleet captain could work out his latitude by shooting the angle of the Sun when it reached its zenith around local noon, longitude (or position east and west) relied totally on accurate time and the chronometer was still being developed. (It's interesting to note that Christopher Columbus navigated almost exclusively on dead reckoning, turning a sand-glass upside down every single half hour of his month's-long voyages).

Not all First Fleet vessels had chronometers and not all captains knew how to reckon their longitude, so the flagship chalked the information on a blackboard and captains therefore had to sail up the flagship's stern to find out precisely where they were. If they lost sight of each other, therefore, they could well be lost forever!, so this need and the naval discipline that could enforce it, bound the First Fleet together as though with bonds of rope.

The Re-enactment fleet, however, was a disparate group of vessels owned by individuals and making the voyage for fun and profit. Also they varied considerably in their rigs and speed. Bounty, being a faithful replica of the state of play 200 years ago, could not sail at all unless the wind were behind the beam and in perfect conditions she could manage seven knots. R. Tucker Thompson, though only 18 metres on deck, had a modern hull shape, steel rigging and synthetic sails, and could sail much closer to the wind and get her seven knots with ease. Each vessel had her own strengths and weaknesses and the individuality of each captain and how he reckoned the weather should be used or how much sail to carry in what conditions.

The consequence of all this was simply that the re-enactment fleet left port as a fleet and arrived in port as a fleet but in the meantime sailed as separate vessels in radio contact.

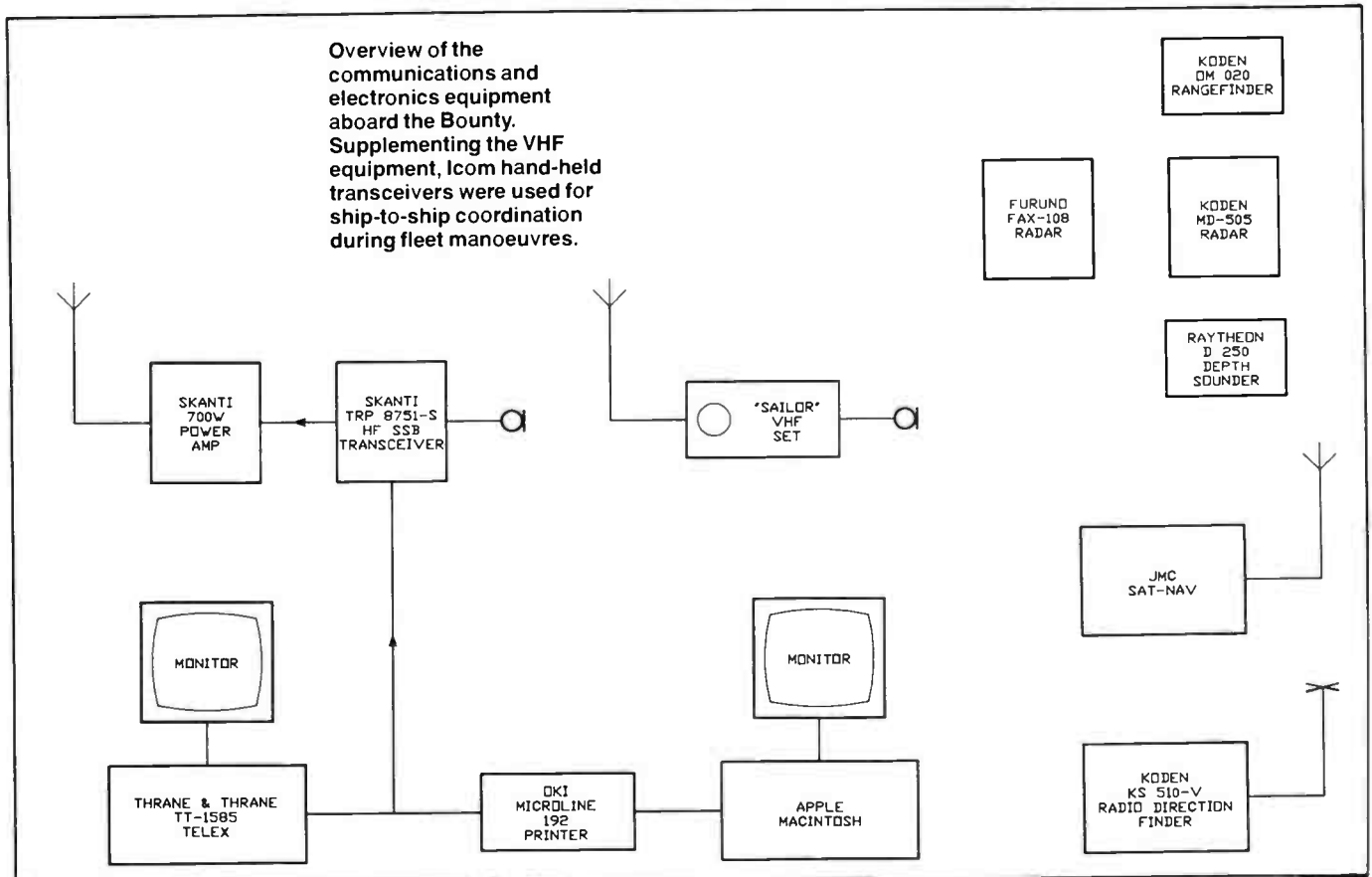


Bounty's Captain Adrian Small with Icom marine VHF hand-held transceiver.

Had modern radio communications been less sophisticated (requiring, for example, the use of morse code) there would not have been enough people around who knew it to allow them to go there own way, and those trainee crew who paid big money to sail in sight of other ships would have been happier.

Bounty

When I joined Bounty in Rio de Janeiro she had no radio officer as such, but she carried Jonathan King, and he had staggering media commitments to Australia. Among their other coups, the owners of the Bounty had secured a lucra- ▶





At sea, with the weather clew and mainsail raised to get better airflow over the foresail. The ceramic aerial insulators for the HF SSB transceiver can be seen at the base of the mast in the foreground.

tive sponsorship deal with Australia Post which involved sending a daily captain's log back to Australia. This message was then faxed to several thousand post offices throughout the country. Australia Post, to ensure the messages got through, re-equipped Bounty with a 700-watt Skanti HF SSB transceiver and a Thrane & Thrane telex. The latter had a simple keyboard and monitor and its memory included an automatic list of stations. One simply key-stroked the message in, edited it on the monitor, switched the Skanti into telex mode and started hunting around for a receiving station.

Right up to deep in the southern Atlantic ocean we used Portishead Radio in the UK. This was automatic. Once contact was made (the receiver gives off a Morse signal when the station is free) a computer-to-computer dialogue would establish who was talking to whom and the operator would simply punch the key indicating "send message" when given that code by the receiving station. At the end of the message the operator signified as such by punching in KKKK. On that signal the receiver would repeat the answerback and list the time.

From approaching South Africa to past Mauritius, however, we could not use automatic telex because of a (still) untraced fault in Bounty's internal wiring which blew the circuit breakers on the generators every time we transmitted above 8 MHz, and all telexes were sent manually to stations

* (The Q code is a three-letter code sequence, each beginning with the letter Q – QRN means "there is noise on your signal", or, "is there noise on my signal?"; QSY means "please change frequency to –", or, "I will change frequency to –"; etc).

in Cape Town and Durban. The only problem with this was that the operators were as interested in the First Fleet Re-enactment as the general public and we had to have long and complex conversations with them every time we called up! By Cape Town, Bounty had realised its telex was in great demand by other fleet vessels as well, and our SSB had better range than that of the flagship, so a full-time operator was needed. Working with shore operators who were more fully versed in the "Q code" (*) than I occupied many an otherwise dull morning.

The role of the radio

From Cape Town, then, the fleet had a part-time communications officer aboard the flagship (David was also second mate, and had to stand a watch) and a full-time one on Bounty, me. It was a full-time job! My day's work looked a bit like this:

0815. Ist sked (normally around 30-35 minutes). Record positions, weather experienced, any other information.

0845. Transmit to Cape Town or Durban Bounty's weather log. This was a service we decided to do when I was appointed. A deck officer had to note the cloud cover, sea state, temperature, barometer, water temperature and the information was encoded into a set formula of five figure groups. Our information would then be used to help draw the weather maps we, among many others, would later receive via our weatherfax.

0915. Key-in the previous day's Captain's Log, ready for telex when conditions were right.

0945. Set up weatherfax for the first of the day's charts. This varied on transmission, naturally, but we used Pretoria exclusively for a month.

1000-1200. Monitor 2182 and VHF channels 16 and 8. If we were in range of any ship on VHF we kept up a running contact. From Cape Town, Bounty sailed virtually in sight of the Swedish ship Amorina and the two skippers discussed tactics over VHF two or three times a day.

1215 Noon sked. After taking positions I would then plot them out on the working chart, compare day's runs etc.

1245. Transmit second weather bulletin. In theory we monitored the weather every six hours; in practice I sent between



Isle Amsterdam in the southern Indian Ocean is seen astern of Bounty, past the JMC satellite navigation antenna.



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One example is the ICOM ICM700 AUS (pictured).

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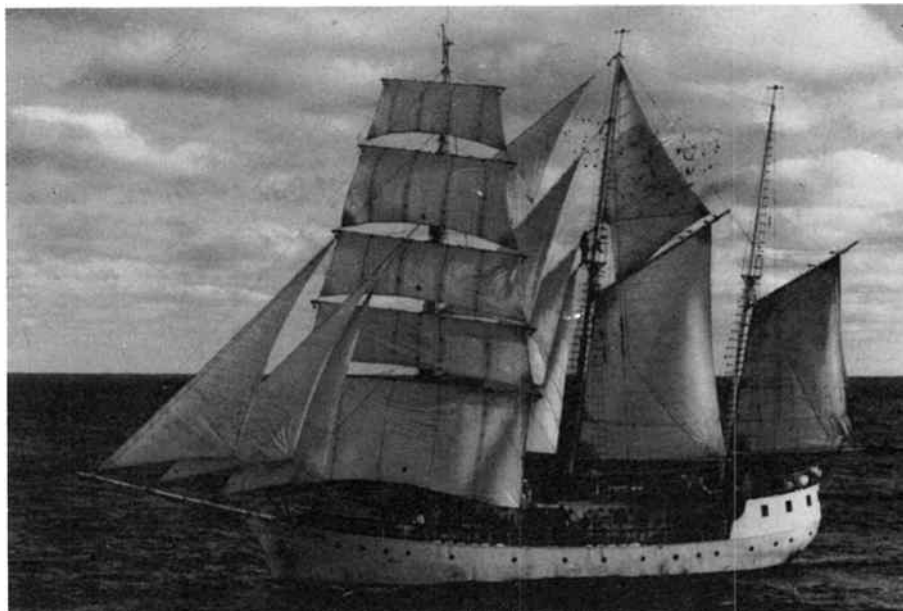
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Swedish barquentine, Amorina. They signed "Radio Amorina" on VHF.

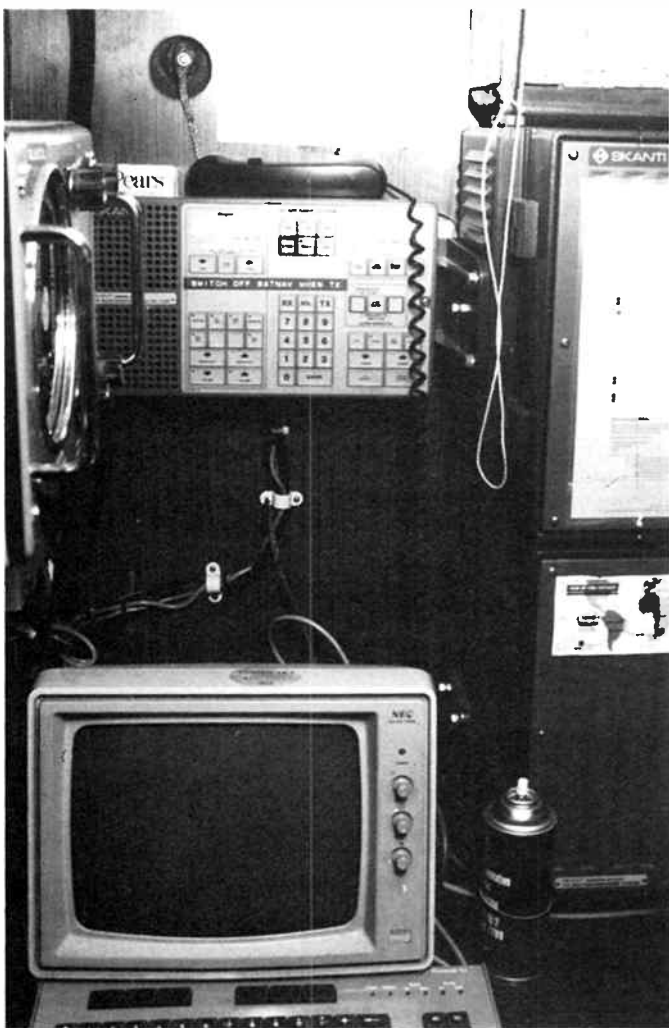


two and three bulletins off a day.

1300-1600. Monitor, organise phone calls from crew to shore.

1615. Afternoon sked.

1700. Radio Piranha or Radio Amorina. This happened every few days while the two ships sailed in company, and was a light entertainment program we put together for the benefit of both crews. Typically it would run for 20 minutes and



include world news bulletins (monitored off BBC World Service), Fleet News – an irreverent look at ship-board life, music and straight comedy. The radio programs were always transmitted on Channel 8, and though probably illegal use of the equipment, one can't really imagine anyone doing anything about it.

1800-2000. Sending telex. Restricted to the use of lower frequencies I found (no doubt like radio operators since the medium was first exploited) that dusk was the best time to get through. Later in the voyage I would have to get up at 0300.

2015. Final sked.

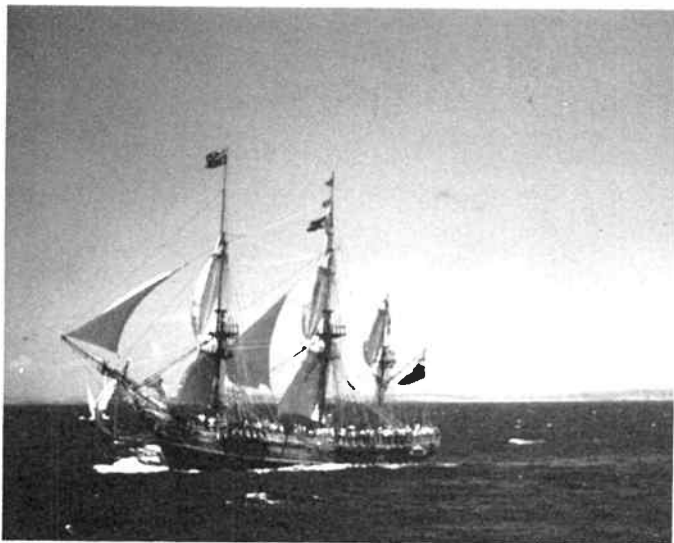
Although that was a fairly solid 12-hour day, there would often be times when phone calls to, say, England would have to go through because of local time there. That kept me up to midnight and later, and I was on call 24 hours a day for tricky sail manoeuvres on deck. After Mauritius, however, the telexing time came down when I could work Perth's automatic facility, and I gave up solidly monitoring VHF when we fixed an extension speaker that allowed the officer of the watch to keep an ear on it.

On the leg from Mauritius to Cape Town, we changed the skeds to every six hours – 0815, 1415, 2015 and 0215, and as the fleet split into two sectors, brought 4 MHz frequencies into play at times. Although both Soren Larsen and Bounty were in the same sector I found myself having to relay much more. The fleet surgeon was aboard Soren and there were a number of small injuries aboard ships in the other sector that needed advice from her. Iggulden and I never really figured out why Bounty had better range. Soren, too, had a Skanti but an earlier model, and our aerial systems were similar. Iggulden arranged with SeaSafety in Canberra that the fleet would not have to report under the AUSREP requirements as individual vessels; he would transmit daily the fleet's positions.

When the fleet came close to arriving at a port, the Commodore, Mike Kichenside, would arrange for a rendezvous outside the actual port of entry, to allow the stragglers to catch up. Thus our entry to South Africa was at Saldanha Bay, 60 miles north of Cape Town; to Mauritius, at Black River, 30 miles south of Port Louis, and at Rottneest Island, east of Fremantle. From then on communications were exclusively by VHF with the ships' sets supplemented by hand-helds.

Each time we entered or left a port it was strictly as a disciplined fleet in a pre-arranged order. My job then would be to

The Skanti high frequency (HF) SSB transceiver and the Thane & Thane telex – supplied by AWA, courtesy of Australia Post.



The Bounty, just prior to arriving in Sydney Harbour.

use the hand-held on deck and relay to our captain the Commodore's orders, or inform the Commodore of our intentions.

The hand-held had other uses as well. On the way into Fremantle the passage past Rottnest was cluttered with fishing boats, so a deck officer worked in the bows and conned the ship from there – his instructions coming out loud and clear over a speaker next to the helm.

The closer we got to Australia, the more communications played a pivotal role. Media people were forever trying to contact us through Perth radio; two journalists aboard Bounty were sending long daily reports; the RAAF and Qantas were in contact – the former to locate us so they could send SAR craft loaded with media photographers and the latter so we could provide some amusement for their inflight entertainment on the Perth-Harare run.

There was also a curious incident when trainees aboard Amorina revolted against an edict by the company that we had to be in port by a certain date. Under the guise of making private phone calls, a spokesman for the trainees rang radio station 2GB in Sydney asking that a message complaining about their treatment be sent to all major media groups in the country. Amorina told us they had done this via Radio Amorina, but when the journalists aboard subsequently tried to report it, the Captain vetoed the transmissions until they had been cleared with the Commodore. I, therefore, had to read the entire draft of a long newspaper piece to the Soren Larsen, where it was transcribed. The Commodore duly replied he thought the story was factually inaccurate and after several hours of prolonged radio work, it was subsequently transmitted.

The question it raised, however, was of the power of censorship a ship's captain has of messages leaving his ship. My Captain had instructed me that nothing should be transmitted without his OK, and people wanting to make telephone calls first had to gain permission from him. Presumably had those making the calls asked me to call a radio station rather than, say, a relative, I would have been in the classic dilemma: when is a telephone call private?

The First Fleet Company were very sensitive to adverse publicity and the commodore had put a blanket ban over all employees (by the contract, any paid crew on any ship was an employee) contacting the media without permission.

Navigation systems

The eight ships of the fleet all had radar, though of all the tools currently available to vessels it was employed least. Sailing vessels travel slowly by normal shipping standards and all vessels posted manual lookouts constantly at sea. We used our Furuno set with its 48-mile range mostly to look for squalls.

Most of the ships had satellite navigation and used it as a matter of course, though without exception the traditional methods of navigating, sextant and tables, was also used. Some vessels including Bounty had RDF, but ours was deemed to be so little use no-one had ever figured out how to calibrate it! Neither did Bounty have an electronic log or windspeed and direction instruments in use. They had broken down sometime earlier and were never repaired. When the captain wanted to gauge our speed, we threw overboard an old fashioned chip log and counted how many knots unreeled in a set time.

Bounty was sailed the old fashioned way, as befitted what she was, and the captain regarded her electronics and communication systems with only marginal tolerance. It was he who first made the point that without radio, the fleet would have had to have sailed as a fleet. Three ships had weatherfax and after each chart came through, we would pass on our conclusions about the weather to those ships without. As we were helping provide the information for the charts we had, as it were, a personal stake in them. They were very accurate and reception from Pretoria OK most of the time.

Conclusion

The 10 000 miles I sailed aboard Bounty added fuel to my conviction of some years that marine electronics, especially communications equipment, is now so well engineered as to be virtually trouble free. The Skanti is the most advanced, and therefore simple to operate, radio I have ever used, to the point where an idiot could operate it. You literally dial any frequency from 500 kHz to 30 MHz (on both transmit and receive), press the transmit tit on the handset for 1.5 seconds, and the automatic antenna tuner supplies the correct SWR. If you use those frequencies again, pushing another button holds them permanently in a memory. In another memory are the simplex and duplex frequencies used throughout the world, so if Durban's 4 MHz telex channel is '404', all you do is dial in 404, ENTER, and you have it!

A similar Skanti set aboard Anna Kristina copped a full wave one day and lost the ability to transmit until they took the covers off, let it dry, squirted some compressed air inside and did it up again. No trouble. No-one else on the fleet ever reported any trouble with any of their radio systems.

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Sony goes VHS!

Beta video leader, Sony, has acknowledged market forces and announced in early January that it will market VHS video recorders, but will continue to sell and develop its Beta format products.

Sony's launch in the VHS market has commenced in Europe but we won't see Sony VHS VCRs here until later this year. Hitachi will be making Sony's VHS machines and Sony will have to pay a licence fee to its arch rival, JVC, on every unit sold.

So far as continued support of the Beta format is concerned, Ian Black, Visual Products manager for Sony Australia, said "Sony will continue further development of the Beta format due to its strong demand by discerning consumers for superior picture quality and performance."

Sony also intends to develop its "extended definition" Beta format for introduction to PAL video markets, Mr Black indicated.

Sony lost out in the format battle because JVC (who developed VHS) and its parent, Matsushita, persuaded dozens of other manufacturers to licence the production of VHS machines. VHS is now the dominant VCR system worldwide, holding 93% of the market.

Only two major manufacturers joined Sony in exclusively making Beta format VCRs - Toshiba and Sanyo. But Toshiba capitulated along the way and Sanyo ended up making both VHS and Beta machines.

Sony isn't the first casualty in the VCR format wars, either. Philips capitulated in 1982, abandoning their V2000 system and taking on Sharp-made VHS recorders. This prompted an advertising campaign in the UK headed by the slogan "VHS. From Firips!"

Despite being relegated to a special market niche, Beta is not dead. Tapes and pre-recorded software will be available for some years to come, although movie tapes will continue to dwindle judging from recent history.

A number of major American distributors of movies on video have dropped Beta in favour of VHS, but all major local distributors are continuing to support both formats. But for how long is anyone's guess.

Perth Show moves to mid-July

In past years, the Perth Electronics Show has been held over the last week of July/1st weekend in August. This year it will be held two weeks earlier, over July 13 to 17.

These new dates avoids a clash with a conference being held by the giant electronics and electrical retailer, Retravision, at the end of July.

Claremont Showgrounds remains the venue as a number of unresolved problems with the Burswood Island venue, including the cost, parking and noise difficulties, precluded a move there as had been mooted at last year's show.

The Perth Electronics Show has become the most successful consumer electronics exhibition in the southern hemisphere. This year, the committee plan to enhance the trade section with the establishment of eastern states-based industry representation.

The committee has fresh ideas on content and promotion and the Show's tenth year looks set to be a real winner.

"We are planning to bring all the latest technology together to create the ultimate in the house and office of the future", show manager, Chris Gulland, said.

"By gathering the products of tomorrow together, the public will be able to get the feel of what it will be like to live in a house or work in an office where technology has made a considerable difference to the appliances we are familiar with now", he said.

The Perth Electronics Show has been the advanced launching pad for many new consumer products not due for release for anything from three to twelve months after the show.

New Ortofon MC cartridges

Scan Audio has released a range of three new Ortofon high output moving coil cartridges - dubbed the "X Series"; X1-MC, X3-MC and X5-MC.



Super-VHS here later in the year

JVC distributor, Hagemeyer (Australasia), expect to release S-VHS video recorders onto the local market in late 1988, according to a recent press release.

S-VHS offers superb resolution - over 400 lines horizontally, compared to around the 230 you get with current equip-

ment.

To deliver this sort of resolution, the S-VHS system splits the chrominance and luminance signals and records them separately. Recording bandwidth is 1.6 MHz, compared to 1 MHz on current standard VHS equipment.

A sophisticated non-linear sub-emphasis system is used to obtain a significant reduction in the signal to noise ratio.



They are half-inch mount types, the X5 having a nude FG type II stylus which gives extended frequency response to 45 kHz, Ortofon claim.

The X1 costs \$169.00 rrp, the X3 costs \$299.00 rrp, while the X5 is \$379.00 rrp.

At the same time, Ortofon's all-new state-of-the-art MC3000/T3000 cartridge and transformer combination was released, aimed at the well-heeled record lover. If you've got \$1990.0 (rrp) to indulge on the MC3000, then you'll also not

quibble at \$1790.00 (rrp) for the T3000 matching transformer.

The MC3000 sports a ceramic cartridge headshell, said to be virtually immune to vibration and resonances. The new stylus features an exceptionally slim profile ensuring wide contact area with the groove wall on the record. It also has, at 0.1 mV, double the output of its widely acclaimed predecessor, the MC2000.

Further details from Scan Audio, 52 Crown St, Richmond 3121 Vic. (03)429 2199.



ONE STOP computer shop



80286 Mother Board

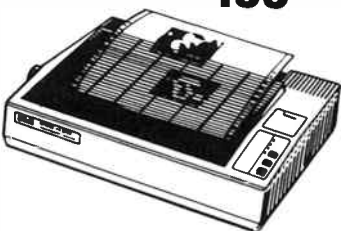
Your own 'Baby AT'! Use it with our do-it-yourself kit or your own custom computer. Provision for 256K, 512K, 640K or 1024K RAM, selectable 6, 8, 10 & 12MHz speeds, 8 input/output slots, IBM PC/AT compatibility, Award BIOS and much more! Cat X-1000

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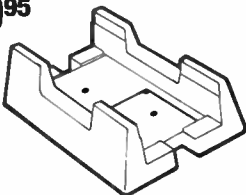
\$499



CPU Floor Stand

Lets you store your CPU on it's side out of harms way. Great when space is at a premium! With more space on your desk you'll most likely end up with less mess — now that seems sensible. Cat X-3810

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Easy Serial Links

Male/Male Gender Bender. Adapts female serial cables without resoldering or re-connecting. All 25 pins wired pin to pin. Simply plug in twin male DB25 sockets. Cat X-3565

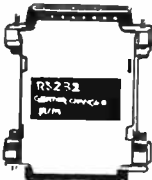
\$12⁹⁵



Female/Female Gender Bender

The same as above but with twin female sockets permanently wired. Makes cable connections quick and hassle free! Cat X-3566

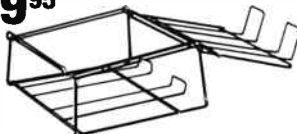
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80 Column Printer Stand

Takes the foul-ups out of printing. Keeps your printer and paper working NEATLY together and gives you the time to go about your work while the printing's being done. Saves space and time. Cat X-3811

\$39⁹⁵



132 Column Printer Stand

When you need to use the larger format paper then this is the printer stand for you. Just like the 80 column stand. Helps eliminate paper jams by storing and taking-up paper during printing. Cat X-3812

\$49⁹⁵



RS232 Breakout Box

Just what you need for modems or any serial applications. DB25 male to female. Pin 1 is permanently wired, all others are open with wire links supplied. Perfect for making up special serial cables. Cat X-3568

\$27⁵⁰



RS232 Permanent Jumper Box

This one's similar to the breakout box but the connections are made internally and soldered for permanent applications. All 25 pins are open with wire links supplied. Cat X-3569

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Parallel Switch Box

No more cable changing! The parallel switch box can save you heaps of time. Lets you run one printer and two computers or even two printers and one computer. Just plug it in and it does the rest. Cat X-3571

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Serial Switch Box

What a pain in the they never give you more than one serial port! What's more, there's so many serial applications. Well, we've solved the problem. The serial switch box lets you connect two devices to your serial port. A modem and a mouse, two modems, a printer and a whatever you like. Cat X-3573

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Locally made CD-ROM launched by Disctronics

Melbourne-based CD manufacturer Disctronics has released their first CD-ROM product to mark the establishment of what they call Australia's first "one-stop-shop" facility for CD-ROM production.

Disctronics claim to be the world's third largest manufacturer of audio compact discs. They are part of the publicly listed company, Quatro Limited, which has other CD manufacturing plants in the UK and US. Global production capacity is in excess of 65 million discs a year, the company says.

Disctronics' first CD-ROM is a "multi media" disc containing text, graphics, images and audio. It contains a wide variety of information, including: a telephone and business directory, a parts catalogue with data and associated diagrams, a 600-page book with pictures with reference documents (e.g. for service or instruction manuals), an interactive multi-media training database, a financial procedure manual and – the St. James Bible!

Roger Richmond-Smith, Disctronics' MD, said the company's establishment of the only one-stop-shop facility for CD-ROM production was a major development for the local information management systems industry.

The company's optical storage division can take a project all the way from data preparation through software design to manufacture of the completed disc.

They have offices for the optical storage division in both Sydney and Melbourne.

Disctronics can supply a client with a finished disc within eight weeks of supply of the raw data for a first title, and updates can be done within days, they said.

2400 bps upgrade for the 4610 Supermodem

We have been receiving an increasing number of enquiries about the 2400 bps (V22bis) upgrade for our popular AEM4610 Supermodem, produced by Maestro Distributors.

Design was well under way late last year, but the chip on which it was based, the Silicon Systems K224 (see Semiconductor Scene in our Nov. '87 issue) encountered production bugs, and delivery was suspended. Exit design no.1.

Finding a replacement has not been easy, but prototyping is now under way using the Exar XR2401/2402 chip set.

Based on the Texas Instruments digital signal processing (DSP) chip, the XR chip set provides V22bis (2400 bps full duplex) and V22 (1200 bps full duplex) operation, along with Bell 103 and 212 compatible operation. Two useful functions supported are automatic call progress monitoring and DTMF (tone) dialling.

Discussing the project with Chris Darling of Maestro recently, he said they expected to have the unit ready by April. For the moment, they were concentrating on the Novix Super-Computer. Don't go away now!

Real time interface module

A real time interface module that can accept a wide vari-



ety of inputs from transducers and connects to any computer's RS232-C serial port has been released by Melbourne manufacturer, Novatech Controls.

Known as the RIM-1000, the unit has 17 analogue inputs, two analogue outputs and 14 digital inputs or outputs. Eight of the digital inputs can be used as counters or accumulators.

Inputs can be taken from temperature sensors, load cells, pH meters, power meters, position transducers, shaft encoders, proximity detectors, limit switches, relays etc.

The RIM-1000 is Australian designed and you can find out more details from Novatech Controls, PO Box 240, Port Melbourne 3207 Vic. (03)645 2377.

And now for the flicks!

Autodesk will shortly release an animation package for the IBM PC that can be used in conjunction with AutoCAD and AutoShade.

Imaginatively dubbed "Autoflix", the package allows you to leap from two dimensional modelling to three dimensional modelling, without actually having to build something – a technique widely used in the design of complex mechanical parts.

The human ability to perceive spatial relationships through movement – which is why you rotate an object in your

hand when looking at it – is precisely why so many designers build physical models.

But building models is time consuming and expensive. Computer animation offers the same facility much earlier in the design cycle and at much less cost, Autodesk say.

Autoflix makes a computer "movie", exactly as a camera does, by taking multiple pictures and then presenting them to the eye rapidly enough to create the illusion of motion.

Autoflix allows you to make two kinds of movies, "Walkthroughs" and "Kinetic Animation". In a walkthrough, the camera is the only object that moves; objects in the frame do not move relative to one another. In Kinetic Animation, objects in the model move as well as the camera.

Autoflix movies can have a soundtrack (synchronised, too!), can be made interactive, have multiple images overlaid or other Autoflix movies spliced-in.

The Autoflix package is to be released mid-year. Hardware requirements for the initial package include: IBM/PC/XT/AT or compatible with 640K of RAM, hard disk, EGA display adapter and compatible display. A pointing device (mouse or digitizer) is optional.

Further details from Debra Donegan at Autodesk Australia, (03)429 9888.

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DDB TAT 3526

Modems on parade!

Jamye Harrison

A grand scale review of a wide range of "smart" modems currently available.



Modems on parade! Everything's here, from the latest PEP modem to an old acoustic coupler – but we're only reviewing the latest models.

JUDGING FROM the attitudes of many people I know who use modems, both for leisure and in their professional lives, a common misconception is, "So, a modem is a modem. It either works or it doesn't!". Well, on face value, this statement, especially in the world of "Hayes compatible" modems, does carry some weight. However, on deeper investigation, and from experience using a wide range of modems, it could not be more wrong.

It seems that Hayes compatible modems vary widely in their operation and features. So, "What defines a good modem or a bad (or maybe that's less good) modem?" you ask. This question had to be answered before I took on the already daunting job of reviewing the crowd of units that were submitted for this review.

In previous modem articles it seems that it has never been considered, "Who uses modems, and what for?". This can obviously affect the method by which a modem is evaluated.

There is the hoard of users, a great number of them students, who use a modem to log-on to public bulletin boards to swap software and messages. The requirements called for in a modem from such users can differ greatly to the professional market, who rely more heavily on a fuss-free, highly streamlined system to say, provide remote communications to their company mainframe computing system, receive and send inter-company electronic mail, etc. Then there is the humble (or not so humble) sysop (SYStem OPERator),

who depends upon a highly automated, non-temperamental set-up which can be left unattended for long periods of time without problems.

Evidently, these three basic groups of modem users all place different demands on a modem, and thus require different features and usage parameters than each other, although there would be some overlap. What the great body of modem reviews I've read in the past have done is neglected the professional and sysop groups, sifting through a pile of modems with the BBS user in mind. What I have attempted to do in evaluating the group of modems here is to consider all three of these groups and establish, in regard to each each modem, how the different types of users would view their features and failings and what they might find useful.

When evaluating these modems I established a few basic areas which differ enough to make a genuine distinction from one unit to the next. Firstly, the physical appearance of the modem, while perhaps being fairly

important to the corporate user, may not be as important to a sysop or BBS user. The dimensions of a particular modem might also lend themselves more to one application than another.

On a software level, what the industry describes as "Hayes compatible" I found to vary markedly. What I found greatly enhances the operation and flexibility of a modem is an 'extended' AT command set, which facilitates the implementation of some useful features. Anyway, I will go through each modem, one at a time talk about their drawbacks, features and what particular applications to which they might lend themselves.

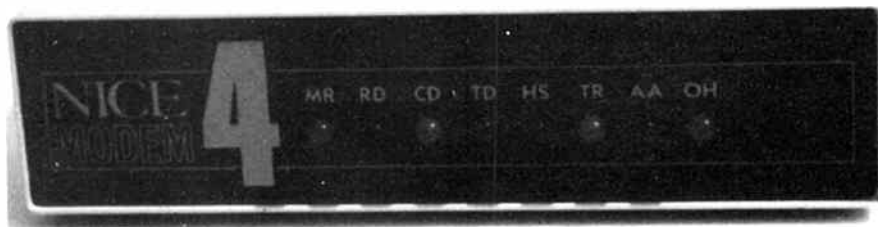
Nice Modem 4

This modem has just been released and the additional features offered over and above previous models are also offered as an upgrade for existing Nice Modem owners. The modem supports 300/300, 1200/75, 1200/1200 and 2400/2400 bps operation (i.e. it's a "1-2-3-4" modem) plus the corresponding Bell standards. Overall, in terms of appearance and presentation this is a very smart modem. Physically, although quite long, it doesn't stand very tall. However, this is where its meekness ends.

The Nice Modem 4 supports the full AT command set as well as coming with a hoard of other AT commands which are both helpful and some, unique in the modem world. This was one of the few modems reviewed that had a constant bit rate interface between modem and computer. By using the ATBRX command the user can vary the speed, parity and numbers of stop bits and data bits of the two data interfaces (i.e. the modem/computer and the modem/line links) independently of each other. IBM users will appreciate the usefulness of this command if using V.23 (1200/75) mode due to the lack of a split rate data interface on the serial ports.

Another notable feature of the Nice modem is the provision of ring-back security, where a list of names, passwords and telephone numbers are stored in the modem's memory. When a caller rings up he/she is interrogated for their name and password and, if validated, is rung back at a pre-arranged telephone number. This is a feature usually not supported by this end of the modem market but is supplied as standard with the Nice modem, making it suitable for high-security, dedicated use in either a corporate or private installation.

While being a very powerful unit, the Nice Modem 4 also lives up to its name, being aesthetically pleasing. It comes with a detailed, well set-out manual. (I dread to think what would happen if the "Hostile Computer Com-



pany" produced a modem, the term "user friendly" would take on new depths!). While on the subject of user friendliness, the command set features a help-screen command (AT?) which displays a screen with all the acceptable AT commands and parameters. Two other help commands are also provided, ATD? and ATS?. These commands display the dialing sub-commands and the status of the S-registers respectively. Although these commands may seem trivial they prove to be very important when trouble shooting or when you're suffering from a lapse of memory.

Synops will find the Nice Modem 4 both reliable and easy to use for dedicated bulletin board use. As well as providing an extended Hayes command set and S-registers the manual contains a whole section dedicated to suggested settings for the modem in a BBS application, providing many useful hints and tips.

Also in the manual are many reference sections useful for initial setup and trouble shooting. These include an ASCII reference table, suggested RS-232 cabling instructions for many different computers including: IBM XT, IBM AT, most clones, Commodore C-64, Amigas, Atari ST series, Apple IIe, Macintosh, Mac Plus, Apple IIc, Olivetti M24s, and most Amstrad brand computers; very comprehensive indeed! So what!, you might say. One thing which has never ceased to amaze me is the number of times either a hardware or software installation problem has not been able to be resolved due to a simple quirk common only to a particular range of computers. So with a Nice modem you are pretty well covered.

One problem I noticed when setting up the Nice modem was the lack of labelling on the back panel of the modem. This would not have been a drawback because it is quite obvious (to me at least) which connector is the serial port and where you plug the power in. But, when it came to connecting the phone line this presented a problem. The phone line connector and the connector for a telephone handset are the same and no distinction was made between them. However on further investigation I found out it didn't matter which was which.

The appendices in the manual include detailed and easy to read information on file transfer protocols, serial communications and modem specifications. This makes the modem ideal for the inexperienced data communications user. This, and the inclusion of V.23 mode (1200/75) make the modem useful for using on the host of dial-up information services operating in a Viatel-like (Videotext) format. (Great for business-people with stocks and shares using the Elders service, tax agents, the real estate world, etc).

Equipment-wise the Nice Modem 4 was supplied with: the main unit, a telephone cable, 12 Vac plugpack power supply, manual, reference card and an "Australian Bulletin Board Directory". An RS-232 cable is the one thing lacking here, many of the other modems which I evaluated were supplied as standard with one. This is not a serious drawback, except for the computer or data comms virgin, where a serial cable probably would

not be amongst his standard equipment. Being powered from an external supply means that no circuitry is needed to be devoted to providing the correct voltage inside the modem is needed, reducing size, and the dissipation of heat from the body of the modem.

A reference card proves to be an extremely useful accessory. Once you're set-up, or for detailed re-configuration, the manual need not be consulted. This holds true for the BBS directory also, although out of date (July 1987), it was well set-out and comprehensive.

Another feature of the Nice Modem which sets it apart from all of the others is the inclusion of a hardware volume control. A potentiometer accessed from the bottom panel permits the modem's internal speaker volume to be varied, a much preferred method to using the conventional ATLx command.



Netcomm's pocket modem – for the hacker who has everything?

In summary, the Nice Modem 4 proved to be a unit of high standard, both in performance and in operation. It has many features above and beyond what the modem industry has delivered in the past. It is reasonably priced for a software controlled modem with V.22bis capability. The Nice Modem 4 is also available with MNP error correction, allowing all error checking to be done within the modem and not at the computer, saving time and trouble.

It is definitely a modem suitable for either the experienced computer user looking for a full-featured, world-class modem, or the inexperienced computer user exploring the world of data communications and in the market for a powerful, yet easy to use tool. With Videotext operation, the modem also lends itself to semi-professional use on the plethora of Videotext compatible dial-up services around. For the SYSOP, this modem comes highly recommended, being reasonably priced, having a reputation for being very reliable and with all the features necessary for a trouble-free, dependable installation.

Netcomm Pocket Modem

The perfect companion for the successful businessman with a mobile phone, who drives a BMW 735CSI, religiously eats lunch at the Berowra Waters Inn, belongs to a DINKY family (Double Income No Kids Yet), sports a Compaq 386 portable in his car and

is dreadfully bored driving around the country-side; the Netcomm Pocket Modem! Seems ridiculous, a modem about the same size as a cigarette packet, battery operated and fully Hayes compatible, why on earth would anybody need something that small?

Well, with the growing number of mobile cellular phones and truly portable PC-compatible computers, the Pocket modem seems destined to become the status symbol of the late eighties. Or, maybe, for the serious systems hacker who, after numerous threats from the Federal Police is now in hiding, living in a serviceman's duct in an underground railway tunnel somewhere underneath Sydney, dutifully hacking his way into high-security computer systems, and after the essential life-supporting commodities – a coffee pot, five boxes of disks, three boxes of system manuals and two folders of AEM back issues, doesn't have room for anything but the Pocket modem.

That describes two potential users of the Netcomm pocket Modem, can anyone outline somebody else? Perhaps remote data acquisition and retrieval applications could fully exploit its size.

It seems that the world of modems has also become the slave of miniaturisation most other areas of technology have fallen to.

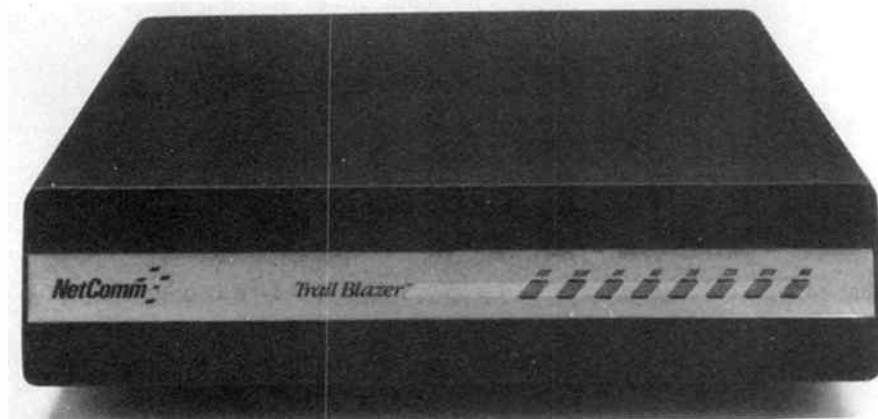
Jokes aside, the Pocket Modem offers V.21, 22, 23 and Bell 103 and 212A compatibility, pulse and tone dialling, auto-answer and auto-dialling functions. The premium package is for IBMs and is supplied with a rechargeable NiCad battery, a mains battery charger, a car cigarette lighter adaptor, plus the Netcomm program and Pop-up. The Pocket Modem is also available in two other versions, targeted at owners of the Amiga and Commodore 64. These versions do not come with all the extras of the Premium, and sell for considerably less.

The AT command set of the Pocket Modem lacks nothing, it has extended result codes, pulse or tone dialling and provides 10 S-registers. It is of the same quality as the rest of the Netcomm range, quite well presented. However, the manual is not as easy to read as some other manuals I've seen.

What did become apparent after using the Pocket Modem was that, while Netcomm has minimised the size of the modem, they have not diminished the quality in comparison with other entry level, software controlled modems. The unit is easier to set up than most, especially if being battery run – just plug-in the serial cable.

There is but one LED indicator on the top panel of the modem. This is configurable as to what it indicates, either power on/off, or on-hook status of the phone line.

Certainly, software controlled modems are getting smaller and smaller. Judging from the size of the Avtek Megamodem and the Bit Blitzers, this is becoming a more important consideration; why waste space? However, the Netcomm Pocket Modem certainly carves a new niche in the market place, being the size of a small power transformer, while having all of the features of its larger brothers. What I hope we will see is that users will fully exploit the physical and operational features of the Pocket Modem, and others similar in size, opening up a range of applica-



Top of the line – Netcomm's Trailblazer. It can rattle along at up to 18 000 bps, but only in one direction.

tions where a modem would not have been considered in the past.

The Trailblazer

Many readers will probably have heard of the Netcomm Trailblazer already, having become something of a Superman in the marketplace. What has attracted the most attention about this modem is the ability to communicate in what is termed PEP mode (Packetised Ensemble Protocol), which allows the modem to operate at speeds at up to 18 000 bps. However, what is rarely mentioned is that it only achieves this speed in one direction. In the other direction the Trailblazer only loafs along at 1200 bps, typically.

What might redeem its high profile is the fact that the modem, while connected to the line, will analyse the phone line and determine the best speed at which to communicate. The Trailblazer will determine such things as; the signal/noise ratio of the line, noise level, and general line quality. In PEP mode the Trailblazer will then break up its

transmission data into frequencies best suited to the particular line conditions. In effect the 'Blazer uses up to 512 channels with separate carriers for each, based on the particular frequencies best suited to the telephone line.

Apart from the PEP mode, the Trailblazer is otherwise a fully functional, top quality Hayes-compatible '1234' type modem, providing operation at V.21, 22, 23 and V.22bis speeds. In comparison with other '1234' type modems, the Trailblazer performs well. It has the advantages of a constant speed interface and an AT-command set well endowed with a host of extra commands. Also, the Trailblazer supports 51 S-registers, allowing the user a high degree of control over the operation of the modem. Many of these registers are also devoted to holding statistical information about the telephone line, and the internal workings of the modem.

A swag of extra equipment is supplied with the Trailblazer. Aside from the the main unit, which is comparable in size to a family-

sized jaffle maker, there was also a largish external power transformer and a line isolation unit.

The manual is up to Netcomm's usual standard. It is comprehensive and clearly set out. Explanations are given of the Trailblazer's unique functions and features.

Overall, the Trailblazer is quite a good modem, obviously the high price pays for the technology to achieve the PEP mode and the inclusion of the sophisticated line analysis circuitry. However, I don't think the price is fully justified unless the modem can achieve up to 18 000 bps in BOTH directions. The lower speed reverse channel is a bit limiting, something of a compromise, in much the same way that the 75 bps back channel on V.23 (1200/75) can be limiting.

Netcomm 1234SA

Netcomm is a well known, well respected name in the marketplace, and they have a very wide range of data communication products. Just added to its Smartmodem series is the 1234SA, similar to its 1234A but providing synchronous as well as asynchronous serial communication. The 1234SA is not unlike the other modems in Netcomm's Smartmodem range in appearance.

As the model number suggests, the 1234SA is capable of V.21, 22, 23, and V.22bis operation. In addition to the conventional row of indicating LEDs on the front panel the modem also has a series of switches. These

THE 'STANDARDS' JARGON

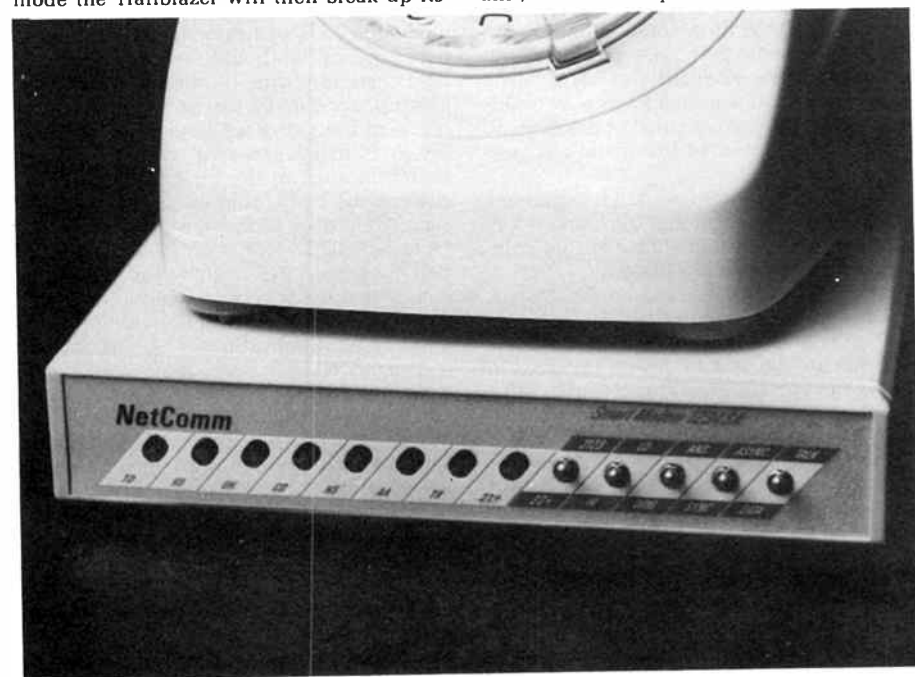
In order that modems can 'talk' to one another, no matter where or by whom they are made, standards have been set down by an international engineering committee called the CCITT (it's a mnemonic for the title, which is in French). The standards are long, dry, complex documents describing the manner in which communications takes place.

Certain tones and encoding methods are used for given data rates. The most commonly used data rates (in bits per second – bps), and the corresponding CCITT standards, are:

- 300/300 bps – V.21
- 1200/75 and 75/1200 bps – V.23
- 1200/1200 bps – V.22
- 2400/2400 bps – V.22bis

Modems which featured V.21, V.22 and V.23 operation first appeared on the market a few years ago and were quickly dubbed "1-2-3" modems. When modems offering V.21, V.22, V.23 and V.22bis appeared, they were dubbed "1-2-3-4" modems. The logic is a little hairy, but you get the picture.

The Bell Telephone company in North America established their own data communications standards, known appropriately as the 'Bell standards'. While the same data rates are catered for, different tones are used. For communications with users in North America, or other areas using Bell standards, Bell 103 is for 300/300 bps and Bell 212 for 1200/1200 bps communications.



The Netcomm 1234SA – comes with useful software.

control operations like V.22bis or slower speed operation, originate/answer modes, asynchronous or synchronous communication, and data/talk modes. The rear panel of the modem also has a set of DIP switches for configuring some of the modem's other features, such as toggling auto-answer, and tying certain RS-232 lines high or low. These can be very useful if the computer or software you are using expect to have, say, the DCD line always high, this can then be set by hardware easily and simply. One thing that stood out was the fact that the indicators are hard to see unless you're looking more or less straight-on to the modem's front panel.

In the software area, the 1234SA has an extended Hayes command set and extended S-registers, making it a well-rounded, useful package. Amongst the great number of BBSs, this particular model of the Netcomm range seems very popular. Indeed, it provides all of the speeds anybody could wish for at the moment, without using PEP modes, of course.

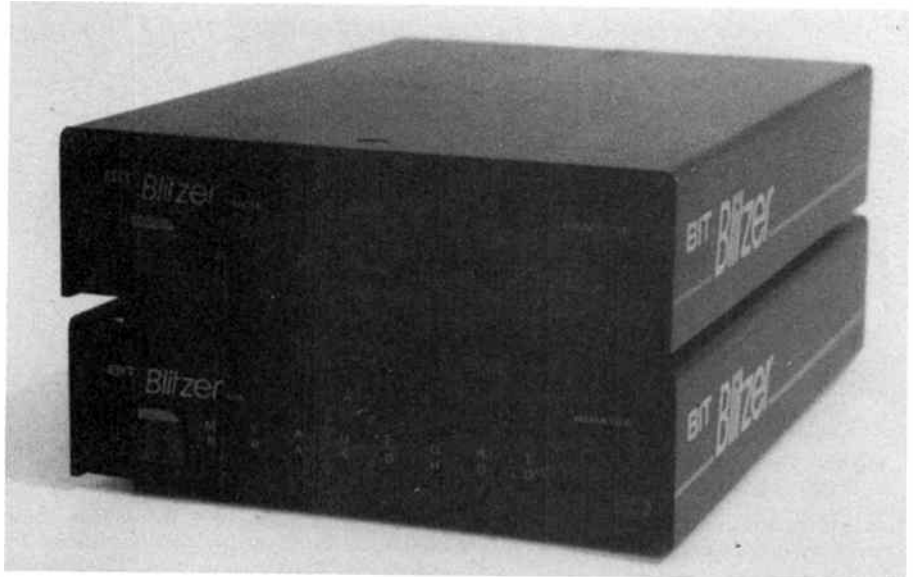
The implementation of synchronous communication on the serial port makes the Netcomm 1234SA suitable for mainframe usage. This, and the feature of hardware switching on the front panel make the modem useful in specialised setups, where dedicated, long term usage is required.

Included as standard equipment with all the Netcomm range are two software packages for IBM PCs and compatibles, "The Netcomm Program" and "Pop-Up". Although including terminal software with a modem is not unheard of, it is still by no means common. However, Netcomm go one further than this by not only including the Netcomm Program, but also including Pop-Up, a useful desktop utility.

On first appearances the Netcomm Program appears to be a powerful, well-presented package. However, while it is powerful, it is not as easy, or as pleasing, to use as it could be. It does, however, solve the problem of initial communication software for the first-time user. You know the old problem, get a modem home and fire it up to discover you have never bothered to investigate communications software for your computer, and the quickest, cheapest and easiest way to get terminal software is to download it from a bulletin board; but you need communication software to do this in the first place!

Pop-up is similar in features to the many desktop programs which are designed to run in the background on an IBM-PC. It offers similar operation and features to Sidekick: a phonedialer, appointment system, desktop calculator, card filing system, etc. It is not an essential item, but certainly nice to have.

In conclusion, the Netcomm 1234SA is certainly a well-presented, high class modem, having an extended Hayes command set and S-registers, while also providing two software packages for the IBM-PC user. This is exceptional value by any standard. It is definitely a modem to be considered by all facets of the modem marketplace, being especially suitable for the up and coming sysop, or the BBS user with more pocket money than most. Corporate use is also well catered for with the 1234SA as its appearance, and fuss-free operation lend itself well to the



A brace of Bit Blitzers! The 12E (bottom) and 123E. Hot contenders at the "entry level".

demands of business use.

The BIT Blitzer 12E & 123E modems

No doubt many of you will have seen the Bit Blitzer modems advertised around the place, Dick Smith are selling them, along with Mike Boorne Electronics (the importer and distributor) and a host of other outlets. The Blitzers are about the size of a slimline 5.25" disk drive and are powered from an external plug-pack power supply. Two models are currently available in the 'range' - the 12E and the 123E, providing V.21, V.22 and V.21/22/23 operation, respectively.

What first struck me about the 12E was that it lacked some of the standard AT commands, such as AT&W, AT&F, etc. Most of the commands which allow you to alter the operation of the serial port were missing, along with some other standard commands. This was partially compensated for by a set of DIP switches in the bottom panel of the modem, which perform some of the operations lacking in the software.

Otherwise, the Bit Blitzer 12E is certainly a good, reliable modem for the money-conscious user. It is quite suitable for the uninitiated BBS user on a low budget.

The Bit Blitzer 123E makes up for the lack of software commands in the 12E, while also adding 1200/75 bps operation. Both of the modems in the Blitzer range are easy to install and operate, providing the user with a trouble-free, no frills communications setup.

Their size also distinguishes them, as they are quite small (the Avtek Megamodem and the Netcomm Pocket Modem being the only ones smaller). Also, I noticed, the two Blitzers don't run as hot as other modems when used over an extended period of time. The 123E would be ideal for sysops with a chronic lack of money. The 123E responds to DTR control probably a bit better than most other modems, lending itself well to the demands of BBS software such as the Opus

and Fido packages.

The lack of non-volatile RAM in the 12E could prove to be a serious drawback to some users, while the low price might override this consideration for the BBS user. Many features in the 123E would attract BBS users, sysops and corporate users alike. The implementation of V.23 operation, and complete DTR control make it a viable option for business people using the range of Viatel compatible dial-up services around the place.

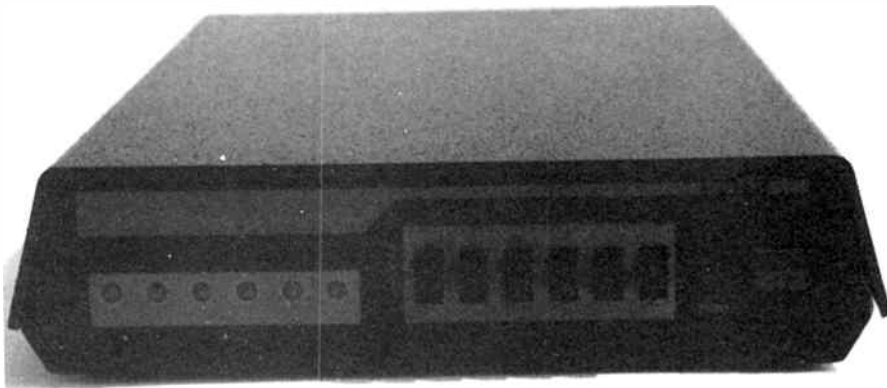
The manuals are of the plain and simple variety, but are written in clear language - no "Chinglish" here.

Dataplex DPX-224

On first appearances, the Dataplex-224 modem looks like a heavy, highly specialised data product. Well, after investigation, this holds certainly true. It's housed in a heavy gauge pressed metal casing, definitely placing it in the heavy-weight/hard-duty category. It is mains powered, with the power switch located on the front of the modem. Also on the front panel are six push-button switches and six LEDs. Speeds provided for include; CCITT - V.21, V.22, V.22bis, V.23 and Bell Standards 212A, 202S and 103. Synchronous and asynchronous serial communication is possible, making it useful for mainframe system applications.

Also offered by the DPX-224 is an extended and enhanced AT command set, eight stored, non-volatile configurations, MNP error-correction, security ring back, constant speed data interface and multiple help screens and interrogation. The Dataplex modem was supplied with an RS-232 cable for connecting the computer and the modem, making for a complete, plug-in-and-go installation. The modem supports an amazing number of AT-type commands above and beyond the conventional command set.

Initial set-up was relatively trouble-free, although the actual use of the buttons on the front panel was confusing, being labelled;



The Dataplex modem was the "parent" of Telecom's. Sort of your tough "four wheel drive" unit with plenty of features.

"LLB, NORM, RDL, ST, 4, 2, 1, SET,". After consulting the manual I was none the wiser, although it did explain that these were used to access stored number dialling, remote/local loopback testing and different dialling modes, so I put them on the "Later on, if I'm interested list". The manual contains detailed information on installation and configuration, where necessary explaining the serial interface connections and hardware/software configurations. After further reading the manual, is definatly not one to be tackled by the first-time modem user without some background reading first. While the documentation is detailed and well set-out, it doesn't make for "bedtime reading" like many manuals I have read.

Above and beyond the accepted standard AT commands and conventional extended commands, the Dataplex still has a lot to offer. The modem has extensive self-testing, and quite a number of commands to change the operation of other features in the modem, such as dialling and communication parameters. For special circumstances the AT*R command will send the modem into remote configuration mode, enabling a remote user to configure and operate the modem as if he or she were right there with the modem in command mode.

The modem also provides for full baud rate masking, allowing the modem to be set up for highly specialised communication modes. Fifty-odd S-registers are utilised for setting-up the modem and storing important operation information. A set of registers are set in "bit-mapped" mode. This means that the registers are configured by either setting or not setting different bits in each. i.e: setting them to either a 1 or a 0. This method of setting up the registers is useful for quick re-configuring and is good for un-manned, software controlled applications.

Another convenient feature is the Fastdial command (AT&Q1) which allows the user to dial telephone numbers without continually having to input the ATDx prefix. Thus, after entering AT&Q1 you are left with a "Please enter telephone number:-" prompt and all that need be done is enter the telephone numbers you wish to dial. This is useful for trying a list of numbers, usually infrequently called, which are not stored in your autodialling software.

I have described only some of the more unusual operation features here. The Dataplex DPX-224 is indisputably a full-featured, very powerful data communications tool. It is probably more suited to commercial or professional use, rather than for the BBS user. In terms of a BBS, it would be better suited to a highly specialised dial-up for a club or corporate body, and not for the garden variety bulletin board service.

In finishing, I should point out that the extra commands I mentioned are by no means exhaustive. Other than the conventional ATxnn and AT&xnn commands the modem also has a full suite of AT*xnn and ATxxx type commands.

Telecom TEL-424

The Telecom TEL-424 is a "badge-engineered" modem, being the same hardware and software product as the Dataplex DPX-224. Unfortunately, this was only apparent after both of them had been received for review, and came as quite a surprise. If I had have known I would have been saved quite a deal of trouble because getting a modem out of Telecom is like trying to extend your overdraft with your bank manager, in other words DAMN NEAR IMPOSSIBLE! It can be done, but it takes persistence.

As I have already described the Dataplex modem I won't go into the operation or fea-

tures of the Telecom model as they are the same. However, the TEL-424 is packaged not only with the necessary serial data cable but with communications software for the IBM and compatibles. Supplied with the modem is Supercom, fast becoming an almost industry-standard package with many third party arrangements with large corporations around Australia.

Including communications software with their product is a smart move by Telecom, adding strength to an already feature-packed product. It gives the IBM user a complete package, available from one source, something unusually sensible for the computer industry (and Telecom for that matter!). Full marks, here.

Also supplied with the modem is a standard telephone double adaptor. What with the software, the interface cabling and telephone double adaptor, it really is a plug-in-and-go product.

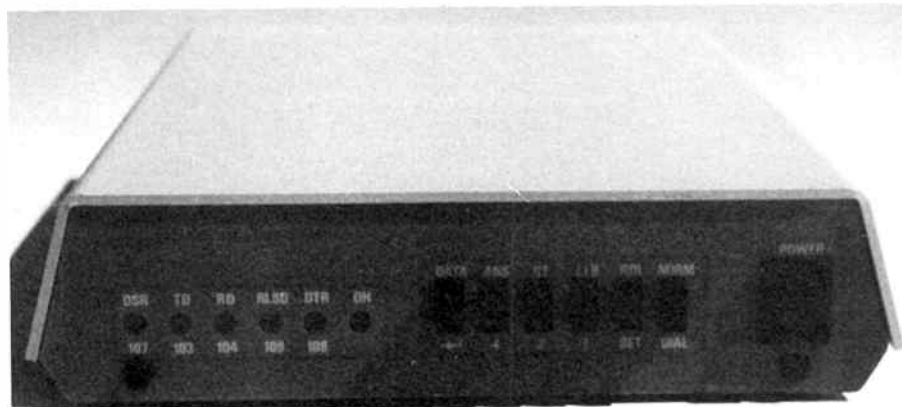
Avtek Megamodem 12/123

Avtek submitted one of the smallest modems in its class. It has a sleek black case, and certainly competes well, both in appearance and performance, with other modems far above its price range, offering a Hayes compatible command set. Two models of the newly released Megamodem are available, the 12 and the 123. As is now conventional with modem naming the "12" is capable of 300/300 and 1200/1200 bps operation, while the "123" adds 1200/75 bps (V.23) operation.

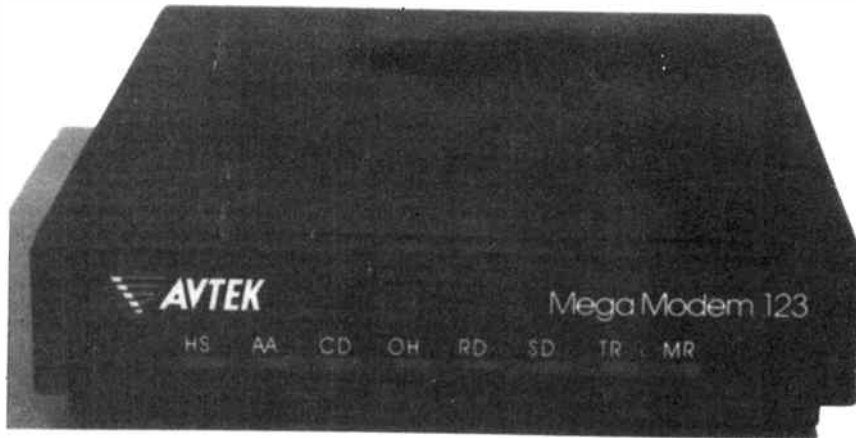
The manual for the Megamodem is actually larger than the unit itself! It is well set out and contains a great amount of information for the uninitiated user, discussing various methods of data communications, including many of the unique terms often used. Also in the manual are summaries of the various AT commands, and S-registers.

Appearance-wise, the modem has the 'usual' array of lights along the front, indicating data receive, transmit, power on, carrier detect, etc. In operation, the modem is easy to set-up and use, providing a full-Hayes compatible command set, with extended result codes if desired.

It is amazing how Avtek crammed all the features of a fully Hayes compatible modem into the unbelievably small case, ending up



This modem is from Telecom – the Tel 424. It comes with everything you need to plug-in-and-go and is targeted to PC users.



Avtek's Megamodem 123 – low-priced "entry-level" unit, but sports all the required "smarts". Aussie made, but no "average technology" here.

considerably smaller than a 5 1/4" disk drive. The review unit was supplied with a phone cord, (telephone double adaptor fitted to the end), plug-pack power supply and RS-232 cable, providing all the hardware necessary to get going.

The Megamodem has many features which make it suitable for a range of applications. It is relatively cheap, making it suitable for up-and-coming BBS users with a small budget to consider, or for other applications where space is at a premium and its size makes it ideal. Also, sysops with a small budget, as most do have, would be attracted to the Avtek modem. It offers full Hayes compatibility with no fancy, or unnecessary extra features at a very reasonable price.

Overall, the Avtek Megamodem 12/123 compares favourably with the other modems submitted for review, being easier to set up than most, and being small in size but not lacking in features. It provides a base level modem with V.22 capability, very cheaply. The Megamodem is certainly a consideration for the money conscious BBS user or sysop.

Pulsar SAM modem

For some unknown reason, Pulsar dubbed their rather unattractive black box 'SAM'. While the appearance of the SAM modem is

not wonderful, it offers some very good features and is wholly Australian technology. The SAM modem supports V.21, 22 and 23 operation with auto-answer, security ring-back, a full AT command set and extended S-

standard modem usage. The manual is a little on the large side, and while not the most well written document, still covers all the features and operation of the modem. However, the manual supplied with the review unit was lacking appendices D through R, containing some important information. A complete manual, however, would provide detailed installation instructions for IBM-PCs, NEC APCIIIs, Amigas, Apple IIs, and TurboDOS support. Viatel instructions are also provided for the IBM and APPLE computers. According to the manual, software is available from Pulsar to support Viatel operation.

The SAM modem is 240 Vac powered and comes with a serial cable, manual and telephone cord. A set of DIP switches on the rear panel control baud rate masking, RS-232 signal switching and result code selection.

One interesting feature of the SAM is the use of only a single dual-colour LED indicator for showing originate or answer mode. A potentiometer volume control adjustment is used in the SAM modem, just like the Nice Modem 4, a good feature to look for. In use, it proved straightforward and reliable. One thing it had over many others, was good, bright indicators that could be viewed from a

PRICE TABLE

Modem	Tax Paid	Ex-Tax	Comments
Netcomm Pocket Modem			
– IBM	\$675	\$590	
– C64/128	\$499	–	
– Amiga	\$499	–	
Netcomm 1234SA	\$1499	\$1315	
Netcomm Trailblazer	\$3468	\$2990	
Dataplex 224	\$1399	\$1154	
Data Bridge 2400	\$995	\$845	rrp \$1189, \$1095 ex-tax.
Schmidt 123AT	\$650	\$560	
Pulsar SAM Modem	\$649	\$560	
Nice Modem 4	\$1099	\$1051	
Bit Blitzer 12E	\$399	\$349	
Bit Blitzer 123E	\$499	\$449	
Telecom TEL-424	\$1390	\$1320	\$120 p.a. maintenance
Avtek Megamodem 123	\$449		

registers.

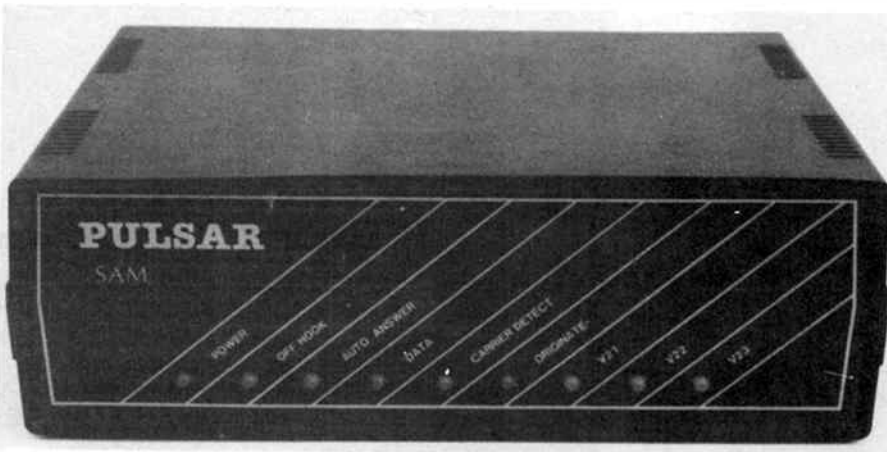
In operation, the Pulsar SAM modem obviously lends itself to dedicated, security-conscious users, while also probably suitable for

range of angles.

All in all the Pulsar SAM modem is a reliable Australian product, holding its own in the software controlled modem market. Apart from its physical appearance and size, the SAM modem is of the same quality as other entry level Hayes compatible modems in the market-place. The security dial-back feature, and hardware or software controlled baud rate masking are features that suit the modem well to a dedicated, security dial-up service or for a security conscious company, requiring after-hours data transfer.

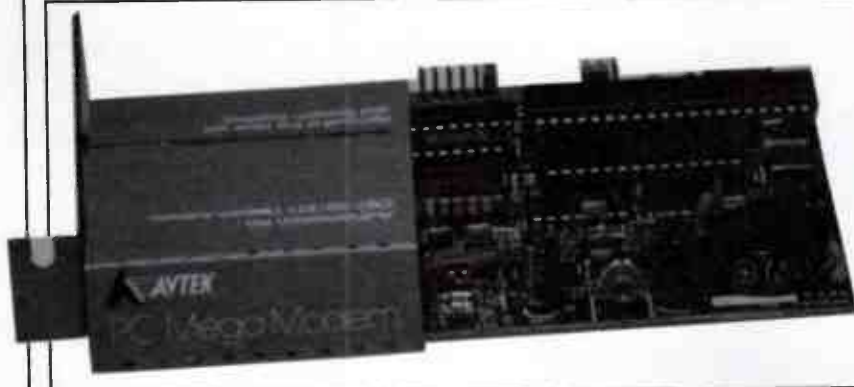
Schmidt 123AT

The Schmidt 123AT was one of the more aesthetically pleasing modems sent in for review. It is 240 Vac powered, and is supplied with the power and telephone cords already attached permanently to the main unit. On the front panel are seven LED indicators, recessed behind a clear cut-out with the mnemonic of the signal it is indicating adjacent, making for a refreshing change from most of the other modems I have seen. Indicators show the status of data Txd/Rxd, Ring ▶



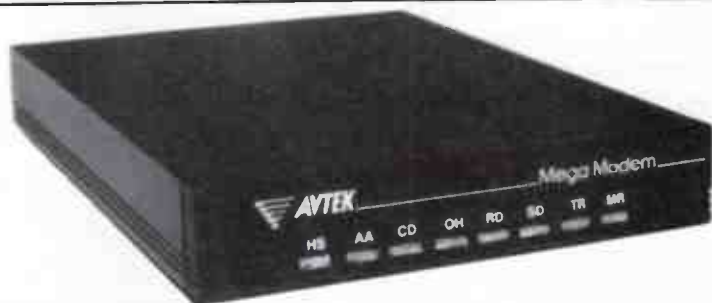
Meet SAM, wholly Australian designed, made and supported by Pulsar Electronics in Melbourne.

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**The Avtek advantage -
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Australian manufactured
Australian supported**



MEGAMODEMS 12/123

The Avtek Megamodems provide Australia's best value communications products, with a range of fully automatic, autodialling modems. Megamodems are suitable for data transfer from personal computers, terminals, mainframes and mini host computers and for all videotex services such as Viatel. The use of the latest technology has enabled us to make the Megamodem more compact and reliable than any other modem. Price is very competitive and reflects efficiencies incorporated in the design. The Megamodems are locally designed and built. Service, support and specialist R&D for the Megamodem range is all based in Australia. Available either as a standalone RS232 model or as a plug in 1/2 card for IBM PCs and compatibles. The Megamodem range of modems are Telecom authorised.

Automatic Dial, Answer, and Disconnect: The Megamodems will automatically answer an incoming call and connect the computer to the line. When originating a call it will then dial out the required number and auto-connect to the computer at the other end. It will then "hang-up" at the end of a communications session. Both pulse and tone dialling are supported. The modem is compatible with new Telecom exchanges and modern PABXs and can handle high speed tone dialling.

Fully Hayes AT Smartmodem Compatible: The Megamodems are industry standard "HAYES SMARTMODEM" compatible which means they can take advantage of all the communications facilities of packages such as Crosstalk, Open Access, Symphony and Multicom. All communications parameters such as baud rate, parity and number of stop bits are set up automatically by the software and the Megamodem. Using appropriate software data can be sent and received while the Megamodem is unattended.

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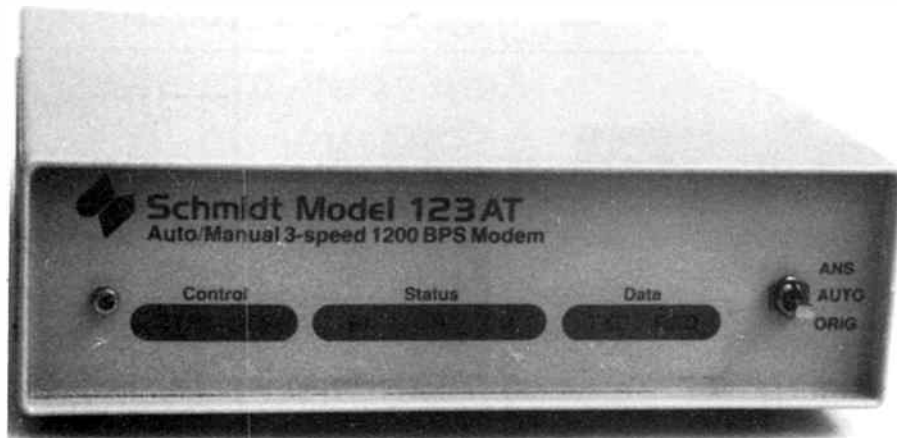
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A solid performer – the Schmidt 123AT. It looks “no frills”, but don’t judge this book by its cover.

status, On Hook, Carrier Detect, DTR (data terminal ready) and CTS (clear to send) on the serial interface.

On first powering up the modem, and trying to use it, it seemed to not respond to any commands. On further investigation a set of DIP switches needed to be set in the base, before either the speaker would work or result codes would be sent by the modem. After these were set correctly however, the modem held its own against other ‘123’ type modems in its class. A standard set of AT commands is supported by the modem, along with the regular S-registers for altering modem operation. The modem is also capable of accepting synchronous or asynchronous data through the serial interface.

The Schmidt manual isn’t very well written or clear at all, both in its explanations and set-out.

While the Schmidt 123AT has nothing exceptional to report about its operation, it is still a well-priced, auto-dial, auto-answer Hayes compatible modem, probably good for dedicated corporate usage in a dial-up set-up, or even for the committed BBS user. Overall, the Schmidt modem is a well engineered, reliable modem which would adequately support a garden variety BBS operation, or suit daily use accessing the vast field of dial-up data services.

Data Bridge DSP-2400

The DSP-2400 Data Bridge modem, on first inspection, is quite ugly, notwithstanding the Australian Design Award sticker that came with it. It has a steeply raked-back front panel sporting an extensive line of indicators. The manual supplied was a preliminary copy only, and consisted of a comprehensive, although un-entertaining, pile of stapled together sheets.

The modem supports 1200 and 2400 bps operation, although other ‘123’ and ‘1234’ type models are available. Synchronous and asynchronous data on the serial port is also possible.

On first using the modem it didn’t reply to commands with the usual “OK” and the speaker, if there is one, was not working, even after issuing an ATM3 command. A set of DIP

switches on the rear panel didn’t have any labels on them and I couldn’t find anything in the manual about them.

The raked front panel allows you to see the indicators quite readily, which is convenient if you place the unit on a desk, particularly so if you sit a phone on top of it.

An extended set of AT commands are supported, although only a few extra commands are supplied. The DSP-2400 has the ability to store a set of telephone numbers in its internal directory, also the modem supports two help screens for the status of the S-registers and stored telephone numbers. Extensive self-testing can also be invoked through software.

Apart from these features, the Data Bridge modem is otherwise reliable, doesn’t run hot over a long period of time and would do well in a dedicated set-up, especially on a main-frame computer. The Data Bridge probably

wouldn’t be a serious consideration for the BBS user or sysop.

Conclusion

What stands out the most about all these modems, is not their similarities, but their differences! If you’re in the market for a modem, at whatever cost or level of features you’re looking at, there’s probably a modem here worth considering. It’s a matter of “horses for courses”, and it’s the differences that become the deciding factor.

Review units kindly supplied by:

Schmidt 123AT, Data Bridge 2400, Dataplex 224: Rosser Communications, Suite 4, 1051 Pacific Highway, Pymble 2073 NSW (02)449 8233.

Trailblazer, Netcomm Pocket Modem, Netcomm 1234SA: Netcomm Australia, PO Box 284, Pymble 2073 NSW (02)888 5533.

Bit Blitzer BBM12E, BBM123E: Mike Boorne Electronics, Suite 3, 61A Hill St, Roseville 2096 NSW (02)46 3014 and Microbee Systems, 1A Pattison Ave, Waitara 2077 NSW (02)487-2711.

Pulsar SAM Modem: Pulsar Electronics, Catalina Drive, Tullamarine 3043 VIC (03)330 2555.

Avtek Megamodem 123: Avtek Electronics, PO Box 651, Lane Cove 2066 NSW (02)427 2177.

Nice Modem 4: Nice Computer Company of Australia, Unit 112/396 Scarborough Beach Road, Osborne Park 6017 WA (09)242 2422.

Telecom TEL-424: Telecom Data Sales, 13 Floor, 157 Liverpool St, Sydney 2000 NSW (02)267 6767.



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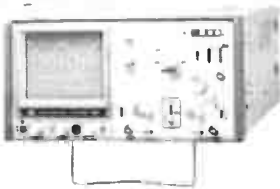
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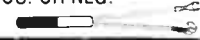
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The "Supermicro" computer project

Part 3

Roy Hill

Now we get down to the exciting bits! – checking it out and powering it up for the first time. No special tools are required, other than a multimeter and a 5 V power supply.

RIGHT, you might be "champing at the bit", but take it step by step and you'll get the project going much more quickly and with fewer mishaps. Please remember that you are going to be dealing with CMOS chips – don't touch the pins of these chips (pick them up by the ends of the package gripped between your thumb and forefinger) and ensure that you have grounded yourself (against the metal case of a power supply is one good way), prior to handling any of these components. You will also need a multimeter, some test leads and flying leads (with probe clips on the end), IC inserters and extractors etc. Also, if at any time none of the signals described below is present, please recheck your soldering to ensure that pins have not been missed and that solder bridges have not been created in the soldering process.

You are going to need a multimeter and a temporary 5 V power supply. If you don't have a multimeter, you'll have to buy one, won't you! If you have, or buy, an analogue (meter type) multimeter, it should have a sensitivity specification of at least 20 000 ohms/volt. Your power supply should be regulated and be able to deliver around 200-300 mA.

STEP 1. Place the board in the orientation used for construction – that is, with the overlay diagram in reading position and the edge connector fingers in the bottom right-hand corner. The first important aspect of the testing is the location and memorisation of the power supply connector.

This connector is labelled P8 and is located at the bottom far right-hand side of the board. The positive supply bus (i.e. +5 volts) almost completely circumnavigates the board on the overlay side (the top of the board – the component side) and the bottom two pins of P8 are connected to this positive supply. The third pin from the bottom is reserved for a -5 volt supply to be added at a later date and the very top pin is the ground pin. Note that the ground bus also almost completely circumnavigates the board on the solder side.

A link will be temporarily required on the far left-hand two pins of P1 (at the top LHS of the board). This link will be a permanent link for those persons wishing to use this board outside an IBM. The testing procedure *will not work if this link is omitted* (the board won't work either). The break in the ground track has been deliberately created to prevent earth loops, which would produce undesired noise in the A/D portion of the board.

STEP 2. We are now going to check the power supply lines to all of the ICs to ensure that there are no open or short circuits to the chips. Switch your multimeter to the resistance (ohms) range and select the lowest range. Switch on the meter and short out the two leads to check that the meter is operating correctly. Adjust the "set Ohms" control to zero the needle if

you have an analogue meter. Connect the black lead of the meter to the ground pin (the top one) of P8. Place the red probe on the ground pins of each of the chips in turn and check for continuity. For normal 14, 16, 20 and 28 pin ICs, the ground pins are 7, 8, 10 and 14, respectively.

Note that the TL497 (IC28) has pins 4, 5 and 8 all connected to ground. IC41 (the LM386) has pins 2 and 4 connected to ground. The AD7569 (IC37) has pins 1, 3, 10 and 18 connected to ground. The MAX232 chip (IC40) has pin 15 as its ground.

The NC4016 has multiple ground connections, eight of these in total. The four internal corner pins are all ground. The other four pins are located in the centre of each of the four edges of the internal grid. If there is any doubt, refer to the circuit diagram. Note that the index pin (the only one by itself – location 121) is on the bottom LHS of the board.

Now to check the positive (+5 V) supply. Connect the red probe to either of the bottom two pins of P8 and check each of the IC sockets. For the conventional chips, the positive supply pins are diagonally opposite the ground pins. The MAX232 (IC40) has pin 16 as its positive supply. The TL497 (IC28) has pin 14 as its positive supply and the LM386 (IC41) has pin 6 as its positive supply. The AD7569 (IC37) has pins 4, 5 and 20 connected to +5 V. The NC4016 has four positive supply pins. These are in the middle row of each of the four edges of the socket, adjacent to the four corresponding ground pins. Once again, if there is any doubt, refer to the supplied circuit diagram of the NC4016.

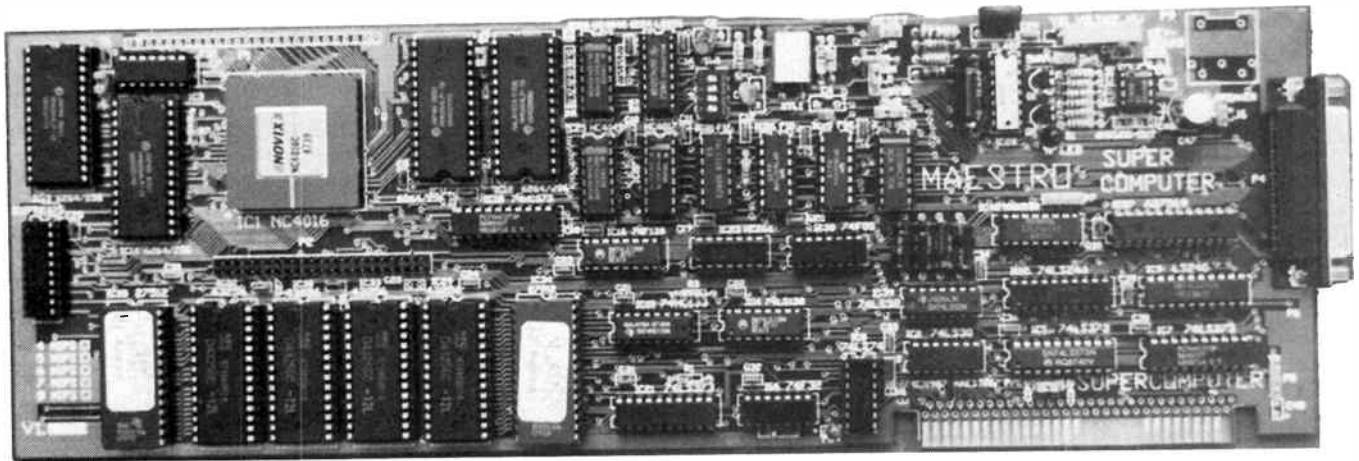
You must check each of the above signals. Once the Novix has been installed in its socket, it is nearly impossible to remove it without damage (unless you have access to the special extractor tool required).

Now check the -5 V bus to ground, using the highest resistance range on your multimeter. It should measure greater than 100 kohms.

STEP 3. Now to check the clock circuit. At this stage it becomes necessary to start inserting ICs into their sockets. Start with IC20 – remember that this part is a 74HC02. Pin 1 is towards the top LHS of the board. Now install ICs 25 and 26. Both of these chips must be 74HC4040 parts. Once again, pin 1 of each of these chips is towards the top LHS of the board.

Connect the black lead of the multimeter to a suitable ground point (the negative pin of J6 is ideal) and connect the power. Set the meter to an appropriate range to measure 0-5 volts dc.

Place the red lead of the meter on pin 1 of IC25. The needle should oscillate between 25% and 75% of the supply at a rate of about 1 Hz. Pin 15 of the same IC should oscillate at twice



the frequency. So far – congratulations. If the clock circuit doesn't work, a detailed visual inspection (check soldering, IC orientation, passive components, etc.) is necessary. If you have access to a CRO, check that the crystal is oscillating and check the lines from the crystal to each of IC25 and IC26.

REMOVE THE POWER SUPPLY.

We now have to add some additional ICs. Insert ICs 19, 21, 24, 27 and 39. Install the shorting lug for SW2 in the RHS position. Please remember that IC21 must be a Fairchild component. It's easy to tell Fairchild components – one can rarely read the writing clearly!

Re-apply the power to the board and check IC21. Pins 15, 16 and 19 of this chip should fire up in the high state (+5 volts). To test the remainder of the clock circuit, it will be necessary to remove the power and to test IC24. If you have a clip that fits over the top of 14 pin ICs, use that. Otherwise you'll have to remove IC24 from its socket and bend pin 9 slightly outwards. PLEASE BE CAREFUL.

Re-insert IC24 into its socket and connect a jumper from a ground location (e.g. the negative lead of J6) to pin 9 of IC24. This forces IC24 to provide the lowest clock speed. Remove IC21 from its socket, re-apply the power and read pin 5 of IC24, which will be the 1 Hz oscillation that we previously obtained on pin 1 of IC25. Also check pin 1 of IC25.

The next position that we find this signal is pin 3 of IC27 (a 74HC4017). This signal should be half the frequency of the previous signal (i.e. approximately 0.5 Hz). The next point to trace this signal to is through IC19 (a Schmidt trigger). This is inverted twice to provide a clean inverted and non-inverted (and buffered) clock signal for the remainder of the board. SW2 selects the inverted/non-inverted clock signal for the board. Check this signal at pin 20 of ICs 11, 12, 13 and 14. These are the RAM chips which act as the Data and Return stacks. The final pin to trace this signal to is pin 6 of the NC4016

This completes testing of the clock circuit. Remove the power, and remove IC24, straighten the pin and replace it in its socket. Replace IC21 as well.

STEP 4. Connect the RESET line to J2, using the momentary contact, N/O (normally open) switch. Install the shorting lug on J1 in the upper position. Place the red lead of the multimeter on pin 12 of IC19, press the reset button (only for a moment) and observe the meter. It should start high, go low when pressed and then return high. Check pin 8 of the NC4016 as well. This is the reset line for the Novix and should follow the above transition.

STEP 5. Well, here we go – switch off the power and remove all the multimeter leads. Insert the remainder of the ICs, with the exception of IC28 (the TL497) and IC37 (the AD7569). Check to make sure that you don't bend over any of the pins of the ICs as you insert them into their sockets. It's best to straighten the pins against a flat, conductive surface, prior to attempting to insert the ICs into their sockets.

When inserting the EPROMs into their sockets, the EPROM marked "HI" goes into IC35 and the one marked "LO" into IC34. Remember to check the orientation of all of the ICs as you insert them. Note particularly that ICs 11 and 12 are inserted in the opposite direction to the remainder of the RAM/EPROM chips.

The NC4016 will require a moderate amount of force to seat correctly. Ensure that the force is evenly distributed over the chip, as too much force on one point may break the ceramic. Do not exert any pressure on the centre of the chip where there are no pins. Confine the pressure to the edges of the NC4016. Perhaps the easiest way to remove the Novix (if it should become necessary) is to use two small, broad-bladed screwdrivers on opposite corners on the same side of the chip, and, rather than levering up, a gentle twist of the blades will move the chip up. Repeat on the opposite side of the chip and this should lift the Novix sufficiently for easy removal.

The kit will be supplied with 6264 static RAMs and the shorting lugs for J4 and J5 must be installed in the upper position. If you have a few fast 43256 chips lying around, you are welcome to use them, of course. Just remember to change the position of the shorting lugs.

STEP 6. Re-apply the power to the board and watch the LED carefully. It should blink rapidly with about a 70% duty cycle. The blinking will stop after about two to three seconds, indicating that the Novix is up and running and ready to commence operation via the serial port. The LED should also blink once only on each depression of the reset button.

Now we can connect the RS232 line to the Maestro Super-Computer. This is done using P7. Pin 1 (on the far LHS of the board) is TxD (marked "OUT" on the overlay). Pin 2 is RxD (marked "IN") and pins 3 and 4 are ground. Next month's article will extend this, describing how your SuperComputer can be up and running with your selected computer/terminal. If you have FAITHFULLY followed all of the steps as outlined above and your Maestro board DOES NOT WORK, do not despair. Return the board to Maestro and include a cheque or money order for \$30 (you must pay the forwarding agent/courier). Maestro will determine the cause of the prob- ▶

lem and advise its solution. Obviously, they are unable to effect the actual repair for this figure – that will be up to the individual.

The next exciting step!

In the next part, we take you through the steps of hooking-up the SuperComputer to a serial terminal and getting it running. Now read through the remaining documentation.

CIRCUIT DESCRIPTION

The circuit is most easily understood, like most complex things, by breaking it up into several sections or areas and taking them piece by piece. So, let us start at the "core", the NC4016 Novix microprocessor. In Part 2 we published por-

TROUBLESHOOTING

For a realistic troubleshooting procedure, a CRO with at least a 10MHz bandwidth is required. The fastest signal on the board is the clock oscillation, running at 16 MHz. There should be no real need to check this signal, as it is divided by the 74HC4040 (the HC ICs have a higher frequency range than the standard parts). Checking the output pins of these chips will prove whether or not the crystal is oscillating correctly.

For those people who do not have a CRO, the only possible testing that can be done has been covered under steps 2 and 3 of last month's issue. Two of the most important things to remember about the board are:

1. Do not leave a malfunctioning board operating for any length of time. If the board has been working correctly and now is not, then suspect such faults as dry solder joints, short or open circuits and failed components (the latter is the least likely of all possibilities). A dead short on the Novix part of the circuit could easily destroy the Novix. If the LED fires up in the correct sequence (as described in the previous issue), it is safe to leave the board running whilst quick checks are made. However, it is strongly suggested that a milliammeter (or multimeter) be connected in series with the power supply, in order to ensure that the board is NOT DRAWING IN EXCESS OF 200 mA.

2. A visual inspection of the board will often yield the best results. Suspect solder joints should be automatically re-soldered, using a soldering iron with a properly earthed tip.

It may never have worked at all, so the steps in the initial test procedure should be followed in detail. If this procedure fails to locate the fault, then it is strongly suggested that a phone call to Maestro is in order. It may be necessary to take advantage of the "Dear Maestro" offer and return the board for determination of the cause of the problem.

For those persons who can gain access to a CRO, checking the data bus for activity (particularly during the half second or so fire-up period) will determine if the Novix is operating correctly. If the Novix crashes after the first half second or so, suspect that the lower RAM is not being correctly selected. Check the Chip Enable (CE) lines of ICs 32 and 33. Also check that there is a system clock present on pin 20 of these ICs.

If the LED doesn't fire-up correctly and the Novix appears to be generating the correct signals, then one can suspect either a faulty LED or a faulty MAX232 (or ICL232) chip.

This is about all that can be done, other than a complete workshop diagnosis, which is well beyond the scope of the average constructor. The notes provided below in the Circuit Description section, may also provide guidance for more extensive troubleshooting procedures.

tion of the circuit, showing the Novix processor, the Data and Return stacks, the RAM and some of the address decoding. The rest of the circuitry is published in this issue.

The Novix section

It must be remembered that the Novix is not your usual microprocessor. It is capable of simultaneous addressing of three separate data and address buses – the main data, the return stack and the parameter stack. It is possible for the Novix to operate without either the data stack or the return stack in operation, albeit in an extremely limited form. All of the unused inputs to the Novix from both of these buses must be held in a known logic state, otherwise the Novix will draw excess current, overheat and possibly expire.

When the board was in its prototype stage, Chris Darling used a combination of software and hardware to verify the operation of these areas. For example, writing simple loop programs and watching them operate via a CRO was one method of ensuring that the Return Stack (using R and R) and the Data Stack were operating correctly. To correctly test the Return Stack using software, no calls to existing Forth words should be made, as this may cause a system crash. This would only occur if the Return Stack was not working correctly. The parallel nature of the Novix allows it to operate at the high speeds that it does. For example, the Forth words SWAP OVER and SWAP – can be performed in the one cycle. The Novix uses eight address lines for each of the Return and Data Stacks, for addressing 16-bit words, but the project provides an extra seven address lines for paging up to 32K words for each of the Data and Return stacks.

Note that only 8K RAMs are provided in the basic kit. Also note that eight address lines is only sufficient to provide 256 storage locations. To address more than these 256 locations requires the use of "paging" techniques. An example of this in the use of two Forth words, the "TIMES" and "+" (non-destructive incremental Fetch). When both of these are used together, it is possible to collect from main memory to the Data Stack in one cycle, thus having an effective data transfer rate equal to the speed of the system clock. When 254 (say) bytes of data have been collected in this manner, there is a brief pause (or slow-down) in the transfer rate, whilst the next page of RAM is selected and then the transfer continues at the system clock speed.

There are separate Read/Write controls for each of the stacks, as well as main memory and I/O. This means that the stacks are ALWAYS selected (allowing the parallel access to occur) and are synchronised by the system clock.

The Novix has a 16-bit I/O port which is taken to P1 for the constructor to make use of in whatever fashion required. This is known as the "BPort." There is also a 5-bit I/O port called the "XPort." This is also provided on P1. However, the two lines X0 and X4 are used for the RS232 transfer between the Novix and its host. If the board is being used inside an IBM, via the IBM bus, then it is possible to use these two lines as well. However, in order to do this, the MAX232 (or ICL232) chip must be removed from its socket. More complete details of the use of the ports and registers will be provided in another section.

On fire-up, the NC4016 looks for a program residing at address \$1000 in EPROM. At this stage, IC21 is latched in such a manner that any READ takes place from EPROM and any WRITE takes place to RAM. Whilst the Novix thinks that it is reading from address \$1000, the EPROM is in fact providing data from address \$9000, which is in the top half of EPROM (starting at \$8000 plus \$1000). Any user-written EPROM applications must be burned from address \$9000 upwards. More details on this feature will be provided in a

future article.

One of the first duties of this bootstrap program is to download the Forth Kernel into RAM and then enable reading from and writing to RAM only. This then allows us to change to a faster clock speed, which is roughly twice the speed at which we were able to access the EPROM. The exact speed up obtained depends upon the speed of RAM used, the mark/space ratio selected, and finally, the access speed of the EPROM.

Address decoding

One of the criteria for correct decoding of addresses requires that we take into account the relatively short time we have available on a single clock cycle to access both the Novix and RAM. The amount of time required by the Novix is fixed by its upper speed limit and the access time for the RAM is determined by its speed. Thus, we need to keep decoding to a minimum of gates in order to avoid unacceptable decoding delays.

This means that the circuit design would not allow us to have more than a single gate propagation delay in the physical decoding of the Address lines and it is for this reason that all decoding chips used are the "F" series of chips, to reduce these delays to an absolute minimum. In particular, IC6b (a 74F32) and IC36c (a 74F10) are used for selecting HIGH and LOW RAM (shown on the circuit diagram as HI and LO), respectively. Both of these chips use A15 as the decoding signal for either HIGH or LOW. If A15 is high, then HIGH Ram is selected and vice versa.

Pins 2 and 5 of IC21 (mentioned earlier – a 74LS373) form the latch that ultimately determine whether we are addressing EPROM, RAM or EPROM burning. Pin 2 high indicates reading from EPROM and writing to RAM. Pin 2 low indicates reading from RAM and, depending upon the state of pin 5, writing to RAM (pin 5 low) or writing to EPROM (pin 5 high). IC21 is a "jack-of-all-trades" chip. Pin 6 controls the A/D-D/A converter (it actually starts the conversion process), pin 9 displaces the I/O window in RAM (or EPROM) downwards by 8 bytes (that is, from \$FFF8-\$FFFF to \$FFF0-\$FFF7). This enables us to program the whole of the EPROM, without losing any of the I/O capacity. Pin 12 is used as Address line A15 for the EPROM. The Novix A15 is not used, because we wish to be able to talk to either half of the EPROM under software control. Pins 15, 16 and 19 are used to control IC24 (the 74LS251 multiplexer) and the various states of these pins control the selection of the system clock rate for the Novix.

IC21 is selected by a combination of IC15, IC16, IC20 and IC23. When all the address lines entering IC15 (a 74HC133 13-input NAND gate) are high, the 8 bit I/O window is selected. Pin 15 of IC15 is fed through IC23 (a 74HC266 two input XOR gate), one of whose inputs is A3 and the other is fed from pin 9 of IC21. When pin 2 of IC23 is high, the I/O window will be in the higher location, and vice versa. Pin 9 of IC15 is fed into Pin 4 of IC16 (a '38 three to eight line decoder). Address lines A0, A1 and A2 also input to pins 1, 2 and 3 of IC16 and these, in combination with pin 4 (and the system clock – pin 5), give us 8 x 16 bit wide I/O locations for reading/writing.

Pin 7 of IC16 (the top address location) is applied to pin 2 of IC20 (a 74HC02 two input NOR gate). Together with pin 3 of IC20, this pin determines the selection of IC21 (the latch). When the DR/W line is low and pin 2 of IC20 is low, we can write to IC21. When DR/W is high (that is, reading), and pin 2 of IC20 is low, we are in fact reading the condition of the IBM status line.

System clocks

The main system clock is provided to pin 10 of IC26 (a 74HC4040 – a 12-stage binary counter). This provides 12 clocks out, the last of which is fed into the input of IC25 (another 74HC4040) to provide a further 12 stages of clock output. A total of 8 of these outputs are provided to the input gates of IC24 (a 74LS251 multiplexer). Pin 5 of this chip (the Z output) is applied to pin 14 of IC27 (a 74HC4017 – a 5 stage Johnson counter with 10 decoded outputs). Pin 3 of IC27 is the output clock to the rest of the system.

The four-position DIP switch determines the "divide by" ratio of the incoming clock stream. It does this by providing a feed-back pulse from the selected output to the reset line (pin 15) of IC27. This reset pulse determines the number of stages reached by the counter, before the process is re-started.

Pin 3 is then passed to pin 9 of IC19 (a 74HC14 – an inverting Schmitt trigger) and the output (pin 8) is applied to one side of SW2 to give an inverted clock, whilst pin 8 is also applied to pin 11 of IC19. The output of this signal (pin 10) provides a non-inverted clock signal to the other side of SW2.

ICs 17 and 18 (74HC373) provide the extra address lines for the Return and Data stacks.

The IBM interface section

The IBM section has been provided to give fast data transfer rates between the Novix and the IBM. It is an unfortunate fact of the life that even a 10 MHz AT clone is going to have a lot of trouble keeping up with the Novix. In fact, Chris spent two days optimising "EMIT" to try and let the IBM's incredibly slow screen drivers keep up with the Novix. It was decided that the project would communicate with the IBM by emulating a serial port. This has the advantage that most standard comms package will be able to communicate with it. Even if the comms package returns the error "Device not Found" (CrossTalk is the culprit here), the project still should work.

The project uses the IBM's Parallel data bus, but uses it in such a manner that it appears as a serial link to the board.

IC2 (a 74LS30 – an 8-input NAND gate) is used to decode the address of the comms port of the IBM. The output of this (pin 8) is fed into pin 5 of IC4 (a 74LS138 – 3-to-8 line decoder). This decoder is used in conjunction with IBM address lines +A0, +A1 and +A2 to select the "pseudo registers" of the comms port. Pins 10 and 15 of IC4 are the only two signals required to enable these "pseudo registers". Pin 15 is applied to pin 9 of IC20 and pin 2 of IC6. IC20 is used to decode the WRITE instruction from the IBM. IC6 decodes the READ instruction from the IBM. Pin 10 of IC20 is applied to pin 11 of IC7 to allow IBM data to be written to the latch (IC7). Pin 3 of IC6 is applied to pin 1 of IC5, which turns on the output of IC5, allowing the IBM to read data from the latch (IC5). At the same time, the Novix needs to know if the data present has been read or written. Therefore, the same signal is applied to pin 3 of IC8 (a 74LS74 – flip-flop). Pin 10 of IC20, therefore is also applied via an inverter to pin 11 of IC8b, so that every time this pin is pulsed, a logic "1" appears on pin 9 (the "Q" output). This is held in this state until a reset appears by the generation of a subsequent Novix read.

Pin 9 of IC8b is applied to Pin 13 of IC9 (a 74LS240 – an inverting buffer) and Pin 4 of IC10 (a 74LS244 non-inverting buffer). IC9 is read by the IBM as the Status Register and IC10 is read by the Novix as the Status Register.

ICs 5 and 7 are the latches that read the data being passed from the board to the IBM and vice versa, respectively.

Details of other circuit components will be described at appropriate times. ▶ – to page 64

letters

AEM 10, opposition nil!

Dear Roger,

I would like to take this opportunity to say how much I enjoy reading AEM each month. A measure of my satisfaction with AEM may be gauged from the fact that my ten most recent electronic projects have all been featured in AEM, opposition nil!

I hope that your move to new premises will result in continued prosperity for the magazine, although you will have to content yourself with the image of the kookaburra on the magazine cover, rather than the real ones in Fox Valley.

**D.B. Quick,
Wahroonga NSW**

Thanks for the encouragement. The cover kookaburra is not the only type seen in the "wilds" of Balmain - there are real ones and they make just as much din around here as their Fox Valley cousins most mornings!

Roger Harrison

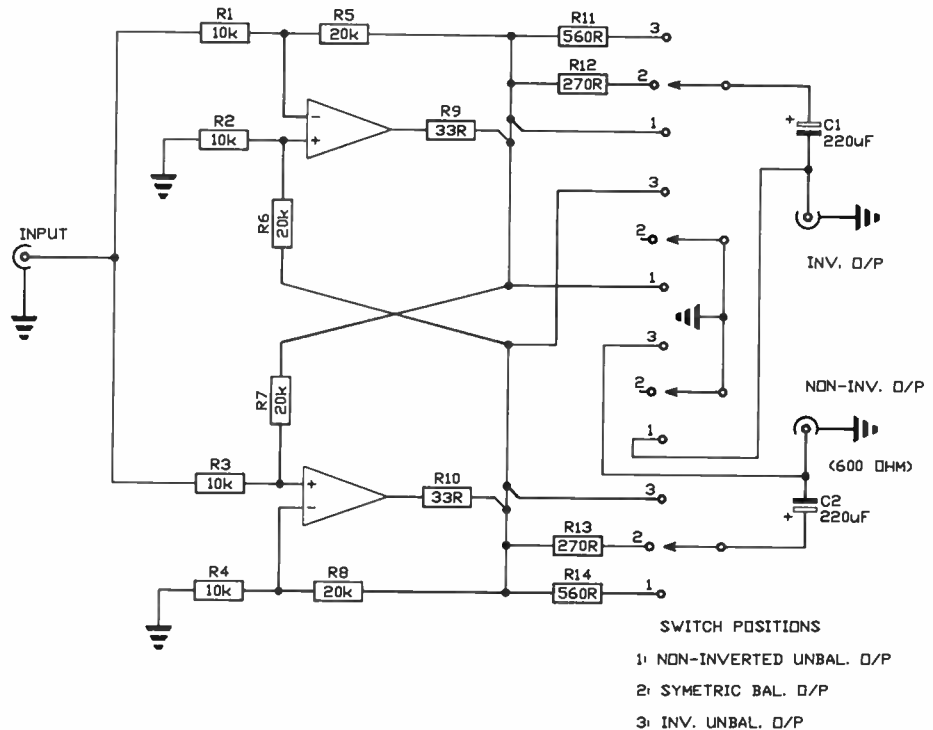
Audio bal-to-unbal converter

Dear Roger,

I saw your reply to Ben Furby (*Letters*, p.16 Nov. '87) on the subject of getting balanced outputs from audio gear and I don't think your circuit will do what's required.

For the interest of Ben Furby and others who have such an application, the circuit here (adapted from those used in several brands of professional recording equipment) provides the desired symmetrically balanced output and 0 dB gain. It also has the useful attribute of enabling the unbalancing of either "leg" of the output without changing the total output voltage. The cross-coupling used has the side effect of cancelling differences due to offset voltage drift, too, so that the headroom of the circuit is limited only by the power rails used. Note that power rails and bypassing, compensation and trim components have been omitted for the sake of clarity.

The 33 Ohm "build-out" resistors are as low as possible for a stage which may have to drive a long line; anyone using



lines over a metre long may need to increase the value of these two resistors to ensure unconditional stability. If they are changed, the 270R and 560R resistors must be changed, too, so that the total value always comes to a touch under 600 Ohms; the output impedances of the op-amps make up the rest (i.e. to 600 Ohms).

The preferred op-amp type is the NE5534 since it permits tailoring of the bandwidth and phase shift etc, and has also a much better performance when used to drive lines, rather than the TL0xx series devices. The 5534 also has much lower noise and is not significantly more costly.

This circuit (and yours) suffer from the disadvantage that if the output impedance is not closely matched, the output level will vary quite widely. Can you or anyone else suggest a way to overcome this?

Thanks for a well presented and informative magazine.

**Chris Wendt,
Hawthorn, Vic.**

You're right, the circuit we gave in answer

to Ben Furby's letter won't do the job. It was selected from material on-file - and the wrong item was selected! We'll check more thoroughly in future.

Regarding level variations with variations in output matching, I think only automatic level control circuitry would overcome the problem - adding more complexity and expense.

Roger Harrison

Pleased with his prize

Dear Roger,

This is just a short note to tell you how pleased I am with the Philips 2618 DMM I won in AEM's Second Birthday Contest.

In the few weeks I have been using this multimeter I have found it to exceed my expectations in every way.

Thank you once again, and also thanks to Philips (Test and Measurement) for donating such a great prize.

Keep up the good work with the top electronics magazine in Australia.

**Wil Schomaker,
Hurstville, NSW**

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in AEM

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

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UNIVERSAL MULTIPLEXER

A fast, analogue and digital compatible, 16-channel multiplexer with provisions for manual and computer control. The circuit is offered as a design idea, and should find applications in test, measurement and instrumentation equipment.

The circuit described here is essentially an electronic 16-way rotary switch. It is composed of 2 functional sections: one takes care of the connection between the selected input channel and the "pole" of the 16-way switch, i.e., the output of the circuit, while the other provides the control signals necessary to select a particular channel from the 16 available. The control section accepts manual as well as computer or automatically generated channel selection codes. Applications of the universal multiplexer include quasi-simultaneous temperature measurement in a network of sensors mounted in different locations, controlled capturing of signals from strain gauges, light sensors or transducers, and the routing of command signals and voltages in automated test, measurement and production systems.

Manual or automatic control

In the manual mode, the desired channel is selected by the user pressing the channel increment key as many times as required. In the automatic mode, an oscillator provides the channel increment pulses. With reference to the circuit diagram of Fig. 1, the user selects between manual and automatic channel increment pulses with the aid of toggle switch S_1 . This supplies a clock pulse to bistable FF_1 via set-reset bistable IC_{11b} , whose Q and \bar{Q} outputs toggle on each rising edge of the CLK signal. Thus, each time S_1 is pressed, the multiplexer changes between manual and automatic channel control, or vice versa. LEDs D_{17} and D_{18} indicate the currently selected mode. On power up, network R_1-C_1 at the SET input of FF_1 selects manual channel increment pulses. These are generated by S_2 and S-R bistable IC_{11a} , which functions as a debounce circuit. AND gate N_{3b} blocks the manual channel increment pulses when the unit is set to the automatic mode. Similarly, N_{3a} prevents the channel increment pulses from oscillator IC_4 being applied to pin 1 of N_{2a} in the manual mode. The oscillator pulses are only used in the automatic channel increment mode, that is, when \bar{Q} of FF_1 is logic high. The output frequency of the oscillator set up around IC_4 is adjustable to enable the channel increment speed being set as required for the application in question.

The channel increment pulses are not

routed direct to the switching section: AND gate N_{3c} effectively blocks them when the microprocessor or microcomputer holds circuit input $\mu P/\overline{MAN}$ logic high. In that case, LED D_{19} lights to indicate that the increment pulses originate from the computer, and are applied to the CLK input of binary counter IC_1 via N_{31} and N_{4b} . The clock pulses received by IC_1 increment the 4-bit binary value at outputs $QA \dots QD$. LED D_{20} indicates the presence and the relative speed of the received or internally generated clockpulses.

Computer control

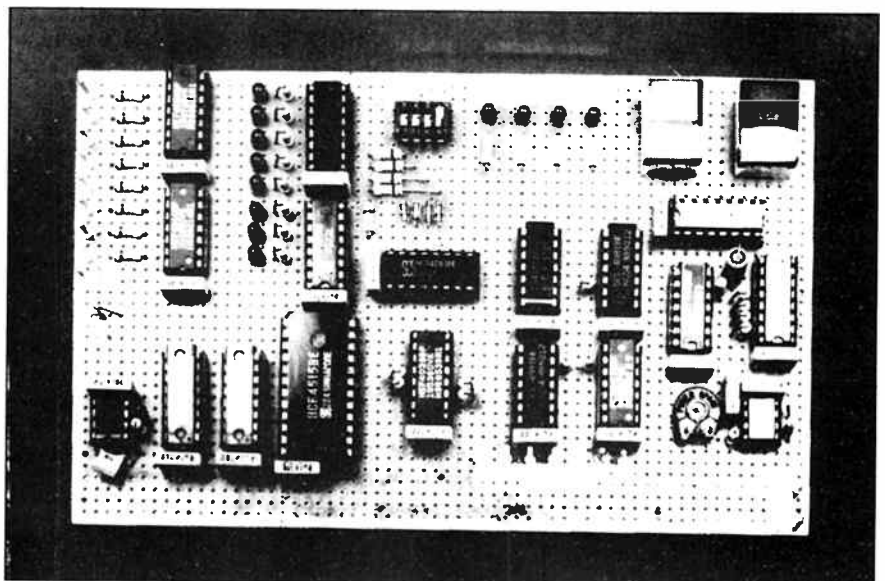
So far, the circuit description suggests that channel selection in the multiplexer is sequential and unidirectional. This means that if, for example, channel 3 is currently selected, the next channel can only be number 4, making it impossible to step back to, say, channel 2, or on to 5 with a single clock pulse. This restriction was found unacceptable, so that the circuit was extended to enable the direct selection of any 1 of the 16 channels via input lines $D_0 \dots D_3$, which control counter inputs $A \dots D$ direct. When the computer's output port applies a logic high level to inputs $\mu P/\overline{MAN}$ and \overline{LOAD} , pin 1 of IC_1 goes high, so that the binary value on $D_0 \dots D_3$ is transferred to $QA \dots QD$. The control of input lines $D_0 \dots D_3$,

$\mu P/\overline{MAN}$ and \overline{LOAD} is within every programmer's reach when the appropriate data is sent to the computer's parallel output port (e.g. the Centronics outlet) with the aid of a simple BASIC program or (machine language) subroutine.

The use of computer control on the proposed multiplexer makes it possible to activate any 1 of 16 (2^4) channels at any time. This is in contrast to the sequential and unidirectional channel selection in the manual (automatic or switch-controlled) mode.

The 4 DIP switches marked RESET in the circuit diagram determine the last (highest) channel that can be activated. Four-bit comparator IC_3 compares the number of the selected channel to the configuration of the DIP switches, i.e., to the number of the channel defined as the last one. Output $A=B$ (signal RS) goes high when equal channel numbers are applied to the A_n and B_n inputs of IC_3 . The \overline{LOAD} input of counter IC_1 is activated, and inputs $A \dots D$ read 0000 thanks to pull-down resistors $R_2 \dots R_5$ incl. This resets the counter to output state nought.

The current channel number is indicated by 1 of 16 LEDs selected by 4-to-16 decoder IC_2 . The channel code is also applied to display driver IC_{10} , which arranges for the decimal channel number to be shown on a $1\frac{1}{2}$ -digit common cathode display. It should be noted that binary input 0000 on the SAB3211



A prototype of the universal multiplexer built on a piece of veroboard.

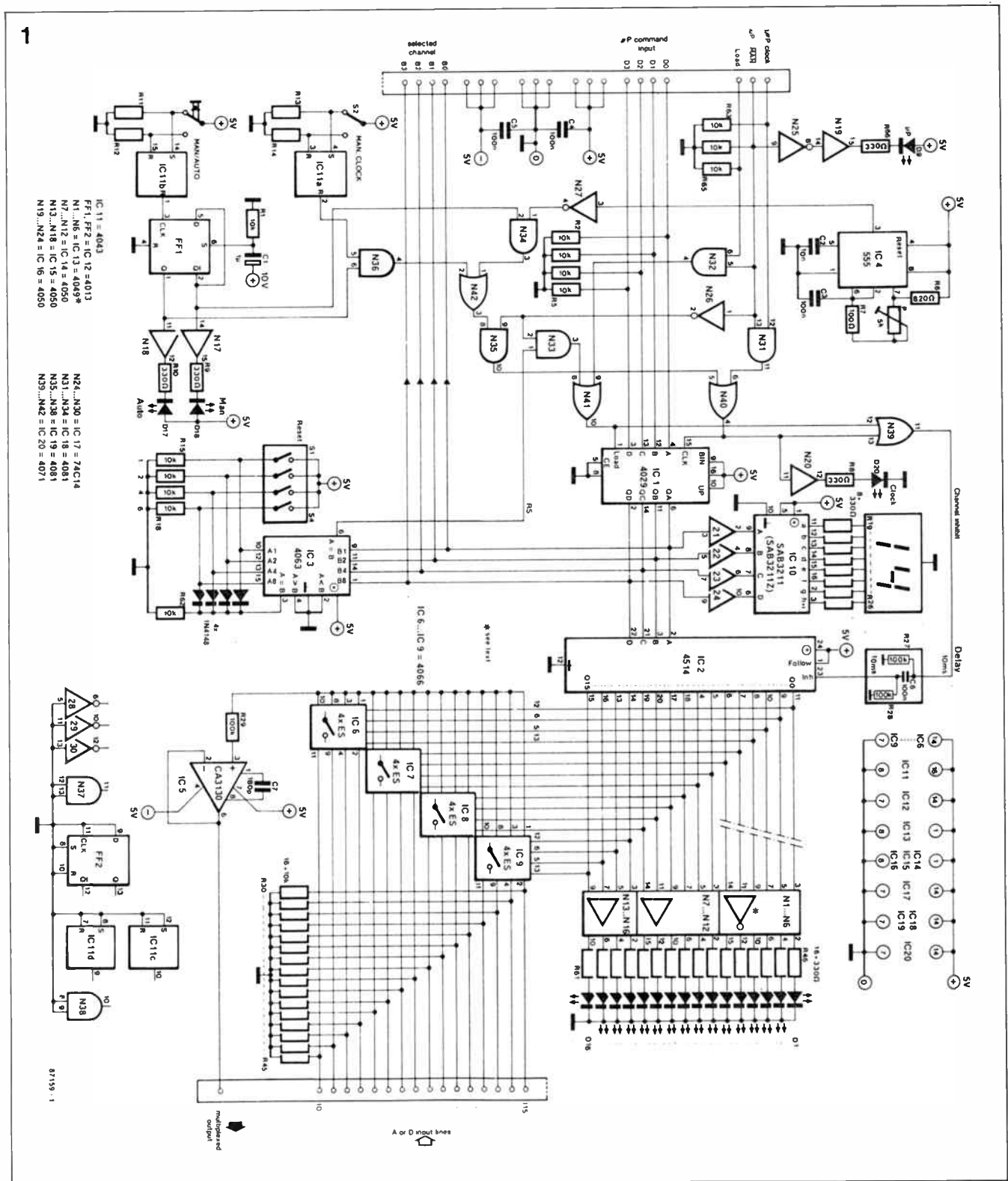


Fig. 1. Circuit diagram of the universal multiplexer.

causes the display to read '16'. The Type SAB3211 is manufactured by Siemens, and may be a difficult to obtain component. The more familiar Type 9368 is suggested as a suitable alternative, but it should be noted that this causes the channel numbers to be displayed in hexadecimal (0...F) rather than decimal.

Relays or electronic switches

Some applications of the multiplexer call for the use of relays rather than electronic switches in IC6...IC9 incl. The modifications to the circuit to enable operation with relays are shown in Fig. 2. The Type 4514 decoder is replaced by a 74HC154, whose outputs are active low,

so that inverters Type 4049 are required instead of non-inverting buffers Type 4050. Do not forget to fit a protective diode across each relay coil as shown. The R-C filters on the input lines may not be required in all cases, but are recommended as a protective measure against crosstalk and switching noise. Electronic switches not only consume

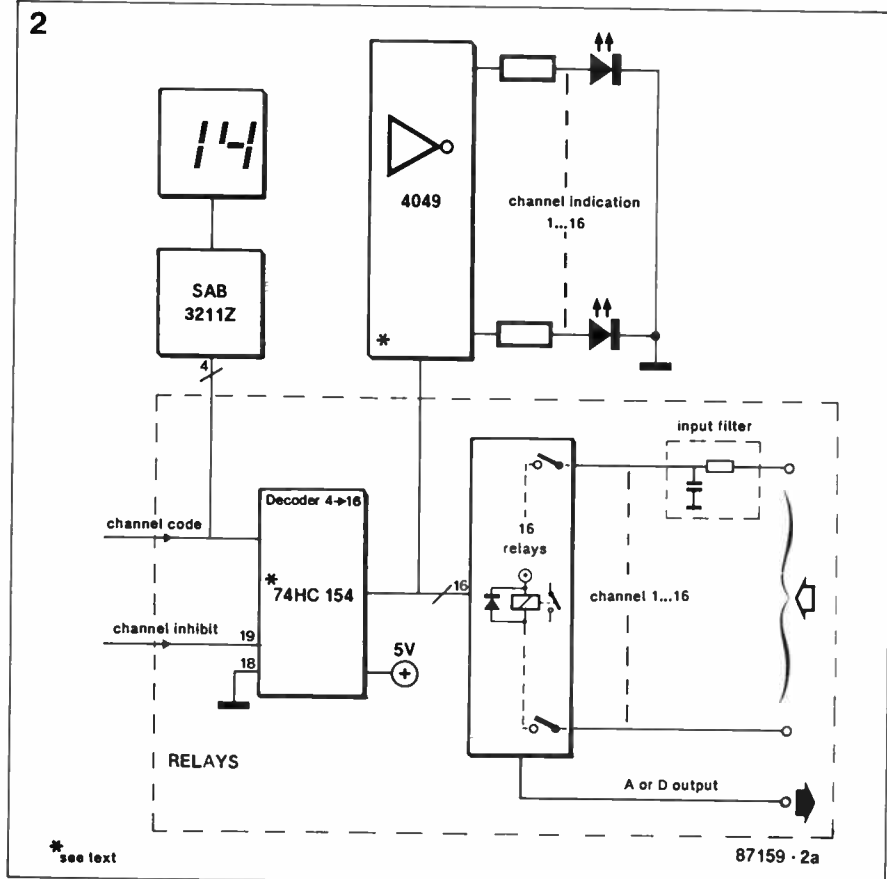


Fig. 2. Modifications to the multiplexer to enable the use of relays in the switching stage.

little power, they also have the advantage of being fast, silent, small, and inexpensive. They do not, however, allow the safe use of different potentials in the channel selection circuit (i.e., the multiplexer) and the circuit(s) driving the input lines. In applications where this is expected to

cause problems, it is recommended to ensure adequate insulation through the use of relays.

The multiplexed signal is buffered in operational amplifier ICs. This guarantees light loading of the selected channel, and a relatively low output impedance

for driving a wide variety of test equipment.

The analogue switches may be protected against static discharges by fitting 2 small-signal diodes on each input line. One diode is connected with its cathode to ground, and its anode to the input line; the other with its cathode to the positive supply voltage, and its anode to the input line.

Depending on the type of relay used, and the multiplexing speed, the inertia of the contacts may give rise to erroneous measurements owing to brief short-circuits between input channels. This is prevented by delay network R₂₇-R₂₈-C₆ freezing the output state of decoder IC₂ for about 10 ms in between 2 clock pulses. This ensures that the currently energized relay has enough time to complete opening its contacts before the next channel is selected.

The multiplexer can be fed from any supply voltage between 5 and 16 V, provided the series resistors for the LEDs and the display are dimensioned accordingly. Relays, as well as the 74HC154, require a supply of 5 V.

Finally, it should be noted that the circuit described is experimental: it can be extended as well as simplified to individual needs. The RESET configuration around IC₃ can be simplified by hard wiring the relevant inputs A_n on the comparator; the 1½ digit read-out can be set up around a display driver other than the SAB3211; the LEDs and associated driver ICs are optional; the number of channels can be reduced, and the gates used for the microprocessor interface may be omitted if computer control is not envisaged.

CORRECTIONS

SSB receiver for 20 and 80 m

Resistor R₆ shown in the circuit diagram is not present on the printed circuit board. This has no consequence for the operation of the receiver.

Long-range infra-red receiver-transmitter

Factor π was erroneously omitted in the denominators of the 2 fractions preceding equation [6].



Ratings: Available as standard types: 240V Primary
VA SEC VOLTS

VA SEC VOLTS	15	30	50	80	120	160	225	300	500	625
6+6	•	•	•	•	•					
9+9	•	•	•	•	•					
12+12	•	•	•	•	•					
15+15	•	•	•	•	•					
18+18	•	•	•	•	•					
22+22	•	•	•	•	•					
25+25	•	•	•	•	•					
30+30	•	•	•	•	•					
35+35					•					
40+40					•					
45+45					•					
50+50					•					
55+55					•					

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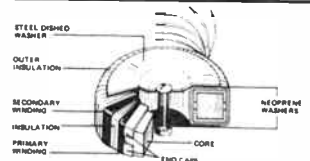
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INFRA-RED HEADPHONES

A low-cost infra-red transmitter and receiver to put an end to the inconvenience of an ever too short headphone cord.

The infra-red band around 950 nm is ideal for short-range communication: no permits are required, there is very little interference, and active components for transmission and reception are readily available at reasonable prices. This article discusses a frequency modulated infra-red transmitter and associated receiver capable of covering typical "living room" distances. The designs of transmitter and receiver are fairly simple, offering many ways for further experiments in infra-red communication. Readers interested in a theoretical background to the subject are advised to consult reference (1).

The transmitter

Figure 1 shows the circuit diagram of the transmitter. The design is based on only 2 integrated circuits: one for AF amplification and pre-emphasis (IC₁), the other, IC₂, for frequency modulation (FM) of the pulsed current passed through IRED (infra-red emitting diode) D₁.

Resistors R₄, R₅, R₆, and capacitors C₃ and C₄ form the negative feedback network for the operational amplifier, and provide a 6 dB/octave pre-emphasis circuit whose roll-off is set at about 3,000 Hz. The gain of the opamp is defined almost exclusively by R₄: a higher resistor value results in higher gain of the input stage.

IC₂ is a voltage controlled oscillator (VCO), whose central frequency, f_0 , is determined by the product $(P_2 + R_9)C_6$, and the direct voltage applied to pin 5. In this circuit, f_0 is about 150 kHz. This frequency can be set with the aid of P₂ in the absence of a modulating signal. The modulation signal applied to the input of the transmitter is translated into a corresponding change of the direct voltage at the input of the VCO, and so results in a frequency modulated output signal, which is used for switching the IRED on and off.

The rectangular output signal of the VCO is applied capacitively to switching stage T₁. This transistor is switched hard at the VCO output frequency, and so pulses the forward current through connected IREDs between R₁₂ and the positive supply line. Dimension R₁₂ as follows (the value is given in brackets after the number of IREDs):

1 (120R); 2 (100R); 3 (82R); 4 (68R); 5 (47R); 6 (33R); 7 (22R).

Finally, the 12 V regulated power supply

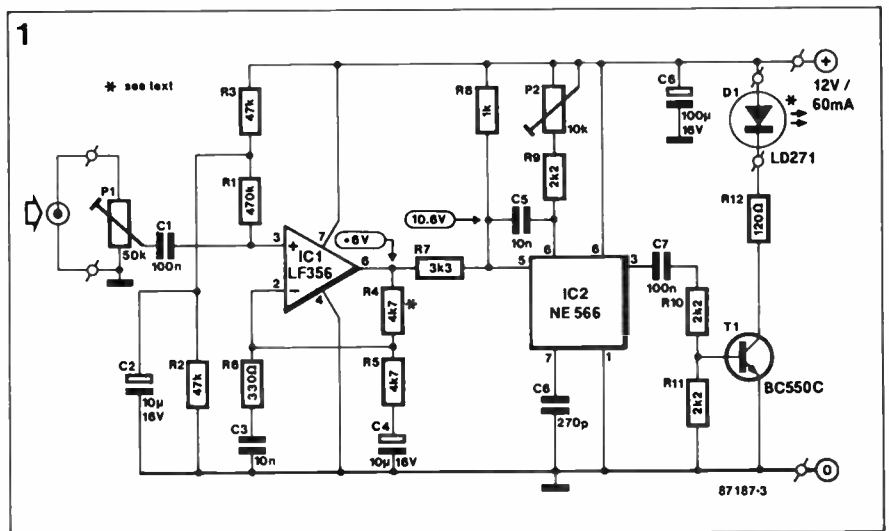


Fig. 1. Circuit diagram of the infra-red transmitter.

for the transmitter is conventional as shown in Fig. 2.

The receiver

With reference to the circuit diagram of Fig. 3, photodiode D₁ conducts when it receives incident infra-red radiation. The base of T₁ is pulled to ground at the frequency of the modulated IR signal from the transmitter. A parallel tuned circuit, L₁-C₁, forms a filter that can be set for a centre frequency of about 150 kHz. The filter forms a low impedance for all signals other than those at about 150 kHz, and keeps the base of T₁ at about +2.5 V when no IR signal is received.

The received pulses are magnified in a 2-stage, direct coupled transistor amplifier. Gate N₁, and anti-parallel diodes D₃-D₄, function as limiters to prevent overdriving the FM detector. This is composed of phase comparator N₂, VCO N₃-N₄, and low-pass filter R₁₃-R₁₄-C₈. Gates N₃ and N₄ form an astable multivibrator, or oscillator, whose output frequency is set by the voltage at junction R₁₀-R₁₁. This voltage depends on the setting of P₁, and the signal at the output of N₂. Figure 4 shows how this XOR gate can work as a phase comparator: the carrier pulses are applied to one input of the gate, the VCO signal to the other. The output of the XOR gate goes high when the inputs are driven with different logic levels. As the IRED, D₁. The output power, and, therefore, the range, of the transmitter can be increased by fitting up to 7 series-

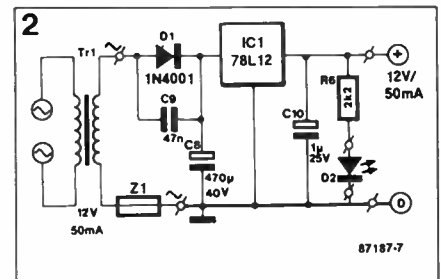


Fig. 2. Suggested power supply for the IR transmitter.

period, the output signal has roughly twice the frequency of the input signals, while the period is directly related to the phase difference of the input signals. The output signal of N₂ is applied to integrating and averaging network R₁₄-C₈, whose operation is illustrated in the curve below the rectangular signals shown in Fig. 4.

The averaged output of the phase comparator forms the control voltage for the VCO. The FM detector is a closed loop, so that the VCO has its output frequency corrected until the phase difference with respect to the received pulses is constant. Referring back to Fig. 4, constant phase difference is achieved only when the VCO signal and the received signal are of equal frequency. The received signal is frequency modulated, however, so that the control voltage of the PLL is, ideally, a copy of the modulation signal applied to the transmitter. In other words, the demodulated signal is available on junction R₁₃-R₁₄.

Low-pass filter R₁₅-C₉ forms the de-▷

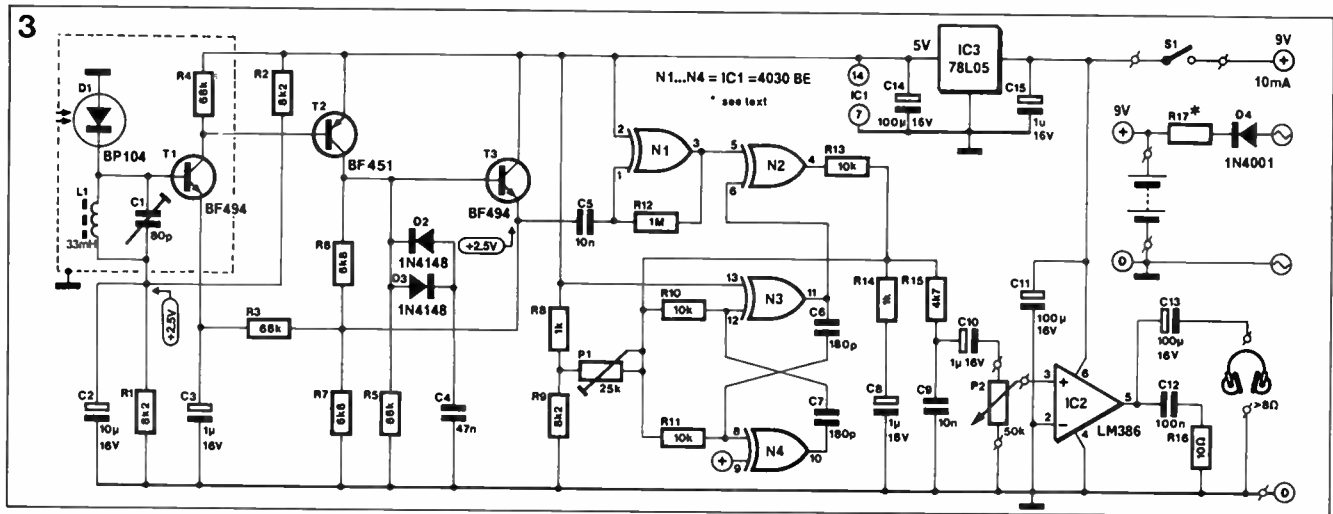


Fig. 3. Circuit diagram of the infra-red receiver. Note the use of CMOS gates in the FM detector.

emphasis network in the receiver. The demodulated and filtered signal at junction $R_{15}-C_9$ is applied to volume control P_2 and from there to integrated head-phone amplifier IC_2 .

The receiver is powered from a 9 V PP3 or NiCd battery. The latter has a higher capacity, and can be charged from the circuit shown to the right in Fig. 3. The value of current limiter R_{17} is calculated from

$$R_{17} = 10(U_{TR} - 9.6) [\Omega]$$

where U_{TR} is the secondary voltage supplied by the mains transformer. Regulator IC_3 ensures the stability of the supply voltage for the DC coupled input stage and the FM demodulator. Current consumption of the receiver is of the order of 10 mA.

Construction

Construction of the project is commenced by cutting the printed circuit board shown in Fig. 5 to enable building the transmitter (right-hand section) and the receiver (left-hand section) as separate units.

The majority of parts on the 2 boards is mounted upright to make for compact units. Observe the correct orientation of the transistors, diodes, ICs and electrolytic capacitors.

The power supply for the transmitter is conveniently built on a small piece of prototyping board. Provision has been made for fitting 3 series-connected IREDs in position D_1 : these should, of course, protrude from holes in the top panel of the transmitter enclosure.

The rectangle drawn on the overlay of the receiver board corresponds to the dashed lines in the circuit diagram of the receiver. The lines denote a vertically mounted, 15 mm high screen cut from brass or tin metal sheet. The 10 cm long metal plate is shaped as shown, and then secured in the corners onto 4 grounded

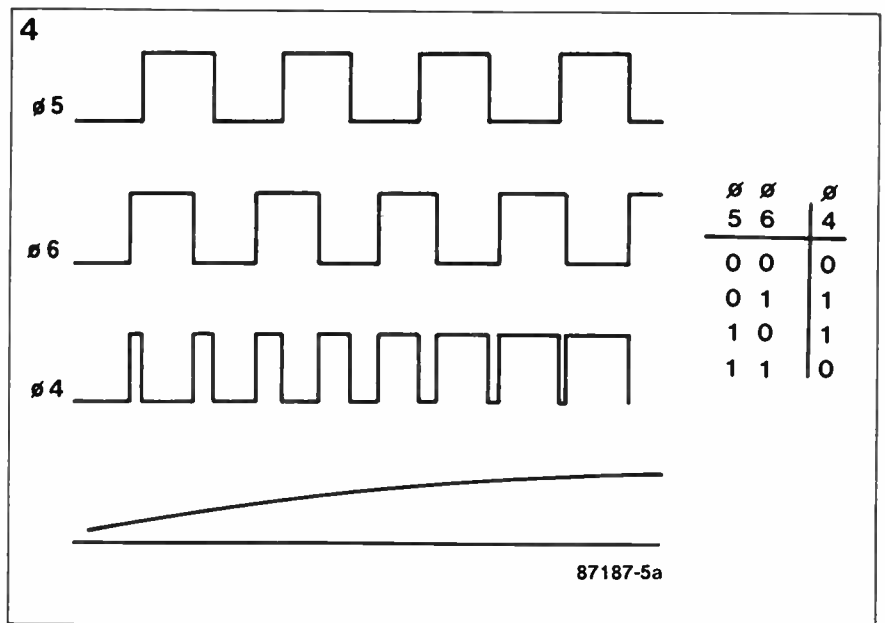


Fig. 4. A single XOR gate and an integrating network can work as a demodulator for FM signals.

soldering pins. Photodiode D_1 should be fitted on soldering pins to ensure that its face is above the rim of the metal screen. The receiver board can be fitted in a transparent Heddic enclosure Type 222. If an opaque enclosure is used, D_1 should, of course, be fitted in a small clearance to ensure that it can receive the transmitted IR beam. The connections of volume control P_1 are soldered direct onto the board, and the potentiometer is secured in the top panel of the enclosure. The photographs in this article can be used as a guide in fitting the completed transmitter and receiver in the respective enclosures.

Setting up

After carefully checking the completed boards for the correct position and value

of all the components, the absence of short circuits and faulty solder joints, and the connections to the supplies and external controls, it is time to set up the transmitter. Power up the unit, and verify the presence of the voltages indicated in the circuit diagram. Use a long-wave radio, an oscilloscope, or a frequency meter connected to pin 3 of IC_2 , for adjusting the centre frequency of the VCO to 150 kHz with the aid of P_1 . Apply a monaural line signal of about 200 mV_{pp} to the modulation input on the transmitter. Place the IR receiver 3 metres or so from the transmitter, and set C_1 and P_1 to the centre of their travel before switching on. Connect a small loudspeaker or headphones to the AF output. Point the IRED(s) and the photodiode in each other's direction. Peak C_1 and P_1 in the receiver for optimum reception, increasing the distance in steps of 1 metre. Prototypes of the IR

Parts list

TRANSMITTER. CIRCUIT DIAGRAM: FIG. 2.

Resistors ($\pm 5\%$):

R₁ = 470K
R₂; R₃ = 47K
R₄; R₅ = 4K7
R₆ = 330R
R₇ = 3K3
R₈ = 1K0
R₉; R₁₀; R₁₁ = 2K2
R₁₂ = 120R; 0.5 W (see text)
P₁ = 50K or 47K preset H
P₂ = 10K preset H

Capacitors:

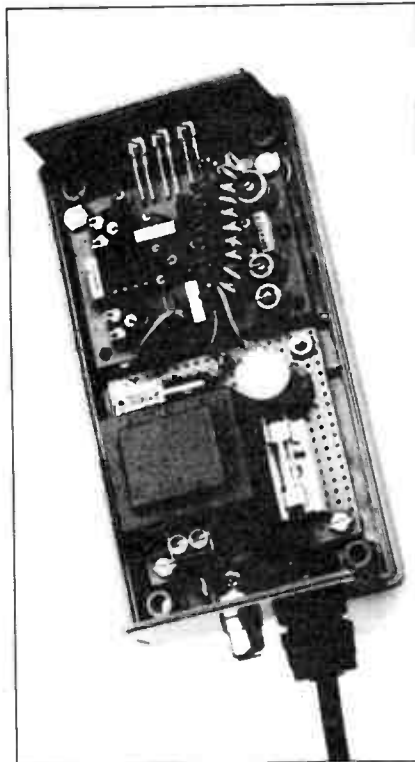
C₁; C₇ = 100n
C₂; C₄ = 10 μ ; 16 V
C₃; C₅ = 10n
C₆ = 270p
C₈ = 100 μ ; 16 V

Semiconductors:

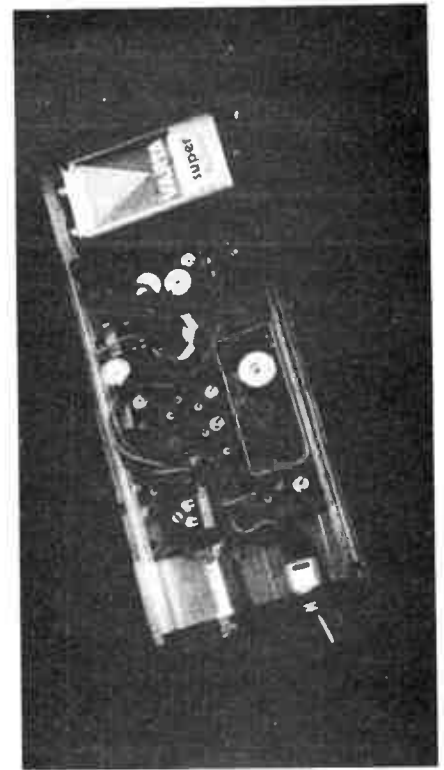
D₁ = LD271 (see text)
T₁ = BC550C
IC₁ = LF356
IC₂ = NE566

Miscellaneous:

12 V power supply (Fig. 2).
suitable ABS enclosure.
Cinch socket for AF input.



The IR transmitter and associated mains power supply fitted in a small ABS enclosure.



Prototype of the battery-operated IR receiver fitted in a transparent Heddic 222 enclosure.

transmitter and receiver had a usable range of nearly 20 m. *B*

Reference:

(1) Long-range infra-red transmitter-receiver.

5

Parts list

RECEIVER. CIRCUIT DIAGRAM: Fig. 3.

R₁; R₂; R₉ = 8K2
R₃; R₄; R₅ = 68K
R₆; R₇ = 6K8
R₈; R₁₄ = 1k0
R₁₀; R₁₁; R₁₃ = 10K
R₁₂ = 1M0
R₁₅ = 4K7
R₁₆ = 10R
R₁₇ = see text
P₁ = 25K or 22K preset H
P₂ = 50K logarithmic potentiometer

Capacitors:

C₁ = 80p trimmer
C₂ = 10 μ ; 16 V
C₃; C₈; C₁₀; C₁₅ = 1 μ ; 16 V
C₄ = 47n
C₅; C₉ = 10n
C₆; C₇ = 180n
C₁₁; C₁₃; C₁₄ = 100 μ ; 16 V
C₁₂ = 100n

Inductor:

L₁ = 33 mH; e.g. Toko Type 181LY-333 (Circuit stock no. 34-33302)

Miscellaneous:

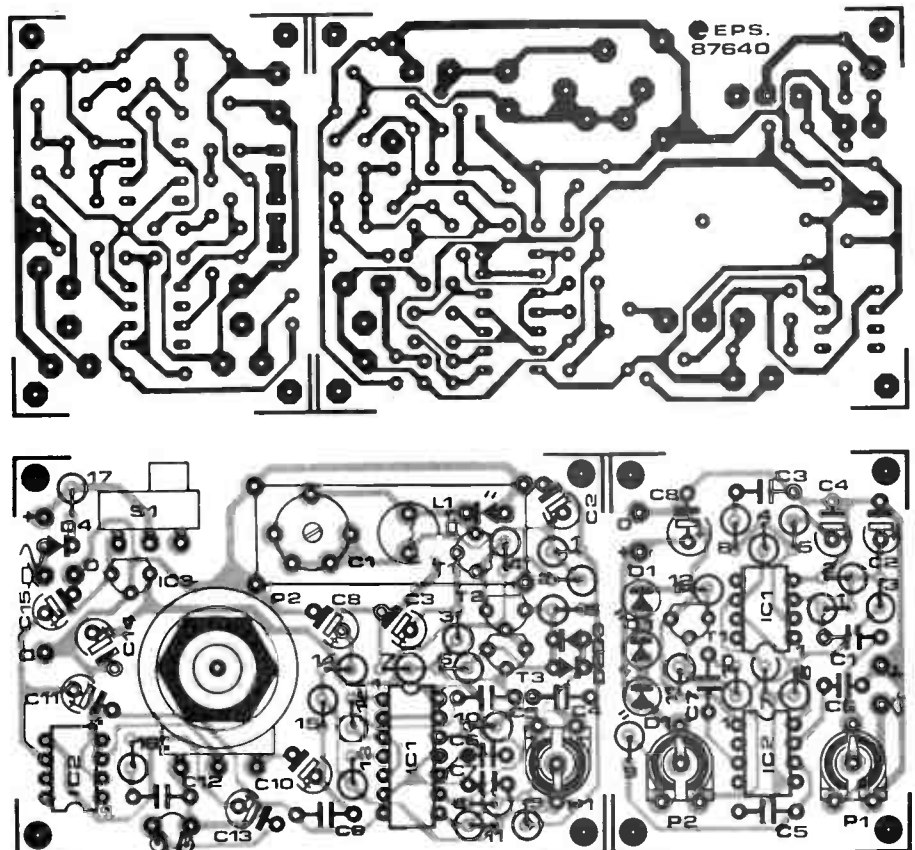
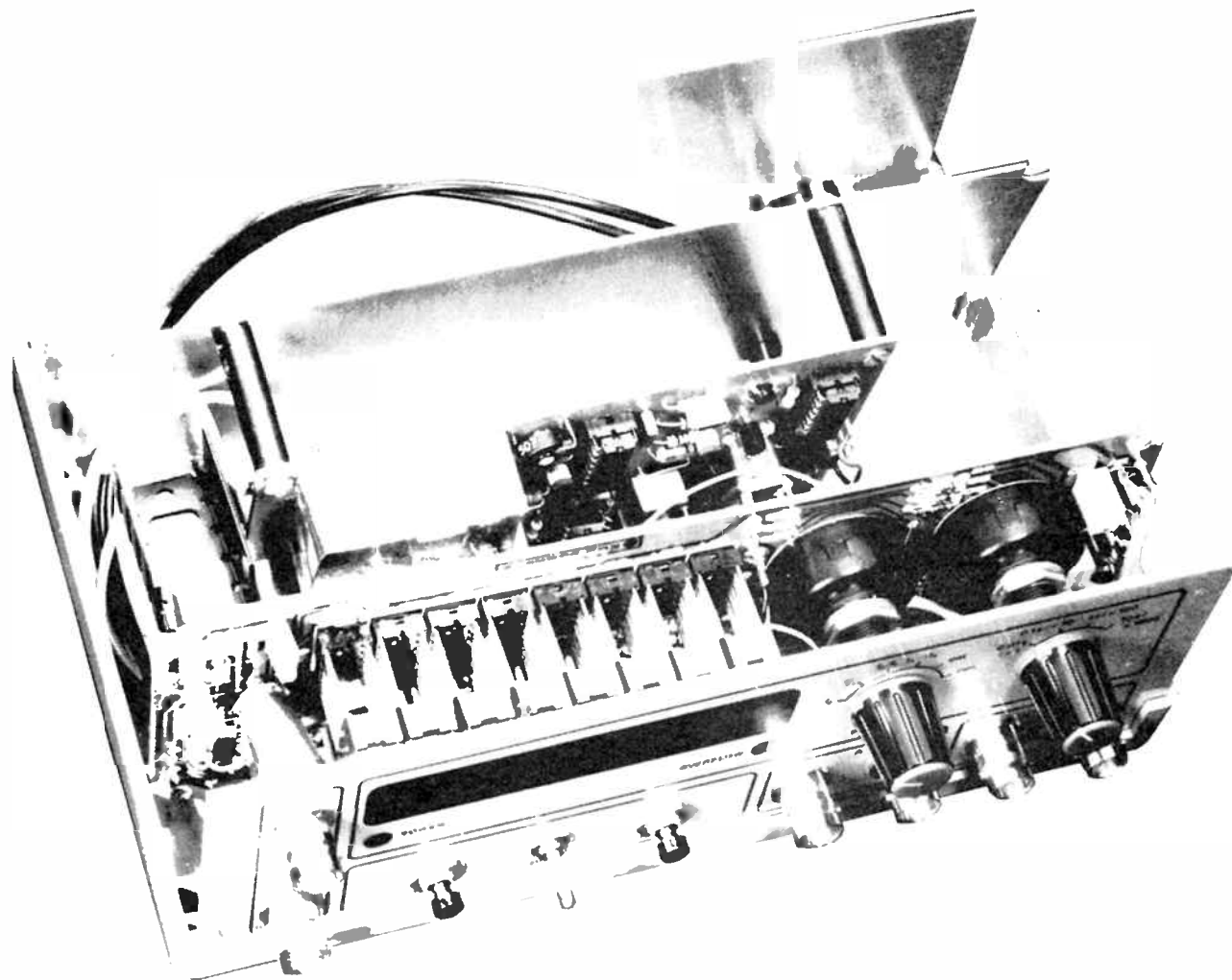


Fig. 5. This printed circuit board should be cut in two to separate the sections for the receiver (left) and the transmitter (right).

PRESCALER FOR MULTI-FUNCTION FREQUENCY METER

An add-on board that extends the usable frequency range of the instrument introduced 2 months ago from 10 MHz to well over 1.2 GHz.



The prescaler described here is intended as an optional extension of the multi-function frequency meter introduced in reference (1).

There are various ways of adding a prescaler to an existing frequency meter. The simplest of these is based on the assumption that the instrument is mainly intended for measuring relatively low frequencies, indicated on a kilohertz (kHz) scale. Fitting a prescaler with a divisor of 1,000 to the input of such a frequency meter effectively changes the kHz scale into a MHz scale, obviating the need for changing the position of the decimal point. The main disadvantage of the above method is the reduction by 1,000 of the meter's resolution.

A better approach entails increasing the

gate time of the counter by a factor 1,000. This results in more count pulses fed to the counter circuits, and hence retains the formerly available resolution.

The gate time of a frequency meter is determined primarily by the output frequency of the central clock oscillator, which is quartz-controlled in most cases. The oscillator frequency is scaled down internally to obtain the required gate time. Inserting, for instance, a binary scaler between the clock output and the internal divider cascade results in a doubling of the gate time, so that the measured signal must be passed through a $\div 2$ divider also. These applications are often thought to be restricted to the use of decade scalars, while in practice any other divisor works equally well.

Block diagram

The present prescaler was designed for ready connection to the multi-function frequency meter without compromising its usability in other, similar, instruments.

With reference to the block diagram of Fig. 1, electronic switches ES_5 , ES_6 and ES_7 select between 10 MHz, 2.5 MHz and 78.125 kHz at point ϵ . The switches are controlled by signal detectors on the input channels. The existing 10 MHz input on the multi-function frequency meter is retained along with the 2 prescaler inputs, so that the complete instrument has 3 frequency ranges in all. A separate 10...40 MHz input is used in view of the reduced sensitivity of the

÷64 prescaler in this frequency range. The sensitivity of the ÷64 prescaler is highest at around 250 MHz. The use of the 10..40 MHz input is also advantageous because it enables the use of relatively short gate periods.

With the greatest divisor, 128, the available gate periods are in the range from 0.14 to 140 s. Detector controlled switches ES₁ and ES₂ arrange the correct selection or disconnection of prescaler outputs on the 10 MHz input of the main frequency meter. ES₄ functions as an inverter, while ES₈ takes care of the "mode" settings, and the shifting of the decimal point.

The switch configurations for the 3 frequency ranges of the meter are as follows: ▷

Switch (ES)	1	2	3	4	5	6	7	8
Range (MHz)								
40 – 1250	x	•	•	•	x	x	•	•
10 – 40	•	x	•	•	x	•	x	x
< 10	x	x	x	x	•	x	x	x

x: switch opened
•: switch closed

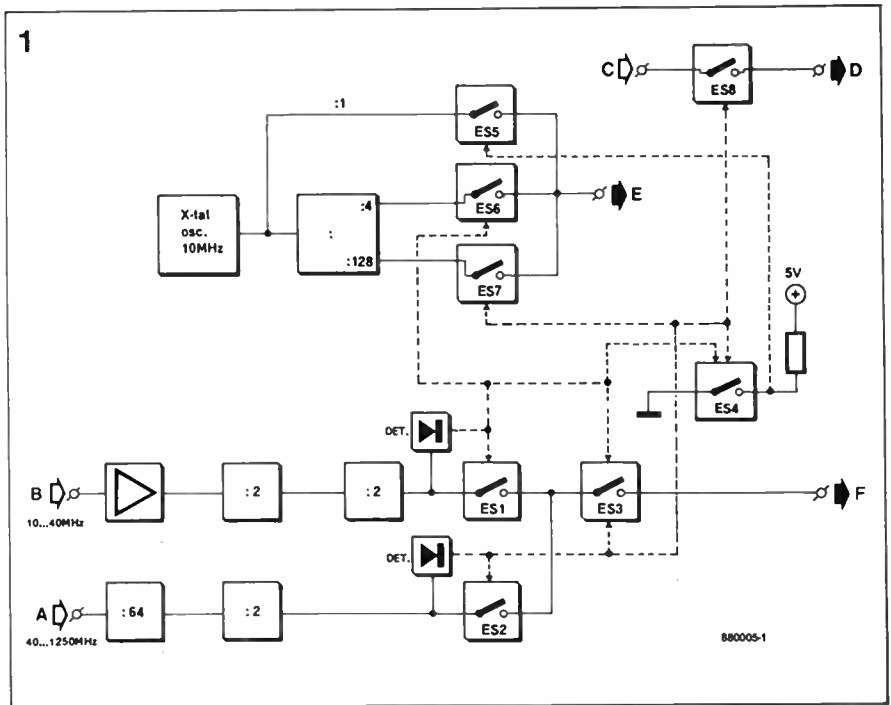


Fig. 1. Block diagram of the 1.2 GHz prescaler.

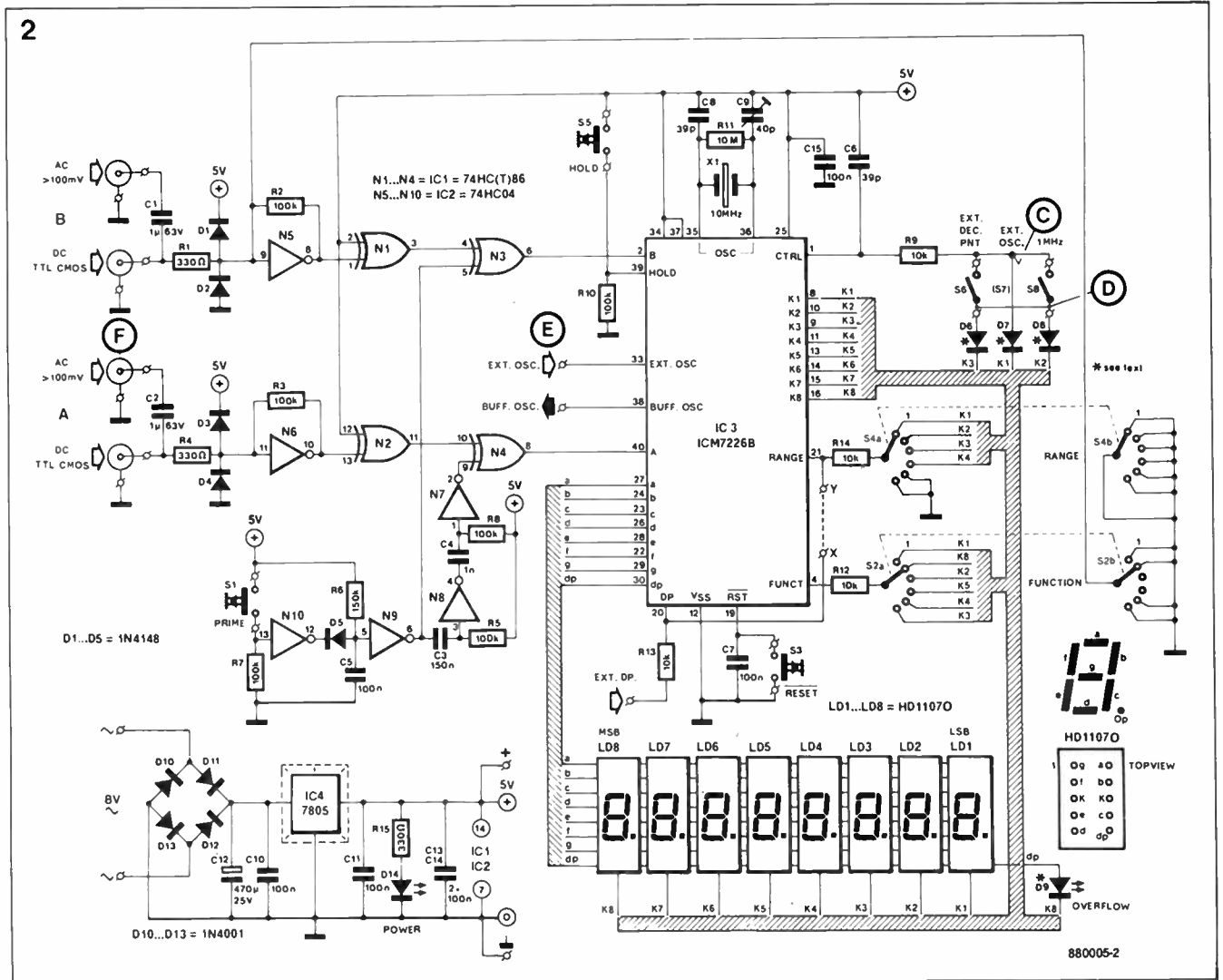


Fig. 2. Modifications to the multi-function frequency meter to enable using the prescaler extension.

Preparing for the extension

A few simple modifications are required on the main frequency meter board before the prescaler extension can be used.

With reference to Fig. 2, power for the prescaler is available from terminals + and ⊥ at the output of the regulated 5 V supply on the frequency meter board. The AC coupled input of channel A on the frequency meter, point F, accepts the prescaler output signal. The divided or undivided clock signal from the pre-

scaler board is connected to the EXT.OSC input of IC₃ (point E). Points x and y are connected by a wire link as shown. Configuration switch S₇ is replaced by a wire link. Remove S₆ and S₈, since their functions are taken over by ES₆ on the prescaler board. Connect the anodes of D₆ and D₈ to create point D. Point c in the prescaler circuit is connected to junction R₉-A₀7. The 10 MHz crystal may be removed for re-use in the oscillator on the prescaler board. Figure 3 shows the locations of the various points and connections on the frequency meter board.

Circuit description of the prescaler

The main functional blocks in the prescaler discussed under *Block diagram* are readily found back in the circuit diagram of Fig. 4. Crystal oscillator and buffer T₁-T₂ ensures the required stability of the 10 MHz digital signal applied to counter IC₁ and electronic switch ES₅. Binary ripple outputs Q₂ ($\div 2^2=4$) and Q₇ ($\div 2^7=128$) of IC₁ carry the 2.5 MHz and 78.125 kHz clock signal, respectively.

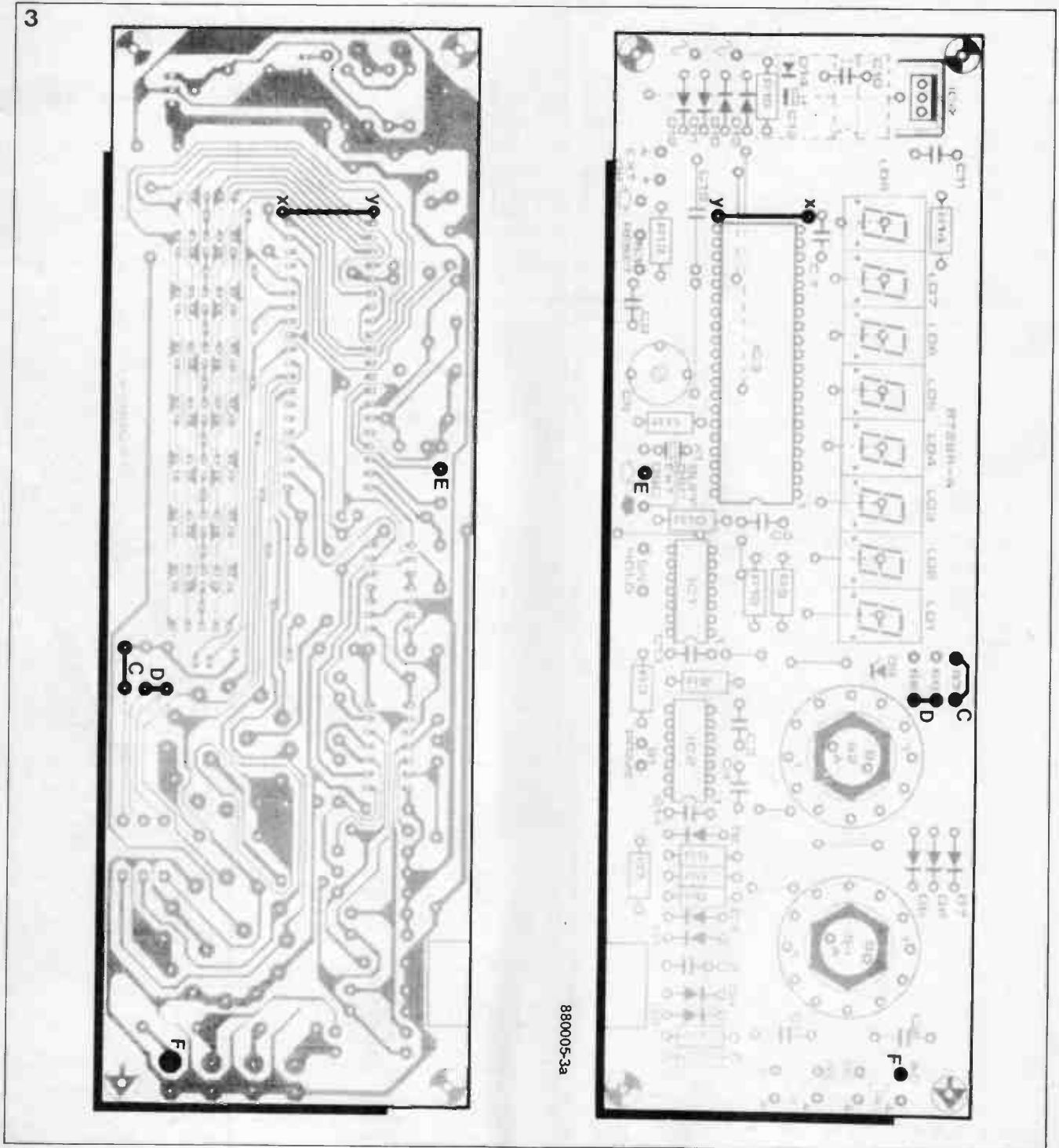


Fig. 3. Location of the wire links and terminals to be fitted on the main frequency meter board.

Signals applied to the 10...40 MHz input are amplified in fast opamp IC₂, and divided by 4 in bistables FF₁ (÷2) and FF₂ (÷2). Preset P₁ enables accurate setting of the bistable's switching threshold to 2.5 V. The rectifier (signal detector) for controlling the electronic switches as discussed is formed by diodes D₃, D₄ and D₇, together with R-C combination R₉-C₁₂.

Signals in the frequency range of 40...1250 MHz are applied direct to ÷64 prescaler IC₄, a Type U664B from AEG-Telefunken. Bistable FF₃ divides

by 2, so that the total divisor on this channel is 128. The function of the rectifier and the threshold preset is similar to that of the corresponding circuits in the 10...40 MHz channel. The dashed lines in the circuit diagram denote metal screens fitted to prevent stray radiation and erroneous meter readings caused by digital interference.

Construction of the prescaler

The first components to be fitted on the prescaler board are leadless ceramic

capacitors C₁₃ and C₁₄. Both disc and rectangular versions may be used in these positions. Cut the required slots in the PCB, push-fit the capacitors, and carefully solder the pretinned sides to the relevant copper areas. Solder fast and accurately: leadless ceramic capacitors are relatively brittle components. The next somewhat unusual part is prescaler IC₄. Use precision pliers to carefully bend the 8 pins of this IC over 180°, and mount the chip at the track side of the board, observing the orientation indicated on the component over-

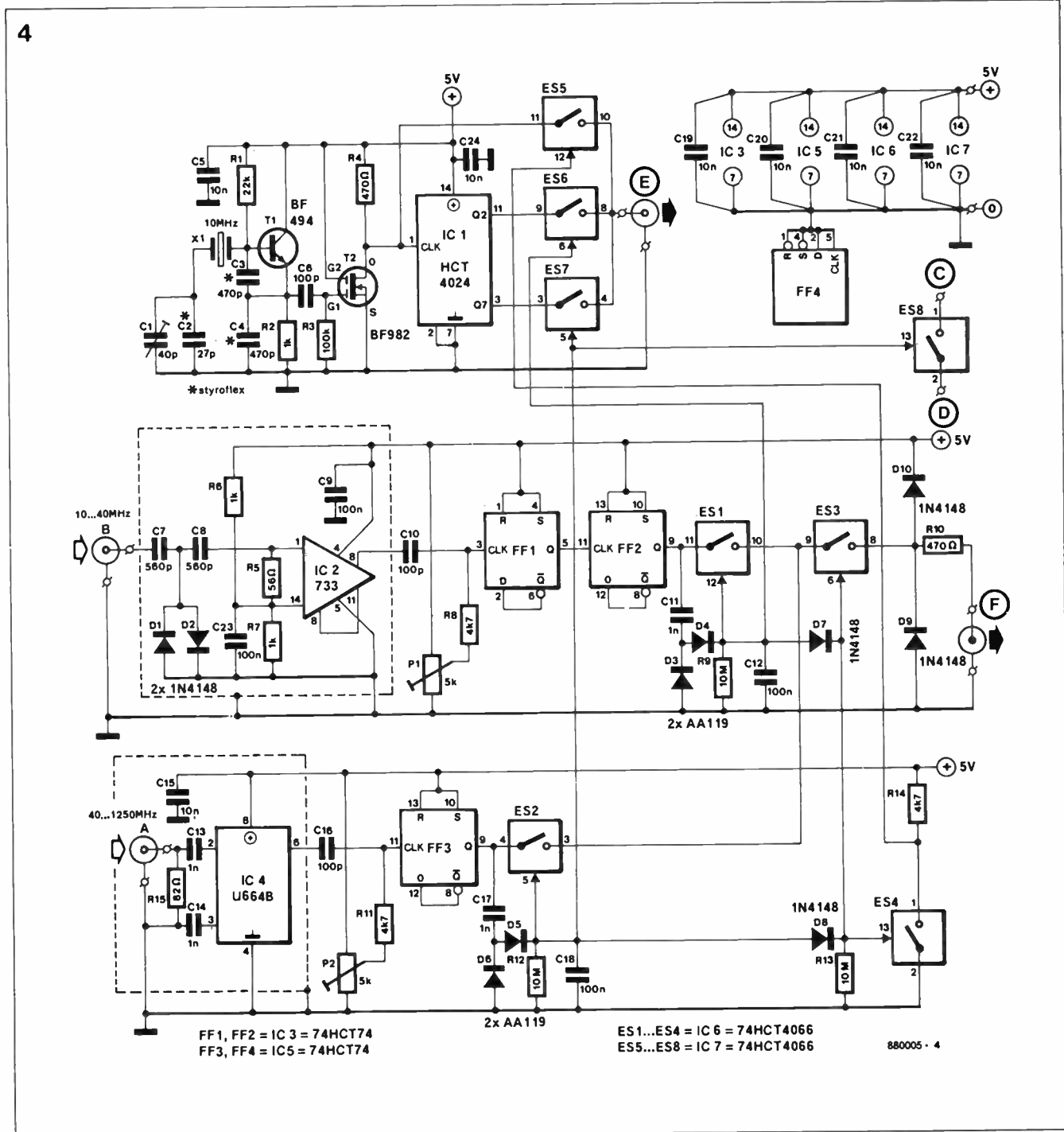


Fig. 4. Circuit diagram of the 1.2 GHz prescaler for the *Elektor Electronics* multi-function frequency meter. The dashed lines denote metal screens.

lay. If bending the pins is considered risky, it is also possible to mount the IC at the component side of the PCB, provided a suitable clearance is cut. Whatever mounting method is adopted, the connections to the prescaler pins should be as short as possible.

The fitting of the remaining components on the prescaler board is straightforward. It is recommended to use sockets for the 6 ICs. The screens at the component side of the PCB are made of 15 mm high brass or tin metal sheet, bent to shape and secured with the aid of

soldering pins—see Fig. 6. The screening of the VHF/UHF prescaler is "continued" at the track side of the PCB as shown in Fig. 7. The connections between the BNC sockets and the prescaler inputs are made in thin ($\varnothing 3$ mm) coaxial cable, e.g. Type RG174/U. Keep the connection of the centre cores to the prescaler inputs as short as possible. The shielding braid of the 40...1250 MHz input cable is soldered direct to the screening plate at the track side. Use copper foil to shield the connections of the BNC sockets to the coax cables. It is

recommended to make the connections between the prescaler and the main frequency meter board in coaxial cable, with the exception of the supply wires.

The completed prescaler board is fitted vertically behind the main frequency meter board as shown in the introductory photograph of this article.

Finally, make sure that the mains adaptor can handle the additional current drain of the prescaler board.

Parts list

Resistors ($\pm 5\%$):

R1 = 22K
R2; R6; R7 = 1K0
R3 = 100K
R4; R10 = 470R
R5 = 56R
R8; R11; R14 = 4K7
R9; R12; R13 = 10M
R15 = 82R
P1; P2 = 5K0 or 4K7 preset H

Capacitors:

C1 = 40p trimmer
C2 = 27p polystyrene or styroflex

C3; C4 = 470p polystyrene or styroflex
C5; C15; C19; C20; C21; C22; C24 = 10n
C6; C10; C16 = 100p
C7; C8 = 560p
C9; C12; C18; C23 = 100n
C11; C17 = 1n0
C13; C14 = 1n0 leadless ceramic (disc or rectangular, e.g. Cirkit stock no. 04-10211)

Semiconductors:

T1 = BF494
T2 = BF982
D1; D2; D7... D10 incl. = 1N4148
D3... D6 incl. = AA119
IC1 = 74HCT4024
IC2 = 733 or μ A733

IC3; IC5 = 74HCT74
IC4 = U6648*
IC6; IC7 = 74HCT4066

Miscellaneous:

X1 = 10 MHz quartz crystal; 30 p series resonant.

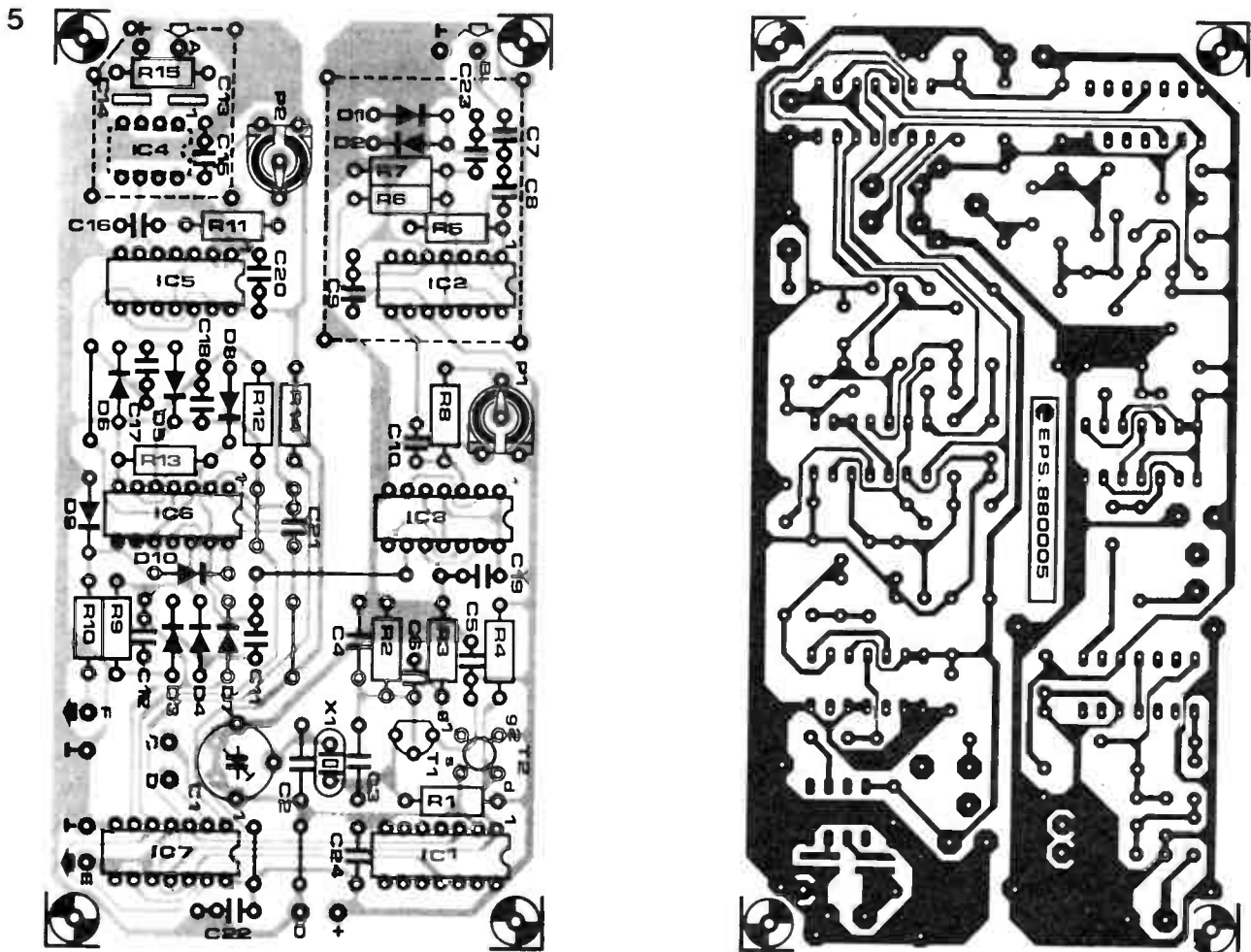


Fig. 5. Track layout and component mounting plan for the prescaler PCB. READ THE TEXT BEFORE FITTING IC4, C13 AND C14.

Setting up

The setting up of the extended frequency meter is fairly simple if a signal source of 10...40 MHz and 40...1250 MHz is available. To begin with, set the clock oscillator to 10.000 MHz precisely with the aid of a second, calibrated, frequency meter.

Apply a test signal at a frequency higher than 40 MHz to prescaler input A, and reduce the generator output until the read-out becomes unstable. Adjust P_2 to restore the correct read-out, reduce the input signal, re-adjust P_2 , and so on, until the optimum threshold setting is achieved. The sensitivity of the prescaler's B input is set likewise.

A carefully aligned prototype of the frequency meter achieved a sensitivity of about 400 mV_{rms} at 1190 MHz. *B*

Reference:

- (1) Multi-function frequency meter.

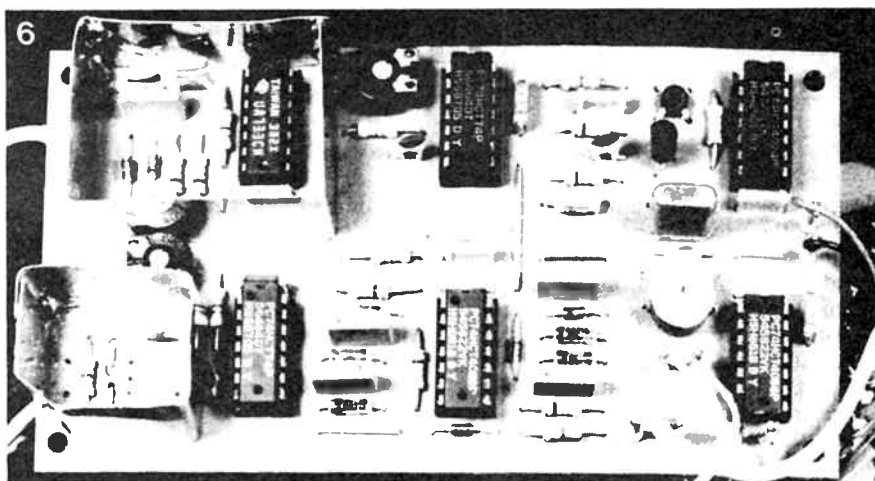
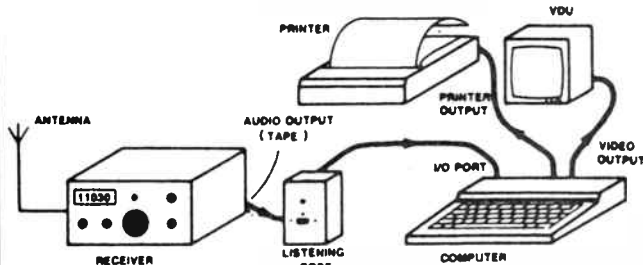


Fig. 6. Prototype of the prescaler board. Note the use of metal screens around the input sections.



Fig. 7. Close-up photograph showing the screen around the VHF/UHF input at the track side of the board.

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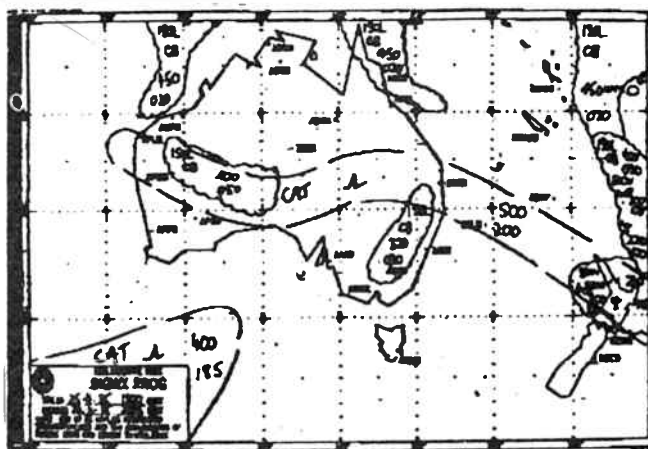
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FLAT AERIAL FOR SATELLITE TV RECEPTION

Matsushita Electric Works (MEW) have recently introduced a flat, easy-to-install, 12 GHz aerial developed by Comsat Corporation. The new product is available in seven versions. Simple to install, unobtrusive, and complete with a low-noise down converter, the flat aerial is an attractive alternative to the conventional parabolic or off-set dish.

The flat aerial for satellite TV reception was developed by Comsat Corporation, known worldwide as one of the technical consultants of Intelsat and Inmarsat as regards microwave technology. Comsat's research and development laboratories recently succeeded in designing a 12 GHz aerial which forms a radical departure from the parabolic concept used for dishes of diameter between 50 cm and 1 m. The signals to be beamed down by the direct broadcasting satellites TV-SAT1, TDF-1, Olympus, Tele-X, and others, are strong enough to be picked up by relatively small—and,

therefore, easy to install—aerials, in combination with a low-noise block down converter (LNB or LNC). But even a so-called off-set dish of, say, 60 cm diameter may be difficult to install in built up areas. In many cases, a building permit is required before the aerial may be fitted onto the roof. Another important point is the total depth of the dish aerial including the pointing system at the rear, and the the LNB mounting system in front. Compared to a depth of 30 cm or so for a modern dish of the off-set type, the aerial introduced by MEW is truly flat at only 20 mm.

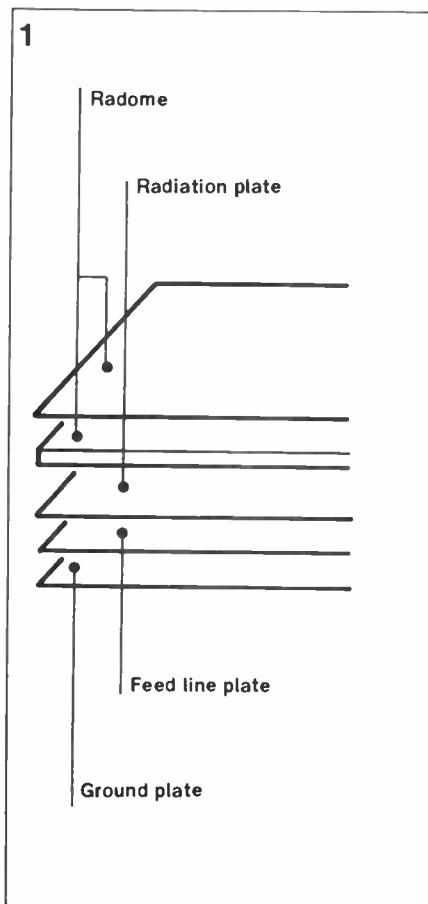


Fig. 1. The flat aerial is a multi-layer structure developed by Comsat Corporation.

Tentative Performance		MODEL NO.			
		PA33-R PA33-L	PA36-R PA36-L	PA66-R PA66-L	PA66-D
FREQUENCY RANGE	11.7 - 12.5 GHz (Europe) 12.2 - 12.7 GHz (USA) 11.7 - 12.0 GHz (Japan)				
ANTENNA GAIN	31.0dBi	33.5dBi	36.0dBi	33.0dBi Both R and L	
POLARIZATION	R or L (Right-hand Circular Pol or Left-hand Circular Pol)				
CROSS-POLAR-CHARACTERISTIC	25 dB Frequency band dependent				
BEAM SQUINT ANGLE	0° or 12°				
IF-OUTPUT FREQUENCY	0.95 - 1.75 GHz (Europe) 0.95 - 1.45 GHz (USA) 1.022 - 1.322 GHz (Japan)				
LNB CONVERSION GAIN	55 dB (Europe) 55 dB (USA) 48 dB (Japan)				
NOISE FIGURE	2.3 dB				
IF-OUTPUT CONNECTOR	F type connector				
SUPPLY VOLTAGE/CURRENT DRAIN	15 - 24 VDC < 150 mA				15 - 24 VDC < 200 mA
SIZE (PANEL ONLY)	□ 354 × 20mm	385 × 720 × 20mm	720 × 720 × 20mm	720 × 720 × 20mm	
WEIGHT (PANEL ONLY)	abt. 1.3kg	abt. 5kg	abt. 9kg	abt. 9kg	
OPERATING TEMPERATURE	- 30° ~ 60°C				
WIND LOADING	50m/sec				

R: Right-Hand Circular Polarization
L: Left-Hand Circular Polarization
D: Dual Polarization

Multi-layer structure captures received power

The operation of a dish aerial is based on reflection of the received microwave power to the focus, i.e., the feed horn or LNB input. This is in contrast to the flat aerial, which receives power direct on a multi-layer laminated structure as shown in Fig. 1. Power loss is minimized by virtue of the stacking system of radome, radiation plate, feed line plate and ground plate. The multi-layer laminated structure developed by Comsat is claimed to yield high efficiency (60–70%), and sufficient gain for DBS reception over a wide frequency band. The flat aerial is much easier to point at the satellite than the dish. This is because of the greater half power beamwidth, which is typically 6–8° in the azimuth plane. With the exception of the "top of the range" model, the Type PA66-D, the flat aerials receive either right-hand or left-hand circularly polarized signals in the DBS band. The accompanying table shows the main technical characteristics of the available models. Note the use of the standardized LNB intermediate frequency (IF) of 950–1750 MHz, which ensures ready connection to most types of indoor unit

via an F connector and a download cable that carries the RF signal and the supply voltage for the LNB. The noise figure and LNB conversion gain are also fairly standard at 2.3 dB and 55 dB, respectively.

The ease of use, and a number of installation options, of the new aerials is illustrated in Fig. 2. The smallest type has a size of 35×35 cm and weighs only 1.3 kg: it is, therefore, ideal for semi-portable applications.

The flat aerial from MEW is among the most important of new components introduced in support of individual reception of TV satellites. It is a rugged, easy to handle component that can even be mounted behind glass surfaces for experiments in the reception of audio programmes transmitted in narrow bandwidth pulse code modulation (PCM)

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1048 Kadoma-Shi • Osaka 571 • Japan
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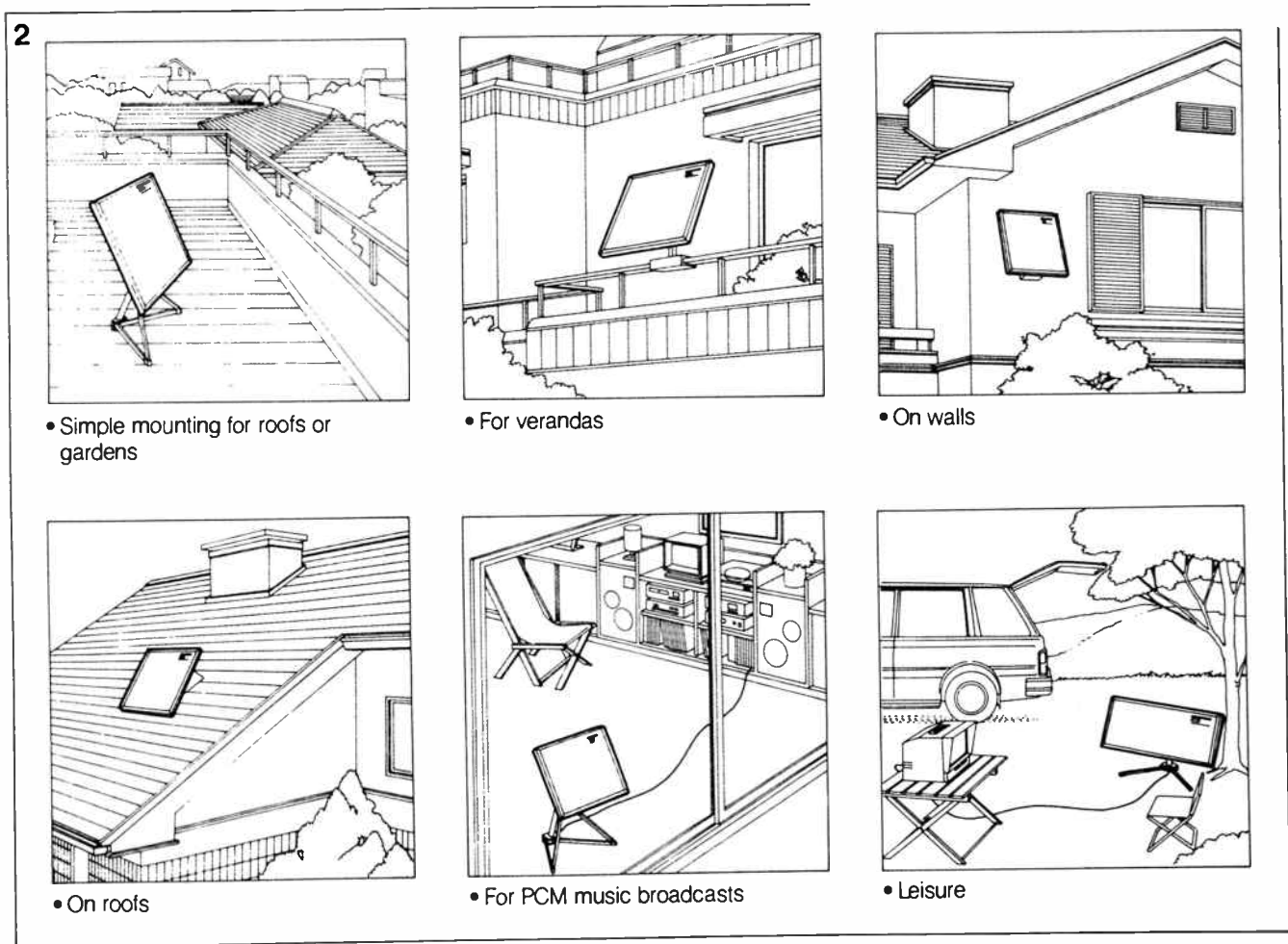


Fig. 2. Various applications of the new flat aerial for DBS reception.



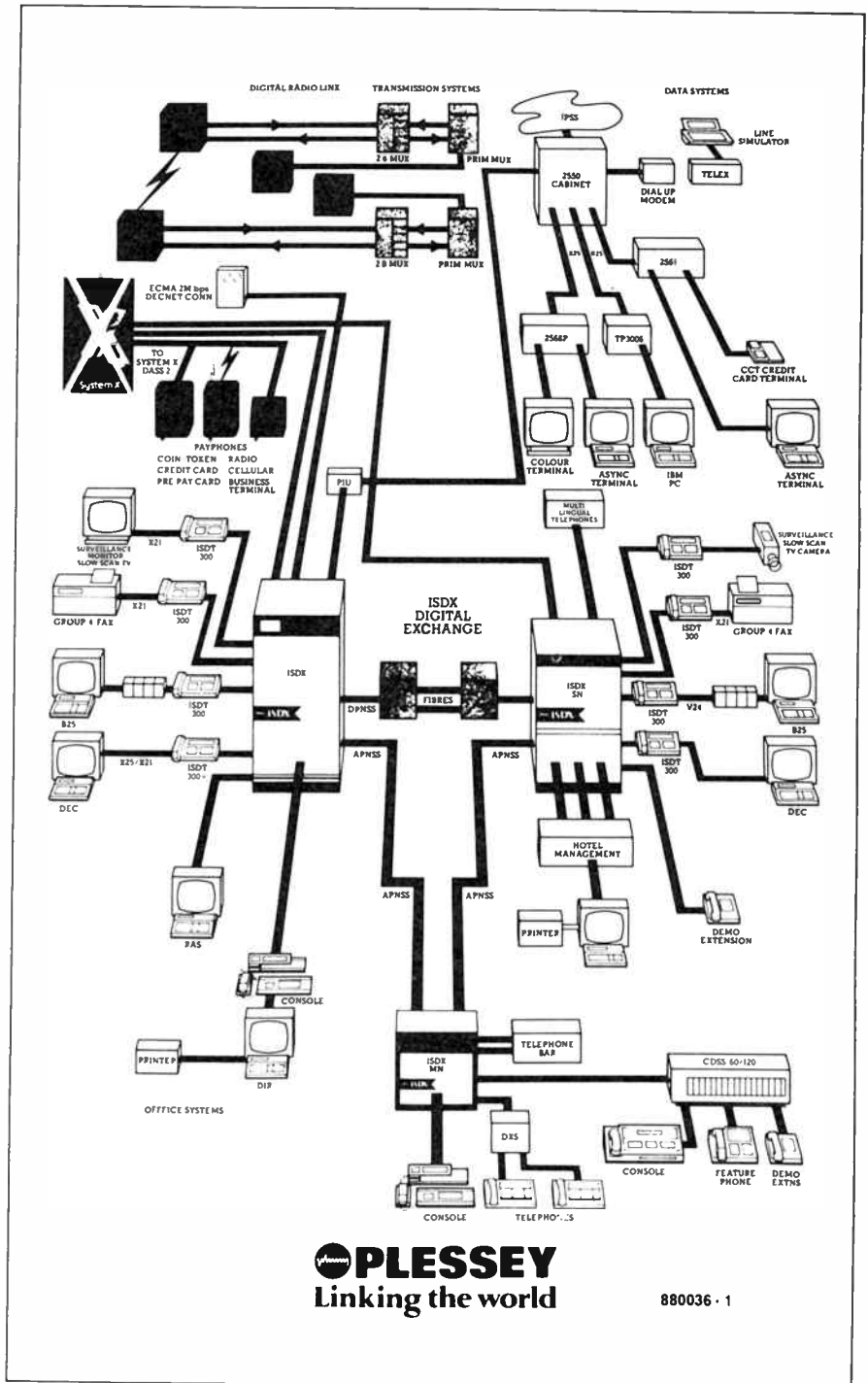
GENEVA CALLING: ISDN AND SATELLITES AT TELECOM 87

A brief look at some of the new technical concepts introduced at Telecom 87, the world's largest and most comprehensive telecommunications exhibition held in Geneva last October.

The main technical topic at Telecom 87 was *integrated services digital networking*, ISDN. The underlying principle of this far-reaching technical concept is the total integration of all electronic communication equipment in a network that allows continuous data transfer in all directions, at the highest possible speed. Ideally, wait times are eradicated, and every communication unit, whether this is an electronic typewriter, a telex, a grade-4 facsimile machine, or a voice synthesizer in a telephone exchange, can communicate direct to every other unit in the network. Communication is, therefore, interactive at all levels. An ISDN structure can only handle digital data, so that all types of analogue messages, including voice, require digitizing.

ISDN supports a multitude of communication services: telephone, videophone, telex, fax, videotext, slow-scan television, local area networks (LANs), videoconferencing systems, data terminals, personal computers, telephone exchanges, printers, payphones, and many more.

It is all very well for communication units to be part of an efficiently operating network, but can we connect two or more ISDNs to form an even larger network? In other words, can we connect an ISDN to the outside world? Satellites and fibre optic cables provide the answer. Digital signals in ISDN channels travel at 64 kbit/s, and processor-controlled central units (*concentrators*) regulate the multitude of data streams in accordance with the capacity of the lines in the system. Obviously, the higher the bandwidth of the channels, the more traffic can be carried at a relatively high bit-rate. The increasing use of fibre-optic technology is certain to bring the transmission of moving pictures in ISDNs within reach in the not too distant future. An important aspect of ISDN is that the routing and buffering of data in the system are completely invisible. This means that the user of, say, a personal micro can send out a data file to another computer user in the office building without having to wait for access if the "receiver" is engaged in other work: the data is automatically buffered and kept stored until the receiver is ready to accept them. Data from the ISDN in an office may be



PLESSEY
Linking the world

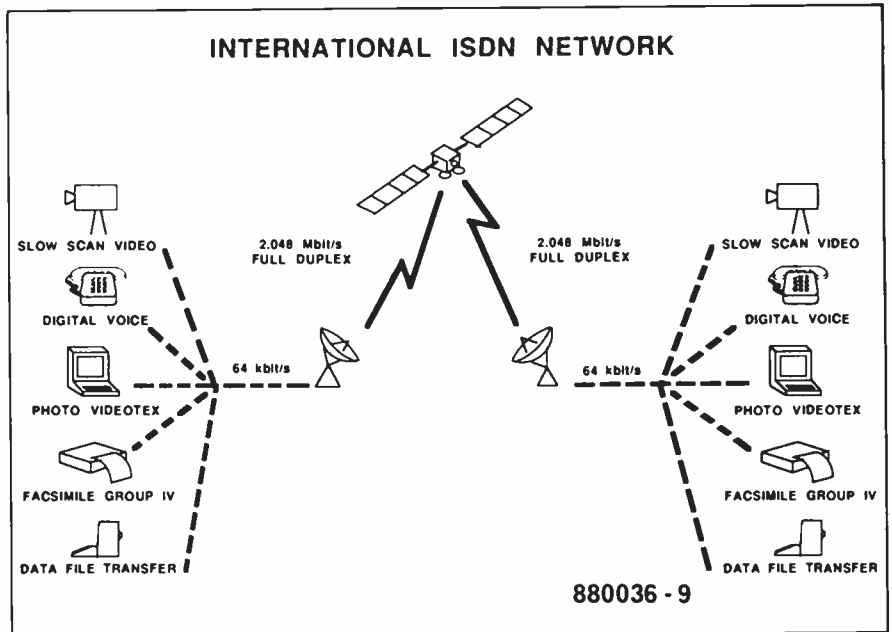
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Example of an integrated digital systems network (ISDN). Data flow is regulated and optimized by processor-controlled exchanges, which are completely invisible to the users of communication equipment connected (courtesy Plessey/GEC).

fed to a satellite uplink unit. It is then digitally transmitted to a geostationary transponder, which amplifies the signal, and beams it down to the receiving station, which may be thousands of miles away from the sending office. Both offices are equipped with transmit and receive equipment for access to a particular satellite, or even a network of satellites, so that high quality full-duplex communication channels are continuously available.

On the aerial grounds outside Telecom 87, a number of companies demonstrated new, transportable, satellite uplink equipment in various power ratings, geared to connection to an ISDN. Dish sizes varied from about 1.5 m to 10 m and more.

Companies actively engaged in building ISDN equipment include NEC, Siemens, Hewlett Packard, the Northern Telecom consortium, Philips/AT&T (Sopho-S system), IBM and Olivetti.

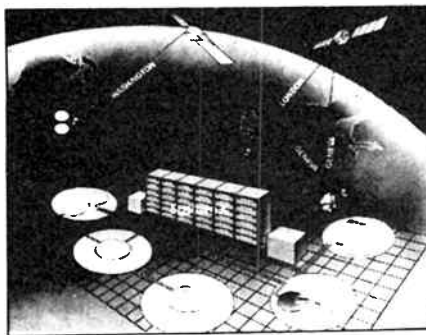


Example of communication equipment installed in 2 offices, and connected to an ISDN network with an uplink/downlink interface. A geostationary satellite puts the offices in contact with each other.

ISDN in practice: System X

Plessey and GEC-Marconi are currently regarded as the leaders in the development of ISDN systems to CCITT standards. Their joint product is called System X. Although System X equipment has been in use for a number of years in British Telecom's main trunk exchanges, recent improvements as regards the achievable speed on the internal and external data links have aroused the interest of many national PTTs planning and building new data and voice communication networks. Recently, the data transfer rate of System X has been upgraded from 80 to 144 kbit/s, with full compatibility between old and new systems guaranteed.

At Telecom 87, Plessey/GEC demonstrated the versatility of the latest version of an ISDN compatible trunk exchange. The system installed on the stand was in



System X live at Telecom 87: London literally transferred to Geneva. With the co-operation of British Telecom, the Geneva based System X exchange from GEC/Plessey operates as an integral part of the UK telephone network. Two other companies exhibiting at Telecom 87, Comsat and STC, had access to the "London" exchange and its ISDN services (courtesy Plessey/GEC).

continuous operation, functioning as part of a telephone exchange situated in London. Two-way satellite links between Geneva and London had been set up for the occasion of Telecom 87 to show that part of the traffic carried by a main London telephone exchange could be transferred to the system installed on the System X stand. In fact, the public was invited to contact London extensions direct from the stand, without having to prefix calls with STD code 01. The ISDN exchange occupied relatively little floor space, yet carried fax, telex, slow-scan, computer, LAN, voice and videophone services for 5 companies simultaneously.

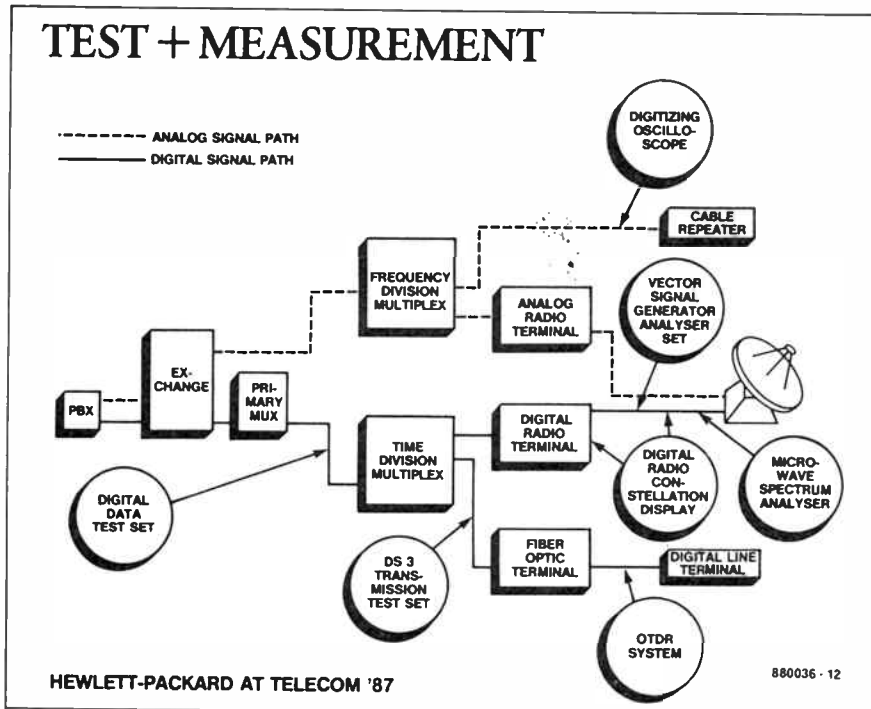
An interesting technical novelty developed specifically for use in ISDN systems is *dynamic line inductance balancing*. A computer simulation on the System X stand showed how an intelligent test and control system runs a fast and invisible check on the electrical characteristics of the telephone line. This takes place within a second or so after the line has been selected, and provides the basic settings for the active fork circuit that terminates the line at the ISDN side. The combined termination and source inductance of the fork is continuously adjusted to achieve optimum suppression of noise, pulse ringing, and line echoes. These are often troublesome effects in data transmission, causing distortion and, of course, a reduced bit rate (data speed). In short, the active fork circuit makes the best of every line, irrespective of the length, or the equipment connected to it. As such, it offers new ways to use existing telephone lines for high-speed modems.



The new ISDN compatible videophone from Philips Communication Industries.

The operator console coupled to an ISDN compatible exchange is a radical departure from the well-known "switchboard". The bulk of the work is now carried out automatically by a computer. A high-resolution screen gives an overview of all current and pending connections between internal and external extensions. Internal extensions do not have numbers, but easy to memorize letter codes, which are all displayed on the screen, complete with extension status information. Extensions can be called up with a single command from the keyboard. Automatic redialling, call diversion, automatic reminders, priority level assignment, interrupting calls, group extension calling, conferencing arrangements, extension scans to locate called up persons, and fully automated dialling of emergency services are among the many features of the new operator console, which records the day's activities on a printer. The speed at which the system works is unbeatable by even the most experienced and efficient of exchange operators. ▷

TEST + MEASUREMENT



Hewlett Packard proposes to use ISDN structures for fast data throughput in complex automated test and measurement systems.

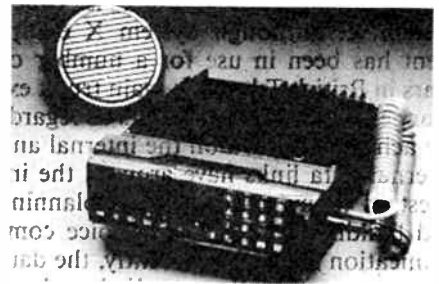
Large transparent panels allowed a glance at some of the latest electronics technology fitted into racks that together form the digital and voice compatible System X ISDN exchange. Plessey/GEC have relied mostly on their own expertise as regards the use of high density multi-layer PCBs, VLSI chips, SMA components, 8 Mbyte memory boards, multi-tasking processor systems, and fibre optic connections between modules, instead of complex and costly bus structures. The System X exchange is completely modular, and can be tailored

and programmed to customer requirements: it is, for example, possible to select a synthesized, male or female, voice, which upon request advises cost and duration of the call. Field technicians can also make use of the synthesized—but remarkably real—voice to obtain technical information on the line or exchange section brought into service. An array of lead-acid batteries provides the memory back-up function, enabling the complete exchange to be brought into service again within 2 minutes after a mains failure.

One of the most interesting demonstrations of the capabilities of ISDN was the full-duplex slow-scan link with one camera installed on the Plessey/GEC stand, and the other in an office in Manchester. A high-speed fax message was sent to this office via the System X exchange, and an office employee could be seen to collect it from his fax receiver. For reasons unknown, a demonstration of data file transfer to a UK-based bulletin board via the ISDN exchange was less successful.

Satellites: competition and co-operation

Much excitement, optimism and good cheer at the stands of EutelSat, Aero-Spatiale, EuroSatellite, ArianeSpace, and many other companies and institutions involved in the building, launch, and operation of the first European direct broadcasting satellite (DBS), TV SAT-1. At long last, and after much negative publicity caused by the Columbia disaster and the launch failures of 2 communication satellites, ArianeSpace was hopeful again: the countdown for TV SAT-1 was the topic of the day. Mr



The Stornophone 6000 multilingual radio-telephone can prompt and instruct the user in 10 different languages.

	EUTELSAT I-F1	EUTELSAT I-F2 and following	EUTELSAT II
Stabilization	3 axis	3 axis	3 axis
Mass at launch	1 045 kg	1 160 kg	1 700 kg (7 years) 1 800 kg (10 years)
Mass in orbit ⁽¹⁾	510 kg	550 kg	866 kg
Span (with solar panel deployed)	13.80 m	13.80 m	22.40 m
Electrical power ⁽¹⁾	900 W	900 W	3 000 W
Lifetime	7 years	7 years	7 to 10 years
Frequency bands	14/11 GHz	14/11 and 14/12 GHz	14/11 and 14/12 GHz
Number of transponders	12	14	16
Number of transponder for simultaneous use	10 ⁽²⁾	10	16
Transmit power of each transponder	20 W	20 W	50 W
Antennas:			
— receive/transmit	—	1	1
— receive only	2 ⁽³⁾	1	—
— transmit only	4	4	1

(1) at end of life — (2) 6 only in eclipse — (3) one antenna as a back-up for the other.

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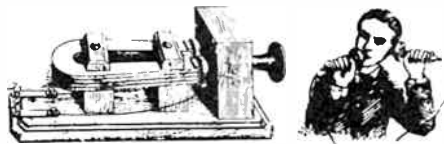
Comparison of the technical features of future Eutelsat Series-2 satellites to the "good old" Series 1 spacecraft Eutelsat 1 F1 (ECS-1) and Eutelsat 1 F2 (ECS-2). Not shown in the table is the recently launched Eutelsat 1 F4 (ECS-4; OP=10° E), which is also a Series 1 type. ECS-3 was lost in an unsuccessful launch (courtesy Eutelsat).

Jean-Pierre Baudry of EuroSatellite received telexes straight from the ESA launch site at Kourou, French Guyana, and faithfully added a tick to a long list of check items related to the preparations for the launch of the Ariane 2 rocket to carry TV SAT-1 into geostationary orbit. Now, almost 4 months after Telecom 87, it has evolved that the launch was successful, but that TV SAT-1 is unlikely to be taken into service as scheduled owing to technical difficulties with telemetry equipment and one of the solar panels. This was the last thing the German electronics industry had expected: a successful launch, but a defective satellite.

How does the American satellite industry regard the European efforts at putting high power TV satellites in orbit? Mrs Walda W Roseman, chief press officer of Intelsat, argued that the combined power of the European satellite industry is not, or not yet, a serious competitor to her company, simply because "the technology lacks the experience". She then went on to show the huge technical potential and the good financial results achieved by Intelsat, an international consortium renowned for its experience in operating tens of geostationary satellites for data communications and TV services. The 4-channel German and French DB services, TV SAT and TDF, are so heavily sponsored by the respective governments as to be economically unviable: in other words, they can not be, nor become, profitable simply because they have no channels available for leasing to commercial TV

stations. In this context, it is interesting to note that SES of Luxemburg have signed a contract with RCA for the construction of Astra, a 16-channel medium power satellite to be launched later this year.

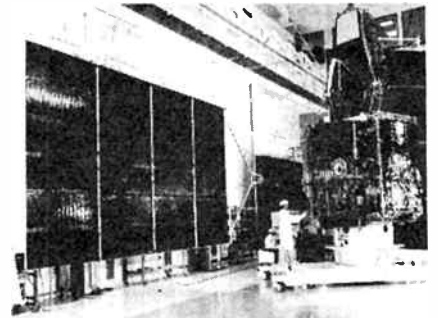
Meanwhile, Eutelsat has started a program for the construction and launch of their Series-2 satellites in the early 1990s. These satellites will be considerably improved with respect to the current types in Series-1 (ECS-1, ECS-2, and, recently, ECS-4). Transmit power will be 50 W per transponder instead of 20 W. Again, it is interesting to note that Eutelsat has no intention whatsoever of building satellites with the power rating of the "heavy-weights" TV SAT, TDF or Olympus. Mr Michel Chabrol, operational planning engineer of Eutelsat, said that 50 W would be adequate, even for direct (individual) reception, considering the recent technical advances achieved in satellite receiver technology. Indeed, lowering the receiver's noise figure by about 0.5 dB is easier, and certainly less costly, than increasing the satellite transmit power by, say, 100 W. ▷



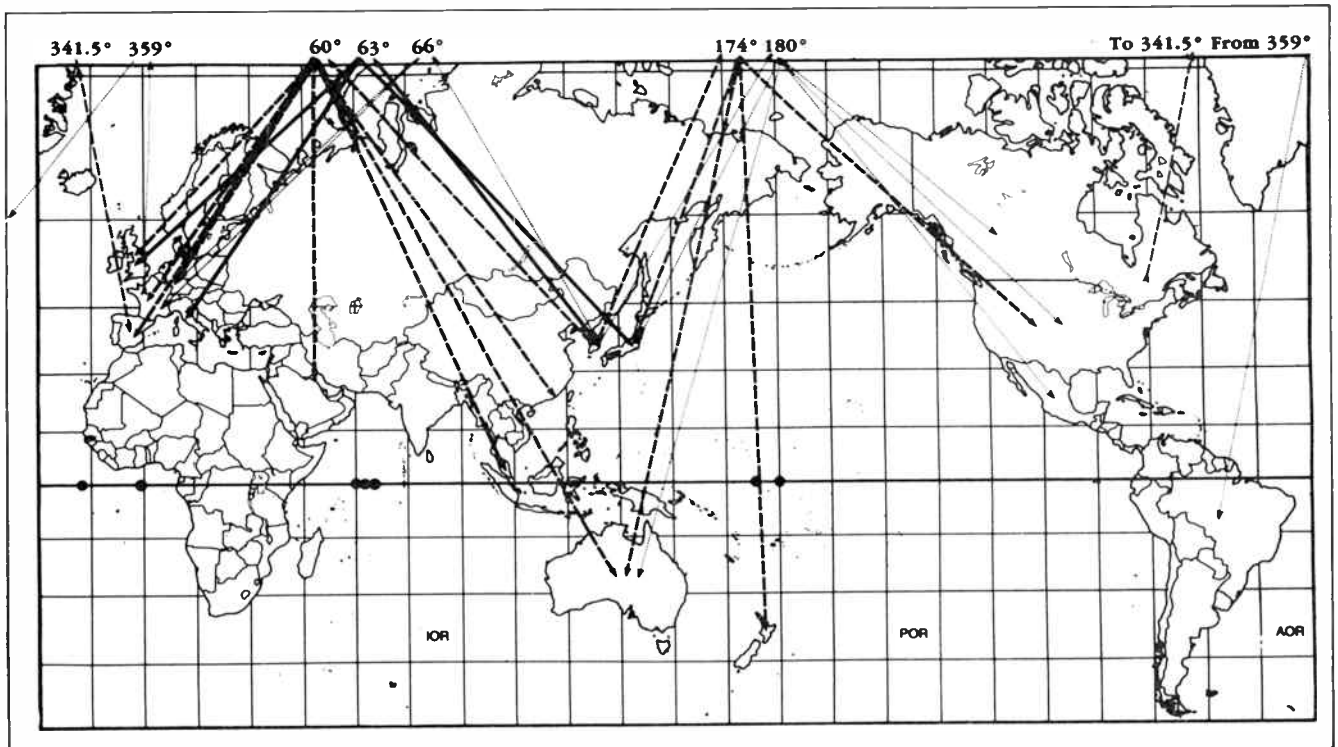
Telecommunications has developed spectacularly since Alexander Graham Bell's invention of the telephone in 1876 (courtesy ITU).



Fuba's off-set parabolic dish aerial Type OAP120 for satellite TV reception (Fuba press photograph).



Better luck than TV SAT1, we hope: engineers working on the French national DB satellite, TDF-1 (courtesy Aerospatiale).



Proposed network of Intelsat geosynchronous satellites for coverage of this year's Summer Olympic Games in Seoul, Korea (courtesy Intelsat).

D2-MAC: already a skeleton in the cupboard?

Not a single West-German company on Telecom 87 was able to show a working, D2-MAC compatible, satellite TV receiver for the consumer market. This was simply because ITT Semiconductors of Freiburg did not have the key component ready in time. Embarrassed press officers and engineers on the stands of Fuba, Hirschmann and Bosch had to admit that receive systems for TV SAT-1 were still incomplete without the Type DMA2270 transcoder chip.

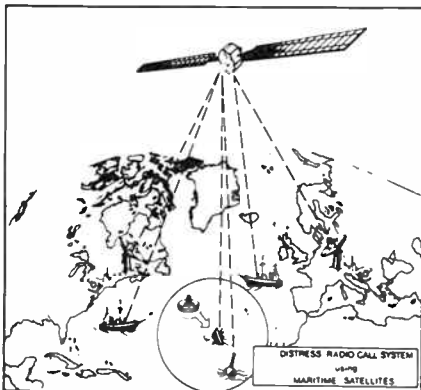
Whether or not D2-MAC will succeed in becoming the new European TV standard, the professional world is ready for it: Matra Communication of France and Fuba of West Germany showed working prototypes of D2-MAC to PAL/SECAM transcoders. These systems are only intended for cable head-end stations, however, and come as a number of racks fitted in a 19 inch enclosure.

Plessey and Philips are also reported to have commenced a joint programme for the development of a MAC transcoder chip, but details of this were not known at Telecom 87.

The Japanese industry has simply skipped everything to do with MAC transcoders, and have come up with the far more powerful MUSE transmission standard, which is briefly discussed further on in this article.

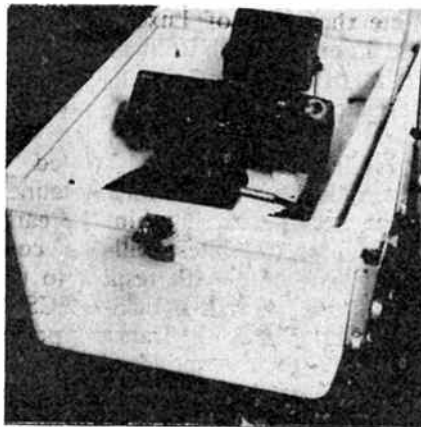
Inmarsat

The International Maritime Satellite Organisation (Inmarsat) had built an impressive and colourful stand. Inmarsat is totally dedicated to operating a network of geostationary satellites that carry data and voice communication between ships, shore stations, and, shortly, aeroplanes. The main topic was Inmarsat's new initiative to extend their services with land-mobile and aeronautical communication systems. In the not too distant future,



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Geostationary satellites operated by Inmarsat can play an important role in the forming of a worldwide distress calling system for ships (courtesy DFVLR).



Motorcycle top box with Storno's "Silent Messenger" radio installed in a shock absorbent enclosure.

airlines will be able to offer passengers world-wide telephone and data transmission facilities. Before long, the businessman on board an aeroplane will be seen sending reports prepared on his lap-top computer to the head-office.

Inmarsat currently operates communications capacity on 9 satellites in geostationary orbit around the world. These are the Mares A and B2 satellites, three MariSat spacecraft, and transponders leased on four Intelsat series-5 satellites. Inmarsat expects to satisfy the ever increasing demand for more communication capacity at higher speed by means of three Inmarsat-2 satellites currently being constructed by an international consortium headed by British Aerospace. Inmarsat will own, rather than lease, these new satellites.

STC, one of the companies that supply Inmarsat approved communications equipment for use on ships, demonstrated a new mechanically steered dish aerial that uses an electronic gyroscope to keep itself pointed at the satellite with an accuracy of tenths of a degree.

Oriental power

Twenty-six Japanese organizations and telecommunications manufacturers participated in Telecom 87. Their collective stand was the third largest on the exhibition, following the United States and France. Japan Radio, Hitachi, Fujitsu, NEC, Sony, Panasonic, Matsushita, NHK (The Japanese broadcasting corporation), Canon, Ricoh, OKI and KDD made their presence as the most important companies.

One of the most interesting technical novelties on display was the HDTV (high definition television) equipment developed by NHK. This TV standard is based on 1,125 lines and a horizontal-to-vertical picture aspect ratio of 9:16, and is expected to revolutionize TV watching. Colour pictures of unparalleled brightness and resolution are displayed on 32 or 40 inch monitors, and the accompanying sound is to CD standards.

Since the Hi-vision picture contains about 5 times the information of a conventional PAL picture, NHK set out to develop the MUSE transmission system for use on satellites. MUSE means Multiple Sub Niquist Sampling Encoding. Studio equipment has been developed to compress the HDTV bandwidth of more than 20 MHz to about 8 MHz, the standard uplink baseband, without reducing picture quality. NHK have already conducted many experiments in broadcasting Hi-Vision signals via the Japanese satellite BS-2B. The aim of NHK is to increase the number of lines in the TV raster to 2,200, while 3-dimensional television is also being studied. A HDTV video cassette recorder is already available, and was demonstrated successfully.

Further interesting new items on the Japanese stand were Ricoh's and Canon's fast, ISDN compatible G4 facsimile machines. The Canon fax Type I4003 is complete with a desk-top publishing system, a vertical A4 monitor, and a medium-resolution laser printer. At the speed of 64 kbits/s, the machine transmits a document in just 3 seconds. Who needs telex any longer? Hitachi presented its new HMAP-D system, which is a complete workstation for the design, storage and retrieval of map information. The system was demonstrated live on Telecom, using a satellite link to receive information from a central storage computer in Tokyo. Real estate listings and detailed maps complete with street names and traffic information were available almost instantly on a 58-inch high resolution colour display, and a colour printer. Colour coding, magnifying, reducing or scrolling of maps are among the many technical features of this powerful system.

IIIrd WORLD BOOK AND AUDIOVISUAL FAIR ON TELECOMMUNICATIONS AND ELECTRONICS

GF-NEVA 20-27 OCTOBER 1987

DIPLOMA

In testimony of our gratitude to

Elektor Electronics

for his contribution to the success of the fair, the technical knowledge, professional advice and efforts made by the staff of the IIIrd World Book and Audiovisual Fair on Telecommunications and Electronics, which was held in Geneva from 20-27 October 1987, under the patronage of TELECOM 87.

RICHARD E. BUTLER
Telecom 87 Secretariat

No way can the telecommunications industry go round informative books and magazines on the subject!

NOISE BLANKER

A noise blanker is indispensable for improving the reception of very weak signals on the SW bands. In most communication receivers, the selectivity of intermediate frequency (IF) filters cause interfering pulses to be widened, blotting out the wanted signal. It is useful, therefore, to suppress interference before this can wreak havoc in the IF sections of the receiver.

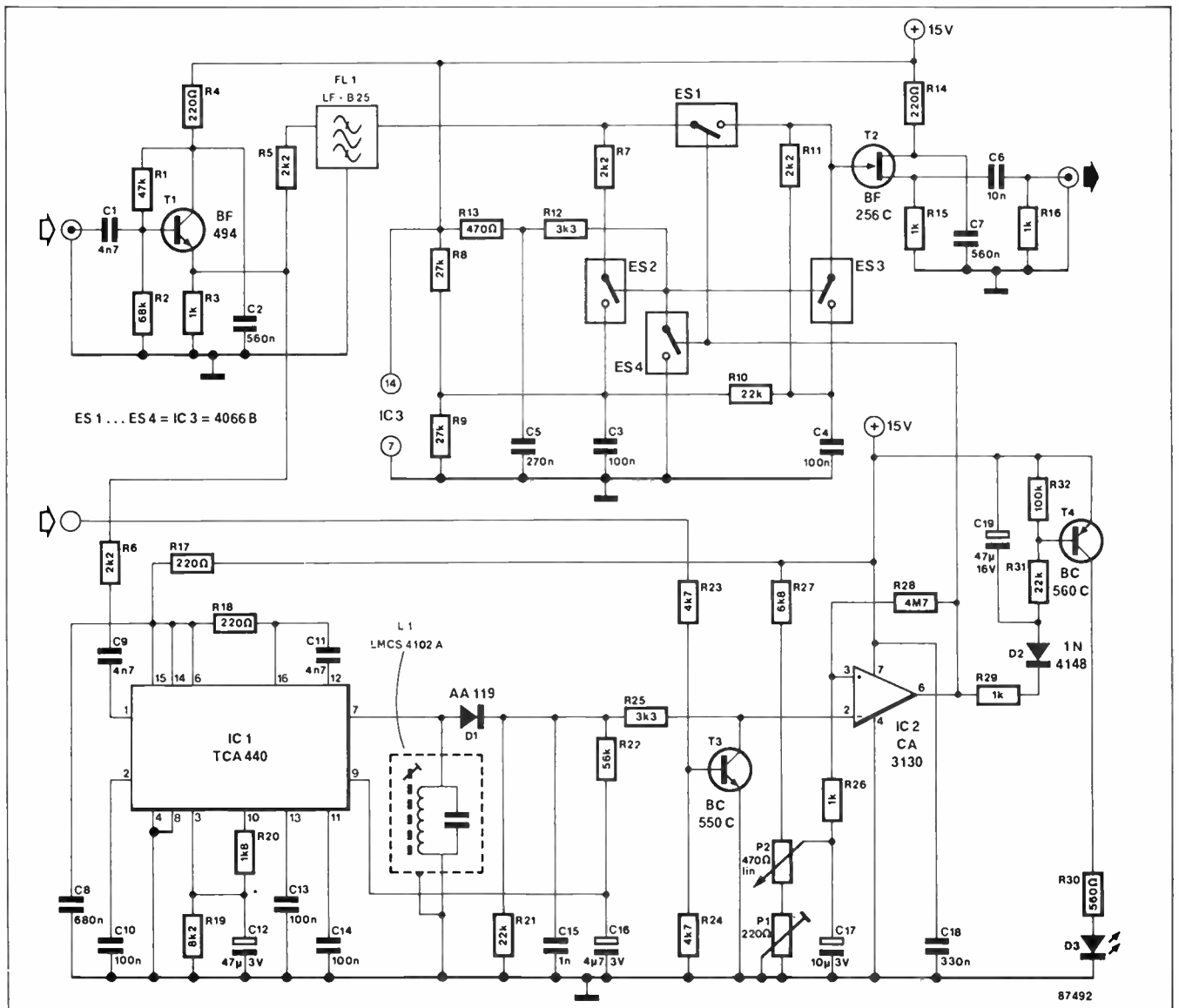
The 455 kHz IF signal is first buffered in T₁, and then processed separately in two circuits.

The lower section of the circuit is a TCA440 based receiver for the interfering pulses. The TCA440 is in itself a virtually complete receiver, since it comprises an RF amplifier, a mixer, and an IF amplifier. All stages in the latter are used since pin 4 is grounded here. The pulse receiver has its own AGC (auto-

matic gain control) to ensure effective suppression of relatively weak interference also. Preset P₁ and potentiometer P₂ enable precise adjustment of the noise blanker for various levels of interference. The circuit can be controlled digitally via R₂₅; a logic high level renders the noise blanker ineffective. The interfering pulses are made logic compatible with the aid of opamp IC₂. LED D₁ lights when noise is detected.

In the upper section of the circuit, the IF signal is first delayed in FL₁ to compensate for the processing time in the pulse receiver. ES₁ is opened when a sufficiently strong interfering pulse is recognized, so that the IF signal is no longer applied to output buffer T₂. Also, the gate of this FET is then grounded for RF signals via ES₁-C₄, while ES₂ is closed

to maintain correct termination of FL₁. Properly constructed, this circuit achieves noise suppression of the order of 85 dB. Alterations to suit operation at an IF other than 455 kHz involve L₁ and FL₁, although due account should be taken of the parasitic capacitance of the electronic switches at relatively high frequencies. (B)



Alternative ICs for the 2506 Instrument Amplifier

A substitute device for the NEC UPC1651 wideband amplifier IC employed in our AEM2506 Wideband Instrument Amplifier project featured last month, is the Signetics NE5205.

This has an almost identical internal circuit and very similar specifications, except for the bandwidth, which rolls off around 600 MHz. However, it's unconditionally stable and you

don't need to take the input loading precautions suggested in the article. It is available in a variety of packages, but the "EC" (can) package is probably the best suited to our project.

PROJECT BUYERS GUIDE

The AEM1520 FM Wireless Mic is an ideal 'start up' project for those just beginning as an electronics hobbyist. It contains a minimum number of components, is easy to build and get going, and gives reliable results. All the components are pretty well readily available and the project will be widely stocked as a kit as a variety of retailers expressed keen interest. And kits are the best way to buy, if you're new to the hobby.

Victorian constructors should try All Electronic Components, Jaycar and Ritronics stores. If you're using components on-hand and just want a few items, the toroidal core for the coil (Amidon type T50-12) is distributed by Stewart Electronic Components in Huntingdale. Any other electronics retailer should carry the other components. The pc board will be stocked by All Electronic Components.

South Australian constructors should breast the counter at any of the five Force Electronics stores.

New South Wales constructors should toddle into any Jaycar store for a kit. The T50-12 toroid can also be obtained through Geoff Wood Electronics in Lane Cove.

Parts for the AEM3106 antenna are readily available from your local hardware store! The balun can be built up from the Amidon "RF Toroid Kit" available from Dick Smith stores (cat. no. L-1410). The appropriate core is also available through Stewart Electronic Components in Melbourne and Geoff Wood Electronics in Lane Cove. Coaxial cable and connectors are widely available at most electronics retailers.

For those constructors who wrote or telephoned us expressing their interest in the Elektor Multi-Function Frequency Meter published in our January issue, this month's prescaler for that instrument will doubtless prove of interest. The specialised semiconductors may be sourced through Stewart Electronic Components in Melbourne (or at least close equivalents). Note that the U664B may be obtained as a spare part through DSE stores. Geoff Wood Electronics in Sydney may also be able to supply many of the semiconductors. For pc boards, enquire with All Electronic Components in Melbourne.

The Infra-red Headphones project is an interesting one. Here, too, for the semiconductors, try Stewart Electronic Components in Melbourne. If they cannot supply your exact requirements, they can likely suggest usable near equivalents. They are also able to supply a suitable pre-wound inductor for L1 (33 mH). Most other components should be widely available. Enquire with All Electronic Components for pc boards.



Adelaide enthusiasts should readily recognise the city store of Force Electronics, located in the "Electronics Belt" at 203 Wright St, Adelaide. The spacious, well-appointed store has a huge self-serve area well-crammed with components, kits and other goodies. Force has four other stores, at Findon, Christies Beach, Enfield and Brighton.

US manufacturer Mini-Circuits also has a suitable device, the MAR-1. This boasts 12 dB of gain from dc to 1000 MHz and unconditional stability. It comes in a micro-X package.

Melbourne specialist component supplier, Stewart Electronic Components, can source both types as well as the special case used for the prototype. With the latter, you can take your choice of either N-type or BNC connectors. In fact, you can source all the components from them! Contact Stewart Electronic Components, PO Box 281, Oakleigh 3166 Vic. (03)543 3733.

Jaycar kits up for the 4605 Super Simple Modem

Our popular Super Simple Modem project, the AEM4605, is now being stocked as a kit by Jaycar.

Published back in September 1986, this V21/23 modem is about as simple as is possible, but still performs well.

It employs the low-cost, phenomenally successful '7910 "World Chip" modem IC and incorporates the simplest RS232 interface using just three lines - receive data, transmit data and ground. It can be powered from a 12 V plugpack, or your computer if it has 12 Vdc available.

Jaycar has eight stores, five in Sydney, two in Melbourne and one in Brisbane. Further details from their head office on (02)747 2022.

Motor start and lighting capacitors

Melbourne retailer All Electronic Components has introduced three new lines of specialist type capacitors.

They are for electric motor starting and running, and for lighting power factor correction applications.

For motor starting, they stock values from 3.75 uF to 240 uF, for motor running applications, they stock values from 2 uF to 30 uF. And for lighting applications, they stock values from 3 uF to 30 uF.

Call or call-in - All Electronic Components, 118 Lonsdale St, Melbourne. (03)662 3506.

Precision 10-turn pots

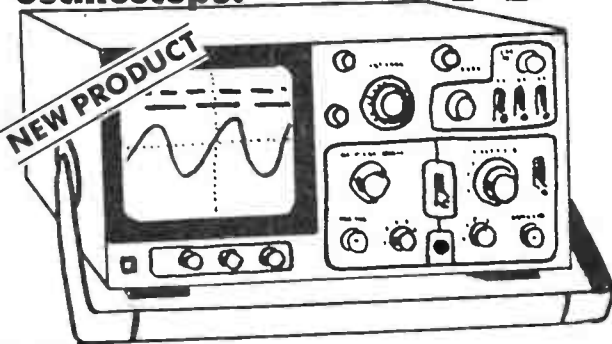
High quality, precision 10-turn wirewound pots are required in many electronic applications. And where they're called for, they have no substitutes.

Ritronics stock a range of precision 10-turn wirewound pot made by Spectrol. They have 0.25" shafts and are equivalent to the Bourns type 3540S and Beckman 7256.

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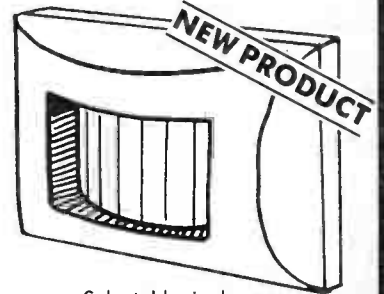
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Build the "Minder" FM wireless microphone

Jamye Harrison

Roger Harrison

Here's an amazingly simple and easy to build, but very effective, 'wireless' microphone that can be used with any FM band receiver to listen-in on sounds from some distance away. It has dozens of uses! Keep an ear on the baby playing or sleeping in its room, or, placed near the swimming pool, you can keep an ear on the action poolside.

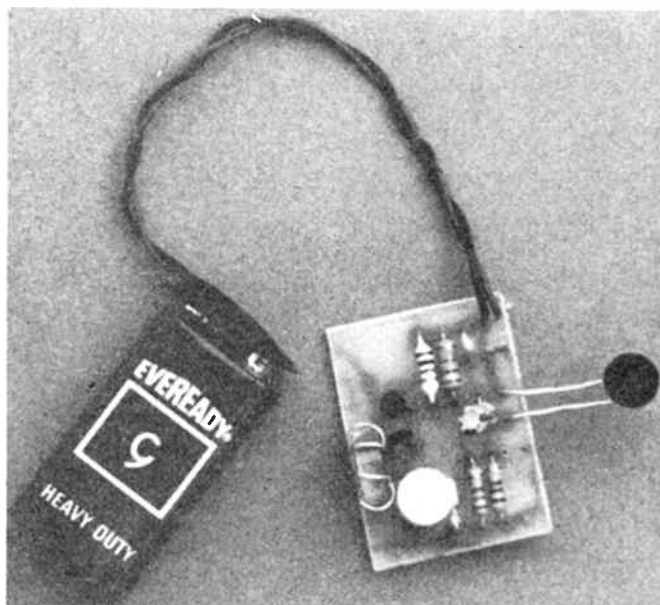
EAVESDROPPING is considered socially "not nice", but there are plenty of applications around the home where one would like to know, or at least hear, what's happening in another room or outside. The examples quoted in the preamble are fairly obvious ones, but no doubt dozens of others will spring to mind. But it was those two examples that led us to call this little project the "Minder". You could probably also think of a few ways to have a little harmless fun "eavesdropping" on family members or situations with this project but we'll have to leave it to your common sense and judgement as to where to draw the line between what is a little fun and what constitutes eavesdropping that's liable to get you in 'hot water' with your 'victims'!

The project comprises a one-transistor oscillator, a simple, very low power transmitter, that incorporates a microphone used to modulate (that is, to vary or to impress upon) the oscillator with sounds it picks up in the vicinity. The oscillator operates in the FM broadcast band, 88-108 MHz, so that it can be set to a frequency where there are no broadcast stations in your area allowing it to be readily picked up on, say, a portable broadcast receiver having FM band reception.

We've built quite a few FM wireless, or radio, mics like this over the years and have become very familiar with the various drawbacks and failings of different circuits and components. The very simplicity of the circuits is both an advantage and a drawback. But some of the problems that arise can be dealt with.

For a start, many FM 'bugs' we've tried are very 'finicky' to set up, the tuning adjustment being very gross. Many are also sensitive to the proximity of hands and other objects which cause them to move off frequency. Many designs have battery and microphone leads (indeed, the battery and the microphone themselves!) 'live' with the radio frequency (RF) energy generated by the oscillator so that they cannot be touched - or even approached closely, while operating. Bringing your hand within 50 mm is enough to upset them, sending the radio mic off frequency, causing 'feedback' squeals in the audio, etc. Setting up such circuits is tantamount to magic!

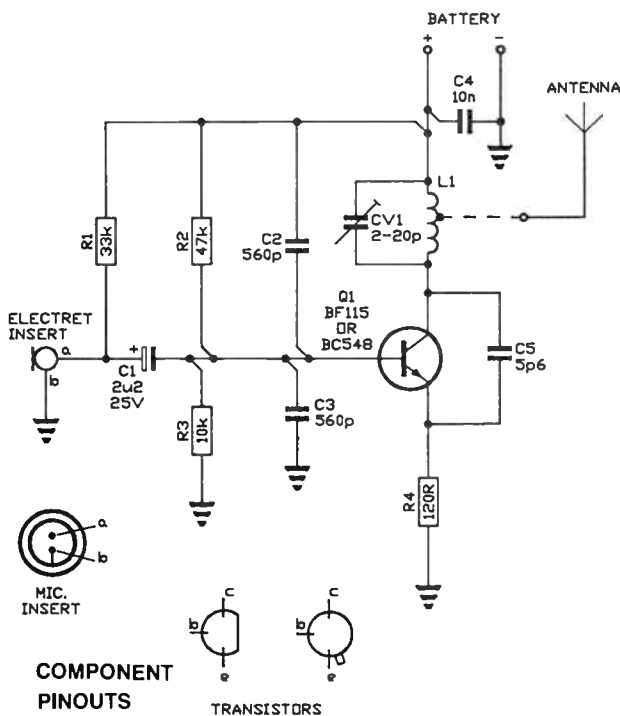
We've tried circuits using small hand-wound air-cored coils and circuits using coils made of a track on the pc board; each has advantages and disadvantages. The hand-wound coil is simple, but getting the coil 'just right' can be a lengthy and frustrating exercise - even though instructive! Those



The project is assembled on a small printed circuit board and powered from a standard 'transistor radio' battery.

with a 'printed' coil have the advantage that this arrangement acts like an antenna, and they radiate very well; but they are quite sensitive to the proximity of other objects, and handling them causes the oscillator to substantially change frequency. If you move one of these designs, you have to 'find' it again or re-tune it. Sometimes, oscillation just stops altogether. Similar problems arise, although perhaps not so drastic, with designs employing air-wound coils.

Another drawback of such designs is the frequency 'drift' they exhibit. Changes in temperature and humidity, and the small, but still significant, dissipation of the transistor bring about small changes in the circuit's components, all of which contribute to altering the oscillator frequency which 'wanders' continually. The wander may not be as much as a megahertz, but if it's 100 kHz (quite typical), that's enough for it to wander away from the frequency to which your receiver is tuned. Now, while many FM band receivers have a facility called 'automatic frequency correction' (AFC, for short), which is there to keep the receiver tuned to the station on



which you set it, the AFC circuit often cannot cope with the range and rapidity with which these oscillators can drift.

In this design, we've attempted to overcome, or reduce, such problems, in the course of which we did a lot of experimenting. We believe this FM wireless mic will prove the most reliable and least troublesome of its type around. You'll have a lot of fun and satisfaction building and using it. If you've had a little experience building FM 'bugs' already, you'll appreciate the advantages of this design immediately.

Design features

The critical part of any free-running oscillator (that is, where it's not 'locked' to any frequency reference such as a quartz crystal which is highly stable), is the tuned circuit. The coil and capacitor, L1 and CV1 in our circuit here, are the principal elements determining the frequency of oscillation. A fixed coil and a variable capacitor may be used to set the frequency initially, or a fixed capacitor and variable inductance coil.

Air-cored, hand-wound coils are simply constructed, but at these frequencies, where the inductance is very small, even minute physical variations in the winding have gross effects on the actual inductance. Hand-wound coils will all exhibit physical variations one to another which have to be compensated for in the circuit design. A variable capacitor with a wide capacitance range will ensure the tuned circuit can be set over a sufficient range to compensate for such variations, but with commonly available trimmer capacitors, a half turn will cover a 30-40 MHz frequency range, making it very 'finicky' to set on a given frequency.

Printed circuit inductors overcome this problem, but have other disadvantages as outlined before. We tried a prewound variable inductance and fixed capacitor combination, which worked very well. The coil was wound on a plastic former and had a threaded ferrite 'slug' that could be screwed up and down inside the threaded plastic former. This was a marked improvement on the previous tuned circuits, showing better stability, accuracy and ease of setting. But 'proximity' effects

CIRCUIT DESCRIPTION

The circuit employs a free-running, one transistor oscillator operating in the 88-108 MHz region, and a high output electret microphone insert to frequency modulate the oscillator with sounds it picks up.

When the supply voltage is applied, a very short pulse of current will flow through the base-emitter junction of the transistor, Q1. This will cause a brief pulse of current to flow through its collector-emitter junction. That current pulse also flows through L1, causing a brief oscillating current in L1-CV1 as it's a resonant circuit, and an alternating voltage will appear across L1 (and CV1). It sort of, 'rings like a bell'. The frequency at which L1-CV1 'rings' depends on the values of the inductance and capacitance, respectively.

Before the initial burst of oscillatory current in L1-CV1 can die away, a small amount is fed via C5 to the emitter of the transistor. This is amplified by the transistor such that it is in phase (or in time) with the oscillating current in L1-CV1, thus sustaining the oscillation. Some of the energy thus built up is radiated by the circuit and can be received on any radio with an FM band. The *actual* frequency of oscillation depends on the TOTAL 'stray' capacitances and inductances encountered by the tuned circuit — component leads and pc board tracks add a little stray inductance; stray capacitance is added by capacitance between tracks, the inter-element capacitances inherent in the transistor, etc.

The base-emitter junction of Q1 is biased by R2-R3 and R4. Note that, if a supply voltage below about 4 V is required, R3 should be changed to 22k.

The electret microphone comprises an insulator with a static charge trapped in or upon it, set between two metal plates to which a dc 'bias' is applied. The plates move in response to air pressure variations caused by sounds. This creates a changing capacitance and thus an accompanying change in voltage. The output level is typically greater than standard dynamic microphones.

In this circuit, the bias is applied to the electret microphone via R1, the varying capacitance of the electret varying the voltage between 'a' and 'b'. This audio signal voltage is coupled to the base of Q1 via C1. Thus, the audio signal from the microphone will swing the base voltage of Q1 with respect to its collector voltage, which is fixed (at the battery voltage). This will vary the *capacitance* of the collector-base junction of Q1 and, as this is part of the *total* tuned circuit capacitance, the frequency of the oscillator will be varied accordingly. It is not the varying capacitance of the electret mic that directly varies the frequency (the mic wouldn't work with RF applied across its terminals!), but the variation of the collector-base capacitance of Q1 that is varied by the signal from the mic.

The base of Q1 does not have any RF applied to it as capacitors C2 and C3 "bypass" it. While a dc bias voltage is applied to the base, it is at 'ground' or common so far as RF is concerned. RF energy is prevented from being coupled into the battery leads and/or the battery by C4, which bypasses any RF on the positive supply track to ground or common.

still affected the circuit's operation and the ferrite slugs were not meant for frequent adjustment.

We then hit on the idea of winding the coil on a toroidal ferrite former. A toroid is a donut-shaped object and toroidal coils have the great advantage of having negligible external magnetic field and are thus markedly less affected by proximity to other objects. We searched the Amidon toroid data (see *Inductors — unravelling a few myths* by John Day in the February 1987 issue) for a suitable core and settled on the T50-12. This measures 12.7 mm overall diameter, 7.7 mm inside diameter by 4.83 mm high. It's small enough to be relatively compact, but not so compact as to be difficult or 'fiddly' to handle. The ferrite material specified has just the right characteristics we need, too.

Sure enough, this proved to be the answer. Using the toroidal coil massively reduced the oscillator's sensitivity to proximity effects, reduced the oscillator drift and proved readily repeatable with remarkably accurate results. This enabled us

to reduce the capacitance range of the variable capacitor used to set the oscillator's operating frequency, permitting easier tuning. We were able to set it up, leave a portable AM/FM radio set on frequency, turn the wireless mic off for a few hours and, when turned on again, it came up spot on frequency. We were even able to set it up, then turn it off, change the transistor (for the same type), turn it on again and it would come up on frequency!

A number of single transistor FM radio mics we tried had inadequate modulation, giving insufficient audio output in the receiver and exhibiting poor microphone sensitivity. The microphone signal is used to modulate (that is, vary) the inherent capacitance of the collector-base junction (see the "Circuit Description" box). This varies a portion of the total circuit capacitance, thus causing a slight change in frequency in sympathy with the applied audio signal.

To get adequate modulation, we need a microphone with good sensitivity and high output voltage swing. Three principal types have such characteristics – the carbon microphone, the electret microphone and some low impedance dynamic mics. The first and last are bulky items, but quite effective if bulk is unimportant. An old telephone will yield a carbon mic and the earpiece makes an excellent high output dynamic mic.

Electret mic 'inserts' are cheap and widely available from electronics retailers, so we opted to use this type of microphone. It draws no power, unlike the carbon mic, and has sufficient output for our purpose – given a circuit which takes advantage of the mic's characteristics, and choice of a transistor which provides enough variation of its collector-base junction capacitance to give good modulation and thus usable recovered audio at the receiver.

Some designs we've seen and tried require an extra transistor to boost the mic output for better modulation. However, this is not essential with the right choice of circuit and components.

The project may be powered from a battery providing anywhere from 3 V to 12 V. If you need compactness, the 3 V or 6 V "button" batteries made for cameras, watches and hand-held games are ideal, but a touch expensive. We used a standard 9 V No. 216 "transistor radio" battery, as can be seen in our photograph at the head of this article.

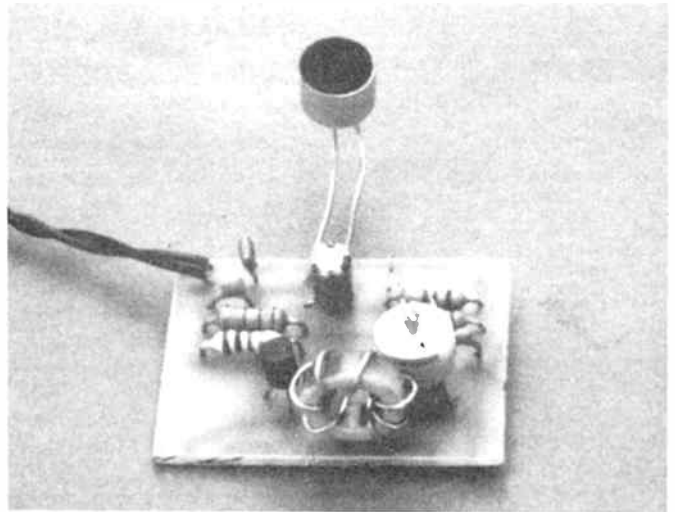
Construction

Although not essential to its operation, we designed a printed circuit (pc) board for this project and recommend that you use a board manufactured to this design. The project could be readily built-up using "matrix" board to hold the components, but a printed circuit board avoids the possibility of making mistakes in interconnecting the parts, despite the simplicity of the circuit.

No matter whether you purchase all the parts separately or buy a kit, when you start assembly of the project, lay out and identify all the individual components. Make sure you identify the positive and negative leads on capacitor C1 and leads 'a' and 'b' of the electret mic insert.

You may elect to either purchase a ready-made pc board or make one of your own if you have the necessary equipment. Such equipment may be purchased at most electronic components retailers. No matter whether you purchase a ready-made pc board or make your own, start by examining the pc board. See that all the holes are drilled and of the correct diameter. The holes for the variable capacitor CV1 may need to be slightly bigger than the others.

Although the components may really be assembled in any order, you'll find it easier to assemble the project in the following order. The components are mounted on the side of the



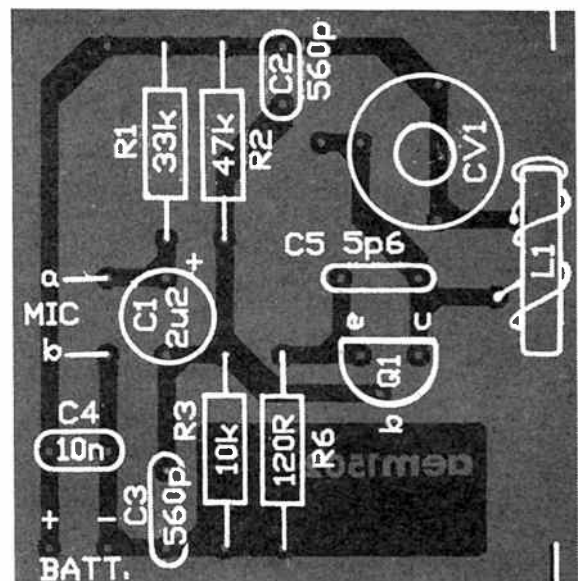
View of the project showing how the toroidal coil is wound and mounted on the board. If you like, it may be secured with a glob of Silastic.

pc board which has no tracks on it, with their leads passed through the holes drilled in the board.

First solder the transistor, Q1, in place. Take care to get it the right way round. Push the leads through the holes on the pc board so that the body of Q1 sits just a few millimetres above the surface of the board. This will hold it in place while you turn the board over and solder the leads carefully one by one.

Apply the soldering iron tip so that it touches both the pad on the board and the component's lead passing through it. Hold it there for a few seconds and then touch the solder to the tip of the iron and see that the solder flows quickly and freely over the joint, then remove the iron. All joints are done in this way.

Next solder all the capacitors in place, with the exception of the small variable (or 'trimmer') capacitor, CV1. Push the leads through the holes so that the body of each component sits within a mm or so of the surface of the board, then turn the board over and solder the leads. Make sure you get C1 the right way round, as indicated on the component overlay diagram here.



Component overlay for the printed circuit board, showing the position of the components.

Now you can wind the coil, L1. Take the toroid and a 200 mm length of 20 or 22 gauge tinned copper wire. Pass the end of the wire through the centre of the toroid for say 150 mm of its length. Then, holding the short end, wind the wire around the outside of the core and pass the end back through the centre again to the right of where you started (moving in an anticlockwise direction). That's one turn. Do this another six times, spreading the turns evenly around the circumference of the toroid so that you end off next to where you started. You actually end up, from start to finish, with an effective total of eight turns.

Pass the coil leads through the appropriate holes on the board so that the toroid sits well down on the board. This helps hold it rigidly in place for good mechanical stability. Now you can solder the trimmer capacitor, CV1, in place. As there are several types of these available, which are different physically, the pc board has been designed to accommodate the different arrangements. Some (such as the Philips type shown in the picture) have three 'legs', some (such as the Murata type) have only two legs. Examine yours.

The three-legged Philips type has one leg clearly connected to the stack of fixed plates, the other two legs being connected to the shaft on which the moving plates are mounted. The leg for the fixed plates is placed in the hole immediately adjacent to capacitor C2 on the board. The two-legged Murata type has one leg clearly attached to the shaft with the slotted end (which carries the moving plates). The other leg is attached to the fixed plates of this capacitor. Once again, it is this leg that goes in one of the holes (there are two) adjacent to C2. The other leg goes in one of the holes in the track that carries the positive supply to L1.

Now you can attach the microphone. You can elect to connect it with suitable lengths of hookup wire or on short lengths of tinned copper wire, as we did. Either way, first solder the wires into the pc board, then solder the mic insert to the other ends, making sure you get it connected the right way round - 'a' goes to the junction of C1 and R1, 'b' goes to the 'common' or 'ground' line.

Now you can solder the battery connector leads in place. As we used a 9 V No. 216 battery, we attached a No. 216 battery "snap" connector, which has colour-coded leads attached - one red, one black. The red lead is the positive, black the

negative. Make sure you get them the right way round. A reverse-connected battery can destroy your transistor.

Thoroughly check your work before proceeding. See that Q1 and C1 are the right way round and that the battery connector is correctly connected.

The try-out!

For this, you will need to use a portable transistor AM/FM receiver or AM/FM tuner. If the latter has an outside antenna, disconnect it and attach a metre or so of hookup wire to the antenna connector. You will need a plastic 'tuning' tool. These come in a variety of styles, but you will want one that has a small metal plate at one end that fits in the slotted shaft of the variable capacitor, CV1. Find a spot around the middle of the dial of your receiver (say, between 98 and 100) which is well away from any stations. Sit the project on a table or bench (making sure that the surface beneath it is not metallic).

Attach the battery, and with your tuning tool, *slowly* adjust the variable capacitor. You should hear the signal 'pop' into place as you tune across the frequency your receiver's set to. If you have the volume turned up somewhat, you may get 'howl-round' audio feedback where the receiver's speaker excites the project's microphone and an oscillation results.

If your tuner or receiver has a signal strength or tuning meter, watch this as you tune CV1 to get an indication that you've tuned across the frequency. A receiver or tuner in the same room as the project will pick it up quite strongly.

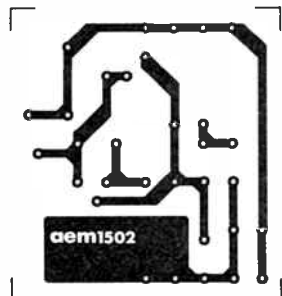
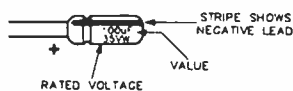
An old fashioned ticking alarm clock is a great way to provide some audio for the signal while you're tuning it. The receiver volume control will probably need to be advanced further than is necessary with ordinary reception as the modulation is less than that used by the FM stations, which also use some audio "compression" which makes softer sounds appear louder to the ear as there is less difference between the soft and loud sounds.

Some receivers will exhibit a few 'strange' effects as you tune the oscillator, stations "popping in and out" as you vary CV1. This is simply that the receiver's front end is "overloaded" by the strong signal from the oscillator, and the receiver acts as if the project is its own local oscillator which tunes-in the stations. Moving the project further away tends to cure the problem.

With the "Minder" tuned in, take the receiver to another room and have someone there read out loud. They don't have to be close to the project as the microphone picks up sound from *anywhere* in the room, or, if you boxed the project, it may be handheld. On your receiver, you should be able to clearly hear what is being said. Remember, however, that you will need to advance the volume control somewhat from where you normally set it for listening to a station. In some circumstances, you may need to turn the volume control virtually all the way up. We found this varied with different receivers.

If it doesn't work

How could it not work?! Well, there may be several reasons. If you can't hear any results, disconnect the battery and once again, thoroughly check your construction. The project will *definitely* not work if Q1 or the battery are connected the wrong way round. Putting C1 in back to front will not stop the project from working and do little harm to the capacitor initially, if at all. See that there are no shorts between adjacent pads on the pc board that are not connected to one another. All joints should have clean, bright solder on them. Any "frosty" or otherwise dodgy looking ones should be reheated with the iron.



Full size reproduction of the printed circuit artwork.

AEM1502 PARTS LIST

Semiconductors

Q1 BC548, BF115
- see text

Resistors all 1/2 W, 5%

R1 33k
R2 47k
R3 10k
R4 120R

Capacitors

C1 2u2/25 V RB electro.
C2, C3 560p/50 V ceramic
C4 10n/50 V ceramic
C5 5p/50 V ceramic
CV1 2-20p or 3-30p trimmer

Miscellaneous

AEM1502 pc board; battery connector; 300 mm of 20g or 22g tinned copper wire; plastic jiffy box (if required).

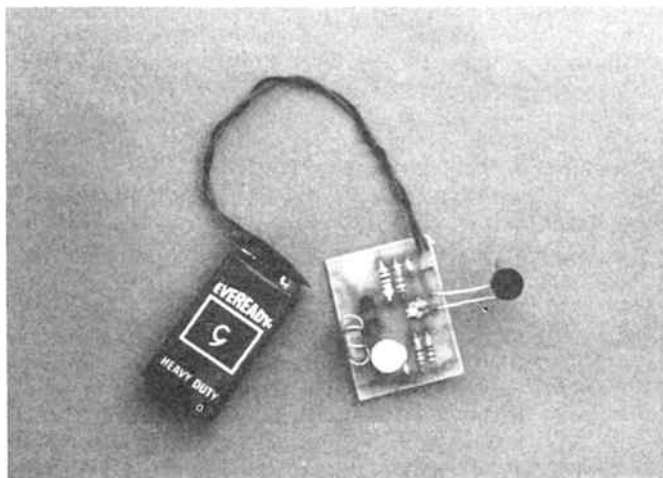
Estimated cost: \$9-\$12.

Further checks should be done with a multimeter. If the oscillator is working, the multimeter may make incorrect measurements due to the RF voltages present. Temporarily short-out the coil terminals with the blade of a screwdriver while making multimeter measurements. Plug in the battery again and measure the voltage between the lead of R4 that connects to the common or negative track on the board, and the collector lead of Q1 (positive). This should be the same as the battery voltage. If not, your battery leads or connections are faulty.

If all's well there, measure the voltage between the base and emitter leads of Q1 (positive meter lead to the base). It should read about 0.5-0.6 volts. If not, Q1 may be faulty or soldered in the wrong way round, despite your checking. Or, R4 may not be properly connected. Check its joints. Whether that's OK or not, measure the voltage across R3. It should be about one-fifth to one-sixth of the battery voltage (that is, between about 1.4 V and 1.7 V or so). If not, you've got trouble with R2 or R3, or their joints on the board.

Using the project

While it's compact enough to stuff in a matchbox (in which case you'd need to use a button battery), most applications just don't call for it. It will fit nicely in a small plastic "jiffy" box, and you'll get a 9 V no. 216 battery in with it – use double sided sticky pads to hold the battery and board in place. Jiffy boxes are readily obtainable from electronic components suppliers. Don't use a metal box – that will just shield it and you won't be able to hear it for any distance, if at all! The pro-



ject will also fit neatly in an audio cassette case, once again held in place with double-sided stick pads. The project will run all day on one Eveready "red" 9 V No. 216 battery.


If you use a button battery, don't solder to the case. Either securely tape the battery leads in place or make-up a connector from springy brass or copper shim available from automotive spares suppliers.

The "Minder" can be easily received over distances of 15 to 30 metres, depending on the sensitivity of the receiver you use. This also means that it may be received by your next door neighbour, so there's no privacy! Avoid interference to stations and set the unit to a part of the band where there are few or no stations in your area, and keep it well away from any stations. The Minder can be quite a useful project, but there's no need to annoy others.

A short "antenna" may be attached to achieve the range needed when the project is used with a relatively insensitive receiver. A short length of stiff tinned copper wire about 100 to 200 mm long, or flexible insulated hookup wire up to a metre long, will serve well. Solder one end onto the coil, on the outside of the toroid, one or two turns from the end connected to the positive supply rail on the pc board.

You will note from the Parts List that a variety of transistors may be used. Experimenting with different types can be instructive and may improve results. The amount of recovered audio in your receiver (which is proportional to the amount of modulation obtained in the oscillator), and the strength of the signal depends on the exact characteristics of the transistor, Q1. The BC548 is the cheapest, most commonly available type and works well in this circuit.

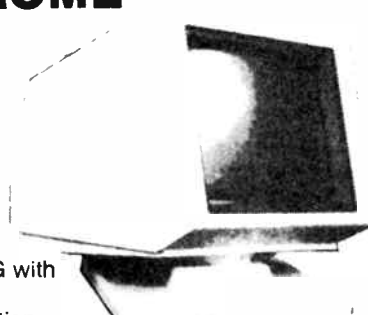
However, different transistors of the same type, as well as of different types, will each have slightly different characteristics and some will give better results than others. You might try the BF115, the 2N2222A, the 2N3563 or 2N3564, the 2N3904, the 2N5770, or the 2N3866 (this one produces quite a strong signal but you'll have to select one from a group which gives the best recovered audio). All are quite common.

We're sure you'll find the project a lot of fun and find plenty of uses for it. Some years ago, a friend used one to successfully catch someone vandalising the family car which was kept parked outside in the street. Perhaps you'll find an equally important application! 

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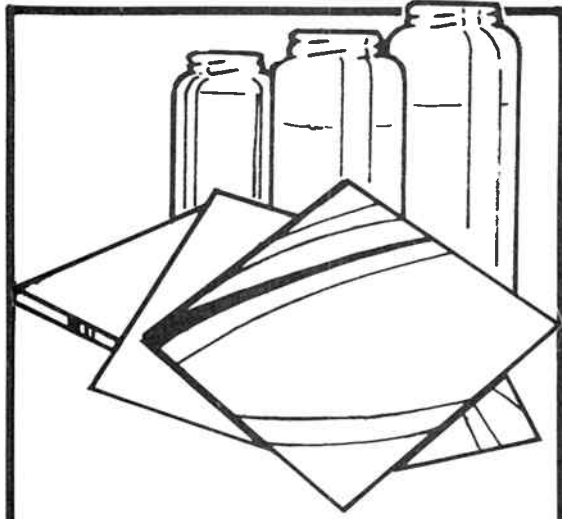
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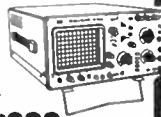
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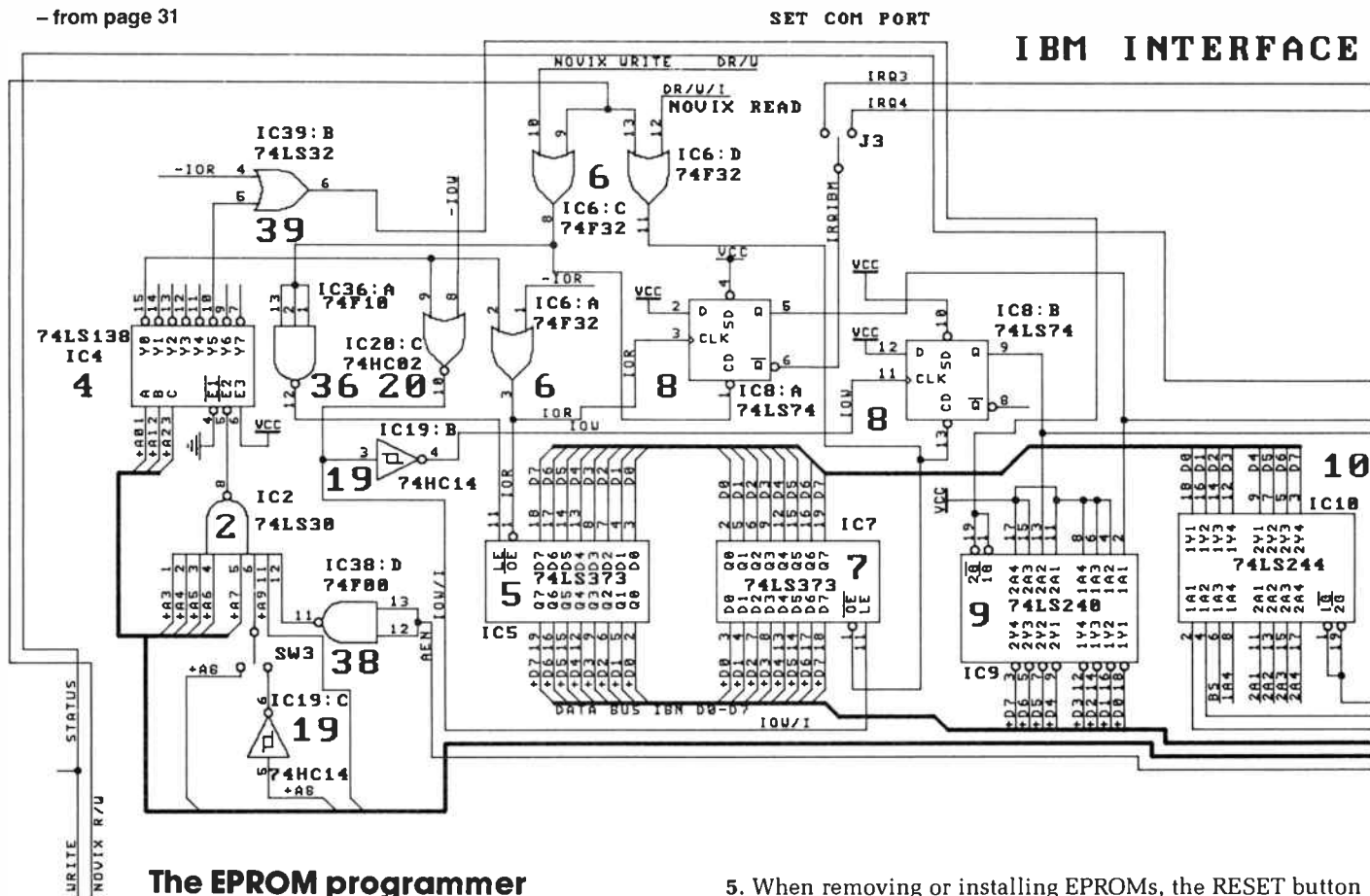
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The EPROM programmer

Before a description of this is given, there are several introductory remarks that need to be made concerning the philosophy behind the design of this part of the circuit.

1. The idea of the EPROM programmer was developed as an adjunct to, rather than a part of, the total project. It was never intended that this portion of the board would be presented as a commercial enterprise. The whole idea of the EPROM programmer was to provide Chris with a convenient means of backing-up source screens as they were developed on the prototype.
2. There are obvious hazards in having such a feature present on the board, notably the possibility of re-writing the source EPROMs and rendering the board temporarily useless. From this, it is obvious that potential EPROM programmers should first make copies of their Master ROMs and store them in a safe location.
3. There is a shorting lug installed on the system (SW4 - also labelled BURN on the overlay), which has been previously discussed in the construction section. With this shorting lug removed, it is impossible to accidentally overwrite an existing EPROM.
4. In order to program new EPROMS, the old ones must be removed from the board. This means removing them whilst the power is applied to the board (otherwise we'll lose the data we wish to program into them). With the board installed inside the IBM, this is not an easy matter. Consequently, it is suggested that the EPROMs be programmed in the external mode, using the true serial ports to provide the communication link. A buffered extender board is being developed by Maestro to allow EPROMs to be programmed whilst the board is inside the IBM.

5. When removing or installing EPROMs, the RESET button should be held down. Removal and/or installation of EPROMs should only take a few seconds.

UNDER NO CIRCUMSTANCES SHOULD THE RESET BUTTON BE HELD CONTINUOUSLY FOR MORE THAN 10 SECONDS.

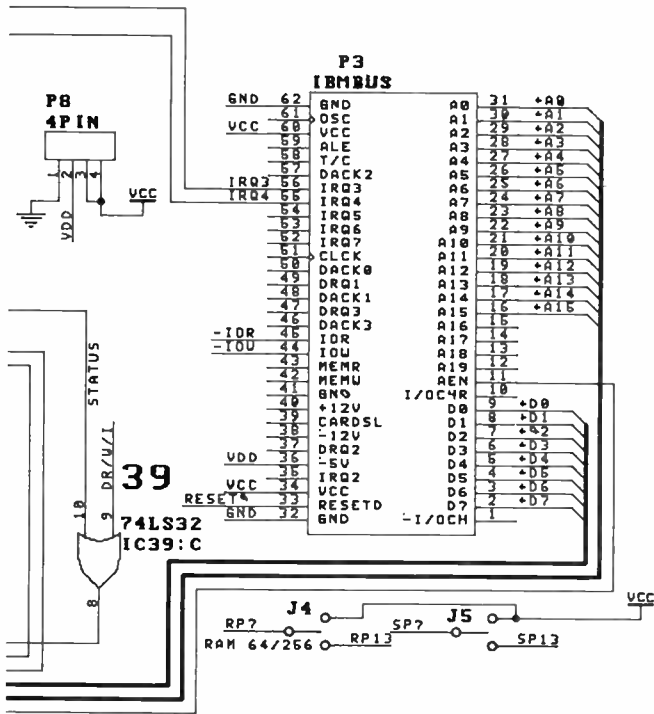
Chris and Dan frequently install and remove EPROMs and it never takes more than five seconds for each EPROM.

6. ZIF sockets are not supplied as part of the kit, particularly due to the low price and the imminent arrival of the extender board. A double (piggy-back) socket technique can be temporarily used to make the insertion/removal of EPROMs a fairly trivial exercise.

Whilst all of the above dire warnings may act as a deterrent, the EPROM programmer works quite effectively and only takes 15 seconds to program a complete kernel.

The programming sequence starts at pin 5 of IC21. When this pin is in the high state, the EPROM programming section is enabled. This signal is applied to pin 9 of IC38 (a 74F00 - a 2-input NAND gate), and together with A15 from the Novix (applied to pin 10 of IC38), produces a signal out of pin 8, which will be low when A15 is high (and when pin 9 is high as well). This means that the EPROM is always programmed in the Novix high address range.

The two halves of the EPROM (high and low) are selected by pin 12 of IC21. When pin 12 is high, the high addresses (\$8000 to \$FFFF) are selected and when pin 12 is low, the low addresses (\$0000 to \$7FFF) are selected. The signal from pin 8 of IC38 is applied to pin 2 of IC39 (a 74F32 - 2-input OR gate). This signal, combined with the DR/W line from the Novix, gives the necessary pulse (marked EBURN on the schematic), to drive the base of Q1 and the "inhibit control" (pin 2) of IC28. Q1 in turn drives Q2, which provides the



*** NOTE 1**
 PINS 25 AND 26 OF P1
 SHOULD BE JUMPERED
 FOR OPERATION
 OUTSIDE THE COMPUTER

programming pulse to one side of SW4. When the shorting lug is installed, the output of Q2 is applied to the opposite side of the shorting lug, and finally to the OE ('output enable' pins - 22) of both EPROMS (ICs 34 and 35).

The TL497 is a dedicated device that is used to supply the 12.5 V programming voltage necessary to program the EPROMs. The TL497 uses Vcc (5 V) to generate the stepped-up voltage. VR1 is used to adjust the voltage to the required level. This should be carried out with the sockets loaded with EPROMs and the shorting lug on SW4 removed.

To actually adjust the voltage correctly, the system must be running and the word written for this purpose, "SLOW", should be run. "SLOW" requires a parameter on the stack which indicates the number of cycles to run through. A value of 10 would give 10 cycles. This means that the Novix is running at its slowest speed (about 1 Hz) and the 10 cycles means that the Novix is slowed down for this number of cycles. A value of 100 would slow the Novix down to its slowest speed for 1 minute and 40 seconds (approximately).

Because the Novix has been slowed down to virtually one second per cycle, it requires several seconds to actually enter the programming loop. This means that you should wait at least five seconds before measuring the programming voltage. It also takes several seconds to exit from the loop, apart from the number of cycles placed on the stack. A multimeter should be connected between ground and the emitter of Q2. The voltage will oscillate between zero and a maximum. Adjust VR1 so that this maximum is 12.5 volts.


There are two Forth words (apart from SLOW) used to program the EPROM. The first word "BURN" requires values for source, destination and number of bytes to be placed on the stack.

HEX 1000 9000 2000 BURN

The above sequence would program 8 kbytes of the kernel into the correct location in EPROM (see earlier).

The other word is KERNEL, which requires no parameters and does exactly what the above sequence performs, with one difference - it calls the word SAVE first, which changes the start-up parameters of the EPROM so that any new words added to the Kernel are automatically programmed to the EPROM for future use.

You can get an overall view of the printed circuit by photocopying the parts reproduced last issue and this issue and carefully "marrying" them.



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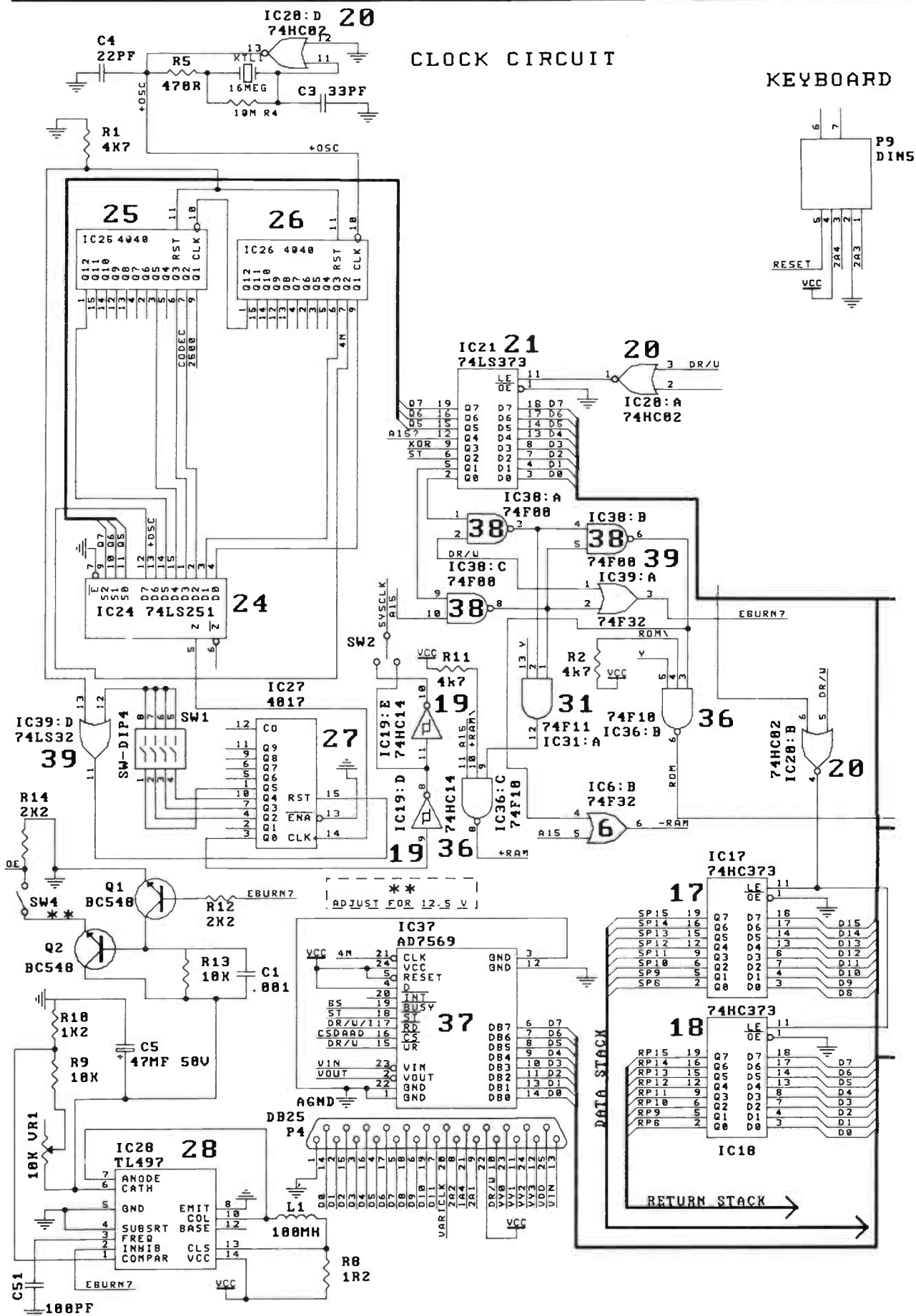
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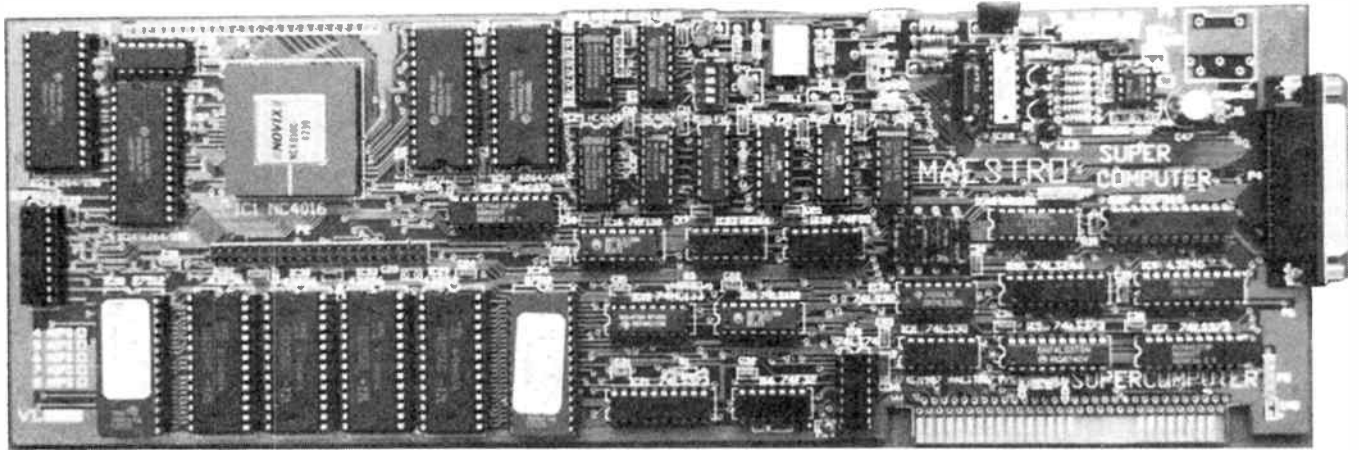
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The fully enclosed acoustic suspension cabinets are easily assembled. All you need are normal household tools and a couple of hours and you've built yourself the finest pair of speakers in their class!

D19 TWEETER SPECIFICATIONS:
Nominal Impedance: 8 ohms
Frequency Range: 2.5 - 20kHz
Free Air Resonance: 1.70kHz
Sensitivity 1W at 1m: 89dB
Nominal Power: 80 Watts (to 5,000Hz, 120dB/oct)
Voice Coil Diameter: 19mm
Voice Coil Resistance: 6.2 ohms
Moving Mass: 0.2 grams
Weight: 0.28kg
Cat. C10301 **\$38**

C20 WOOFER SPECIFICATIONS:
Nominal Impedance: 8 ohms
Frequency Range: 35 - 6,000Hz
Resonance Frequency: 39Hz
Sensitivity 1W at 1m: 90dB
Nominal Power: 50 Watts (120dB/oct)
Voice Coil Diameter: 25mm
Voice Coil Resistance: 5.5 ohms
Moving Mass: 15 grams
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MICROPHONE SPECIFICATIONS:
Transmitting Frequency: 37.1MHz
Transmitting System: crystal oscillation
Microphone: Electret condenser
Power Supply: 9V battery
Range: 300 feet in open field
Dimensions: 185 x 27 x 38mm
Weight: 160 grams

RECEIVER SPECIFICATIONS:
Receiving Freq: 37.1MHz
Output Level: 30mV (maximum)
Receiving System: Super heterodyne crystal oscillation
Power Supply: 9V Battery or 9V DC power adapter
Volume control
Tuning LED
Dimensions: 115 x 32 x 44mm
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Our price, \$99



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- Charges from 1 to 10 D, C, AA, AAA, N, and up to 3 x 9V batteries at the same time
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- 240V AC 50Hz
- Approval No. N10637

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1/4" shaft
Equiv (Bourms 3540S Beckman 7256)
Dials to suit 16-1-11 18-1-11 21-1-11
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Speaker: 9V Battery
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Sensitivity (dB/w/bar) min: 65 mm
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Transmit 4.0 (at 100dB)
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Receiver: 5000
Cat. L19990 (Transmitter) **\$4.75**
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SPECIFICATIONS:
Electrical rating: 220-260 volts (AC) 50Hz 10 Amp
Spikes/RF Protection: 4,500 amps for 20msecond pulses
Maximum clamping voltage: 275V differential mode
Cat. X10088 **\$69.95**



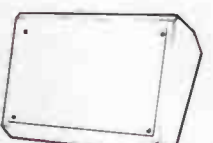
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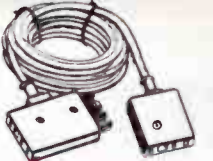
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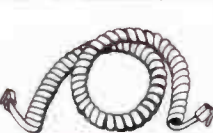
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White durable plastic, 8 ohms
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FEATURES.....

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- Low Price!

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Current Consumption: 10mA at 12V DC
Dimensions: 139 x 165 x 136mm
Exit Delay: 50 seconds approx.
Entry Delay: 12 seconds approx.
Auto reset: 90 Seconds approx.
S15048 **\$39.95**



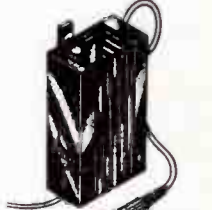
PASSIVE INFRA-RED DETECTOR (WP-800)

- FEATURES:**
 - Walk test LED indicator
 - Walk/corner ceiling mount
 - Micro switch tamper proof protection
 - 24 detection beams in 3 different ranges
 - N.C. silent S P S T dry relay contact output
 - Alarm auto reset approximately 3 seconds after triggered
 - Superior RFI immunity protection
 - Extremely low power consumption
 - Adjustable mounting bracket
 - Easy installation, easy adjustment
 - Dual element, low noise, high signal to noise ratio pyroelectric
 - Detection degree indicator
 - D.C. 8-16V power operatingS15079 **\$89.95**



DIODE SPECIALS

We have millions of diodes in stock!
1-99 100+ 1000+
IN4148 Small signal Cat. Z10135 **3c**
IN4004 400V 1A Cat. Z10107 **4c**
3c **3 1/2c** **3c**



STEREO WIRELESS TRANSMITTER

This unit was developed to allow portable compact disc players to be used in cars by transmitting the headphone output signal directly in to your stereo FM car radio. It will also transmit any mono/stereo signal from any headphone output to any FM receiver.

- SPECIFICATIONS:**
 - Input 3.5mm stereo phone plug
 - Impedance 32 ohm
 - Mono/stereo switch has plug mounting clip
 - FM Transmission approx 90.35MHz (Tuneable 89-91MHz)
 - Range 15 metres (below 15mV/m at 100 metres)
 - Power 1.5W AAA size batteries (100 hours continuous use)
 - Size 72 x 38 x 21mmA16100 **\$69.95**



VIDEO/AUDIO TRANSMITTER

A small compact unit that allows transmission of video and audio signals (RF) to any TV set or VCR within a range of 30 metres (100'), simply by tuning in on Channel 11. Can be used as a transmitter for a video camera. With power on LED on off switch, audio and video leads and supplied with an AC adaptor.
Transmission: VHF channel 11 (PAL)
Video Input: 75 ohms, 1V p-p
Audio Input: 600 ohms
Output Control: Audio-video fine adjustment
Power Sources: 9V battery or power adaptor
Accessories: RCA to RCA audio lead
RCA to BNC video lead
Size: 70(W) x 85(D) x 28(H)mm
Weight: 170 grams
A16150 **\$69.95**

SAVINGS + RANGE + SERVICE = ROD IRVING ELECTRONICS!



METEX M-3650 MULTIMETER

20A, 3 1/2 digit frequency counter multimeter with capacitance meter and transistor tester.

This spectacular rugged and compact DMM has a bright yellow high impact plastic case. It features a frequency counter (to 200kHz) diode and transistor test, continuity (with buzzer), capacitance meter, up to 20 amp current measurement and comprehensive AC-DC voltage current and resistance ranges.

CHECK THESE FEATURES...

- Push-button ON/OFF switch
- Audible continuity test
- Single function, 30 position easy to use rotary switch for FUNCTION and RANGE selection
- Transistor test
- Diode test
- Quality probes
- 1 1/2" High contrast LCD
- Full overload protection
- 20 Amp
- Built in filling ball
- Capacitance meter
- Instruction manual

Q91550 Normally \$165
Special, only \$149



AUTOMATIC CABLE STRIPPER

- Strips cable with diameter of 1 1/2 2 2.6 3 2mm
- Fully automatic action. Squeeze grip will simultaneously strip and eject insulation
- Length 190mm (7")

T11532 \$19.95



ECONOMY ROTARY SWITCHES

Cat. No.	Description	Price
S13021	1 pol 2-12 pos	\$1.95 \$0.95
S13022	2 pol 2-6 pos	\$1.95 \$0.95
S13033	4 pol 2-3 pos	\$1.95 \$0.95
S13035	3 pol 2-4 pos	\$1.95 \$0.95



MINIATURE HOBBY VICE

- Lever operated suction grip base for instant mounting and portability
- Mounts on smooth non-porous surfaces
- Ideal for holding components, and other small light objects

Cat. T12458 only \$5.45



LOW PROFILE IC SOCKETS

Save a small fortune on these "Direct Import" low profile IC sockets! PCB mounting solder tail. Dual-wipe. All tin plated phosphor bronze or beryllium and dual wipe for reliability.

Cat.No.	Description	1-9	10+
P10550	8 pin	\$0.20	\$0.15
P10560	14 pin	\$0.25	\$0.20
P10565	16 pin	\$0.35	\$0.20
P10567	18 pin	\$0.40	\$0.30
P10568	20 pin	\$0.40	\$0.30
P10569	22 pin	\$0.40	\$0.30
P10570	24 pin	\$0.40	\$0.30
P10572	28 pin	\$0.50	\$0.40
P10575	40 pin	\$0.50	\$0.40



GOLD INSERT LOW PROFILE IC SOCKETS

- Gold machined pins
- Extremely high quality
- Anti-wicking
- Ideal for professional use or where held service of components is required

Cat.No.	Description	1-9	10+
P10620	8 pin	\$1.20	\$1.10
P10624	14 pin	\$1.60	\$1.50
P10626	16 pin	\$1.90	\$1.80
P10628	18 pin	\$2.00	\$1.80
P10630	20 pin	\$2.20	\$2.00
P10632	22 pin	\$2.40	\$2.20
P10634	24 pin	\$2.60	\$2.40
P10640	28 pin	\$2.90	\$2.60
P10644	40 pin	\$3.00	\$2.70



WIRE WRAP IC SOCKETS

These quality 3 level wire wrap sockets are tin-plated phosphor bronze

Cat.No.	Description	1-9	10+
P10579	8 pin	\$1.50	\$1.40
P10580	14 pin	\$1.85	\$1.70
P10585	16 pin	\$1.95	\$1.80
P10587	18 pin	\$1.95	\$1.80
P10590	20 pin	\$2.95	\$2.70
P10592	22 pin	\$2.95	\$2.70
P10594	24 pin	\$3.95	\$3.50
P10596	28 pin	\$3.95	\$3.50
P10598	40 pin	\$4.95	\$4.50



TEXTOL SOCKETS

P17016	16 pin	\$14.95
P17024	24 pin	\$18.50
P17028	28 pin	\$24.95
P17040	40 pin	\$29.50



BREADBOARDS

Cat. No.	Description	Price
P11000	100 Holes	\$ 2.75
P11005	640 Holes	\$10.75
P11007	640 + 100 Holes	\$14.95
P11009	640 + 200 Holes	\$17.50
P11010	1280 + 100 Holes	\$26.95
P11011	1280 + 300 Holes	\$32.50
P11012	1280 + 400 Holes	\$39.95
P11015	1920 + 500 Holes	\$59.95
P11018	2560 + 700 Holes	\$69.95



BRAND NEW FANS

Quality, new fans for use in power amps, computers, hotspot cooling etc. Anywhere you need plenty of air.

240V 45 th	Cat T12461	\$14.95
115V 45 th	Cat T12463	\$14.95
240V 31 ²	Cat T12465	\$14.95
115V 31 ²	Cat T12467	\$14.95

10+ fans (mixed) only \$10 each!

FAN GUARDS TO SUIT

45 th	Cat T12471	\$3.95
31 ²	Cat T12475	\$3.95



MINIATURE HEATSINK!

A great little fellow if you are short of space. Great price too, because we import direct so you save!

Dimensions: 19(L) x 13(W) x 9(H)mm

Cat No.	1-9	10+
H10606	\$0.40	\$0.35



HIGH EFFICIENCY RADIAL FIN HEATSINK

Black anodised with a thick base plate, this radial fin heatsink can dissipate large amounts of heat for maximum efficiency.

Designed by Rod Irving

H10520	105 x 30mm	\$ 3.50
H10525	105 x 75mm	\$ 4.95
H10529	105 x 100mm	\$ 5.50
H10534	105 x 140mm	\$ 7.90
H10535	105 x 150mm	\$ 8.90
H10538	105 x 170mm	\$ 9.95
H10542	105 x 195mm	\$10.95
H10543	105 x 200mm	\$10.95
H10546	105 x 225mm	\$11.95
H10549	105 x 300mm	\$12.95
H10560	105 x 600mm	\$26.95



RECHARGEABLE 12V GELL BATTERIES

Leakproof and in 3 convenient sizes, these long service life batteries are ideal for burglar systems, emergency lighting or as a computer backup power supply.

Ideal for many power needs.

Cat. S15029	12V 1.2 AH	\$17.50
Cat. S15031	12V 2.6 AH	\$32.50
Cat. S15033	12V 4.5 AH	\$39.50



REGULAR SOLDER SUCKER

- Light weight
- Sturdy construction
- Easy to remove tip
- Excellent value for money!

Cat. T11271 \$11.95



ANTISTATIC SOLDER SUCKER

- Light weight
- Sturdy construction
- Easy to remove tip
- Excellent value for money!

Cat. T11281 \$13.95



WELLER WTCPN SOLDERING STATION

The WTCPN Features:

- Power Unit 240 V AC
- Temperature controlled iron, 24 V AC
- Flexible silicon lead for ease of use

- Can be left on without fear of damaged tips!
- The best is always worth having.

Cat. T12500 R.R.P. \$149
SPECIAL, ONLY \$129



ADCOLA SOLDERING IRONS

These are professional quality precision soldering tools, similar to those used by the Australian Military Services and industry, for the manufacture, repair and rework of advanced electronic circuits and other scientific equipment.

ADCOLA RS30 12 WATT

- 3mm tip
- 240V operation
- 3 months warranty
- Safety Standards Approved

Cat. T12675 Normally \$36.00
Special, only \$32.00

ADCOLA RS50 16 WATT

- 5mm tip
- 240V operation
- 3 months warranty
- Safety Standards Approved

Cat. T12630 Normally \$36.50
Special, only \$32.50

ADCOLA RS60 21 WATT

- 6.5mm tip
- 240V operation
- 3 months warranty
- Safety Standards Approved

Cat. T12635 Normally \$39.50
Special, only \$35.50



SOLDER ROLLS

Absolutely top quality, unlike our opposition!

60:40 Resin cored

Cat.No.	Description	Price
T31000	71mm 250gm	\$8.95
T31002	71mm 500gm	\$15.95
T31010	91mm 250gm	\$7.95
T31012	91mm 500gm	\$14.95
T31020	16mm 250gm	\$7.50
T31022	16mm 500gm	\$13.95
T31030	71mm 1 metre	\$1.50
T31032	91mm 1 metre	\$1.25
T31034	16mm 1 metre	\$1.00



CENTRONICS GENDER CHANGERS

- Female to Female
- Saves modifying or replacing non-mating Centronics cables
- All 36 pins wired straight through

Cat. X15663	Male to Male	
Cat. X15661	Male to Female	
Cat. X15664	Female to Female	

Normally \$33.95
Only \$24.95

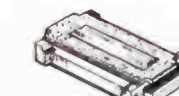


RS232 GENDER CHANGERS

- Saves modifying or replacing non-mating RS232 cables
- All 25 pins wired straight through

Cat. X15650	Male to Male	
Cat. X15651	Male to Female	
Cat. X15652	Female to Female	

Normally \$14.95 each
Only \$9.95



DB15 GENDER CHANGERS

- Saves modifying or replacing non-mating DB15 connections
- All 15 pins wired straight through

X15645:	Male to male	
X15646:	Male to Female	
X15647:	Female to Female	

only \$14.95



DB9 GENDER CHANGERS

- Saves modifying or replacing non-mating DB9 connections
- All 9 pins wired straight through

X15640:	Male to male	
X15641:	Male to Female	
X15642:	Female to Female	

only \$14.95



RS232 MINI TESTER

- Male to female connections
- All pin wired straight through
- Dual colour LED indicates activity and direction on 7 lines
- No batteries or power required

T O Transmit Data
D S R Data Set Ready
R D Receive Data
C D Carrier Detect
R T S Request to Send
O T R Data Terminal Ready
C T S Clear to Send

Cat. X15656 Normally \$39.95
SPECIAL, ONLY \$32.95

RS232 DIP SWITCH LEAD

- 10 Way Dip Switch
- DB25 male plug to DB25 male plug
- Length 2 metres
- Instructions included

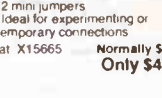
Cat. P19031 \$59.95



RS232 WIRING ADAPTOR BOX

- Male to female
- 25 Detachable plug on leads
- 2 mini jumpers
- Ideal for experimenting or temporary connections

Cat. X15665	Normally \$49.95
	Only \$44.95

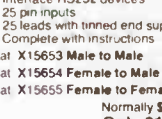


RS232 MINI JUMPER PATCH BOXES

- Interface RS232 devices
- 25 pin inputs
- 25 leads with tinned end supplied
- Complete with instructions

Cat. X15653	Male to Male	
Cat. X15654	Female to Male	
Cat. X15655	Female to Female	

Normally \$25.95
Only \$19.95



Rod Irving Electronics

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56 Renver Rd, Clayton,
Ph. (03) 543 2166 (3 lines)

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ELECTRONIC MOUSETRAP

This clever electronic mousetrap disposes of mice instantly and mercifully, without fail, and resets itself automatically. They'll never get away with the cheese again!
(ETI Aug 84) ETI 1524
Cat. K55240 **\$39.95**

STEREO ENHANCER

The best thing about stereo is that it sounds good! The greatest stereo hi-fi system loses its magnificence if the effect is so narrow you can't hear it. This project lets you cheat on being cheated and creates an enhanced stereo effect with a small unit which attaches to your amp.
(ETI 1405, ETI, MAR 85)
Cat. K54050 **\$79.50**

MICROBEE SERIAL-TO-PARALLEL INTERFACE

Most microcomputers worth owning have an RS232 connector, or port, through which serial communications (input/output) is conducted. It is a convention that, for listing on a printer, the BASIC LIST or LPRINT command assumes a printer is connected to the RS232 port. Problem is, serial interface printers are more expensive than parallel Centronics interface printers. Save money by building this interface (ETI Jan 84) ETI 675
Cat. K46750 Normally \$49.50
SPECIAL, \$29.50

FAIR DINKUM RS232 FOR MICROBEE

The Microbee, among other home computers, has a serial RS232 port in that it doesn't implement negative-going portion of its output signal (Tx/D). Most peripherals with an RS232 input can cope with that but inevitably, there are those that can't. This project fixes that (ETI 676, ETI FEB 84)
Cat. K46760 **\$39.50**

150W MOSFET POWER AMPLIFIER

Here's a high power, general purpose 150W Mosfet Power Amp Module! Suitable for guitar and P.A. applications and employing rugged reliable Mosfets in the output stage.
(ETI 499) (ETI MARCH 82)
Cat. K44990 **\$97.50**
plus transformer **\$49.50**

ELECTRIC FENCE

Mains or battery powered this electric fence controller is both inexpensive and versatile. Based on an automotive ignition coil, it should prove an adequate deterrent to all manner of livestock. Additionally, its operation conforms to the relevant clauses of Australian Std 3129 (EA Sept 82) 82E79
Cat. K82092 **\$19.95**

ELECTRIC FENCE TESTER

This project was developed to take some guess work out of testing or checking an electric fence. Many factors can influence the operation of an electric fence energiser and fence, reducing its effectiveness. This tester indicates the presence of each pulse from the energiser and shows when the pulse voltage exceeds an amplitude of 2kV, 3kV and 5kV, once calibrated. If used in an uncalibrated mode, the unit will indicate pulse amplitudes on the fence of 40%, 60% and 100% of energiser output.
(ETI 1512, Feb 83)
Cat. K55120 **\$19.95**

EPROM PROGRAMMER EP1 KIT

No need for a Micro with EA's great Eprom Programmer suitable for 2716/2758 Eproms.
(EA Jan 82) 82EP1
Cat. K82013 **\$79.95**
(Including Textool Socket)



MODEL ENGINE IGNITION SYSTEM

Get sure starts every time, without glow plug burnouts on your model engines.
(ETI June 83) ETI 1516
Cat. K55160 **\$49.50**

LOW OHMS METER

How many times have you cursed your Multimeter when you had to measure a low value resistance? Well with the "Low Ohms Meter" you can solve those old problems and in fact measure resistance from 100 Ohms down to 0.005 Ohms.
(ETI Nov 81) ETI 158
Cat. K41580 Normally \$44.95
SPECIAL, \$39.95

SPEAKER PROTECTION UNIT

An expensive speaker system can be readily destroyed by a 20 watt amplifier. Carelessly with a high power amplifier can melt voice coils like cheese on toast. However, with this Speaker Protection Unit you can avoid making the misery and expense (ETI 1455.)
Cat. K44550 **\$44.95**

FAST NICAD CHARGER

This project is specifically designed for modellers and photographers who make heavy demands on Nicad batteries quite routinely. There's nothing more frustrating than having your remote control model run out of juice as it runs out of sight, or your flash run out of flash as an inopportune moment. If you use Nicads and need a quick change then this project is a must for you.
(ETI 274, July 80)
Cat. K45630 **\$79.95**

AEM DUAL SPEED MODEM KIT

The ultimate kit modem featuring 1200/300 baud, case and prepunched front panel.
Exceptional value for money!
(AEM 400 Dec 85)

Normally \$169
SUPER SPECIAL, ONLY \$129

LISTENING POST KIT

This device attaches between the audio output of a shortwave receiver and the input port of a computer. It allows decoding and printing out of Morse code, radioteletype (RTTY) and facsimile (FAX) pictures using the computer. It has been designed from all readily available parts. Details for writing the software program are included.
(AEM 3500, July 85)
Cat. K93015 **\$37.95**

MOTORCYCLE INTERCOM OVER 500 SOLD!

Motorcycling is fun, but the conversation between rider and passenger is usually just not possible. But build this intercom and you can converse with your passenger at any time while you are on the move. There are no "push-to-talk" buttons, adjustable volume and it's easy to build!
(EA Feb 84) 84M2C
Cat. K84020 **\$49.95**



MUSICOLOR IV

Add excitement to parties, card nights and discos with EA's Musicolor IV light show. This is the latest in the famous line of musicolors and it offers features such as four channel color organ plus four channel light chaser, front panel LED display, internal microphone, single sensitivity control plus opto-coupled switching for increased safety.
(EA Aug 81) 81M8C
Cat. K81080 **\$114.95**

EFFECTS UNIT

An "effects unit" that can create phasing, flanging, echo, reverb and vibrato effects.
(EA June 83) 83G6A
Cat. K83060 **\$89.00**

VIDEO AMPLIFIER

Bothered by smeary colours, signal breaks and RF interference on your computer display? Throw away that cheap and nasty RF modulator and use a direct video connection instead. It's much better! The Video Amplifier features adjustable gain and provides both normal and inverted outputs. Power is derived from a 12V DC plugback supply.
(EA Aug 83) 83VA8
Cat. K83081 **\$18.95**

SLIDE CROSS-FADER

Want to put on really professional slide show? This slide cross-fader can provide smooth dissolves from one projector to another, initiate slide changing automatically from an in-built variable timer, and synchronise slide changes to pre-recorded commercial music on a tape recorder. All this at a cost far less than comparable commercial units.
(EA Nov 81) 81SS11
Cat. K81110 Normally \$99.00
SPECIAL, \$89.00

MULTI SECTOR ALARM STATION

Protect your home and possessions from burglars with this up to the minute burglar alarm system. It's easy to build, costs less than equivalent commercial units, and features eight separate inputs, individual sector control, battery back up and self-test facility.
Specifications:
• Eight sectors with LED status indication
• Two delayed entry sectors
• Variable exit, entry and alarm time settings; entry delay variable between 10 and 75 seconds, exit delay variable between 5 and 45 seconds, alarm time variable between 1 and 15 minutes
• Resistive loop sensing suits both normally open and normally closed alarm sensors
• Battery back up with in-built charger circuit
• Built-in siren driver

The RIE kit offers a superb printed and prepunched metal case and inside metal plate, plus a gel battery! Unbeatable VALUE!
K85901 without battery backup **\$134**
SPECIAL, \$115
K85900 complete kit **only \$159**
SPECIAL, \$129



AUDIO TEST UNIT

Just about everyone these days who has a stereo system also has a good cassette deck, but not many people are able to get the best performance from it. Our Audio Test Unit allows you to set your cassette recorder's bias for optimum frequency response for a given tape or alternatively it allows you to find out which tape is best for your recorder (81A010) (EA Oct 81)
Cat. K81101 **\$59.50**

FUNCTION GENERATOR

This Function Generator with digital readout produces Sine, Triangle and Square waves over a frequency range from below 20Hz to above 100kHz with low distortion and good envelope stability. It has an inbuilt four-digit frequency counter for ease and accuracy of frequency setting (EA April 82) 82A03A(B)
Note: The RIE Function Generator has a high quality screen printed and prepunched front panel.
Cat. K82040 **\$109**

PARABOLIC MICROPHONE

Build a low cost parabola, along with a high gain headphone amplifier to help when listening to those natural activities such as babbling brooks, singing birds or perhaps even more sinister noises. The current cost of components for this project is around \$15 including sales tax, but not the cost of batteries or headphones. (EA Nov 83) 83MA11
Cat. K83110 **\$14.95**

50/500MHZ 7 DIGIT FREQUENCY METER

Want a high performance digital frequency meter that's easy to build? This unit uses just five IC's, measures period and frequencies up to 500kHz, and features a bright seven digit display. Save a small fortune over comparable commercial units.
Note: The RIE Frequency Meter Kit includes high quality prepunched and silk screened front panel!
(EA December 81)
(50MHz 81m10a, 500MHz 81m10b)
50MHz Cat. K81210 **\$149**
500MHz option Cat. K81212 **add \$29.95**

ELECTRIC FENCE CONTROLLER

Restore discipline to the farm or allotment with this new electric fence controller. It features higher output power and lower current drain than the previous design for use in rural areas.
(EA Dec 85) 85ef11)
Cat. K85110 Normally \$49.95
SPECIAL, \$45.95

TRANSISTOR TESTER

Have you ever desoldered a suspect transistor, only to find that it checks OK? Trouble-shooting exercises are often hindered by this type of false alarm, but many of them could be avoided with an "in-circuit" component tester, such as the EA Handy Tester (EA Sept 83) 83TT8
Cat. K83080 Normally \$18.95
SPECIAL, \$15.95

VIDEO FADER CIRCUIT

Add a touch of professionalism to your video movies with this simple Video Fader Circuit. It enables you to fade a scene to black (and back again) without loss of picture lock (sync) or colour.
(EA Jan 86, 85T10)
Cat. K86010 Normally \$24.95
Special, only \$19.95



LAB SUPPLY

Fully variable 0-40V current limited 0-5A supply with both voltage and current metering (two ranges 0-0.5A/0-5A). This employs a conventional series-pass regulator not a switchmode type with its attendant problems, but dissipation is reduced by unique relay switching system switching between taps on the transformer secondary.
(ETI May 83) ETI 163
Cat. K41630 **\$249**

1W AUDIO AMPLIFIER

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

30 V/1 A FULLY PROTECTED POWER SUPPLY

The last power supply we did was the phenomenally popular ETI-131. This low cost supply features full protection, output variation from 0V to 30V and selectable current limit. Both voltage and current metering is provided. (ETI Dec 83) ETI 162
Cat. K41620 Normally \$73.50
SPECIAL, \$63.50

VIDEO ENHANCER

100's SOLD
Like tone controls in a hi-fi amplifier touch up the signal with this Video Enhancer (EA Oct 83) 83VE10
Cat. K83100 **\$39.50**

ZENER TESTER

A simple low cost add-on for your multimeter. This checks zeners and reads out the zener voltage directly on your multimeter. It can also check LEDs and ordinary diodes.
(ETI May 83) ETI 164
Cat. K41640 **\$11.95**

SUPERB VIFA/EA 60-60 SPEAKER KIT!

The Vifa EA 60 x 60 loudspeaker kit has been designed to completely outperform any similarly priced speakers. This is a 2-way design incorporating drivers which give a deeper, more natural bass response and 19mm soft dome ferro fluid cooled tweeters which provide clear uncoloured sound reproduction. These Vifa drivers are identical to the ones used in such fine speakers as Mission, Rogers, Bang & Olufsen, Monitor Audio and Haybrook just to name a few. Some of which cost well over \$1,000 a pair!

The driving network is of the highest quality and produces no inherent sound characteristics of their own, they simply act as passive devices which accurately distribute the frequency range between both drivers in each speaker.

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

D19 TWEETER SPECIFICATIONS:
Nominal Impedance: 8 ohms
Frequency Range: 2.5 - 20KHz
Free Air Resonance: 1.700Hz
Sensitivity 1W at 1m: 89dB
Nominal Power: 80 Watts
(for 5.00Hz 12dB/oct)
Voice Coil Diameter: 19mm
Voice Coil Resistance: 6.2 ohms
Moving Mass: 0.2 grams
Cat. C10301 **\$38**

C20 WOOFER SPECIFICATIONS:
Nominal Impedance: 8 ohms
Frequency Range: 35 - 6.000Hz
Resonance Frequency: 39Hz
Sensitivity 1W at 1m: 90dB
Nominal Power: 50 Watts
(12dB/oct)
Voice Coil Diameter: 25mm
Voice Coil Resistance: 5.5 ohms
Moving Mass: 15 grams
Cat. C10322 **\$89**

Cat. K86092 (speakers only) **\$379**
Cat. K86091 (complete kit) **\$449**



HEADPHONE AMPLIFIER

PRACTICE WITHOUT ANNOYING THE FAMILY!
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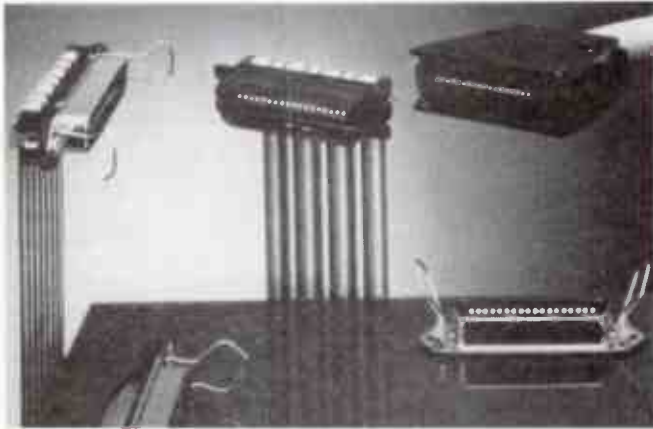
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New range of Centronics IDC connectors



Utilux has just released a new range of Molex Centronics-standard insulation displacement connectors, designed for attachment to ribbon cable, known as the DL 50 Series.

Widely used for printer interfaces and other computer peripherals, as well as business machines and telecommunications equipment, the new connector range includes 24, 36 and 50 pin male and female connectors.

The DL 50 offers metal-shelled straight and right angle pc board mount receptacles with bail locks, mating plug and receptacle for use with 1.27 mm centre ribbon cable, and a cover for the plug which is used with round shielded cable.

Specifications include a contact current rating of three amps and a voltage rating of 500 Vac for the pc-mount receptacles.

The IDC plug and receptacle contacts are rated at one amp and 250 Vac, limited by the ribbon cable specifications.

A bench press for assembling flat cable to the DL 50 series is available and Utilux also provide a cable assembly service.

Further details from Utilux Electronic Division, 14 Commercial Rd, Kingsgrove 2208 NSW. (02)50 0155.

Bose brings on the big gun

Bose has launched what they termed "a revolutionary new professional bass system",

dubbed the Acoustic Wave Cannon, based on the same technology employed in their successful Acoustimass Hi-Fi speaker system.

The system employs a 3.8 m (12 ft) long black tube containing one 300 mm (12") loudspeaker placed about three quarters of the way along the length of the tube.

The system is marketed to the cinema and installed sound system market and was recently used at the Sydney Bicentennial BHP Steel Outdoor Movie season at the Sydney Opera House.

Bose Australia's press release hinted that a domestic hi-fi version may well be seen here early next year.

Further details from Bose Australia, 11 Muriel Ave, Rydalmere 2116 NSW. (02)684 1255.

BWD extend warranty

Australia's only manufacturer of oscilloscopes, BWD Precision Instruments, a Parameters subsidiary, has extended their warranty period on all their equipment.

Whereas warranties were for one year on their instruments, BWD now offer two-year warranties.

The company says this new extended warranty is in line with BWD's on-going commit-

ment to the long term quality and reliability of their products.

The company will be releasing three new oscilloscopes this year. Further details from Parameters offices in Sydney, Melbourne and Perth.

"Pocketphone" for "pocket colony"

Mobiletronics, who manufacture here a cellular mobile telephone known as the "Pocketphone", is to launch its product on the Hong Kong market.

Frank Flammea, managing director of Mobiletronics, is confident the product will be a "hit" in Hong Kong as "... it is the most advanced cellular telephone in the world."

Flammea estimated that the Hong Kong market would be worth about A\$50 million a year to the company.

Mobiletronics expected to complete their Melbourne factory early this year, from which they will supply both the Australian and Hong Kong markets.

The Pocketphone was launched in February 1987 and Mobiletronics claim they now hold 40% of the Australian cellular market. Their next move will be into other Pacific countries, according to Mr. Flammea.



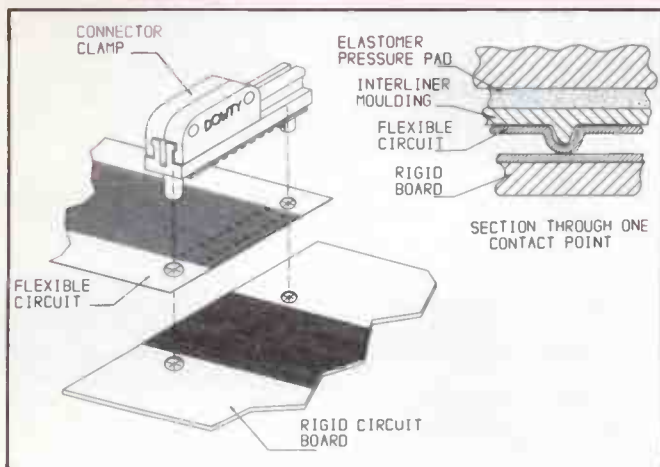
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SM "snap" connector

Alpha Kilo Services has released a new low cost surface-mount interconnect for laminated flat conductor cable with 20 or 40 lines per 25 mm width.

Made by Dowty, the new connector employs a version of their "sustained necessary applied pressure" (snap) system.

The cable has a polyester dielectric with pre-tinned copper conductors exposed at set intervals. The cable is cut to length and contact points formed in the conductors in one simple operation. No soldering or mating connector is required.

The system's benefits include: low cost, no through-hole connections, high contact density, small pc board footprint, zero insertion force, direct interface between cable and pc board, quick connect/

disconnect operation.

Details from Alpha Kilo Services P/L, PO Box 82, Lane Cove 2066 NSW. (02)428 3122.

ESD app. note

An application note from KeyTek Instrument Corp., describes the characteristics of an electrostatic discharge (ESD) from a hand with a metal object (such as a ring, key or screwdriver).

This sort of discharge is typically the worst case situation in the field, we are told and is the stress level normally used by anyone performing ESD testing.

KeyTek Application Note No. 150 shows the waveform required for duplicating this sort of ESD event. Correlation between simulated ESD discharges and that from humans is possible.

App. Note An.150 is available, free of charge, from The Dindima Group, PO Box 106, Vermont 3133 Vic.

Oven for pc boards

Correct heat curing of the Resist is the way to success when making one-off or prototype pc boards.

The latest product from Sesame Electronics is an oven with precise temperature and time controls, allowing correct heat curing treatment for pc board resist.

It's a portable, bench-type unit with an external heater, a

dial thermostat, a thermometer and a digital timer. It will accept pc boards up to 25 x 200 mm. Boards being cured in the oven sit on a wire tray.

Full details are available from Sesame Electronics P/L, PO Box 452, Prahran 3181 Vic. (03)527 8807.

Amber relocates in Melbourne

Amber Technology, the professional audio and cine company, has relocated its Melbourne office, still in South Melbourne, but now over in 189 Gladstone St.

Amber's md, David Hannay, in announcing the new Melbourne address, said it reflected Amber's continuing success in the field of professional audio sales and service since the company was established last year.

Amber's Melbourne office is headed by John Baron. The new phone number is (03)690 5344.

Elmeasco moves

January was the time for moving, it seems! Elmeasco Instruments moved in January, but only 400 metres down the road to a new location at 18 Hilly St, Mortlake.

The new location features larger warehouse, office and administration areas. The company's PO Box and phone number remain as before, but their fax number changes to (02)736 3005.

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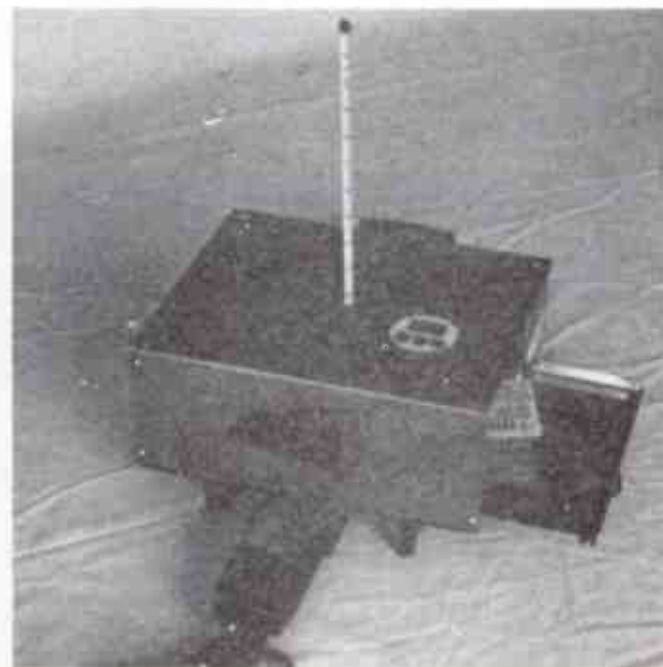
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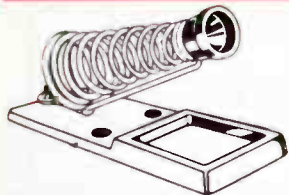
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Practical filter design

— without fears or tears

Part 6 — Other ways of replacing inductors

Jack Middlehurst

Here we meet the "electronic inductor", where a little electronics makes a common-or-garden capacitor seem, to the circuit, like its counterpart — an inductor! For the romantically inclined — in this episode, General Immitance falls for Milli Henry!

FOR MANY YEARS filters were designed using L, C, and R elements. Then some filters were made using electronic valves when these became small enough to include in telephone equipment. But it was the advent of the transistor and, more importantly, the integrated circuit that made active filters really practical propositions. Because of the enormous amount of work that had been done on the design of LC filters, initial attempts were directed at designing circuits that would simulate inductors.

By using these circuits, designs that were known to work could be built by simply replacing the inductors with small circuits containing ICs. In this way everyone was happy, the filter designer didn't have to learn anything new, and the circuit designer was set a clearcut objective. As a result some quite ingenious circuits were designed. We will only consider one class of such circuits.

The original circuit was suggested independently by Mitra and Riorden, but many of its developments are due to Antoniou (pronounced Ant-on-ee-you with the accent on the 'on').

Antoniou's Generalized Immitance Converter

Antoniou's work was based on modifications of a general circuit known as a *Generalized Immitance Converter* (GIC). A GIC can be considered as a black box with two input terminals and two output terminals. If a circuit component (L, C, or R) is connected across the output terminals, the input terminals will behave as if some other component is connected across them. e.g: for a particular GIC, connecting a capacitor across the output terminals will make the input terminals behave as if an inductor was connected across them. Such a GIC would be called an active inductor.

Incidentally, if you haven't come across the word immitance, it can be taken in this context to include impedance, admittance (1/impedance), resistance, and conductance (1/resistance).

The circuit for the GIC is shown in Figure 6.1, where the boxes can contain resistors or capacitors. If ever a circuit looks as if it would oscillate, this is it. Everything seems to feed back into everything else. However, with careful design the thing can not only be kept under control, it can be made to do a considerable range of jobs. Since it only has two terminals, the GIC behaves as a simple circuit component, i.e: there is no output terminal since it does not amplify anything even though it contains two amplifiers.

By varying the contents of the boxes, this circuit can become a gyrator, it can simulate an inductance, it can become a frequency dependent negative resistor, it can

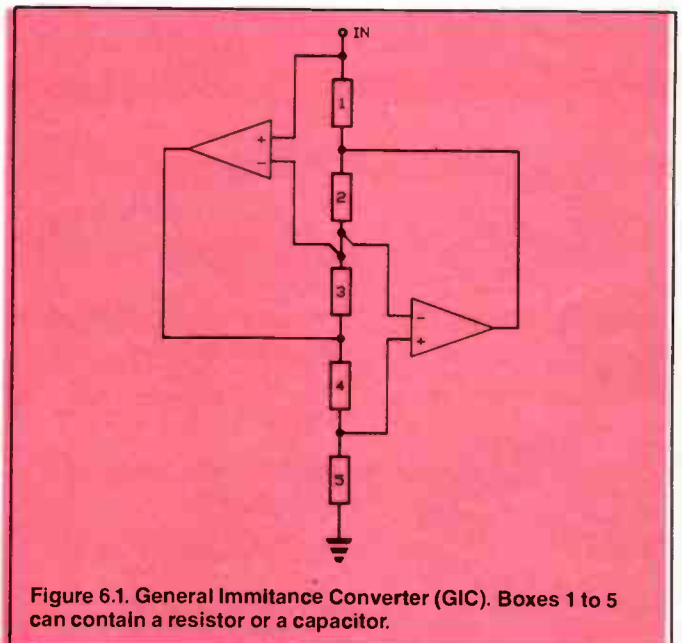


Figure 6.1. General Immitance Converter (GIC). Boxes 1 to 5 can contain a resistor or a capacitor.

become an impedance proportional to the square of frequency, and it can become a tuned filter in its own right. We will look at each of these in turn.

The gyrator

As it is applied to filters, a gyrator is an active circuit element that has some interesting and extremely useful properties. The deceptively simple block diagram of a gyrator is shown in Figure 6.2. If a voltage is applied to the input terminals, a current (proportional to the input voltage) flows out of the output terminals; if a voltage is applied to the output terminals, a current (proportional to the voltage on the output terminals) flows into the input terminals. Notice — into the input terminals, not out of them. In other words, whichever way the current is flowing in the load, the input current is forced to flow in the opposite direction. The constant of prop-

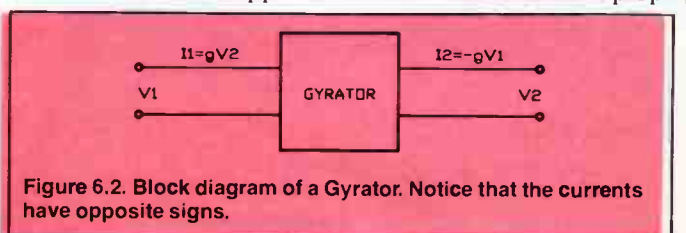


Figure 6.2. Block diagram of a Gyrator. Notice that the currents have opposite signs.

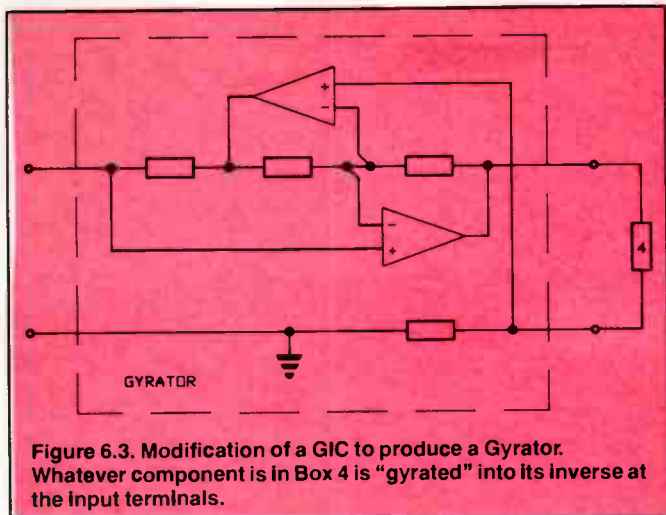


Figure 6.3. Modification of a GIC to produce a Gyrator. Whatever component is in Box 4 is "gyrated" into its inverse at the input terminals.

ortionalality (g) is the same for both currents.

Now consider what happens if we put a capacitor across the output terminals. When ac is applied to a capacitor, the phase of the current into it *leads* the phase of the applied voltage. Since the input current of the gyrator has the opposite sign to the output current, the phase of the current into the input terminals will *lag* that of the voltage applied to them.

This is exactly what would happen if the input voltage was connected to an inductor. So putting a capacitor across the output terminals of a gyrator causes it to simulate an inductor at its input. In the same way, terminating the gyrator with an inductor makes it look like a (lossy) capacitor and terminating it with a resistor makes it look like a negative resistor.

The GIC circuit of Figure 6.1 can be rearranged into that of Figure 6.3, where box number 4 has been made the load device. This is now the circuit of a gyrator and has all the properties that we have just described. If box 4 is a resistor, altering the value of this resistor will change the value of the negative resistance created at the input terminals. If an LC circuit is put across the input terminals, this negative resistance can be arranged to cancel the losses in the LC circuit and the system will oscillate at a frequency set by the values of L and C. The upper frequency limit of this form of oscillator depends on the high frequency response of the amplifiers

and on the stray capacitance across the resistor in box 5.

This is the sort of circuit with which it is fun to experiment. This is best done on one of the "breadboards" designed for trying out circuits. Various values of R, L, and C can be tried, as can the effects of loading box 5 with a small capacitor. You can also try the effect of putting a high value resistor from the junction of boxes 3 and 4 to earth.

Simulating an inductor

To use this circuit as a gyrator in order to simulate an inductor, box 4 in Figure 6.3 is made a capacitor and all the rest of the boxes are resistors. Then the value of the inductance L seen at the input terminals is:

$$L = C \cdot R_1 \cdot R_3 \cdot R_5 / R_2$$

where L is in Henries, C in Farads, and the Rs are in Ohms.

With this particular circuit, it is also possible to simulate an inductor by making box 2 a capacitor and the rest resistors, in which case:

$$L = C \cdot R_1 \cdot R_3 \cdot R_5 / R_4$$

If matched amplifiers are used, e.g: by using a twin FET IC, the performance of the active inductor is excellent; it has a high Q, its stability depends only on the stability of the resistors and capacitor, and its frequency limit is restricted only by the frequency response of the IC. The major limitation of this circuit is that one end of the inductor must be earthed. This means that it can be used in HP circuits, but is not of much value for other types of filter.

Figure 6.4a is the LC circuit of a 4th order Butterworth HP filter using source and load resistors of 1k, with a cutoff frequency of 50 Hz, and Figure 6.4b is the same circuit using active inductors.

The values of the gyrator capacitors in Figure 6.4b were chosen to give reasonable values for the resistors, and the source resistance has been included in the diagram. Any one of the resistors in each active inductor can be made variable in order to tune the circuit; the resistor corresponding to box 5 has been chosen since this allows one end of the variable resistor to be earthed. This in turn means that the adjusting tool is connected to earth during adjustment, so the adjustment does not change when the tool is withdrawn. The nominal values of the resistors are 4.159k and 1.723k for the left and right gyrators respectively. So instead of 4 H and 1.7 H

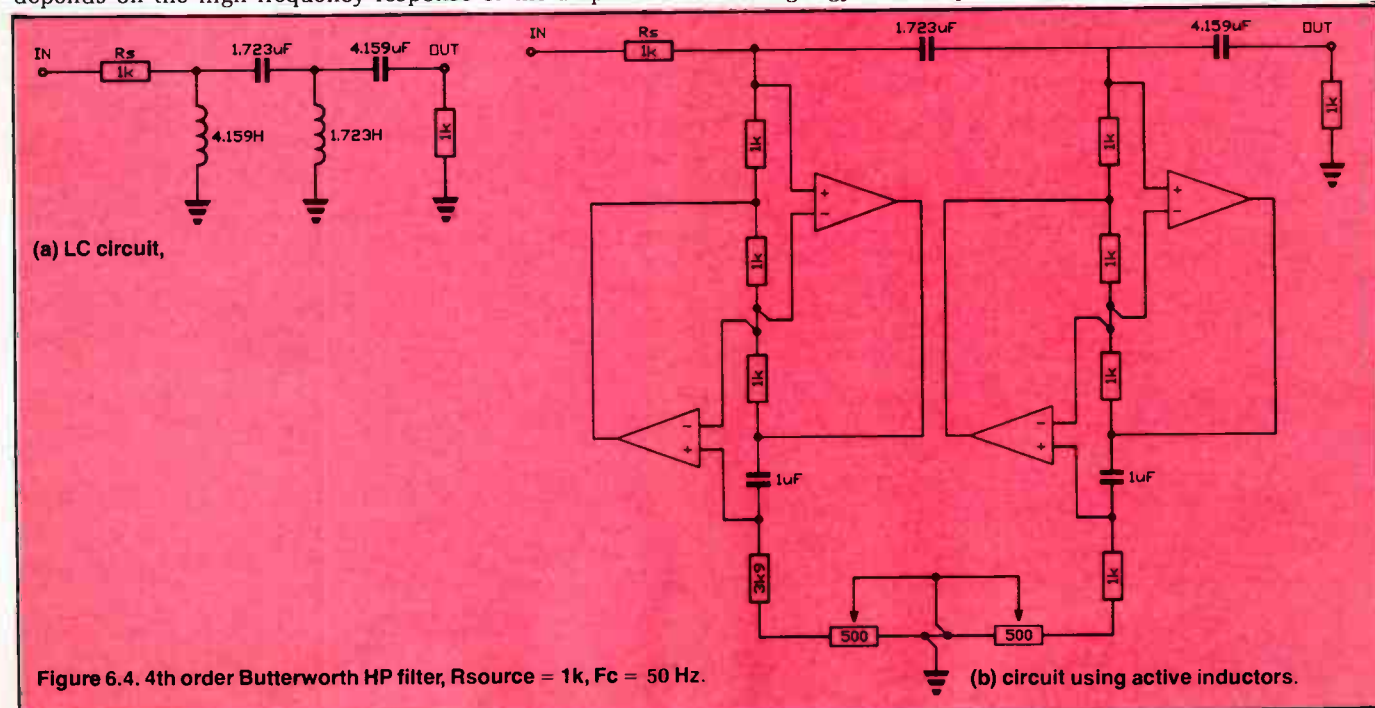


Figure 6.4. 4th order Butterworth HP filter, Rsource = 1k, Fc = 50 Hz.

inductors we only need 4k and 1k7 resistors – a distinct reduction in construction hassles, tuning difficulties, size, and cost, with a considerable improvement in frequency stability and available Q!

In the circuits of Figure 6.4 and in many of the Figures to follow, the source resistance is included in the circuit. This is done because of the way in which the source resistance interacts with the circuit design. It is important to make sure that any circuit that has the source resistance built into the filter is fed from a source having as close to zero resistance as possible. For some filters, for example those discussed in the next section, the load resistance is also included and is an essential part of the design. In this case, it is essential that whatever follows the filter has an extremely high input impedance.

Frequency dependent negative resistors

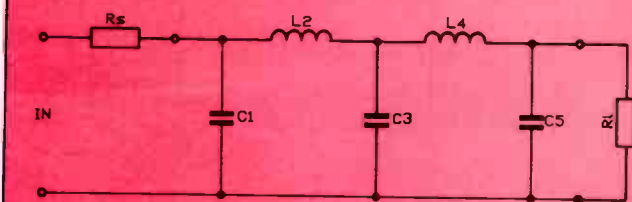
Before we look at how this circuit can become a frequency dependent negative resistor, we have to consider some work done by Bruton. Filter designers have long been familiar with frequency transformations of filters. Given an LP design, a simple frequency transformation allows the designer to convert that design into an HP filter. Such frequency transformations are an essential part of many of the filter-design computer programs that have been presented in this series so far. In the LP to HP transformation, inductors are replaced by capacitors and capacitors are replaced by inductors. You will remember this by referring to the discussion of Figure 2.1 in part 2.

Bruton saw that there could be a way out of using inductors by taking an LC filter design and subjecting it to a special kind of transformation that he invented. This is now known as the LCR:RDL transformation. This converts LC (inductor-capacitor) designs to RC (resistor-capacitor) designs. With this transformation, an inductor is replaced by a resistor, a resistor is replaced by a capacitor, and a capacitor has to be replaced by a frequency dependent negative resistor (FDNR).

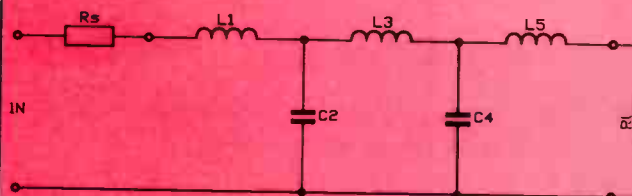
What all this means is that, if an FDNR could be found, the circuits of Figure 6.5b and 6.5c would have exactly the same frequency response provided that the components of Figure 6.5c are given particular values that are calculated using the LCR:RDL transformation. The components marked D2 and D4 have been given the standard symbol for an FDNR.

It was known that the Antoniou circuit could be modified to produce an FDNR, so Bruton went ahead to design the first filter using this transformation. Since we already have com-

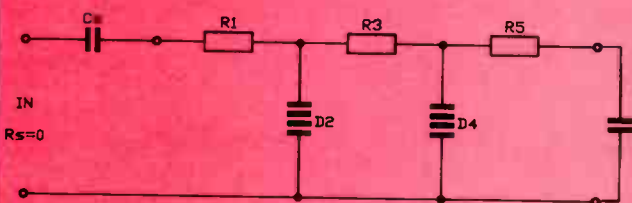
Figure 6.5. 5th order LP Butterworth filter.



(a) minimum inductor LC circuit,



(b) dual of (a) to give minimum capacitor circuit,



(c) circuit of (b) after LCR:RDL transformation. The components marked D1 and D2 are frequency dependent negative resistors (FDNRs).

puter programs that enable us to design a wide range of LC filters, we can now use these same programs to find the values of the L_s , R_s , & C_s , and then, if we wish to eliminate the inductors, all we need is a program to convert these values to R_s , C_s , & D_s respectively.

Now back to the circuit of Figure 6.1. There are three ways of turning this into an FDNR; the circuits are shown in Figure 6.6a, b, & c. The difference is only in the location of the two capacitors. The a & b versions present a slight problem in that they only supply bias current for the ICs if the input terminal

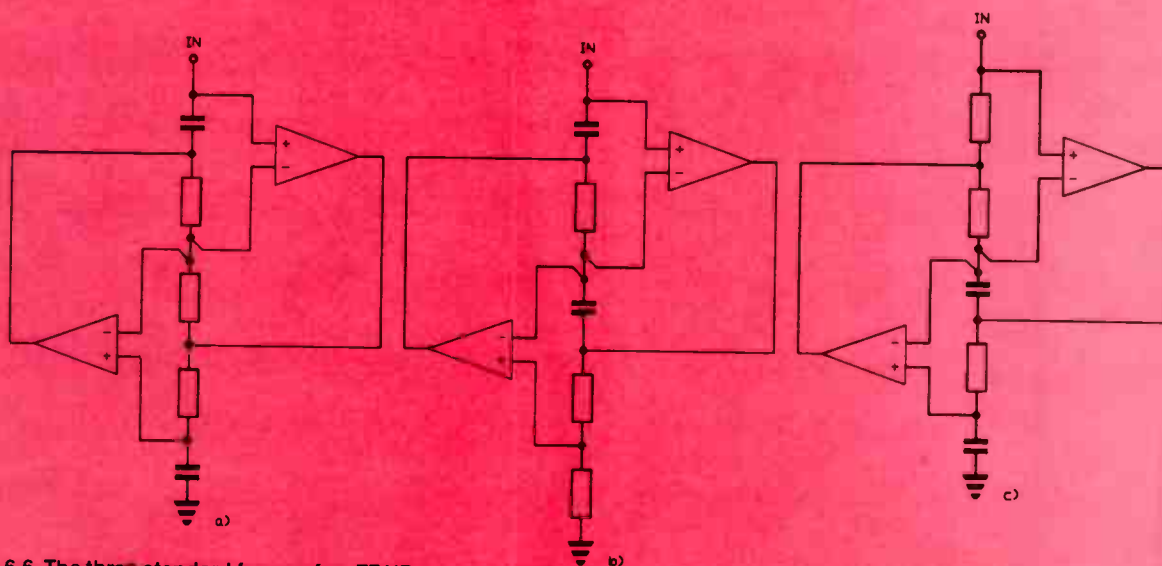


Figure 6.6. The three standard forms of an FDNR.

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Graham S. Mayor, Which Compact Disc, 1988

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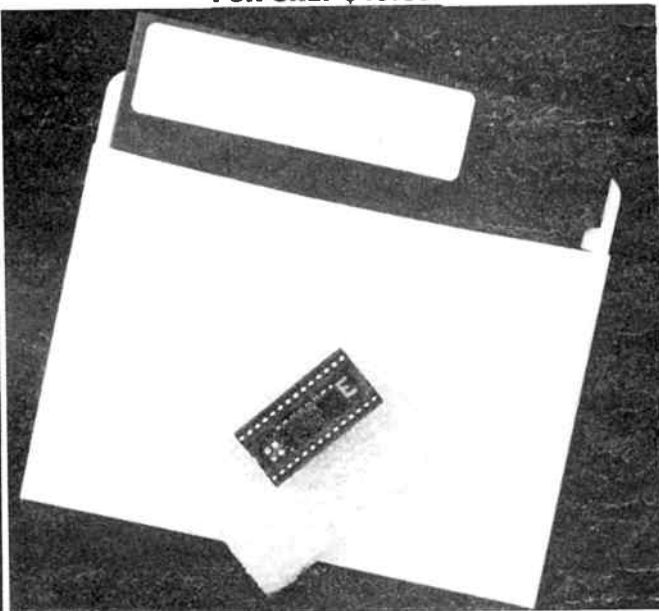
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of the FDNR has a dc return path back to earth. This is rarely the case since the transformation replaces any resistors in the rest of the filter circuit by capacitors. These capacitors would need to have a high value resistor across them to provide the necessary bias current but this degrades performance somewhat. With circuit 6.6c, each input terminal on each amplifier has a return path to an amplifier output from which it can draw its bias current so there is no need for bleed resistors across the capacitors in the rest of the circuit.

Since one end of these circuits is shown as being earthed, and they replace a capacitor, their main use is in LP filters. So we now have two circuits, one to replace inductors in HP filters and one to replace capacitors in LP circuits. Since it is necessary to have one end of the circuits of Figure 6.6a, b, and c earthed, it is not possible to design BP and BR filters using FDNRs. It turns out that there are ways to overcome this problem so that active BP designs are possible. Since the equivalent BR designs require almost double the number of active elements that BP filters require, this form of active design is rarely used for BR filters.

It may seem a bit peculiar to use an IC containing two amplifiers to replace a capacitor. The reason for this is that you can't go half way in a transformation. For example, in a LP to HP transformation, if you just convert all the inductors to capacitors without converting the capacitors to inductors, you would end up with a circuit consisting only of capacitors – certainly not a filter. So when you do the LCR to RDC transformation, the capacitors must all be replaced by D elements (FDNRs). What you gain is that all inductors are replaced by resistors.

To get a feel for designing this type of circuit, we will use the program of Figure 2.2 of Part 2 of the series to design a Butterworth LP filter to be fed from a 1k source, having a cutoff frequency of 12 kHz, with a frequency response at least 20 dB down at 20 kHz. This is a 5th order filter with the following components:

$C1 = 8.197 \text{ nF}$, $L2 = 21.460 \text{ mH}$, $C3 = 26.526 \text{ nF}$,
 $L4 = 21.460 \text{ mH}$, $C5 = 8.197 \text{ nF}$.

The GWBASIC program of Figure 6.7 asks for the values of the L_s & C_s and also the source resistance and the cutoff frequency. It then displays the components that are to be used in

the FDNRs to make up the active circuit.

The LC filter designs presented in earlier parts of this series have tended to be minimum inductor designs. This means that they are automatically maximum capacitor designs. For active filters using FDNRs, maximum inductor, minimum capacitor systems are preferable since each capacitor has to be replaced by a twin amplifier IC. This simply means using the dual of the original LC design. Figure 6.5a has the LC circuit of the Butterworth filter we are making into an active design, and Figure 6.5b shows the circuit of its dual. Notice that the conversion to a dual is NOT the same as a transformation from a LP to an HP filter. With the latter, L_s and C_s are simply swapped. For the dual, a series L is replaced by a parallel C, and a parallel C by a series L.

The program of Figure 6.7 looks at the number of L_s and C_s , and if the latter is the larger, asks if you would like to change to the dual circuit. If so the program converts the circuit to the dual and calculates the resistors and capacitors for the necessary number of FDNRs. Figure 6.8 is the complete circuit of the active filter using the first standard form of FDNRs. The bottom resistors of each FDNR have a nominal value of 1k each. The combination of the 1k2 resistor and the two resistors across it allows the resistance to be varied from about 950 to 1050 Ohms for tuning purposes.

Because all resistors have to be replaced with capacitors, the source and load resistors become an integral part of the filter. So the impedance driving the filter must now be as close to zero as possible, and no load is to be placed across the output. It is worth emphasising that, given the correct circuit components, the three circuits shown in Figure 6.5a, b, and c all have the same frequency responses.

Like all active filters, ones using FDNRs have to be built with due attention to good layout. Every effort should be made to reduce the input capacitances at both input terminals to the two amplifiers by having the minimum possible amount of printed circuit track connected to them. Thin, short lines are essential here. The supply leads to each IC must be separately bypassed and so must the V_+ and V_- leads on the board. Care needs to be taken with the earthing, locating one earth for each IC and returning each of the bottom capacitors to it. If the cutoff frequency is above about 1

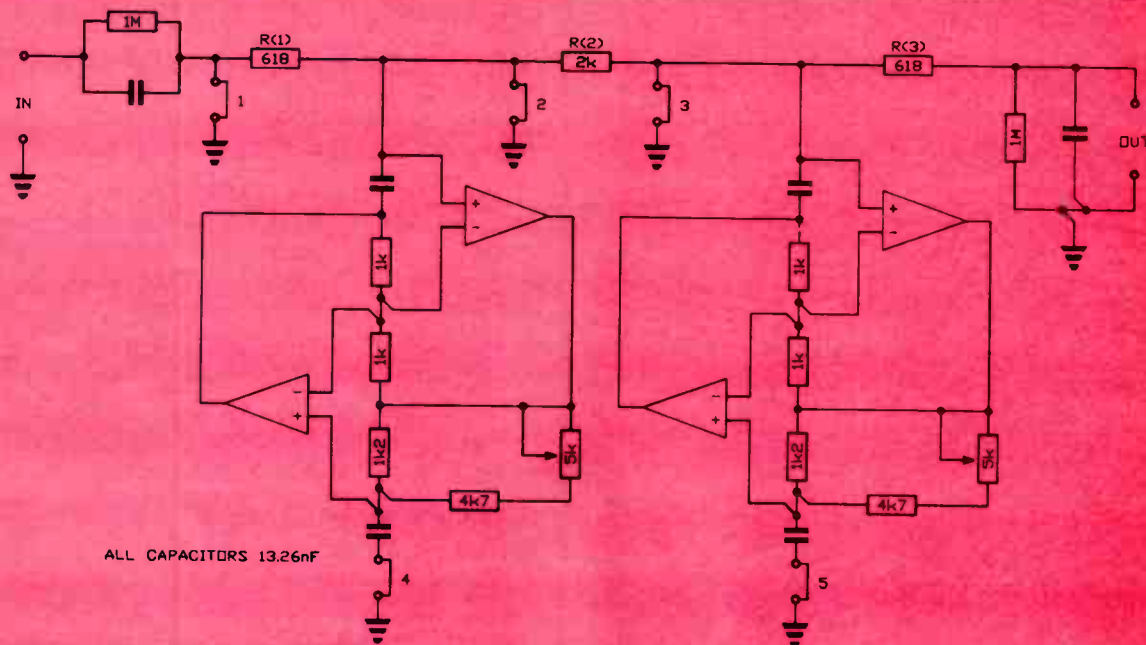


Figure 6.8. 5th order Butterworth filter $R_{source} = 1k$, $F_c = 12 \text{ kHz}$, practical version of Figure 5.5 (c).

Figure 6.7. GWBASIC program to calculate the values of components for FDNRs to be used in LP filters. If requested, the program converts the circuit to its dual by swapping the number of inductors and capacitors and replacing series inductors with parallel capacitors and vice versa. The normalized (Rsource = 1, angular frequency = 1) values of L and C are calculated, transformed using the LCD:RDC transformation, and denormalized, using Rs and Fc, to practical units. This is all carried out in a single step. Since the amount of calculation is small, this program is not optimized for speed.

Lines 30-50 set up the text for the display.
Lines 60-150 request necessary data input; they have traps for incorrect entries.

Lines 160-190 Swap the Ls and Ci if the dual is needed.

Line 200 swaps the number of Ls and the number of Cs

Lines 210-280 contain the main calculations.

Subroutines 290-320 & 410-460 put the answers in usable units, while subroutine 330-360 and lines 370-390 display the component values.

```

10 PRINT "          Design of FDNRs for LP filters" : PRINT
20 DIM L(20),C(20),T(20),R(20),R3(20)
30 A1$="What is the value [ mH ] of L(:A2$=) ?":A3$="What is
the value [ uF ] of C(:A4$="All capacitors are "):TWOPI=2!*3.1
415927#
40 A5$="For FDNr(:A6$=) the tuning resistor is ":A7$="R(:
A8$=) ":A10$="The resistor shunting the input capacitor:"
A11$="The resistor shunting the output capacitor:"
50 A13$="All other FDNr resistors are "
60 INPUT "What is the source resistance [ Ohms ] ?":RS:IF RS<=0
THEN 60
70 INPUT "What is the cutoff frequency [ Hz ] ?":FC:IF FC<=0 T
HEN 70
80 W=TWOPI*FC
90 INPUT "How many inductors are there ?":NL:IF NL<=1 THEN 90
100 INPUT "How many capacitors are there ?":NC:IF NC<=1 THEN 100
110 IF NC<NL THEN PRINT "There are more capacitors than induct
ors.":PRINT "Would you like to use the dual of this circuit ?":I
NPUT "This would reduce the number of ICs. [ Enter Y or N ]":A$
120 FOR I=1 TO NL:PRINT USING "\
#\ \":A1$,I,A2$
130 INPUT L(I):L(I)=L(I)*W/RS/1000:PRINT L(I):NEXT I
140 FOR I=1 TO NC:PRINT USING "\
#\ \":A3$,I,A4$
150 INPUT C(I):C(I)=C(I)*RS*W/1000000:PRINT C(I):NEXT I
160 IF A9<"Y" AND A8<"Y" THEN 210
170 FOR I=1 TO NC:T(I)=C(I):NEXT I
180 FOR I=1 TO NL:C(I)=L(I):NEXT I
190 FOR I=1 TO NC:L(I)=T(I):NEXT I
200 T=NL:NL=NC:NC=T
210 FOR I=1 TO NL:R(I)=L(I)*RS:NEXT I
220 SUM=0:FOR I=1 TO NL:SUM=SUM+R(I):NEXT I
230 FOR I=1 TO NC:R3(I)=C(I)*RS:NEXT I
240 FOR I=1 TO NL:S=R(I):GOSUB 290:GOSUB 330:NEXT I
250 FOR I=1 TO NC:S=R3(I):GOSUB 290:GOSUB 350:NEXT I
260 S=RS:GOSUB 290:GOSUB 390
270 S=1/W/RS:GOSUB 410:PRINT USING "\
###.#
#\ \":A4$,S,A9$
280 GOTO 470
290 IF S>=1000000! THEN S=S/1000000!:A9$=" Mohms":GOTO 320
300 IF S>=1000 THEN S=S/1000:A9$=" kOhms":GOTO 320
310 A9$=" Ohms "
320 RETURN
330 PRINT USING "\###\###.###\ \":A7$,I,A8$,S,A9$
340 RETURN
350 PRINT USING "\
#\ \":A5$,I,A6$,S,A9$
360 RETURN
370 S=1000000!:GOSUB 290:PRINT USING "\
###.###\ \":A10$,S,A9$
380 S=1000000!+SUM:GOSUB 290:PRINT USING "\
###.###\ \":A11$,S,A9$
390 PRINT USING "\
###.###\ \":A
13$.S,A9$:RETURN
400 GOTO 470
410 IF S>=1 THEN A9$=" Farads":GOTO 460
420 IF S>=.001 THEN S=S*1000:A9$=" mF " :GOTO 460
430 IF S>=.000001 THEN S=S*1000000!:A9$="uF " :GOTO 460
440 IF S>=1E-09 THEN S=S*1E+09:A9$=" nF " :GOTO 460
450 S=S*1E+12:A9$=" pF "
460 RETURN
470 PRINT "End of programme":END

```

kHz, the shunting resistors across the input and output capacitors can be reduced by a factor of 10 if you wish.

As usual, the best ICs to use are the LF353 types containing two high gain, wide frequency response FET-input op-amps. It is not a good idea to use ICs with quad amplifiers since the circuit becomes very congested around them and it is difficult to prevent interaction between the various amplifiers. This can lead to some very non-funny effects, such as dis-

torted frequency response or oscillation, that cannot be cured except by rebuilding. High quality components must be used throughout, particularly for the tuning resistors. These should be 10 or 40 turn trimpots from a reputable manufacturer. Any shoddiness here will lead to the filter having a frequency response that changes with time, something dev-
outly not to be wished.

Because what we have done is simply to duplicate an LC filter using other components, the tuning procedure is similar to that of LC filters except that the tuning resistors are varied instead of the inductance of the coils, and there is nowhere to put separate tuning windings to make life easy when tuning. So the link system has to be rather different as you can see by comparing Figures 2.3 and 6.8. It is essential that all the resistors called R() in the program of Figure 6.7, i.e: those that replace inductors, be within 1% or better of their correct value since the tuning procedure assumes that they are exactly at their design value.

For tuning, we now need a signal generator with an output impedance less than 1/100 th of that of the lowest of the series resistor marked R() in the filter, indeed, preferably not more than 1 Ohm. As explained earlier, this can be arranged by putting a simple voltage divider of a 47 Ohm and a 1 Ohm resistor in series across the output of a 50 Ohm generator and taking the signal from across the 1 Ohm resistor. If you happen to have a generator with 600 Ohm output impedance, you will be forced to use a combination such as 560 Ohms in series with 4.7 Ohms. If your generator can produce 1 Volt, then the maximum you will get at the output will be about 8 mV, so the meter that you use for tuning will have to be quite sensitive in this case.

It is best to do the tuning by leaving all ICs out except the one being tuned. Starting with all links out, links 1 and 3 are inserted, the signal generator is set to 13.729 kHz and the signal is applied across the terminals of link 4. The meter or CRO is applied to the junction of R(1) and the top of FDNr(1) and the tuning resistor of the first FDNr is tuned for maximum reading. The frequency for this combination is displayed as the frequency for tuning L(2)C(1)C(3) when the original LC program of Figure 2.2 is run.

Next, links 1 and 3 are removed, link 2 is inserted and the output terminals short circuited. IC(1) is removed and IC(2) inserted, the signal generator is left at 13.729 kHz (tuning frequency for L(4)C(3)C(5)) and applied across the terminals of link 5, the meter is connected to the top of the second FDNr, and the tuning resistance varied to obtain maximum reading. Links 4 and 5 are inserted, all other links removed, the short circuit is removed from the output, and the filter is ready for use.

Frequency dependent impedance.

Capacitors and inductors are circuit elements with which we are all familiar. The impedance Z of an inductor at frequency f is simply given by $Z = 2 * \pi * L * f$ where Z is in Ohms, L in henries and f in Hz. Likewise, for a capacitor, $Z = 1 / (2 * \pi * c * f)$ where C is in Farads. So the impedance of an inductor is proportional to the frequency while that of a capacitor is inversely proportional to frequency.

We have also just met a circuit which has a negative resistance which happens to be inversely proportional to the square of the frequency. Our next circuit has an impedance which is positive and directly proportional to the square of the frequency. It is shown in Figure 6.9. When box 5 contains a resistor, the impedance is also directly proportional to the

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value of this resistor. The main use of this circuit is in active bandpass filters.

Figure 6.10a is the circuit of a part of a bandpass filter. The equivalent circuit using FDNRs is given in Figure 6.10b. Two of the FDNRs are floating with respect to earth and so would require floating power supplies. For, say, a 14th order bandpass filter, this would mean having a minimum of four floating power supplies! To avoid this, the set of three FDNRs can be replaced by two GICs and one device whose impedance is proportional to the square of the frequency, as is shown in Figure 6.10c. All of these active components can be fed from the one earthed power supply.

The complete circuit for such a block of bandpass filter is given in Figure 6.11. Notice particularly that the GICs have resistors in boxes 2 & 4, and capacitors in boxes 1 & 3, whereas the frequency dependent Z component has the reverse. The GWBASIC program of Figure 6.12 can be used to calculate the values of the various components for this circuit. The values of the resistors marked RL() and RC() can be made variable in order to tune the effective L() and C() of the original LC bandpass filter. In the interests of stability, it is best to use a fixed resistor for 95% of the resistance value and to put a variable resistor of 10% of the value in series. In this way the resistance can be adjusted by + or -5% around the correct value.

As with the other versions of Antoniou's circuit, it is best to use ICs containing dual FET amplifiers for the construction. For frequencies up to about 20 kHz, this circuit can be breadboarded to try it out before designing a suitable pc board. It may not be too successful on strip board unless all excess

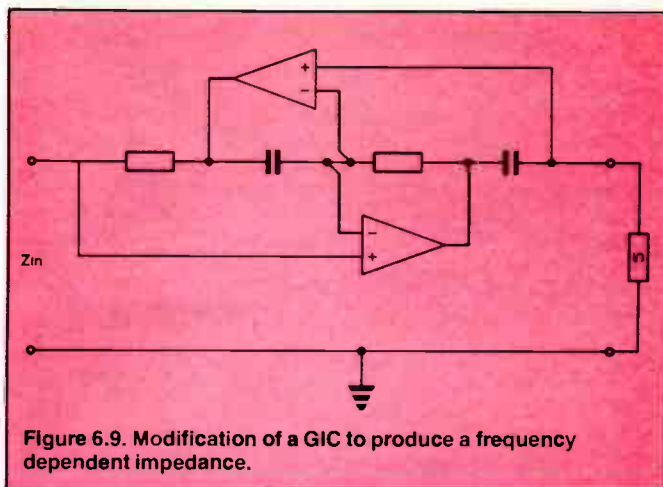


Figure 6.9. Modification of a GIC to produce a frequency dependent impedance.

strips are cut away to keep stray capacitance to a minimum.

The GIC as a tuned filter

The first active filter that we used was a circuit developed by Sallen and Key, and, if you have built any of these you would have found them very reliable. Filter designers are a greedy lot and they are rarely satisfied with anything. There are two main complaints about the Sallen and Key circuit: it is difficult to tune, and the tuning and Q adjustments interact. For most purposes this is of no consequence, but for some professional uses these deficiencies assume major proportions. ▷

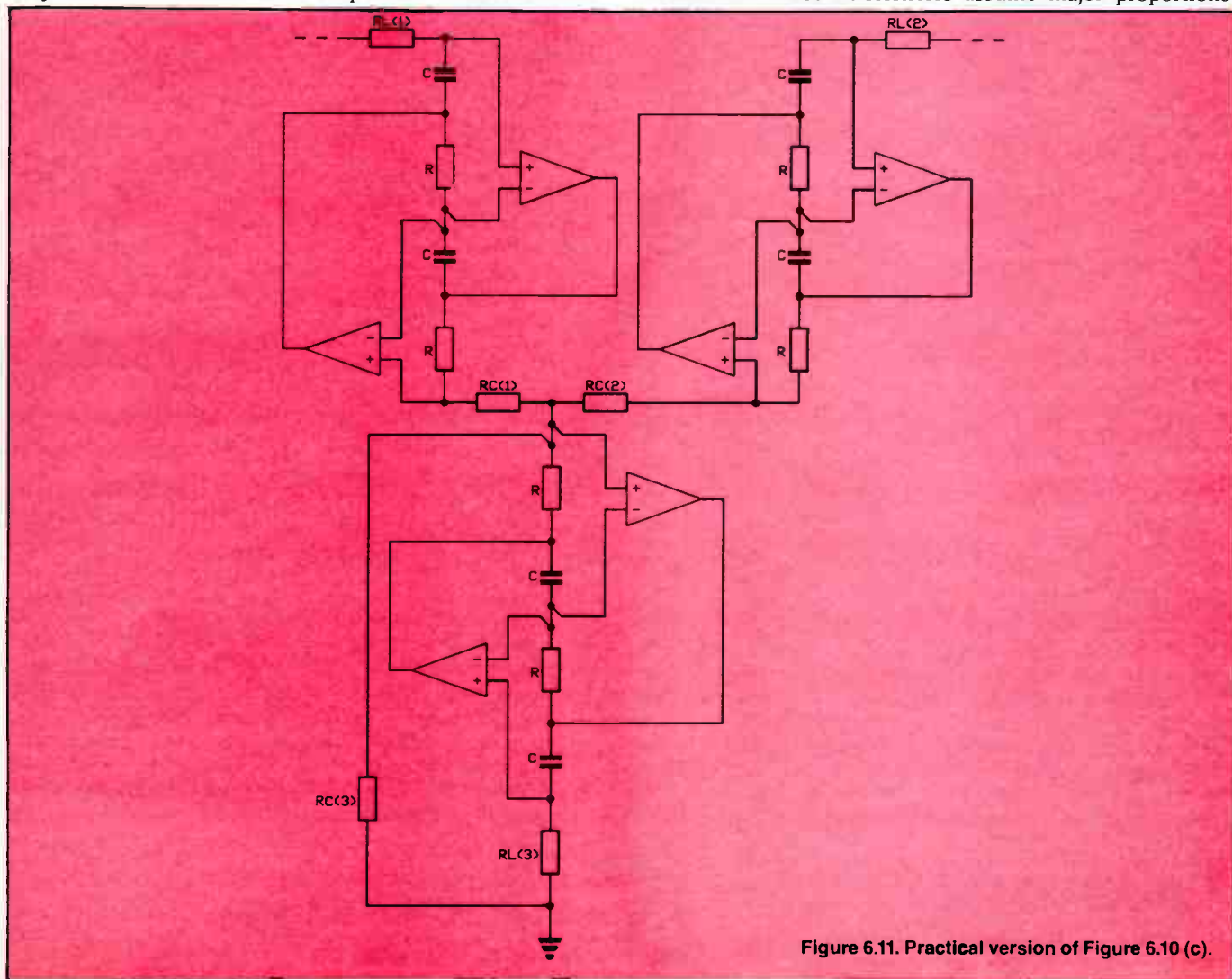
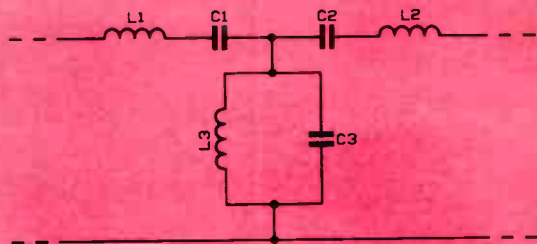
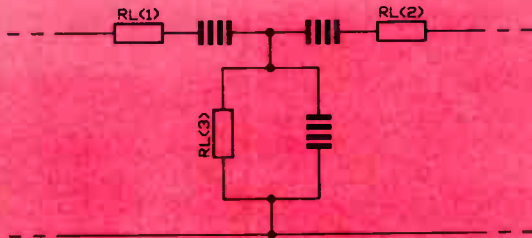


Figure 6.11. Practical version of Figure 6.10 (c).

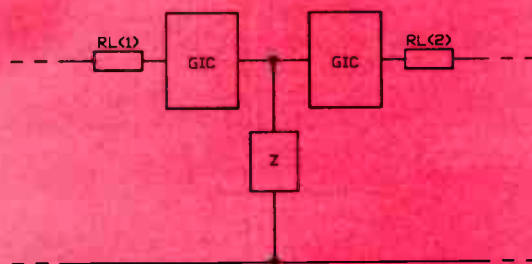
Figure 6.10. Part of a bandpass filter,



(a) LC circuit,



(b) after LCR:RDL transformation,



(c) after conversion of the three FDNRs to two GICs and a frequency dependent impedance (Z).

Consequently, considerable effort was put into designing circuits in which the adjustments are simple and independent. One of the more successful attempts resulted from yet another set of variations on Antoniou's GIC circuit.

Second order circuit blocks in an active LP filter can be replaced by the circuit of Figure 6.13a. This time, the circuit has both input and output connections, the latter being taken from the output of one of the IC amplifiers. Boxes 1 and 3 have been made capacitors, and the rest are resistors. In addition there is a resistor in series with the input and a resistor across box 3. If all resistors except that across box 3 have the value R Ohms and the two capacitors are C uF, the tuned frequency is

$$1\ 000\ 000/(2*\pi*R*C)$$

in Hz, and the Q of the circuit is set by the resistor across box 3. This value of this resistor is Q times the value of the other resistors in the QIC. This makes the Q adjustment simple and independent of the tuning adjustment. This latter adjustment is not, however, particularly simple. Either four resistors have to be adjusted in value, or the capacitor in box 3 has to be adjusted, neither of which is a particularly attractive proposition. Still, it is better than the Sallen and Key circuit.

For high pass filters the circuit to use is that of Figure 6.13b. This time, only box 2 contains a capacitor and the rest are resistors. There is a simple CR filter at the input. The same tuning formula holds as for the LP filter and the Q is set by the value of the resistor of the CR filter divided by the value of each of the other resistors. Again the Q is easily adjusted, but

not the tuning frequency.

Bandpass circuit blocks take the form in Figure 6.13c, similar to the high pass case, but with a simple RC filter at the input. Both the formulae for the tuning frequency and the Q are the same as for the HP case, and the same limitations apply.

It is even possible to use a modified QIC as an element block in an elliptic filter. In Figure 6.14a, using the additional components shown, an LP element with a notch can be realized, provided that the notch frequency is far above the tuning frequency. Because of the complicated feedback, this circuit only has an earth on the input divider resistors and capacitors, not on the GIC. The tuned frequency is

$$1\ 000\ 000/(2*\pi*R*C)$$

in Hz as before, and the Q is now set by the ratio of the two input resistors to R. C1 and C2 are related to the notch frequency as shown on the circuit.

The frequency of the tuned circuit, its Q, and the frequency of the notch are all independently adjustable, with the usual difficulty in the case of the tuning frequency. The notch frequency requires the adjustment of two capacitors, which is a

Figure 6.12. GWBASIC program to calculate the component values for two GICs and one frequency dependent impedance to replace three floating FDNRs in bandpass filters.

Line 30 contains the text for the display.

Lines 40-100 request the necessary data input and contain some of the calculations.

Lines 110-120 contain the remainder of the calculations.

Subroutines 140-170 & 180-230 put the results into usable units.

The program is not optimized for speed.

```

10 PRINT "          Conversion of 3 FDNRs to 2 GICs & 1 Z"
20 PRINT "          Circuits of Figs 5.7 & 5.8" : PRINT
30 A1$="What is the value of " : A2$="L(" : A3$=") [ mH ] " : A4$="C("
  : A5$=") [ uF ] " : A6$="RL(" : A7$=")" : A8$="RC(" : A10$="R=" : A11$="C="
  : A12$="W=" : A13$="1415927#
40 INPUT "What is the source resistance [ Ohms ] ?" : RS : IF RS<=
  0 THEN 40
50 INPUT "What is the centre frequency [ Hz ] ?" : FC : IF FC<=0 TH
  EN 50 ELSE W=TWOPI*FC
60 FOR I=1 TO 3 : PRINT USING "\          \/"
  : A1$,A2$,I,A3$
70 INPUT L(I) : IF L(I)<=0 THEN 60 ELSE S=L(I)*W/1000! : GOSUB 140 :
  PRINT USING "\ \/\#\#\#\#\#\ " : A6$,I,A7$,S,A8$
80 PRINT USING "\          \/"
  : A1$,A4$,I,A5$
90 INPUT C(I) : IF C(I)<=0 THEN 80 ELSE S=1!/(C(I)*W/1000000!) : GO
  SUB 140 : PRINT USING "\ \/\#\#\#\#\#\ " : A9$,I,A7$,S,A8$
100 NEXT I
110 S=RS : GOSUB 140 : PRINT USING "\#\#\#\#\#\ " : A10$,S,A8$
120 S=1!/(RS*W) : GOSUB 180 : PRINT USING "\#\#\#\#\#\ " : A11$,S,A8$
130 PRINT "End of programme" : END
140 IF S>=1000000! THEN S=S/1000000! : A8$=" MOhms" : GOTO 170
150 IF S>=1000 THEN S=S/1000 : A8$=" kOhms" : GOTO 170
160 A8$=" Ohms "
170 RETURN
180 IF S>=1 THEN A8$=" F " : GOTO 230
190 IF S>=.001 THEN S=S*1000! : A8$=" mF" : GOTO 230
200 IF S>=.000001 THEN S=S*1000000! : A8$=" uF" : GOTO 230
210 IF S>=1E-09 THEN S=S*1E+09 : A8$=" nF" : GOTO 230
220 S=S*1E+12 : A8$=" pF"
230 RETURN

```

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bit of a problem. Similarly, Figure 6.14b is the circuit of an HP element for an elliptic filter in which a notch can be realized and gives the formulae to use in calculating the values of the various resistors. In all of these formulae, the variable a is $F_{\text{notch}}/F_{\text{cutoff}}$. Again, the notch frequency must be well separated from the tuning frequency.

More on Antoniou bandpass filters

Before we leave this remarkable circuit, there are two applications of it that are worth mentioning. We have already seen how it is possible to get out of the problem of floating FDNRs when they occur in groups of three in bandpass filters. Unfortunately, floating FDNRs can also occur at the input end of a bandpass filter that starts with a series LC circuit and also at the output end that finishes with one. Since we used GICs to solve the first problem, can we use them to solve the second?

A GIC presented with a pure capacitor as one of its boxes behaves as a pure inductor at its input terminal. When presented with a capacitor in series with a resistor, a GIC can be made to behave as a resistor in series with a FDNR at its input terminal. So the three circuits shown the left hand half of Figure 6.15 behave in identical manners. Notice that by using the LCR:RDL transformation followed by the FDNR:GIC transformation, the L has been replaced by an R, but R_s and C_1 (or R_1 and C_n) have not been changed.

A similar series of transformations converts the series LC circuit at the output of the filter, together with its load resistor, into the GIC circuit of the second half of Figure 6.15. So the three circuits in the right hand half of the Figure also behave in identical manners. In each of the two GIC circuits, the value of R_1 or R_n in Ohms is $2 \cdot \pi \cdot F_c \cdot L() / 1000$, where F_c is the tuning frequency of the circuit in Hz, and $L()$ is the

inductance in the LC circuit in mH; R is equal to the source resistance (R_s). C in μF is given by $1\,000\,000 / (2 \cdot \pi \cdot F_c \cdot C())$, where $C()$ is the value of the capacitance C_1 for the input circuit or C_n for the output circuit in μF .

ADDITIONAL READING

The original references to the pioneers in this field are:

A. Antoniou, *Gyrator Using Operational Amplifiers*, Electronics Letters Vol. 3, 350-352 (1967).

A. Antoniou, *Realization of Gyrators Using Operational Amplifiers and Their Use in RC-active Network Synthesis*. Proc. Inst. Elec. Eng. Vol. 116, 1838-1850 (1969).

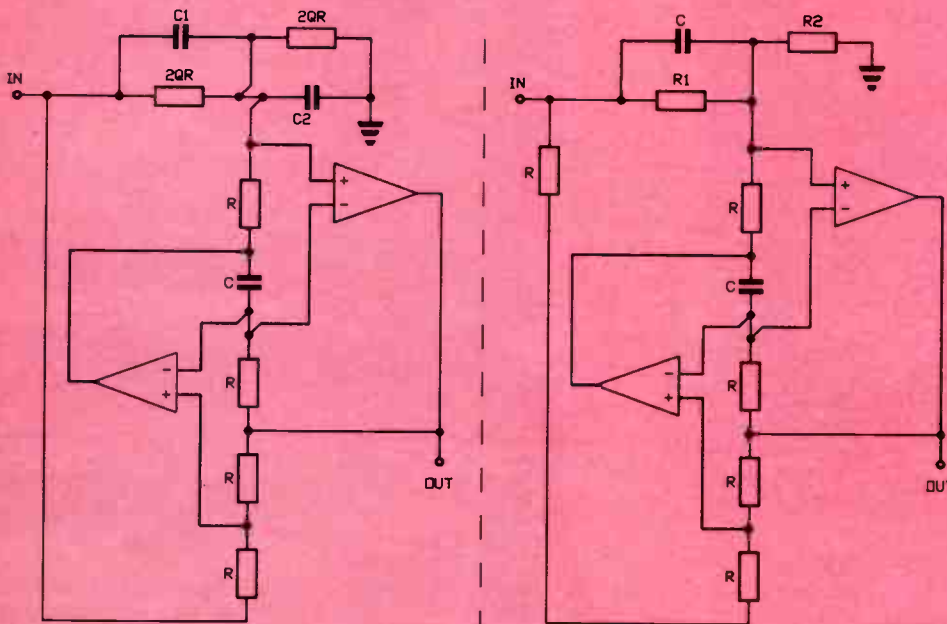
L.T. Bruton, *Network Transfer Functions Using the Concept of Frequency Dependent Negative Resistance*. IEEE Trans. Circuit Theory Vol. CT-17, 541-549 (1970).

S.K. Mitra, *Analysis and Synthesis of Linear Active Networks*, John Wiley & Sons Inc. N.Y., page 494 (1969).

R.H.S. Riordan, *Simulated Inductors Using Differential Amplifier*, Electronics Letters Vol. 3, 50-51 (1967).

A particularly good book for those who wish to delve into GICs and FDNRs in more depth is A.S.Sedra and P.O.Brackett, *Filter Theory and Design: Active and Passive*, Matrix Publishers Inc., Illinois 1978. Indeed, this is a good book on filters in general for those with the necessary maths. It is in the Queensland Institute of Technology library.

Figure 6.14. The GIC as a component of elliptic filters,



$$C1 = (a + 1)C / 2a$$

$$C2 = (a - 1)C / 2a$$

(a) second order low pass with notch,

$$R1 = (1 + a)QR / a$$

$$R2 = (1 + a)QR$$

$$R3 = 2a R / (1 + a)$$

$$R4 = 2a R / (1 - a)$$

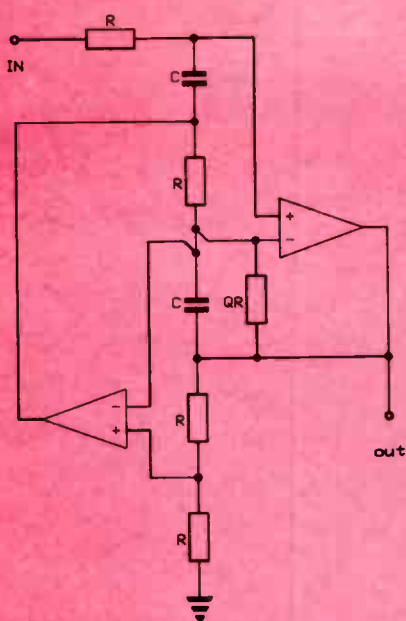
(b) second order high pass with notch, the tuning frequency F_c is given by

$$F_c = 1\,000\,000 / (2 \cdot \pi \cdot R \cdot C)$$

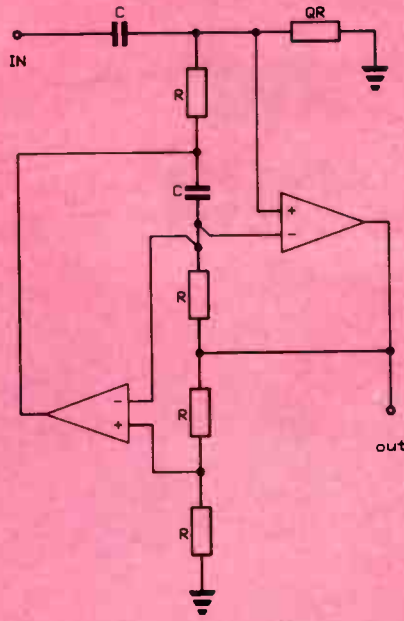
R in Ohms, C in μF , F_c in Hz.

The equations for the components controlling the notch frequency are given in the Figure. In these equations, $a = F_{\text{notch}}/F_c$. For LP filters $a = 1$, for HP filters $a = 1$

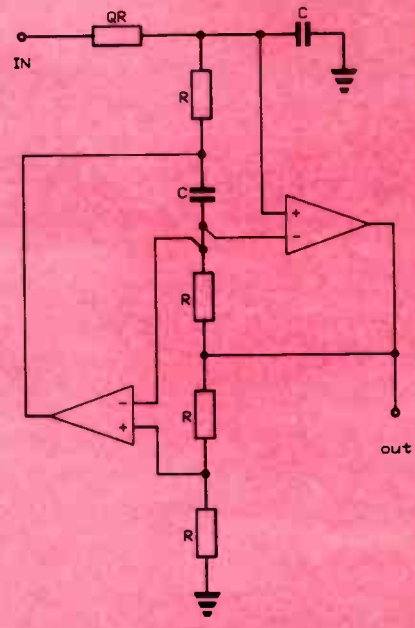
Figure 6.13. The GIC as a filter component,



(a) second order low pass,

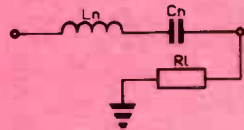
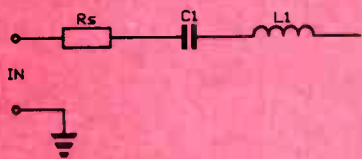


(b) second order high pass,

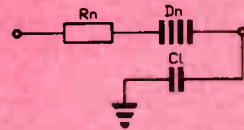


(c) second order bandpass.

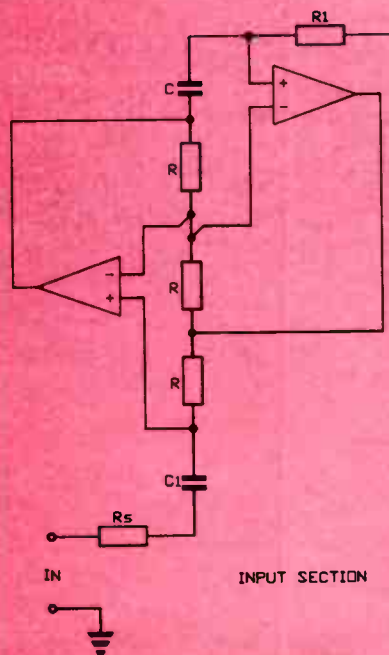
Figure 6.15 Input and output sections of bandpass filters,



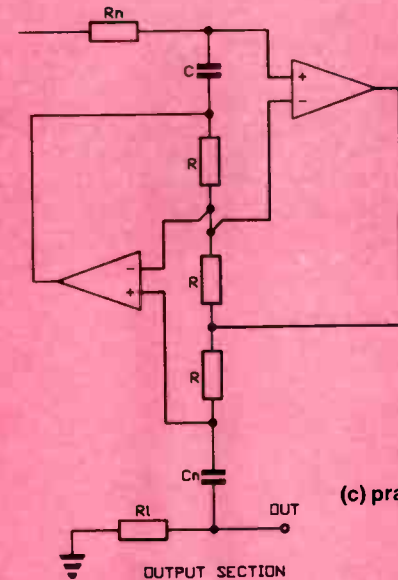
(a) LC circuit,



(b) circuit after LCR:RDL transformation,



INPUT SECTION



OUTPUT SECTION

(c) practical circuit using GICs instead of FDNRs.

Guidelines on the evaluation and selection of an oscilloscope

Will Kennedy

When purchasing an oscilloscope, no matter whether you're doing it for the first time or upgrading, there are a number of fundamental considerations that need to be addressed. Go through this list and you'll have a much better picture of what the brochures tell you – or don't tell you!

IN BUYING an oscilloscope, no matter whether it's for yourself or on behalf of your company or department, you should approach the task much as you would in buying a new car. It will be a major purchase, just as a new car is, and you need to collect the brochures, read the specs, kick a few tyres, go for a test drive, etc. Figuratively speaking, that is.

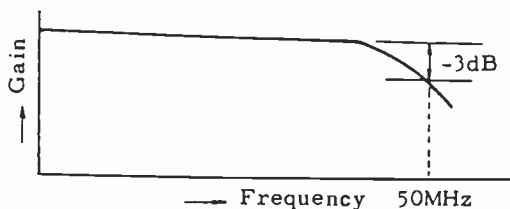
You first need to make a broad assessment of your own requirements. Consider the sort of work you'll be doing which demands an oscilloscope and then you'll have some idea of what's currently required and perhaps a bit of a clue about what might be required in the future. This last bit is important, because if you purchase an instrument to do the job now, it may become obsolescent very, very quickly and quite inadequate for your needs.

You should ask yourself what sort of measurements do you need to make now and what sort of measurements you might need to make in the future. Measurement accuracy is important, as well as taking into account how you currently make measurements of quantities like period and frequency, signal amplitude (including RMS), etc. There are oscilloscopes available these days that can measure the sort of quantities that it took three or four instruments to do in the past. And with a precision rivalling digital meters. So no you can combine, in a single instrument, the functions of a frequency-period counter, digital voltmeter (with true RMS readout!), dB meter and oscilloscope – phew!. And you'll probably get a few other fancy functions thrown in for good measure.

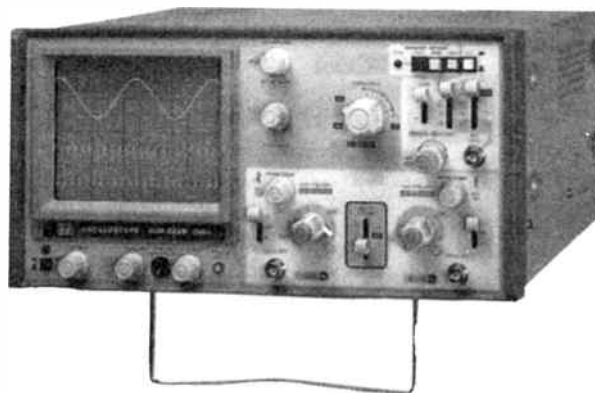
By purchasing the right instrument, you could save unnecessary purchases in other instruments. Right, let's look at the primary considerations in turn.

Bandwidth

This is clearly the first consideration, no matter what else you may require in an oscilloscope – it's the one number by which all CROs are characterised: 20 MHz, 50 MHz, 100



The bandwidth of a CRO is specified where the gain at high frequencies falls by 3 dB. At this point, the display would be 0.7 the height it would otherwise be at a much lower frequency. The example here refers to a "50 MHz" CRO.



This Goodwill GOS522B is a good illustration of the functions and features you get in an 'entry level' 20 MHz Class instrument these days. It's a dual-trace, single timebase unit with a max sweep speed of 20 ns/div. and variable hold-off on the trigger. Goodwill CROs are distributed by Emona Instruments.

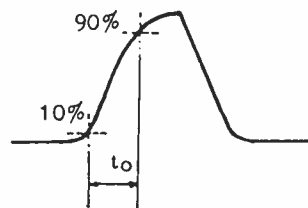
MHz, 300 MHz – then they mention the other specs. The bandwidth specification always refers to the upper frequency limit of the vertical (or Y) channel(s) where the signal amplitude falls to 0.707 (-3 dB) of the lower frequency amplitude. It is dependent in a complex way on a number of factors – the bandwidth of the vertical amplifier stages, the time it takes the electron beam to pass between the deflection plates and the amount of energy required to make the phosphor glow, for example.

The pulse risetime limit of the vertical channel(s) is closely related to the bandwidth, and is often just quoted by reference to this formula:

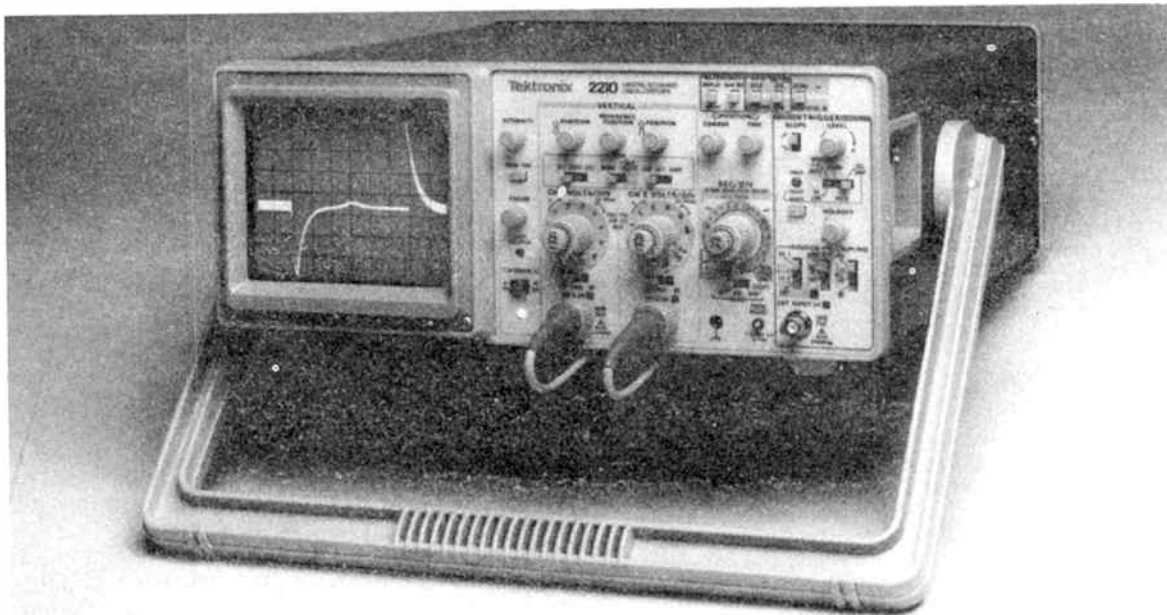
$$\text{Risetime} = 350/\text{Bandwidth (MHz)} \dots \text{nanoseconds}$$

Thus, a "50 MHz" oscilloscope will have a risetime of around 7 ns. This specification is important in pulse viewing and measurement applications.

You need to assess carefully your requirements here – risetime may be more important than bandwidth if you're involved in a lot of digital or pulse work. The risetime needs to be five or more times better than the fastest signals you're likely to encounter. Even so, that limits the risetime measuring accuracy to 2%, so if you need better accuracy in risetime measurement, the CRO's risetime specification will need to be as much as ten or more times faster than expected signal risetimes. That will then dictate the bandwidth class you



Pulse risetime is measured between two points on the waveform, from that point where the leading edge of the pulse is just 10% of the final amplitude to the point where it's 90% of the final amplitude.



need to consider.

In general, you should choose the greatest bandwidth and fastest risetime your budget will allow. If you are, or will be, dealing with pulse or digital signals up to repetition frequencies of 10 MHz (by no means unusual, these days), a 50 MHz CRO would be the minimum you should consider. For applications involving measurement or viewing of sinusoidal signals, a 50 MHz CRO is accurate to at least 40 MHz, and 'usable' to well beyond 50 MHz, depending on its fundamental sensitivity.

Now, probes are a consideration here, too. Generally a set of general purpose probes will be supplied with an instrument, but may be optional. An oscilloscope may be supplied with 1:1 probes, though 10:1 probes are offered more frequently these days.

It is an industry standard with oscilloscopes up to the "VHF" class (60-100 MHz) that the vertical channel(s) input impedance is 1M, quoted with some small capacitance (input 'strays') in parallel, usually about 20 pF. This is measured at 1 MHz, usually. A 1:1, or 'straight through', probe will add more capacitance to this – perhaps 50 to 100 pF – because of the inherent capacitance of the shielded probe cable, the probe construction and connector. The impedance of the CRO input will fall much more rapidly at high frequencies, perhaps affecting circuitry being measured.

A 10:1 attenuator probe obviates this problem. In general terms, they comprise a series 9M resistor, providing a total input resistance at the probe tip of 10M. There will be some inherent capacitance, of course, but this is usually in the order of 10-15 pF, the cable and probe capacitance being compensated by a capacitive divider or L-C "loading" to extend the bandwidth. Such probes may have a bandwidth of 100 MHz or more. Compensation adjustment must be provided to allow calibration of the probe for best accuracy.

Specialised probes may be offered as options: very high impedance – very low capacitance, high voltage – high attenuation, etc. Their utility will depend, as I said above, on a clear assessment of your requirements.

The probes you choose, or may require, will affect your decision on the vertical sensitivity specifications, depending on the minimal signal levels you expect to encounter. We'll be looking at this shortly.

Single or multiple trace?

These days, single-trace oscilloscopes are largely relegated to the low frequency, low-cost 'basic' end of the market. The ver-

This Tektronix instrument, Model 2210, probably represents the sort of features that digital technology can bring to "50 MHz Class" instruments. It offers digital storage of waveforms – ideal for low frequency, single-shot measurements – dual-trace display, 20 MS/s per channel sampling and 8-bit vertical resolution.

satility and usefulness of dual-trace, dual-channel instruments has caught-on to such an extent in the past decade that they now entirely dominate the market in instruments ranging from the 20 MHz class to the 300 MHz class.

Dual-trace CROs employ two vertical input channel amplifiers to produce two displays on-screen by means of an internal switch that sweeps the trace first across the upper section of the cathode ray tube (CRT), then across the lower section of the CRT in successive sweeps of the timebase. The first sweep may display the input to the channel 1 vertical amp, the second sweep displaying the input to channel 2. The vertical deflection plates are switched between the two amplifier channels by an electronic switch.

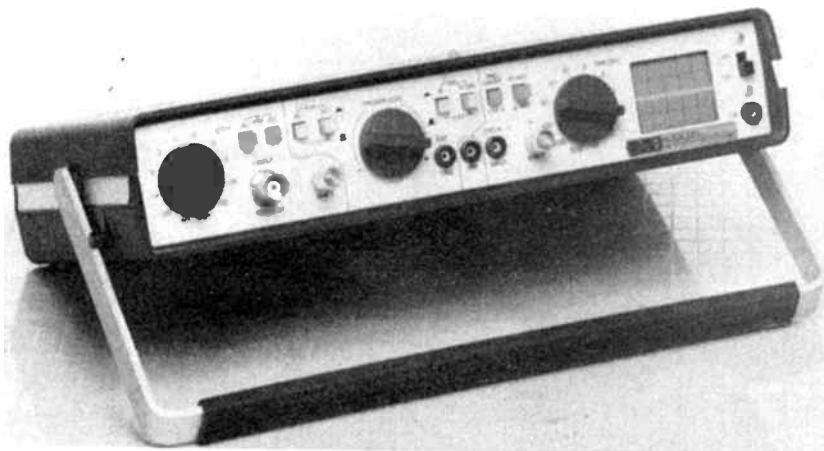
Some, lower-cost, units have a single timebase, others will have two timebases, where usually the second timebase sweep may be *delayed* by a variable control. This is not the place to go into how it all operates and the myriad functions that can be achieved by this arrangement, you should read-up on that elsewhere (see *using the Modern Oscilloscope*, by Roger Harrison and George Smith, AEM July and August 1985).

Some earlier oscilloscopes provided two traces by using a CRT with two complete internal electron guns and deflection plates (dubbed "dual-beam" tubes). Improvements in technology saw them largely superseded.

The principal facility of a dual-trace oscilloscope is in being able to make a variety of comparison measurements, either on a single input signal or between two related or unrelated input signals. To appreciate the facility, you really need a demonstration and "test drive".

Having made the decision to go for a dual-trace unit, you then need to decide whether you want a single timebase or dual timebase instrument. Here, cost may be a deciding factor, but the range of extra facilities provided by a dual timebase unit has to be carefully evaluated in the light of your assessment of your requirements.

Some oscilloscope models offer multiple-trace displays with four input channels. The application of such instruments is getting a little more specialised than the broad requirements of most electronic work, but the need for such



This unit would represent the ultimate in portability, weighing just 1 kg! From OK Industries, it is a 10 MHz unit with a sensitivity of 10 mV/div. and 100 us/div. max. timebase speed. The bright blue display measures 25.4 x 38 mm (1" x 1.5") and in economy power mode it draws just 350 mW. It is powered by four C-cells or an ac adaptor. Electronic Development Sales distribute it.

facilities will, or should, be apparent, once again, from the assessment you made of your needs and the type of work being carried out. If you do a lot of work with multiple-phase power control circuitry, for example, a multi-channel/multi-trace instrument is invaluable. Indeed, a few companies produce instruments especially for such applications.

Sensitivity, accuracy and measurement

The oscilloscope was primarily developed to view signal waveforms. The necessity to accurately measure quantities related to those signals was secondary, and generally left to other instruments. In other words, oscilloscopes have been seen as a qualitative or analytical test instrument, rather than in a quantitative role.

That view has been superseded in recent years, with the incorporation of digital and microprocessor technology into oscilloscopes. Now, they can be used to measure and display quantities such as signal amplitude, frequency, period, pulse risetime, etc. But more of that in a moment. First, we have a few words from our fundamentalist philosopher!

All oscilloscopes have a fundamental sensitivity figure quoted in mV/cm or mV/div. This relates to the vertical amplifier(s), of course. The fundamental rule of thumb is to choose an instrument with the highest sensitivity your budget will allow. You will find many instruments offered that have precisely the same sensitivity specification across a whole variety of models and manufacturers but a few will offer more sensitivity. The erstwhile "industry standard" is 1 mV/div. (The screen will have a graticule divided into 1 cm squares anyway, so that's the same as 1 mV/cm).

The sensitivity figure is important for, in using 10:1 attenuator probes – which will be quite prevalent – the basic sensitivity is reduced by a factor of 10.

The calibration accuracy of the vertical input attenuator(s) and that of the timebase needs to be considered. Linearity of the timebase should also be looked at. Instruments with a quoted accuracy of 5% in these areas abound, while instruments with accuracies of 1% – 3% have become relatively common. As you'd expect, accuracy and price are somewhat interdependent. Get the best accuracy you can afford, that's also in accordance with your other requirements.

With a calibrated attenuator, timebase and screen graticule, you can make useful measurements of signal quantities, but with limited accuracy. The limitation is basically imposed by the screen graticule – a mechanical device, directly akin to an ordinary rule or tape measure. The

graticule may be inscribed on a transparent screen filter or actually on the CRT screen. The latter arrangement has the best accuracy.

However, the incorporation of digital and microprocessor technology into oscilloscopes brought the ability to place cursors (visible markers, internally generated) on the trace and to make measurements related to the time and amplitude positions of the cursors. In addition, this technology permits the display of numerical quantities on the CRT screen and "CRT Readout" instruments are becoming more and more common at lower and lower prices. Hence my earlier comment about it being possible to combine a DVM, dB meter, frequency-period counter and CRO in a single instrument. Such instruments offer a clear cost benefit.

CRT readout instruments may also include % readings of time and voltage – particularly useful in pulse measurement applications (e.g: pulse duration, overshoot, etc), as well as displaying panel control settings. Some manufactures offer the ability to append comments on-screen.

Microprocessor technology also brought the 'automated' oscilloscope, but more on that later.

CROs incorporating an array of the above-mentioned features cost more, as you'd expect. But just how useful such features are to your current and intended application will depend on the results of your initial assessment. Remember that such features can reduce the time taken to make meaningful and useful quantitative measurements, while at the same time presenting a qualitative view of a circuit's operation. A demonstration and test drive are mandatory. If you can borrow the manuals, do so, in preference to just reading the sales brochures.

Sweep and trigger

Sounds like something out of an old cowboy movie! The timebase specifications are an important consideration. First, consider the maximum and minimum sweep speeds. The maximum sweep speed is related to the instrument's bandwidth. Remembering that you're only able to display sinusoidal signals with any accuracy somewhat below the instrument's -3 dB bandwidth frequency (say, at 80% of it), you should be able to display at least one or two cycles per division.

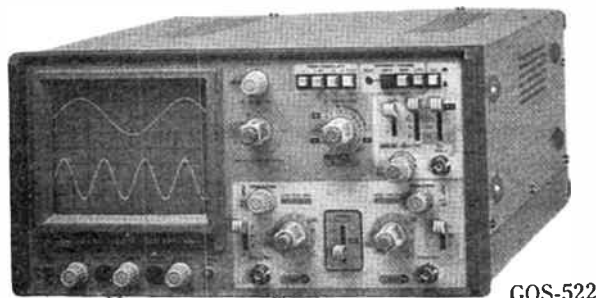
For example, with a 50 MHz CRO, to display two cycles of a 40 MHz sinewave in one graticule division the maximum timebase speed would need to be 50 ns/div. All CROs these days include a "timebase magnifier" vernier control providing (usually) a x10 magnification allowing two cycles of a 40 MHz signal to be displayed across the whole screen, for example, but the sweep is uncalibrated. CROs in the 50 MHz class offering 50 ns/div max. sweep speed are common but some instruments, even low-cost 20 MHz units, now offer a maximum sweep speed of 20ns/div.

There is another consideration to be taken into account ▶

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40MHz



GOS-543

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These extra features are normally not found on low cost oscilloscopes, but GW can offer them at a truly unbeatable price. How do they do it? Probably because GW are the leaders in cost effective CRO technology.

The GOS-522, for example, is a true 20MHz bandwidth CRO with a calibrated 20ns/DIV range (unlike CROs offering ranges calibrated to only 100ns/DIV where timing measurements become very difficult). Also, the Vertical Mode Triggering found on both the GOS-522 and the GOS-543 is especially designed for service applications. This allows you to simultaneously compare test points between good and bad boards.

Other features that make these CROs unique in their class include: Auto Trigger Level Lock ensuring perfect triggering without the need to readjust the trigger level when making measurements; Variable Hold-Off which is ideal for stable viewing of digital and video waveforms; fast 20ns/DIV

sweep speed offering high precision; DC trigger coupling for low frequency signals and Auto, Normal and Single Shot sweep modes.

Features	GOS-522	GOS-543
Bandwidth	20MHz	40MHz
Channels	2	2
Vertical Sensitivity	1mV/DIV	1mV/DIV
Max Sweep Speed	20ns/DIV	20ns/DIV
Delayed Sweep	NO	YES
Trigger Modes	CH1, CH2, VERT MODE, LINE, EXTERNAL	
Variable Hold-Off	YES	YES
Delay Line	NO	YES
Accel. Voltage	2.2kV	12kV
Warranty	1 YEAR WARRANTY ON PARTS AND LABOUR	
Probes	2 QUALITY SWITCHABLE PROBES INCLUDED	
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when assessing maximum sweep speed and the display of very fast signals – and that is, trace brightness. Trace brightness depends on a number of factors to do with the CRT's construction, but the best specification that you can get a "handle" on is the accelerator voltage. A high sweep speed, high frequency CRO with a 12 kV accelerator voltage will outperform, in terms of trace brightness at maximum sweep speed, a CRO which only has 5 kV applied to the accelerator.

The slowest timebase speed you require will be dictated by the sort of applications in which the instrument will be used. Typically, 200 ms/div. or 500 ms/div. are common.

Integral with timebase considerations are the triggering facilities. If you do a lot of video work, then line and frame sync. facilities are mandatory – not all CROs offer it. Some dual-trace units offer a "trigger view" facility. Facilities such as trigger level setting, trigger "holdoff" and trigger signal filtering need to be carefully considered. Here, too, a demonstration and test drive will enlighten you. Some competing instruments offer what seem to be similar controls that actually function quite differently. A hands-on session will sort out the pros and cons of each.

Automation or not?

Now that microprocessor technology has invaded oscilloscopes, semi-automated and automated controls are being offered, so now you have a choice to make between conventional controls (knobs and push or slide switches) and "soft touch" keypad-type controls. In addition, external control via a digital interface is available, allowing remote control of procedures from a personal computer. Naturally, all this costs more in those instruments with it compared to similar units without it. But there are some applications where it's a necessity, rather than a luxury.

Another consideration is whether or not to get a "digitising" oscilloscope (see *Getting the Measure of Digital Oscilloscopes* by Roger Harrison, AEM August 1985). Because they provide the ability to store waveforms, they are ideal for viewing on-off events or slowly varying signals. Digitising CROs are becoming more common and at better and better prices, so they're worth a look as they're finding application in more and more areas whereas once they were fairly specialised.

Summary

It's "different horses for different courses", as they say. The evaluation and selection of an oscilloscope is basically a cost-benefit exercise. Manufacturers are very good at "posi-

Hitachi's V-680 shows what current technology brings to the art of the oscilloscope. It features a 60 MHz bandwidth CRT readout of quantities highlighted with on-screen cursors, three vertical channels and two timebases, with delayed sweep on the second, plus sophisticated triggering. Hitachi CROs are distributed by Bell-IRH.



This portable Hitachi CRO, the V-509, is a 50 MHz dual-trace, twin-timebase instrument featuring vertical sensitivity of 5 mV/div., sweep speeds from 100 us/div. to 200 ms/div. and video (TV) triggering facilities.

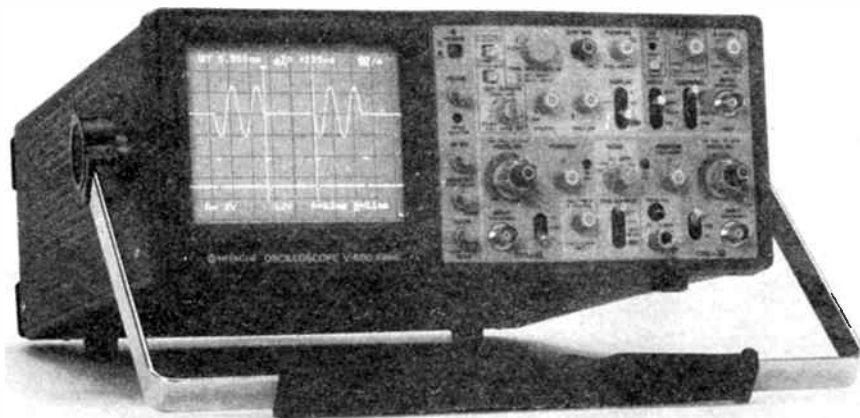
tioning" their instruments so that, while on a basic level they offer similar functions, it is the features and additional functions where they vary most and avoid head-on competition.

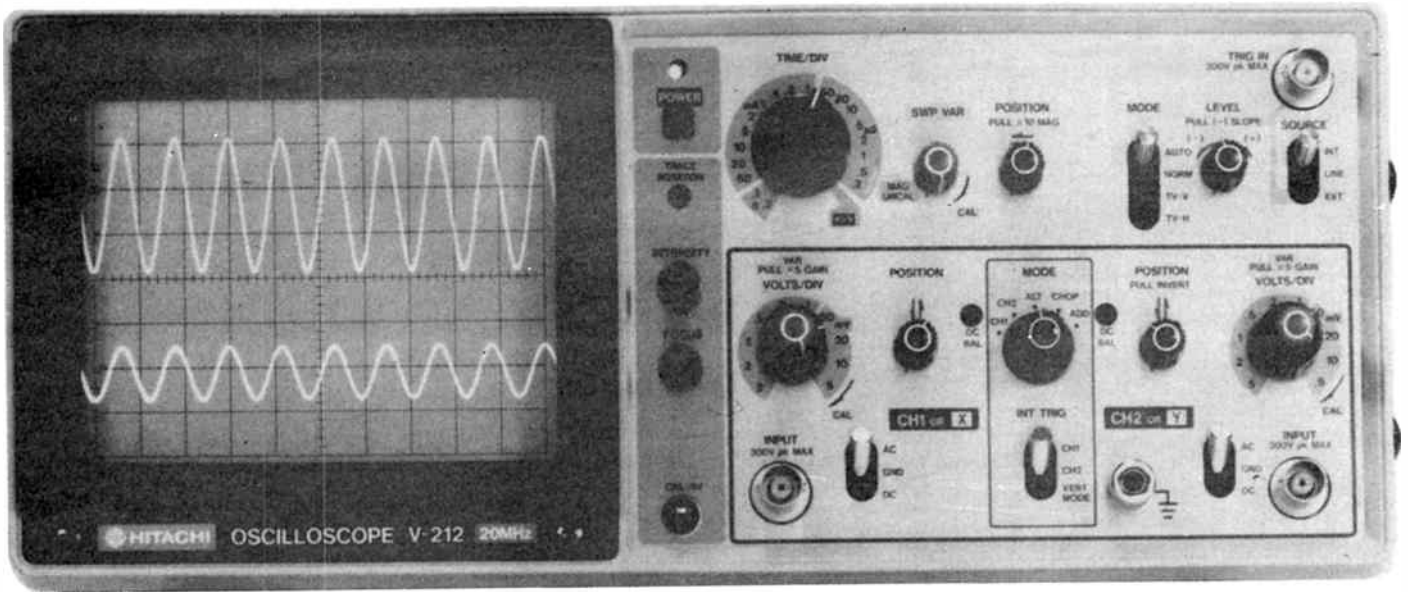
Buying on price alone is an exercise fraught with pitfalls, but that's not to say price is not an important consideration. If that were never so, we'd all be driving Rollers and Britain's trade imbalance would be the other way round! You either set a budget and then search around what's available within that, or you set a certain performance specification and see what unit's available offer the best match to that – then look at the price range. This can be quite illuminating!

Don't hesitate to ask among colleagues and friends about their experiences with oscilloscopes they use or have used. And don't forget such details as warranty period, availability and efficiency of service, spare parts costs and availability, etc. While you're at it, carefully consider the options offered. Sometimes it's less costly to go up a model than to purchase add-on options.

An oscilloscope will last you for some years. It makes sense to consider your purchase carefully. If it's your first CRO, you'll wonder how you ever got along without it, no matter whether you purchase a unit at the low-priced end of the market, or an all-bells-and-whistles model. 🐦

We would like to acknowledge the following firms for assistance rendered in the preparation of this article: Bell-IRH, Electronic Development Sales, Emona Instruments and Tektronix.





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Display CRT	6-inch rectangular.									
Graticule	Internal, 8 x 10 div (1 div = 1 cm), Horizontal and vertical center lines further marked in 0.2 div increments, marking for measurement of rise time									
Accelerating Potential	2 kV.									
External Intensity Modulation	Voltage: 5V or more. Effective bandwidth: DC to 2 MHz. Max. input voltage: 30V (DC + AC peak).									
Vertical Deflection Sensitivity	5mV/div to 5V/div in 10 calibrated steps: 3% 1mV/div, 2mV/div: 5% when using x5 magnifier. Uncalibrated continuous control between steps 1: < 2.5.									
Bandwidth	DC to 20 MHz (-3 dB). DC to 7 MHz (-3 dB) when using x5 magnifier.									
Rise Time	17.5 ns. 50 ns when using x5 magnifier.									
MAX. Input Voltage	300V (DC + AC peak) or 500Vp-p AC at 1 kHz.									
Input Coupling	AC, GND, DC.									
Input Impedance	1MΩ approx 25 pF.									
Display Mode	CH1, CH2 (normal or invert), ALT, CHOP, ADD									
CH1 Vertical Signal Output	Voltage: approx. 20mV/div into 50Ω Bandwidth: 50 Hz to 5 MHz (-3 dB) into 50Ω.									
X-Y Operation Sensitivity	CH1 X-axis, CH2 Y-axis. 5mV/div to 5V/div.									
Bandwidth	1mV/div, 2mV/div when using x5 magnifier.									
Phase Difference	DC to 500 kHz (-3 dB). 3° or less from DC to 50 kHz.									
Horizontal Deflection Sweep Time Range	0.2 μs/div to 0.2s/div in 19 calibrated steps: 3% 100 ns ± 5% when using x10 magnifier (20 ns and 50 ns uncalibrated). Uncalibrated continuous control between steps 1: < 2.5.									
Trigger										
Trigger Mode	Automatic (sweep runs in absence of a triggering signal and for signal below 30 Hz), Normal (sweep runs when triggered), TV-V, TV-H.									
Trigger Source	CH1, CH2, V-MODE, External, Line.									
Trigger Sensitivity	<table border="1"> <tr> <td></td> <td>20Hz to 2MHz</td> <td>2MHz to 20MHz</td> </tr> <tr> <td>CH1 and CH2</td> <td>0.5 div</td> <td>1.5 div</td> </tr> <tr> <td>External</td> <td>20mV</td> <td>800mV</td> </tr> </table>		20Hz to 2MHz	2MHz to 20MHz	CH1 and CH2	0.5 div	1.5 div	External	20mV	800mV
	20Hz to 2MHz	2MHz to 20MHz								
CH1 and CH2	0.5 div	1.5 div								
External	20mV	800mV								
Trigger Coupling	AC.									
Trigger Slope	+ or -									
Calibrator	Square wave. Voltage 0.5V ± 3% Frequency: Approx. 1kHz									
Power Supply	Voltage 100/120/220/240 V ± 10%. Frequency 50/60/400 Hz. Power consumption: approx. 30 W.									
Ambient Temperature	Rated range of use: +10 to 35°C. Limits of operation: 0 to 50°C. Storage and transport: -20 to 70°C.									
Dimensions	310(W) x 130(H) x 370(D) mm, 12.2 x 5.1 x 14.6 in.									
Weight	Approx. 6 kg/13.2 lb.									
MTBF	20,000 hours for target value.									
Accessories Supplied	Two AT-10AJ1.5 probes, Fuse, Power cable, Operation manual.									

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New devices amplify light

Scientists at the AT&T Bell Laboratories in Murray Hill, New Jersey USA, have demonstrated an experimental fibre-optic system using four in-line optical amplifiers made from modified semiconductor laser chips which will increase the span between repeaters in fibre-optic cable systems to a record-breaking 372 km. Fibre-optic cables exhibit losses which increase with length of the cable. Hence, "repeaters" are necessary at intervals to overcome the accumulating loss.

The new optical amplifiers boost lightwave signals without having to first convert them to electrons and back to light, as is done in existing systems. Bell Labs claim it is the first time such a system has been demonstrated.

Bell Labs' researcher, Anders Olsson, described the amplifier as a "converted laser", an indium-phosphide laser made twice as long as usual with anti-reflection coating on the mirrors. When a steady current is sent through the device, low-level light coming in one end can be amplified by about 1000 times in the lab. It is expected that, in a practical system, gains of about 100 times could be expected.

These new semiconductor light amplifiers have an additional advantage in that they can handle various bit rates and signal modulation formats. Conventional repeaters, at present, can only handle specific signal characteristics and have to be replaced if the bit rate or modulation of the signal is altered. These optical amplifiers can handle varying system configurations. In the experiments, the same optical amplifiers were used both for 400 megabit/second FM and 1000 megabit/second conventional amplitude modulation. The bandwidth of the optical amplifiers can be as large as 5000 gigahertz, Bell say!

CMOS RS232 line drivers/receivers

National Semiconductor now offers CMOS replacements for the 1488 and 1489 line drivers/receivers widely used in serial port interfacing between RS232C levels (+3 to +25 V and -3 to -25 V) and TTL or CMOS logic levels in modems and computers, etc.

Known as DS14C88 and DS14C89A, they are pin-for-pin replacements. Both devices are fabricated in low threshold CMOS metal gate technology and provide very low power consumption in comparison to their bipolar equivalents. The receiver draws less than 1 mA (900 uA), compared to 26 mA for the 1489, while the driver draws just half a mA against 25 mA for the 1488. This makes them ideal for use in battery powered applications.

In addition, the DS14C88/DS14C89A simplify designs, according to Natsemi, eliminating the need for external capacitors. For the DS14C88, slew rate control according to RS-232-C specifications is provided on the chip - no external capacitors required! For the DS14C89A, noise pulse rejection circuitry eliminates the need for response control filter capacitors. When replacing the DS1489 with a DS14C89A, the response control filter pins can be tied high, low or left unconnected.

The power-off source impedance of the DS14C88 is quoted as 300 Ohms minimum. This device can be operated over a supply voltage range of 4.5 V to 12.6 V and is TTL/LSTTL compatible. The DS14C89A can withstand input voltages of ± 30 V and features an internal input threshold with hysteresis.

Further details from your local George Brown Group office (Sydney, Melbourne, Adelaide, Canberra, Newcastle and Perth), or The George Brown Group Marketing Division, 456 Spencer St, West Melbourne 3003 Vic. (03)329 7500.

One chip does the work of eight

Texas Instrument's newly released TCM78808 contains eight asynchronous UARTs on-board, which TI claims replaces eight Signetics 2661 UARTs. The device performs the basic operations necessary for simultaneous reception and transmission of asynchronous messages on eight independent lines.

On-chip baud rate generation allows you to select and program any one of 16 rates between 50 and 19,200 baud, individually selectable for each receiver and transmitter.

Summary registers allow a single read to detect a data set change or to determine the cause of an interrupt on any line.

The device functions as a serial-to-parallel, parallel-to-serial converter/controller. It can be programmed by a microprocessor to provide different characteristics for each of its eight serial data lines (stop bits, parity, character length, baud rates etc).

It comes in a 68-pin package about 24 x 25 mm. Further information may be available from your local TI stockist, or by writing on your company letterhead to Texas Instruments, 6 Talavera Rd, North Ryde 2113.

Get into 32-bit processing - cheap

Geoff Wood Electronics is currently offering a great bargain on a National Semiconductors 32000 Designer's Kit for professionals and advanced hobbyists interested in becoming familiar with 16- and 32-bit microprocessing.

The National 32000 Designer's Kit comes in two versions - one with a 32016 (16-bit) processor, the other with a 32032 (32-bit) processor. Both kits include a 32082 Memory Management Unit, a 32201 Timing Control Unit, a 32081 Floating Point Unit and two "Tiny Development Systems" (TDS) PROMs.

The literature supplied can only be described as voluminous and comprehensive. It includes a data book, an instruction set reference manual, a TDS users guide, a programming reference guide, application notes on UNIX, 32-bit architecture and a Pascal listing to aid development of 32000 code using a PC.

The 32016 kit costs \$132; the 32032 kit, \$180. Post and handling is \$6.00 for local deliveries, or \$15 air mail. Contact Geoff Wood Electronics, PO Box 671, Lane Cove 2066 NSW. (02)427 1676.

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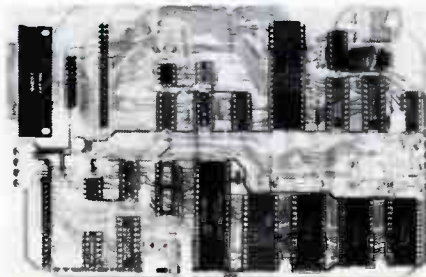
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DOTC's frequency register drives introduction of radio voice scramblers

The ready availability of scanners and the public availability of the Department of Transport and Communications' frequency register has been the foundation of criminal usage of the frequency spectrum, according to Max Pietrushka, marketing manager of GSA Technology, local manufacturer of digital voice 'scramblers'.

This activity has driven users of the spectrum to employ scrambling devices on two-way voice radio services (such as mobile radio networks and cellular mobile telephones) to ensure privacy of communications.

The celebrated and widely publicised example of lack of privacy on mobile phone communications occurred last year when an indelicate conversation between the leader of the Federal opposition and the leader of the Victorian opposition was recorded and the transcript printed in the newspapers.

Max Pietrushka's comment accompanied the release of GSA Technology's new digital voice scrambler, the GSA1300A. Dubbed a "voice privacy device" (VPD - sounds like an exotic and rather nasty disease

of the nether extremities), GSA claim it will provide radio users with a very high level of secure encoded speech.

As the unit has a bandwidth no wider than the standard voice bandwidth, it can be installed in almost any radio system, according to GSA.

Full details are available from GSA Technology Pty Ltd, 511 Keilor Rd, Niddrie 3042 Vic. (03)379 1828.

Radio RSA to feature amateur radio

South African shortwave broadcaster, Radio RSA, is to present a special programme, to be aired on March 12 and 13, featuring amateur radio

activities worldwide.

The programme will be produced and presented by Hans van de Groenendaal ZS6KAV, the president of the South African amateur satellite organisation, AMSAT.

We understand the programme will feature Amateur Radio news from around the world, including satellite activity, DXpeditions, etc.

The programme will go to air on March 12 at 1845 UTC on 17 880 kHz (the UK, Europe and African service), and on March 13 at 0250 UTC on 9580 kHz, 9615 kHz and 6010 kHz (the USA and Canadian service).

- AMSAT Aust.

Townsville AR Club

Townsville is quite a centre in 'the deep north', not only for business and tourism, but in the amateur radio world as well.

Mrs Evelyn Bahr VK4EQ has been, once again, elected President of this active and growing club for 1988 at their recent annual elections which saw 28 positions filled on the Club's management committee.

The Club recently added a new two metre repeater to their inventory, located at Mt Inkerman. They also operate another 2 m repeater located at Mt Stuart in the middle of Townsville, along with beacons on 2 m and 70 cm and an amateur TV repeater. In addition, the Club operates 10 m and 6 m beacons at Mt St John. A portable repeater is reserved for emergency work with the Wireless Institute Civil Emergency Network (WICEN).

Late last year, the Club featured on the TV programme, Newsweek.

Ross Hull Contest Controversy

Controversy still percolates amongst many VHF/UHF amateurs over the philosophy and rules of the Ross Hull contest held over December-January each year (see item in this column in Dec. '87 issue).

Objection centres on its longevity and the discrimination in the scoring given to non-city stations, raising the fact that, in order to achieve a reasonable score, operators have to be active for the whole period of the contest.

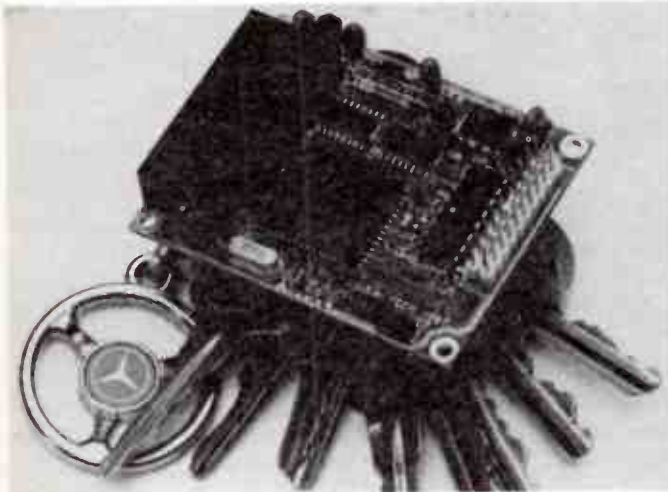
A new proposal regarding the rules and philosophy of the contest - which commemorates an Australian amateur who did much pioneering work on VHF techniques - has been circulated by Doug McArthur VK3UM, a well-known VHF/UHF operator.

The key elements of Doug's proposal are: to hold the contest over two 24 hour periods - New Year's Day long weekend and the Queen's Birthday weekend in June: all amateurs may enter, WIA member or not; no scoring contacts via satellites or repeaters or on common 'calling frequencies'; no serial number reports (so scores are not given away); scoring on a points/km basis for distances up to 900 km, 100 pts/QSO for distances 900-3000 km, 2000 pts for distances over that for the 6 m and 2 m bands - on bands 70 cm and above all contacts score 1 pt/km.

Doug suggests awards by state, by band plus a Champion Award to the station achieving the greatest combined band(s) score.

The philosophy is that the scoring system is based on a station's capabilities, not on the vagaries of propagation and location. All stations can accrue points by across-town contacts or off the Moon. The vagaries of propagation don't disproportionately increase the score on 6 m and 2 m.

Doug's full proposal can be read in this month's issue of the WIA journal, Amateur Radio.



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A flat-dweller's shortwave dipole

Jamye Harrison

Roger Harrison

Here's a low-cost, robust, easy to build and erect dipole antenna for the shortwave enthusiast who wants to pursue the action on the high frequency bands but is confined to a flat, unit or apartment.

UPON MOVING to our new location at Balmain, we immediately felt the lack of an antenna for the high frequency bands. At our Wahroonga premises we had erected a 'random' long wire, festooned across the rooftops. Not ideal, but useful. But now we needed something that was easy to build, quick to erect – without the necessity of clambering across rooftops – and not unwieldy to handle.

This project was devised and knocked together in short order and was such an instant success, we thought many constructors might be interested, too. It's just the ticket for receiving the radio facsimile stations which transmit weather charts (like the Bureau of Meteorology's station, AXM, in Canberra) that are popular with users of our Listening Post project (AEM3500).

The mechanical parts of the antenna are made from standard aluminium extrusions and other components readily available in hardware stores. You don't need to be an experienced metalworker or have special tools to construct it, either. It can be mounted in a variety of either temporary or permanent ways – such as from a window ledge or balcony rail – and has been designed so that it can be partially assembled indoors, passed out a window or balcony where the dipole halves can be swung into place and the antenna mounted in position.

The basic design comprises a dipole fashioned from two, two-metre lengths of aluminium tubing with "loading" coils attached on the extreme ends, the two halves of the dipole being angled to form a "vee". The loading coils effectively "lengthen" the antenna, which is very "short" electrically speaking compared to the sort of wavelengths encountered on the shortwave bands below 30 MHz. The dipole was formed into a vee because only a short boom could be used to support the dipole out from its mounting on a window ledge or whatever, and forming them into a vee as shown swings the antenna halves away from the building, reducing somewhat any influence the building may have on the antenna's operation.

The assembly may be mounted to place the plane of the vee-dipole vertically, for reception of vertically polarised signals, or horizontally, for reception of horizontally polarised signals.



This antenna is quite simple to construct and erect. It is readily mounted on a window ledge or from a balcony. The two halves of the dipole are mounted to short lengths of 25 mm angle which are pivoted on the end of the short 25 mm square section mounting boom. The dipole halves are insulated from the angle brackets by plastic tubing, all held in place with pipe or "muffler" clamps. Connections are made to the ends and brought down the centre of the boom.

The completed antenna can be connected to your receiver via a balun transformer and coaxial cable, or via an antenna tuner interposed between the antenna and receiver. The first way is the simplest, but using an antenna tuner provides improved efficiency – but that should be the subject of another project article!

The general arrangement of the antenna is illustrated in Figure 1.

Construction

You will need a few mechanical tools to do the job. As a minimum, you will need a hacksaw, a hand drill and drill bits – or better still, a handheld electric drill – a small bladed screwdriver, a medium flat file, some medium abrasive paper, sidecutters and a soldering iron.

The Parts List details the hardware you'll need. First job to tackle is cutting the 25 mm angle and the 6 mm dowel pieces in half. Clean up the cut ends with a file and abrasive paper. The dowel should then be coated in an outdoors preservative or Estapol. Each piece has a PK screw screwed-in about 20 mm from one end to anchor the outer end of the loading coil. Set the dowel pieces aside to dry.

When the sealant is dry, the loading coils can be wound. Clean and tin one end of the enamelled copper wire. Solder this to the solder lug under the bolt which secures the dowel to the aluminium tubing. Tape the end of the wire down to the tubing to reduce stress on the solder joint and commence winding the coil, keeping the turns tight and close together as you go. When you reach the PK screw at the end, wind one tight turn around the shaft of the screw, then drive the screw home to secure the wire. Cut off the excess wire.

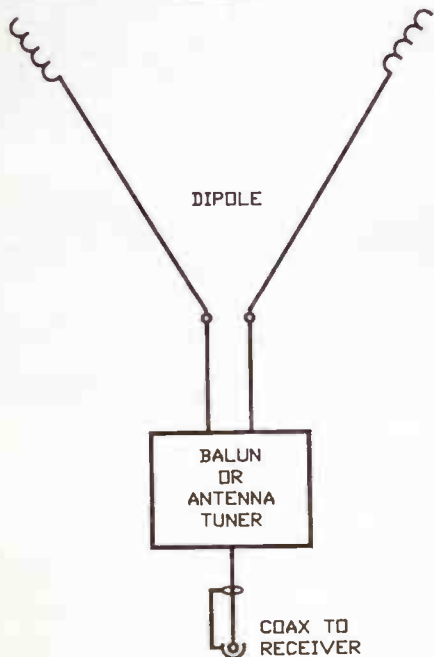
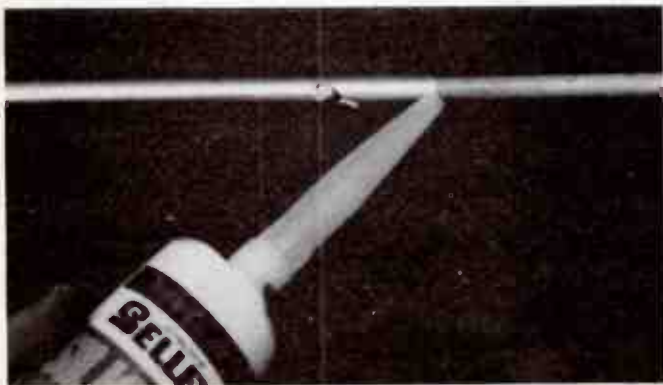


Figure 1. General electrical arrangement of the antenna. The dipole has "loading" coils at its extremities to electrically "lengthen" it and improve its efficiency at the lower frequencies. It may be connected to your receiver either via a balun transformer or an antenna tuner.

Apply some silicone sealant to the area around the bolt and solder lug to weatherproof it. To weather proof the loading coils, cover them in heatshrink tubing. Cut your one metre length of heatshrink tubing in half and slip each piece over the coils, down to the solder lug termination. A hair dryer is an ideal tool to set the heatshrink tubing in place. When you're finished, seal the ends with silicone sealant.

Now to assemble the mounting brackets for each half of the dipole. Cut your 400 mm length of plastic tubing in half. Each piece will serve to insulate the dipole halves from the mounting assembly. Slip them over the end of each tube opposite the loading coils. Now, in the hole through this end of each tube, put a 3 mm x 12.5 mm bolt with a star washer under the head and a solder lug and star washer under the nut. These provide the feedpoint connections.

Slip the plastic tubing down to the bolt and assemble the 25 mm angle brackets to each dipole half using the pipe clamps, as shown in the accompanying picture. Solder about a 500 mm length of heavy duty hookup wire to the solder lug



Use a silicone sealing compound to seal the joint between the dowel and the tubing.

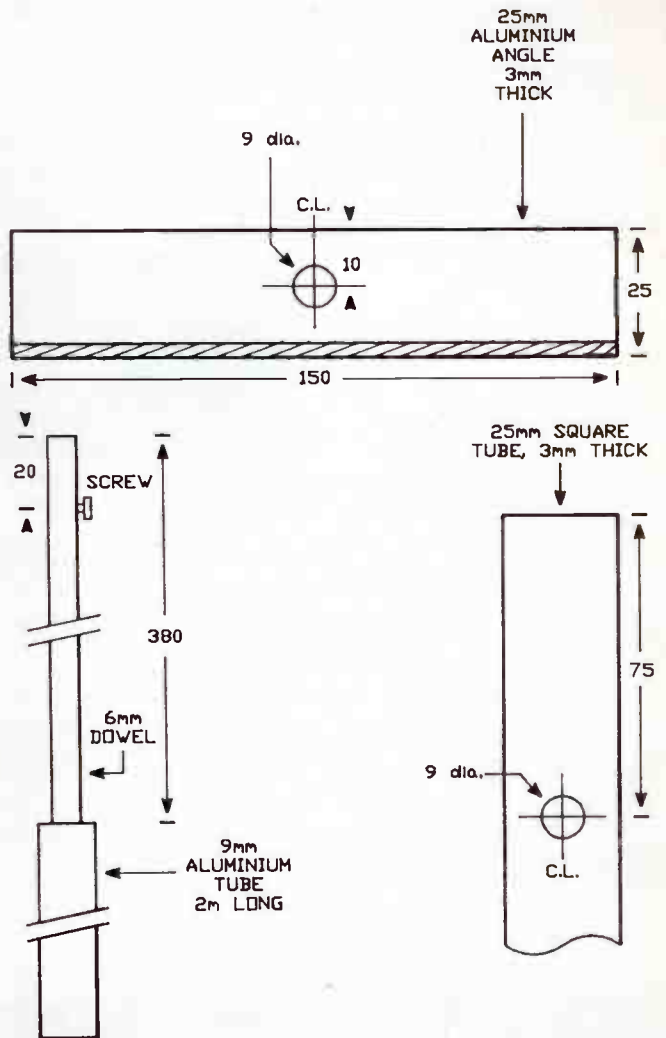


Figure 2. Preparation of the angle brackets, dipole halves and boom. All dimensions are given in millimetres.

PARTS LIST AEM3106

- 2 x 2 m lengths of 9 mm o.d. aluminium tube
- 1 x 1 m length of 6 mm o.d. wooden dowel rod
- 1 x 300 mm length of 25 mm angle, 3 mm thick
- 1 x 1 m length of 25 mm square section tube, 3 mm thick
- 4 x 3 mm dia., 12.5 mm (1/8" x 1/2") long bolts with nut and two star washers
- 4 x pipe or "muffler" clamps
- 1 x 9 mm (3/8") o.d. x 50 mm bolt with wing nut to suit
- 2 x 9 mm i.d. flat washers
- 2 x 12.5 mm (1/2") nuts
- 2 x small PK screws
- 4 x solder lugs
- 400 mm of "half-inch" plastic tubing
- 60 m (approx.) of 20 gauge enamelled copper wire
- 1 m length of heavy duty hookup wire
- 1 m length of 10 mm dia. heatshrink tubing

Silicone sealing compound, external wood sealant or Estapol, mounting hardware (see text), balun (see text), length of RG58 coax and in-line socket to suit (see text).

Now mark out and drill the 9 mm holes in the two angle brackets and one end of the boom. Hole positions should be centre-punched before drilling to prevent the drill bit "wandering". It is also a good idea to drill a 3 mm "pilot" hole before drilling the 9 mm diameter holes. If you need to drill the boom to suit the mounting method you're adopting (see the box headed "Mounting"), do so at this stage. Deburr all holes after drilling. Run out the enamelled copper wire for the loading coils and cut it in half. Lightly coil up each half and set them aside for the moment.



The ends of each loading coil are terminated as shown here. Heatshrink tubing is slipped over each coil and set in place to weatherproof them.

When the dowels are dry, slip each into one end of each of the two lengths of 9 mm diameter tubing which become the dipole halves. They should protrude about 380-400 mm. Drill a 3 mm clearance hole about 20 mm down from the end of each tube, so that it passes through the dowel. Then insert, in each of these holes, a 3 mm x 12.5 mm bolt with a star washer under the head and a solder lug and star washer under the nut. These will terminate the ends of the loading coil and provide connection to each dipole half. Apply silicone sealing compound to the end of the tube where the dowel is inserted, as shown in the photograph here. While you've got the drill out, drill another 3 mm clearance hole in each tube, 10 mm in from the end opposite the loading coils. We'll get back to it later.

and weatherproof the connection and the bolt with silicone sealant. Also plug the end of each dipole tube with silicone



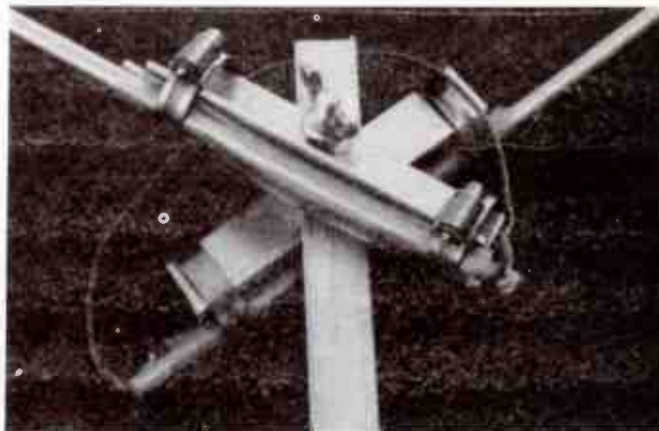
The mounting brackets are assembled to each dipole half as shown here.

sealant. Using your multimeter, check that there are no shorts between each dipole half and its angle bracket.

Each dipole half assembly can now be mounted to the boom using the 9 mm bolt. The accompanying picture shows clearly how it's done.

MOUNTING

As individual circumstances vary considerably, you will have to assess how you can mount the antenna for yourself and prepare the boom accordingly. Here are a few hints: The boom may be secured to a brick ledge with "Loxin" bolts, or to a wooden window ledge with large coach bolts, or it may be secured to a balcony railing with a U-bolt.



Place one of the large flat washers under the bolt head and pass the bolt through one bracket. Now turn this bracket so that the bolt head is towards the floor, slip the boom over the bolt, then place the other bracket/dipole half assembly over the protruding end of the bolt. Slip a large flat washer (or a suitable spring washer, if you wish) and the two 12.5 mm nuts over the bolt end, then screw on the wing nut. The two large nuts are used as spacers to allow ready access to the wing nut which would otherwise foul the angle bracket.

If you're assembling this indoors, the dipole halves can be swung together, leaving the wing nut loose, to allow the assembly to be passed lengthways out through a window or balcony door where assembly and mounting can be completed.

Before you take your antenna outside, however, you need to make arrangements for connections to the feedpoint. We constructed a small balun transformer, as detailed in Project 3015 published in our December '87 issue. The leads from the dipole feedpoint were soldered to the balun's balanced input connections and the joints covered in heatshrink tubing. A short length of RG58 coax was connected to the unbalanced connections of the balun and the joints similarly protected.

The balun assembly was then covered in silicone sealant and pushed in the end of the boom at the dipole feedpoint, and the coax passed down the boom. More silicone sealant plugged the balun into the end of the boom. This also prevents rain water running down the inside of the boom. A coax line socket was assembled to the free end of the coax cable. With the connection arrangements completed, check with your multimeter that there are no shorts between the coax shield and the boom. Now you can get on with mounting your antenna.

With the boom mounted in position, you can then swing the dipole halves into position and tighten the wing nut. The angle between the dipole halves can be set to suit yourself. An angle of between about 150° and about 90° should serve the purpose.

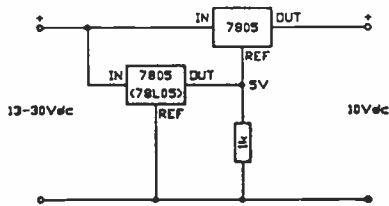
Run a length of cable between the antenna and your receiver; hook up your antenna tuner in-line if you're using one. Tune around on your receiver and see what you can hear. Good listening!

LEVEL

We expect that hobbyists who are

BEGINNERS

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

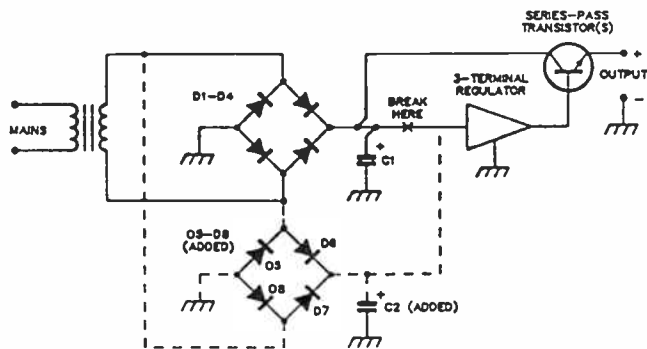


10 V regulator

Some circuits require a regulated 10 Vdc supply, but three-terminal 10 V regulators are few and far between in the stores. However, 5 V three terminal regulators are legion and simple arithmetic says that $5 + 5 = 10$, so why not use a pair of 5 V regulators? The circuit here shows how: one 5 V regulator is used to "jack up" the "reference" pin of the other by 5 V, yielding a 10 V output. You could use two 1 A rated types, or a low-power 78L05 for the bottom regulator in the circuit here.

If you're running high current or a high input voltage, where the upper (series pass) regulator will get hot, and need a heat-sink. If you're using two 7805s (TO220 package), both may be mounted on the heatsink, but make sure they're insulated from the heatsink and each other with mica washers and use plastic bolts.

Peter O'Connell VK2EMU



Low ripple for reg. supplies

The conventional regulated supply using a three-terminal regulator and a series-pass transistor to handle the output current can have significant amounts of ripple present on the output supply rail, particularly when operating at or near full current output. This ripple may be enough to be important in many sensitive circuits.

This circuit modification substantially reduces the ripple by separating the three-terminal regulator's input from the source of that ripple – the main filter capacitor.

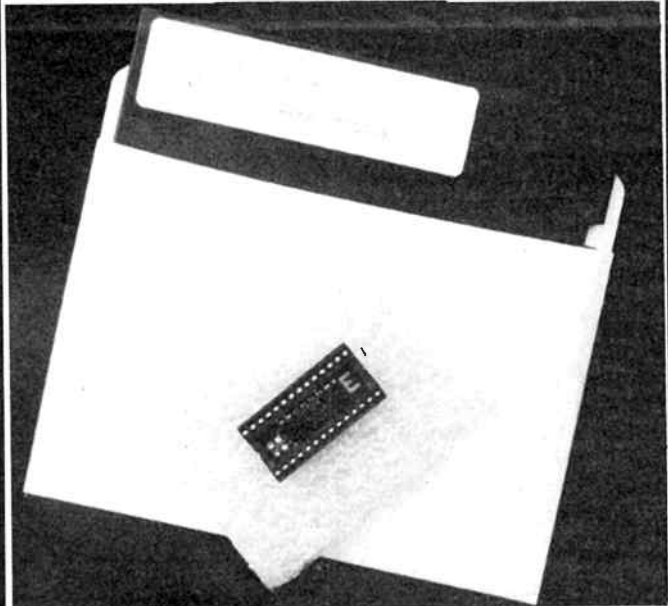
The typical rectifier for such supplies employs a full-wave bridge rectifier, as shown (D1-D4). Or it may employ a centre-tapped transformer and two diodes in a full-wave rectifier.

The solution is to add another rectifier (D5-D8) and a separate, smaller value filter capacitor (C2) to supply the input of the three-terminal regulator. The value of C2 need only be 470-1000 uF to be effective. Make sure it has a working voltage rating above the raw output of the rectifier. If a centre-tapped transformer is employed, only diodes D6 and D7 need be used.

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The Last Laugh

WELL! The Silly Season Competition has certainly stumped the judges! The task has proved formidable beyond our expectations. But, nevertheless, we'll battle on. We'd hoped to bring you a winner by this issue, but such was not to be, what with the high standard of entries, moving office and all.

In the meantime, let us take a look at some inventive answers. First off the rank into our mailbox, was Mr E. Kusilek Ph. D. (failed), who omitted his address. Tsk, tsk. You can't expect to collect a prize if we don't know where send it! Not that we're saying Mr Kusilek's won anything – yet.

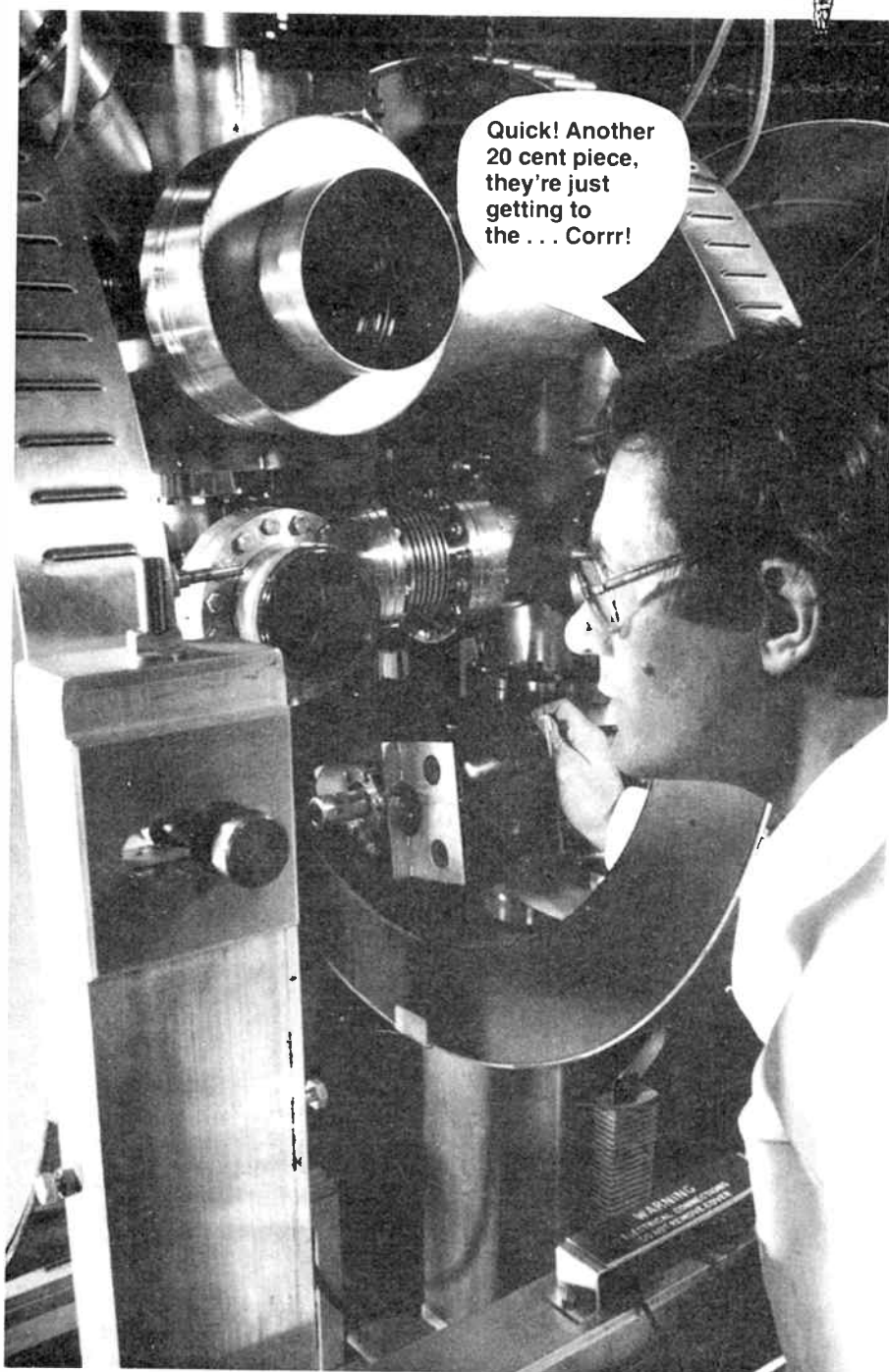
Mr Kusilek's answer to question 1 – *How large is a poofteenth?* – is too embarrassing to print here. We may get over our embarrassment sufficiently to print it in a later issue. (Hint – a poofteenth is the time between when your just-completed kit blows up at first power-on and you realise it's due to a printing error. Oohh, wince!)

However, reader Kusilek's answer to question 2 – *How large is a femtofortnight?* – has an ingenious twist: lime I think. "A femtofortnight" is the time elapsed in a spaceship travelling at nine-tenths the speed of light over two weeks of normal Earth sidereal time. It is sometimes mistakenly referred to as the time taken to produce moonshine, but this is clearly a mistake of spelling as the term in this case is *fermentofortnight*. So many other entrants laboured on about it being something to do with feminist concepts of time. Too trite, unfortunately.

His answer for – *What is infinitely shorter than a nanometer?* – was equally ingenious. "A noneometer." The judges were looking for "a nonometer", but that was pretty close. No other entrants came that close. Mr Kusilek then went on to add that academics had the misconception that it was either the cube root of a nanometer or a nanometer to the power of -1!

For question 4 – *Would you have time for a beer on an atto-arvo?* – Mr Kusilek linked his answer to that for question 2. "Only if you were a fast drinker and weren't on the spaceship above on its relativised fortnight-long jaunt. Care must be taken here not to consume any liquid amber which has not been brewed for less than a fermentofortnight as this will result in extraneous phenomena which are not in keeping with the desired effect."

In answer to question five, entrants varied widely in opinion as to whether a teratwilight was a very long time or a



very short time. Opinion among the judges remains divided (by a quantity around one to the power of -10).

A number of entrants ventured some opinions on the preamble to the competition where we discussed the relative sizes of a billion, a trillion, etc. The relative capacities of American versus British philosophical thought came into it, but I'm afraid we'd be in for a class action suit if we repeated the discussions here!

The indefatigable Kusilek ventured

the opinion that "... Australians, on the other hand, have kept well away from such fruitless endeavours due to our not having much of anything in any great quantities. (Except flies). But all is not lost as can be displayed by our esoteric terms such as *ginormous*, *triffic*, *whop-pin' great*, etc. etc." The fact that we can't distinguish between these terms to any great extent he blames on the Australian habit of going out in the noonday sun!

Keep your hats on, more next month.

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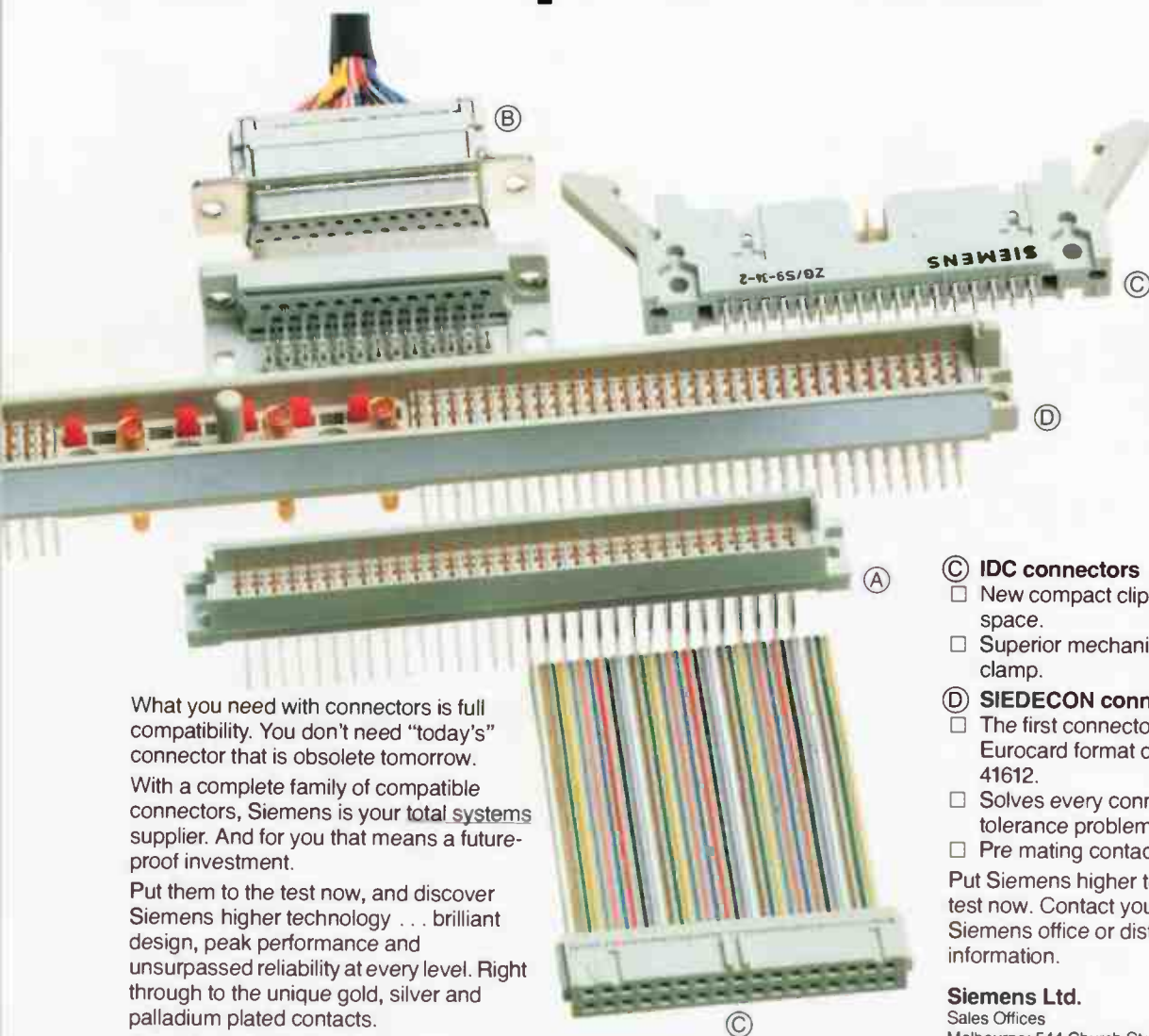
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