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BUILDING OUR NEW TELETEXT DECODER

SIMPLE BENCH SUPPLY TO BUILD

NO-HASSLE CHARGER FOR NICAD BATTERIES

UPDATE ON SATELLITE TV IN AUSTRALIA

Electronics Australia

Volume 51, No.7

July 1989

AUSTRALIA'S LARGEST SELLING ELECTRONICS MAGAZINE – ESTABLISHED IN 1922

Simple low cost bench supply

Whether you're an old hand or a newcomer to electronics, you can never have too many bench power supplies. Here's a very easy to build design producing 1.5 – 15V at up to 500mA, with surprisingly good performance. (See page 70)

NiCad auto charger

A new easy to build design which takes all of the hassle out of maintaining NiCad batteries. It charges both single and multiple cells, switching to trickle charge automatically at the end of the main charging cycle. See page 80.

TV-derived frequency standard

Need really accurate time and frequency signals? Here's the design for a unit which can effectively phase-lock its internal 10MHz crystal oscillator to a TV network's Rubidium standard.

On the cover

Federal staffmember Sally Walker is shown using our new Teletext decoder, to check up on Sydney Futures prices. Construction of the decoder, which was developed by Dick Smith Electronics, is described in this month's article starting on page 114. (Photo by Peter Beattie)

Features

Entertainment Electronics

Projects and Technical

News and Comment

Departments

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Letters to the editor

Anniversary issue – 1

Congratulations on the quality of your 50th Anniversary issue – it was worth waiting for, for 600 months!

Regardless of those who would scorn nostalgia, you have shown that personalised history has true market value.

What a pity that Philips missed the chance of advertising in the inaugural monthly issue of your magazine. Thankfully we've learned a thing or two during the past half century and we were proud to be seen among your celebrating advertising supporters.

Best wishes tor the next 600 monthly issues.

George Sprague
Philips Industries, Sydney

Anniversary issue – 2

Congratulations on your 50th. As one of your original subscribers, I can honestly say that I have never failed to enjoy every one of your issues.

I still have my original copy, a complimentary one, which was issued to readers of 'Wireless Weekly' who sent in suggestions.

No doubt, the old valve circuits seem absurdly simple now, don't they? In those days though, they were quite mysterious to me, as my knowledge of electronics barely extended beyond a rather sketchy understanding of Kettering ignition systems!

However, over the years I managed to gather a reasonable understanding of electronics theory, from your various articles, and can still stay with you in your more recent articles on solid state theory, and 'state-of-the-art' devices.

My most memorable construction project was your 'Vibragram 7', a truly great vintage battery set. This was mounted in a solid cedar cabinet, made by a cabinetmaker friend, and with a salvaged wind-up motor, and a trusty 'crystal' pick-up. The performance was streets ahead of the average set of the day.

Battery charging was no problem, as in common with most dairy farmers of the day, I had an old car generator hooked up to the dairy engine. (Kerosene in those days). This, with a few modifications over the years, and finally a 32 volt record changer and LP records lasted until the TV era, and transistor sets took over.

These days, I take the lazy way out, and buy built-up gear, but I still take a keen interest in all your projects, and hope you can keep up the good work for another 50 years.

Wishing you a successful future.

V.K. Martin
Bororen, QLD

Anniversary issue – 3

I could not believe my eyes when I went into my newsagent and spotted the title 'Radio & Hobbies'! What a great idea, to republish the first issue. I remember buying the original in 1939, and it and following issues, started me on the 'wonderful world of wireless'. Recently I returned to my home town after 28 years in Canadian television.

The Anniversary issue is first class, and of course, I especially enjoyed the informative special anniversary features, as well as the regular items. Would it be possible, for us old timers, and the younger ones too, to print each month, two or more complete pages from the corresponding issue of 50 years ago? (Not just a column or two of '50 years ago this month'). One month could be construction, the next theory, then inventions, then shortwave listings.

The only improvement (!) I would like to see in your present publication is a return of a page or two for short wave listeners. There isn't anything like that available in other publications, and clubs are not interested in the casual SWL who wants to listen to the world for information and entertainment. Maybe Art Cushen would be willing to edit it again? Please consider this.

Again, congratulations to all responsible for the special Anniversary effort.

Geoff Oates,
Stawell, Vic

Comment: Thanks for the kind words, Geoff. We'll see what can be done regarding your suggestions, although space in the magazine is becoming very tight.

AWA history

I was very interested in Philip Geeves' article in the April issue about the pioneer days of radio, as I was employed by Amalgamated Wireless

(A/sia) Limited, now AWA Ltd, as a research engineer in the early twenties and thirties and I supplied Philip Geeves with a lot of information for those articles.

There are two early achievements not mentioned, although he knew about them. In 1922 I had the job of installing a Marconi seven valve receiver in a Melbourne police patrol car. A radiophone transmitter was installed in the VIM coastal radio station in the Domain and police headquarters would telephone the station for the operator on watch to radio a message to the patrol car. This was the first time for any country to use radio for such a purpose.

Another first for any country. In 1925/6 I had the job of designing and developing a short wave transmitter and receiver to operate on 52 metres, which I installed in the SS Niagara and the operator Geoff Maring established two-way telegraphic communication all the way to and from Vancouver. About six months later I installed a second short wave transmitter and receiver in the SS Jervis Bay, and the operator Vic Brooker estalished two-way transmissions all the way to and from England. Special messages were exchanged while the Jervis Bay was in dry dock in London.

At that period ships at sea could only communicate on 600 metres over about 300 miles during daylight and about 1000 miles at night, so the above tests led the way for ships to be fitted with short wave equipment.

S.M. Newman
Waitara, NSW

Comment: Thank you for this additional information, Mr Newman – and congratulations on those two additonal 'firsts'!

Vale Ron Bell

It is with sadness that we record the death of Ronald Albert Bell, founder of RCS Radio and well-known pioneer of the Australian electronics manufacturing industry. Ron passed away on May 16, after a lengthy illness.

Born in 1907, Mr Bell founded RCS Radio in 1932. Former *EA* editor in chief Neville Williams told the intriguing story of the man and his many achievements in our July 1988 issue, under the heading 'Been There – Done That!'

Mr Bell is survived by his wife Olga, to whom we extend our deepest sympathy. Ron was indeed a remarkable man.

Editorial Viewpoint

Striving to give you better value each month

The other day a visitor to our editorial offices asked me how we managed to find and prepare so much technical information, to produce each issue of *Electronics Australia*. I replied that this wasn't really the problem – with so much happening in electronics, in so many different areas, the real problem most of the time is to decide which things we can't handle or fit in, and have to leave until next month!

The truth is that electronics is now so pervasive and so diversified that it's very difficult for *any* one magazine to do it full justice, particularly with each individual issue. Still, we keep trying, and hopefully any shortcomings in one issue will be balanced out by strengths in others. That's our story, anyway, and we do put a lot of effort into trying to make it happen.

In fact producing a magazine like *EA* involves a continuous process of striving to improve it. We're always trying to lift our game in one area or another, hopefully without letting it drop in the other areas. It's a bit like a juggler, I suppose, always trying to master keeping an extra ball or two in the air without dropping the others...

You may have noticed that last month we started an 'Amateur Radio News' column, for example. This month we're also adding a column called 'Spectrum', conducted by David Flynn, to allow us to provide better coverage of news and developments in the overall area of communications technology. We're also putting a lot of effort into giving you more and 'meatier' construction projects each month.

Of course we do make the occasional fumble – we're human, after all. For example back in the April issue, when I wrote my article 'DBS: The Future for TV Broadcasting', I obviously didn't do enough homework on the current state of DBS development in Australia. Almost as soon as the issue hit the streets, a number of upset readers rang in to inform me of the developments I had overlooked.

My thanks to those readers, and sincere apologies for those errors and omissions. But more importantly, in this month's issue we have an authoritative update on the subject written at my request by the affable Leighton Farrell, public affairs manager for Aussat. So I trust that any misapprehensions produced by my own article should now be well and truly corrected.

Jim Rowe

What's New In
Entertainment Electronics

'Digital' midi hifi system

The M-930 is the flagship of Akai's latest midi hifi systems and comprises eight pieces in all including turntable, stereo FM/AM tuner, 9-band graphic equaliser, digital integrated amplifier, compact disc player, double cassette deck, 2 x 3-way speakers and an infrared remote control.

The heart of the system is the AM-M939 Digtal Integrated amplifier boasting 80 watts/channel with less than 0.003/ THD and incorporating facilities to accept CD, tape, DAT, phono, tuner and auxiliary such as VCR or stereo TV. Akai's design philosophy has been to include such features as DC servo circuitry for high stability, massive power supply for sustained bass passages, direct operation select and motor driven volume control.

Direct digital optical transmission inputs (optical fibre) allow for the connection from CD's or DAT, where the sampling format is automatically selected. That is, an internal D/A converter selects either 44.1kHz (CD) or 48kHz (DAT). By placing the D/A converter inside the amplifier, the digital signal remains in digital format until just prior to reproduction.

The AT-M939 quartz synthesised tuner enables up to 20 AM/FM stereo stations to be stored in a random preset memory. A built-in two program daily timer with sleep function for waking up is also an additional feature.

The CD-M95 compact disc player supports a 3-beam laser pick-up and incorporates a newly developed optical direct pre-amp and a double vibration-proof construction to prevent loss of sound quality. A 36 program random select playback with skip, search and various repeat functions. All features are controlled by an infra-red remote control.

All components in the M-930 sound system are finished in brushed anodised aluminium finish with complimenting genuine timber sides and large pedestal feet.

The M-930 has an RRP of $5,995 and is available only from selected Akai dealers and stores.

Double cassette deck

Vector Research has introduced its double cassette deck VCX-325, now available in Australia from distributor NZ Marketing.

The VCX-325 features two-speed dubbing at normal or double tape speed. Unlike some other double cassette decks, this unit provides virtually identical performance whether on double or normal speed.

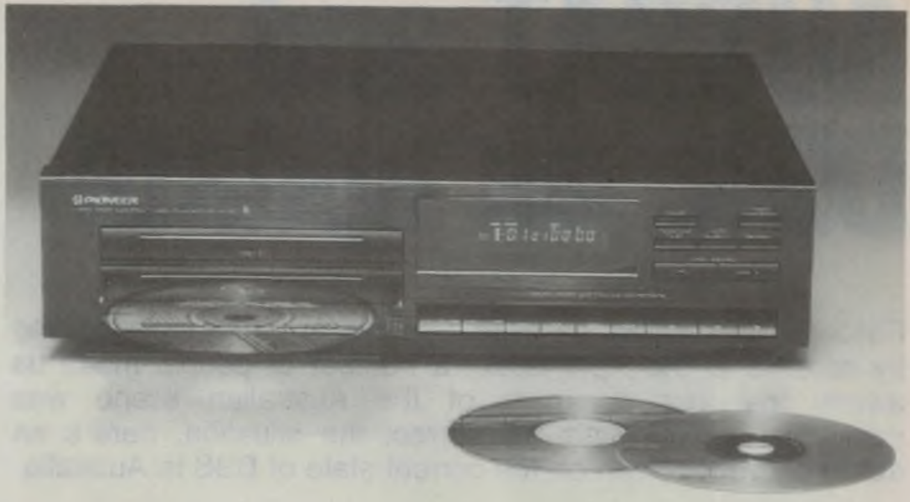
Synchro-start dubbing is another useful feature, allowing one to start both decks by pushing just one button – a simple, foolproof way to start both decks on cue.

The VCX-325 also provides continuous sequential play from Deck 2 to Deck 1, with the tape in Deck 1 starting play automatically as soon as the tape in Deck 2 has finished.

Other features of the VCX-325 include power assisted decks for smooth, reliable performance, separate microphone inputs for right and left channels, manual control of recording level to expand dynamic range and signal-to-noise ratio, and metal tape capability.

Dolby B noise reduction improves the signal-to-noise ratio by as much as 10dB.

CD player has twin drawers



Pioneer's new twin CD player, the PD-Z72T, is a novel twin tray 2 disc compact disc player which can hold and play two discs in any sequence selected by the user, giving greater variety to a listener's music program.

The twin CD allows one disc to be loaded whilst the other plays, ensuring there is no break in the enjoyment of the music or the recording of the discs.

Once the twin trays are loaded the listener can either play each disc in normal sequence, with the machine selecting at random from both CDs or preprogrammed to play from up to 24 tracks off the two discs. When a disc has been fully played it is automatically ejected to allow the disc to be changed whilst the other plays on.

The player is equipped to handle both 'album' compact discs (12cm) and 'singles' (8cm). It also has twin digital to analog converters and 2 x oversampling digital filter to ensure high quality sound reproduction.

Pioneer's PD-Z72T twin player will retail for a recommended $399 and is immediately available throughout Australia from Pioneer stockists.

'Bar system' midi hifi

Sansui's new Bar system 970/770 hifi midisystems consist of 36cm wide components as against the larger dimensions of full size audio gear. They are designed primarily as shelf type units for smaller rooms, space restricted areas, or for owners desiring inconspicuous equipment.

Traditionally, midisystems have equated with low budget, average performance hifi, but the Sansui Bar system provides the performance levels demanded by audiophiles.

Bar system's ergonomic design combines the latest in Sansui engineering, such as the Megalomix crossfader and CARS recording system to produce seamless, professionally mixed music tapes, or Sansui's graphic equaliser with electronic memory preset to Pops, Classic, Rock, Car and Headphone modes.

The exclusive X-balanced amplifier deletes noise degradation caused by ground effects, while the Dolby HX-Pro double cassette deck automatically adjusts recording level.

The Bar series also features a 57 key multi-function remote control, 3 way speaker system, CD with optical digital output, advanced 3-mode programmable timer, direct digital sound switch and audio/video connection capacity.

Presented with sculptured control panels designed in "Dolphin" metallic finish, Sansui Bar Systems will be available from leading hifi specialist stores around Australia. Three models are available from around $3000 up to $4000, depending on options required.

Medium power amplifier

Parasound, makers of the recently introduced all weather speakers which have been a big hit in Australia, also manufacture a full range of amplifiers. One of these is the HCA-500 High Current Discrete Amplifier, claimed to be very suitable for medium power applications, surround sound, remote speakers, on site monitoring of live recorders, and mobile DJ stage monitors.

Features include discrete output circuitry (no integrated circuits); oversized power transformer for high current low impedance drive; gold plated RCA jacks, 1/4" phone jacks, 5-way terminals and front panel level controls. A 19" rack mount is available for easy mounting.

The HCA-500 and other audio products from Parasound are distributed by NZ Marketing.

AUSSAT and DBS: an update

Following our article on developments in direct broadcasting by satellite in the April issue, a number of people made us aware that our summary of the Australian scene was somewhat out of date. To correct the situation, here's an authoritative rundown on the current state of DBS in Australia.

by LEIGHTON FARRELL
AUSSAT Pty Ltd, Sydney

AUSSAT Pty Ltd, the Australian National satellite system owner and operator, is now well into its fourth year of commercial operation.

With three satellites successfully in orbit and in operation, AUSSAT has begun to fulfill much of the promise heralded prior to the launch of AUSSAT 1 in 1985 – particularly in the vast outback regions of the country.

Whilst the satellite system has brought significant change into the telecommunications market place, providing new services and the choice of diverse suppliers for private network communciations for voice, data and video communciations needs, it is in the broadcasting arena that AUSSAT's presence has been most sharply felt.

Broadcasting and related services are AUSSAT's largest source of revenue, representing up to 65% of the satellite system's total use at the present time.

The largest use in this area is for the low-powered DBS (direct-to-home) services operated by the ABC throughout the country and the three licensed operations providing commercial services in Western Australia, Central Australia and Queensland.

In fact the ABC is AUSSAT's largest customer, utilising four 30W transponders which are switched into the four spot beam footprints to provide the Homestead and Community Broadcasting Satellite Service (HACBSS). It also uses three 12-watt transponders, which are used for both television and radio program interchange and distribution, as well as news gathering and special event coverage.

Remote Commercial Television Services (RCTS) are also DBS television services, operated by the Golden West Network in Western Australia, Imparja, the Aboriginal broadcaster operating out of Alice Springs and covering the Central Australian footprint and in Queensland, Queensland Satellite Television (QSTV) operating out of Townsville.

Each RCTS operator utilises a 30-watt transponder, with the service being able to be received on common HACBSS receivers and decoders in the respective footprints.

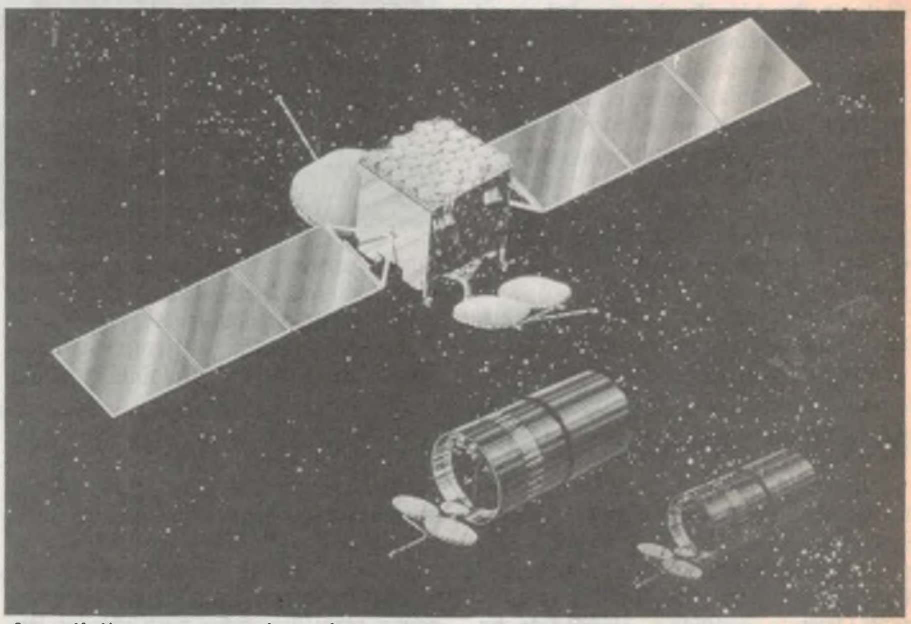
In addition to HACBSS and RCTS, in the South East footprint SBS provides a DBS service into HACBSS receivers. This service uses a 12-watt transponder and is thus of much lower power than HACBSS and RCTS. A sufficiently strong signal is available, however, to provide a good viewable picture.

In addition to these publically available DBS services there is also the service provided by Sky Channel to pubs and clubs throughout Australia.

While technically not a broadcasting service, rather licensed as a Video Audio Entertainment and Information Service (VAEIS) under the Radio Communication Act, Sky is effectively a DBS service that is able to be accessed directly from the satellite by authorised customers. Interestingly Sky, as a subscription service – albeit to a limited market – is a forerunner to Pay TV in Australia.

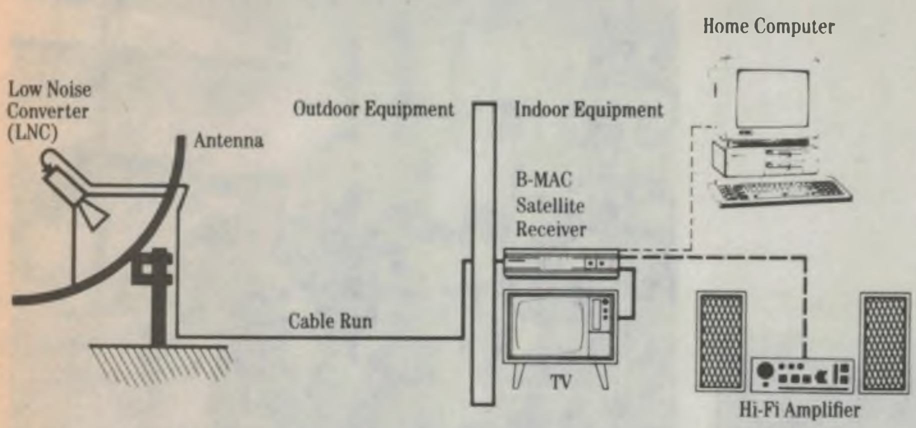
The service utilises a 30-watt transponder operating in the national beam, and services in excess of 5,500 customers throughout Australia.

As a measure of DBS application in Australia over 16,000 TVRO (Television Receive Only) satellite earth stations are in service. These include all HACBSS and RCTS dishes, Sky receivers, and a number of community dishes used to receive signals from the satellite



An artist's representation of the existing AUSSAT 'A' series satellites at lower right, with the soon to be launched 'B' series at upper left.

Recommended Equipment Configuration



The basic receiving system used for reception of DBS signals from the AUSSAT satellites. Note that the satellite receiver must be designed for decoding of B-MAC signals. The antenna dish and low noise converter must be designed for Ku-band reception (12.25-12.75GHz).

and then rebroadcast the signals terrestrially for reception through normal television aerials.

Apart from DBS applications the Australian commercial networks are all major users of the AUSSAT satellite system. The seven, nine and ten networks, while restricted from providing DBS are extensive users of the system for program distribution and interchange, news gathering and special event coverage such as major sporting events.

In total four 12-watt transponders and one 30-watt transponder are used by the networks to provide these services.

One notable and innovative development that has recently been seen in Australia is the use of Satellite News Gathering (SNG) equipment. These small, relatively light and very powerful satellite earth stations allow transmit capabilities from virtually any location direct via satellite.

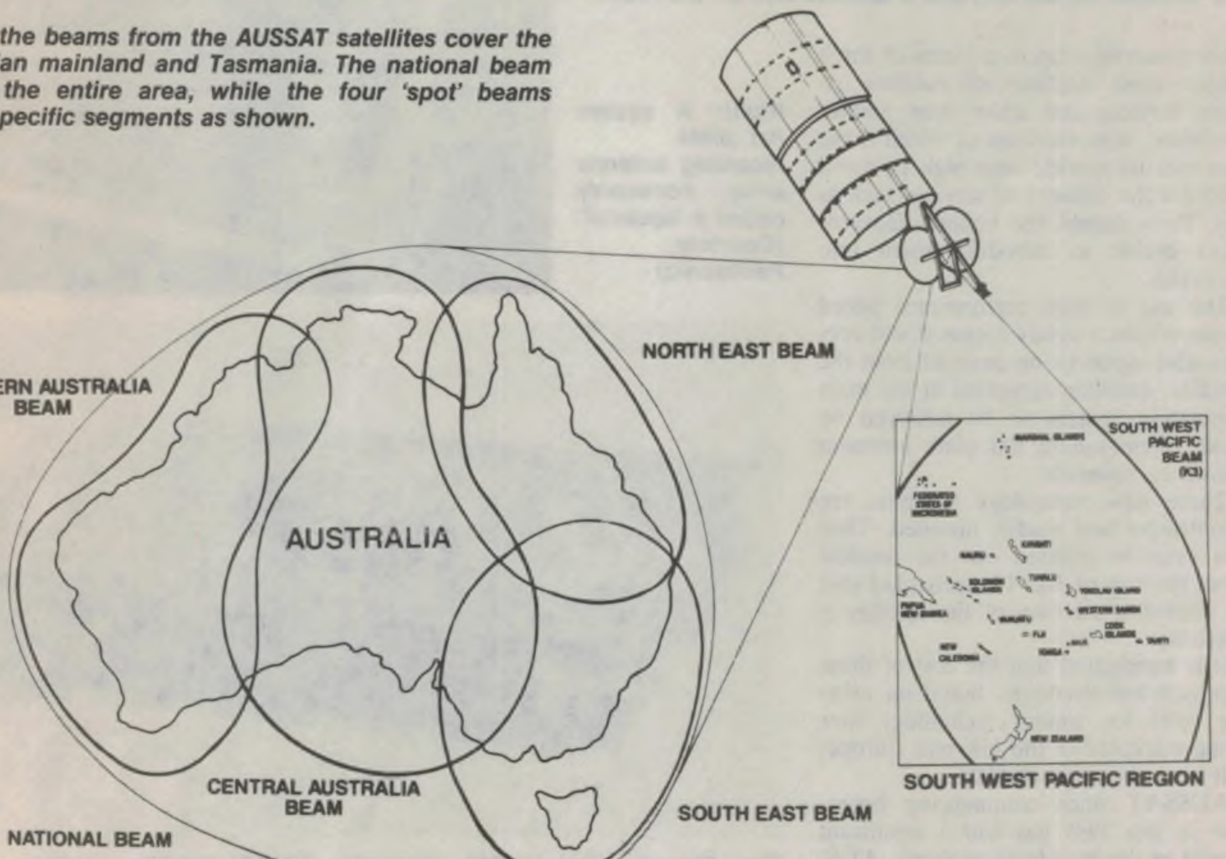
Weighing in at around 200kg and able to be dismantled into easily carried transportable packs, these incredible devices allow broadcast quality transmissions to be relayed from any location and put direct to air from the studio.

The dish, measuring about 1.8 metres in diameter, is able to be dismantled into small petals. Once packed the SNG can be flown by light aircraft or helicopter to any location and can be assembled and in service within a very short time. As such they add great flexibility to the networks' operations, and are ideally suited to emergency situations that could not in normal circumstances be provided with access for broadcast or news services.

Currently the Seven and Nine Networks and the ABC each operate one SNG unit.

AUSSAT's B series replacement satellites, to be launched in 1991 and 1992 by the Chinese Long March rocket, promise even more. Considerably

Five of the beams from the AUSSAT satellites cover the Australian mainland and Tasmania. The national beam covers the entire area, while the four 'spot' beams target specific segments as shown.



Above: One of AUSSAT's portable uplink terminals in use during a cycle race.

The old and the new: an outback pub with conventional VHF antenna on the left, and a satellite dish on the roof.

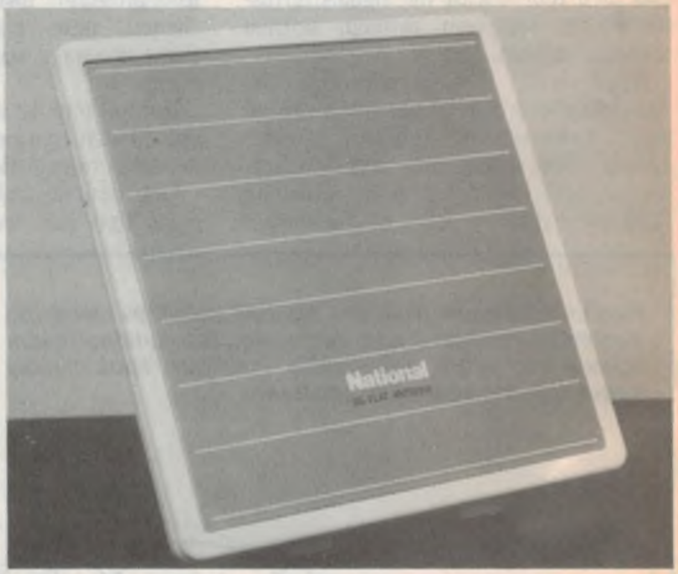
more powerful – up to a factor of three times – these satellites will enhance existing services and allow even greater flexibility, none-the-least of which is the potential to provide true high powered DBS for the delivery of services such as Pay TV – should the Federal Government decide to introduce them into Australia.

The use of high performance pencil beams allows a tightly focussed and very powerful signal to be beamed from the satellite, enabling reception in the main population centers to be achieved on small 50-cm square flat plate antennas known as 'squarials'.

These new technology antennas are unobtrusive and readily installed. They can even be pointed out the window from the top of the TV, provided that an unobstructed view of the satellite is available.

It is anticipated that the cost of these receivers and decoders, based on existing costs for similar technology now being marketed in the UK and Europe, will be in the order of $500.

AUSSAT since commencing operation in late 1985 has had a significant impact in the broadcasting arena. AUSSAT B is set to continue the revolution – perhaps even expand it.



Right: A square flat plate receiving antenna array, commonly called a 'squarial'. (Courtesy Panasonic)

The Plessey model 2001 domestic B-MAC satellite receiver, designed specifically for Australian HACBSS and RCTS reception from AUSSAT satellites.

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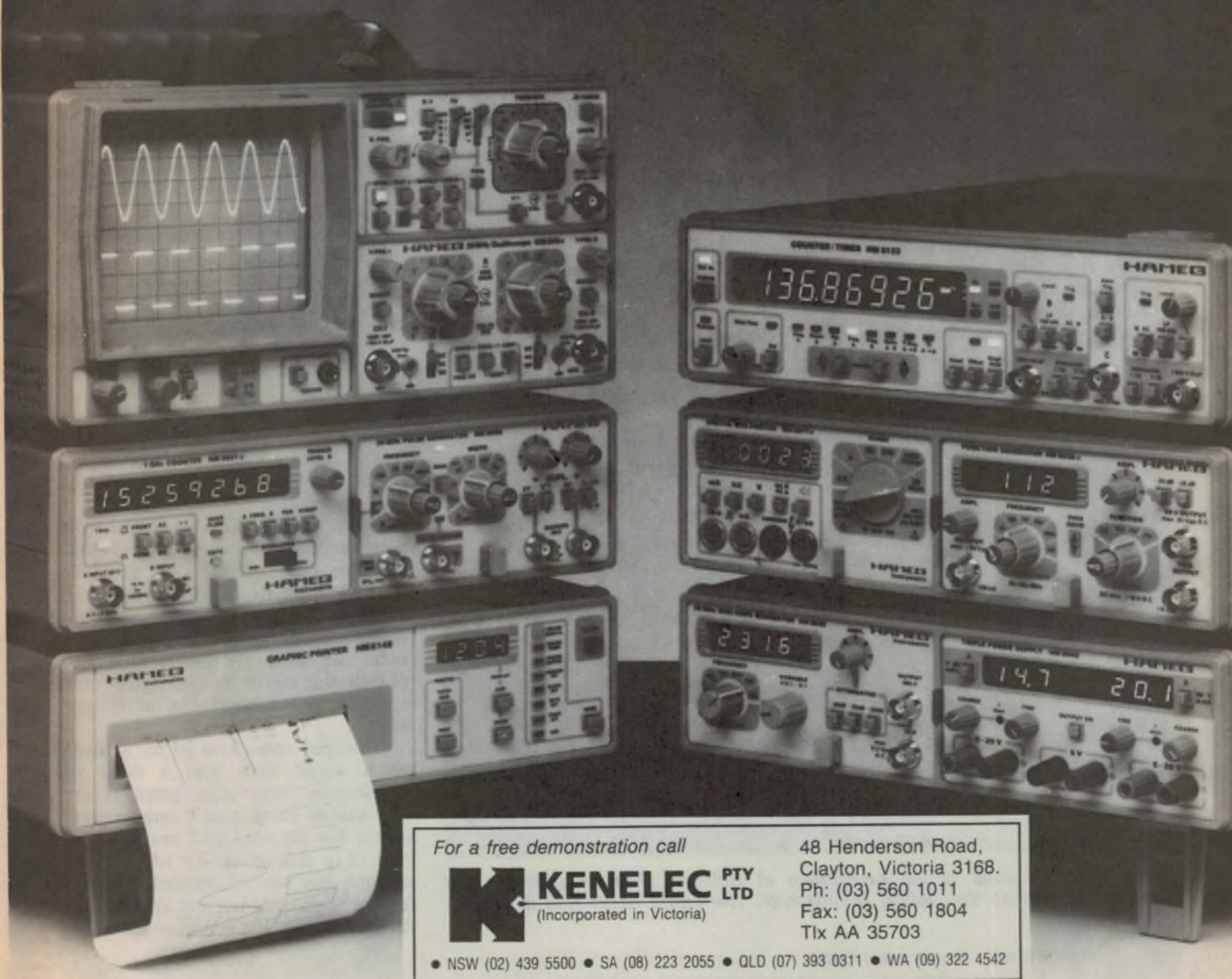

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Father of Radio Astronomy:

An interview with Grote Reber

Surely most radio amateurs, and virtually all self-respecting communications engineers and radio astronomers, know of the legendary Grote Reber – pioneering radio ham, 'father' of radio astronomy and inventor of the ubiquitous microwave dish antenna. But how many of you knew that Mr Reber is still going strongly, and quietly carrying out his research in rural Tasmania?

by TOM MOFFAT

"Grote Reber?" said the lady in the post office. "Try the bright yellow house just opposite the school. It looks like a grandstand. Or ask someone. Everybody knows where Grote Reber lives."

No problem. The house looked like a grandstand all right, sitting right on the edge of Bothwell in Tasmania. Bright yellow it certainly was, except for the part where the audience would be if the house WAS a grandstand.

From a distance, the north wall looked like a big black opening, but it was in fact a gigantic solar collector. This was Grote Reber's experimental solar house, another one of the many research projects that have occupied his long and active life.

Taped on the front door (around on the shady side) was a handwritten notice: 'I AM DEAF. STEP INSIDE AND SHOUT.' This was obviously the home of a straight talker. Right. Here we go. I'd arrived unannounced. I'd wanted to meet this fellow for a long time. Was I going to be chucked out?

"MISTER REEEBERRR!"

"Hello! Who is it?", and a spritely man with a beaming face comes scampering down the stairs. During my many years in journalism I've been tossed through doors by the best of them, but it wasn't going to happen this time. I put out a little feeler: "Can we sit down and talk about your work?"

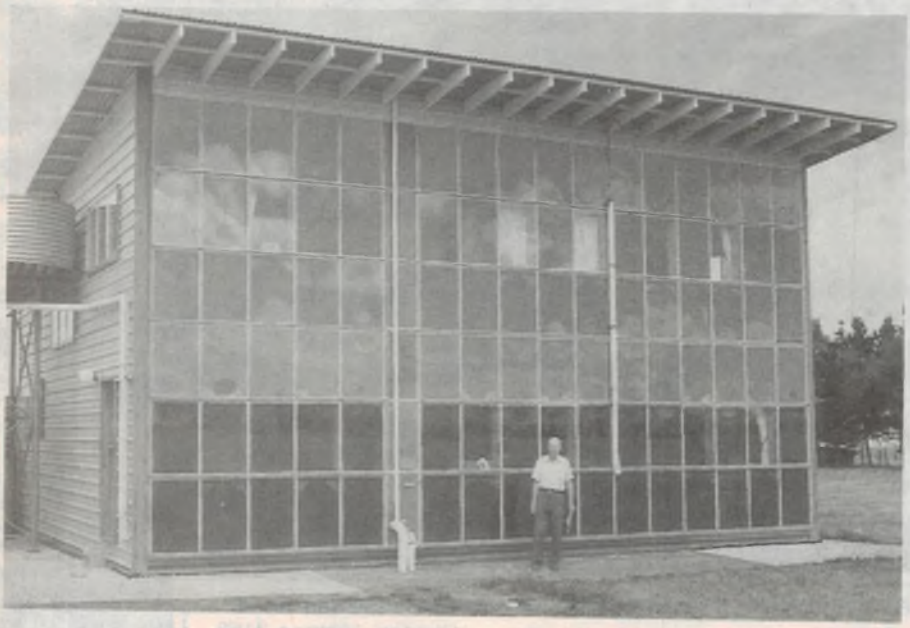
"Sure, what do you want to talk about?". Great! We were off and running.

If you look on top of just about any pub in Australia, you'll see Grote Reber's stamp on it. The TV satellite dish is just one example of the parabolic reflector microwave antenna, Grote Reber's most important invention. Look on city buildings, Telecom towers, ships, airport radars, Pine Gap. Wherever microwave communication is used, the antenna follows Grote Reber's original design. And with more and more communications channels moving onto satellites, parabolic reflectors seem to be multiplying like rabbits – Grote Reber's rabbits.

Who needs the Tasmanian movie character 'Young Einstein' to split the beer atom and invent the electric guitar, when we've got a REAL inventor right here who would run circles around him!

So how did the world's first parabolic reflector come about? The trigger came 50 years ago in America, when Grote Reber was doing pioneering work in radio astronomy. He needed some way of collecting extremely faint signals over a very large bandwidth. As he tells the story...

"I needed some kind of an antenna which would work over a range of wavelengths. Now most antennas are only narrow band; they'll only operate over a few percent. So I needed some kind of a pick-up device which could operate over several decades of wavelengths. This ruled out any kind of wire or rod antenna. But a dish would do it,



Grote Reber's solar house experiment at Bothwell, Tasmania, which the locals describe as the 'yellow grandstand'. The entire north wall is a solar collector.

Grote Reber in close-up, tuning an elderly National HRO communications receiver.

and to change wavelength, all you'd have to do would be to change the equipment at the focal point. That was all there was to it."

It was a totally new and original concept. But the parabolic reflector antenna was never patented. I asked Grote Reber if he ever regretted not applying for a patent.

"Not really, because, true, they're used today, but the patent would have run out years ago. These kind of things are inventions that are way before their time. If I could have invented it 10 years ago, yes! But 50 years ago, no."

How do you feel nowadays when you're driving around and you see one of these dishes on top of every pub? Grote Reber laughs, "Well, they're copycats!"

But isn't it a satisfying feeling to be able to point at a dish and say, that's mine? "Well, it served my purpose very well, and if this device serves somebody else's purpose, that's good too."

Move to Tasmania

It seems an enigma that Grote Reber is best known for his microwave parabolic dish, because his real love is radio astronomy on the low frequencies – around 2MHz, just above the broadcast band. This is what brought him to Tasmania for the first time, back in 1954...

"See, most of these radio astronomy people are fiddling around with centimetre waves, and now millimetre waves, and the hot stuff supposedly today is sub-millimetre waves. Well, there's no sense to be fiddling with that! I'll give them credit for being competent and having the gear and knowing what they're doing, and getting results."

"My philosophy is, don't do what everybody else is doing. Do something different! And nobody else was interested in doing these low-frequency observations. At these low frequencies you've got to get them through the ionosphere to the ground if you're going to measure them. You've got to find a place where the ionosphere is as transparent as possible. I started by investigating a lot of ionosonde data. Ionospheric soundings are a popular sport for the un-imaginative, and it was being done at about a hundred places around the world."

"I examined a lot of data by brute force, and it turned out that this region is a band that comes out of the Southern Ocean, crosses the South Island of New Zealand, and crosses southern Tasmania and back into the Southern Ocean. It has very low electron density. This was in the data, you see, but nobody knew it because nobody looked for it. I looked! So I found this band, and I made representations and came here. That was in 1954."

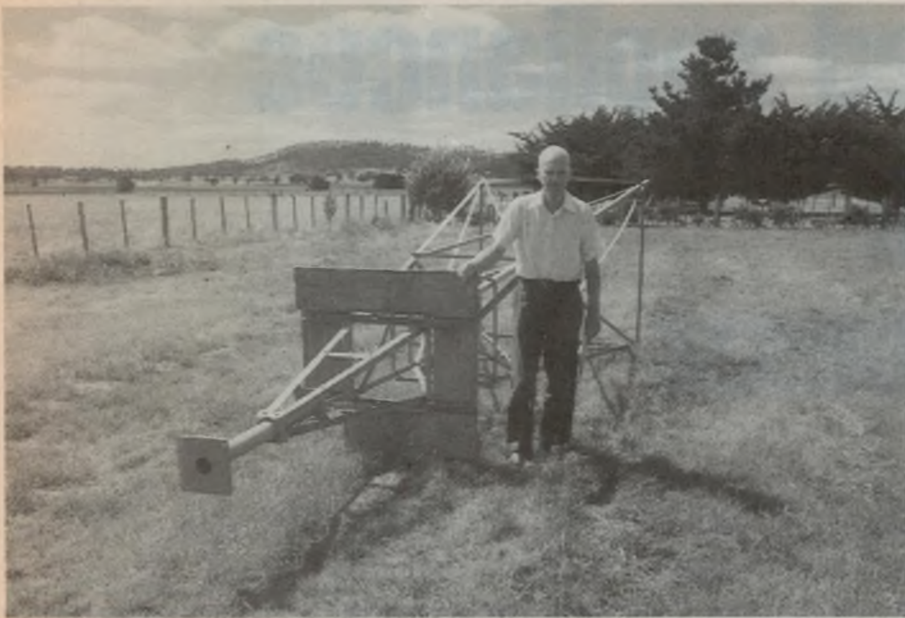
By 1961 Grote Reber was ready to go with his biggest project: a radiotelescope with an antenna system over 1.1km in diameter. This was made up of 192 horizontal dipoles hung on 128 stringybark poles. The dipoles were interconnected so that together they had a beamwidth of 7.1 degrees. By changing the interconnections, the beam direction could be steered at will.

This radiotelescope system was operated on one fixed frequency, 2085kHz. The frequency was chosen, after much searching around, because it was free of man-made interference. The antenna connected to a fairly conventional fixed-tuned receiver using valves with 1.4 volt filaments. These were the devices chosen for early portable radios and military equipment because they could be operated from batteries.

"All the equipment for this thing was built in the 50's, while I was still back in the States, and shipped down here. I knew it was going to have to operate where there was no power, and so it was all built with these 1.4 volt tubes."

"It worked very well, but the trouble with the tubes was that, like all tubes, they gradually died. And so I had an attenuator, and I would gradually cut some of the attenuation out as the tubes died to compensate. And finally you'd come to the end of the attenuator; then you had to open the whole business up and pull out the defunct tubes and put better ones in."

A collection of microwave dish antennas at Telecom Australia's Chimney Pot Hill installation, near Hobart. Grote Reber was inventor of the dish antenna.



Mr Reber with the old windmill tower, which may eventually feed electricity into the national power grid.

So Grote Reber continues his research, less than 100 metres from the school. The solar heating experiment occupies much of his time on sunny days. He goes outside every half hour and records the sun angle in relation to the collector array occupying the whole north wall. Similar research has been done before, but Reber feels it's not sufficient for his interests, so he's doing more research himself. The solar house heats itself nicely throughout the winter, despite it being in Bothwell – the town which constantly records Tasmania's lowest temperatures. Maybe he's got something there...

In his back yard is an old windmill tower, donated by a friend and currently lying on its side like a fallen trophy. Grote Reber intends to get the tower upright and then "We'd have a wind driven DC generator, 500 or 1000 watts, and then a DC to AC converter which converted the DC from the wind generator into 240 volts 50 cycles. This then would plug into a power point and if you are using electricity in the home, the amount contributed by the wind generator would reduce the amount drawn from the mains."

"If you're not using electricity in the home, this energy from the wind generator would be fed back into the power system. And the meter isn't fussy. All it does is tell quantity and direction. So the meter would run backwards by the amount that your local wind generator fed into the mains. You'd have to have a DC to AC converter that was triggered by the mains; in other words you couldn't have a local oscillator because it wouldn't sync."

Every home a power station, all feeding a common electric grid! Will it work?

Can anybody prove it won't work? Obviously the power authorities aren't the least bit impressed by the idea, and politicians are skeptical. Then again the 'experts' once laughed at solar houses too. We shall wait and see...

I finally had to drag myself away from the Reber residence. I walked out to my car, which was actually in the school's carpark. It had been easier to leave it there and hop his fence, and escape would have been quicker if he'd thrown me out. The sun had moved around so that it was shining on the car's floor. A bottle of rubber preservative I'd bought that day had started to leak from the heat, and one of those big plastic bottles of Coke was sitting next to it, swollen, about to burst.

I sat there and looked at the school. Would the students in there understand why heat made the rubber preservative leak, why the Coke bottle was swollen? Would they understand why the sun was shining in the car, when it wasn't a couple of hours ago? Did they care? It could have been Thomas Edison living in that house over the road. So what?

I thought about my Uncle Bill, when I was a kid. He had a cellar FILLED with interesting things, most of which came from military disposals stores and auctions. Every Saturday morning he'd do the rounds, and when he arrived home his wife would greet him: "Get that thing out of my kitchen!". A treasure to Uncle Bill, but junk to his wife. And downstairs it would go.

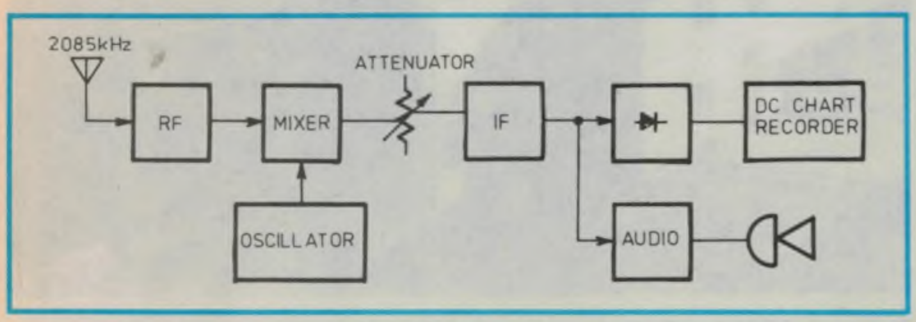
I spent many long hours of my childhood browsing through that cellar full of treasures, picking up things, feeling things, playing with things. They were things mostly mechanical and electronic, that would shape my own career many years into the future.

And I too have learned to "Get that thing out of my kitchen." I now work, and write my magazine articles, in a treasure-filled cellar.

Browsing through Grote Reber's mind is like browsing through Uncle Bill's cellar. Treasures everywhere. I've only given you readers a few tid-bits, almost totally verbatim. I'm certain there's a lot more where that came from. Grote Reber is a wise old man, and like so many like him throughout the ages, he feels an urge to pass his wisdom down through the younger generations. But will he be allowed to?

"You see now, the school is just across the street. And I haven't encouraged it, or suggested it even. But if they were on the ball over there, the Headmaster would make representations to me about having a select few of his students come over occasionally and look. But it's never mentioned."

All I can say is, if and when I visit Grote Reber again, I'll be keeping my own kids home from school that day and taking them along. I wouldn't have them miss it for the world.



The basic arrangement used by Grote Reber for his medium-frequency radio telescope at Bothwell, which operated at 2085kHz.

Networked appliances may bring 'smart' homes

The age of home automation may be coming closer, with the American Electronic Industries Association having now settled upon a standard for communications between appliance controllers. Consumers may not be exactly clamouring for 'smarter' home appliances, but economic pressures may well bring them to market – with unexpected benefits.

by TOM SCHMITZ

It's 4:30 in the morning, and all through the house not a creature is stirring – except your appliances. They're chatting up a storm.

The dishwasher, being the miserly type, knows that power company rates go down during the wee hours. So it just told the water heater to fire up and put the kettle on. When the dishes are done, it will signal the water heater to turn back down.

In the front yard, the automatic sprinkler system blows a head and starts to douse the driveway. Sensing trouble, it turns itself off and slips a note to the television. The news will flash across the bottom of the screen when the one of the residents turns on the television in the morning.

Fantastic? You bet. Futuristic? Yes – and no. The technology to build such a system already exists. And several companies in the USA and elsewhere are trying to transform their dreams of home automation into reality, by forging agreements about how that capability should be used.

"I think you'll see some products by the end of 1989," says Donald Pezzolo, president of Diablo Research of Sunnyvale. "It's a new industry that's being created, and it's going to have a tremendous impact on the market."

What Diablo and other electronics firms are working to create is 'smart technology' – a communications link that will allow everything from the light fixtures to home computers to work together without human intervention.

Some available now

Some previews of the 'smart' household have already hit the market. There are television receivers that adjust their picture to suit the lighting in the room; microwaves that 'hear' when the popcorn is done; and programmable 'plug-in' modules that can control several appliances according to pre-set instructions.

This new US$1.3 million home overlooking California's 'Silicon Valley' has been fitted with the new 'Home Manager System' developed by Advanced Security Engineering.

But while such gadgets allow a *degree* of automation, they are currently not compatible with each other. Industry planners are now taking aim at the next generation: off-the-shelf appliances that can coordinate a variety of functions among themselves, regardless of the manufacturer.

And one recent Silicon Valley start-up, Echelon, is working to develop a local area network technology that will enable appliances to better communicate with each other.

For example, suppose you buy a GTE telephone and a Sony stereo. As soon as you plug them into the wall, the two would instantly introduce themselves. And when the boss calls while you're blasting the Beach Boys, the phone would automatically signal the stereo to

The ASE Home Manager features a touch screen display that can be used to control the temperature in every room, turn lights and appliances on and off, and maintain tight security both in and around the house.

turn down the volume.

All this is possible because nowadays most appliances already come with a set of brains – tiny computer chips called microprocessors that control their internal operations. Now, automation advocates want those brains to be built according to a common standard, or at least be capable of speaking the same lingo, allowing the devices that house them to exchange information.

Standard announced

To help make that happen, the US Electronic Industries Association (EIA), a trade group, recently developed some ground rules for gadget-speak – the 'home automation standard'. Introduced at January's Consumer Electronics Show in Las Vegas, the standard creates a 'road map' that directs messages over all types of electronic links, from household wiring to infrared beams and fibre-optic cables.

Several companies are designing chips that use the new standard, and at least one has begun exhibiting a prototype. AISI Research, a Canadian firm, says its SPIRIT chip will both help appliances 'talk' and make them simpler to use.

At present, there is a "breakdown in communications" between a standard television set and video-cassette recorder, according to AISI chairman James Baroux. "The two understand themselves within their boxes. The problem is they don't understand each other."

That leaves the user with the job of translating – usually by pushing a lot of buttons. The result is VCRs that are hard to program, for most people, and television sets that must be tuned to a specific channel before the recorder will play.

"What's happened is that technology has raced ahead of the consumer's ability to use it", Baroux says. "That VCR is not user-friendly to me, and it's not user-friendly to the TV."

In addition, Baroux says chips that use the EIA standard (AISI's chip is made by LSI Logic Corp. of Milpitas, in California) will also shrink the size of many electronic goods. By simplifying communication within the appliances themselves, such chips can replace many internal control networks, reducing the number of required components.

"A TV may be just a screen. A VCR may have no keys or buttons on it, just a place to slap in the tape," Baroux says. "That reduces the costs to manufacturers and the cost to consumers."

The driving force

Lower costs, rather than consumer demand, may prove the key to the success of home automation technology. Even its most vocal advocates concede that while most people would benefit from having their appliances work together, few are willing to pay more for the privilege.

"There aren't a lot of people who will forego a new car for this," says Tony Livingston, marketing director for Echelon of Los Gatos.

Echelon is developing the Lon System, a chip-based automation network similar to AISI's. Livingston predicts that 'smart' systems will likely find their first home in industry, where the increase in efficiency will more than justify the costs.

"There's a high incentive to do it in automated manufacturing, to control which machines are on or off at a given time," Livingston says. "People in that area know what they want the technology to do."

Still, several major electronics firms have shown an interest in developing 'smart' products for the home. Sony, Marantz and Matsushita, the parent company of Panasonic, participated in developing the EIA standard, but none has announced a TV or stereo that incorporates it. And like dancing the tango, it takes two appliances to have an electronic conversation.

"There's a Catch-22 involved here," says Michael Watson, engineering manager for Sony of America. "There's not a product using it right now. Who is going to make the first product, so someone else will make the second?"

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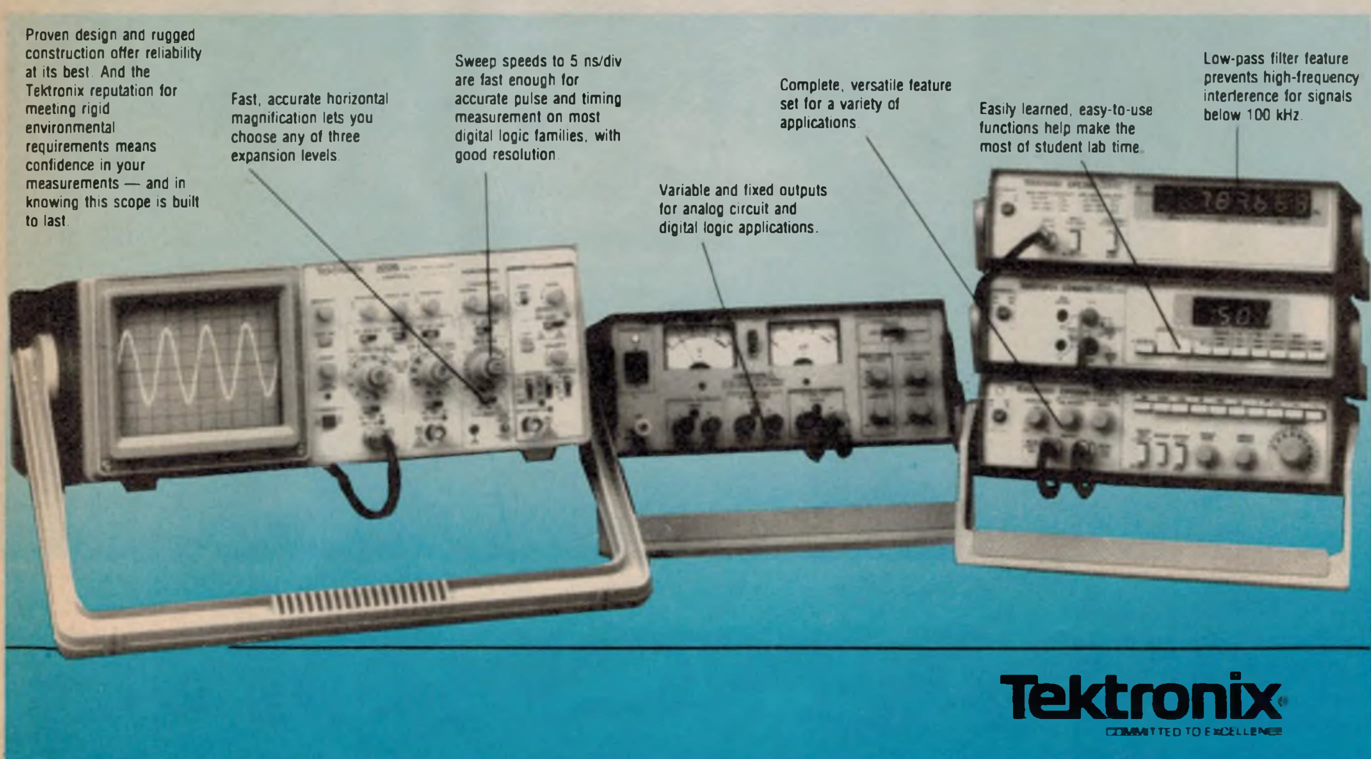

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Navy Apprentices

NAVY HANG ALL

HMAS NIRIMBA, QUAKERS HILL, SYDNEY

The Royal Australian Navy enlists about 240 young men and women as trainee apprentices each year. They are divided into two groups. Intake A in January and Intake B in July.

All new apprentices start their training at HMAS NIRIMBA just west of Sydney.

Here the young apprentices learn their skills on well maintained machinery in light, airy, clean workshops, in an environment dedicated to achieving the highest possible skills in trade and technical training.

There is plenty to do during these first two years and all young apprentices are encouraged to take part in spare time activities such as sports of all kinds and their own personal hobbies. These can range from Go-kart racing to bush walking and camping expeditions.

APPRENTICE TRAINING PART ONE.

The first part of apprenticeship training takes place at HMAS NIRIMBA just west of Sydney, and lasts for two years. The working year is split into two terms of 23 weeks with 4 weeks leave over Christmas and a further 2 weeks leave mid-year. When the settling-in period is completed work starts in earnest in the apprentices' chosen branch.

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ETW*ETP	Electrical/Fitter Mechanic
ETC*/ETS	Radio Fitter Mechanic
AIR ENGINEERING	
ATA	Ground Engineering (Airframes/Engines)
ATWL	Ground Engineering (Instrument/Electrical)
ATC	Radio Fitter Mechanic

*These job categories are open to males only.

APPRENTICE TRAINING PART TWO.

At the completion of the first two years, all apprentices are promoted to either SEAMAN or WRAN and posted to their next billet.

* The second part of apprentice training takes place on board ship, or at any one of the many naval establishments all around the country.

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Test equipment review:

The Fluke 85 handheld DMM

Among the most recent additions to the respected Fluke range of test instruments are the 80 Series of handheld digital multimeters, offering improved resolution and many novel features in addition to the usual Fluke ruggedness and reliability. Here's a look at the model 85, positioned in the middle of the range.

At about the same time that Fluke and Philips entered into their 'global alliance' last year, Fluke announced its brand new 80 Series of handheld DMMs. The model 85 is representative of the new series, offering many of the features provided by the range as a whole – except for a few provided only on the top model 87, such as true RMS readings on AC, and 4.5-digit resolution.

Like all of the models in the 80 Series, the model 85 comes in a nicely styled but rugged plastic case, measuring 186 x 86 x 31mm and weighing 355 grams. To provide additional protection it can be slipped into a matching 'holster' of compliant yellow plastic, which also provides both test prod anchoring clips and a swing-out 'Flex-stand' at the rear which can function as both a tilting bail and a mouldable-profile hook to hang the instrument from any convenient rack handle, railing, pipe, the top of a door or some other appendage, for 'hands free' operation. Adding the holster/stand brings the overall size to 201 x 98 x 52mm, and the weight to 624gms.

As with the other 80 Series models, the case of the model 85 is sealed, dustproof and splashproof. An internal nickel/graphite shell also offers a high degree of EMI shielding.

Both the model 85 and the down-range model 83 are essentially 3.5-digit instruments, but unlike many such instruments they offer a basic 'full scale' reading capability of 4096. For many readings this can give roughly double the resolution available from instruments with the more common maximum reading of 1999.

The instruments are essentially auto ranging, but with the main functions and gross range changing performed by a single rotary control switch and selection of input lead jacks. The main digital part of the high contrast LCD display used in all instruments has very readable digits 12mm high.

Other features shared with the rest of the 80 Series are an analog 'bargraph' display, below the main digital display; the ability to measure capacitance, from 10pF to 5uF, and frequency and duty cycle from 0.5Hz to over 200kHz; a patented Fluke feature called 'Touch Hold', which provides sample and hold; the ability to make 'Relative' measurements, for nulling test lead capacitance/resistance, checking component or voltage tolerances, or measuring regulation performance.

The instruments also offer a 'Min-Max' recording function, automatically storing the maximum, minimum and mean values of a measured circuit parameter over a period – which may be as long as 36 hours. An associated function called 'Min Max Alert' causes the instruments to emit an audible tone whenever a new minimum or maximum

reading has been recorded. All three models provide selectable response times of either 1 second or 100ms for this Min-Max function, while the model 87 also offers 1ms sampling for capturing transients.

A further feature of all three models is an 'Input Alert' function, which gives an audible warning if the positive test lead is plugged into one of the current jacks, but the instrument is not set for the appropriate current measurement. In fact the meters emit a pained series of 'bleeps' even if you have the lead plugged into the high current 'A' jack, with the function switch in the sensitive 'uA' position. As well as helping prevent circuit disruption by inadvertent 'shorting', with the meter set to current instead of voltage, this also prevents meter damage due to gross overload.

Quite apart from this handy feature, the instruments all provide 1000V RMS input protection on all ranges – including ohms and diode test.

Basic input impedance for all voltage measurements is 10 megohms shunted by less than 100pF. Power for the instruments comes from a single internal 9V alkaline battery, which has a typical rated life of 500 hours.

The model 85 itself provides a total of five DC voltage ranges, with full-scale readings of 400mV, 4V, 40V, 400V and 1000V respectively. Accuracy on these ranges is +/– (0.1% + 1 LSD).

Similarly there are five AC voltage ranges, with the same FSR figures; these have a basic accuracy of +/-0.5% at 50-60Hz, +/- 2 LSD's on the four upper ranges and +/-4 LSD's on the lowest range. The basic accuracy is derated to +/-1% for the four lowest ranges, and +/-2% for the highest range, over the wider frequency range 45Hz-5kHz, and further derated to 4% for most ranges between 5kHz and 20kHz. Common mode rejection ratio on the AC voltage ranges is better than 60dB, from DC to 60Hz.

There are six current ranges, each catering for both DC and AC and with full-scale readings of 400.0uA, 4000uA, 40.00mA, 400.0mA, 4000mA and 10.00A – although the highest range can cope with up to 20A for 30 seconds or less. Accuracy of these ranges for DC is +/-(0.2% + 2 LSD's), and for AC between 45Hz and 2000Hz is +/-(0.6% + 2 LSD's). The voltage drop is 100uV/uA on the uA switch range, 1.5mV/mA for the mA ranges and .03V/A for the top A range.

There are a total of seven resistance ranges, six of which are calibrated in terms of resistance and the seventh in terms of conductance. The full-scale readings for the six lower ranges are 400.0 ohms, 4.000k, 40.00k, 400.0k, 4.000M and 40.00M, while the highest range reads from 0 to 40.00nS. That's nanosiemens, equivalent to 'nanomhos' or 'nanoamps/volt' for old-timers like me! So in effect, this range covers a resistance range of from 25M (40nS) up to around 100,000M (.01nS) – making it suitable for checking the leakage resistance of PC boards, transformers, capacitors, diodes and the like.

The accuracy on the five lowest resistance ranges is +/-(0.2% + 1 LSD), while on the two higher ranges it is +/- 1%, +/-3 LSD's for the 40M range and 10 LSD's for the 40nS range. So you can't measure those ultra-high resistances all that accurately, but this is unlikely to be much of a problem.

In addition to the resistance ranges *per se*, there's also a separate 'Diode Test' range for checking diodes and other semiconductor junctions. This applies a maximum testing voltage of only 3.9V between the test leads, and reads the voltage drop on a 3.0V range. This allows the forward voltage to be read quite accurately, for matching and checking of devices as well as identification of semiconductor type (Si/Ge/Schottky/LED, etc). Reverse polarity will normally give an 'OL' display, except for zeners with a knee below 3V.

Capacitance is also measured in the resistance position of the main range selector, but by pressing the blue 'function toggle' button. There are in effect four ranges for capacitance, with full-scale readings of 5.00nF, .0500uF, 0.500uF and 5.00uF. The accuracy is +/-(1% + 2 LSD's), and this applies even on the lowest range provided that the 'Rel' key is used to zero out the residual and test lead capacitance.

The frequency counting facility provides five ranges, with full-scale readings of 199.99Hz, 1999.9Hz, 19.999kHz, 199.99kHz and '200kHz'. The basic accuracy for frequency measurements is +/-(.005% + 1 LSD), and readings are updated 3 times per second. Input sensitivity is 30mV for measurements from 5Hz to 20kHz, rising to 150mV for the wider range 0.5Hz – 200kHz.

The alternate duty cycle measurement mode measures from 0.1% to 99.9%, with an accuracy of +/-(.05% per kHz + 0.1%) for a 5V logic family signal. This makes it very suitable for checking PWM controller outputs, etc.

In practice

We don't have access to a calibration lab facility, so we weren't really able give the model 85 a rigorous calibration check. However comparing it with known reference instruments and components in our lab, the impression gained was that it met its specs quite comfortably and conservatively. This is of course the kind of thing one has grown to expect from Fluke.

Just as an example, we found the frequency counter range extended up to over 500kHz, for an input of only 0.7V RMS.

The instrument is obviously very solidly made, and in operation is very convenient to use. The display has a very comprehensive set of annunciator symbols, so it's always very clear which range has been selected, the units of measurement and any special functions which may be in operation.

All in all then, we found the model 85 a very impressive instrument and one that would make an excellent addition to most workshops, labs or service kits. For the current quoted price of $410 plus tax, it surely also represents very good value for money, in an instrument of this quality.

The review sample came from Philips/Fluke distributor Obiat Pty Ltd, of 129 Queen Street, Beaconsfield 2014, who can be contacted on (02) 698 4776. (J.R.)

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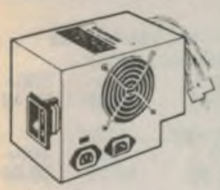

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- Switchable 1.44 M/Byte formatted or 720K formatted
- Double sided, Double density
- 5 1/4" mounted

C11911....................$225

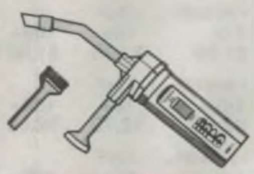
CONTROLLER CARD TO SUIT
X18006................................$139

MOUNT WITH POWER CABLE ONLY
X11920..............................$19.95

EXTERNAL PS/2* COMPATIBLE 5 1/4" DISK DRIVES
Capacity: 360K formatted
Track/Disk: 80/160
Number of Cylinders: 80
Average Access Time: 91 (94) msec
MTBF: Greater 10,000 hours
MTTR: 30 min. or less
- External 37 pin connector cable
- Internal 40 pin adaptor cable for PS/2 models
- 40 pin card edge
- Installation Guide

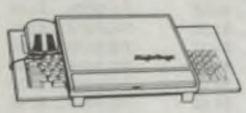
C11907....................$495

KEYBOARD & ACCESSORIES



MINI VACUUM CLEANER
Use it to clean:
- Computer keyboards
- Printers
- Video recorders
- Computer circuit boards

C21087................$14.95

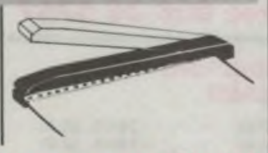


MAGIC STAGE
A working bench for your Mouse.
- High quality ABS plastic and anti-static rubberised top
- Stationary holder
- Includes pull-out shelf for Mouse
- Dimensions: 280 x 260 x 25mm
- Fits over keyboard

C21080................$24.95

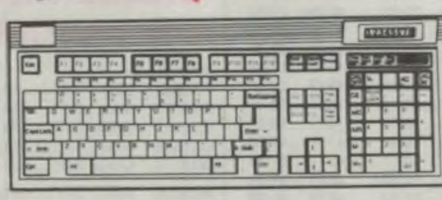
PRINTER ACCESSORY

RIPPER STRIPPER
Remove ugly paper feed edges quickly and cleanly with this simple little gadget
C21085.................$14.95



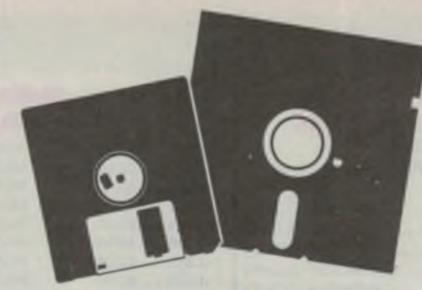
GRIP CLIP COPY HOLDER
- Attaches to the top of your monitor
- Put your copy, right where you need it
- spring clip to hold paper
- Velcro at mount for easy removal

C21065.................$14.95



KEYBOARD WITH SOLAR CALCULATOR
- Enhanced RT layout plus calculator function keys
- Size: 495 x 195mm (W x D)
- Custom mold logo tab
- FK-3002, 112 keys European version
- Big-caps calculator function Japan Alps Mechanical tactile"Click" keys

X12024............$189.95



"NO BRAND" DISKS

Now you can buy absolute top quality disks that are also the cheapest in Australia! They even come with a lifetime warranty, which indicates the quality of these disks. So why pay 2-3 times the price for the same quality?
Packs of 10, D/S D/D without boxes, or brand name, just their whitepaper jacket, and index label. (5 1/4" disks includes write protects)

5 1/4" 2S/2D "NO BRAND" DISKS

10+ DISKS	100+ DISKS	1,000+ DISKS
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5 1/4" HIGH DENSITY DISKS
(DOUBLE SIDED)

10+ DISKS	100+ DISKS	1,000+ DISKS
$21ea	$20ea	$19ea

3 1/2" 2S/2D "NO BRAND" DISKS
Suitable for IBM, PS/2, Macintosh, Atari, etc.
$21
(ALL PRICES PER 10 DISKS)

VERBATIM DISKS
(ALL PRICES PER BOX OF 10 DISKS)

DESCRIPTION	1-9 BOXES	10+ BOXES
3 1/2" 1S/2D	$39.95	$37.95
3 1/2" 2S/2D	$46.95	$43.95
3 1/2" 2S/HD	$99.00	$89.00
5 1/4" 1S/2D	$22.00	$21.00
5 1/4" 2S/2D	$26.00	$24.00
5 1/4" 2S/4D	$75.00	$70.00
5 1/4" 2S/HD	$41.00	$39.00

DISK BOXES

80 x 3 1/2" DISK STORAGE UNIT
- Holds up to 80 x 3 1/2" diskettes.
- Smoked plastic hinged lid
- Lockable (2 keys supplied)

C16038.........only $16.95

40 x 3 1/2" DISK STORAGE UNITS
- Holds up to 40 x 3 1/2" diskettes
- Lockable (2 keys supplied)
- High impact plastic lid and base

C16035.........only $14.95

120 x 3 1/2" DISK STORAGE UNIT
- Holds up to 120 x 3 1/2" diskettes
- Smoked plastic hinged lid
- Lockable (2 keys supplied)

C16039.........only $17.95

50 x 5 1/4" DISK STORAGE UNITS
- 50 x 5 1/4" Disk capacity
- Smoked plastic hinged lid
- Lockable (2 keys supplied)

C16025.........only $14.95

100 x 5 1/4" DISK STORAGE UNIT
- 100 x 5 1/4" disk capacity
- Smoked plastic hinged lid
- Lockable (2 keys supplied)

C16020.........only $12.95

DD 120 x 5 1/4" DISK STORAGE UNITS
- Holds up to 120 x 5 1/4" diskettes
- Lockable (2 keys supplied)
- High impact plastic lid and base

C16028.........only $19.95

ROD IRVING ELECTRONICS

ROD IRVING ELECTR

SEMICONDUCTORS

GREENCAP CAPACITORS

- POLYESTER
- 100V WORKING

R15136 ....0.001uF (1nF)
R15137 ....0.0012uF (1.2nF)
R15138 ....0.0015uF (1.5nF)
R15139 ....0.0018uF (1.8nF)
R15140 ....0.0022uF (2.2nF)
R15141 ....0.0027uF (2.7nF)
R15142 ....0.0033uF (3.3nF)
R15143 ....0.0039uF (3.9nF)
R15144 ....0.0047uF (4.7nF)
R15145 ....0.0056uF (5.6nF)
R15146 ....0.0068uF (6.8nF)
R15147 ....0.0082uF (8.2nF)
R15148 ....0.01uF (10nF)
R15149 ....0.012uF (12nF)
R15150 ....0.015uF (15nF)
R15151 ....0.018uF (18nF)
R15152 ....0.022uF (22nF)
R15153 ....0.027uF (27nF)
R15154 ....0.033uF (33nF)
R15155 ....0.039uF (39nF)
R15156 ....0.047uF (47nF)
R15157 ....0.056uF (56nF)
R15158 ....0.068uF (68nF)
R15159 ....0.082uF (82nF)

1-9 $0.20 | 10+ $0.18 | 100+ $0.15

R15160 ....0.1uF (100nF)
R15161 ....0.12uF (120nF)
R15162 ....0.15uF (150nF)
R15163 ....0.18uF (180nF)

1-9 $0.30 | 10+ $0.25 | 100+ $0.20

R15164 ....0.22uF (220nF)
R15165 ....0.27uF (270nF)
R15166 ....0.33uF (330nF)
R15167 ....0.39uF (390nF)

1-9 $0.40 | 10+ $0.35 | 100+ $0.30

R15168 ....0.47uF (470nF)

1-9 $0.60 | 10+ $0.50 | 100+ $0.40

R15169 ....0.56uF (560nF)
R15170 ....0.68uF (680nF)

1-9 $0.80 | 10+ $0.70 | 100+ $0.60

R15171 ....0.82uF (820nF)

1-9 $0.90 | 10+ $0.80 | 100+ $0.70

R15172 ....1uF (1,000nF)

1-9 $1.20 | 10+ $1.10 | 100+ $1.00

R15173 ....1.2uF (1,200nF)
R15174 ....1.5uF (1,500nF)
R15175 ....1.8uF (1,800nF)

1-9 $1.50 | 10+ $1.30 | 100+ $1.10

R15176 ....2.2uF (2,200nF)

1-9 $1.50 | 10+ $1.40 | 100+ $1.20

R15178 ....3.3uF (3,300nF)

1-9 $2.50 | 10+ $2.00 | 100+ $1.80

R15180 ....4.7uF (4,700nF)

1-9 $4.90 | 10+ $3.90 | 100+ $3.50

R15182 ....6.8uF (6,800nF)

1-9 $7.50 | 10+ $6.00 | 100+ $4.90

SEMICONDUCTORS 74LS SERIES

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74LS01 ......$0.60	74LS113.....$0.70	74LS245 ....$2.95
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74LS03 ......$0.60	74LS122 ....$1.00	74LS248 ....$1.40
74LS04 ......$0.60	74LS123 ....$1.30	74LS249 ....$1.50
74LS05 ......$0.60	74LS125 ....$1.00	74LS251 ....$1.50
74LS08 ......$0.60	74LS126 ....$1.00	74LS253 ....$1.35
74LS09 ......$0.60	74LS132 ....$1.00	74LS257 ....$1.20
74LS10 ......$0.60	74LS133 ....$0.90	74LS258 ....$1.20
74LS11 ......$0.75	74LS136 ....$1.20	74LS259 ....$2.25
74LS12 ......$0.80	74LS138 ....$1.00	74LS261 ....$2.50
74LS13 ......$0.90	74LS139 ....$0.80	74LS266 ....$0.70
74LS14 ......$0.60	74LS145 ....$1.50	74LS273 ....$1.95
74LS15 ......$0.60	74LS147 ....$2.50	74LS275 ....$6.80
74LS20 ......$0.60	74LS148 ....$1.90	74LS279 ....$0.80
74LS21 ......$0.60	74LS151 ....$1.20	74LS280 ....$2.60
74LS22 ......$0.60	74LS152 ....$1.95	74LS283 ....$1.20
74LS26 ......$0.60	74LS153 ....$1.00	74LS290 ....$1.20
74LS27 ......$0.60	74LS154 ....$3.80	74LS293 ....$1.10
74LS28 ......$0.60	74LS155 ....$1.50	74LS295 ....$1.50
74LS30 ......$0.60	74LS156 ....$1.50	74LS299 ....$3.90
74LS32 ......$0.60	74LS157 ....$1.20	74LS323 ....$6.50
74LS33 ......$0.60	74LS158 ....$1.00	74LS324 ....$2.20
74LS37 ......$0.70	74LS160 ....$1.50	74LS352 ....$2.20
74LS38 ......$0.60	74LS161 ....$1.00	74LS365 ....$1.00
74LS40 ......$0.60	74LS162 ....$1.50	74LS366 ....$1.00
74LS42 ......$1.20	74LS163 ....$1.10	74LS367 ....$1.00
74LS47 ......$1.50	74LS164 ....$1.40	74LS368 ....$1.00
74LS48 ......$1.60	74LS165 ....$1.20	74LS373 ....$2.00
74LS49 ......$1.50	74LS166 ....$2.55	74LS374 ....$2.00
74LS51 ......$0.70	74LS169 ....$2.95	74LS375 ....$1.00
74LS54 ......$0.50	74LS173 ....$1.20	74LS377 ....$2.15
74LS55 ......$0.60	74LS174 ....$1.20	74LS378 ....$1.20
74LS73 ......$0.60	74LS175 ....$1.00	74LS379 ....$1.90
74LS74 ......$1.00	74LS181 ....$4.00	74LS386 ....$1.00
74LS75 ......$1.00	74LS190 ....$1.50	74LS390 ....$1.80
74LS76 ......$1.00	74LS191 ....$1.20	74LS393 ....$1.80
74LS83 ......$1.20	74LS192 ....$1.20	74LS395 ....$2.00
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74LS109 .....$0.90	74LS243 ....$2.10	74LS645 ....$2.75

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7406.....$0.50	7445.....$0.80	
7407.....$0.50	7474.....$0.60	

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4000.....$0.75	4027.....$0.85	4054.....$3.90	4096.....$2.40
4001.....$0.45	4028.....$1.15	4055.....$3.90	4097.....$6.50
4002.....$0.45	4029.....$1.50	4056.....$4.20	4098.....$2.90
4006.....$1.55	4030.....$1.50	4060.....$2.50	4099.....$3.90
4007.....$0.45	4031.....$2.95	4063.....$2.00	40194....$2.50
4008.....$1.70	4032.....$2.30	4066.....$0.80	4510.....$1.40
4009.....$0.90	4033.....$2.75	4067.....$9.90	4511.....$1.45
4010.....$0.90	4034.....$3.10	4068.....$0.50	4512.....$1.40
4011.....$0.45	4035.....$1.80	4069.....$0.50	4513.....$2.65
4012.....$0.45	4038.....$2.25	4070.....$0.50	4514.....$2.60
4013.....$0.70	4040.....$1.20	4071.....$0.50	4515.....$2.90
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4021.....$1.50	4048.....$1.20	4082.....$0.75	4526.....$1.90
4022.....$1.45	4049.....$0.60	4085.....$2.20	4527.....$1.90
4023.....$1.45	4050.....$0.60	4086.....$2.30	4528.....$1.95
4024.....$1.30	4051.....$1.20	4093.....$0.80	4558.....$2.25
4025.....$0.45	4052.....$1.20	4094.....$3.35	4584.....$0.90
4026.....$2.40	4053.....$1.20	4095.....$2.40	4585.....$2.10

TAG TANTALUM CAPACITORS

3V TAG TANTALUMS

- R16020.........100uF — 1-9 $1.00 | 10+ $0.80 | 100+ $0.70

6.3V TAG TANTALUMS

- R16032........47uF — 1-9 $1.00 | 10+ $0.80 | 100+ $0.70
- R16036........100uF — 1-9 $2.00 | 10+ $1.90 | 100+ $1.80

16V TAG TANTALUMS

- R16124........10uF — 1-9 $0.60 | 10+ $0.50 | 100+ $0.40
- R16026........15uF — 1-9 $0.80 | 10+ $0.70 | 100+ $0.60
- R16128........22uF — 1-9 $0.90 | 10+ $0.80 | 100+ $0.70
- R16030........33uF — 1-9 $1.20 | 10+ $1.10 | 100+ $1.00
- R16132........47uF — 1-9 $2.80 | 10+ $2.70 | 100+ $2.60
- R16034........68uF — 1-9 $4.95 | 10+ $4.30 | 100+ $3.90

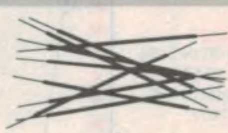
25V TAG TANTALUMS

- R16216........2.2uF — 1-9 $0.60 | 10+ $0.50 | 100+ $0.40
- R16218........3.3uF — 1-9 $0.80 | 10+ $0.70 | 100+ $0.60
- R16220........4.7uF — 1-9 $1.20 | 10+ $1.00 | 100+ $0.70
- R16224........10uF — 1-9 $1.50 | 10+ $1.30 | 100+ $1.10
- R16228........22uF — 1-9 $2.00 | 10+ $1.80 | 100+ $1.50

35V TAG TANTALUMS

- R16300........0.1uF — 1-9 $0.60 | 10+ $0.50 | 100+ $0.40
- R16302........0.15uF — 1-9 $0.80 | 10+ $0.70 | 100+ $0.60
- R16304........22uF — 1-9 $1.20 | 10+ $1.00 | 100+ $0.70
- R16306........33uF — 1-9 $2.00 | 10+ $1.70 | 100+ $1.50
- R16308........0.47uF — 1-9 $0.50 | 10+ $0.40 | 100+ $0.35
- R16310........0.68uF — 1-9 $0.60 | 10+ $0.50 | 100+ $0.40
- R16311........0.82uF — 1-9 $0.80 | 10+ $0.70 | 100+ $0.60
- R16312........1.0uF
- R16314........1.5uF
- R16316........2.2uF — 1-9 $0.60 | 10+ $0.50 | 100+ $0.40
- R16318........3.3uF
- R16320........4.7uF — 1-9 $0.80 | 10+ $0.70 | 100+ $0.60
- R16322........6.8uF — 1-9 $0.90 | 10+ $0.80 | 100+ $0.70
- R16324........10uF — 1-9 $1.00 | 10+ $0.90 | 100+ $0.80
- R16326........15uF — 1-9 $1.90 | 10+ $1.70 | 100+ $1.50
- R16328........22uF — 1-9 $2.80 | 10+ $2.70 | 100+ $2.50
- R16330........33uF — 1-9 $3.80 | 10+ $3.70 | 100+ $3.60
- R16332........47uF — 1-9 $4.50 | 10+ $4.00 | 100+ $3.70

GENERAL COMPONENTS



BRAND NEW WIRE WRAP WIRE

- Precut wire

W19002 Blue 3.0" $4.75
W19022 Red 3.0" $4.75
W19042 Yellow 3.0" $4.75
W19062 Black 3.0" $4.75
W12784 Green 3.0" $4.75

W19026 Red 5.0" $5.95
W19046 Yellow 5.0" $5.95
W19066 Black 5.0" $5.95
W12790 Green 5.0" $5.95
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W19036 Red 10.0" $10.50
W19056 Yellow 10.0" $10.50
W19076 Black 10.0" $10.50
W12796 Green 10.0" $10.50

- Spool wire

W19390 Green 50ft........$8.00
W19400 Blue 50ft........$8.00
W19406 Purple 50ft........$8.00
W19407 White 50ft........$8.00
W19408 Orange 50ft........$8.00
W19410 Yellow 50ft........$8.00
W19415 Black 50ft........$8.00

W19416 Green 100ft $10.75
W19417 Brown 100ft $10.75
W19420 Blue 100ft $10.75
W19425 Red 100ft $10.75
W19426 Purple 100ft $10.75
W19427 White 100ft $10.75
W19428 Orange 100ft $10.75
W19430 Yellow 100ft $10.75
W19435 Black 100ft $10.75

W19460 Blue 500ft $33.75
W19461 Green 500ft $33.75
W19465 Red 500ft $33.75
W19475 Black 500ft $33.75

RoD IRVING ELECTRONICS

KITS
GENERAL

ELECTRIC FENCE
Mains or battery powered, this electric fence controller is both inexpensive and versatile. Based on an automative ignition coil, it should prove an automative ignition coil, it shoild prove an adequate deterrent to all manner of livestock.
Additionally, its operation comforms to the relevant clauses of Australian Standard 3129. (EA Sept. 82) 82EF9
K82092..................$19.95

PHONE MINDER
Dubbed the Phone Minder, this handy gadget functions as both a bell extender and paging unit, or it can perform either function separately. (EA Feb. 84) 84TP2
K84021..................$27.50

rie

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KITS
TV/ AUDIO

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)
HEATSINK NOT INCLUDED
K44990..................$97.50
Plus transformer..$49.50

SOUND PRESSURE METER
Noise is one of the many pressures of todays often stressful lifestyle. To be able to combat noise in its many forms, you must be able to measure it. This low cost Sound Pressure Meter will measure sound levels of less than 30dB to more than 120dB, either fast or slow response to the "A" weighting curve. (EA May. 81, 81sp5)
K81053..................$39.50

AUDIO TEST UNIT KIT
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. Out 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.
(81AO10) (EA Oct. 81)
K81101..................$59.50

100W SUB-WOOFER AMPLIFIER
Capable of up to 120 watts Rms into 4 ohm loads and up to 80 watts RMS into 8 ohm loads, this power amplifier module has been specifically designed for use as a sub-woofer driver amplifier in a tri-amped hi-fi system. It uses four power Mosfets for rugged, reliable operation. (EA July. 82, 82PA7)
K82075..................$97.50

VIFA

SPEAKER KITS
"CLEARANCE" SALE
ON NOW

NEW KITS

PC DRIVEN FUNCTION GENERATOR
Here's a simple and low cost little unit which lets you use your personal computer to generate signals with almost any conceivable waveform. It hooks up to the computer via a standard Centronics-type parallel printer port, making it compatible with almost any kind of computer. Building and using it will also give you valuable insight into the growing trend towards computer-driven test instruments, too! Software included. (EA JAN 89)
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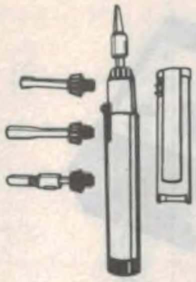

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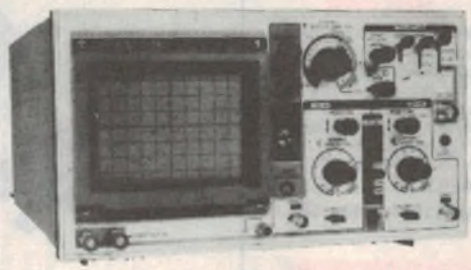

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- Transistor hFE Test

Q91530......................$79

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- Readout hold
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METEX 3580 MULTIMETER

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Electronics in Industry – 1

Ever wondered what the difference is between commercial and industrial electronics? To answer the riddle, we examine that most fundamental industrial requirement – the control system. We keep away from the usual heavy metal maths and on the way we also try to define 'industrial electronics'.

by PETER PHILLIPS

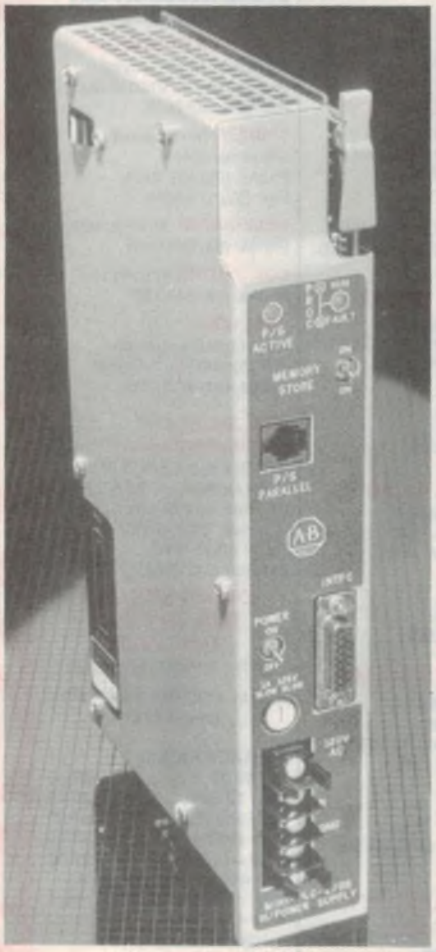
Mention industry and most people think of dust, heat and noise. It is certainly true that heavy industry fits this description, although some industries need an environment where dust and dirt are measured in microns. In other words, generalising is not really possible, which begs the question: what is industry?

There is no clear line of distinction between that type of electronics generally associated with the commercial/domestic arena and that for industry. One typically industrial requirement however is the need for a *control system*. Somewhere, somehow a variable needs to be controlled in order that a process can occur.

In commercial and consumer electronics, control systems are likely to be limited to, for example, the servo circuit that keeps the video head rotating at a constant speed. However, a characteristic that would usually apply to a non-industrial system is low power.

So perhaps we can say that it's industrial if it involves significant power. But it goes deeper than that – for example, there are many industrial functions that have no real parallel in domestic equipment, or at least are far more sophisticated. As well, the tolerances allowable in domestic equipment are probably far wider than those for the industrial equivalent.

So, for the purposes of this article, I'll regard industrial electronics as being that electronics used wherever there is a need to control high power (say a kilowatt or more), or where high accuracy is required. And some functions are so clearly industrial that it goes without saying.



PLCs are now very common in industry, and range from small units costing $500 to units with the ability to accept analog inputs and to even communicate with other PLCs.

The basis of electronics in industry is often to control something, so a good place to start is with the general form of a control system.

Industrial control

The *closed loop* control system is to industry as the amplifier is to domestic electronics. In the home, a lot of equipment has an amplifier somewhere in the chain; in industry controlling a variable is equally as fundamental. Very often a number of smaller control systems form a complete system, and if any one section gets out of whack, the whole system becomes unstable.

A power station is a good example, in which the final output product, electricity, needs to be at the correct voltage and correct frequency. This means the turbine driving the alternator needs to spin at the right revs per minute, (usually 3000rpm), in turn requiring the steam pressure to be controlled, which needs the temperature of the steam, and hence that of the furnace to be correct.

To keep the fire burning, coal needs to be supplied to the bunkers, for subsequent crushing in the mills. Too much coal will overfill the bunkers, too little and the fire goes out. The air/coal mixture needs to be controlled to maintain the unburnt oxygen at a particular level for the best efficiency. The combustion products need to be extracted from the furnace, requiring a certain level of draught to draw them from the furnace without setting up too high a draught that could blow the fire out.

A means of extracting the fly ash and other pollutants from the exhaust is needed, again controlled to prevent the extraction equipment from becoming

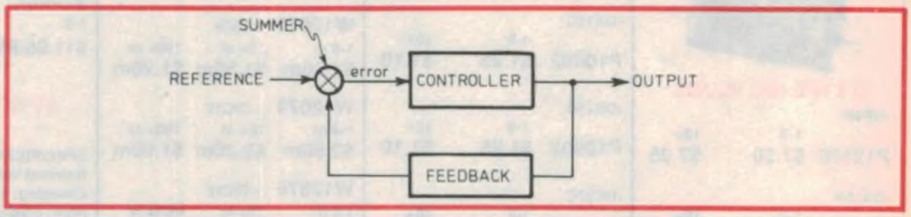


Fig.1: The block diagram of a closed loop control system needs these component parts. The output is the variable being controlled by comparing the feedback to the reference signal.

blocked and stopping the draught. Then there are other ancillaries, such as the level of make-up water to replenish that lost in the steam-to-water cycle.

So the list goes on. Control systems within the control systems, all requiring a means of measuring the variable and a means of keeping the variable constant.

A control system

Fig.1 shows the basic block diagram of a closed loop control system that can describe most controllers. The basic parts are the reference input, the summer, the controller and the feedback. The reference input is a value, often a voltage, used to set the final output. By varying the reference value, perhaps by means of a potentiometer on a control panel, adjustment of the system becomes possible.

The summer is a means of comparing the feedback signal to the reference, and any difference, called the error signal, is applied to the controller. Achieving a difference signal using the process of addition, as with a summer, requires the feedback to be of the opposite polarity to the reference. Alternatively, the summer might just as well be called a subtractor or comparator.

The controller has the task of causing the variable to move in the required direction, until the error signal is zero. The feedback is that section that samples the output variable and converts the sample to a form that can be applied to the summer.

Driving a car requires a closed loop control system to be in place, and if any section fails, giving open loop control, an unpredictable situation becomes likely. In this rather biological system, the reference is the road, the brain fulfills the function of the summer, the feedback is via the eyes, and the controller is the muscular action of the driver's arms and legs. The variable is the status of the car, which includes direction and speed of the car. The quality of this control system is clearly a function of the individual parts, which possibly explains the phenomenon of the 'mug' driver...

In industry, control systems are either pneumatic or electric, although our concern here is the electrical type. Pneumatic systems are used where there is a risk of fire, such as in a petrol refinery, and an instrument technician would need to be able to understand both.

Electrical control system

In an electrical control system, all component parts are electrically operat-

Programming a PLC unit. Photo courtesy of Allen-Bradley.

ed. The controller may be a motor or a solenoid, and the summer would be some sort of amplifier (perhaps an op amp). In order that the summer can control a load such as a motor, some form of motor control electronics is needed, perhaps in the form of triacs, SCRs or relays.

The feedback needs to have an input signal that is an electrical representation of the variable being controlled, and the feedback network would treat the sampled signal to convert it to a form suitable for application to the summer.

Control systems can be either a simple on-off arrangement, or so sophisticated that they can almost predict something before it happens. In fact, the quality of a control system can be gauged by its *response* to a change and how it behaves to correct the change.

A simple example is a control system that keeps the level of a tank of water constant, as shown in Fig.2. A basic on-off system would maintain the level by opening or closing a solenoid valve to control the water flowing into the tank. In this system, the valve is either on or off, and water either flows at maximum or not at all.

A more complex system, such as one using *proportional* control, would actually control the rate of water flowing into the tank, in direct proportion to the difference between the actual level to the required level. In the tank example, proportional control would cause the water flow to decrease as the water level approached the required value. This system reduces the possibility of *hunting*, unlike the simple on-off system, where *overshoot* and *undershoot* are likely.

Fig.3 show this graphically, in which

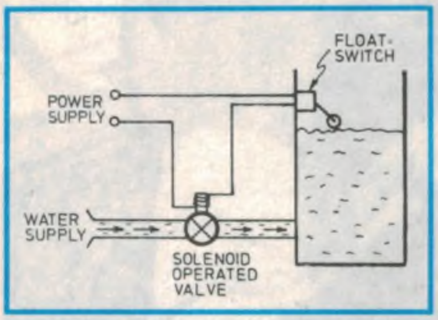


Fig.2: An on-off water level control system. The reference is the position of the float switch in the water tank, and the controller is the solenoid valve. The summer is the combination of the float switch and the power supply, giving an error signal of zero or maximum.

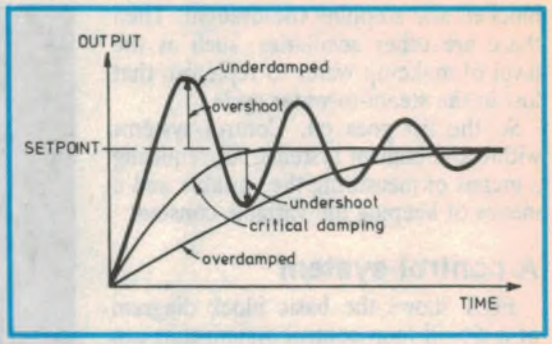


Fig.3: Damping a control system usually requires more than simple on-off control. Ideally the system response should immediately return the variable to its set point, with no overshoot or undershoot.

the water level could oscillate around the desired *set point* for some considerable time before settling down. The graph is therefore a pictorial representation of the response of the system, and is usually derived by analysing the system behaviour to a sudden change, known as a *step input*.

The ideal response is one that quickly restores the variable to its correct value, but with a minimal amount of overshoot or undershoot. This sort of response curve requires not only sensing that the variable is away from the set point, but by how much. All kinds of fancy methods are used to optimise the response curve, and involves the use of proportional, integral or derivative (PID) control systems.

You can probably see by now that a control system can be a very complex thing, and in-depth discussions on this topic can quickly become rather technical. Most books on control theory concentrate on the mathematical analysis of the system, and use Laplace transforms, integral calculus and other 'nasties' to describe the action of the system to a step input. But some systems are not so bad, and it is interesting to look at a simple example to show how a system fits together.

A regulator

Control systems can be roughly categorised into *regulators* or *positional* controllers. The difference concerns the error signal, which, as already described, is the difference between the reference and feedback signals. A positional controller has *no* error signal, unless the system is away from its set point. In this case the system will operate to reduce the error signal back to zero.

A regulator, however, requires that the error signal be maintained at a certain value for the system to operate. An example may help to illustrate the point, but before launching into the example, we need to describe the term *transfer function*. This rather technical term is merely a way to describe the relationship between the output and the input of a device. For example, a motor may have a transfer function of 100 rpm/volt, which simply means that the output will be 100 rpm for every volt applied to drive the motor. Now to the example...

Fig.4(a) shows the diagram of a closed loop motor speed controller, and Fig.4(b) shows the system in block diagram form. The motor is driven by a power amplifier with a gain of 10, (or a transfer function of 10 volts/volt) and the motor is connected to a tacho generator with a transfer function of 10mV/rpm. The transfer function of the motor is 100rpm/V, as already described.

Let's say we want the motor to run at 1000rpm. This allows us to work backwards, to see what value of reference voltage is required, and to calculate the value of the error voltage.

For the motor to produce 1000rpm, the amplifier needs to produce 10V at its output. This requires an error voltage of 1V, meaning the difference between the reference and the feedback has to differ by 1V. When the motor is running at 1000rpm, the tacho will output 10mV x 1000rpm, giving a 10V output. To get the required 1V difference for the error signal therefore requires a reference input of 11V.

If the amplifier had a gain of 100, the error voltage would be 0.1V and the reference would now be 9.9V. In other words, the higher the gain of the amplifier, the less the error voltage. But note how there needs to be a finite error voltage, in the first place.

Computer simulation

A control system can usually be broken down into a mathematical equation, albeit a rather complex one. The interesting thing about this is the ability of an *analog* computer to simulate this equation. As an example, consider the way a motor behaves when its input voltage is changed.

When a motor is first switched on, some time lapses before it has reached full speed. Similarly, when the supply voltage to the motor is varied, the

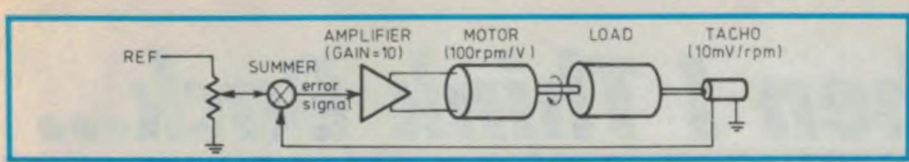


Fig.4(a) showing a motor speed control system. The motor is shown driven by an amplifier, although a special output stage would usually be required.

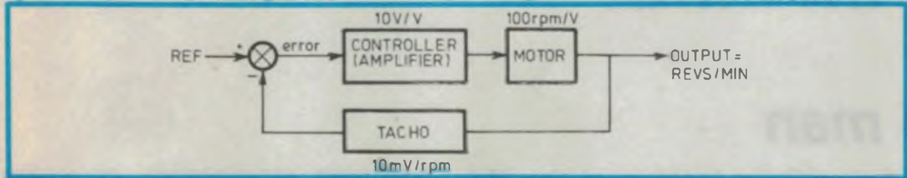


Fig.4(b) shows the motor speed control system in block diagram form, with the transfer functions of each section.

motor speed will take some time to match the new voltage. This is rather similar to the way the voltage across a capacitor changes when the capacitor is connected to a voltage source through a series resistor. If the resistor and capacitor values are adjusted to simulate the motor, it becomes possible to pretend that the RC network is in fact the motor.

This allows the designer to observe how the motor behaves for various input voltages, but using an RC network as the simulation. Now, without all the usual noise and dangers, the designer can apply a range of input voltages, ranging from DC, through various types of waveforms to step inputs and the like, and observe the voltage across the capacitor with a scope.

By relating the capacitor voltage to the speed of the motor, a lot can be learnt about the motor without even running it.

Unfortunately, this simple simulation doesn't allow for all possibilities of the motor, such as stalling or gear backlash and the like, but it illustrates the possibilities of simulation.

A more sophisticated method is to use an analog computer to simulate the transfer function of the system, which must first be calculated and expressed as a mathematical equation. An analog computer uses a number of operational amplifiers that can be wired to simulate each section of the equation. By joining each 'function' together, and applying a voltage to represent a change in the system conditions, a complex simulation becomes possible.

This way, a complete control system can be simulated before it is even constructed and problems dealt with beforehand. Oh yes, not all computers are digital!

Programmable controllers

So far I have only described the basics of a control system, and have not mentioned the component parts. It is now common practice to use Programmable Controllers as the control system, rather than a discrete system made up of various sections. Controllers of this type are often referred to as PLCs (programmable logic controllers), and can fulfill a range of control functions depending on how they are programmed.

Although usually digital, implying on-off control only, some of the more sophisticated PLCs allow PID control as well, meaning they can handle analog as well as digital inputs. The PLC is attractive in that its operation can be modified by rewriting the *software* if the system being controlled requires changing.

This way, a firm can purchase a number of PLCs, all identical to start with, and then program them to perform different tasks. Because the program is usually installed in an EPROM (erasable programmable read only memory), a spare PLC can be brought into service in the event of a failure, simply by inserting the correct EPROM.

Yet to come

Perhaps the most interesting components are those used to measure the variable being controlled. These devices are called transducers, and deserve a section all to themselves. In a following article, we will describe some of the transducers used in industry, concentrating only on those that interface to an electrical system. It's a fascinating subject, and some of the devices used are a true testimony to man's ingenuity to measure something that often seems impossible.

But industry is about achieving the impossible – from ensuring the coffee jar has exactly 250gms of coffee, to automatically separating small, medium and large eggs, and even controlling the width of a 100-tonne metal slab as it is milled into a flat sheet with precise dimensions. Industry does it all, but more of that next time...

When I Think Back...

by Neville Williams

Ernest Fisk – the man

Last month, in the first of these two articles looking at the life of Sir Ernest Fisk, I told of the way he played a vital role in the founding of AWA and guided the company through two world wars. This month we look more closely at the man himself.

The heading 'The Man Fisk' appears at the top of an interesting article in *Radio in Australia and New Zealand* published by Wireless Newspapers, Sydney – the same company that owned *Wireless Weekly* before it was taken over by Associated Newspapers. Kindly supplied to me by Neil Bonney of Bundaberg, Qld, the article is dated August 15, 1927, and was probably prompted by the inauguration of the Beam Radio service.

Described in the introduction as 'an intimate pen-portrait' of Mr E.T.Fisk, it was written by 'a friend and colleague' F.W.Larkins – presumably the same Fred Larkins that I remember as AWA's General Advertising Manager, when I worked there in the mid 1930's.

The article traces the career of Ernest Fisk, along parallel lines to what has already been set out in the first of these articles. Larkins makes the point that maritime radio telegraphy had made fairly rapid progress in the northern hemisphere in the decade 1900-1910, with several thousand shipboard and land stations in operation.

Meant to be funny, this cartoon produced by a Wireless Weekly artist caused no official amusement in AWA top management. They cancelled all advertising in WW, to emphasise their displeasure.

By contrast, when Fisk first entered Australian waters, there were no permanent shore stations and accessible wireless equipped ships could be counted on the fingers of one hand: the P&O *ss Malwa*, the Orient *ss Otranto*, the Norddeuscher-Lloyd *ss Bremen* and the HMS *Powerful*.

Says Larkins: "As Marconi discovered wireless, so E.T.Fisk discovered a continent – a continent without wireless, but a continent where he was destined to be one of its greatest pioneers".

In the article Larkins comments on 'The Man Fisk' in a manner more suited to the '20s than the late '80s:

- "The man behind the impenetrable suave mask, which so baffled a formidable array of legal talent at the Royal Commission".
- "His inner self is 'overcovered' by his work. The trivialities, all the manifestations of mediocrity which mark the ordinary are submerged, absorbed in his pursuit of a definite objective".
- "He is so far above the crowd that he is frequently misunderstood when he descends to a more earthly level of thought".
- "Yet he is by no means an impractical visionary... It is his grasp of everyday affairs which has enabled him to pursue his objective and to force men to recognise his genius".

In more down-to-earth terms, Larkins elsewhere refers to Fisk's 'abnormal capacity for work', whether at a technical or business level. Even when ostensibly relaxing, says Larkins, he was most content when experimenting, or reading scientific books, or dreaming up ideas outside his immediate field of expertise.

An independent tribute to Fisk the amateur, the enthusiast, is provided by the fact that, in 1921, while he was hobnobbing with the Prime Minister and making his presence felt at an Empire level, he was still chairing meetings and 'chewing the rag' with fellow amateurs as President of the NSW Division of the Wireless Institute of Australia (see panel last month).

Be that as it may, in August 1927, when Larkins' article was written, some 200 ships of the Australasian mercantile marine had been equipped with radio, manned by 250 operators – largely the result of Fisk/AWA initiative. The company's radio-electric works had expanded from an original dozen-odd to around 150, employed in producing a wide range of receiving and transmitting equipment.

Questioned at the time as to what lay ahead, Fisk nominated international radio-telephony and picturegram services and, further down the track, television. True to form, the first two became a reality in the early 1930s, with television being delayed by World War II.

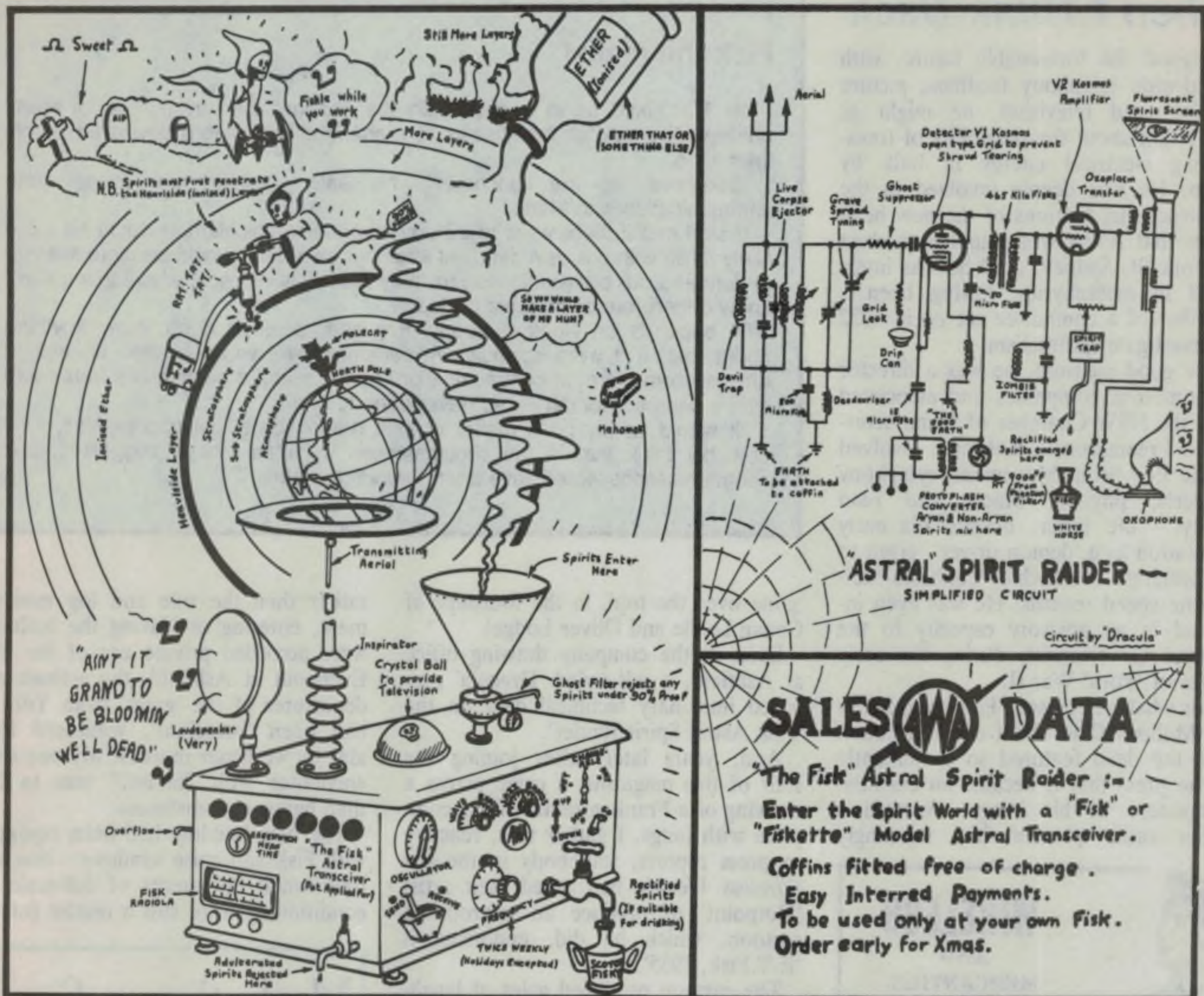
Fisk & broadcasting

But Fisk didn't get everything right as, for example, his blueprint for broadcasting in Australia. He was certainly keen to promote it, along with AWA's ability to supply transmitting and receiving equipment.

In 1919, in Australia's first public demonstration, a recording of 'God Save the King' was broadcast from AWA's office in Clarence St, Sydney to a meeting of the Royal Society in Elizabeth St – an organisation of which E.T. Fisk was a member.

In 1920, at Prime Minister Hughes' request, AWA transmitted a live program from the home of AWA's Melbourne Manager L.A.Hooke to politicans and others in Queen's Hall.

In 1921, AWA began a series of



Following Fisk's observation about possible communication with the dead, this highly irreverent drawing was produced anonymously in AWA's own drawing office.

weekly demonstration wireless concerts for the Melbourne area, with similar concerts in Sydney commencing shortly afterwards.

1923 saw the official commencement of public broadcasting, with AWA poised to dominate the production of receivers and transmitters, and to collect royalties on the many patents for which it held Australian rights. Under the Fisk 'sealed-wireless' scheme, listeners would nominate the station to which their receiver would be pre-tuned – and sealed – and would pay the required fee to that station.

Despite intense public interest in broadcasting, the sealed set idea was a resounding flop. Listeners wanted all or nothing while, at the commercial level, there was strong opposition to the scheme and to AWA's potential monopoly.

Under the heading 'A monopoly in wireless will not be tolerated', the *Australasian Wireless Review* for March 1923 reported the formation of an Association to voice those objections. Involving a dozen or more companies, it was headed up by George A. Taylor, with O.F. Mingay as Hon Sec – a man who featured large in the radio/electronics industry in subsequent years.

In November of the same year, *AWR* carried another story on thirteen wireless retailers in Sydney who had combined to form the Free Broadcasting Company. Their aim was to provide programs from 10am to 10pm daily, free of all charges, in return for a 'fair share' of listeners' patronage.

The following year saw the end of the sealed set scheme and the introduction of 'national' stations supported by licence fees, plus 'commercial' stations relying on advertising revenue. It was hugely successful.

Despite the setback, however, AWA still managed very nicely – thank you – as a supplier of transmitting equipment, and of receivers ranging from traditional wireless sets of the 1920's through to the popular 'Fisk Radiolas' of later years.

Talking to spirits

In terms of his image, Fisk also got it wrong (even if inadvertently) at a luncheon at the Millions Club during 1935. This was when he mentioned the possibility that, some day, radio technology might provide a means of communicating with the dead.

The remark was not out of character. As Sir Ninian Stephan observed in the lecture referred to in the first of these articles, Fisk combined with his technical knowledge and business acumen a free-ranging intellect, not limited to current committments.

When I Think Back

Beyond the foreseeable future, with world-wide telephony facilities, picture services and television, he might as easily talk about the possibility of transmitting electrical energy in bulk by radio. He was deeply involved in the constructional features of the new head office that AWA was planning to erect in York St, Sydney. And he was interested in metaphysics, having been a member of a committee set up in 1932 to investigate spiritualism.

For good measure, he was a director of numerous companies and associated with the NSW Chamber of Manufacturers; a Freemason, a Rotarian, involved in the Boy Scout Movement, symphony concerts, physical fitness and road safety – the latter, despite his early reputation as a 'demon driver', given to challenging Sydney-Canberra-Melbourne speed records! He was even involved in an advisory capacity to the Federal Government, during the early stages of World War II.

For whatever reason, Fisk's remark in the Millions Club about communication with the dead featured so prominently in the press that it became an essential component of his image. Australia's senior radio pioneer had seemingly 'gone over the top', in the footsteps of Conan Doyle and Oliver Lodge!

Even in the company drawing office at Ashfield, a self-styled 'Dracula' prepared imaginary technical data on the 'Fisk Astral Spirit Raider'.

And, years later, after joining the staff of this magazine, I came across a drawing of a Frankensteinian Fisk, complete with fangs. I gather that, reacting to press reports, somebody in the old *Wireless Weekly* had asked their artist 'Hotpoint' to produce an appropriate cartoon, which he did, endorsing it 'E.T.Fisk, 1935'.

The cartoon produced gales of laughter in the *WW* office and was duly published. But the laughter was somewhat muted away when AWA reacted by officially cancelling all advertising in the magazine!

But enough said. It is appropriate that the last word on the incident should be an extract from a clipping from my files, itself an eloquent comment on the man. (See panel 'Fisk the realist')

Fisk the realist

Mr Fisk fixed us in a chair with the impenetrable mystic eye of many photographs; and all our visions of a changed world were destroyed by his brief logic.

"Someone at the luncheon", he said, "asked me about radio communication with Mars."

"I said that if there were to be any such communication, it would be more likely to be with our own dead. At least our own dead would be more likely to understand our communication for they WERE alive once, whereas we don't know if there are any people on Mars."

"It depends on whether people live after death; I don't know anything about that. If it were scientifically demonstrable, we could then attempt to arrange some form of communication. I don't mean a seance in a dark room with a neurotic woman – I've never been to one."

"It would simply be a matter of cold reason on scientific principles, for I certainly think that, if the circumstances were as I have suggested, any communications would have been through the ether."

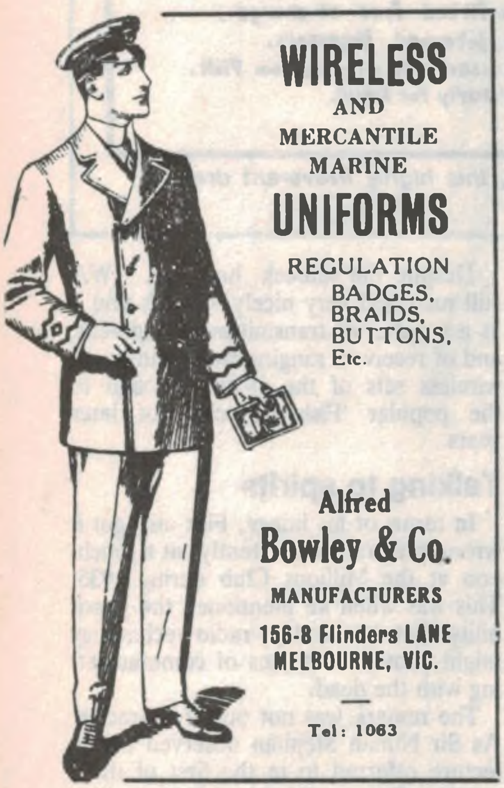
Personal memories

Ernest Fisk was knighted in 1937 and honoured by the various societies and groups of which he was a member.

It was about then that I transferred from the Valve Company lab in Ashfield to the new Head Office in 45-47 York St, ironically occupying exactly the same site where I had begun work with Reliance Radio in 1933. But whereas Reliance had been a struggling family company in a run-down building, AWA was a prosperous, formal semi-government institution in just about every sense of the term.

Christian names were the exception rather than the rule and top management, entering or leaving the building, were accorded private use of the lifts. Even out at Ashfield, the arrivals and departures of the 'great' from York St had been 'occasions', witnessed from afar by we lesser mortals. My one close encounter with ?himself' was in less than happy circumstances.

The new building had been equipped with Fisk anti-noise windows – this at a time when the merits of full-scale air conditioning were still a matter for de-



Maritime wireless communications became very important during WW1. Here's what an operator of the day was expected to wear.

Marketing a Service

Seven years ago the Wireless Company was incorporated to develop in Australia the art and science of Wireless Communication. To give to travellers at sea the benefits arising from communication with their friends on land, and to the latter reciprocal advantages, has been our immediate aim.

Modern, efficient and economical service is the keynote of the organisation.

To this end we direct a large staff engaged in the production, installation, maintenance and operation of wireless telegraph stations, the direction of personnel, and the recording and accounting of thousands of messages daily.

Every ship station is a floating telegraph office and every post-office a medium of communication.

Lodge your message at the nearest Post-office.

Amalgamated Wireless (Australasia) Ltd.

OPERATING

AN ORGANISED RADIO SERVICE

Around 1920, Fisk was ensuring that AWA publicised its wireless telegram service, providing a communications link with maritime travellers.

bate.

The Fisk windows involved the use of overlapping glass panes, which blocked much of the street noise but allowed a somewhat convoluted passage for air movement, assisted by small built-in fans. The idea worked well enough on mild days, but certainly not in the heat of a Sydney summer.

On one particular day, with the sun full on the western windows, the temperature in the Valve Company office on the 5th floor was intolerable. Street noise notwithstanding, I/we had opened wide the hinged panes in an effort to gain a breath of fresh air.

It was then that Sir Ernest, with a VIP in tow, chose to walk into the Valve Company office to boast about the effectiveness of his pet idea. The half-closed eyes blazed as he diverted into the departmental manager's office to deliver a brief oration that was never documented for posterity!

Return to Britain

In 1944, much to the surprise of industry journalists in both countries, Sir Ernest Fisk resigned his position in AWA, leaving the management reins in the capable hands of his long-time deputy, Lionel Hooke. In fact, he had accepted the position of Managing Director of Britain's Electrical and Musical Industries (EMI).

Perhaps he saw it as a triumphant return to the land of his birth but, viewed from afar, it proved to be scarcely that – due in part to the entrenched conservatism of the EMI/HMV group.

With the end of the war in sight, there had been mounting pressure from the audio-hifi industry for a quantum leap in disc recording technology. British Decca, in due course, released their ?ffrr' low noise pressings. In Australia, Fisk's old company produced something similar. Then British Decca, American CBS, RCA and smaller companies elsewhere began talking about radically new fine-groove, low noise, long-playing vinyl pressings, spinning at 33 or 45rpm instead of the established 78rpm.

The moves caused confusion in the record market, but few doubted that the long overdue technological revolution had begun. If it hadn't, the way would be wide open for magnetic tape.

But EMI's reaction was beyond belief, even to talk of retaining the 78rpm format so that it could continue to serve both electrical and mechanical reproducers!

The one statement that I can remember from EMI Chairman Fisk was a solemn assurance to record vendors and consumers alike that, as far as EMI was concerned, 78rpm records were still the industry standard and the company would not adopt any other without first giving 6 months clear notice of their intention.

With the microgroove tide already flowing strongly (Refer John Moyle's ?Off the Record' columns in *Radio & Hobbies* during 1951) Sir Ernest's widely publicised emulation of King Canute caused only an incredulous shaking of heads – including mine. But mention of King Canute is perhaps not entirely inappropriate.

Drawn from the *Australian Dictionary of Biography*, Sir Ninian Stephan's final picture of Sir Ernest is of a man in his sixties, covering the 50 miles from London to Brighton on a bicycle during an English winter and, having arrived, plunging into the chilly waters for a swim. This in the cause of physical fitness.

Enthusiasm notwithstanding, it's perhaps little wonder that, following his ultimate retirement at 65, he chose to return to a more appropriate outdoor climate for the final years of his life. Sir Ernest Fisk died in 1965 at age 78.

Silicon Valley NEWSLETTER . . .

Computer rental now big business

American business executives rent everything from videotapes to cars. So why not rent a computer?

Increasingly, that's what businesses are doing to satisfy short-term needs for computing power, to help train new employees to use their machines and even to keep travelling executives in touch with their electronic calendars.

A few years ago, renting a computer was usually a case of finding a mom-and-pop computer retailer with some old or extra equipment to let. Now, two long time national renters of electronics gear have thriving computer rental businesses and have been joined by a 40-outlet franchise and an established national computer retailer.

Personal computer rentals are now a US$200-million-a-year business in the US and are growing at 30% a year, according to Businessland Inc. of San Jose, which began a rental business in January. Suppliers say Silicon Valley, which accounts for $20 million of that business, is one of the biggest rental markets in the US along with Los Angeles, New York and Washington, DC.

Users can rent for a day, a week, a month or a year. They can lease or rent-to-own machines, as well as printers, big-screen displays and other peripherals. Typically, the rental includes delivery of the system to a customer's office, set-up by a technican and pick-up at the end of the rental period. Usually included in the bargain is more support than a buyer gets from a computer store. Broken machines are repaired on site or replaced the same day, and renters' technical questions are usually answered immediately over the phone.

But renters pay for that kind of service – renting a computer can be far more expensive than buying one. Even a basic IBM Personal Computer XT, clones of which can be bought for well under $1000, typically rents for $125 to $150 a month. Newer, state-of-the-art equipment can carry dizzying prices. At Micro-Rent in Corte Maders, a top-of-the-line Compaq 386/25 with a 300-megabyte hard disk, which sells for about $13,000, rents for $800 or $900 a month. Most computers offered for rent can be purchased outright for the equivalent of less than a year's worth or rental payments.

With such economic factors, businesses account for the bulk of computer rentals by far, suppliers say. Businesses can afford to pay a premium to get a computer – or several – on short notice.

"About 90 percent of our business is large corporations", said Gail Ray, president of Personal Computer Rentals, a Coral Gables, Florida, franchise with 40 outlets throughout the country.

Businesses say they're willing to pay the steep prices in exchange for the service that most rental firms provide.

"We expect to pay the premium for delivery, ease of set-up and speed", said Alan Bowker, director of management information systems at Dolby Laboratories, the San Francisco maker of audio noise reduction equipment. "I need to pick up the phone at 10 in the morning and get the computer by 3, because that's the way decisions come down here."

Two more valley firms go bankrupt

Two more Silicon Valley companies, Scientific Micro Systems and Univation, have filed for Chapter 11 bankruptcy protection. The filings followed similar action by Plexus, a start-up in which venture capitalists had invested a whopping US$40 million.

At Scientific Micro Systems (SMS), company officials blamed heavy losses for the hard times the firm is experiencing. Most recently, SMS lost $43 million during 1988.

As it operates under the protection of the bankruptcy law, SMS officials vowed to continue to develop, manufacture, and distribute the firm's complete product line of data controllers and storage devices, and 'conduct business as usual'. Company spokeswoman Melanie McNulty said management is considering selling the company, but no decisions have been reached in that respect. No immediate layoffs of the company's 300 workers will result from the bankruptcy filing, she added.

Meanwhile, Univation which makes computer local area network products, said it was forced to seek bankruptcy protection after it lost a court battle against Lifeware Systems Designer Team Inc. over distribution rights to the 'Lifenet' program.

Drive-thru mortuary

In one of those 'only in America' type innovations, a Chicago funeral home has employed the latest in video camera and speakerphone technology to build the world's first – and so far only – 24-hour drive-through mortuary service.

Trying to capitalise on the success of drive-through restaurants and banks, Gatling's Funeral Home in South Chicago now allows on-the-go visitors to view their loved ones 'one last time', and sign the visitor registration book without ever leaving their car. A large-screen television at the drive-through window displays the remains of the deceased.

Lafayette Gatling, owner of the funeral home, said the idea has proven quite popular, particularly among senior citizens confined to wheelchairs, and working people pressed for time.

When driving up to the drive-through gate, visitors press a speakerphone button at one of several stations and the attendant asks whom they would like to see. The attendant then turns on the lights and camera over the corpse of the deceased, lying in one of the rooms.

Along with last year's microwave cloth dryer, this innovation certainly deserves some special mention in the annals of the development of the human race.

Sony inks $100 million disk drive deal with Apple

Just as Seagate Tehcnologies appeared to be recovering from its financial problems of 1988, it appears the company has lost one of its biggest customers. Japan's Sony confirmed it is making its first entry into the US market for 3.5" hard disk drives with a US$100 million contract to supply Apple Computer, which will use the 40 megabyte Sony drives in its Macintosh line of systems.

At Sony's US headquarters for the magnetic products group in San Jose, marketing manager Peter Schwieder said his company didn't take business away from Seagate which apparently had stopped supplying Apple several months ago. Instead, Sony will be taking some business away from Milpitas-based Quantum.

Sony's order will account for about half Apple's demand for Macintosh disk drives. Previously, Quantum supplied between 70 and 80% of Apple's drives.

Motorola opens new MOS plant

Motorola recently unveiled MOS 6, a new metal-oxide-silicon semiconductor fabrication facility in Mesa, Arizona that represents an investment of more than US$100 million.

"MOS 6 provides world class manufacturing leadership in the United States. No production line anywhere uses more advanced equipment or processes," said James A. Norling, executive vice president and general manager of Motorola's Arizona-based Semiconductor Products Sector.

Norling said MOS 6 will employ approximately 300 people and generate US$200 million in products annually, operating on a seven-day-a-week basis. He said the facility has already achieved good yields on first production wafers.

Company managers said Motorola will use MOS 6 primarily for production of popular one-megabit DRAMs and high density, semi-custom application-specific integrated circuits (ASICs).

Sematech meets first production deadline

Less than a year after moving into its new research facility in Austin, Texas, Sematech announced it has produced the semiconductor consortium's first batch of chips.

The 64K SRAM memory chips are a far cry from the level of design and process technology Sematech hopes to develop over the next couple of years. But industry observers agree the event marks a major milestone for the group, which hopes to provide American semiconductor manufacturers with the manufacturing expertise to compete effectively with the Japanese in any future semiconductor market.

The Sematech chips were produced with 1-micron process technology.

According to Sematech officials, the group was able to meet a very tight production deadline with the first run of wafers.

THE CREATIVE MUSIC SYSTEM

It's New and it's at Dick Smith Electronics!

It's astounding! The Creative Music Synthesizer card simply plugs into your IBM PC or compatible and gives you 12 channels (Voices) stereo music output and 32 preset instruments to choose from. Plus, there's a stereo amplifier to drive speakers, headphones or home stereo directly. You can actually define your own instruments, play background music while you work on your computer, create albums or your favourite tunes and play them in any sequence (great for non-stop party music) or compose your own music. And it allows you to utilize the new Sierra range of software! Cat X-2020

$299

ALL NEW! COMPUTER PERIPHERALS

RS-232 Multilink Adaptor

A complete in-line tester/adaptor which makes complex and time consuming Serial connections a breeze. Comes with 25 pin male and 25 pin female connectors, jumper pads and wires, as well as 24 in-line switches, for quick selection for any RS-232 configuration. 8 bicolour LED's tell you at a glance when you've got it right. Cat X-2654

$49.95

'Voice Master' Sound Input Card

Analogue to digital card lets you sample any sound, then view and edit the wave form. If you have 'Speech Thing' the recorded sound can then be played back. Comes with headset and software for experimenting with voice recognition.
Set up to 256 different voice activated keyboard macros. Requires an 8-bit expansion slot (XT & AT compatible).
Cat X-2038

$199

'The Speech Thing'
Digital Sound Synthesizer

Adds sound capability to your PC! It's a full featured 8-bit digital to analogue converter, audio amplifier and software system which is capable of creating almost any sound. Converts text to high quality speech. Just plug it in. Can be used in conjunction with the 'Voicemaster' (X-2038) to sample and edit digital sounds. Cat X-2036

$149

The CASIO fx-61f

Without doubt one of the most useful tools anyone working with electronics could have! With 27 of the most used electronics/electrical formulas built-in and a programming function which allows you to input your own formula. Includes 74 scientific functions, 10 digit display, programming functions . . . it's unbelievable.
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Copy Images Direct To The Screen!
Handy Scanner

Now you can copy any image direct to your computer screen with the incredible Handy Scanner! 105mm wide, Handy Scanner can be used with Hercules, VGA, EGA or CGA displays. Gives black and white and 3 x 32 quasi-tones. With high 400DPI resolution. Suitable for PC/XT/AT and compatibles and comes complete with Desktop Publishing Editor.
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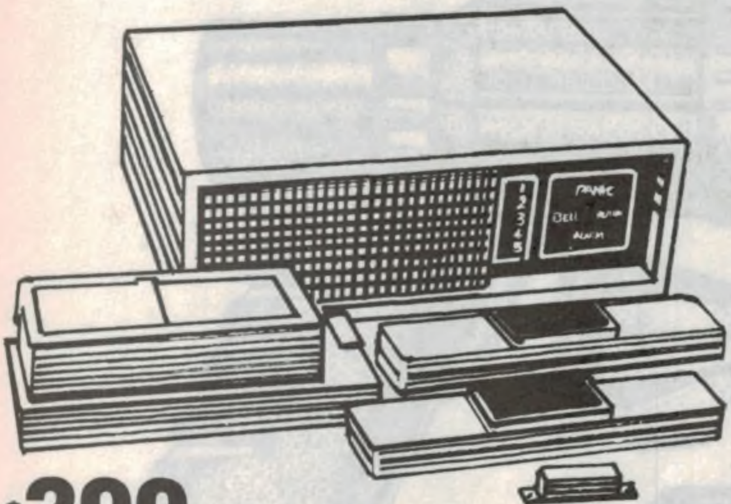
DICK SMITH COMPUTERS

New Release!

Wireless Home Alarm System



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So Easy To Install!

Complete Wireless Home Alarm

Five zone protection for your home that can be installed in no time - Without Wiring! It's the ideal security system for home units, apartments, etc - or where ever wiring is a problem.

Simply Plug It In!

That's right, all you have to do is plug it in, set the code and you've got instant protection.

Safe As Houses

With features like instant/delay modes, five zones of protection, 4 function modes, built-in speaker and provision for external speaker you get quality security in a compact unit which fits easily on bookshelf or bench.

Comes As A Complete System!

Yes, it comes as a complete security package. You get the central alarm unit, a remote controller, a remote Reed switch (for door or window protection), infrared sensor (for room or entrance surveillance) and mains adaptor! Cat L-5125

ADDITIONAL UNITS AVAILABLE

Remote Control

Allows full control of your wireless remote security system. The remote controller fits in pocket or bag and allows you select any of the system's functions. Even has an emergency button. Cat L-5129

$59.95

Remote Reed Switch

Ideal protection for windows or doors! A magnetic Reed switch with digital coding transmitter. Incredibly easy to install, just set the security code and forget it. Cat L-5127

$59.95

Remote Infrared Sensor

Infrared sensors are the best sensors you can get. For full room, hall or entrance protection this one offers 64 sq metre coverage and adjustable zone control. Has inbuilt transmitter. Cat L-5128

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Window Sticker

Sticks to the inside of the window or glass door so they'll know you've got an alarm system and go pick on someone else! Cat L-5311

$2

Aluminium Sign

Large 245 x 270mm sign made from heavy gauge aluminium. Suitable for fixing to wall, fence, etc. Cat L-5312

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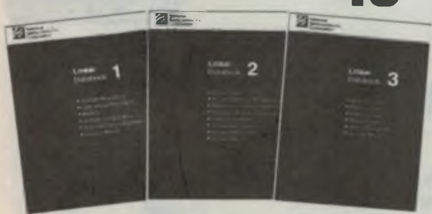

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Another quality hard cover edition of the ARRL Handbook for the radio amateur. Updated with all the latest information. With new projects, sections on oscilloscopes, spectrum analyzers, digital frequency synthesis and more.
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An introductory text for students and enthusiasts. Starting with basic theory. Very defined chapters and excercises takes you through to constructing electrical circuits.
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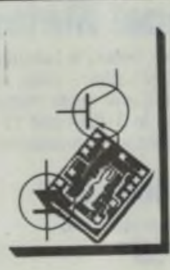

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Bruce Stannard - 128 pages Not just electronics and alarms, it also delves into the crim's mind so you're ready to fight back! A must for every person with property to protect.
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World Radio TV Handbook

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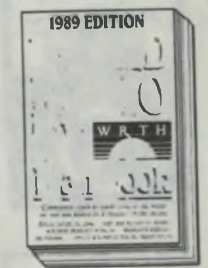

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15th Edition
The biggest edition ever! Comprehensive discussions and principles on virtually all aspects of antenna design and performance. Examples of hundreds of antennas with full construction details. No amateur should be without one!
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Satellite Anthology

'Satellite Anthogolgy' represents a collection of the best of recent QST articles on Amateur Radio satellite operation and hardware covering OSCAR's 9 through 13, as well as the Russian RS satellites. Covers antenna and rig requirements, tracking information, operating practises, and much more. A must for any Amateur satellite enthusiast.
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AX.25 Link Layer Protocal

For the advanced packet radio enthusiast, this ARRL publication is intended as a guide in the design and use of AX.25 Version 2 packet systems to ensure link-layer compatibility between systems.
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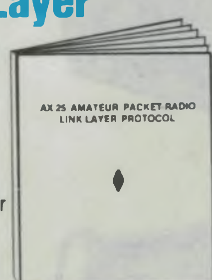

Interference H/Book

This handbook covers every aspect of interference to TV, stereo, radio, telephone, amateur radio, and CB equipment. Helpful facts on how to locate and cure problems, how to work with the public, important 'do's' and 'dont's', case histories, as well as safety precautions are covered. Ham radio and CB operators will find this handbook invaluable when dealing with interference problems. B-2401

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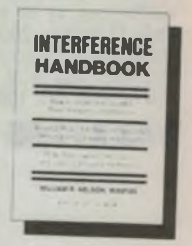

The Screwdriver Experts Guide

This unusual book teaches the average person how to recognise and repair many of the most common CB problems, and how to get the best performance from a rig. Written in laymans terms, the reader is guided to the problem area by simple illustrated instructions. B-2324

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Your Gateway to Packet Radio

Interested in Packet Radio, but think detailed information is hard to find? Look no further! This new ARRL publication is an 'everything you always want to know' book containing information that both packet-radio novices and experts will find useful and interesting. Cat B-2402

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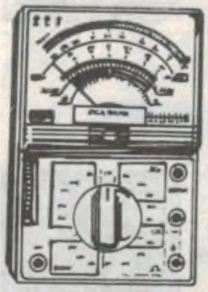
An amazing little multimeter that's ideal for anyone just starting out...or for anyone who gives their meter a hard time. 11 ranges, 2000 ohm/volt meter that fits easily in the pocket and is perfect for general test work. DCV/ACV: 10, 50, 250 & 1000. DC: 100mA. Cat Q-1010

WAS $17.95 **$9.95**

Multimeter



With Audible Continuity Tester. Compact and reliable with built-in buzzer for continuity testing. Even has a battery checker and 10A DC range. Plus high sensitivity (20,000 ohms/volt), diode and fuse protection and 19 ranges plus dB. DCV: 2.5, 10, 50, 250 & 1000. ACV: 10, 50, 250 & 1000. DC (mA): 5, 50, 500 & 1A. A fantastic buy! Cat Q-1022

Now Just $29.95

Hand-Held RC Oscillator

Comes complete with test leads! A compact oscillator that's a must for the tool box. With 23 ranges of sine and square waves switchable between 20Hz and 1.5kHz plus x100 range. That's 46 settings in all. Continuously variable amplitude and -20dB attenuator gives you total control. Output is standard 600 ohms. Cat Q-1220

Reduced to $89.95

$30 Off!

Bargain Protective Pouch

Helps you care for your multimeter and keeps it free from dust, dirt, etc. Quality vinyl pouch with velcro seal. Suits Q-1516 multimeter and many other similar size meters. Cat Q-1513

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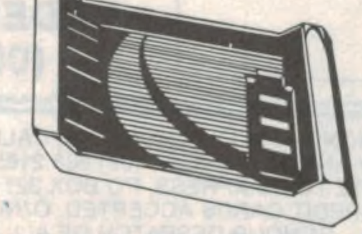
A great Idea!

Multimeter Holster



Impact absorbing case to protect your multimeter that's ideal for the bench of field work. Comes complete with belt and allows you to carry your Q-1515 or Q-1516 multimeter around without it being a hassle. Cat Q-1522

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$7.95

Auto-Ranging 3.5 Digit

With Memory!

Auto-ranging makes worker easier and faster - you don't have to worry about what setting you're on! This super meter also has auto-polarity PLUS high levels of overload protection on all ranges. Features include 'lo ohms' setting which limits o/c voltage for in-circuit resistance measurements, a handy buzzer which sounds at 1.9 digits, switch selectable auto-ranging (manual gives extended resolution, transistor check, continuity and more! Cat Q-1516

Now $99!

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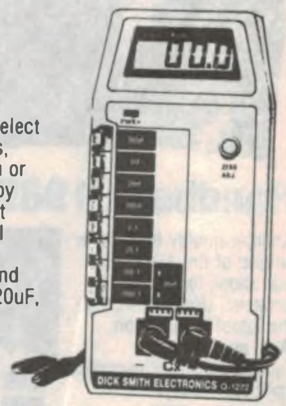

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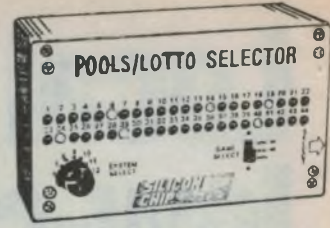

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Local firm develops low-cost photoplotter

Melbourne-based Quest Electronic Developments has released a range of 'personal' photoplotters, much lower in cost than previous models and based on a newly-patented system of 'photopens'.

Back in the early 1980's, the cost of a CAD workstation was around $250,000, and a matching photoplotter was about $100,000 – or in other words 40% of the cost of a workstation.

By 1988 a typical CAD workstation had come down to $40,000 and a typical low cost photoplotter cost $80,000 – which was 200% of the cost of a workstation.

It has taken a small Australian-owned R and D operation to rectify this cost imbalance. By doing so, it has brought the design and processing of printed circuit board master artworks out of the laboratories, and into the realm of the commercial user.

Quest Electronic Developments (QED), based in Melbourne, has developed a range of Personal Photoplotters priced from $7000, which generate 1:1 PCB artwork directly onto film, negating the need for any photographic reduction. These products represent the first in-house commercial product to come out of the R & D arm of parent company Quest International Computers.

According to Quest's Managing Director David Brown, "The first product decision that had to be made was whether to use a vector or raster technique."

The first photoplotters manufactured used the vector plotting technique, and initially all features of the photoplot produced on these machines were imaged solely by flashing light through different apertures contained on a slide or wheel.

The type and size of aperture is used to represent different component pads or to draw lines. The aperture would be moved to a position and flashed, then be moved to a different position and flashed again, creating the image of the circuit board as it went. The photoplotter head was never moved while the light was on, as this added complications to the control of the exposure.

Later, vector-type photoplotters developed techniques for moving the plotter head while at the same time exposing the photographic film.

Today, vector photoplotters are capable of drawing lines directly through a series of co-ordinates, as well as flashing features such as component pads quickly onto the film. The plotting time of a vector plotter is proportional to the complexity of the plot, so its general measure of performance is in inches per minute (IPM).

Laser rasterising technology, a more recent development in photoplotting, appeared around 1980.

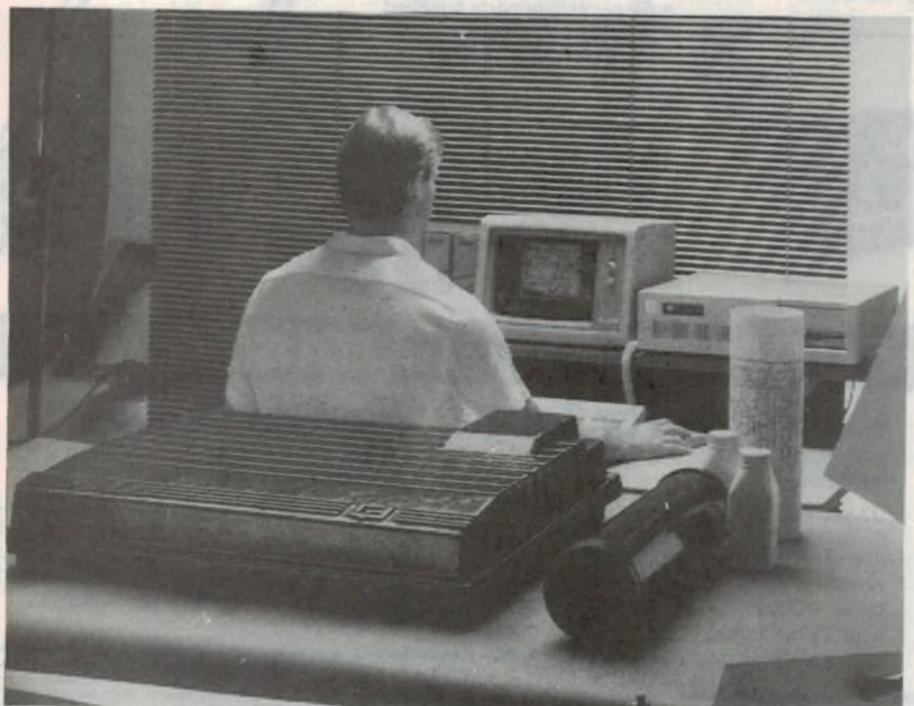
Plot time on laser photoplotters in contrast to vector systems, depends on the area plus computer time to rasterise the original data file, so its performance is measured in square inches per minute (SIPM).

The resolution of a laser plotter is measured in dots per inch, or pixel size. Pixel size can vary from 5 thou (thousandths of an inch) or 0.127mm for an office laser printer, to 0.125 thou or .003mm for a high quality laser photoplotter.

A characteristic of laser photoplotters is the digitising effects on diagonal or curved lines, which causes a 'staircase' effect. But as the resolution increases this effect becomes barely noticeable.

Due to the expense and limitations of laser technology, Quest decided to use vector techniques for the Personal Photoplotter.

"If we were going to satisfy our primary product objective and produce a functional photoplotter at 40% of the



The new QED 'personal' photoplotter in the foreground. Low in cost, it is very suitable for use with PC-based CAD workstations.

cost of a CAD workstation, vector was the only viable choice", said David Brown. "When we also considered that by using vector techniques we could provide pen plotting in the same unit, at no additional cost, our minds were made up."

Novel 'photopens'

According to QED, the innovation which sets its photoplotter apart is the use of patented 'photopens', which replace ink pens in a conventional X-Y drafting plotter.

"Vector photoplotters can use two techniques for producing images onto film", Brown said. "These can either be a shadow image or a projected image."

Shadow image is the simplest of the two methods, as no optics are required. However, one traditional drawback of the shadow technique is that the aperture needs to be in contact with the film. This means it must be able to follow the contours in the plotter bed, yet press lightly enough so as not to damage the emulsion on the photographic film.

Brown says that "QED achieved this using a photopens 'force control', which overcomes the drawbacks of shadow techniques."

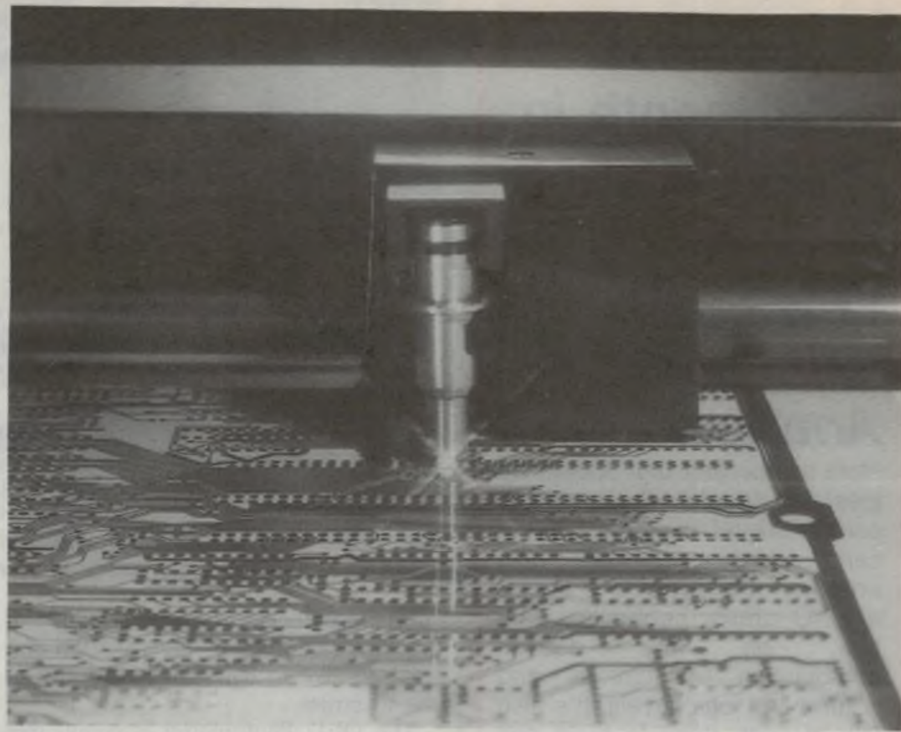
Power to control the semiconductor light-source inside the photopens is supplied via electrical contacts at the top of the pen, and changing apertures is accomplished by simply changing the photopens. Current aperture widths vary from 8 to 100 thou, and developments on smaller apertures are under way.

Input to the QED photoplotter is via a comprehensive software package that accepts Gerber, EMMA or HPGL file formats and enables panelisation for either step and repeat, or multiple plot files, aperture optimisation and global aperture changes.

The photopen is driven around an X-Y coordinate table by the drive system, controlled by the software. The microcomputer control system turns the photopens on and off as required, exposing the precise shape of the photopen aperture onto the light sensitive film.

Perfect exposures are achieved every time using a velocity dependent light intensity algorithm. The system operates directly from an RS-232C port, and can be used in any laboratory or office set up except when loading or unloading film, which requires a darkroom environment.

A set of eight photopens is supplied with the photoplotter, each with an



A close-up of one of the QED shadow-image photopens, in operation.

aperture size designed to provide maximum flexibility and efficiency for selection of track widths and pads. The photopens are secured in a pen-stock and are automatically selected under software control. This provides for the most common sizes of pads to be placed with a single flash of light, enabling up to 10 pads per second to be imaged on to the film.

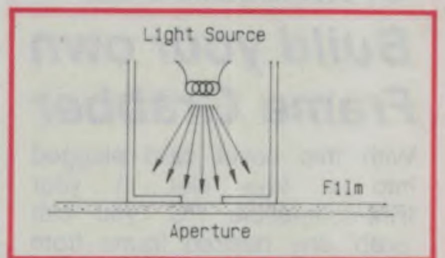
The eight photopens can be replaced with normal inkpens, so that drafts or 'checkplots' can be made on paper before the final artwork is created on film.

Extra apertures are generated by the software, which selectively uses the available photopens to create any aperture – round, square or rectangular, from 20 to 999 thou in 1 thou increments.

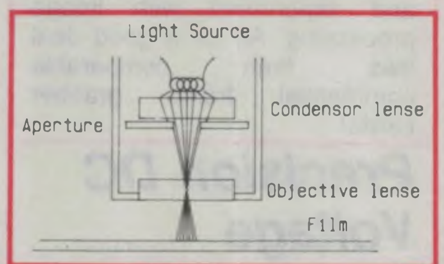
Any width line can be drawn using the eight photopens available. Line widths that do not exactly match one of the eight pen sizes will be drawn with multiple passes of the photopens.

The only maintenance required by the photopens is an occasional clean, to remove built-up emulsion collected on the tip of the pen. Film emulsion consists of silver halides suspended in a gelatinous material and are therefore easily dissolved in warm water.

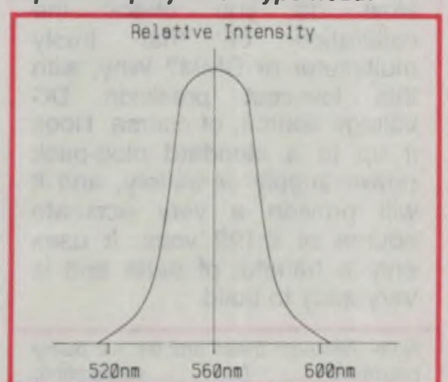
The semiconductor light sources used in the photopens emit green light at a wavelength of 565nm. As a result QED recommends that high contrast orthochromatic film such as Agfa HDU or Kodak Ultratech UGF is used, to make optimum use of the photoplotter. These



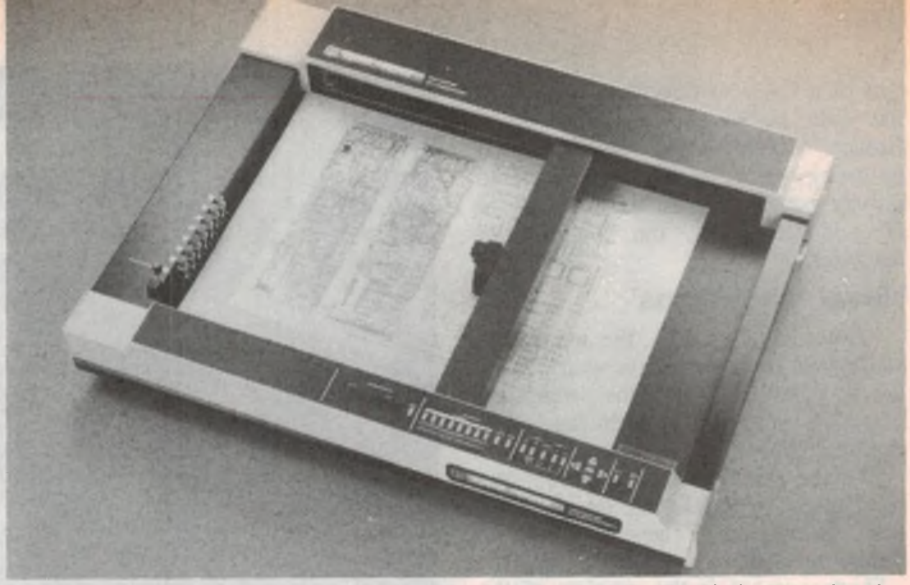
Basic principle used in a shadow-image photoplotting pen.



For comparison, a more complex and expensive projection-type head.



Spectral plot of the light produced by the light source in QED's photopens.



The basic QED photoplotter with light-proof cover removed. It can also be used as a conventional ink-pen plotter.

films are particularly sensitive to light in the blue/green end of the spectrum and less sensitive to light in the red end of the spectrum.

The QED Photoplotter is compatible with P-CAD, Racal, Protel, Mentor, Pads PCB, AutoCAD and VersaCAD software, and provides a plot accuracy that is better than 0.05mm (.002") and typically claimed to be .025mm (.0001").

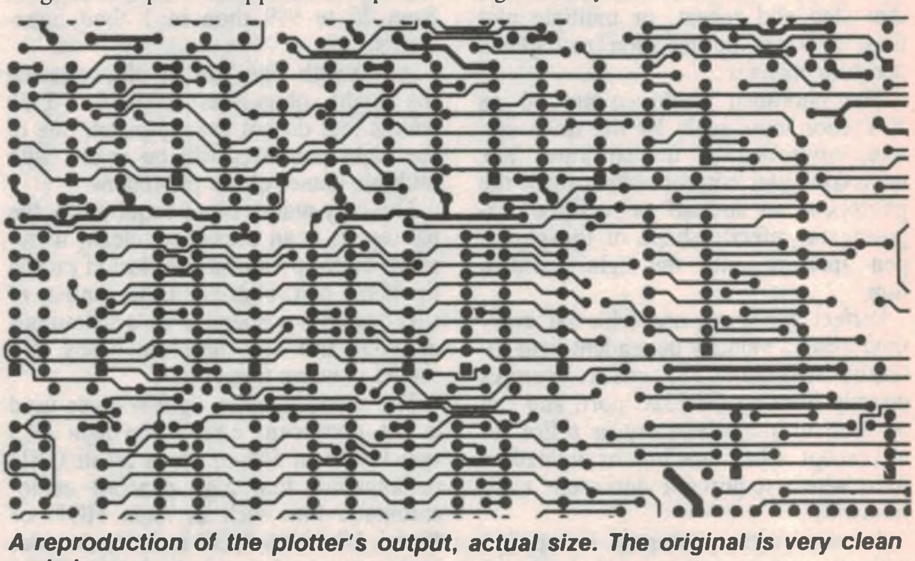
One organisation reaping the benefits of in-house design and production of its own PCB's is the Department of Defence in Melbourne. The office has been using P-CAD and VersaCAD CAD/CAM packages from Quest International to do all of its electronic and mechanical drawings for two years, and has now added a QED400 Personal Photoplotter.

Its drafting office supports the design and development of new equipment for the Department of Defence, which ranges from power supplies to sophisticated microprocessors.

Norm Dyson, Supervising Draftsman at Defence Central said "We need in-house facilities, because the computer and communications systems we design are responses to urgent requirements that do not allow for lengthy contractural action."

Before Defence Central bought the photoplotter, it tried using a normal Hewlett-Packard high quality penplotter to create the same effect, but could not achieve the necessary results because of lack of contrast and poor line definition. The line edges were too furry for accurate reproduction.

"The QED Photoplotter eliminates the filming reduction step and puts us directly at the board manufacturers' doorway, with the final positives at the right size", Dyson said. "The major advantage is that the board manufacturer begins with a known quantity concerning accuracy." EA



A reproduction of the plotter's output, actual size. The original is very clean and sharp.

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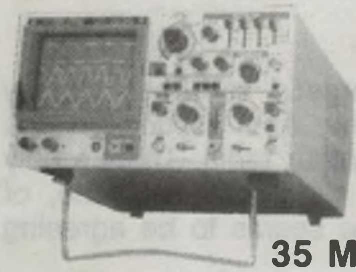

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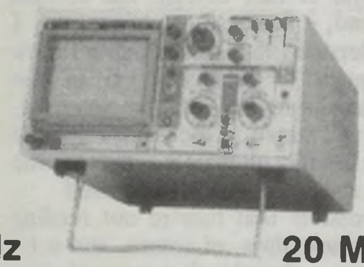

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FORUM

Conducted by Jim Rowe

My April 'stir' on ham radio: the initial response...

So far there's been quite an energetic response to my deliberately provocative piece in the April issue, on the apparent demise of experimental amateur radio. There's only one problem – far from seeking to tar and feather me, or prove me wrong, just about everyone seems to be agreeing with me! That wasn't the idea at all.

When I wrote the April column, I was of course doing some deliberate 'stirring'. My suggestion that the experimental side of amateur radio was *dead* was obviously an exaggeration, but I took this approach in the hope that it might goad people – particularly hams themselves – into getting off their behinds and proving me wrong.

At this stage I have to admit that it doesn't seem to have worked. While there have been quite a few responses to the column, both in writing and over the 'phone, and almost totally from amateurs, pretty well all of them have *agreed* with me.

Now I don't want to criticise the good folks who have responded, who have obviously acted in good faith and given me their honest opinion. In fact some of the points they've raised are very pertinent, and I'm going to quote from them shortly. But all the same I have to confess that I find the response so far quite disappointing.

The idea was not to agree with me, folks, but to *prove me wrong*! As I explained in the April article itself, the last thing I want to hear is that the experimental side of ham radio really is dead, or even dying.

In fact I'm pretty sure (or at least I thought I was!) that the situation *isn't* hopeless. I'm aware that there are at least a few hardy souls out there, still valiantly making their own 'home brew' equipment, and I'm hopeful that they aren't alone.

There must be quite a few others out there as well, surely. I simply can't accept that old-time ham radio has all but died – even though one might well believe that it had, judging from the response to date.

Perhaps the hams who *are* still home brewing their gear aren't reading *EA* nowadays? If that thought has crossed your mind, it has occurred to me, too. I can understand that there mightn't have been much to interest them in the magazine during the last few years, although as I noted in the April issue the reasons for this ultimately reflect on the current state of amateur radio itself.

It's possible that they're not reading us much nowadays, of course, and yet I would have thought that even if they haven't been reading us regularly lately, the special features in our '50th Anniversary' April issue would have been enough to interest almost anyone with even a passing interest in any aspect of electronics and communications. Certainly the excellent sales figures for the issue concerned would seem to bear this out.

In fact it was no coincidence that the April issue was the one in which this column appeared. I deliberately chose this topic when we were working on the Anniversary issue, in the expectation that it would have sales higher than normal – and hence would be likely to reach amateurs and other people who mightn't have been regular readers of late. Quite a schemer, aren't I?

I suppose we magazine editors do have a touch of the Machiavellian about us, particularly when we have an axe to grind and the subject is one we believe in.

Ah well, all I can hope is that the current crop of responses are just the first wave, and that they'll be followed soon by another and rather more encouraging crop – with articles describing lots of interesting ham radio projects, from people who *are* keeping the hobby alive.

That said, though, here are extracts from some of the responses I've received to date, to show you the way people have reacted so far.

One of the first to respond was John Higson, VK3ABW, of Chadstone, Victoria, who wrote:

Congratulations on your timely article 'Whatever happened to Amateur Radio?'. I could not have expressed it better myself. For some time I have been talking on air about the lack of technical expertise among hams. It is difficult to enter into a technical ragchew these days unless the other operator is an old timer, or a limited licence holder who is generally a technician working in the field. The general comment is "I have an FT757" or the like, backed up with other commercial gear, and in no way would they remove the cover if a fault developed – preferring to return it to the appropriate service outlet...

I have spent most of my working life in electronics, mostly in design and development of test equipment. I retired from Monash University six years ago, and am now able to spend full time in amateur radio. I have a machine shop, including a good lathe, and have just completed a properly engineered tri-band beam which is working well.

I am not against commercial gear. After all, we were pleased when the surplus gear came on the market. Many happy hours were spent in the disposals outlets. However I am dead set against hams having to return their rigs for service. I always thought the conditions of issuing an amateur licence were that the holder must maintain and faultfind his own equipment.

It is indeed a 'CB' band now, which is a shame.

Keep up the good work, many of us are behind you.

Thanks for the comments, John, and for the kind words about the April issue itself. I guess the main reason that many hams don't try servicing their own gear is that a lot of it is now so complex – and so expensive – that they simply don't have the confidence to tackle it when something goes wrong. But what-

ever the reason, I agree with you that it's certainly a shame.

Incidentally, I may be a bit oversensitive, but your comment about 'limited licence holders who are mostly technicians working in the field' touched a sensitive spot. Perhaps it's because I'm a limited call myself, but over the years I've noticed a certain snobbery towards 'Z-calls', from those with so-called 'full tickets'. Instead of trying to make the most of shared interests and helping each other to promote common goals, some full calls seem determined not to recognise limited licence holders – even to the point of ignoring them on the air.

Mind you, I've also noticed a kind of super-technical and hypercritical attitude among some limited licence holders, who seem ever-eager to prove that they have greater technical knowledge and expertise than their full-call colleagues. Perhaps this is in retaliation for the snobbery – I don't know.

But surely neither of these attitudes is very constructive when it comes to promoting amateur radio itself, as a satisfying and worthwhile pursuit...

Anyhow, another interesting letter came from Geoff Syme VK3ACZ, of Irymple in Victoria, who offered some rather sobering reasons for the decline in experimental ham radio:

You certainly do like sticking your neck out, but on the subject of amateur radio I am quite willing to join you.

I have been an amateur for only 13 years, however I have been involved in electronics and interested in amateur radio for about 40 years. I cannot disagree with a single comment you make and I cannot offer any cures, however may I suggest some of the reasons.

Amateur radio has for a long time had two distinct groups – those for whom the hobby is 'communicating' and those for whom it is 'technical experimentation'. There was a third large group, those who found fun in 'building things', and radio was a convenient outlet – requiring few tools, little space and involving a new and novel technology. Sometimes the results were useful, and occasionally money was saved!

Modern radio technology is too sophisticated to be 'fun'; radio is no longer new, and money is unlikely to be saved. Far simpler electronic devices can frequently satisfy the chronic 'builder'. Writing computer programs would seem to be the ultimate for such people – they can be as complex as the writer desires, they can be useful or just pure nonsense, they may save a considerable amount of money if they avoid the purchase of a commercial alternative, and apart from the purchase of the basic tool (a computer) they cost almost nothing to create. It is also a new and novel technology.

The technical experimentation group is still there, working with exotic technologies which are totally beyond the average amateur's resources. It is now dominated (as I suspect it has always been) by professionals for whom their work is their hobby, and probably their life.

There are amateurs exprimenting with less technical demanding areas like packet, but it is interesting to note that this involves that relatively new technology – computers. Is their hobby computers or radio?

The communicators are today most numerous and of course, most visible. Most, if not all of them, are glorified CB operators. They do not justify, and (by implication) we amateurs, do not justify the segments of the frequency spectrum allocated to us.

Before I get my head kicked too hard, nor do many other users of the spectrum. A broad band way up the top for *those experimenting up there, and a couple of slots in the HF bands for those experimenting with exotic modes. All the rest could be shoved in the 11-metre band! I might leave a few slots for some of the old timers who played their part many years ago...*

Keep up the good work. I feel that EA is returning to some of its former glory. Please continue to 'stir the pot' about amateur radio – maybe the cause is not as hopeless as I believe.

Thanks for those comments, Geoff. I'm sure you're right with your implication that computers and programming have 'lured away' many of the people who might once have been attracted to amateur radio. But although computers are currently seen as more novel and exciting, frankly I'm not convinced that amateur radio has lost its excitement.

There are lots of exciting things happening in the field of communications technology, and surely many areas where amateurs can still make a contribution. And I'm not sure that this necessarily requires exotic resources, beyond the reach of the average amateur.

Perhaps I'm an optimist, but it seems to me that past history has shown that amateurs working patiently with simple gear have often achieved results, where professionals equipped with labs full of exotic gear have failed. And this in itself can further the technology, by showing that there can be simpler and more elegant ways of achieving the same result.

Thanks for your suggestions regarding possible amateur radio projects, Geoff. I've noted these carefully, even though there wasn't space to reproduce them here.

As for your suggestion that amateurs don't deserve all of the bands they currently have allocated to them, I have a suspicion that you might indeed get your head kicked in, for even thinking of the idea. Even I would hesitate to stick my neck out that far!

Another writer who responded with some interesting comments was Tony Zuiderwyk VK3ZMP, of Endeavour Hills in Victoria. Here is some of Tony's letter:

It is with regret that I must agree with your contentions. The technical challenge and excitement of the hobby which attracted me to its ranks some 15 years ago seems to have all but died. These days it seems that very few people I speak to over the air seem 'fired up' about their latest home brew success, and even fewer are willing to discuss mine. In fact the mention of home brew transmitting gear has, on occasions, resulted in rather critical/sarcastic signal reports.

I believe you have summarised the reasons for these changes in the hobby quite well in your article. Perhaps just one more observation could be made, that of the nature of today's society. Our 'consumer' orientated society is not one which encourages slow methodical creativity. After all are we not constantly told how we must have the latest, all bells and whistles, time saving gadgets to fill our homes. Not that I am suggesting these gadgets to be a bad thing; just that we are not encouraged to create or modify such gadgets ourselves.

Your comparison of amateur and CB operators is not an unreasonable one, although in fairness the poor operating practice and bad language prevalent on the CB bands is not evident on the amateur bands. Certainly not all amateurs behave like gentlemen, but even so most refrain from the crudities often encountered on 27MHz.

Thanks for your comments also, Tony. Your point about the critical and/or sarcastic signal reports which have sometimes resulted when you have let it be known that you are using home-brew transmitting gear also struck a familiar chord. I've had the same reaction myself, in the past, and I gather that it's quite common. It really does seem that some hams regard home brewing as an activity for their poorer colleagues, who must 'roll their own' because they presumably can't afford to buy the latest model commercial gear.

What an ironic turn of events, when building and adjusting one's own amateur radio gear is somehow regarded as inferior to buying a ready-made appliance!

By the way I fully agree with Tony's comments about the general conduct of amateurs, compared with that which you can hear on the CB bands. Despite my comments about snobbery and other kinds of unfriendly behaviour, I must still admit that amateurs on the whole behave a great deal more responsibly than many CB operators.

Another reader who thinks I was being rather unfair in the comments I made in the April column is Drew Diamond, VK3XU, of Wonga Park in Victoria. Drew also seeks to explain some of the reasons for the decline in amateur radio activity:

Your observations regarding the direction amateur radio is taking were probably fairly accurate, and your article should stimulate some discussion. However I do think that some of your comments were unfair.

Before we talk too much about the amount of actual building or experimentation, we must first put radio – as a hobby – in its true perspective. Simply look at the way things were only 20 years ago. Just what was there for a technically minded person with limited means to do for a hobby?

I recall that my fellow school mates were interested in radio/electronics, model building, go-kart construction and photography – with perhaps a few other miscellaneous activities like bicycle repair and so on. All activities of a very practical and worthwhile nature.

Now look at what is available now. All of the above, but now to a lesser degree because by far the most popular 'technical' hobby of all – personal computing – seems to have eclipsed just about every worthwhile 'hands-on' activity (how many hackers build their own PC's?), plus trailbiking (how many of those awful things are home made?), car restoration, hifi and so on.

All the older people who grew up during the period when electronics and radio was a 'wonder' have probably now reached a stage where they no longer have the energy or enthusiasm to tackle a complex electronics project, and have been absorbed into the bowls/golf/fishing mob. Many of the older radio amateurs would probably fit into this group, with any time for technical activity being spent on antenna work.

The probable first level entry into radio, the desire to have a radio of one's own, nowadays simply does not exist. There is no economic incentive to construct a broadcast radio. The interest must be there first, not the other way around, which was once the case.

Nevertheless, my own experience, having published a number of articles in Amateur Radio magazine, is that there are a significant number of truly technically-minded experimenters, keen to have a go at building their own receivers, transmitters, measuring equipment etc. This is evidenced by the amount of correspondence received as a result of these articles. A large number of fellow amateurs regularly submit quality technical articles to this magazine, all freely given and with no view of pecuniary gain.

Thanks for your comments also, Drew. You obviously agree with Geoff Syme about the impact of computers and programming in 'sucking' potential amateurs away, and as noted earlier I'm sure this has been a factor. However the response you have received to your articles in *AR* describing amateur projects is encouraging, and bears out my own optimism that the hobby isn't on its death-bed yet.

Incidentally, perhaps you're right that there's no longer a strong practical reason why young people are likely to be attracted into amateur radio. But on the other hand, neither the amateur radio movement nor we magazines has been particularly good at explaining and promoting the unique rewards provided by the hobby.

For example, I still remember the thrill of firing up my first 144MHz transmitter, tuning it up and then having my friend Tom Pyke VK2ZZ come back to say my signal was '5 and 9'. And hams like Dick Norman VK2BDN, who have made pioneering contacts on UHF and microwave bands tell me that there's an enormous satisfaction in 'going where no man has gone before' using gear that you've built yourself.

It's a pity that we haven't been very successful in explaining these thrills and satisfactions of amateur radio. I believe myself that they can be just as great as from personal computing – and as most of our readers may know, I've done my more than my share of that, too.

The last letter that I'd like to quote from this month is from Bert Hollebon VK6EQ, of Cloverdale WA. Although Bert too seems to agree with much of what I wrote, he certainly adopts a fairly optimistic approach, and makes some worthwhile practical suggestions:

I agree with your general comments on the decline in the experimental side of amateur radio, but believe that it may not be too late to do something to reverse the trend.

On the basis that it is difficult to teach an old dog new tricks, I suggest that it may be appropriate to leave the present generation of appliance operators to play with their store-bought black boxes, and not target them in technical articles in the magazine. On the other hand there may be a very real possibility of encouraging a new crop of amateurs among the youngsters in the community, who may either now have licences or could be motivated into gaining them.

I believe that it may be possible to generate interest by publishing a series of theoretical and constructional articles aimed at the raw beginner in the amateur field. Since the target group would probably be in the younger and less affluent section of the community, the emphasis at least initially would need to be on low cost and relatively simple equipment.

The magazine has in past years run several fairly long-term series of articles on specific subjects such as digital electronics, etc. I believe that these have been very well received by readers, and I would suggest that there may be room for one more aimed at new or potential licensed amateurs. In parallel with this it would then be appropriate to run a series of constructional articles covering both receiving/transmitting equipment and test gear.

It would not be desirable to try and compete with commercial manufacturers, and a few small steps backward would not necessarily be out of order. There is nothing wrong with a simple CW or DSB transmitter, and people got along very well for many years with separate receivers and transmitters.

There is a close similarity between what has happened over the years in amateur radio and amateur astronomy, in that commercial manufactured equipment has become increasingly complex and expensive. In both cases much of the equipment is priced out of the reach of the average amateur, and it is not possible to home-brew it with the facilities available in the average home workshop.

In the case of amateur astronomy, a revolution has occurred in the past few years due to a development in San Francisco of a new type of telescope mounting, by a gentleman named John Dobson. The 'Dobsonian mounting' is constructed from a few pieces of plywood and Teflon, and requires no precision engineering.

Thousands have been built by amateurs all over the world. This mounting does not provide automatic star tracking or other fancy facilities, but it does have two virtues: (a) it is cheap and easy to

Perhaps there is a need for a 'Dobsonian' amateur radio system.

Thanks indeed for those suggestions, Bert, and I'll certainly see what we can do along those lines. I fully agree that what is needed are designs for simple and easy to build 'Dobsonian' projects, rather than complex ones that try to compete with the commercial gear. And I'm sure that this kind of gear would go a long way towards rejuvenating the hobby.

A full-scale series of articles is already planned for at least one aspect of amateur radio, by the way, and I hope to be able to begin publishing it shortly. You'll also be seeing some small constructional projects, before long.

So there you are, folks. Even though most of the people who have responded to date seem to agree with my claim that the experimental side of ham radio is currently pretty sick, there's still a strong conviction among most of us that it isn't dead yet, and that there's still hope that we can restore the hobby to its former popularity.

And of course I'm still hoping that there's a further crop of letters coming, with articles describing some great little ham radio projects – to demonstrate how wrong I was, with my original claims. Make no mistake, it will give me the greatest of pleasure if this happens.

Finally, then, a plea: if YOU are one of those hams still active in home brewing, please send in details of your latest projects and help me prove that the hobby isn't dead after all.

Don't forget that *EA* is by far the largest of the local electronics magazines in terms of sales and readership, reaching a lot more people than most of the others put together. This makes us very good at reaching the 'interested but not yet converted' – all of those people with an interest in electronics, and hence a potential interest in amateur radio, but who have not as yet been shown how interesting and satisfying this area of electronics can be.

I'd suggest to you that having your project described in *EA* might well do more good, as far as rejuvenating amateur radio is concerned, than having it published in a dedicated amateur radio magazine. Because excellent as these magazines may be, they're largely 'preaching to the converted' – wouldn't you say? *EA* is the ideal magazine to publish amateur radio projects. We have a long tradition of involvement in amateur radio, and during much of our own history and development I don't think anyone could deny that we've taken a leading role in Australian amateur radio. Most of our editors have been hams (including myself), and people like Ross Hull, John Moyle and Neville Williams have made an enormous contribution to the hobby.

Frankly I do think ham radio – *real* ham radio – is indeed at a low ebb in Australia at the moment. But at the same time I'm convinced that it is capable of being revived. With the help of at least a few of the hams who are still active in home brewing, I'm sure *EA* can play an important role in bringing it back to life.

What do you say, folks – isn't it worth the effort?

Compact Disc Reviews by RON COOPER

BACH

J S Bach concertos
Dir/Cond: Francesco Macci
ZYX – CLS 4001 DDD
Playing Time: 75 min 13 sec

PERFORMANCE
1 2 3 4 5 6 7 8 9 10

SOUND QUALITY
1 2 3 4 5 6 7 8 9 10

Here is an excellent all-Bach disc of over 75 minutes duration, which contains the following:

Double Violin Concerto in D minor (BWV1043); Italian Concerto in F major (BWV971); Violin Concerto in A minor (BWV1041); Chromatic Fantasy & Fugue in D minor for Harpsichord (BWV903); and the Brandenburg Concerto No. 4 in G major (BWV1049).

The famous harpsichordist Wanda Landowska once said "All Bach's works seem to sing the chorale: A safe stronghold is our God". The artistic genius of the is composer would suggest that he composed only to the glory of God.

This disc is delightful. Apart from the 18 minute Brandenburg Concerto, the tracks are well played digital recordings. Although I did feel the Italian Concerto was a little laboured by the slowness of the first movement.

The performers are not well known here, but this does not detract from these very commendable performances.

Sound-wise it is clean and well balanced, with varying acoustics and a moderate amount of reverberation. The disc is probably the best I have heard to date on this budget label.

STRAUSS

Johann Strauss (junior)
VMK: 100.41808 DDD
Playing time: 60 min 40 sec

PERFORMANCE
1 2 3 4 5 6 7 8 9 10

SOUND QUALITY
1 2 3 4 5 6 7 8 9 10

Lanner and Johann Strauss senior were the original dominant personalities of Viennese music, having both begun their careers in Pamers Dance Studio. The early waltzes had a moderate tempo and a short introduction. Johann Strauss junior continued this form, but went on to expand the introduction into a kind of orchestral prelude with more instrumental sophistication overall.

The selections on this disc are somewhat different from the norm but, as ever with Strauss, most enjoyable. The selections are:

1. Morning Papers, Op279;
2. Acceleration Waltz, Op234;
3. Vienna Bonbons, Op307;
4. Liebeslieder, Op114;
5. Seid umschlungen, Millionen, Op443;
6. Champagne Polka, Op211;
7. Voices of Spring, Op410;
8. Egyptain March, Op335;

The playing is not stunning, but quite good and mainly by the Vienna 'Opern Orchester' conducted by Peter Falk with 2 tracks by the Royal Philharmonic under Frank Shipway.

All the recordings are digital, with clean well balanced sound – somewhat bass light with slightly boxy acoustics, but overall an excellent value disc at $9.99.

DVORAK

Anton Dvorak
VMK: 100.41807 DDD
Playing time: 62 min

PERFORMANCE
1 2 3 4 5 6 7 8 9 10

SOUND QUALITY
1 2 3 4 5 6 7 8 9 10

This is a rather unusual disc, not as far as the technical side is concerned, but the choice of performances.

It starts with the Largo from the New World Symphony and then goes into 7 of the Slavonic Dances – but these virtually alternate between excellent piano performances, and mediocre orchestral performances. It then ends with the wonderful Allegro from the Symphony No 8, expertly performed by the ORF Symphony Orchestra under Milan Horvat.

Basically all the music here is excellent, although I really prefer complete versions. I would recommend this disc more for playing to dinner guests than really serious listening. However, the piano versions of the Slavonic Dances are quite stunning.

Recording wise it is not spectacular but certainly very good, being virtually all recent digital recordings and exhibiting very low background noise.

If you like a somewhat mixed Dvorak in a lighter vein, you will certinly get a lot of enjoyment for $9.99.

BRAHMS

Hungarian Dances
Symphony No. 2
London Festival Orchestra
Dir/Cond: Julian Armstrong
ZYX: CLS 4017 DDD
Playing time: 59 min 47 sec

PERFORMANCE 1 2 3 4 5 6 7 8 9 10

SOUND QUALITY 1 2 3 4 5 6 7 8 9 10

This disc contains eight Hungarian Dances and the complete Symphony No. 2, all being performed by the London Festival Orchestra under Julian Armstong.

The Hungarian Dances were written between 1869-1880 for piano for 4 bands, but Brahms also arranged 3 of them for full orchestra.

The 2nd Symphony is certainly my favourite and has been called his Pastoral Symphony. It was written during a happy holiday in Portschach in 1877 and had its first performance in December the same year by the Vienna Philharmonic. It was an immediate success, and the 3rd movement was repeated.

The performance here of these great works is most commendable and well detailed. The first two movements of the Symphony are slightly slower than I would prefer, but there is sheer joy (as usual!) in the 3rd and 4th movements – with fluent woodwind detail.

The sound is, as usual with these discs, not in the spectacular class, but nonetheless very good with no audible background noise from the all-digital recordings and very good value for the $10 price tag.

By the way, all these discs are available from A V Pty Ltd, 1306 Yarramalong Road, Yarramalong 2259, phone (043) 56 1077.

News Highlights

Aussie car phone helps Cheerleaders

When the glamourous Dallas Cowboy Cheerleaders were in Sydney recently, their tight schedule of media interviews and store appearances left little time to phone home.

Transportable car phones were the answer. While the girls were on the move, and in between appointments, they made their local and international calls with Philips transportable cellular car phones.

These FM9000 car phones, designed and manufactured in Australia (Clayton, Victoria) are exported to North America and are well known in Dallas.

Melbourne switch manufacturer scores contract at Hanover Fair

Making its first-ever appearance at the Hanover Industry Fair, Melbourne electrical switch manufacturer Swann Electronics has reported landing a substantial contract from Israel.

The company's managing director Ulf Lindstrom was accompanied at the fair by National Sales Manager Ian English, who confirmed the Israeli contract for the switchgear, but would not put a price on it at this stage other than to say it was "more than substantial enought to cover our costs of participating at the fair."

Mr English said that because there was no one single standard for electromechanical switches in Europe, "we went ahead and designed and manufactured a unit specifically for the European market. It has a completely new mechanism which gives it longer life, better performance ratings and is very competitively priced.

"We were very pleased with the reaction it recieved," he added.

Inmos acquired by SGS-Thomson

SGS-Thomson Microelectronics BV has announced the acquisition of UK-based Inmos, in a merger which will consolidiate Europe's largest semiconductor manufacturing company in MOS. The addition of Inmos' world-leading products and market strengths to SGS-Thomson's existing broad product range and technological expertise will create a European company with a truly worldwide capability, and enable it to move into the top ten of the world league of semiconductor companies.

Commenting on the acquisition, Pasquale Pistorio, President and CEO of SGS-Thomson, said, "The benefits which the acquistion of Inmos will bring to SGS-Thomson are clear: an entry into the 32-bit microprocessor market with the revolutionary Transputer, the enhancement of SGS-Thomson's existing product ranges with fast SRAM's, DSP and colour graphics products, strong market shares in Japan and the USA, and a strong base in the UK. All these are important in our program of international expansion".

Power supply receives IBM award

Two years of zero defect performance has earned special recognition from 'Big BLUE' for the Boschert OL80-4084R power supply. In presenting the prestigious 'Zero Defects in Quality' award to Computer Products/Boschert, the IBM Data Systems Division of Poughkeepsie, New York has acknowledged an excellent record in quality control.

In Australia, Boschert/Computer Products power supplies are distributed exclusively by Amtex Electronics.

Kodak releases lithium battery here

Kodak (Australasia) has launched its long-lasting lithium 9V battery on the Australian consumer market. The battery, while clearly branded as a Kodak product, will feature the new brand name 'Ultralife'. It will be sold to consumers through pharmacies, photo stores and convenience stores.

The new battery has the long life expectancy that specialised users of lithium batteries have become accustomed to. This high-tech cell offers a long shelf life and is a good all round performer. In particular in areas of widely varying temperatures of between −40° and +70°C.

Because lithium reacts so readily, even the small quantity used in the Ultralife power cells produces more energy and power than other cells of similar volume. Lithium's greater electrical potential produces higher voltages per cell.

The Ultralife power cell generates 3 volts per cell, as opposed to 1.5 volts produced by the other most common types of power cells. The power cells are ultrasonically welded in a polypropylene casing to keep out air and moisture. The battery even features a proprietary safety shutdown mechanism, which operates in the event of short circuit, to prevent overheating.

AWA to supply traffic systems to China

AWA Traffic and Information Systems, (AWA TAIS), has won a contract in excess of $1.5 million to supply an area traffic control system to Shenyang in the Lianoning Province, China.

The traffic control system being marketed by AWA TAIS, called the Sydney Co-ordinated Adaptive Traffic System, (SCATS) is a development of the Roads and Traffic Authority of New South Wales.

In addition to supplying the SCATS system, AWA TAIS will be manufacturing most of the equipment to be used in Shenyang's traffic control system. Some manufacturing will also take place in China.

For the past three years, AWA TAIS has been working with Chinese Traffic Engineers to ensure that SCATS installations in China are tailored for local conditions.

Panasonics's founder passes away

Mr Konosuke Matsushita, founder and executive advisor of Panasonic Australia Pty Ltd's parent company, Matsushita Electric Industrial Co Ltd, died on April 27, aged 94.

He died from pneumonia at Matsushita Memorial Hospital in Osaka.

MEI, one of the world's largest consumer and industrial electronics and electrical goods manufacturers, was established by Konosuke Matsushita in 1918 to produce a double adaptor socket. The company now employs more than 150,000 people worldwide and markets 14,000 products under the brand names 'Panasonic', 'National', 'Quasar' and 'Technics'.

Hospital Chaplain wins our subscription prize

The lucky winner of our December 1988-February 1989 'Tandy Computer System/Hifi Video System' subscription promotion was Father John Shanahan, Chaplain at the Lidcombe Hospital in Sydney. Father Shanahan elected to receive the hifi/video equipment prize, and is now the delighted owner of a magnificent new Tandy setup worth over $6400 – including:

A Realistic STA-2280 FM Stereo/AM Synthesised Receiver, with 100W per channel output and 11 step bass, treble and balance controls.

A Realistic LAB-801 fully automatic precision belt drive turntable

A Realistic CD-6000 CD player with 6-disc automatic changer

A Realistic SCT-83 auto reversing stereo cassette deck with Dolby B and C noise reduction

A Realistic 15-1278 Sound Processor with Surround Sound

A Realistic 31-3020 Equaliser with spectrum analyser and IMX stereo expander

Two Realistic Nova-15 2-way bass reflex speaker systems with 200mm long-throw woofers

Two Realistic Minimus-7 extension speakers

A Realistic CTV-2001 deluxe 51cm colour TV receiver with digital tuning and IR remote control

A Realistic VR-2000 remote control VCR, with 29-key multi-function remote control

A Realistic universal 8-in-1 remote control unit

A Utility equipment cabinet with toughened glass doors, and matching lift-top cabinet

Father Shanahan has been a reader of the magazine for over 20 years, and has built various construction projects – including the 40-40W Stereo Playmaster. He is also a keen model engineer. Before learning of his good fortune, he was planning to upgrade his stereo system by building a 60 + 60W Playmaster Amplifier, but needless to say the unexpected arrival of the new Tandy system caused a change of plans!

Our picture shows Father Shanahan being congratulated by *EA's* managing editor Jim Rowe, with Intertan Australia's marketing director Robert Morris lending his support.

100km underwater fibre-optic cable

The longest, single-length fibre optic cable ever laid in the sea now links the Phillipine Islands of Cebu and Negros, which are almost 100 kilometres apart. A submarine cable, less than the thickness of one finger, covers this distance without repeaters. Two hairlike optic fibres (the cable contains four) can carry 1920 telephone conversations and TV programmes if necessary.

Manufacture of the cable required exceptionally high degrees of quality during the production in the Siemens cable plant at Neustadt/Coburg (Federal Republic of Germany). The non-stop production process lasted five days. The cable laying concept developed by Siemens allowed all laying operations to be carried out simultaneously. A submarine plow (pictured) operated from the ship buried the cable in the seabed, with continuous measurement of all cable/fibre characteristics.

Clocks have 9 faces

International times can be read off the wall at a glance with two new clocks just released in Australia by Hertz Electronics, which claims the wall clocks are the first of their kind to be available in Australia.

Each combines a 12-hour clock with eight 24-hour clocks in one housing – thus eliminating the need for an expensive barrage of wall clocks. The 12-hour clockface can be set to local time and the 24-hour clockfaces to corresponding times in eight capital cities of the user's choice, names of each city being displayed under each clockface. Each 24-hour clockface is half shaded to clearly distinguish between day and night times.

WZ9 Universal Time Clocks, as they are called, are available in two models: the WZ9 Battery Clock and the WZ9 Secondary Clock. The battery powered model sells for about $1,200 and can be installed simply by hanging it on a wall.

The other model, selling for about $1,600 is for connection to a master-clock system and needs to be installed by a technician.

'Sound-powered heat engine' developed

Researchers at Los Alamos National Laboratory in the USA have developed a new type of engine which may some day be used for everything from the household refrigerator to turning factory waste heat into electricity.

The engine, called an acoustic heat engine, relies on two simple principles understood for centuries: the nature of how sound vibrates and the fact that changing temperatures make materials expand and contract.

"We've moved from physics studies to engineering development, " said researcher Greg Swift, the Los Alamos physicist spearheading the project.

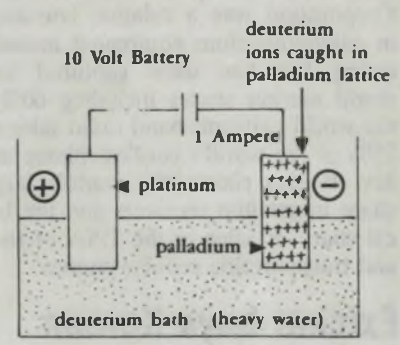
In general heat engines are devices that convert heat to work or use work to pump heat, such as conventional refrigerators and steam turbines. But they tend to be complex mechanical machines requiring a lot of maintenance. The Los Alamos engine is much simpler is design and it has no moving parts.

In one type of heat engine developed by Swift, the air 'sloshes' over the hot end of the plates, where it warms and expands. When the air reaches the other side of the plates, it cools and contracts – all at about 400 times a second. Sound is created by this rapid, repetitive expansion and contraction.

Another type of heat engine converts sound from a radio speaker into cool temperatures. In one of Swift's experiments, a vibration from a small speaker starts the air vibrating around in the heat engine. One end of the engine becomes warm, the other becomes cool.

It's this type of acoustic heat engine, except larger and using different materials, that Swift says might become the grandfather of future 'cryo-coolers' for reliably cooling superconductors.

Sydney University to probe 'cold fusion'



An experiment to test the production of cold fusion power is being set up at the University of Sydney in a joint venture between the Schools of Physics and Chemistry.

The collaborative research will attempt, as part of the study, to identify the source of the immense heat reported to be given off by the palladium/deuterium experiments as carried out recently by Martin Fleischman of the University of Southhampton and B. Stanley Pons of the University of Utah.

"There appears to be a reaction of great significance going on," says Professor Max Brennan, Head of the School of Physics and Pro Vice-Chancellor. "That is why we are taking the step of setting up an experimental laboratory here at Sydney University."

Cold fusion presents the possiblity of fusing nuclei by gentle persuasion rather than brute force. It is based on the fact that palladium, a silvery metal, can act as a gaol cell for certain positively-charged particles, in particular, deuterium, a heavy hydrogen ion.

Using an electrolysis cell, heavy hydrogen ions (deuterium) are soaked up by the palladium – being deposited not only on the outside but also in the interior, so that the deuterium ions are packed more tightly than normally (in nature) but are still mobile. This situation causes a significant number of fusions of deuterium ions, resulting in the production of energy in the form of high-speed neutrons. Or so the story goes. It is this story which is being investigated by the Sydney University team.

How are the ions held in this close proximity? The chemical explanation is that the ions are contained under pressure. Physicists at Brigham Young University, who also claim to have observed cold fusion, suggest that hypothetical quasi-particles, a few times as massive as electrons, combine with the heavy hydrogen ions, allowing them to overcome partially their mutual positively-charged repulsion and move closer together.

One of the interesting aspects of research at the University of Utah is the claim that the energy produced by cold fusion cannot be accounted for simply by standard deuterium fusion. There seems to be an unknown nuclear process or processes occurring, and one of the aims of the collaborating Sydney University team will be to test this hypothesis.

Research into cold fusion is also being carried out by ANSTO (Australian Nuclear Science and Technology Organisation), the Australian National University and Flinders University. As Professor Brennan syas, the procedure, if verified, would provide the world with simple, relatively inexpensive and comparatively clean power – certainly, many greenhouse contributing factors would be side-stepped.

Mobile phones go mini

Cellular mobile telephones entered a new era recently when Telecom Australia launched the smallest and lightest hand held mobile phone on the market. Known as the Walkabout Mark 2, it was selected by Telecom after an exhaustive study and evaluation of new generation units being developed throughout the world.

Produced for Telecom at Mitsubishi Electric Australia's manufacturing plant at Rydalmere, in Sydney, the Walkabout Mark 2, because of its size and weight, has been called the 'smallest of the cellular mobile telephones litter'. It is claimed to offer features not available on other current mobile telephones in Australia and a much-improved battery life, and is expected to take a significant market share in the future.

News Briefs

- This year's ***Hong Kong International Electronics Fair***, scheduled for October 16-19 at the new Hong Kong Convention and Exhibition Centre, will feature over 300 manufacturers from Hong Kong itself, China, Taiwan, Japan, Korea, the USA and Europe. This is the first time that the Fair has been open to overseas exhibitors.
- Melbourne-based PCB design bureau ***RCS Cadcentres*** is now able to offer full bureau facilities using the latest Racal-Redac CAD software, at its Sydney office in Unit 12, Eden Park Estate, 33 Waterloo Road, North Ryde 2113 or phone (02) 805 1916. The company has also appointed Colin Hutchinson as National Marketing Manager, based at its Melbourne office in Alphington.
- ***Cooper Tools*** of Albury have extended their national distribution for Weller and Xcelite products with the appointment of ACD Elektron in addition to existing national distributors the George Brown Group.
- RF communications specialists the ***Vicom Group***, based in Melbourne, has been appointed exclusive Australian distributor for the digital communications testing and simulation equipment of US firm Telecommunications Techniques Corporation (TTC), including the industry standard Fireberd MC6000 Communications Analyser.
- Well-known UK firm ***Marconi Instruments*** has formed a wholly-owned subsidiary company in Australia. Formerly a division of GEC Australia, the sales and service facility is now in prestigious new premises at Level 4, 15 Orion Road, Lane Cove 2066 or phone (02) 418 6044.
- Keynote speaker at this year's ***IREECON '89***, to be held at the Royal Exhibition Building in Melbourne from September 11 to 15, will be Dr Irwin Dorros, Executive Vice-President (Technical Services) at Bell Communications Research. Further information from Cherie Morris, IREE Convention Administrator on (02) 327 4822.
- CAE software tools and controller maker Wizdom Systems, of Illinois USA has appointed Melbourne-based ***Current Solutions*** as its exclusive Australian distributor.
- Sydney-based audio systems specialist ***Jands Electronics*** has opened a sales office in Auckland, New Zealand. The address is 34 Shaddock Street, Mt. Eden, or phone (09) 366 7021. The company has also upgraded its manufacturing facilities in Sydney, with the addition of a NC turret press.
- Adrienne Lambert has been appointed Dealer Manager at Sydney-based PC enhancement board maker ***Hypertec***. Ms Lambert was formerly marketing manager for Financial Computing Services.

Uniden buys Santronics

Australian electronics distributor Santronic Corporation has been acquired by international communciations giant Uniden Corporation of Japan, the world's largest producer of two-way communications equipment.

Key assets in the deal, which now forms Uniden Australia P/L, were Santronics Australian and New Zealand wholesale distribution systems comprising 1200 dealer outlets for industrial, business and domestic communications equipment.

The agreement leaves decision-making in the hands of the company's existing Australian management.

Explaining the size of the sale, Mr Roy Metaxas, 38, Uniden Australia's managing director and former Santronic principal said, "Last year we grossed $30 million. This year we are on target for a $50 million turnover."

Mr Metaxas says Uniden products have Australia's largest market share in radar detectors, VHF marine radio and radio scanners, and 15% of Australia's cellular phone market.

Founded in Japan in 1972, Uniden Corporation was a relative late-starter in communications equipment manufacturing but has since captured large world market shares including 60% of the world's citizens band radio sales and 25% of the world's cordless phone market. It also claims the world's largest share in satellite receivers and the largest share of sales in the USA of in-car and transportable cellular phones.

Exicom buys Korean technology

Australian firm Exicom Limited and Goldstar Telecommunication Co Ltd of Seoul have signed a technology transfer agreement covering the core electronics developed by Goldstar for telephone switching systems.

The Exicom-Goldstar systems have the capacity for between two and 36 lines servicing up to 112 stations. Exicom has purchased this technology to re-design and develop products which have local and export opportunities.

Mr J Y Lim, president of Goldstar, said he believed it was the first time a Korean company had offered to transfer technology of this kind to a foreign corporation.

Exicom's managing director, Mr Alan Kenyon, said Goldstar has designed simple, rugged but highly reliable electronics which were easily adaptable to the stringent Australian environment.

Exicom and Goldstar are also jointly developing digital systems ready for ISDN's basic rate services which will be available in 1990/91 in Australia. Exicom plans to produce these modern telephone systems developed from the Goldstar agreement at its new Sydney manufacturing plant from early 1990.

Computers with 3-year warranty

NEC Information System Australia (NEC/ISA) has dropped something of a bombshell in mid-range computing in Australia and the world, by offering a three years, free parts-and-labour maintenance with each of its new UNIX System XL/100, XL/200 and XL/300 systems.

The new strategy is unprecedented in the Australian and international mid-range computer product and service industry.

Mr Graeme Poulton, NEC/ISA managing director said the three years of free maintenance not only applies to the three new UNIX systems just released, but also to NEC listed peripherals, such as printers and XL workstations, purchased to connect to any of the new systems.

"The offer is totally credible, with no added cost built in to the price of the systems," said Mr Poulton.

The Serviceman

A wet weekend spent fixing some dry joints!

Somebody once said that life wasn't meant to be easy, and as far as the life of a self-employed TV serviceman is concerned, it ain't!

Occasionally, rarely, a series of simple, straightforward jobs makes life cosy for my Bank Manager – and a bit easier for me. But then I'll get one or more real stinkers, and for a month I'll earn less than the dole.

Then again, a self-employed serviceman can't afford to take off four weeks at Christmas, like most other people. If he's lucky he can grab a few days here and a week there, while he hopes that would-be customers will wait until he gets back.

For 10 years I have been watching the growth of the rust patches on my roof, and promising myself that one day I'll take a week off and get the iron painted.

Unlike the wage-slaves, I can't afford to employ a painter, so I had to wait until work slackened off enough to give me a week or so clear from important jobs.

The first few days aloft went quite well, with nary a single customer nor even a phone call. But half way through Thursday a car stopped outside, and the lady driver called me down from the roof to help her unload a TV she wanted to have repaired.

After that I was up and down the ladder for the rest of the day, to accept work from a constant stream of customers. By evening I had five TV's, three stereo radios and a video recorder piled in the workshop. Fortunately, none of the work was urgent and the customers were quite happy for me to put it all aside until I had finished the painting.

So it was back up the ladder and more brushwork, until the weather turned foul and drove me indoors, to the pile of work awaiting. And so to the first job:

A Kriesler 59-04 that was, in the owner's words, "playing up!" It was left to me to decide what 'playing up' meant. As I lifted the set onto the bench, I offered a silent prayer that the symptoms would be clear and unambiguous.

As it happens, the set started up with a perfect picture, but it wasn't long before it started to 'play up'.

First, there were intermittent dark lines across the screen. Then a few white lines flashed up and some parts of the picture started to pull to the right. All of this was accompanied by a quiet, irregular popping sound from the speaker.

After half an hour of this unpleasant demonstration, the picture gradually cleared and the symptoms faded away to nothing. But an hour later they were back, and this was to be the standard performance, until the fault was found and corrected.

The symptoms looked for all the world like a line output stage dry joint. I've had the black and white lines before, except that here the line pulling was more like a line oscillator fault.

To begin with, I went over the line board with my soldering iron, looking for the dry joint which I felt had to be the answer to the problem. When I had covered every joint on the board and the fault was still present, I decided that only my CRO could show me what kind of fault this one really was.

Now this is where the story really gets interesting, because from the collector of the line output transistor, the pulses were perfectly clear and steady. But the other side, on the *base* of the same output transistor, the drive pulses were jumping about all over the place!

The oscillator output was also varying, mostly in amplitude, but also occasionally shifting in time. This seemed to explain the lines and the pulling – but why was the output so steady? (This part of the story remains unexplained, still!)

The Kriesler 59-04 is powered from a single 35 volt rail, and my CRO showed that even this was jumping around quite vigorously. I didn't know if this was cause or effect. But although it was worth investigating, it soon proved to be a result of the fault rather than the reason for it.

About an hour later, I had to acknowledge that the fault could not be in the line stage or the power supply. I had checked these areas thoroughly and could find nothing wrong.

The next clue came by accident. During one of the set's lucid moments, I happened to knock the 'small signals' board – and all the symptoms suddenly returned.

I couldn't turn them off, but after a while the picture settled down and I began a gentle tapping on various parts of the board. It was soon clear that the fault was on this board and also that it was going to be a dry joint.

One useful thing about dry joints, if anything about these faults can be said to be useful, is that they are mostly associated with heavy currents. Any component which carries substantial current will heat up and it is the stresses set up by the thermal changes that generally cause the dry joint.

There are not many high current components on the small signal board in the Kriesler. It didn't take long to check all of these, and none of them were dry!

The CRO was again pressed into service, to look at the video signals and supply rails. Whenever the fault appeared, the signals went frantic. Video, sync and supply all jumped about, increasing and decreasing in time with the black and white lines on the screen.

I was able to trace the disturbances back as far as the output from the video IF module, in the top left corner of the small signals board. Then, using a soft plastic knitting needle, I very gently probed around the module – and found it to be extremely sensitive.

The IF module is mounted in a tinplate box, for all the world like an extra tuner. I was able to remove the top and bottom lids from the module and found that inside, the components were even more sensitive – the lightest touch sent the screen into paroxysms of flashing lines and extreme pulling.

I removed the module and set it up on the bench, under a strong light. Using a 10x magnifying glass, I examined every joint on the board. All were perfect, except for two pins under the TDA2540 IF amp and demodulator chip.

These showed the classic dry joint appearance, yet they were only minimal current, signal type pins with no real 'excuse' for going dry-jointed.

I resoldered the pins, replaced the module, refitted the cabinet back and the job was done. Solid as a rock!

And it was on to the next one. This was a Toshiba C810 with no colour.

This is not an unusual fault with these sets. It is caused by dry joints, among the many through-board connections on the double-sided motherboard and modules that make up the main part of the set.

My experience has been mostly no-colour, but similar faults can occur in the IF, video, sync or vertical sections of the chassis. All in all, the model is often 'money for jam' as far as we servicemen are concerned.

This particular set had been in before with a similar fault, and resoldering the pin-throughs on the chroma module had cured the trouble. Now it had recurred and deeper investigations were needed.

I found that I could restore colour by flexing the mother board under the chroma module. This led me to suspect that there was another dry joint among the pin-throughs on the main board. But although they were visible on the top of the board, they were quite inaccessible among the module sockets, delay lines and other components.

There was nothing for it but to remove all the hardware, to give my tiniest soldering iron access to the tracks. This took quite some time, but was straightforward enough and the job was eventually done, with the set showing perfect colour. Let's hope it stays that way.

Job number three was an NEC video recorder, reported to play the sound but not the picture.

This was another of those 'money for jam' jobs. It was nothing more than dirty video heads, and cleaning them restored the unit to first class condition.

The NEC is not quite as easy as most VHS machines, when it comes to cleaning the heads. The whole tape path is hidden under a complicated tinplate shield and this has to be removed for access to the heads. A five minute job in most machines can be stretched out to at least half an hour with the NEC, particularly if the opportunity is taken to clean the whole tape path while the covers are off.

Job number four was a Philips 34cm portable, reported as having bad colour and to be shutting down occasionally. The shutting down wasn't hard to cure – the bad colour was quite another story.

A dry joint at the collector pin of the line output transistor turned out to be the cause of the shut down. Resoldering this was a complete and permanent cure, but it did nothing for the colour problem.

All in all, this model is often 'money for jam' as far as we servicemen are concerned...

Actually the owner had made the understatement of the year when he said the set had 'bad colour'. In fact, all the colours were reversed, with cyan-faced footballers playing on bright blue grass, under a sort of browny-green sky.

When first faced with this kind of fault, one worries about all kinds of chroma problems. Delay lines, demodulators, reference oscillator phases, a hundred and one possible sources of trouble come to mind.

With the colour turned down, the set gave a near perfect black and white picture – and this only complicated matters, because good monochrome actually pointed away from the real cause of the trouble.

In fact, these symptoms were caused by gross purity errors, in turn caused by the failure of the set's degaussing circuit. In this case the degaussing coil had gone open circuit a couple of years ago, and the tube had been subject to progressive magnetisation by the stray field from a nearby hifi speaker!

Restoring the picture to normal was easy, restoring the set to normal was not. It took only five seconds with the degaussing wand to restore the purity and with it, normal colour to the footballers and their playing field.

I set about removing the faulty degaussing coil, only to find that it appeared to be secured *under* the picture tube mounting screws. Getting it out would require the complete removal of the tube from the cabinet. Then there would be a delay of a week or so, while I got the new coil and fitted it to the set.

Finally, while I was pondering on the problem, the owner rang to ask if the set could possibly be done by the next day. I explained the situation to him, and after a bit of discussion, we came to an arrangement.

He would take the set as it was, and would remove the offending loudspeaker to another room. If and when the purity goes funny again, he will bring the set back for me to degauss with my 'magic wand'.

I will fit a new coil next time the set comes in for repair, while it is opened up. This will save the owner money on the present repair, and will give me time to get the needed part into stock.

Next, I had a look at one of the stereo radios that had come in. It was one of those yard-long 'ghetto blasters', and it had had an interesting accident. I was told that it had been run over by a car!

It had been left sitting on the boot of the car and the driver, unknowingly, reversed down the driveway. The radio slid off the boot and reappeared in front of the car a few yards further down the drive.

Incredibly, the only obvious damage was that the cabinet back had a large hole in it near the AC power cord socket, and cracks radiating outward to the top and bottom of the cover. Unfortunately there was more serious damage inside the set, but I was able to repair it all with bits of wire and Araldite.

The cabinet back was beyond repair and at the time of writing I am still waiting to see if a replacement is available from the makers. If it's not available, I'll patch the broken one with Araldite (what else?) and fibreglass and the owner will have to relegate it to use as the kitchen set.

Finally, to round up a wet day in the workshop, I tackled a job that I should never have started so late in the day. It was a National TC1401A with two unrelated problems.

The owner had brought it in mainly because it had developed low height and bad linearity. But he also brought in a new cabinet and asked if I would change it over for the old one!

It seems that the set had once been involved in a small fire. Burning curtains had fallen on the cabinet and had badly distorted the plastic. The set suffered no other trouble and continued to work quite satisfactorily.

The owner's insurance policy covered replacement of the damaged cabinet and this was obtained from National, but was never installed. The owner decided to wait for the next service call, and have the new cabinet fitted then.

For eight years the owner has put up

Serviceman

with his distorted telly while all this time the new cabinet has sat in a cupboard in the hallway. My call to repair the bad vertical linearity was the first service the set has had in its 13-year life.

Removing the old cabinet back was no trouble, but the front panel and escutcheon was a different story. The TC1401A weighs no less than 23.5kg, or just over 50 pounds. It's the least portable 'portable' I've ever come across.

Most of the weight is in a large and cumbersome power transformer. This makes the chassis extremely awkward to handle, once the brackets that hold it to the front panel are removed. I had several close shaves before I had the picture tube safely mounted on the new front panel.

It was quite late in the evening before I had the chassis refitted and ready for the vertical repair, so I decided to leave that for another day. In the event it was quite simple – an open circuit bypass capacitor (C463, 22uF/250V) on the supply to the vertical output transistors.

All of this had nicely filled in a wet weekend, and by Monday the sun was shining again and I was back to painting my roof.

While standing on the topmost ridge, I was struck by an odd fact. As far as I could see, my roof was the only rusty one for miles around. A cynical colleague suggests that it is galvanic action from all the electronic/electrical work that goes on under the iron!

Philips footnote

Back in the January issue this year, I told the story of a Philips television with a power transformer of doubtful quality. The transformer had been cooked and after several unsucessful tries to get a replacement, I had to refit the old one and hope that it would stand the test of time.

Well, Philips couldn't supply a new transformer, but there are still hundreds, even thousands of good transformers out there, in sets that are now being junked for bad tubes or other faults quite unrelated to power problems.

Just recently I helped the widow of a former colleague to clean up his workshop and junkheap. Under long grass behind the garage I came across no less than *four* KT2A-3's with broken cabinets or picture tubes. Two of them still had their transformers intact, though rather rusty.

If only I had known that he had those junked sets! He could have sold them to me for money, and I could have returned that set to my elderly customer with much more confidence!

Cry from the heart

Finally this month, I'd like to pass on the following item which appeared recently in the Melbourne BBC User Group newsletter. I don't know who the author was, but he deserves a much wider audience because the philosophies expressed here are fundamental to all electronics servicing.

The tips it gives apply just as much to radios, videos, TVs, CD players, etc., as they do to the computers he refers to. They should be heeded by everyone with a piece of modern technology that needs attention.

FIVE THINGS YOUR REPAIRMAN WOULD LIKE YOU TO KNOW:

READ THE MANUAL. Granted, most are written by semi-literate types who probably should be relegated to writing the tax laws, but you may find some golden nuggets of information that will save your technician's time – and your money. A large number of computer problems result from not following instructions.

BE SPECIFIC. The more accurately you can describe a problem, the easier it will be to fix. Don't come in and announce, "My printer's broken". The biggest problem is with intermittent problems – those that come and go without explanation. Try to determine a pattern: Do they happen after the computer's been on a long time? Do they happen after you perform some type of operation, such a printing a document or retrieving a file? It is with such information that technicians fix things quickly and effectively.

MOVE IT GENTLY. When you bring your equipment in for repairs, put it in a box and secure it so it won't rattle around. Bumping and jarring the computer as you carry it around unprotected can cause additional problems.

FIXING COMPUTERS IS AS MUCH AN ART AS A SCIENCE. Computer owners expect things to be fixed perfectly the first time. Don't expect too much too quickly. It may be unfair to expect a technician to resolve in an hour what has resulted from years of abuse and neglect.

NO TECHNICIAN DOES EVERYTHING RIGHT ALL THE TIME. There are less-than-scrupulous technicians, of course, but the complexities of computers are immense. The best technicians aren't those who never make mistakes, but **those who make sure no customer is dissatisfied.**

Excellent advice, don't you agree? I hope you'll join me again next month.

Fault of the Month

Blaupunkt 'Cardona' or similar chassis.

SYMPTOM: Frequent failure of R1140 (3.3 ohms in 26" sets, 0.22 ohms in 22" sets). This resistor is the main feed to the vertical output transistors so customer complaint is "..a horizontal line".

CURE: Resolder dry joints under the thick film resistors on the vertical board. Also, replace C1050 (47uF 16V) and C1051 (2.2uF 63V) with conventional electros if the ones fitted are in rectangular, white plastic packages.

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

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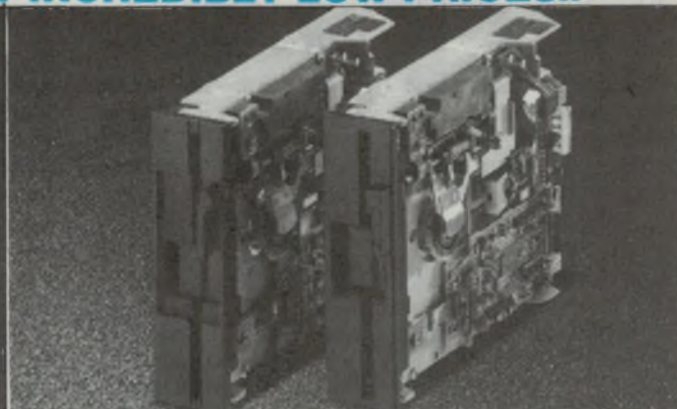

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Simple, low cost variable bench supply

Here's a great little project for the newcomer to electronics. It's not only easy to build and low in cost, but very useful – providing safe, adjustable, ripple free power for your future projects. And as an additional bonus, it's also overload and short-circuit protected.

by JIM ROWE

There's an old adage in electronics that says you can never have too many power supplies. It applies just as much to the engineer or scientist in his lab, as to the radio amateur in his 'shack' or the hobbyist in his workshop. Somehow or other, you always seem to need at least one more power supply than you have – it seems to be a kind of law of nature, like Murphy's famous one dealing with the perversity of inanimate objects.

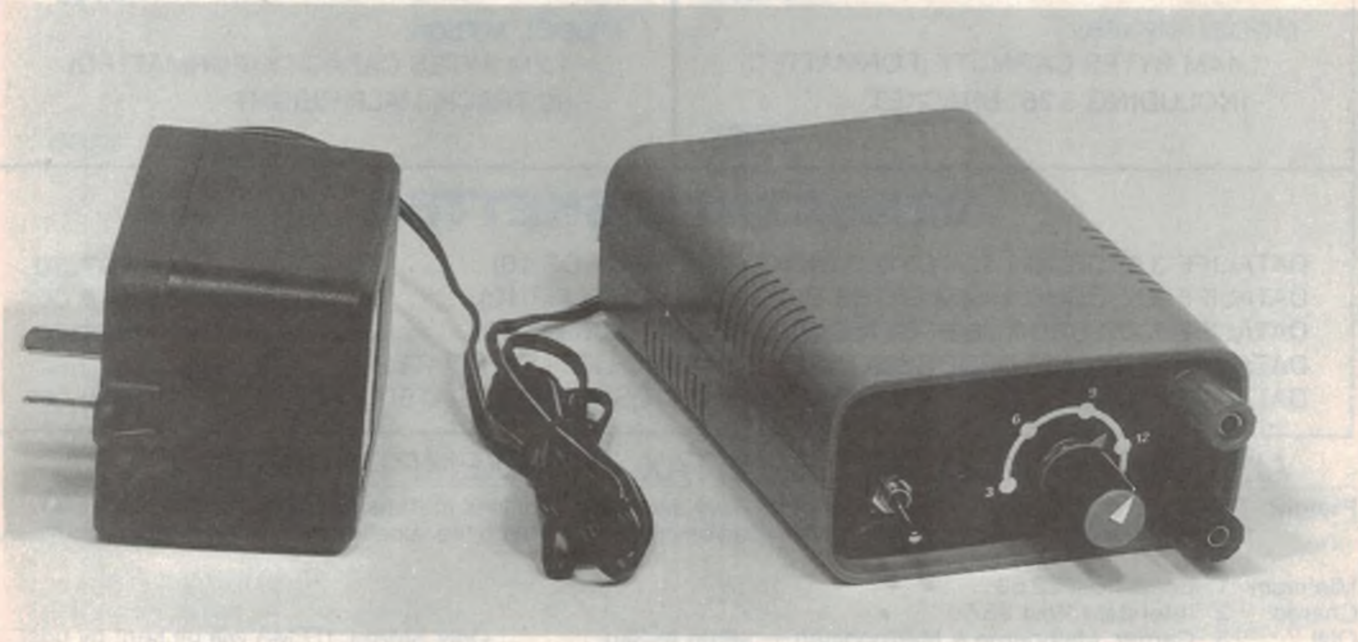
This being the case, building up a power supply as a project is almost *always* a good idea – time and money permitting, of course. And this is true especially for the newcomer to electronics, who may well have very few existing power supplies at their disposal.

The new power supply design described here has in fact been designed especially for the newcomer and beginner. It is very simple and straightforward, and therefore very easy to build. So much so that it would make an excellent educational project, for technical colleges and school electronics courses – particularly in view of the low cost for the parts involved.

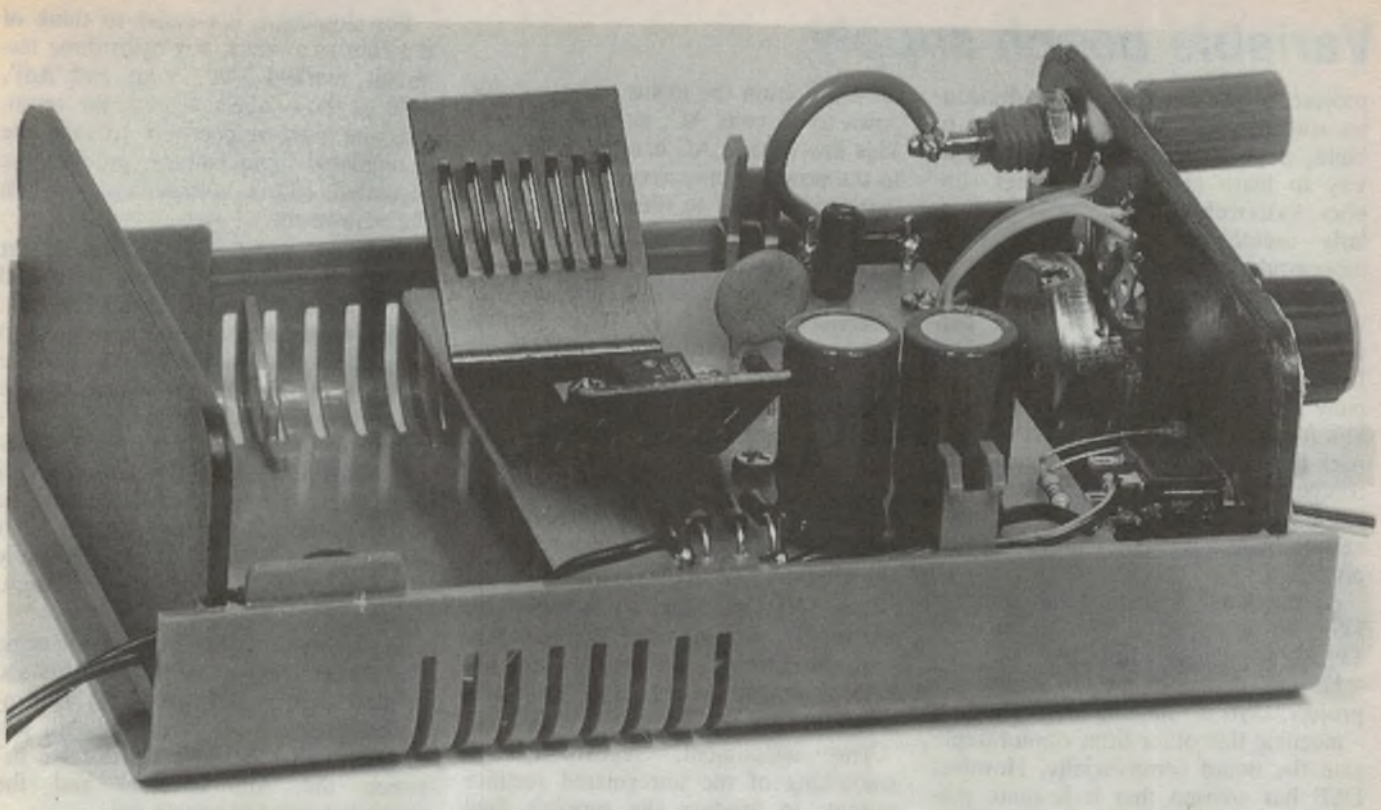
Yet at the same time, the resulting supply provides a source of clean, well regulated low voltage DC, smoothly variable from about 1.5 volts to above 15V and capable of delivering currents of up to more than 500 milliamps. This makes it very suitable for powering a very high proportion of experimental circuits and simple projects, of the kind likely to be built by newcomers.

Thanks to the use of a high-performance regulator IC, the actual performance is actually quite impressive. For most output voltage settings the output level drops less than 2mV (millivolts) from its no-load value, for any current level up to the rated 500mA (milliamps). Even at the 15V output setting, where the regulation is not quite as good, this droop only increases to a mere 6mV – representing a regulation figure of 0.04%.

The AC ripple rejection performance is equally good. As you would expect, this too is dependent upon the output voltage setting and load current, being worst at 15V output and a 500mA load. However as the output ripple figure for this condition is still only 5mV peak to



The completed power supply. The use of a plug-pack power transformer ensures that it is not only safe to build, but to use as well. The output is very clean and well regulated up to above 500mA.



A close-up inside the case, showing many of the components. Note the rectifier diodes, nestling under the 'wing' of the regulator IC's heatsink.

peak, and falls to less than 2mV p-p at lower voltages, you can see that it compares favourably with supplies costing very much more.

Of course a power supply to be used on the workbench for powering experimental circuits also needs to be fairly rugged, and not vulnerable to damage from the occasional short circuit or other mishap. How does such a simple and low cost supply cope with this requirement?

Very well, in fact. The regulator chip itself provides current limiting, thermal overload protection and safe operating area protection, making it a very rugged device. In addition, the circuit used here augments the chip's own protection with a simple sensing circuit which monitors the load current and effectively shuts down the regulator chip when it detects an overload condition. As a result, and despite its simplicity and low cost, the supply is really very 'rugged'.

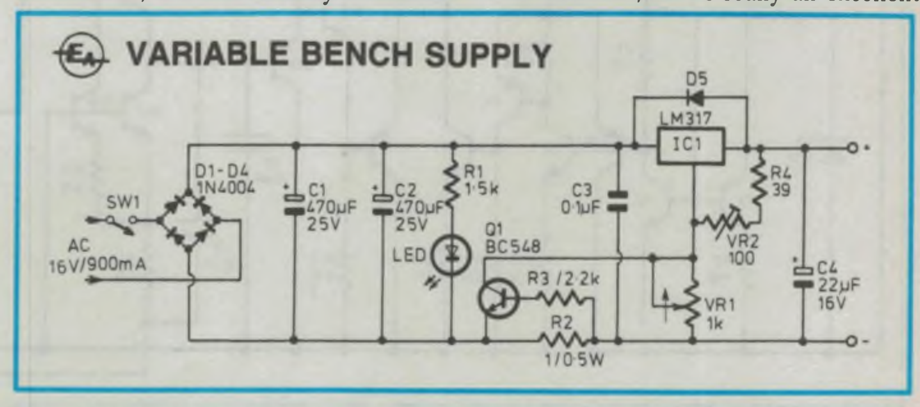
At this stage you may be thinking that there must be a catch in all this. A really simple and low cost supply, with all these features – surely something must be missing, compared with the fancier and more expensive models? Of course there is.

The things that you *don't* get in this design are meters or digital displays, to tell you exactly what the output voltage and/or load current are, at all times. Nor do you get adjustable current limiting, which can be nice if you want to provide protection for the devices in your experimental circuit, as well as the supply itself. Nor do you get multiple voltage outputs, separately adjustable or alternatively able to 'track' each other so that you can adjust them all up and down with a single knob.

All of these frills are missing, to be sure. But then the output voltage is very well regulated, and can be adjusted quite closely enough for most circuits using the markings provided on the control knob. In any case, you can always check the output voltage level with your multimeter, and if necessary tweak the output control to the exact value needed for circuits that are especially critical. And most of those other facilities are not needed for the majority of basic electronics work, particularly the kind of work tackled by the newcomer.

On the positive side, a further important feature of this design is that it makes use of a separate 'plug pack' stepdown transformer, which keeps all dangerous high voltages isolated to within the sealed case of the transformer itself. As a result, all of the accessible circuitry of the supply carries only low-voltage AC and DC – making it completely safe, even for inexperienced beginners.

So all in all, this is really an excellent



The circuit is very straightforward, but despite this the performance is surprisingly good – thanks to the LM317 regulator IC.

Variable bench supply

project for the newcomer and electronics student. It is low in cost, easy to build, a good performer, an excellent way to learn about basic power supplies, extremely safe, and also particularly useful when completed. What more could you want?

Incidentally the basic development work for this project has been performed by the R&D department of Dick Smith Electronics, and this company will be making available complete kits for it. These will include the plug-pack transformer, etched PCB, and case complete with a pre-punched and silk-screened front panel, making it very easy to build a professional-looking supply.

At the time of writing the complete DSE kit is expected to sell for only $39.95, or possibly a little less.

Having designed the PCB for the project, DSE is retaining copyright on it – meaning that other firms cannot duplicate the board commercially. However DSE has advised that it is quite prepared to supply transparencies of the PCB artwork to schools and colleges, if they wish to etch their own PCBs for the project as part of practical class work.

How it works

Now let us look at the circuit schematic, to see how it works.

The plug-pack transformer used takes the 240V from the mains and steps this down to 16 volts AC, at up to 900mA. This low-voltage AC becomes the input to the power supply circuit proper, with switch SW1 used to turn the supply on and off.

Diodes D1-D4 are connected in a standard 'bridge' rectifier configuration, to convert the incoming AC into unidirectional current pulses. Capacitors C1 and C2 are then used as a 'reservoir', smoothing the output from the rectifier and producing an unregulated DC output which varies between about 23V for no load, down to about 18-19V at a loading of 500mA. At this current level there will also be a significant 'ripple' superimposed on the DC.

The LED provides a 'pilot light' for the supply, showing when power is present. Resistor R1 is used to limit the current drawn by the LED to a safe value, around 14mA.

The adjustment, regulation and smoothing of the unregulated rectifier output, to produce the supply's final output voltage is all performed by IC1, which is an LM317T adjustable 3-terminal positive regulator chip. We needn't go too deeply into what goes on inside this device, because in reality it is quite complicated – as you can see from Fig.1, it consists of some 25 bipolar transistors, a FET, three zener diodes and 30-odd passive components.

For simplicity, it's easier to think of the chip as a 'black box' with three terminals, marked 'Vin', 'Vout' and 'Adj'. And as these labels suggest, the terminals are used respectively to take the unregulated input voltage, produce the regulated output voltage and perform the adjustment.

In many ways, IC1 behaves rather like an 'intelligent' resistor, connected between the Vin and Vout terminals, whose value varies in such a way as to keep the output voltage constant despite changes in the output voltage or the load current. And the actual value of output voltage at the Vout terminal depends upon what we do with the Adj terminal, as the IC itself is designed to maintain the voltage between the Vout and Adj terminals fixed very accurately at a voltage V_{REF}, which is very close to 1.25V.

Fig.2 shows the basic circuit for using the LM317 as an adjustable voltage resulator. A fixed resistor R1 is connected between the Vout and Adj terminals, with a variable resistor R2 between the Adj terminal and the grounded negative supply rail.

Since the action of the regulator chip is to maintain the voltage across R1 at V_{REF}, this causes a fixed current I1 to flow through R1, where

$$I1 = V_{REF}/R1$$

This same current I1 flows through the adjustable resistor R2, together with

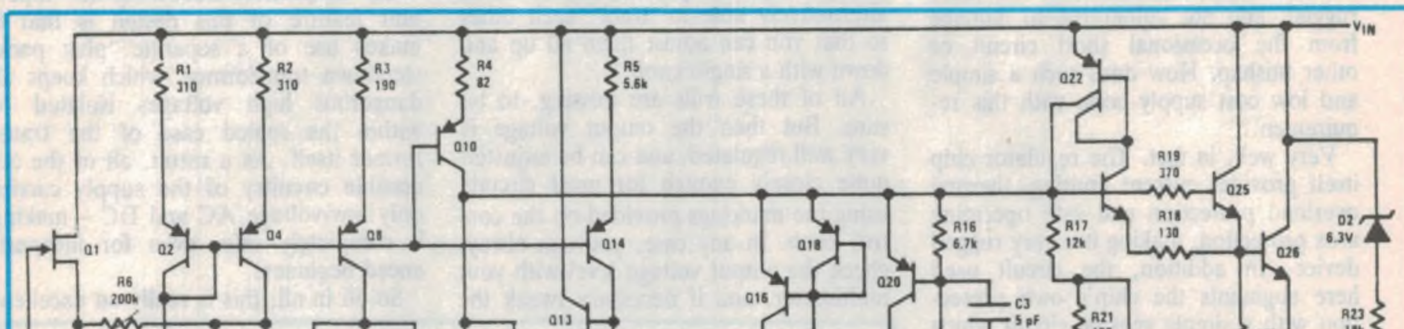


Fig.1: A look inside the LM317 regulator IC. It may look simple on the outside, in its 3-leaded transistor type case, but inside there's a lot of circuitry – as you can see!

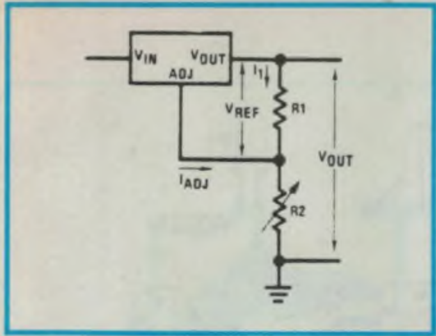


Fig.2: The basic circuit configuration used with the LM317 regulator.

the small sensing current I_{ADJ} which flows out of the chip's Adj terminal. The chip is designed to keep I_{ADJ} also very stable, typically at about 50uA (microamps), so the total current through R2 is virtually constant.

By varying R2, we can therefore vary the voltage across it due to I1 and I_{ADJ}, and hence the voltage between the chip's Adj terminal and the negative rail. And because the overall output voltage V_{OUT} will be equal to V_{REF} plus the voltage across R2, this means that R2 becomes an adjustment for V_{OUT}.

The relationship between R2 and V_{OUT} is therefore:

$$V_{OUT} = V_{REF} + R2.(I1 + I_{ADJ})$$

and because I1 is simply V_{REF} divided by R1, this expression can be re-written as:

$$V_{OUT} = V_{REF}.(1 + R2/R1) + R2.I_{ADJ}$$

In other words, V_{OUT} is controlled only by R2, R1, the chip's output voltage V_{REF} and its small sensing current I_{ADJ}. And as all of these are essentially independent of both the input voltage V_{IN} and the current drawn by the load, this means that V_{OUT} is tightly regulated at whatever value we set it at using R2.

In fact because I_{ADJ} is quite small compared with I1, we can almost ignore its effect, and simplify that last expression down to:

$$V_{OUT} = V_{REF}.(1 + R2/R1)$$

From which you can hopefully see that V_{OUT} is basically equal to the sum of two parts: V_{REF} itself, plus a second part equal to V_{REF} multiplied by the ratio of R2/R1.

So if R2 is set to zero, V_{OUT} will be equal to V_{REF} – around 1.25V. This is therefore the minimum output voltage.

If R2 is set to a value equal to R1, then V_{OUT} will be very close to double V_{REF}, or 2.5V. Similarly if it is set to 5 times R1, V_{OUT} will be 6 times V_{REF}, or 7.5V. And if R2 is set to 11 times R1, V_{OUT} will be equal to 12 times V_{REF}, or 15V.

The maximum value to which we can set V_{OUT} is governed not so much by R2, but by the input voltage V_{IN}. This is because the chip needs at least 2.5 volts between its Vin and Vout terminals, in order to work properly. So we can only increase R2 to the point where V_{OUT} rises to within 3V of V_{IN}, before the chip will start to lose its control of the situation.

The actual ratings of the LM317T allow it to handle voltage drops of up to 40V between input and output, so the basic circuit of Fig.2 can be used to regulate up to around 37V, if required. Similarly it can handle up to about 1.5A of load current, when it is provided with a suitable heatsink.

Now let's turn back to the actual circuit schematic of the supply, and see how it compares with Fig.2.

Variable control VR1 is obviously equivalent to R2 in Fig.2, but instead of fixed resistor R1 we now have 100-ohm trimpot VR2 in series with 39-ohm resistor R4. The reason for this is to allow minor adjustment of the value of the upper 'R1' resistor, so that the control range of VR1 can be set for correct reading of the pointer knob against the front panel markings.

Typically VR2 will be set to around 51 ohms, giving a total upper resistance of 90 ohms and a maximum resistance ratio of 11 times – for a maximum output voltage of 15V (12 times 1.25V).

Capacitors C3 and C4 are to ensure that the regulator chip IC1 operates in a stable fashion, and does not have any tendency to oscillate or 'hunt' when there are sudden changes in input voltage or load current.

By this stage you're no doubt wondering what is the purpose of transistor Q1, and resistors R2 and R3. These are not part of the basic regulator circuit, but provide the overload protection.

Q1 is normally cut off, with no forward bias applied to it. However resistor R2 is in series with the negative supply rail, and as the load current rises so does its voltage drop. As as the base of Q1 is connected to the load side of R2, via R3, this voltage drop provides the transistor with forward bias.

Since the value of R2 is 1 ohm, this means that when the total current drawn by VR1 and the load reaches about 600mA, the voltage drop across R2 reaches 0.6 volts. And when this level is reached, as forward bias for Q1, it begins conducting – and shunting VR1.

This reduces the effective value of VR1, 'turning down' the regulator's output voltage just as if VR1 had been turned down itself. The regulator thus shuts down, its output voltage falling to only 1.25V. Together with the regulator chip's own internal protection circuitry, this prevents any damage – even when the output is short-circuited.

The remaining component to be explained is diode D5, connected between the Vin and Vout terminals of the regulator chip. If you followed the previous discussion of the way the regulator works, you'll no doubt realise that when the circuit is operating normally, this is reverse biased by at least 3V, and therefore inoperative.

The purpose of D5 is not to take part in normal operation, but to protect the regulator chip against possible damage, when the input power is turned off.

When the power is turned off, by opening SW1 or the mains switch, the voltage across C1, C2 and C3 may drop to zero faster than that across C4 and any capacitors connected externally across the load. If this happens, a reverse voltage may be applied across IC1, with its output terminal temporarily more positive than the input terminal. And this reverse voltage can damage the internal circuitry of the chip. However by connecting D5 in the manner shown, it will conduct in this situation and prevent the reverse voltage from rising above 0.6 volts.

Just before we discuss construction there is a small point which you should note about circuit operation. This is that because the supply uses a 'plug-pack' stepdown transformer, for safety, the 'power' switch SW1 only controls the output from the power supply – not the 240V input to the transformer.

This means that while SW1 can be used to turn the power supply output on and off, during normal operation, the mains power should also be turned off at the 240V outlet when the supply is not to be used for some time. Otherwise, the plug-pack transformer will be left connected to the power, and there is a small risk that it could overheat.

This comment applies not just to the present power supply project, of course, but to any project which uses a plug-pack transformer or 'battery eliminator' supply.

Building it up

Apart from the plug-pack transformer, all of the circuitry for the power supply is housed in a small plastic utility case measuring 95 x 135 x 46mm. This is sold by Dick Smith Electronics as Cat. No. H-2503, and has two clip-together top-and-bottom half sections with removable front and back panels.

Power switch SW1, output voltage control pot VR1 and the two output terminals are mounted on the front panel, as you can see from the photographs, while all of the rest of the components are mounted on a small PC board measuring 78 x 65mm and coded ZA-1427. Although mounted on the front of the PCB, the LED is mounted with its lead left at full length; these are then bent at 90°, so that it can be pushed through a small hole in the front panel alongside SW1.

The placement of all of the parts mounted on the PCB should be fairly clear from the overlay diagram, and the internal photographs. The regulator chip IC1 is mounted on a small pressed-metal heatsink, on the top of the PCB at the centre rear. The heatsink is normally in the shape of a 'U' (DSE Cat. No. H-3402), but as its height is a little too great to fit inside the current box, if left in this form, the two sides are accordingly bent down to angles of 45° to the centre section. This just allows everything to be assembled snugly, while still giving IC1 sufficient heat sinking.

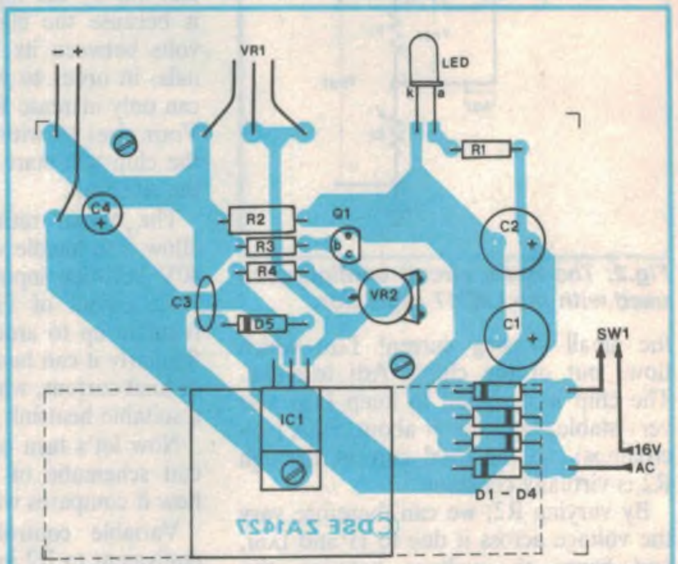
Note that the two four rectifier diodes D1-D4 are at the rear of the board, behind the reservoir capacitors C1 and C2, and are therefore underneath one 'wing' of the regulator heatsink. This doesn't effect operation, but does make them a little harder to find!

To wire up the board, we suggest that you fit the PCB pins used for the various off-board connections first, pushing them snugly into the board from the component side before soldering. Then fit the resistors, bending their leads so that they too fit snugly down against the board before soldering.

Next fit the trimpot VR2, making sure that its three lugs are again pushed firmly through the PCB holes before soldering.

Now fit the capacitors, taking care with the three electrolytics to ensure that they are fitted with the correct polarity. Then you can fit the five diodes, in much the same way as for the resistors but again watching that they are fitted with the correct polarity.

Transistor Q1 can now be added, taking care both to get its connections right and not to push its leads through the board too far. Leave around 4 or 5mm of device leads above the board, as the PCB holes are further apart than the leads where they leave the transistor body, and the leads will be subject to undue strain if the body is pushed too close to the board.



The PCB overlay and wiring diagram for the supply. As you can see, there's very little involved in putting it together.

Now mount the LED, again making sure that it is fitted the correct way around. Leave its leads at their full length, pushing them through the PCB holes just far enough to make good solder joints on the copper side. Then bend the leads carefully over at 90° just above the board, ready to locate the LED body in the front-panel hole when everything is assembled.

Finally the regulator chip IC1 can be added, in the following way. First bend the heatsink fins down to the correct angle of around 45°. Then bend the three leads of IC1 downwards at 90°, at a point about 4mm from the body – just past the point where they reduce in width.

It should now be possible to mount the heatsink on the top of the board, with the regulator above it so that its leads are passing down through the three small matching holes in the PCB, and with the mounting holes of heatsink, IC1 and PCB all in alignment. You can then fit a 3mm (or 1/8") machine screw and nut, carefully tightening up to hold everything together without disturbing the IC pins. And finally you can solder the three pins, to connect the IC into circuit electrically.

At this stage the output terminals, output adjustment pot VR1 and power switch SW1 may be mounted on the front panel, using the red terminal in the upper position for the '+' output. The pot should be mounted so that its three connection lugs are uppermost, as the panel is asymmetrical and there is no room for them below.

Now connect short lengths of red and black hookup wire to the rear of the

PARTS LIST

- 1 16V/900mA plug-pack transformer
- 1 Instrument case, 135 x 95 x 46mm
- 1 PC board, 78 x 65mm, ZA-1427
- 1 SPST miniature toggle switch
- 2 Screw terminals, 1 red & 1 black
- 1 Small pointer knob
- 1 Small 'U'-shaped metal heatsink, for TO-220 devices
- 7 PCB terminal pins

Semiconductors

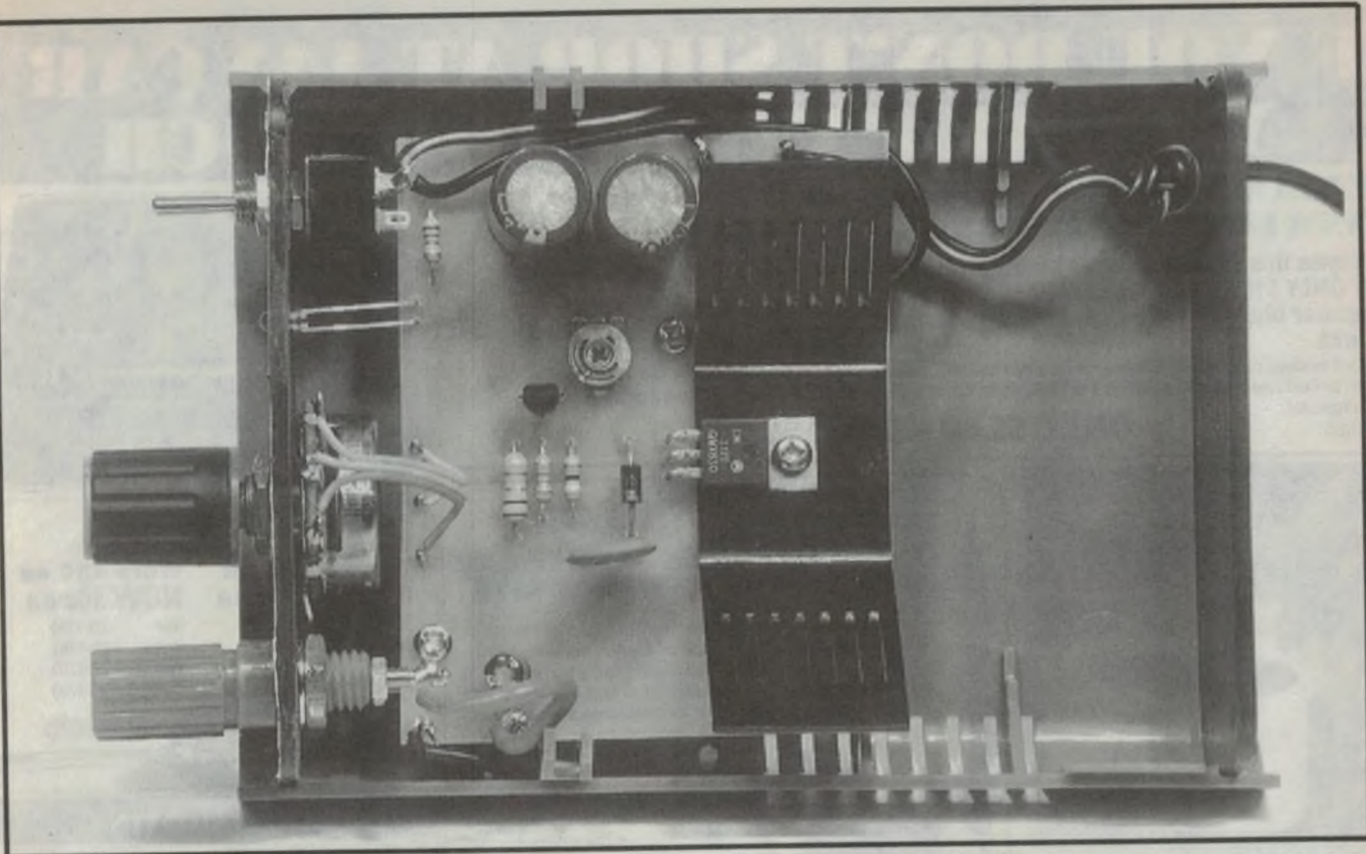
- 1 LM317T three-terminal regulator
- 1 BC548 or similar NPN transistor
- 1 Red LED, 3mm diameter
- 5 Power diodes, 1N4001, 1N4004 etc.

Resistors

- 1 1 ohm 1/2 watt
- 1 39 ohm 1/4 watt
- 1 1.5k 1/4 watt
- 1 2.2k 1/4 watt
- 1 1k linear pot
- 1 100 ohm horizontal trimpot, small

Capacitors

- 1 0.1uF ceramic
- 1 22uF 16VW electrolytic, PCB mount
- 2 470uF 25VW electrolytic, PCB mount



Another view inside the case, this time looking straight down. Use this together with the diagram opposite, as a guide to assembling your own supply. Note the knot in the incoming low-voltage AC cable.

two terminals, about 35mm long, and similar lengths of light hookup wire to the three pot lugs. You can also bring the end of the plug-pack output lead through the 4mm hole in the rear panel of the case, tying a double knot in the free end about 150mm from the end itself.

After this prepare the end of the power lead by pulling the two insulated wires apart, for a distance of about 75mm. Then strip about 4mm of insulation from the ends of each, and solder them to the centre and upper lugs on the rear of the switch.

Following this, locate a point on one of the two wires about 60mm from the switch, and cut that wire *only* at this point. Then strip back the insulation on both cut ends, and solder them to the pins at the rear left of the PCB, just alongside the four rectifier diodes.

You can now mount the PCB inside the bottom half of the case, making sure that the LED fits comfortably through its allocated hole in the front panel. After this you can solder the three wires from the pot lugs to the three PCB pins immediately behind the pot, and the two heavier leads from the output terminals to the two remaining PCB pins, at the front right-hand corner of the board.

The wiring of the supply is now complete, and you are ready for the 'smoke test'. This is simply a matter of plugging the plug-pack transformer into a convenient power outlet, with SW1 in the 'up' or off position, and then gingerly turning on the 240V power. If there is a puff of smoke, and/or a nasty 'phhhhutt' sound, you have probably made a wiring mistake – so switch off fast, and check everything again. It may be necessary to make repairs, if there has been any permanent damage.

It's really quite unlikely that there will be any smoke, thanks to the PCB and if you've been following the above description of construction. So if there is no obvious problem, and a finger applied to the regulator IC and the plug-pack transformer shows that they are still quite cool, your supply has probably passed the test.

Just to make sure, try turning on SW1. You should be rewarded by a reassuring glow from the LED, and still no other ill effects. The regulator IC, transistor Q1 and plug-pack transformer should still be as cool as cucumbers, showing that everything is in order, and ready for the final adjustment.

Setting up

There is really only one adjustment to be done, before the case can be clipped together. However before beginning, just make sure that you have fitted the control knob to pot VR1 so that it reaches the mechanical stops at each end in a balanced way. In other words, the positions of the knob pointer in both the fully anticlockwise and fully clockwise positions should be as close as possible to identical, in terms of angle to the vertical axis of the pot shaft.

With this right, the adjustment itself should be quite straightforward. The only additional items you will need are a small jeweller's screwdriver or similar tool, and a digital multimeter or analog multimeter of known calibration, set to a range where 15V DC can be read as accurately as possible.

First set the knob on VR1 to the '15' mark on the front panel – i.e., a few degrees short of maximum. Then, using the DMM to monitor the output voltage, simply adjust the internal trimpot VR2 with the jeweller's driver, until it is as close as possible to 15 volts. That's all there is to it.

This done, you can turn off and fit the top half of the case, pushing it down carefully so that it locates correctly over the front and rear panels. Then push it home until the spigots click together, and your power supply is complete. EA

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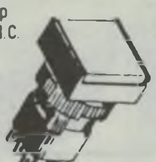

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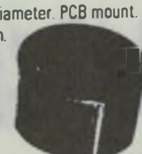

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Ref: Silicon Chip March 1989

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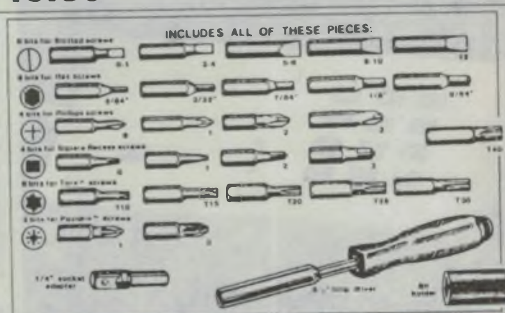

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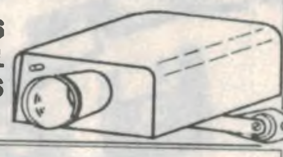

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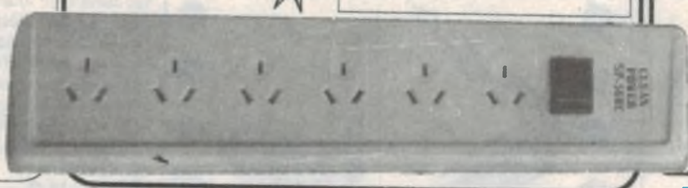

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Ref: Silicon Chip May 1989
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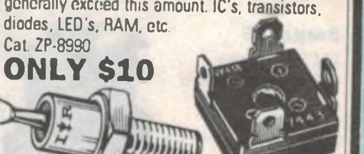

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Construction project:

Automatic charger for NiCads

Here's a fully automatic NiCad battery charger that is simple and cheap to build. It can charge single cells or cells in series up to 9V. Once the battery is charged, the unit automatically switches to trickle charge until you switch it off. It is fully featured, yet surprisingly simple.

by PETER PHILLIPS

Like so many projects, this one was developed to fulfil a need. As a result of an over-benevolent Santa, I was either faced with an annual bill for batteries that would send me broke, or I could invest in some NiCads and a suitable battery charger. As NiCads are now cost effective, it remained to see about a suitable general-purpose charger.

There were three choices available to me; buy one (shock horror), build one of the many designs published in magazines such as *EA*, or design my own. No way would I buy one, so out with all the old mags to see what was available.

As it turns out, *EA* has only ever published two NiCad charger designs, whereas other magazines, both locally and imported, have collectively presented quite a range. After examining all the designs I could find, it seemed that they were either too complicated, lacked features I felt necessary, or were for specific use only.

Some designs had features I liked – but none seemed to satisfy all my requirements. After all, I wanted a simple design that did everything; surely a reasonable thing to ask! However there was much to learn from the previous designs, particularly the opinions held by the authors concerning treatment of NiCads.

So it seemed that I would need to design my own. I wanted a circuit that would charge any of the popular sizes, either as single cells or in series, and would do it automatically – that is, it must have a timer. I also wanted it to have trickle charge facilities and to be simple enough for the kids to use (it was their bloomin' batteries I was doing this for, after all!). Finally, it had to be cheap and easy to build.

The end result meets all my criteria. If you look at the photograph of the prototype, you will notice it has two switches and three indicator LEDs. One switch selects the type of cell being charged and the other the charge time required. The LEDs indicate power ON, another signifies battery 'charging' and the third shows if the battery is on 'trickle' charge.

A nice feature of the circuit is that if for some reason no current is actually flowing into the battery, either when on charge or trickle, neither of these two indicator LEDs will light. That is, these LEDs are true current indicators – no current, no light.

When the charge time is up, the charger automatically switches to trickle charge, allowing the battery to be left connected indefinitely. It all fits into a jiffy box, and everything, including the switches and the LEDs are mounted on the PCB. All components are bog standard, so it is simple to build as well as use.

But that's not all. As you will read further on, NiCads are best charged only from a fully discharged state. To this end, there is a companion project, a NiCad *discharger*, to be presented shortly. It operates from the charger's power supply and will be able to automatically discharge any of the popular cells, either singly or as series packs. Combining the two projects will give incredible flexibility when it comes to looking after your NiCads.

Before getting into the charger description and construction, it is worthwhile looking briefly at the NiCad cell itself, to see what all the fuss is about.

The NiCad

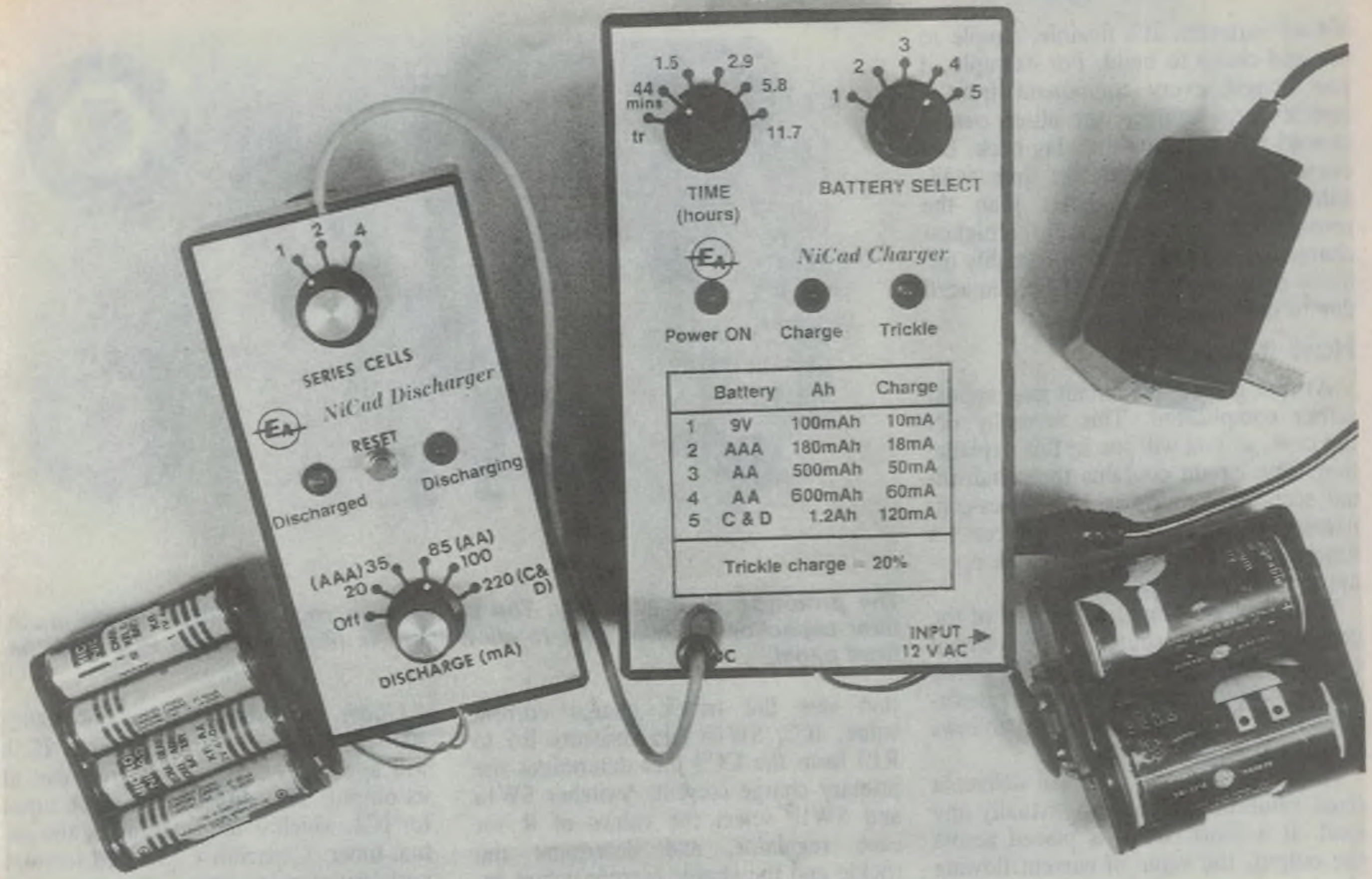
There has been much written about the NiCad cell, concerning how to treat it if you want the longest possible life from it. The NiCad cell is an interesting device in that it produces almost a constant voltage over its range of operation. From fully charged to virtually discharged, the voltage will vary by not much more than 0.2V, assuming a nominal output of 1.2V. This means the voltage of the cell does not really indicate its state of charge.

For this reason, the best way to charge a NiCad is for a fixed period at a constant current. That raises the questions: what value of current and for how long?

Ideally, to maintain it in best working condition, the cell should be regularly discharged, then recharged for 14 hours at a certain recommended current. However, because a NiCad will slowly discharge itself, even on no load, trickle charging is then needed to maintain the charge after it has been fully charged.

To determine the charge current, you need to know the ampere-hour rating (Ah) of the cell. All NiCad cells are given such a rating; for example the AA size cell is usually rated at around 500mAh. The Ah rating is roughly a function of current multiplied by time, which suggests a 500mAh cell should be able to deliver 500mA for an hour or 50mA for 10 hours. In fact, most cells, lead acid or NiCads alike can only live up to their Ah rating if the current drain is no greater than a certain value. If this current is exceeded, the battery will deliver less than its rated Ah capacity.

For the NiCad, the 10 hour rating is used, which means the specified capacity can only be delivered if the cur-



The battery charger with its companion discharger module. Combine the two and give your NiCads a new lease of life.

rent drain is one tenth the rated Ah value. Higher discharge currents will not only give less than the Ah capacity, but will also reduce the life of the cell.

Recharging a NiCad must also follow certain rules for best life expectancy. For example, it is recommended that a cell be charged at its 10-hour discharge current for 14 hours, meaning a 500-mAh cell should be charged at 50mA for 14 hours to fully recharge it. If you allow the charge time to exceed this, say up to 24 hours, permanent damage can occur due to overcharging. Also, if the charge current is too great, the cell can overheat and explode.

Alternatively, it is possible to trickle charge a NiCad over an indefinite period, providing the current is no more than around 20% of its normal charge current. This is not the best way to treat a NiCad though, as its life expectancy will be reduced if this is the only way it is ever charged.

There is also a school of thought that believes NiCads benefit from being given a heavy discharge, followed by a heavy, short duration charge. Maybe so; I'm not really game to try. Perhaps a NiCad expert might like to write in with some comments on this and NiCads in general.

So there are certain criteria that should be met if the cells are to have a long life. However, one can be too critical as well. After all, in some cases, NiCads can be picked up for a price not much more than a good quality alkaline battery. Also, the extra life one might get from a cell given the very best of treatment may not be significantly greater than that given by a cell treated a little more harshly.

There is room for compromise, an approach I've taken with this project in the interests of simplicity and versatility. Experts of the field may argue the case for 'cottonwool' treatment of the NiCad, but will also surely agree that there is such a thing as overkill.

The compromises

The ultimate way to look after a NiCad is therefore to discharge it almost completely, then recharge it for 14 to 16 hours at the 10 hour rate.

But say you want to ensure the torch batteries have sufficient charge to last for a particular task. Are you going to bother discharging them first (over a time interval that could take half a day) then recharge them for 14 hours? If they only cost a few dollars, it's more likely you would prefer to give them a boost charge for a few hours, regardless of their existing state of charge, then get on with the job.

The charger here allows that. It has five time settings, from 44 minutes to 11.7 hours. It also has various charge currents, matched to five Ah ratings typically found with NiCads. For example, you could give your 500mAh cells a charge for 2.9 hours at any of the current settings, preferably the correct one, but at a higher value if you were in a hurry. OK, this might eventually reduce the life of the cell, but it gets the job done!

The variations available make this charger extremely flexible, although some care should be exercised. For example, charging a cell at a current significantly higher than the 10 hour rate could lead to internal heating of the cell and cause it to explode. Also, continual recharging without using the cell would probably end up damaging it due to overcharging, and shorten its life considerably.

But used sensibly, this charger should be a great asset if you use a range of

NiCad charger

NiCad batteries. It's flexible, simple to use and cheap to build. For example, if you bought every component from a typical parts supplier, the all-up cost is around $45 including the plug pack. Because the maximum charge time available is 11.7 hours, rather than the recommended 14 hours, and the highest charge current is 120mA, it is highly unlikely cells can blow up, or be damaged due to overcharging.

How it works

At first glance, the circuit may appear rather complicated. This is really not the case, as you will see in this explanation. The circuit contains three individual sections comprising two series-connected constant current sources, a timer, and two comparators that operate the indicator LEDs.

Fig.1 shows a simplified version of the constant current source (CCS) circuit used in this project. The current that flows through the regulator is determined by the value of R, and follows the relationship of I = 1.25/R.

A CCS is a circuit that will deliver a fixed value of current into virtually any load. If a short circuit is placed across the output, the value of current flowing should not be any different to that when the circuit is coupled to a resistor or a voltage source such as a battery. The circuit of Fig.1 has excellent characteristics, despite only needing two components, and was chosen for these reasons.

With this circuit, the charge current is virtually independent of the load, from a short-circuit to a 9V battery. Naturally, the battery being charged cannot have a voltage higher than the input voltage to the CCS. For this project, the battery voltage limit is around 10 to 12V, although a 9V battery is probably as much as most users would need.

In the actual circuit IC1, SW1a and resistors R1 to R5 comprise the CCS

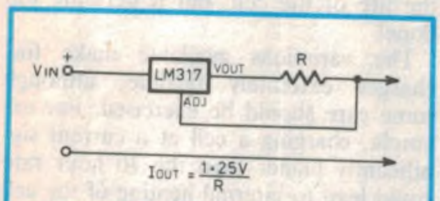
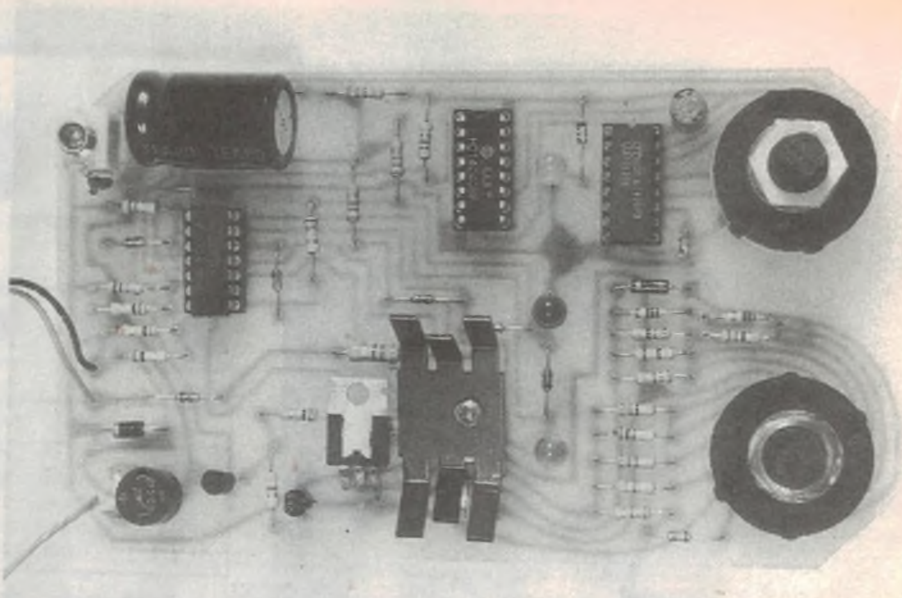


Fig.1: The constant current regulator circuit used in the project is basically this circuit. The current equals 1.25V/R. By changing the value of R, the current can be set as required.



The prototype PCB assembly. The two current regulator ICs and the main filter capacitor are bent over to allow them to fit between the PCB and the front panel.

that sets the trickle charge current value. IC2, SW1b and resistors R6 to R10 form the CCS that determines the primary charge current. Switches SW1a and SW1b select the values of R for each regulator, and determine the trickle and the charge current values respectively.

Transistor Q1 is connected in parallel with the trickle charge CCS. If Q1 is turned on, it will bypass this section, allowing the full charge current to flow from the power supply, through Q1, then through IC2 and its circuit to the battery. The value of resistor selected by SW1b will determine the charge current.

If Q1 is turned off, the current flowing is now determined by the circuitry around IC1. Diode D1 prevents the battery discharging through the circuit if the power to the charger is turned off. Resistor R11 is both a current sense resistor and protection if both regulators fail.

The timer section includes two counters (ICs 4 and 5) and a comparator (IC3b) that is used to convert the 100Hz ripple from the bridge rectifier to a clock signal for IC4. The counters are both CMOS 12-stage ripple counters, type 4040.

The fully rectified AC signal is isolated from the filter capacitor by D1, giving a 100Hz input signal to IC3b, attenuated by R17 and R18. The inverting input of IC3b is connected to the junction of R12 and R13, and the value of the voltage produced at this junction is used to control IC3b.

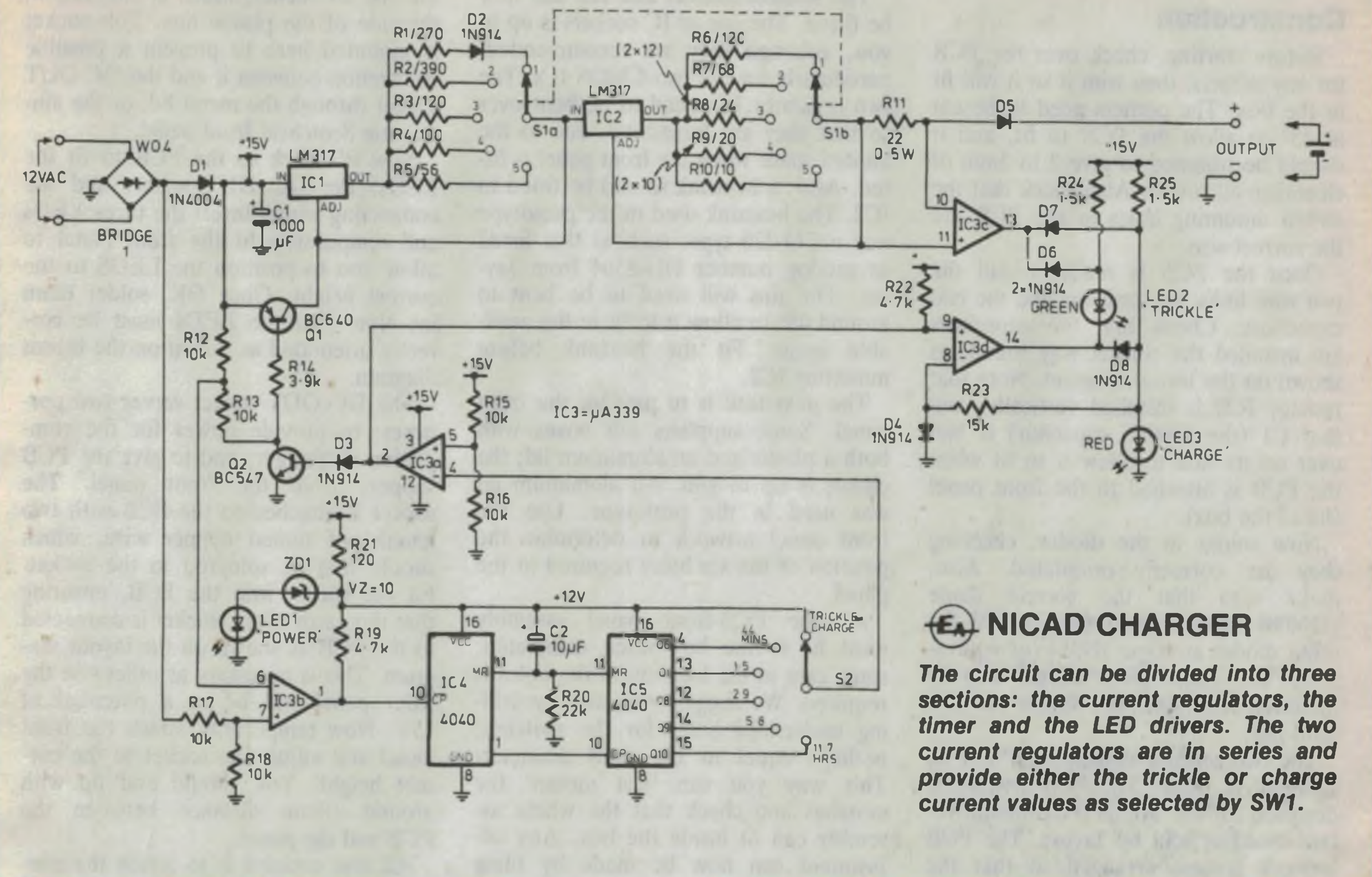
Under normal operation, the 100Hz AC signal at the inverting input of IC3b will appear as a 100Hz square wave at its output. This signal is the clock input for IC4, which is the first half of the actual timer. Capacitor C2 is used to reset both counters to zero when power is first applied, and resistor R20 holds the reset terminals of both counters low to allow them to operate.

The time interval between each high to low transition of the clock to IC4 is 10ms (one period of the 100Hz input signal). The counter will divide the clock frequency and at pin 1 (output 12, or Q11) a square wave with a period equal to 2^{12} (or 4096) times 10ms will result. This gives a total cycle time of 40.96 seconds, meaning each high to low transition of the clock signal to IC5 is spaced by this time interval. The outputs Q6 to Q10 of IC5 are used to give the required time delays.

For example, at output Q6 the input clock frequency will be divided by 2^7, or 128, giving a total cycle time of 5242.88 seconds or 87.38 minutes. The time the output of Q6 is low (from initial reset) will be half this (approximately 44 minutes), and if this output is selected by S2, a charge time of 44 minutes will result.

By using subsequent outputs, the time delays shown on the circuit are available. The highest time delay being used is 11.7 hours, which is as near to 14 hours as this circuit can produce.

So therein lies a tradeoff. To obtain a 14 hour delay, a separate clock oscilla-



NICAD CHARGER

The circuit can be divided into three sections: the current regulators, the timer and the LED drivers. The two current regulators are in series and provide either the trickle or charge current values as selected by SW1.

tor would have been required, with all the necessary adjusting and so on. The circuit here used is simple, highly accurate, and keeps the IC count down by at least one. If you really want a 14 hour charge time, select 11.7 hours, then when it has timed out, switch to either the 1.5 hour or 2.9 hour times and restart the charger.

The output of the timer is connected to the inverting input of comparator IC3a, which has its non-inverting input biased to half rail by R15 and R16. While the timer output is low, the output of IC3a will be high, turning Q2 on, which in turn allows Q1 to conduct. This means the first CCS regulator (IC1) is bypassed, and the charge current is determined by the second CCS regulator, IC2.

When the selected counter output goes high, the output of IC3a will switch low, turning off Q2 and Q1. This means the charge current is now limited by the CCS regulator of IC1, and trickle charging now takes over. The next trick is to stop the counter.

When Q2 is turned off, the voltage at the junction of R12 and R13 will rise to the rail voltage, from its previous value of approximately half rail. This voltage is connected to the inverting input of IC3b, which will respond by sending its output low – as the 100Hz signal at the non-inverting input is now always less than the voltage at the non-inverting terminal. This now means there is no clock signal to the counters, and everything remains in this condition until the counters are reset.

As no reset button has been fitted, reset is accomplished by turning off the power to the charger. The cycle will then recommence when power is restored.

The zener diode and the 'power' LED are used to regulate the supply voltage to the CMOS counters, which have a maximum operating voltage of 15V. Resistors R19 and R22 are pull-up resistors for the open-collector output stage of the comparators. D3 ensures the output voltage of IC3a must exceed 1V or so to operate Q2.

The final section concerns IC3c and IC3d, which collectively operate LEDs 2 and 3. If the output of IC3a is high, allowing the full charge current to flow, the output of IC3d will also be high. This will reverse bias D8, hold LED 2 off, and allow LED 3 to turn on, indicating that 'charge' is in progress.

The network of R23 and D4 sets the inverting input of IC3d to 0.6V, meaning the voltage to the non-inverting input must fall below this value before the comparator can change state. This will occur when the output of IC3a goes low, sending the output of IC3d low. Under these conditions, LED 2 will light, and D8 will be forward biased, shorting out LED 3. This will give the desired indication that the charger is now in 'trickle charge' mode.

However, IC3c is arranged to detect the presence of current by sensing the voltage across R11. If current is flowing, the output of IC3c will be high, and both diodes D6 and D7 will be reverse biased. If no current flows, the output of IC3c will be low, allowing the diodes to conduct. This will short out the LEDs and extinguish whichever one happened to be on.

So it really is simpler than it looks. The whole circuit is powered by the bridge rectifier which is connected to a 12V AC plug pack. C1 is a filter capacitor for the power supply. Building it is even simpler.

NiCad charger

Construction

Before starting, check over the PCB for any defects, then trim it so it will fit in the box. The corners need to be cut at 45° to allow the PCB to fit, and it should be trimmed to give 2 to 3mm of clearance all round. Also check that the switch mounting holes in the PCB are the correct size.

Once the PCB is ready, install the two wire links, the resistors and the two capacitors. Check that the capacitors are installed the correct way round, as shown on the layout diagram. Note that resistor R20 is installed vertically, and that C1 (the 1000uF capacitor) is laid over on its side to allow it to fit when the PCB is attached to the front panel (lid of the box).

Now solder in the diodes, checking they are correctly orientated. Also, make sure that the correct diode (1N4004 type) is used for D1. All the other diodes are type 1N914 (or equivalent). The zener diode should also be mounted now, but the LEDs are left until last.

The two selector switches can now be soldered in place. The PCB artwork is designed for the 'Alpha' PCB-mount rotary switches sold by Jaycar. The PCB artwork is also arranged so that the pointer of the recommended knob will align with the front panel artwork. Therefore check that the switches are correctly fitted before soldering them in.

The semiconductors and ICs can now be fitted. The use of IC sockets is up to you, although they are recommended, particularly for the two CMOS ICs. The two regulator ICs need to be bent over so that they are horizontal, due to the limited space when the front panel is fitted. Also, a heatsink should be fitted to IC2. The heatsink used in the prototype was a TO-220 type, such as that listed as catalog number HH-8504 from Jaycar. The fins will need to be bent to around 45° to allow it to fit in the available space. Fit the heatsink before mounting IC2.

The next task is to prepare the front panel. Some suppliers sell boxes with both a plastic and an aluminium lid; the choice is up to you. An aluminium lid was used in the prototype. Use the front panel artwork to determine the position of the six holes required in the panel.

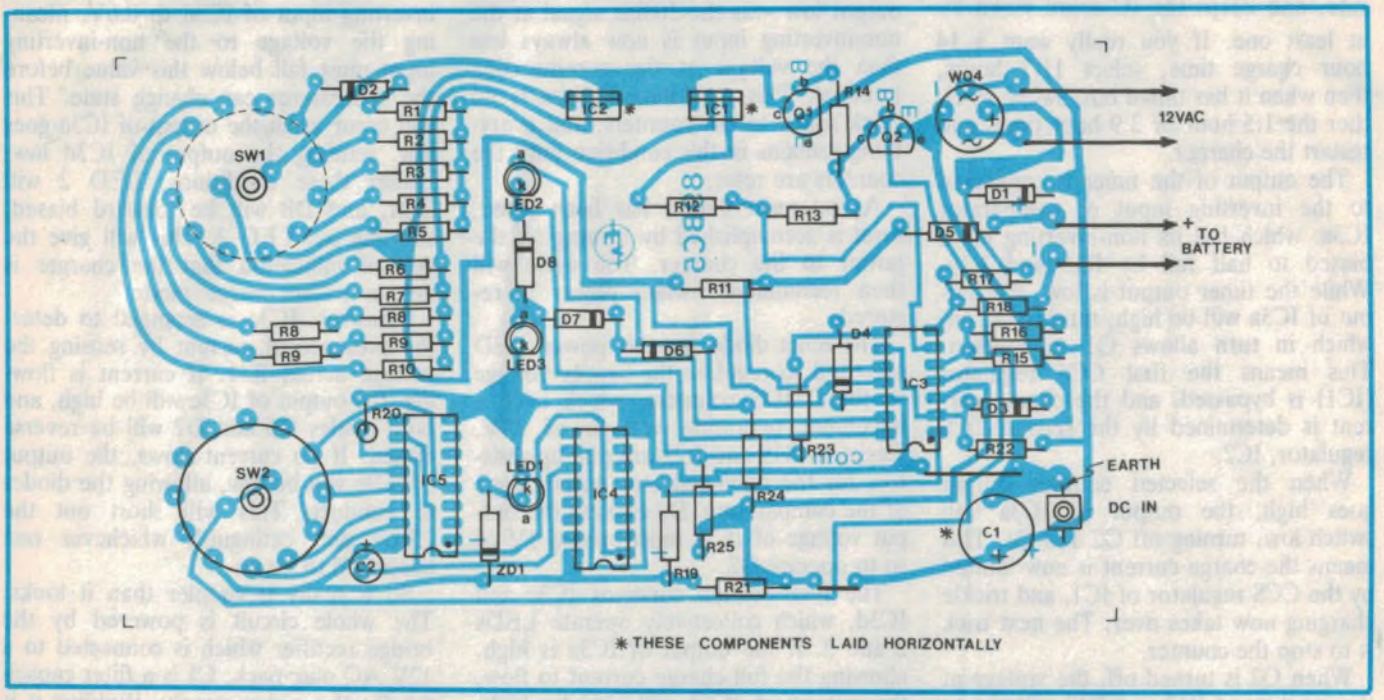
As the PCB-front panel assembly must fit in the box when completed, some care in the location of the holes is required. We suggest you start by drilling undersized holes for the switches, perhaps equal to the shaft diameter. This way you can 'test mount' the switches and check that the whole assembly can fit inside the box. Any adjustment can now be made by filing these holes to compensate.

Once the switch mounting holes are drilled, use the artwork again to locate the holes for the LEDs and the DC OUT socket. The only other hole is for the AC IN socket, which is mounted in the side of the plastic box. This socket is mounted here to prevent a possible connection between it and the DC OUT socket through the metal lid, or the aluminium Scotchcal front panel.

Now it's back to the PCB to fit the LEDs, the DC OUT socket and the connecting wires. Insert the three LEDs and temporarily fit the front panel to allow you to position the LEDS to the correct height. Once OK, solder them in. Note that the LEDs must be correctly orientated as shown on the layout diagram.

The DC OUT socket serves two purposes; to provide power for the companion discharger, and to give the PCB support from the front panel. The socket is attached to the PCB with two lengths of tinned copper wire, which should first be soldered to the socket. Fit the socket into the PCB, ensuring that the earth of the socket is connected to the PCB as shown on the layout diagram. This is necessary as otherwise the front panel will be at a potential of 15V. Now temporarily attach the front panel and adjust the socket to the correct height. You should end up with around 18mm distance between the PCB and the panel.

All that remains is to attach the connecting leads for the AC IN socket and for the battery holder(s). File a slot in the top of the box as an exit point for the battery holder leads.



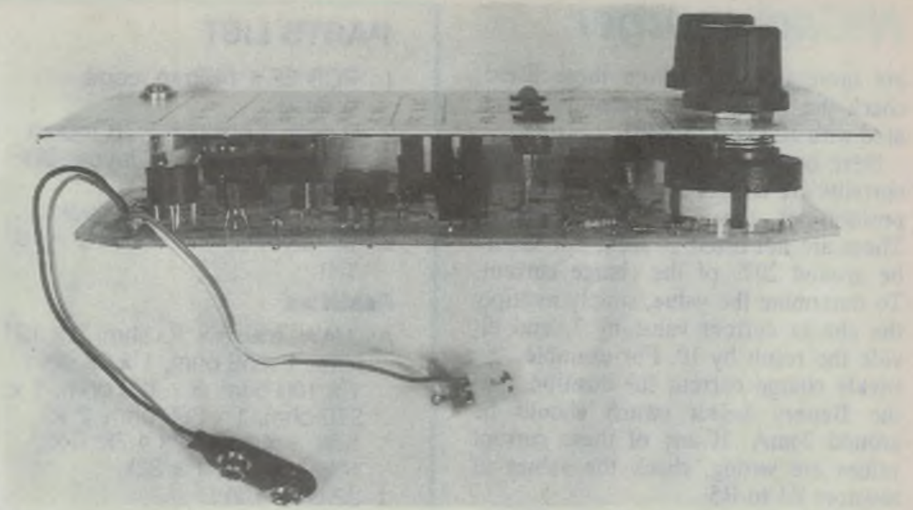
The PCB layout diagram. Note that R8 and R9 both require two resistors to give the required values of 24 and 20 ohms respectively.

Testing

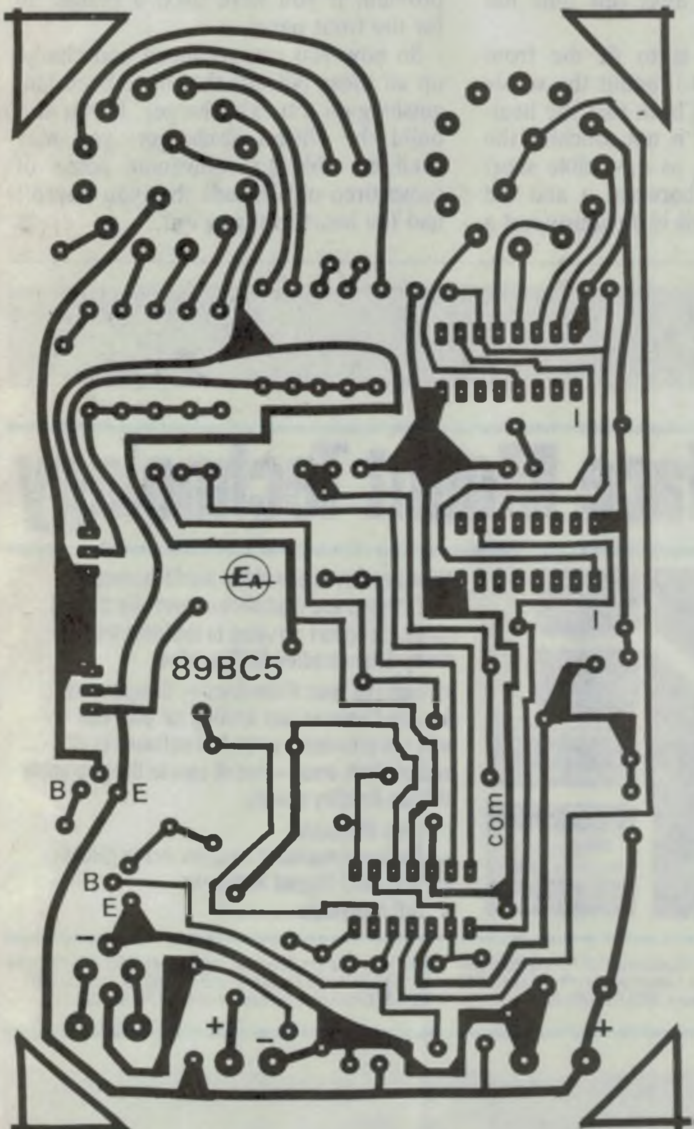
Having completed construction, check your work for any possible mistakes. Check particularly for possible track shorts and wrongly orientated components.

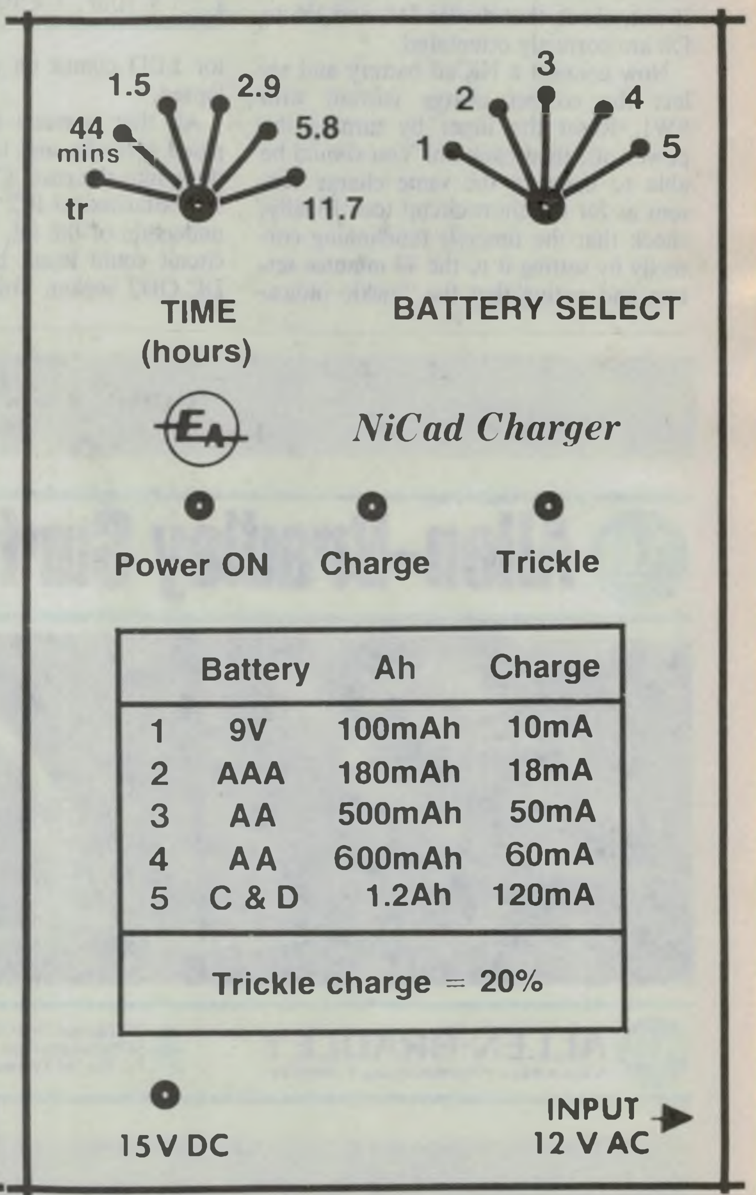
Connect a 12V AC source to the unit, and note that the Power ON LED lights. If it doesn't, trace through with a voltmeter to find out why. If it does, connect an ammeter across the battery holder wires to give a short-circuit between them. Depending on the position of the selector switches, you should be able to measure a current and observe that one of the current indicator LEDs is now on.

If all is well, check that the current is the correct value for each of the settings of the Battery Select switch. Make sure the Time select switch is not on trickle (tr) when checking the values of the charge currents. If any of these values



The complete assembly, showing how the front panel and the PCB are attached together. The switches give support for the PCB at one end, and the DC OUT socket support at the other.





The PCB artwork and the front panel artwork are both reproduced full size. Use the front panel artwork to assist in marking out the front panel for drilling.

are more than 10% from those listed, check the values of the resistors associated with IC2 (R6 to R10).

Next confirm that the trickle charge currents are correct, by selecting the 'tr' position of the Time select switch. These are not listed as such, but should be around 20% of the charge current. To determine the value, simply multiply the charge current value by 2, and divide the result by 10. For example, the trickle charge current for position 5 of the Battery Select switch should be around 24mA. If any of these current values are wrong, check the values of resistors R1 to R5.

Also confirm that both the Charge and Trickle LED indicators extinguish when there is no external current path. If not, check that diodes D4, and D6 to D8 are correctly orientated.

Now connect a NiCad battery and select the correct charge current with SW1. Reset the timer by turning the power off, then back on. You should be able to measure the same charge current as for the short-circuit test. Finally, check that the timer is functioning correctly by setting it to the 44 minutes setting and noting that the Trickle indicator LED comes on after this time has lapsed.

All that remains is to fit the front panel artwork, and to mount the whole thing into the case. Check that the heatsink attached to IC2 is not touching the underside of the lid, as a possible short circuit could result between it and the DC OUT socket. This is obviously not a problem if you have used a plastic lid for the front panel.

So now you can go ahead and charge up all those NiCads that have been languishing on a trickle charger. If you also build the NiCad discharger, you may even be able to rejuvenate some of those tired old NiCads that you haven't had the heart to throw out.

PARTS LIST

1 PCB 85 x 145mm, code 89BC5
2 2 pole 6 position PCB mount selector switches (Jaycar SR-1212)
1 12V 300mA AC plug pack
3 IC sockets, 1 x 14 pin, 2 x 16 pin.

Resistors

All 1/4W, 5%: 3 x 10 ohm, 2 x 12 ohm, 1 x 56 ohm, 1 x 68 ohm, 1 x 100 ohm, 3 x 120 ohm, 1 x 270 ohm, 1 x 390 ohm, 2 x 1.5k, 1 x 3.9k, 2 x 4.7k, 6 x 10k, 1 x 15k, 1 x 22k.
1 22 ohm 1/2W.

Capacitors

Electrolytics, 25VW, PCB mount: 1 x 10uF, 1 x 1000uF

Semiconductors

6 1N914 signal diodes
2 IN4004 diodes
1 WO4 1 amp bridge rectifier
3 5mm LEDs, red, green and yellow
1 10V 400mW zener diode
1 BC640 PNP 1 amp transistor
1 BC547 NPN transistor
2 LM317, TO220 adj. voltage regs.
1 uA339 quad comparator
2 4040 12 stage CMOS counters

Miscellaneous

2 x panel mount 3.5mm phono sockets, zippy box, size UB1, 50 x 90 x 150mm, 2 x 20mm dia knobs to suit switches, (Jaycar cat HK-7762), battery pack connector to suit, LED mounting bezels. TO220 heatsink.

Construction project:

3–chip SCSI host adaptor card for PC's

Back in the January issue, we gave details of a new application-specific IC from NCR Microelectronics, the 53C400, which provides just about all of the circuitry necessary to provide IBM PC's and compatibles with a SCSI interface. Here's the design for a complete low cost and easy-to-build host adaptor card using the 53C400.

by JIM ROWE

As noted in the previous article describing the NCR 53C400 chip (January 1989, pages 136-139), the Small Computer Systems Interface or 'SCSI' bus has quickly gained acceptance as the preferred way to interface hard disk drives, laser printers and other mass-data-transfer peripherals to microcomputer systems. It is essentially a local-area interface, designed to transfer data in parallel byte-wide form at rates of up to 4M bytes/second, between as many as 8 different devices – including the computer.

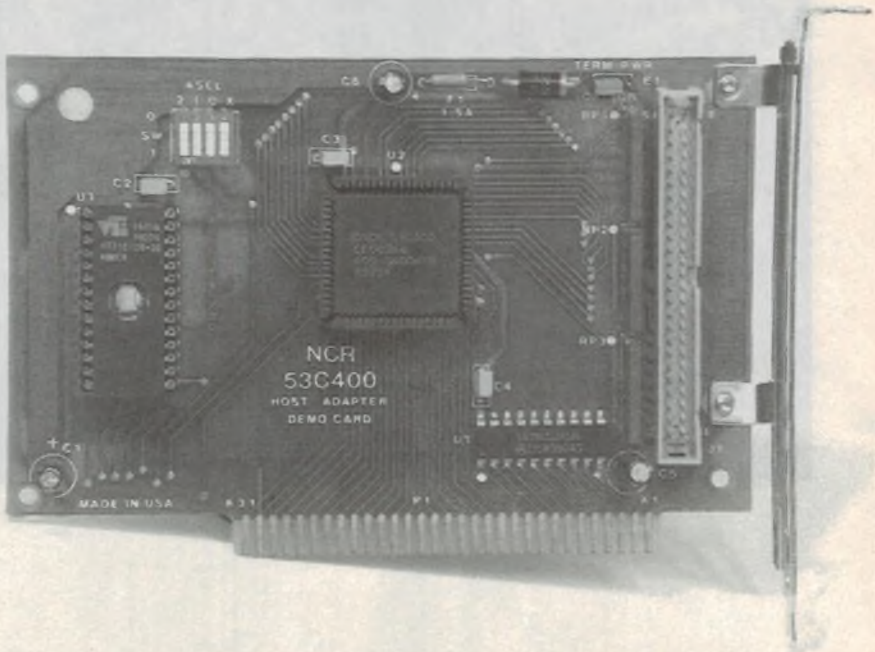
With the SCSI system, all devices have their own intelligent controllers, which perform local control of all 'primitive' device operations, behaving externally as logical subsystems capable of sending and receiving blocks of data. The controller/interface which resides in the host computer is generally known as the 'host adaptor'.

Until recently, SCSI host adaptor cards for the IBM PC family and compatible machines were quite expensive, with many medium- and low-level ICs. However with the release of ASIC controller chips such as the NCR 53C400, it has now become possible to produce a complete PC-compatible host adaptor controller card at much lower cost than before.

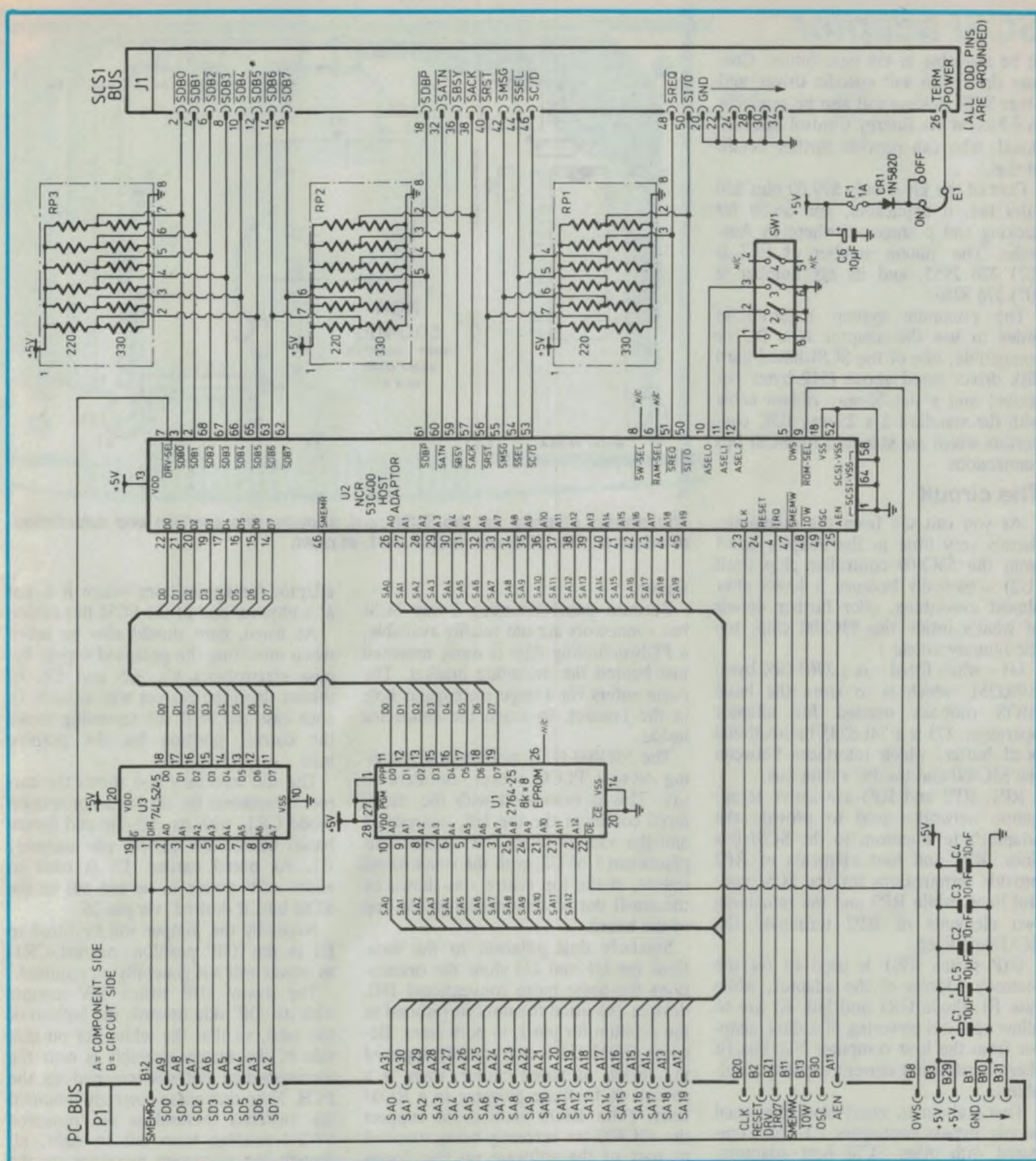
The 53C400 is a VLSI chip which comes in a 68-pin PLCC (plastic leadless chip carrier) package. It contains a pair of high speed bidirectional parallel ports for the SCSI bus data and control lines, plus high-current output drivers and logic to implement basic bus handshaking and physical control of data transfer phases – equivalent to an industry-standard 53C80 low-level physical SCSI bus controller.

Together with these, however, it also provides two 128-byte rotating (FIFO) RAM data buffers, for speed matching, a 64-byte scratchpad RAM for storage of BIOS tables or calculations, programmable interrupt level logic, memory mapped host addressing and PIO block counting circuitry to allow the use of block move instructions for faster bulk transfer of data. In short, just about all of the functions required for a high-performance SCSI host adaptor are available on the 53C400 chip itself.

The card design presented here has actually been developed by the applications people at NCR Microelectronics, to demonstrate how easy it is to use the 53C400 chip as a host adaptor for IBM PC's and compatibles. It normally uses only two other chips apart from the 53C400 itself – a 2764-25 8K byte EPROM, and a 74LS245 octal buffer – plus a mere handful of other parts. Everything fits on a single half-length PC plugin card, and is very easily put together in a couple of hours.



The completed SCSI adaptor card. Thanks to the 53C400 VLSI chip, few other components are needed to produce a complete SCSI host adaptor.



The complete circuit for the card. EPROM U1 is not actually supplied in the kit, which uses RAM drivers.

Incidentally, complete kits for the SCSI host adaptor will be available via mail order from the Australian distributors for NCR Microelectronics, who are Energy Control International, of 26 Boron Street, Sumner Park, Queensland 4074. The kit is complete with a floppy disk containing installable BIOS device drivers, together with a program to test operation of the adaptor and a formatting utility for SCSI hard disk drives.

I should note here that the kit currently does not include a BIOS ROM. The BIOS driver routine supplied as a file on the kit's floppy disk is intended to be installed in RAM via your CONFIG.SYS file, as explained later. Also it will currently support only the following SCSI hard disk drives:

1. Conner CP3100
2. Seagate SD157N
3. Quantum Prodrive 405
4. Rodime RO632
5. Rodime RO 3057S

Support for other drives is expected

to be available in the near future. Custom drivers to suit specific drives and other SCSI devices will also be available in EPROM via Energy Control International, who can provide further details of this.

Cost of the kit is only $99.00 plus $20 sales tax, if applicable, and $6.50 for packing and postage anywhere in Australia. The 'phone number of ECI is (07) 376 2955, and its fax number is (07) 376 3286.

The minimum system required in order to use the adaptor is a PC or compatible, one of the SCSI-based hard disk drives listed above (512 bytes per sector) and a flat 50-way ribbon cable with the standard 2 x 25-way IDC connectors which are standard for SCSI bus connections.

The circuit

As you can see from the schematic, there's very little in the adaptor apart from the 53C400 controller chip itself (U2) – basically because it looks after almost everything. (For further details of what's inside the 53C400 chip, see the January article.)

U1 – when fitted – is a 2764 (8K byte) EPROM, which is to store the basic BIOS routines needed for adaptor operation. U3 is a 74LS245 bidirectional octal buffer, which interfaces between the 53C400 and the PC's data bus.

RP1, RP2 and RP3 are active termination networks used to provide the adaptor's terminations to the SCSI bus lines. RP1 and four elements of RP2 provide terminations for the SCSI control lines, while RP3 and the remaining two elements of RP2 terminate the SCSI data lines.

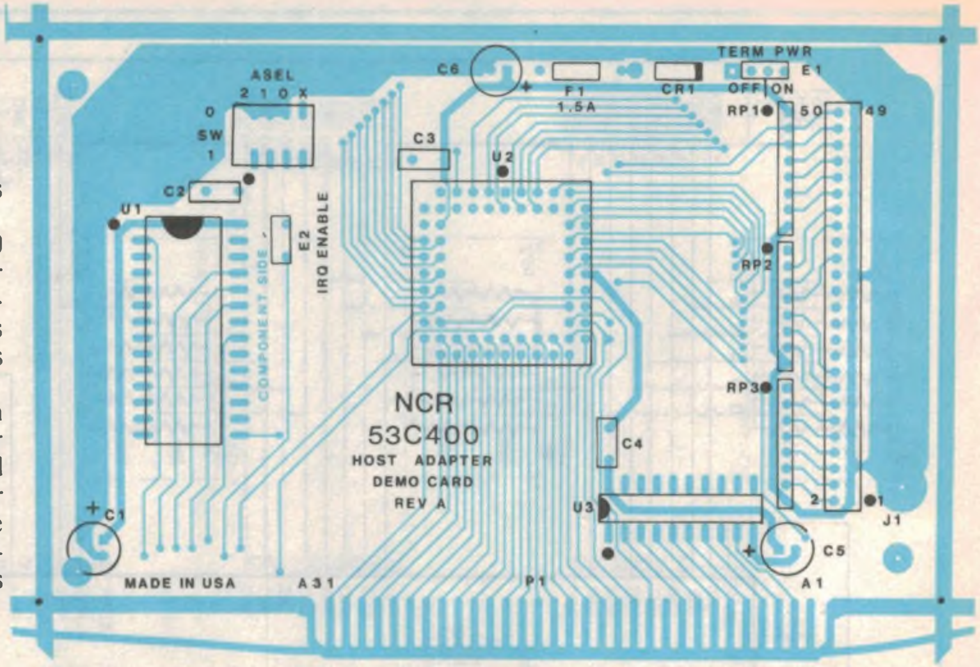
DIP switch SW1 is used to set the memory address of the adaptor, while fuse F1, diode CR1 and link E1 are to allow optional powering of a slave adaptor from the host computer Vcc line (if there is sufficient current capacity available).

That's about it, apart from the usual supply bypass capacitors C1-C6. Compared with other SCSI host adaptors, there's very little involved – at least outside the 53C400.

Construction

Everything fits on a 'short' PC plugin card, which measures only 140 x 95mm including edge connector – but not the mounting bracket.

As you can see from the picture and the overlay diagram, the board is anything but crowded. In fact it's positively roomy.



The overlay diagram for the SCSI card, showing the position and orientation of all parts. The SCSI connector is J1, at right.

Because panel-mounting 5-way SCSI bus connectors are not readily available, a PCB-mounting type is used, mounted just behind the mounting bracket. The cable enters via a large rectangular hole in the bracket, to reach the connector inside.

The 53C400 (U2) mounts in a matching 68-way PLCC socket, needless to say. This is orientated with the chamfered corner at the top left, nearest C3 and the address select DIP switch. This places pin 1 of U2, with the small round indent, at the top centre - as shown by the small dot screen-printed on the top of the board.

Similarly dots adjacent to the locations for U1 and U3 show the orientations for these more conventional DIL devices. As usual the dots correspond to the position for pin 1, in both cases. Because ROM U1 is not actually supplied in the kit, as noted earlier, there is a socket, to facilitate plugging in a ROM later. (The BIOS routines to support the 53C400 are currently being supplied as part of the software on the floppy disk supplied with the kit.)

Much the same care must be used in mounting the terminating resistor blocks RP1-3, which are in SIP (single-in-line packages). As they are not electrically symmetrical these must also be orientated the correct way around, with the 'notch' ends towards the top of the card and nearest the dots. These blocks also mount in 8-way SIL sockets, to allow removal of the terminations from the adaptor for applications where it is not at a physical end of the SCSI bus cable.

As usual, care should also be taken when mounting the polarised supply bypass electrolytics C1, C5 and C6, to mount them the correct way around. In each case the PCB silk screening shows the correct position for the positive lead.

The silk screening also shows the correct orientation for the series protection diode CR1, with its cathode end (white band) nearest the jumper pin assembly E1. As noted earlier, E1 is used to allow +5V power to be fed out to the SCSI bus, if desired, via pin 26.

Normally the jumper will be fitted to E1 in the 'Off' position, nearest CR1, as power will not generally be required.

The 4-way DIP switch SW mounts with its 'Off' side towards the bottom of the card, so that the white dot on that side of the switch assembly is near the corresponding dot silk-screened on the PCB. Note that when correctly mounted the switches themselves are mounted SW1-4 reading from left to right, although the silkscreen markings on the PCB actually read 2-1-0-X.

The only remaining point to watch with the PCB assembly is that the 50-way SCSI bus connector J1 is orientated with its centre gap facing towards the mounting bracket, as visible in the picture.

Setting it up

The only real setting up required for the adaptor card is to set the address

TABLE 1 - Segment Addressing

SW1	SW2	SW3	Address Segment
0	0	0	D400
0	0	1	D000
0	1	0	CC00
0	1	1	C800
1	0	0	E400
1	0	1	E000
1	1	0	DC00
1	1	1	D800

segment of the 53C400 controller in the PC's memory space, using switches 1-3 of the DIP switch. (Switch 4 is not used.)

There are eight possible address segment settings possible, using all combinations of the three switches. Table 1 shows the eight settings, and the corresponding address segments. For use with the BIOSTEST.EXE program supplied with the kit, the switches should be set for a segment address of D000 (switch setting 001 – SW1-2 on, SW3 off). However if this conflicts with the segment address of any other I/O card in your PC, you may need to change it.

The address space mapping used by the 53C400 within the selected segment is as shown in Table 2. Note that on this card, no external SRAM is used so that addresses 3A00-3FFF are not occupied.

Testing & operation

The software disk enclosed with the kit contains the following files:

1. README.DOC – a text file describing how to use the software.
2. SDFORMAT.COM – a format utility for SCSI hard drives.
3. SCSIIDD.SYS – an installable driver for SCSI hard drives.
4. BIOSTEST.EXE – a utility to access and trace calls to the logical interface.

To use the SCSI software on the disk you must do three things. Because the software doesn't have a SCSI ROM to work with yet, it expects the NCR host adapter to have its segment selection switches set to the D000 setting noted earlier. When the ROM version is ready it will dynamically find out what the real setting is and adjust itself accordingly.

Secondly, you must format the disk drive that is hooked up to the host adapter via the SCSI cable. To do this you must run the SDFORMAT.COM program, provided on the floppy disk.

With the drive hooked up to the system and powered up, log on to the floppy disk and issue the following command:

SDFORMAT id lun

Where 'id' stands for the SCSI disk drive's target id, and 'lun' stands for the SCSI disk's logical unit number.

The formatting program will then issue a few commands to the drive, to find out what kind it is, and show you this information. It will then ask whether that is the correct drive to format. If you answer anything but 'y' or 'Y', it will not do the formatting.

If you answer y or Y to the prompt, formatting will be performed. Note that this version of the software doesn't support the '/s' option to put the operating system on the SCSI drive.

TABLE 2 - 53C400 Address Space

14K byte external ROM	0000-37FF
64 byte internal SRAM	3800-373F
Internal 53C80 registers	3880-3887
Host interface data port	3900-397F
Control/status registers	3980-3982
1.5K byte external RAM (opt.)	3A00-3FFF

Once the above has been done successfully, you are ready to install the SCSI Installable Device Driver. This is done by editing your CONFIG.SYS file and adding the line:

device = SCSIIDD.SYS

You must then copy the SCSIIDD.SYS file from this disk to the root directory of the disk your PC will be booting from (this is the same directory and disk that your CONFIG.SYS file resides in).

Just to make sure that you can re-boot if there are problems with the software, you may want to copy this software to a floppy that has the system and the CONFIG.SYS file on it. Then after modifying the CONFIG.SYS file on the floppy, try booting from it. In this way, if it fails, you can take the floppy out and re-boot from your regular disk.

By the way, you only need one 'device = SCSIIDD.SYS' line added to the CONFIG.SYS file, even if you have several SCSI drives on the SCSI bus. The software will find them all, and assigns drive letters in ascending order according to their target id.

After setting up as above, booting will bring the SCSI drive (or drives) up with the next available drive letter(s). If you currently have a C: drive, and no D: drive, then the SCSI drive will come up as D:. If you have a D: drive already, then the SCSI drive(s) will come up as E: (and F:, G:, etc.).

The starting drive letter that DOS assigns is also dependent on the position of the added 'device = SCSIIDD.SYS' line in your CONFIG.SYS file. If this line is *after* any other 'device =' lines, then will be assigned a drive letter that is one beyond what your system currently has. But if you place it *before* any existing 'device =' lines that are also for block devices, you will possibly cause your existing drives to have different logical drive letters than those you and your software are used to. This is just how DOS works, and has nothing to do with the SCSI software.

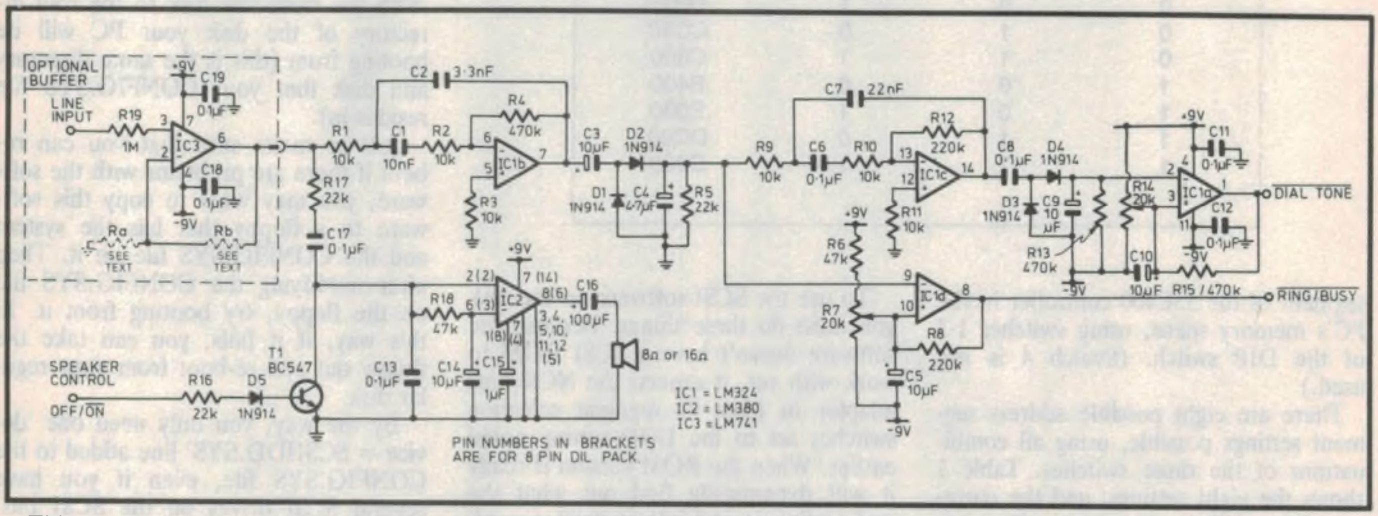
Finally, to use the BIOSTEST utility, simply type in the command 'BIOSTEST' at the DOS prompt (while still logged onto the drive containing the kit floppy). This utility will ask several questions, to perform a limited number of SCSI commands to the hard drive(s) on the SCSI bus. Tracing can also be enabled during its use.

Further information on software aspects of using the adaptor are available from Energy Control International, at the address given earlier.

Circuit & Design Ideas

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

Telephone ring/busy dialtone detector



This telephone tone detector will enable a modem to act as a phone dialler. Dial tone is detected separately from ring/busy tone, enabling a computer to decide if a line is available. Very handy if an outside line is not guaranteed by either the exchange or a PABX. After dialling, the software would monitor the RING/BUSY output to decide whether the dialled number is busy or is ringing out. Appropriate action can then be taken by the computer.

Ring and busy tones are both sine waves of about 430Hz. Line tones amplified by band pass filter IC1b and then fed to D1/D2 and RC network R5/C4, where it is rectified. A DC voltage is built up, triggering IC1d, whose RING/BUSY output will go low. C6/C7 prevents this DC voltage reaching IC1c, thus IC1a output DIALTONE will remain high.

Dialtone is also 430Hz, but amplitude modulated by 50Hz. D1/D2 etc., then acts as an AM demodulator recovering the 50Hz tone. While IC1d will trigger repeatedly, band pass filter IC1c will amplify the 50Hz signal, which is then rectified by D3/D4. the resulting DC voltage over R13/C9 triggers IC1a, forcing DIALTONE low. It will remain low while dial tone is present due to filtering by R13/C9.

Trimpots R7 and R14 adjust triggering the level of the respective outputs. A high setting increases the response delay, the opposite may cause false triggering. Both outputs are RS232 compatible.

The input signal is also fed to an optional audio amplifier IC2 via R17 and C17, driving a monitor speaker. This monitor circuit is enabled by a negative or zero voltage on SPEAKER CONTROL input. Bringing it positive causes T1 to conduct, effectively shorting out the input to IC2, and disabling the speaker. Volume may be reduced by increasing R17 from 22k.

The line input should be connected to an EXTERNAL RX or MONITOR output from the modem, if one exists. Alternatively a speaker output, or even a microphone placed near any built-in speaker in the modem could be used.

When the modem output is high impedance, or noise from a long connecting wire could upset modem performance, an optional buffer (IC3) should be installed as close as possible to the modem – not on the detector board. I built mine into a DB25 plug, at the modem end of the line. Noise on the connecting line did interfere with modem reception before the buffer was introduced. Resistors Ra, Rb may be inserted to produce some gain if required – try a 100K trimpot. Otherwise tie pin 2 to pin 6.

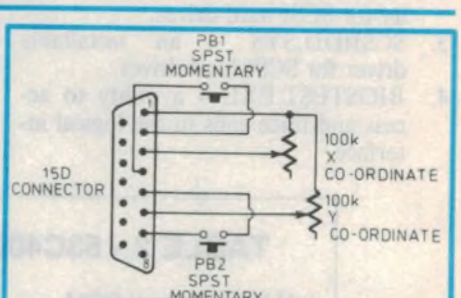
Note that if you actually solder any connections inside your modem, any Telecom approval (and warranty) will be void. Having said this, a suitable take off point for the detector is the modem side of the line isolation transformer. UNDER NO CIRCUMSTANCES SHOULD THIS UNIT BE CONNECTED DIRECTLY TO THE TELEPHONE LINE.

C.V. Palm,
Boulia, QLD **$50**

Joystick 'Y' adaptor

Most IBM and compatible computers come with a games adaptor or joystick port of some description, which appears only to be able to contain one joystick at one time. This isn't true, because the port can actually hold and address two joysticks at once. All that is required ia a Y adaptor with the correct cross overs, and presto!

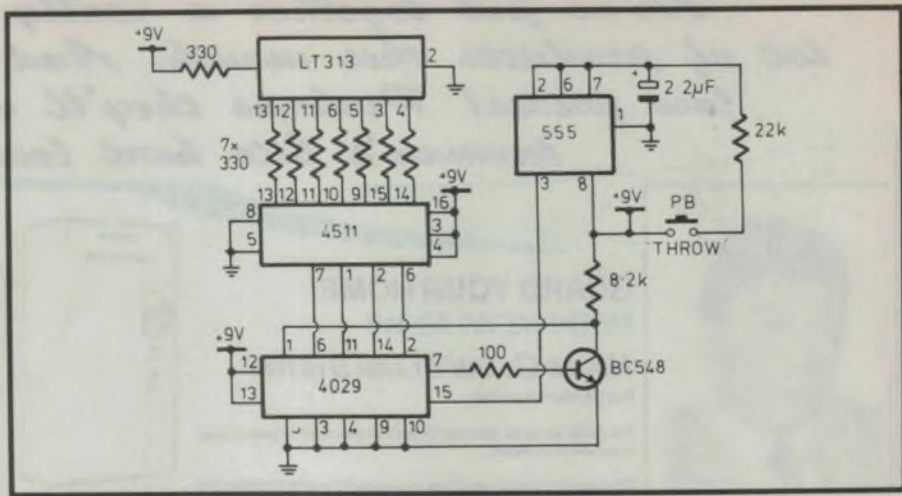
Some computer retailers will try to sell you another controller card with the same port you have on your multifunction card, except it contains a built in Y adaptor on board – allowing two normal joysticks to be connected.



With the Y adaptor shown, simply plug the male connector into the computer and your joysticks in the other connectors.

Brett Wood,
Bellbird Park, Qld **$20**

Digital Dice



This circuit simulates rolling a dice, in which pressing and releasing a button causes any number between 1 and 6 to be displayed.

The display is an LT313 7-segment LED display, driven by a 4511 BCD to 7-segment decoder/driver. The input to the 4511 is from a programmable binary decade counter, type 4029, in turn clocked by a 555 timer connected as an astable multivibrator.

When the button is pressed, current will charge the timing capacitor (2.2uF) via the 22k resistor. When the threshold point is reached, the capacitor is discharged by the 555, and the output (pin 3) changes state. The cycle repeats as long as the button is pressed. The output of the 555 is applied to the clock input of the counter.

The parallel load pins of the counter are preset to binary 0110, or decimal 6. However, it is necessary to ensure the counter only counts from 6 down to 1, instead of zero. This is achieved by connecting pin 7 (terminal count) to the base of the BC548 transistor, turning it off when the counter equals zero. This action sends the collector high and applies a logic 1 to the parallel load pin (pin 1) of the counter.

The binary code of 0110 is then loaded into the counter, and the cycle continues as long as the button is pressed. The final count is applied to the 4511, which will then cause the display to show the final count value. While the button is pressed, the display will show a flickering figure 8, and the final value is a random number between 1 and 6.

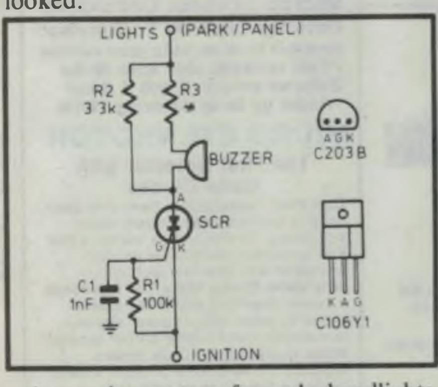
James Hemphill,
Blacktown, NSW.

$30

'Lights on' alarm

Recently, while fitting a digital clock to my car, the following light warning system evolved as an after-thought and, due to its low component count, was grafted onto the clock, where all the required connecting points to the car wiring – lights, ignition, ground – are already available.

This is the time of year where one may leave home in the morning in semi-darkness, possibly only with the parking lights on, to arrive at the destination in bright daylight, where the fact that lights are still on is forgotten and overlooked.



A warning system for only headlights would require no more than a buzzer in series with a diode across the headlight and ignition wiring. However, if all lighting is to be monitored and the car is occasionally required to be parked with parking lights on, switching is required to silence the alarm.

In this circuit the diode is replaced by an SCR. With the ignition on, C1 is charged via R1. Turning the ignition off returns the SCR's cathode to ground potential (via various gauges and warning lights as well as the coil itself, if the points are closed) and, if any lights are on, C1 triggers the SCR into conduction. R2 ensures minimum latching and holding current. R3 is required only if the car's voltage exceeds the rating of the buzzer.

To cancel and re-set the alarm, when lights are required to be left on, only requires briefly turning the lights off.

This circuit will work reliably down to 5V and as such is suitable for connection to panel lights on a dimmer circuit and 6V cars.

B. Theobald,
Bonnet Bay, NSW

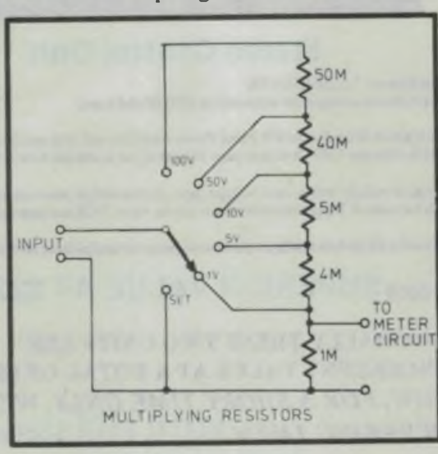
$30

Simple high-Z voltmeter

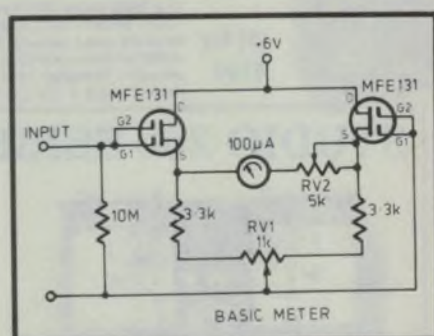
In need of a high impedance voltmeter, I came up with this circuit.

The basic meter circuit has an input impedance of 10 megohms, with one volt giving full scale on the MU-65 0-100uA meter.

With the input grounded, RV1 is adjusted to give zero on meter, then with 1 volt on input, RV2 is adjusted to read full scale.



MULTIPLYING RESISTORS



BASIC METER

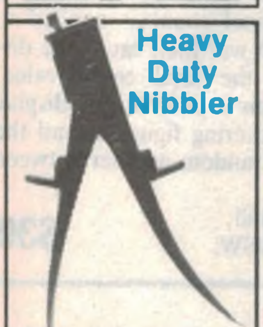
Because the multiplying resistor values get a bit out of hand if you try to maintain a figure of 10 megohms per volt, I used the values shown, which give 1M/V.

Overall cost is about $30-$40, and the MU-65 meter is big and easy to read.

Peter Buckman
Boggabri, NSW

$30

We've put together a really exciting lot of products this month. And look at the low prices! Perhaps they'll make the taxman's bite hurt less.



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(See EA March/April '89)

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Features:(See EA Jan/Feb'85 or our 1989 Catalogue for full features)

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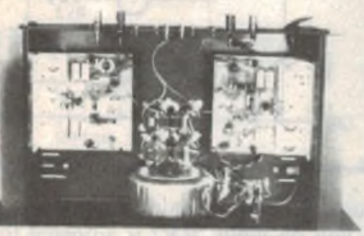

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(See SC Feb'88)

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(See Silicon Chip June/July '88)

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Altronics kit includes fully professionally punched and printed panels.

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Massive 200 W Max.
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Normally $129
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100Watt RMS 150W Max.
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60Watt RMS
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Was $69.00
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2-Way kit complete with crossovers and cabinets 70W RMS power handling. Cabinet Size: 250D x 260W x 490Hmm
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30W RMS power handling.
Cabinet size:
210D x 170W x 260Hmm
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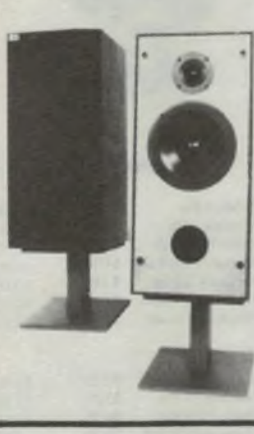

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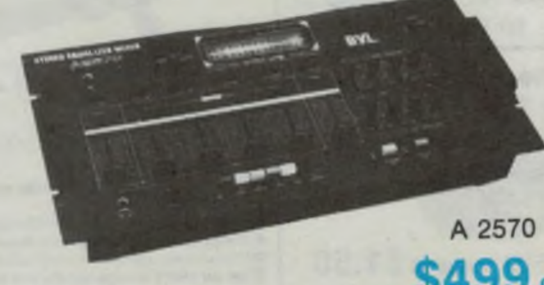
Input - Mic 1: 0.5mV, 600 Ohms, Mic 2: 0.5mV, 600 Ohms (Low Imp.), 2.5mV, 10kOhms (low Imp.); Phono 1&2 (Mag.) 3mV, 50kOhms; Phono 1&2 (Cry.), 150mV, 100kOhms; Tape/Tuner 1&2 150mV, 100kOhms. Equaliser - 5 frequency bands: 60Hz, 250Hz, 1kHz, 4kHz, 12kHz - Boost Cut Range, plus or minus 12db @



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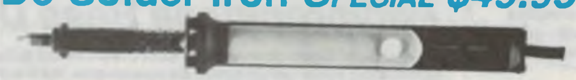

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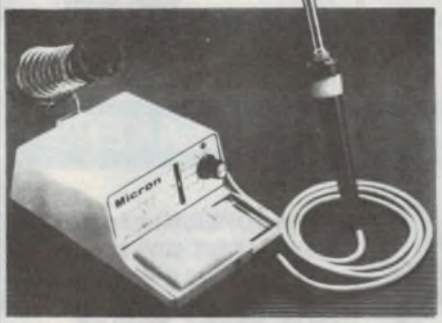

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S 3060	8Way	$2.50	$1.80
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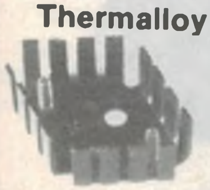

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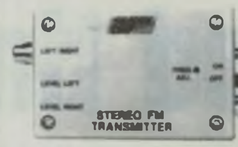

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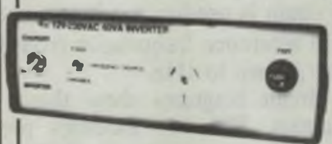

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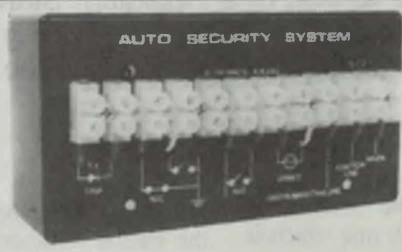

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Construction Project:

TV-derived time & frequency standard – 1

Here's the design for a relatively inexpensive unit which will allow you to generate frequency and time signals with an accuracy very close to that of a Rubidium Standard – within a few parts in 10^{11}. It does this by phase-locking a local 10MHz crystal oscillator against the horizontal sync pulses of TV networks.

by IAN POGSON

Of the various possible sources of known accurate frequency, one which is often overlooked is the synchronising pulses of TV transmissions. These vary considerably in accuracy, but some are very good indeed – being derived from 'atomic' Rubidium Standards.

The TV-Derived Frequency Standard which is described here makes use of the TV sync pulses, to provide a local source of standard frequency signals having a long-term accuracy equal to that of the TV signal to which it is set. It does this by extracting the pulses from the composite video signal, and then using them to phase-lock a high quality 10MHz crystal oscillator.

Due to causes not fully understood, the short term stability (minutes) does suffer from some small disturbances. However this amounts to a 'jitter' in the order of only 0.3 microseconds peak-to-peak, which for many purposes may be ignored.

Not all TV synchronising pulses are stabilised to a high degree, but the ABC can be relied upon all over Australia. ABC network synchronising pulses are derived from a Rubidium Standard located in Sydney. Sydney is also fortunate in that TCN-9 derives its synchronising pulses from a Rubidium Standard. I understand that GTV-9 in Melbourne is also similarly equipped.

The order of accuracy quoted for Rubidium Standards is a few parts in 10^{11} and when our unit is locked to one of these, that is the kind of accuracy we are looking at. Prospective builders in some of the more remote areas where only a local commercial TV station is available, would be wise to check with the station to determine the accuracy of the synchronising pulses.

I should note that this project has been made possible by the availability of a TV tuner module and matching TV IF/detector module, imported by Dick Smith Electronics.

How it works

The basic arrangement used in the unit is shown in the simplified block diagram of Fig.1. As this shows, a 15,625Hz signal derived from the local 10MHz crystal oscillator is compared in phase with the 15,625Hz horizontal sync pulse frequency from the received TV signal. Any phase error between the two produces a correction signal, which after filtering is used to correct the frequency of the crystal oscillator and hence lock it in phase. An additional divider chain is used to produce a series of useful reference frequencies from the oscillator, down to 1Hz.

The circuit diagrams show things in more detail. The two modules previously mentioned constitute a basic TV receiver, which is capable of receiving all Australian channels in both the VHF and UHF ranges. Apart from a power supply, all that is needed is an appropriate antenna connected at the tuner input, and composite video is available at the output of the IF module.

TV channel selection is by means of switched voltages to specific points on the tuner. In our case, we have provided for only three channels, but more can be added if necessary.

For this application we're not interested in the composite video as such, but merely in the sync pulse components. The video appearing at pin 4 of the IF module is therefore passed to Q10, and then Q11 as a sync separator. Sync pulses are then fed into an active filter (IC15), which is tuned to line sync frequency (15,625Hz), and from which it emerges as an approximate (albeit

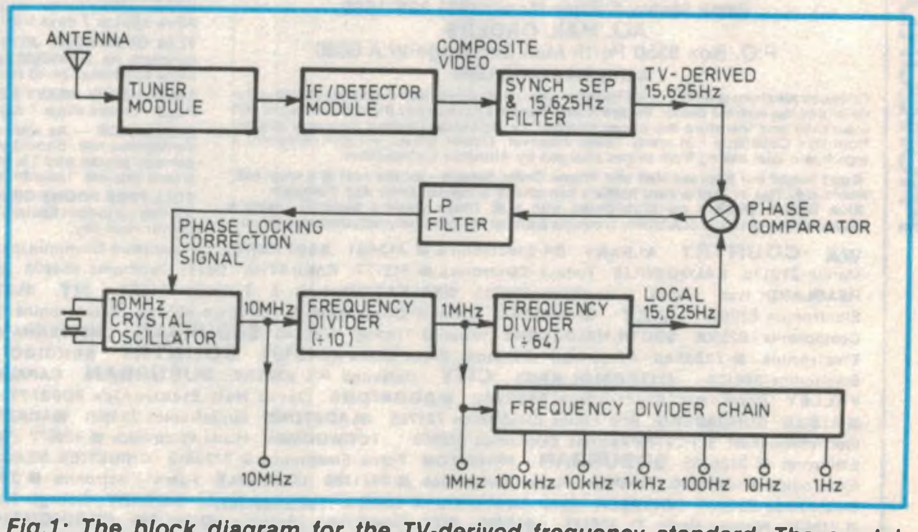
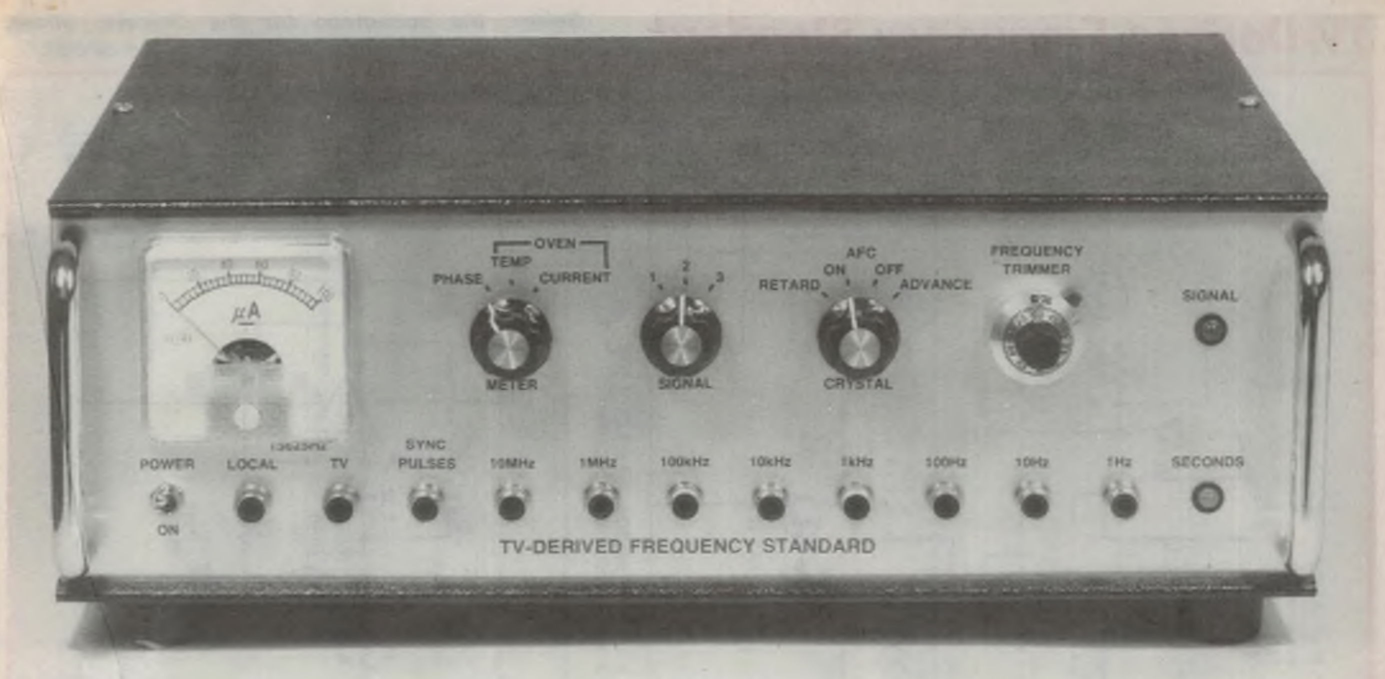


Fig.1: The block diagram for the TV-derived frequency standard. The crystal oscillator is in a temperature-controlled oven.



The completed time and frequency standard, which provides signals with an accuracy close to that of the TV network's sync pulses – which in some cases are derived from a Rubidium Standard.

rough) sine wave. The 'sine wave' feeds a Schmitt trigger (IC16a), with a 50-50 square wave emerging. This is fed into pin 14 of a 4046 phase comparator (IC13).

Now let us turn to the crystal oscillator and oven temperature regulation circuits. Both circuits are included on a PC board, housed in a die-cast metal Eddystone box which forms the crystal 'oven'.

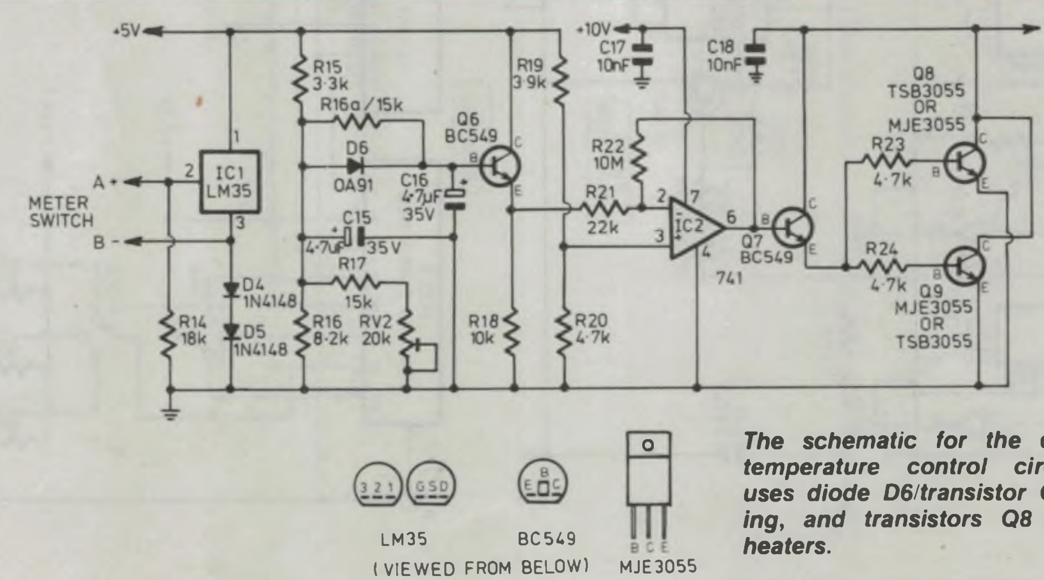
The crystal oscillator itself is a Pierce circuit, using FET Q1 running at low power level in the interests of frequency stability. A measure of AGC is applied via C6, D3 and Q2. The bias generated by C6/D3 varies the DC resistance of Q2 and hence provides degeneration in the source circuit of the oscillator transistor. The crystal is a precision AT-cut unit in a cold-welded holder and cut to operate at a temperature of between 45 and 50°C.

Coarse frequency of oscillation is set by TC1 and fine frequency is adjusted by VR1, controlling D2 as a variable capacitance diode. A second diode (D1) is fed via switch S1, selecting either the AFC signal from the phase comparator, (AFC on) or various DC levels for the settings marked 'AFC off', 'Retard' and 'Advance'. The latter two facilities provide for setting the unit precisely to time.

Output from the oscillator is buffered by Q3 and Q4, with Q5 functioning as an interface to drive the TTL gate IC3a.

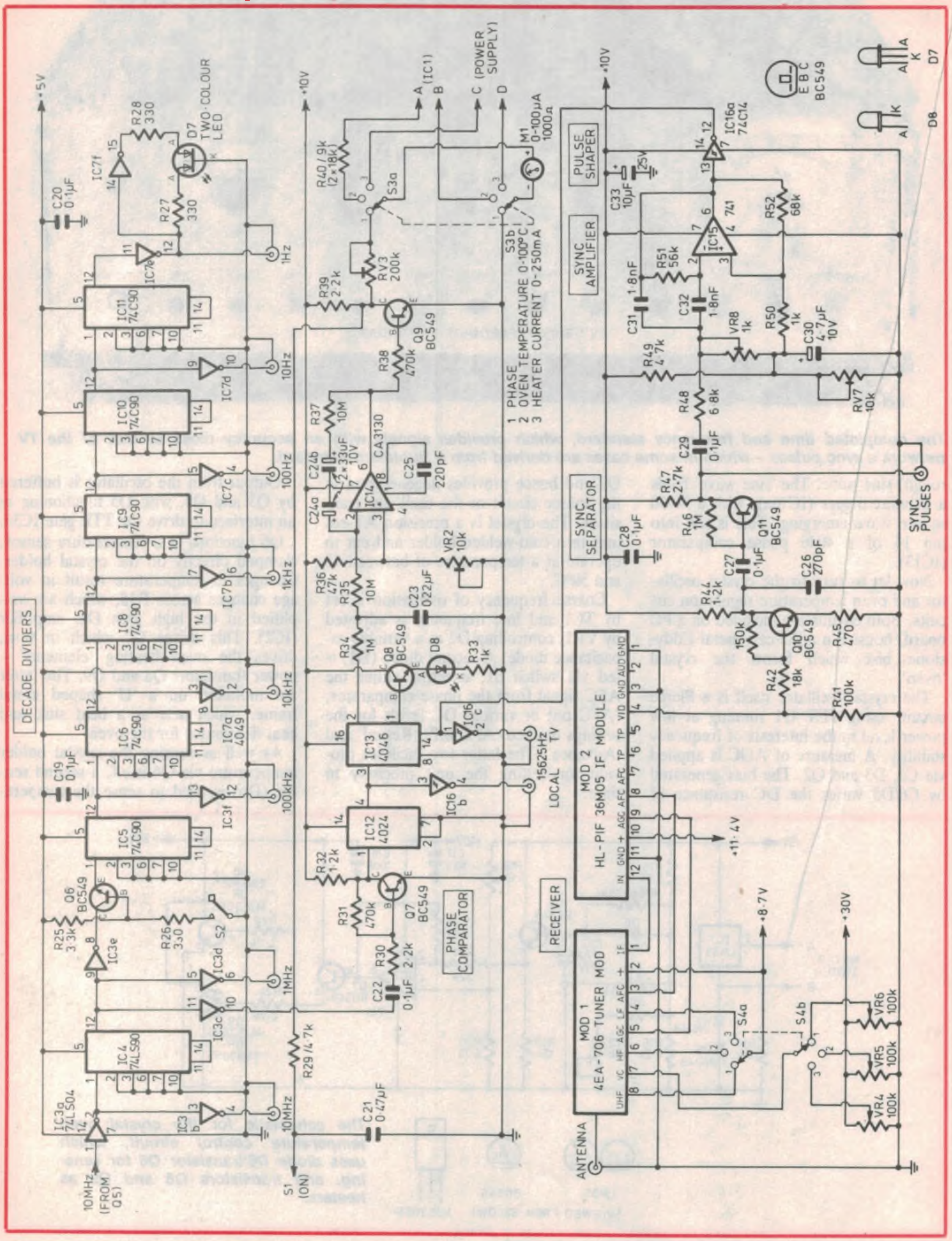
Q6 functions as a temperature sensor, clamped directly on the crystal holder. Changes in temperature result in voltage changes across R18, which are amplified in the high gain DC amplifier (IC2). This drives Q7 which in turn, drives the oven heating 'elements' – power transistors Q8 and Q9. The latter are mounted on a 'U' shaped metal frame, which acts as a heat sink and heat distributor for the oven.

As well as sensing the crystal holder temperature via Q6 itself, a second sensor (D6) is used to sense the tempera-



The schematic for the crystal oven temperature control circuit, which uses diode D6/transistor Q6 for sensing, and transistors Q8 and Q9 as heaters.

Below: the schematic for the dividers, phase comparator and receiver sections of the circuit.



ture on the top of the oven box. These circuits hold the crystal temperature within close limits – a fraction of one degree Celsius. The actual temperature is set by VR2.

IC1 is a separate temperature sensor for the meter, which reads off oven temperature in degrees C when meter

PARTS LIST

1 Horwood box, 305 x 102 x 203mm
1 crystal oscillator & oven heater assembly (see later)
1 power supply PCB assembly
1 front panel label, 305 x 98mm
1 Meter, 0-100uA, 50 x 50mm, 1000 ohms
1 10k 10 turn potentiometer (Bourns or similar)
1 10-turn precision dial to match potentiometer
2 2-pole, 3-position rotary switches
1 single-pole, 4-position rotary switch
3 19mm knobs
1 SPDT miniature toggle switch
1 miniature push-button switch (momentary make)
11 RCA panel-mounting sockets
1 RCA plug
1 Belling Lee coaxial socket
1 mains cord and plug
1 cord clamp
1 rubber grommet
1 earth lug
1 3-way mains terminal block
1 power transformer, Ferguson PL1.5-18/20VA
1 PCB, code 89tfr5a, 177 x 124mm
2 16-pin IC sockets
10 14-pin IC sockets
2 8-pin IC sockets
1 TV tuner module, 4EA-706 (available from DSE)
1 TV IF module, HL-PIF (available from DSE)

Semiconductors

1 74LSO4 hex inverter
1 74LS90 decade counter
6 74C90 decade counters
1 4049 hex inverter
1 4024 7-stage binary divider
1 4046 phase-locked loop
1 CA3130 op amp
1 741 op amp
1 74C14 hex Schmitt trigger
6 BC549 transistors
1 LED, red or green, with bezel
1 dual LED, red and green, with bezel (available from Geoff Wood)

Capacitors

2 33uF 10VW tantalums
1 10uF 25VW tantalum
1 4.7uF 25VW tantalum
1 0.47uF polypropylene
1 0.22uFpolypropylene
6 0.1uF ceramic or polypropylene
2 1.8nF polypropylene
1 270pF polypropylene
1 220pF polypropylene

Resistors

All 5%, 0.25W: 3 x 330ohms, 1 x 470 ohms, 2 x 1k, 2 x 1.2k, 2 x 2.2k, 1 x 2.7k, 1 x 3.3k, 3 x 4.7k, 1 x 6.8k, 3 x 18k, 1 x 56k, 1 x 68k, 1 x 100k, 1 x 150k, 2 x 470k, 2 x 1M and 2 x 10M
1 1k trimpot (flat mounting)
1 10k trimpot (flat mounting)
1 200k trimpot (flat mounting)
1 10k multiturn trimpot (vertical mounting)
3 100k multiturn trimpots (vertical mounting)

Miscellaneous

Hookup wire, single shielded cable, tinned copper wire, screws, nuts and solder.

CRYSTAL OSCILLATOR AND OVEN HEATER ASSEMBLY

1 PCB code 89trf5b, 85 x 71mm
1 Eddystone box, 6908P, 118 x 92 x 60mm
1 10MHz crystal, 30pF load, 45-50°C Hy-Q TS05E in QC48A holder, or equivalent
1 8-pin DIL socket
1 1mH RF choke
1 3-lug tagstrip (see text)
1 solder lug

Semiconductors

3 2N5485 FETs
2 BF495 transistors
2 BC549 transistors
2 MJE3055, TSB3055 transistors with insulators and screws
2 15V 400mW zener diodes (variable capacitors)
3 1N4148, 1N914 diodes
1 OA91 germanium diode
1 LM35 temperature sensor
1 741 op amp

Capacitors

1 26pF Philips trimmer (green)
1 10pF NPO ceramic
1 15pF NPO ceramic
1 18pF NPO ceramic
1 27pF NPO ceramic
1 47pF NPO ceramic
1 68pF NPO ceramic
1 100pF NPO ceramic
1 220pF polypropylene
1 470pF polypropylene
1 4.7nF polypropylene
6 10nF ceramic or polypropylene
1 0.1uF ceramic or polypropylene
2 4.7uF 35VW tantalum

Resistors

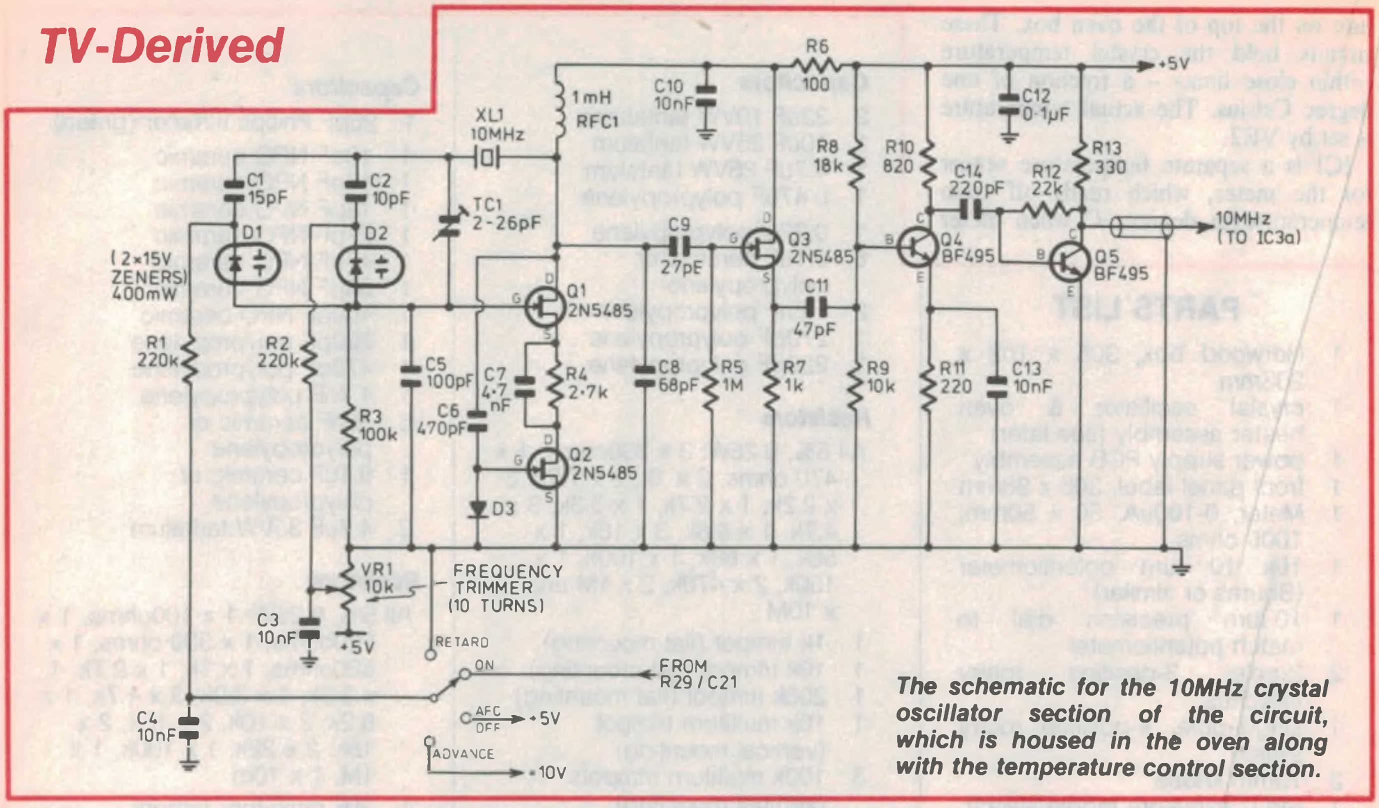
All 5%, 0.25W: 1 x 100ohms, 1 x 220ohms, 1 x 330 ohms, 1 x 820ohms, 1 x 1k, 1 x 2.7k, 1 x 3.3k, 1 x 3.9k, 3 x 4.7k, 1 x 8.2k, 2 x 10k, 2 x 15k, 2 x 18k, 2 x 22k, 1 x 100k, 1 x 1M, 1 x 10m
1 20k multi-turn trimpot

Miscellaneous

Hookup wire, single shielded cable, 28 PCB pins, foam insulating material, screws, nuts, solder. 30 x 14mm tinplate for OA91 diode. Aluminium or copper sheet approx. 1mm thick; one piece 158 x 73mm, 2 pieces 30 x 19mm, 1 piece 30 x 9mm.

POWER SUPPLY PCB ASSEMBLY

1 PCB code 89tfr5c, 101 x 72mm
1 7812, LM34OT-12 +12V regulator
1 7805, LM34OT-5 +5V regulator
1 heatsink for 7812, LM34OT-12
1 BC337 transistor
10 1N4002 power diodes
1 30V 1W zener diode
1 3.3V 1W zener diode
4 2200uF 25VW electrolytics
2 220uF 50VW electrolytic
1 33uF 35VW electrolytic
11 0.1uF ceramic or polypropylene capacitors
1 3.9k 0.25W 5% resistor
3 1.2ohm 0.5W 2% resistors



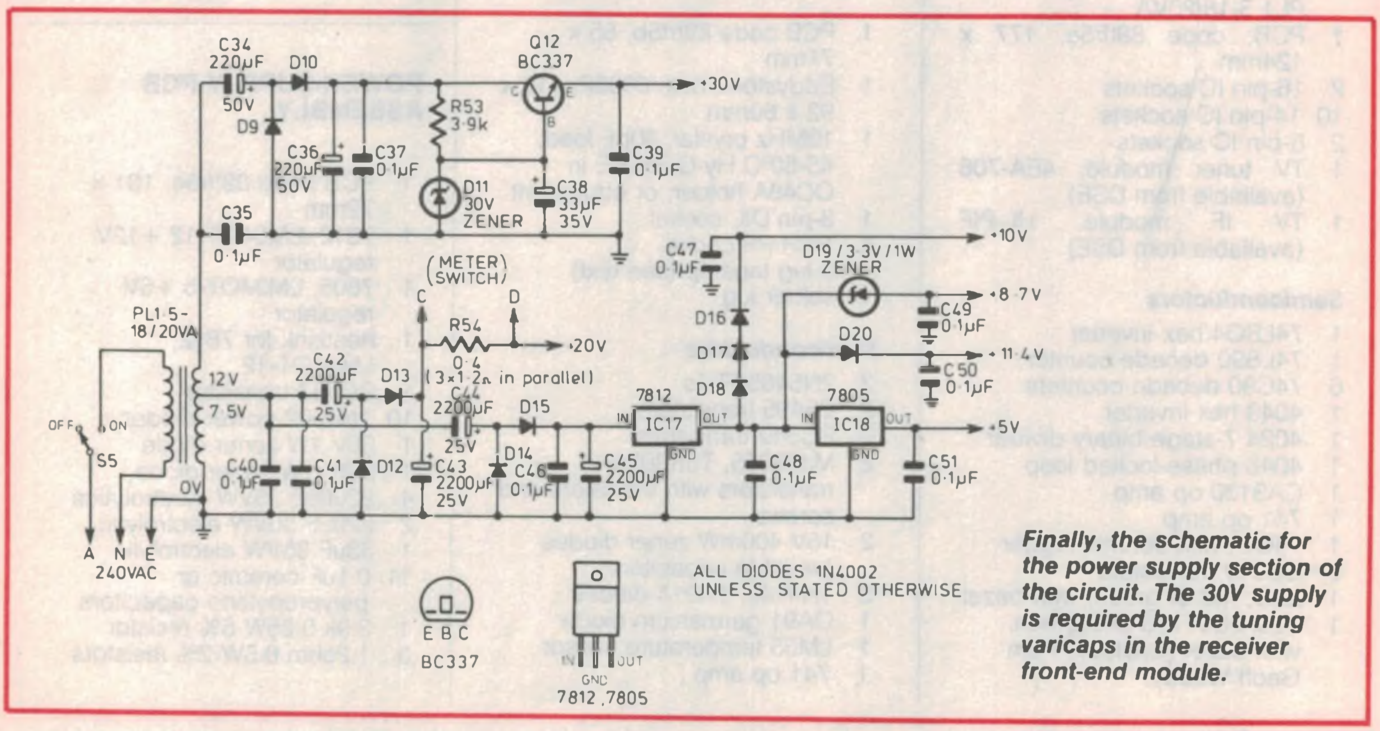
The schematic for the 10MHz crystal oscillator section of the circuit, which is housed in the oven along with the temperature control section.

function switch S3 is in position 2. The idea of having a separate sensor for the meter is to ensure that there is no disturbance to the temperature stabilisation loop when the meter is switched in and out.

The 10MHz TTL output from the oven assembly, via buffer IC3a, drives a series of decade dividers, producing signals down to one pulse per second. All outputs are buffered. The 1MHz output from IC4 also drives a 4024 binary divider (IC12), via level interface stage Q7. Output is taken from IC12 via pin 4, giving a division factor of 64 (2^6), or 15,625Hz. This passes along to the second input of phase comparator IC3, at pin 3, for comparison with the 15,625Hz from the TV receiver as mentioned earlier.

The resulting 'phase error' output voltage from pin 2 of IC13 is given some filtering by R34 and C23, and then passes to an active filter circuit around IC14. A buffer stage (Q9) follows, and its output provides the AFC voltage for the crystal oscillator, via R29/C21, and the metering circuit – via VR3 and S3a/b.

Returning for a moment to the dec-



Finally, the schematic for the power supply section of the circuit. The 30V supply is required by the tuning varicaps in the receiver front-end module.

ade divider chain, transistor Q6 between IC4 and IC5 is used to momentarily cut off the drive from IC5 when pushbutton switch S2 is pressed. This allows the phasing of the 1Hz 'seconds' pulses to be adjusted if desired, approximately in line with the correct time. The dual LED (D7) changes colour on the rising and falling components of the seconds pulses, and either one may be chosen to indicate the correct time.

Special components

Most of the special components for this project were obtained from Geoff Wood Electronics, of Lane Cove NSW. In particular, GWE is able to supply the 10k 10-turn Bourns potentiometer used for VR2, and the mating 10-turn precision dial, along with the TSB3055 power transistors. The Eddystone box is also available from GWE and David Reid Electronics. Both of these firms can also supply the Horwood box, which is also listed by a number of other suppliers, including Jaycar Electronics and Rod Irving Electronics.

While we are on the subject of the Horwood and Eddystone boxes, it may be observed from the photographs that there are some unscheduled holes in evidence on the prototype. These boxes happened to be available from earlier projects and they have been 'recycled'.

The TV tuner and the TV IF modules are made by Murata in Japan and Hwa Lin in Taiwan, respectively, and were supplied by Dick Smith Electronics. As far as I am aware they are only available from this firm at present.

The 10MHz crystal was supplied by Hy-Q International, in Melbourne. It should be ordered as shown in the parts list. It is also worth noting that this crystal is specified to operate at 45-50°C. This is all right for most environments where the room temerature is not likely to exceed 35°C. But in cases where this temperature is likely to be exceeded, the operating temperature of the crystal should be increased and specified accordingly when ordering.

It should be stressed that there is no point in specifying a higher operating temperature for a crystal than that which is necessary.

Having commented on the source of those components in the foregoing, quite obviously some of them will be available from alternative sources.

Hopefully the foregoing will be sufficient to whet your appetite, and show you how the unit works. In the second of these articles, I will describe its construction. EA

Basic Principles of VCRs – Part 6

The complete VHS recorder

In this final part of the current series, we begin by considering the complete video cassette recorder. We also discuss some sections of the VCR that were notcovered in the earlier parts of the series.

by DAVID BOTTO

Fig.1 is a simplified block schematic of a typical Video Home System (VHS) format machine. You will remember that during the transmission of a television programme, the energy radiated by the TV station is in the form of an electromagnetic field.

When this energy reaches the TV receiving antenna (via the transmission path) an electrical signal is extracted. This signal is then fed down through the antenna cable, entering the Booster/Mixer circuitry at point A in Fig.1.

Fig.2 shows a more detailed block schematic of one type of Booster/Mixer circuitry. The signals at point A enter broad-band amplifier 1 (the 'booster'), which can handle the whole range of TV station frequencies.

From one end of coil L1 the signal passes through the filter circuit formed by RF choke 1, capacitor C2, and RF choke 2, via capacitor C3 to socket A2. A co-ax lead from this socket feeds the signal to the antenna socket of a colour TV receiver.

Because of the wide bandwidth of amplifier 1 the TV set user can still tune the TV receiver to any 'off-air' TV channel. Through capacitor C1, the opposite end of coil L1 and resistor R2 the received TV signals also arrive at point A3, where they are supplied to the VCR tuner. The VCR tuner can select any TV programme that the viewer may wish to record.

In both the record and playback modes video and audio signals are supplied to points V1 and AU1. The video signal passes through the video buffer amplifier and via resistor R3 to point M1. The audio signal amplified by the audio amplifier modulates the 5.5MHz oscillator (point OS). This FM (frequency modulated) signal is fed into transformer T1. Via resistor R5, capacitor C4 and RF choke 3 the modulated 5.5MHz signal reaches point M1.

The carrier oscillator generates a TV channel signal frequency – typically channel 1 (VHF) or channel 36 (UHF) – an unused TV channel frequency. Both the video and audio signals at point M1 modulate the carrier oscillator, producing a composite TV signal carrier. Via capacitor C5, resistor R2, capacitor C2 and capacitor C3 this signal is supplied to socket A2 and through the co-ax lead to the TV set.

One of the selector buttons of the TV is then tuned to channel 1 or 36. Should a 'beat pattern' then be observed on the TV screen, the frequency of the carrier oscillator can be varied by adjusting preset capacitor TC.

By selecting channel 1 or 36 on the TV, the viewer can monitor programmes being recorded by the VCR, or of course view programmes previously recorded on the video cassette magnetic tape. By selecting a different channel on the TV it's also possible to

The Panasonic model NV-D80 VCR, which features both bar-code programming and digital 'freeze-frame' as well as more common facilities such as hifi stereo sound.

record one TV programme and at the same time watch a different programme on another channel.

Tuner & IF stages

Because the VCR tuner/IF stages (Fig.1) operate as a superheterodyne receiver, the tuner contains a local oscillator which beats with the received amplified station frequency. To tune in the various TV stations varicap diodes are used. (See part 7 of 'Understanding Colour TV' in the August 1987 issue of *Electronics Australia*). Control of these may be by selector buttons, an electronic memory system or a remote control unit.

Two intermediate frequency signals are produced at point B. One carries the vision information, the other the sound signal in exactly the same way as in a colour TV receiver. You'll remember that for Australia the vision IF signal is 36MHz and the sound signal 30-

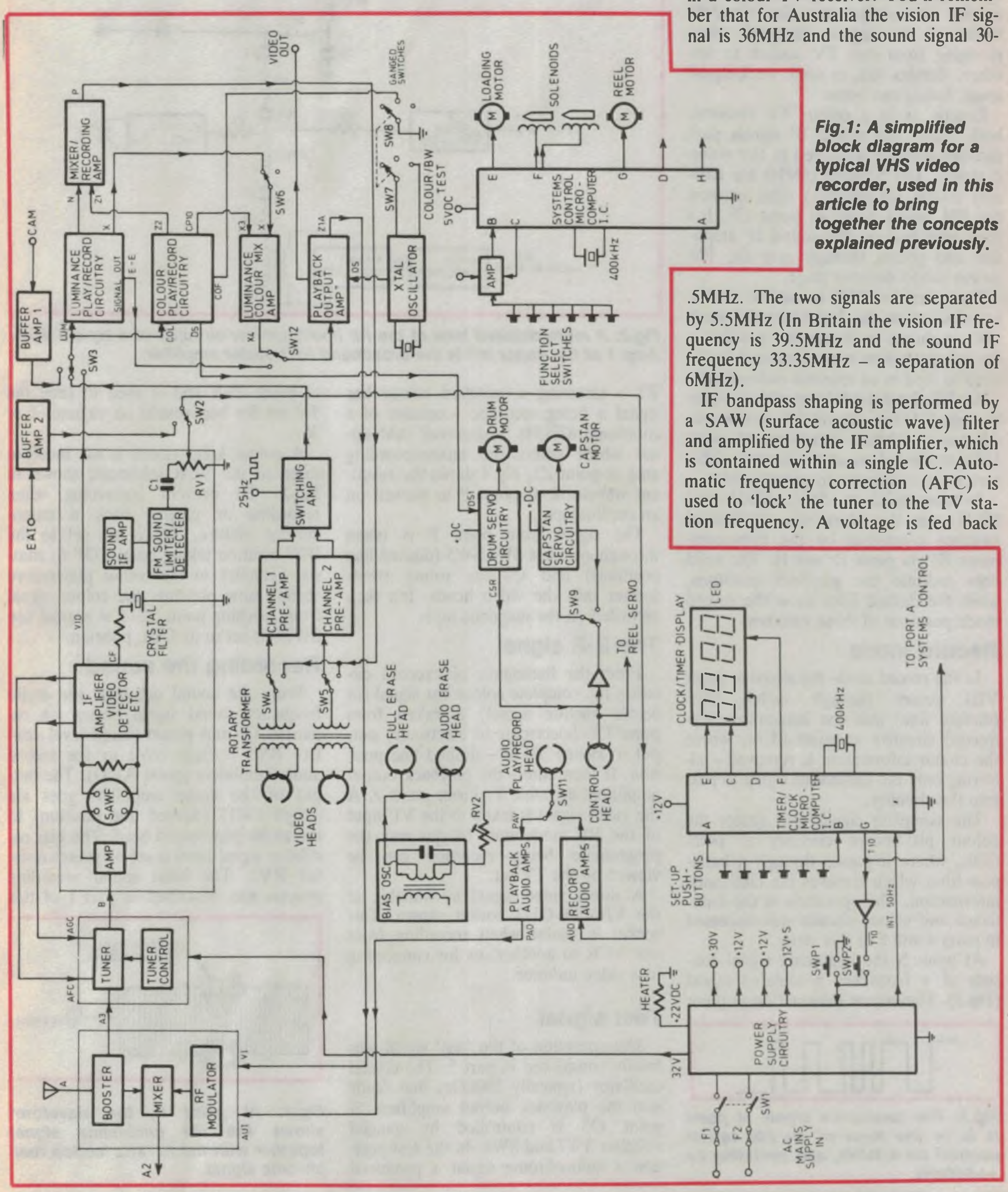


Fig.1: A simplified block diagram for a typical VHS video recorder, used in this article to bring together the concepts explained previously.

.5MHz. The two signals are separated by 5.5MHz (In Britain the vision IF frequency is 39.5MHz and the sound IF frequency 33.35MHz – a separation of 6MHz).

IF bandpass shaping is performed by a SAW (surface acoustic wave) filter and amplified by the IF amplifier, which is contained within a single IC. Automatic frequency correction (AFC) is used to 'lock' the tuner to the TV station frequency. A voltage is fed back from the IF amplifier to the TV tuner's local oscillator varicap. If any 'drift' occurs the AFC voltage changes slightly to correct it.

Automatic gain control (AGC) voltage is also fed back to the tuner. This is needed to compensate for possible variations in signal strength when changing from one TV station to another. Besides this, in some weak signal areas, fading can occur.

Exactly as in a colour TV receiver, both vision and sound IF signals pass through and are amplified in the vision if stages. The 5.5MHz (6MHz for Britain) crystal (or ceramic) filter extracts the FM sound signal at point CF. It's then amplified by the sound IF amplifier and passes through into the FM limiter/sound detector stage.

Preset resistor RV1 is used to set the sound signal to the desired level. Switch SW2 is shown in its normal position – the other position is used when it is desired to feed in an external audio signal.

An RF signal modulated with a colour bar signal fed in at point A would produce the standard waveform at point VID, as viewed on an oscilloscope. This waveform was shown in parts 5 and 6.

Switches SW3 to SW6, SW11 and SW12 are the electronic play/record switches controlled by the microcomputer IC via ports D and H. The solid lines indicate the playback positions, while the dashed lines show the record mode positions of these switches.

Record mode

In the record mode the signal at point VID passes through switch SW3 (dashed line) into the luminance play-/record circuitry at point LUM, where the colour information is removed – allowing only the luminance signal to pass into the circuitry.

The complete signal also enters the colour play/record circuitry at point COL, where it passes through a bandpass filter which removes the luminance information. The operation of the luminance and colour circuits was discussed in parts 4 and 5 of this series.

At point N the luminance signal consists of a frequency modulated signal (Fig.3). The colour information at point

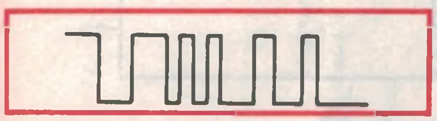


Fig.3: The luminance signal at point N is in the form of an FM carrier centred on 4.3MHz, and deviating by +/-500kHz.

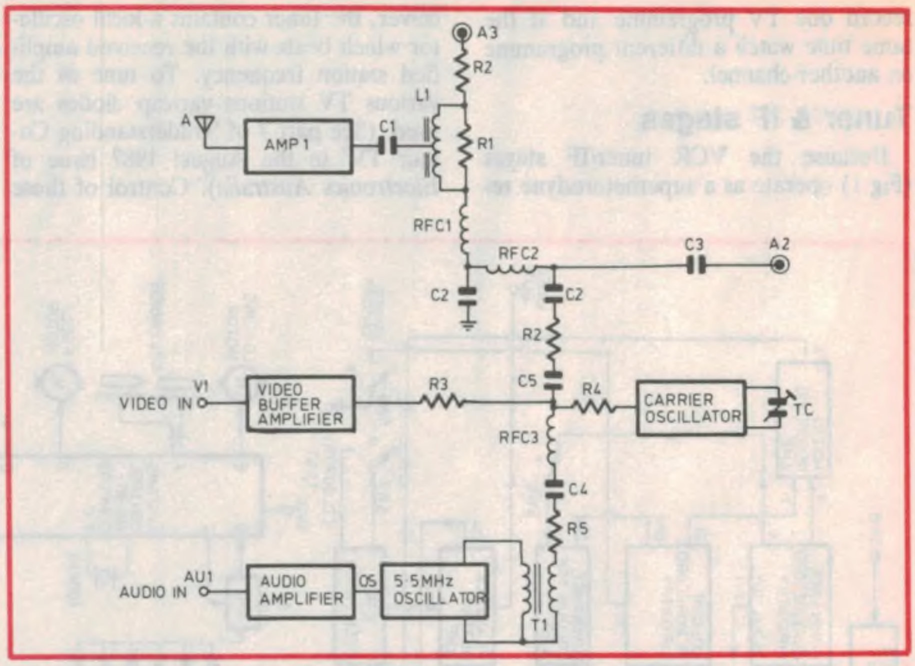


Fig.2: A more detailed look at the RF booster/mixer circuitry of a typical VCR. Amp 1 at the upper left is the broadband RF booster amplifier.

Z2 – assuming a standard colour bar signal is being recorded – consists of a rotational 627kHz 'cotton-reel' AM signal which enters the mixer/recording amp at point Z1. Fig.4 shows the resultant waveform at point P as viewed on an oscilloscope.

The signal from point P is taken through switches SW4/SW5 (dashed line positions) and via the rotary transformer into the video heads. It's then recorded on the magnetic tape.

The E-E signal

From the luminance play/record circuitry the complete colour bar signal (or colour picture signal) is taken from point EE (electronic to electronic) output to switch SW12 – dashed line position. It then enters the playback output amplifiers at point Y. From point Z1A the video signal is taken to the V1 input of the RF modulator. In this way the programme being recorded can be viewed on the TV set.

A direct video signal is available at the VIDEO OUT socket shown. This socket is useful when recording from one VCR to another, or for connecting to a video monitor.

Test signal

The operation of the 'test' signal was briefly considered in part 5. The crystal oscillator (typically 500kHz) that feeds into the playback output amplifiers at point OS is controlled by ganged switches SW7 and SW8. In the test position a monochrome signal is produced at point Z1A and is used to tune the TV set for best results on channel 1 or 36.

A colour killer circuit is not incorporated in the VCR schematic shown in Fig.1. To prevent patterning when recording or playing back a monochrome picture, SW7/8 are set to the B/W position taking point COF to chassis. Circuitry in the colour play/record section now prevents the colour signal from reaching point Z2. For normal use SW7/8 is set to its COL position.

Recording the sound

From the sound detector, the audio frequency sound signal passes via capacitor C1 and preset sound level control RV1 through SW2 to the record audio amplifiers (point AUD). The output of the audio amplifiers goes via switch SW11 (dashed line position) to the audio play/record head. The bias oscillator signal level is set by preset resistor RV2. The basic sound recording process was described in part 1 of this

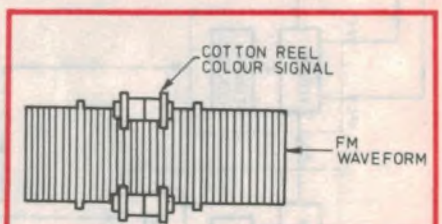
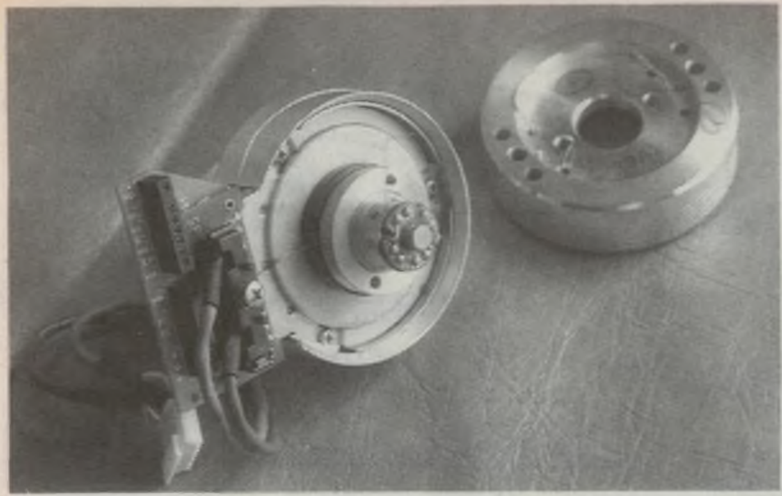
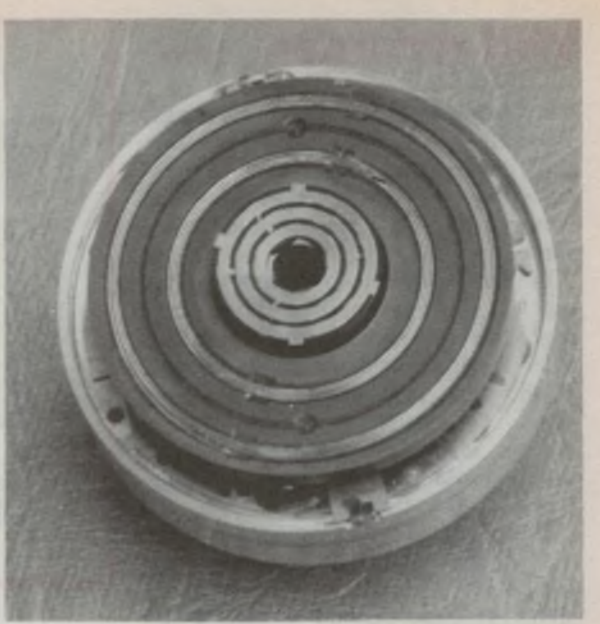


Fig.4: At point P, the waveform shows the FM luminance signal together with the 627kHz 'cotton reel' chroma signal.



The rotary head drum assembly of a VHS machine, with the rotating section lifted off.



Underneath the upper section of a head drum assembly from a Philips VCR, showing the rotating halves of the rotary transformers for each head. The windings are the lighter rings in the central (annular) grooves.

series.

The bias signal also energises the full erase head and audio erase head, to remove previous recordings from the video cassette tape. You'll notice that an EXTERNAL AUDIO IN socket can be selected by means of switch SW2.

When playing back the recorded sound signal voltage induced in the audio play/record head goes via SW11 (solid line position) into the playback audio amplifier (point PAU).

The output from this amplifier (point PAO) is then fed to the 'Audio In' socket (point AUI) of the RF modulator. In practice the two audio amplifiers are usually combined – we've shown them separately for ease of understanding. (Many VCRs now have provision for stereo sound recording and playback. The playback head contains two audio play/record heads, and stereo record/playback amplifiers are used).

Playback mode

As the head drum rotates a signal voltage is induced in each head. This signal travels via the rotary transformer through switches SW4 and SW5 (solid line position) to the channel 1 and 2 preamplifiers and switching amplifier (see part 5).

Via switch SW3 (solid line position) the signal enters the luminance and colour play-record circuitry at points LUM and COL. At point X the signal is as in Fig.5 and at point CP10 the standard 'cotton-reel' signal is seen.

The luminance signal enters the luminance/colour mixing amplifier via switch SW6 (solid line position) at point X2, and the colour signal from point CP10 enters the luminance/colour mixing amplifier at point X3. At point X4 an oscilloscope would show the standard colour bar signal. Via switch SW12 (solid line position) the signal enters the plyback output amplifiers at point Y. The amplified signal (point Z1A) is supplied to the 'Video in' socket of the RF modulator (point V1).

Control head signals

From point DS a 50Hz signal is taken from the synchronisation separator, within the colour play/record circuitry. You will remember from part 3 that the drum servo circuitry divides this by two, to produce a 25Hz pulse (point CSR). In the record mode this signal is recorded on the video tape control track. In the play mode the recorded 25Hz control track pulse is fed back to the capstan motor servo circuitry, and also to the reel motor servo circuitry.

Rotary transformer

Fig.6 shows a schematic of a standard transformer, with a primary and secondary winding. It is wound on a core made from laminated iron sheets. As you will know, when an alternating current (AC) signal is supplied to the primary winding a current is induced into the secondary winding, producing a signal across the secondary winding.

To pass the energy from the video heads to the VCR circuitry, a special type of transformer is needed.

Fig.7(a) represents a VHS rotary head drum, viewed sideways. The dashed lines show its internal cut-away sections. This drum pushes down over the rest of the head drum assembly shown in Fig.7(b). Photograph A shows a VHS head drum at the right of the picture, with the rest of of the head drum assembly on the left. The drum is secured to the upper section of the assembly by two non-magnetic screws.

The upper rotating ferrite section (driven by the drum motor shaft) rotates and contains two transformer windings. The lower ferrite section (which does not rotate) contains two

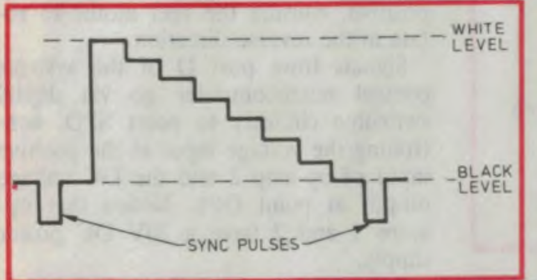


Fig.5: The luminance signal at point X, when a standard colour-bar signal is being played back.

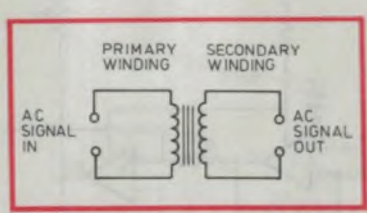


Fig.6: In case you've forgotten, the basic schematic for a standard AC transformer. Bear this in mind when trying to visualise the rotary head transformer.

more (stationary) transformer windings. Between the two ferrite cores is a tiny gap, just sufficient to prevent the two cores touching each other as the upper core rotates. Fig.7(c) shows the schematic.

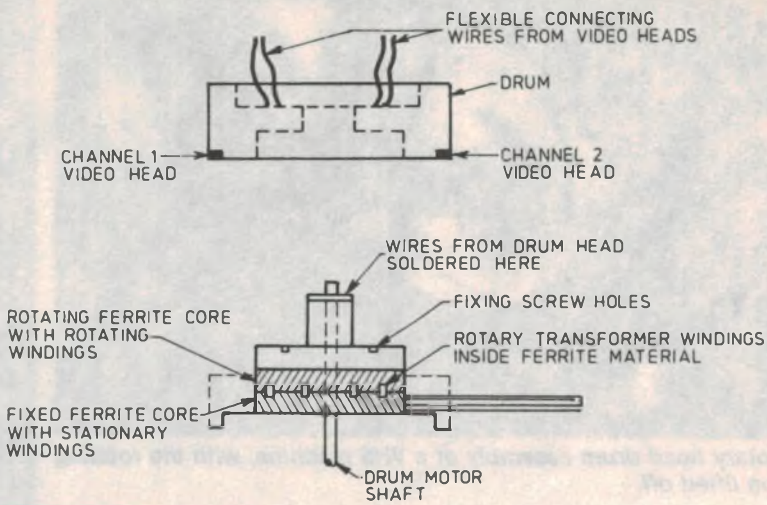
In Fig.7(b) and photograph A you can see the little stud connections onto which the colour-coded wires from the video heads are soldered. In photograph A the dark rings are the two ferrite cores. Also visible in the photograph are the enamelled copper wires from the non-rotating transformer windings that go to the terminal board.

Photograph B shows the upper section of a Philips head drum assembly. This head is not a VHS head, but it serves to show the basic method of placing the windings within the ferrite cores. (The VHS windings are far more compact). The two windings are set into slots in the rotating ferrite core. The other two windings are set into identical matching slots in the lower stationary ferrite core.

When a signal is being recorded the fixed windings act as the two primary windings and induce signal voltages into the rotating windings, which act as secondaries. The rotating windings energise the two heads and the video information is impressed upon the video cassette magnetic tape tracks.

In the playback mode the magnetic information on the video cassette tape induces a signal voltage into the video heads. The two rotating windings now act as primary windings and induce signal voltages into the fixed windings, which now become the secondaries.

The operation of the systems control microcomputer circuitry was discussed



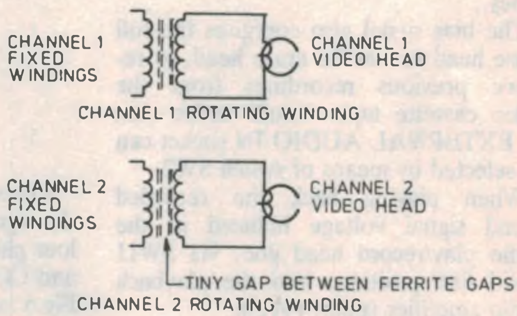


Fig.7: (a) at top shows a sketch of the upper section of the head drum carrying the actual heads, while (b) below it shows the lower section and rotary transformer. Schematic (c) at right shows the two head circuits.

in part 3. However because the operation of the reel motor and the 'port A' signals were not covered in that article, we'll describe them here.

Reel motor servo

Reel motor forward and reverse control signals are obtained from port G of the systems control microcomputer.

Fig.8 is a block schematic of one type of reel motor servo circuit. The reel servo circuit operates only in forward and reverse picture search modes. The signals from port G are inverted by the inverter circuits 1 to 4. When 'play', 'fast forward' or 'fast forward picture search' modes are selected by the function switches, points A and C on the motor drive amplifier are at binary 0 (low) and points B and D at binary 1 (high).

The output voltage at point M is positive and at M1 negative, and the motor rotates in the forward direction. If the rewind or reverse fast picture search function is selected then the binary signal outputs at port G are inverted and point M becomes negative and point M1 positive, causing the reel motor to rotate in the reverse direction.

Signals from port D of the systems control microcomputer go via digital switching circuitry to point SPD, controlling the voltage input at the positive input of op-amp 2 and the DC voltage output at point OP1. Notice that op-amps 1 and 2 have a 20V DC power supply.

Point OP1 connects via resistor R4 to point OP2 on the motor drive amplifier, controlling the voltage fed to the reel

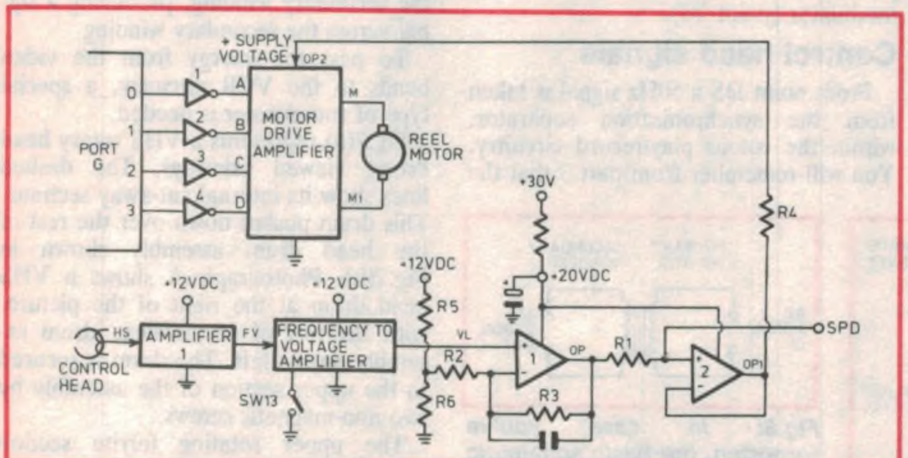


Fig.8: A block schematic of a typical reel motor servo system. Digital signals from port G of the microcomputer are used to control reel motor direction, via the motor drive amplifier.

motor, and thus its speed. When electronic switch SW13 is closed there is no output signal from the frequency to voltage amplifier.

In the fast/forward and fast reverse picture search modes, the voltage input at point SPD is such that the tape moves at nine times its normal speed. Switch SW13 is now open.

The signal from the control track of the video cassette tape is picked up by the control head (point HS) and amplified by amplifier 1. Since the tape is travelling at nine times its normal speed, the 25Hz signal recorded on the control track becomes a 225Hz signal (9 x 25Hz = 225Hz). This signal frequency is fed into the frequency to voltage conversion amplifier at point FV.

The voltage output at point VL remains steady as long as the speed of the tape is exactly nine times its normal speed. Op-amp 1 drives the positive input of op-amp 2 via resistor R1.

If the tape speed increases or decreases, the frequency of the signal from the control head will change. The voltage at point VL will then rise or fall, as will the voltage at point OP1 – by just the right amount to correct the speed of the reel motor and keep the video cassette tape speed exactly 'locked' to nine times its normal speed.

Port A inputs

Fig.9 shows one possible arrangement of signals that feed to port A of the systems control micro-computer.

W, X, Y and Z are digital multiplexers controlled by signals from port H. (You'll remember that a digital multiplexer circuit selects and directs any one of a number of input logic signals to a single output). So all the signals fed to each multiplexer can be selected as required and fed to the four inputs of port A.

Should the cassette lamp fail, a signal passes through multiplexer W to port A data line 3, and the VCR will not work. When the tape is unloaded this condition also reaches line 3.

The two switches connected to multiplexer X convey first the information that a cassette has been inserted, and then that it is properly loaded. Signals reach port A data line 2, allowing the VCR function switches to operate. Should light strike phototransistors A and B (cassette lamp sensors), signals through multiplexers Y and Z will reach data lines 1 and 0 and halt the movement of the magnetic tape.

If the user selects the timer mode, a signal into multiplexer Y informs the microcomputer via data line 1. When the timer switches on the VCR a signal reaches multiplexer Z and data line 0.

Cassette lamp, sensors

Fig.10 is a sketch of the cassette lamp and sensor arrangement. As the tape from the video cassette passes over phototransistor A (the start sensor) the light from the lamp cannot reach it. This lamp may be a tiny bulb with a filament, or a light emitting diode (LED).

When the magnetic tape returns to the cassette it passes phototransistor B. The current flowing through both phototransistors remains constant.

If the magnetic tape should break, light from the lamp will reach one (or both) of the phototransistors. The current through the phototransistor(s) increases as the light strikes it/them, and a signal is sent to port A of the control microcomputer. The tape transport mechanism then stops and the function select switches will not work.

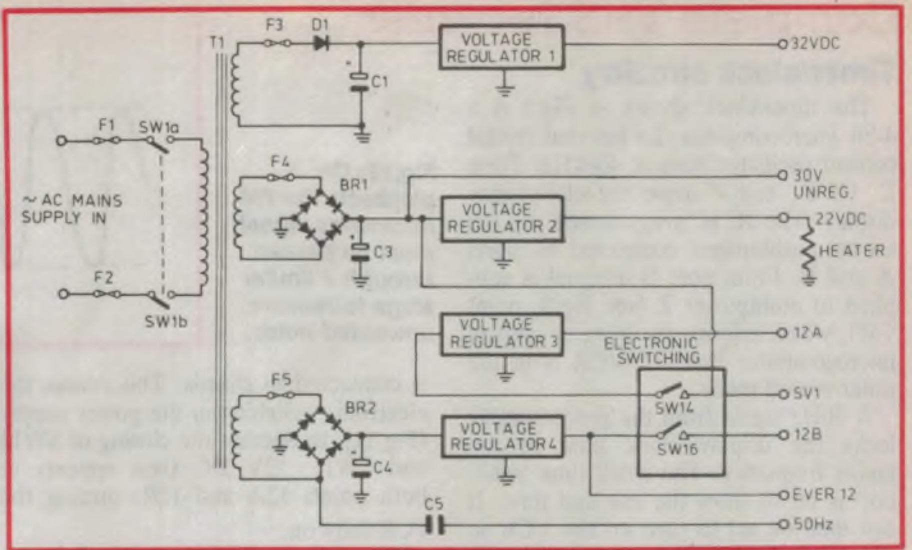


Fig.11: The power supply circuitry of a typical modern VCR. Note electronic switches SW14-15, used for timer recording etc.

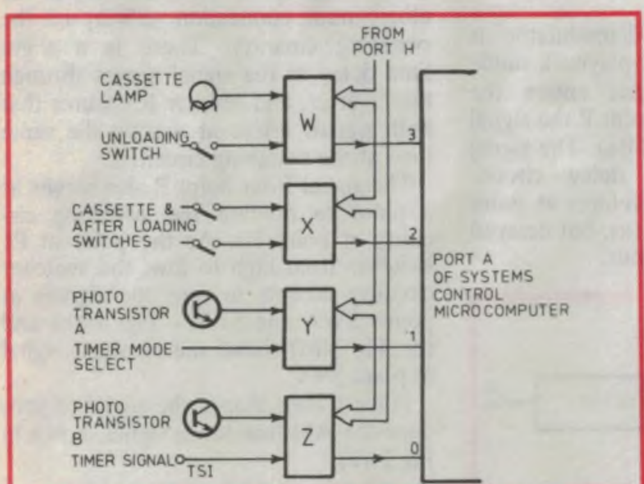


Fig.9: Port A of the microcomputer accepts signals from the cassette lamp, cassette sensing switches and tape loading photodetectors.

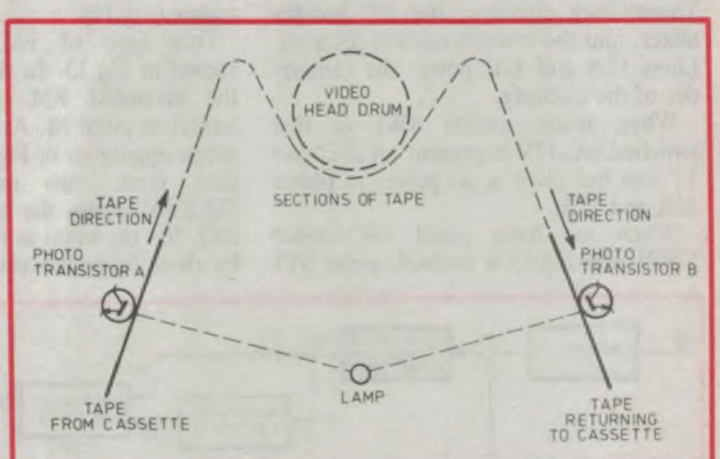


Fig.10: A sketch showing the cassette lamp and photodetector arrangement used to sense correct tape threading.

Timer/clock circuitry

The timer/clock shown in Fig.1 is a 4-bit microcomputer. Its internal crystal control oscillator runs at 400kHz. Ports E, C, D, and F drive the clock/timer display. The IC is 'programmed' by the set-up pushbuttons connected to ports A and B. From port G a signal is supplied to multiplexer Z (see Fig.9, point TSI), which informs the systems control microcomputer that the VCR is in the timer-record mode.

A 50Hz signal from the power supply locks the display clock time to the mains frequency. The clock time 'read-out' is set to show the day and time. It can then be set to turn on the VCR in record mode, at a desired day and time for a selected period of time to record a TV programme. It does this by turning on a section of the power supply. It is not necessary to have the TV set switched on during this recording period.

The power supply

Power supply arrangements in different makes and models of VCRs vary widely. Fig.11 shows a basic schematic of one type of regulated supply.

Regulator 1 produces 32V DC for the tuner varicap voltage supply. The unregulated 30 volt line supplies the capstan and reel motors. Regulator 2 produces 22V DC to power the little heater fitted to the lower section of the head drum assembly. This heater prevents (or removes) condensation (known as 'dew') that might otherwise form on the head drum and prevent smooth running of the tape.

There are three +12V DC supply lines. The 'ever' 12V line supplies the Timer/Clock circuitry, the RF booster mixer, and the systems control circuitry. Lines 12A and 12B power the remainder of the circuitry.

When mains switch SW1 is first switched on, 12V is present on the 'ever 12' line but there is no power at points 12A and 12B.

When the front panel 'on' switch SWP1 (see Fig.1) is pressed, point SV1

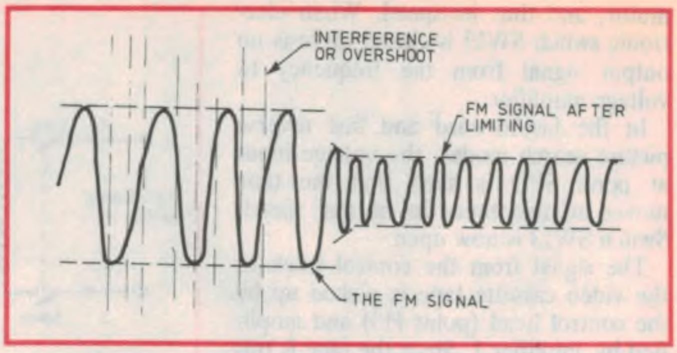


Fig.12: On playback, the FM luminance signal must be passed through a limiter stage to remove unwanted noise.

is connected to chassis. This causes the electronic switching in the power supply (Fig.11), to operate the closing of SW14 and SW15. 12V DC then appears at both points 12A and 12B, turning the VCR fully on.

When the user desires to select the timer mode button SWP2 is pressed (switch SWP2 will not operate until switch SWP1 is released). The user now sets the clock/timer display to switch the VCR on (in the record mode) at the desired time – for example at 8pm.

At 8pm port G of the timer/clock microcomputer puts out a binary 1 signal (point TIO). This signal is inverted (point ?not-TIO') and point SV1 is taken to chassis. DC voltage now appears on supply lines 12A and 12B, and the VCR starts to record the desired TV programme.

The on/off and timer mode switches usually have an LED lamp that indicates when 'On' or 'Timer' mode has been selected.

FM demodulator

Before demodulating the luminance FM signal it is necessary to feed it through limiting circuitry. This circuitry clips the amplitude of the FM signal to a value below any unwanted noise pulses (Fig.12).

One type of FM demodulator is shown in Fig.13. In the playback mode the recorded FM signal enters the limiter at point M. At point P the signal might appear as in Fig.14(a). The signal then feeds into the delay circuit. Fig.13(b) shows the waveform at point DO. It's the same as in (a), but delayed by about 0.06 microseconds.

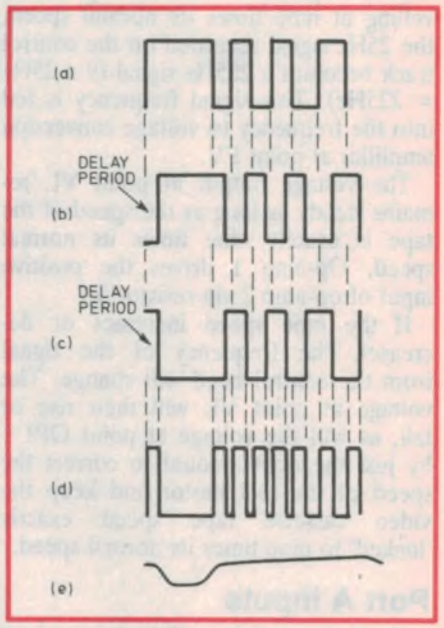


Fig.14: Waveforms found in the FM luminance demodulator of Fig.13. The signal at (a) is converted into pulses 0.06us wide (d), and then filtered (e).

From point DO the signal goes directly through resistor R to one input of the switching circuitry (SWA). It is also fed through the inverter circuitry to the other input connection (SWB) of the switching circuitry. There is a slight time delay as the signal passes through the inverter, and resistor R ensures that both signals arrive at exactly the same time at the switching circuitry.

The signal from point P also serves as a pulse to operate the switching circuitry at point P1. As the pulse at P1 switches from high to low, the switcher circuitry accepts in turn the signals at points SWA and SWB – Figs.14(b) and (c). Fig.14(d) shows the resultant signal at point SWC.

Filter 1 then shapes the signal to produce the AM luminance signal shown in Fig.14(e).

System switching

Some VCRs have circuitry that enables them to select and use either the

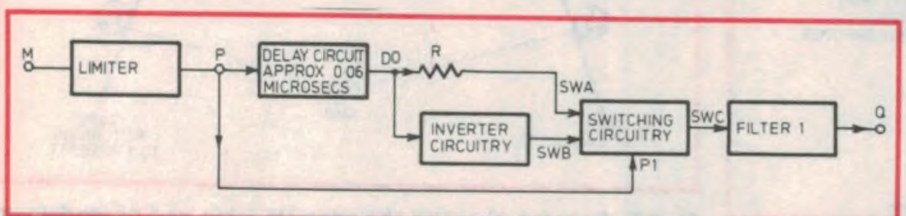


Fig.13: One form of FM luminance demodulator uses a delay/switching circuit which effectively converts the FM signal into a series of fixed-duration pulses, before filtering.

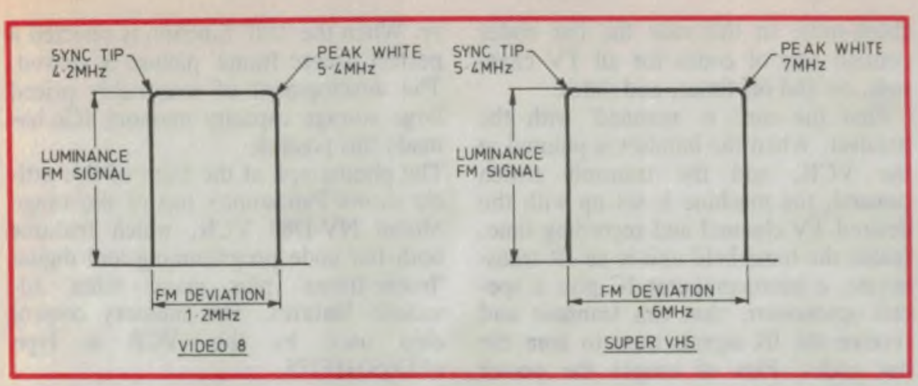


Fig.15: The FM luminance signal frequency deviations used with the Video-8 system (left) and the Super-VHS system (right).

PAL or SECAM system. A special SECAM detector with suitable change-over switching is included in the circuitry. Also Mullard produce the TDA3952A PAL-to-SECAM transcoder IC. This is useful if you live in Europe where it's possible to receive both TV systems. It's also handy if someone from another country sends you a video cassette tape recorded in SECAM!

However VCRs are manufactured – for example by Sony – that can switch between PAL, SECAM and the NTSC system. These machines are specially designed and quite expensive. More is involved than switching between systems – bandwidths, sound separation frequencies and many other considerations are involved.

Camera input circuitry

Practically all modern VCRs are equipped with a socket for a video camera. In Fig.1 the upper position of switch SW3 connects via buffer amplifier 1 to point CAM, where the composite signal from the video camera is fed in. The sound detected by the camera's microphone and amplified by its circuitry is supplied to point EAI, through buffer amp 2 to switch SW3 set in its lower position.

The S-VHS system

In the standard VHS system, when the luminance signal is converted to FM the tip of the synchronisation pulse corresponds to a frequency of 3.8MHz and the 100% white peak level to 4.8MHz – a range of 1MHz. This is known as the *carrier deviation*. (Please refer back to part 4 and its Figs.9 and 10).

In the S-VHS (Super VHS) system, a newly developed video cassette tape is used, surfaced with a special type of ferric oxide material. This tape was developed by the Victor Company of Japan (JVC) – the same company that invented the VHS system.

A top quality VHS tape will have a coercivity of about 730 – 750 Oersteds. However the new S-VHS tape has a coercivity of 900 Oersteds. (Coercivity refers to the magnetic force needed to reduce the magnetisation of a ferromagnetic material to zero. An Oersted is a unit of magnetic field strength).

An S-VHS video tape cassette has an ID (identification) hole on its case. If a standard tape is inserted in an S-VHS machine, it will not record.

This new video tape makes it possible for the Super VHS system to use a luminance signal bandwidth of over 5MHz, instead of the 3.2MHz maximum of the standard VHS system. The FM carrier now has a deviation of 1.6MHz, with the sync tip corresponding to 5.4MHz and the peak white signal to 7.0MHz (Fig 15).

This produces an excellent increase in picture definition on the recorded picture and does away with what has been called the 'weaknesses' of the video signal produced by a standard VCR.

Video 8 system

In the Video 8 system the deviation of the FM signal is 1.2MHz (Fig.15). The white peak level corresponds to 5.4MHz and the sync pulse tips to 4.2MHz. This system uses metal tapes (see part 2).

Metal tape in general has a high coercivity – around 1,500 Oersteds. The chroma signal, you'll remember, is down-converted from 4.433619MHz to 732.422kHz. Picture definition is very good with the Video 8 system.

VHS-C

The VHS-C compact tape system is used in video cameras and is fully compatible with the standard VHS system. The tape width is the same – 12.65 millimetres. However a VHS-C cassette is far smaller than a standard VHS cassette. It measures approximately 92 x 58 x 22mm. The video head drum is only 41.3mm in diameter instead of the 62mm of a standard VHS drum. In order to produce the same magnetic tape pattern as in a standard VHS machine, *four head* helical scanning is used as shown in Fig.16(a).

When a recording is made the video heads signal outputs are switched on and off in sequence as shown in Fig.16(b). The head switching circuitry opens electronic switches SWH1, SWH4, SWH3 and SWH2 in turn so that the signal from each head slightly

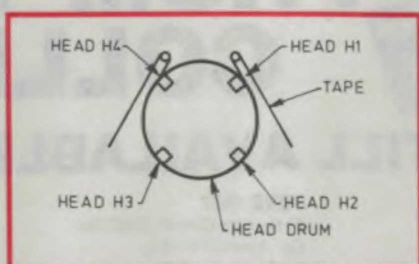


Fig.16(a): With the VHS-C format a smaller head drum is used but with four heads to retain compatibility with normal VHS machines.

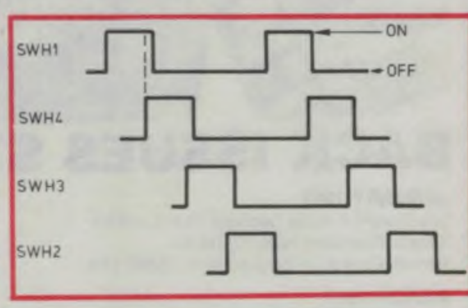


Fig.16(b): The VHS-C head switching signals are gated sequentially as shown, with a small overlap to prevent noise bands.

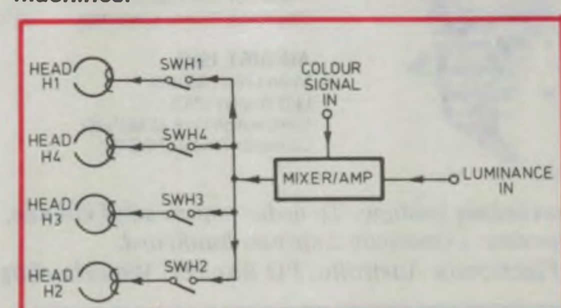


Fig.16(c): The electronic head switches SWH1-4 direct the composite FM luminance/chroma recording signal to the appropriate heads in turn.

VHS recorder

overlaps the previous signal – see Figs.16(b) and (c).

The recorded VHS-C cassette can be fitted into a special adaptor that is loaded into a standard VHS machine and played back as a normal VHS cassette.

Remote control

One basic method of remotely controlling the functions of a VCR was described in part 3. You'll remember that the control signals are transmitted by a hand-held unit, in the form of digitally encoded modulated infra-red (IR) light beam signals. An IR receiver unit in the VCR detects the signals and feeds them to the systems control microcomputer circuitry.

The latest hand-held control units can not only control the VCR functions but program the timer circuitry by means of a bar code.

Panasonic video recorders use this system. A programming card is supplied that holds bar codes – similar in principle to those used on groceries and scanned by a laser at supermarket check-outs. In this case the bar codes contain sets of codes for all TV channels, on and off times, and dates.

First the card is 'scanned' with the handset. When the handset is pointed at the VCR, and the transmit switch pressed, the machine is set up with the desired TV channel and recording time. Inside the hand-held unit is an IR transmitter, a microcomputer IC plus a special optosensor, that can transmit and receive the IR signals used to scan the bar codes. Plus of course the power supply batteries.

Developments in VCRs

Many brilliantly engineered advancements are now being incorporated into the latest machines. What once were remote possibilities are now realities. Long-play machines using six video heads set in the video drum, high fidelity stereo audio frequency modulated on two carriers, vastly improved circuitry for picture search modes and many other advancements are found in the latest VCRs.

By converting analog picture signals to digital signals, some of the new VCRs can store one complete 'frame' of picture within digital integrated circuitry. When the 'still' function is selected a perfect 'freeze frame' picture is viewed. The development of reasonably priced large storage capacity memory ICs has made this possible.

The photograph at the front of this article shows Panasonic's top of the range Model NV-D80 VCR, which features both bar code programming and digital 'freeze-frame' plus many other advanced features. The memory control chip used by this VCR is type uPD65031F175.

Conclusion

In this series we've covered the basic principles of domestic video cassette recorders. VCR techniques will continue to improve and advance. You'll find that the basic knowledge of VCR technology gained from this series will help you in the understanding of new developments.

My thanks are due to Mr Henry McAloon, the Technical Training officer of Sony (UK) Limited, for providing technical data on the Video 8 system.

Thanks are also due to Sony (UK) Ltd, Panasonic UK Ltd and Philips Test & Measurement for the loan of photographs used in these articles.

New, improved Teletext decoder – 2

In this second article describing our new design for a Teletext decoder, we deal with the actual construction, adjustment and faultfinding for the basic decoder unit. Thanks to the use of a new decoder chip set, this is all quite straightforward.

Virtually all of the decoder circuitry, with the exception of the power switch and transformer, is mounted on a single PC board measuring 200 x 173mm. This fits neatly inside the compact metal case, which measures 380 x 180 x 65mm.

The IR receiver diode and LEDs LD1 and LD2 are mounted at the front-panel edge of the board, while the RF modulator and video/audio inputs and outputs are along the rear edge. The power transformer, mains switch and associated wiring are all at the left-hand end, as viewed from the front (see pictures). Space has been left in the right-hand end of the case for the addition of the TV receiver module, to be described in a later article.

Because of this simplified construction, assembly should be very straightforward – although if you're a complete novice, it would be a good idea to get some practice in soldering before you start.

Mounting all of the components on the main PCB is made particularly easy with the DSE kit for this project, because the top of the board has a silk-screened pattern with all component locations identified. However in any case, these are shown in the PCB overlay diagram shown on these pages.

As usual, the best plan is to mount the relatively low profile passive components first – the resistors, capacitors, links, PCB pins, trim pots, inductors and diodes. Take care with the electrolytic capacitors and diodes, as these are polarised and must be inserted the correct way around.

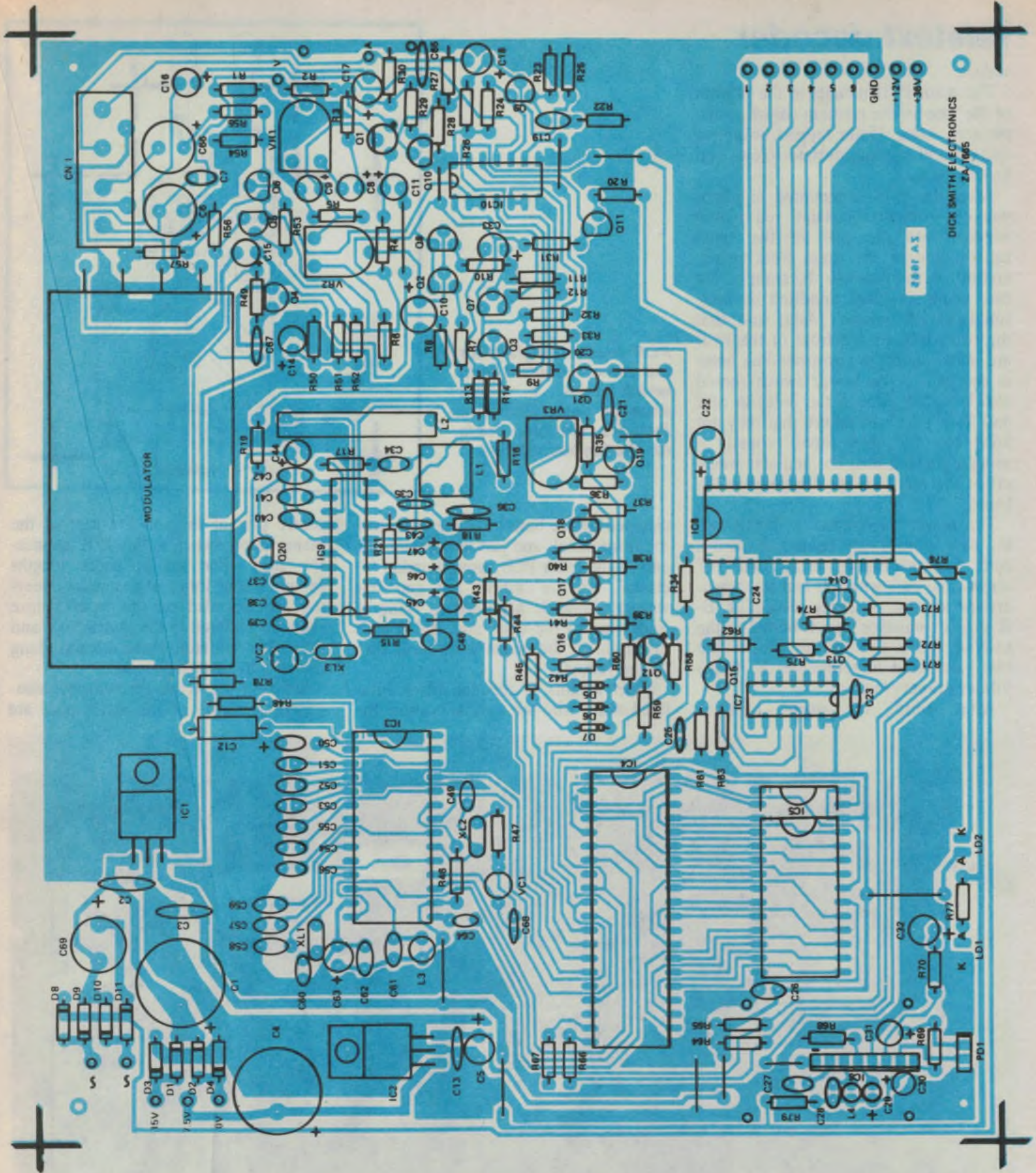
The next items to mount are the transistors and quartz crystals, taking care not to overheat these when you're soldering their leads to the PCB copper. As before, watch the polarity of the transistors. Trimmer capacitors VC1 and VC2 can also be fitted, alongside XL2 and XL3 respectively.

The RCA input/output connectors can be mounted to the board at this stage, along with the RF modulator unit.

And finally the ICs can be mounted, taking particular care here to observe the polarity when inserting them, as some may be quite expensive to replace. The two voltage regulator ICs mount on their backs, with their leads cranked down by 90° about 4mm out from the body and a 1/8" screw and 1/2" long hex tapped pillar used both to fasten each regulator's heatsink tab to the board, and to add a small amount of extra heat dissipating ability.

Note that the IR preamp (IC6) is shielded by a tinplate cover. This cover is held in place by soldering it to four PCB pins. Also note that when soldering in place the two LEDs (LD1 &

The finished decoder, complete with its matching IR remote control unit. An optional TV receiver front-end module can be added internally if desired.



The overlay diagram for the decoder's main PCB, showing where everything goes. A shield encloses IC6 and PD1.

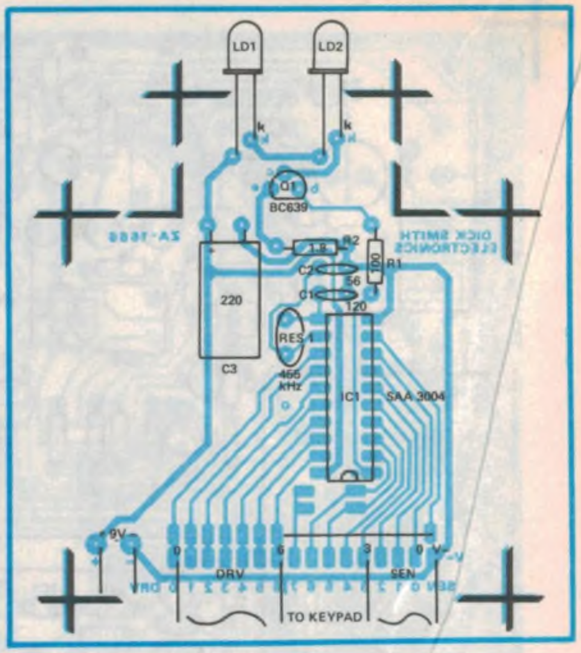
LD2) and the photo-diode (PD1), these components should be left with most of their leads – at least 15-20mm, anyway. This is so that the LEDs can fit comfortably into the front panel holes, and the photo-diode can be bent (carefully) at right angles to sit at the centre of its red bezel.

That more or less completes the main PCB assembly, and you can turn your attention to the case.

The rear self-adhesive label must be stuck on before the mains cable and grommet/clamp are put in. This label should be carefully centered and pressed firmly in place. After it is in place, the various holes can be carefully cut out with a sharp knife – but NOTE that there is no reason to cut out the holes at the left-hand end at this stage, because these are used for the optional TV tuner module. For the present the label should be left intact, to cover the holes until the TV tuner module is installed.

The main PCB mounts in the bottom of the case in the position shown in the pictures, using 15mm tapped insulating spacers and the appropriate screws and lockwashers.

After the PCB is mounted in place, you can cement the small red plastic window into the rear of the small square hole in the dress front panel, and attach the panel to the front of the case using six black anodised countersink-head PK screws. Make sure that the two LEDs on the front of the PCB are mated with the corresponding holes in the panel. The power switch should also be fitted through the holes in case and front panel, to ensure that they are lined up, and then fitted properly – using a packing nut, flat and star washers at the rear and the dress nut at the front.



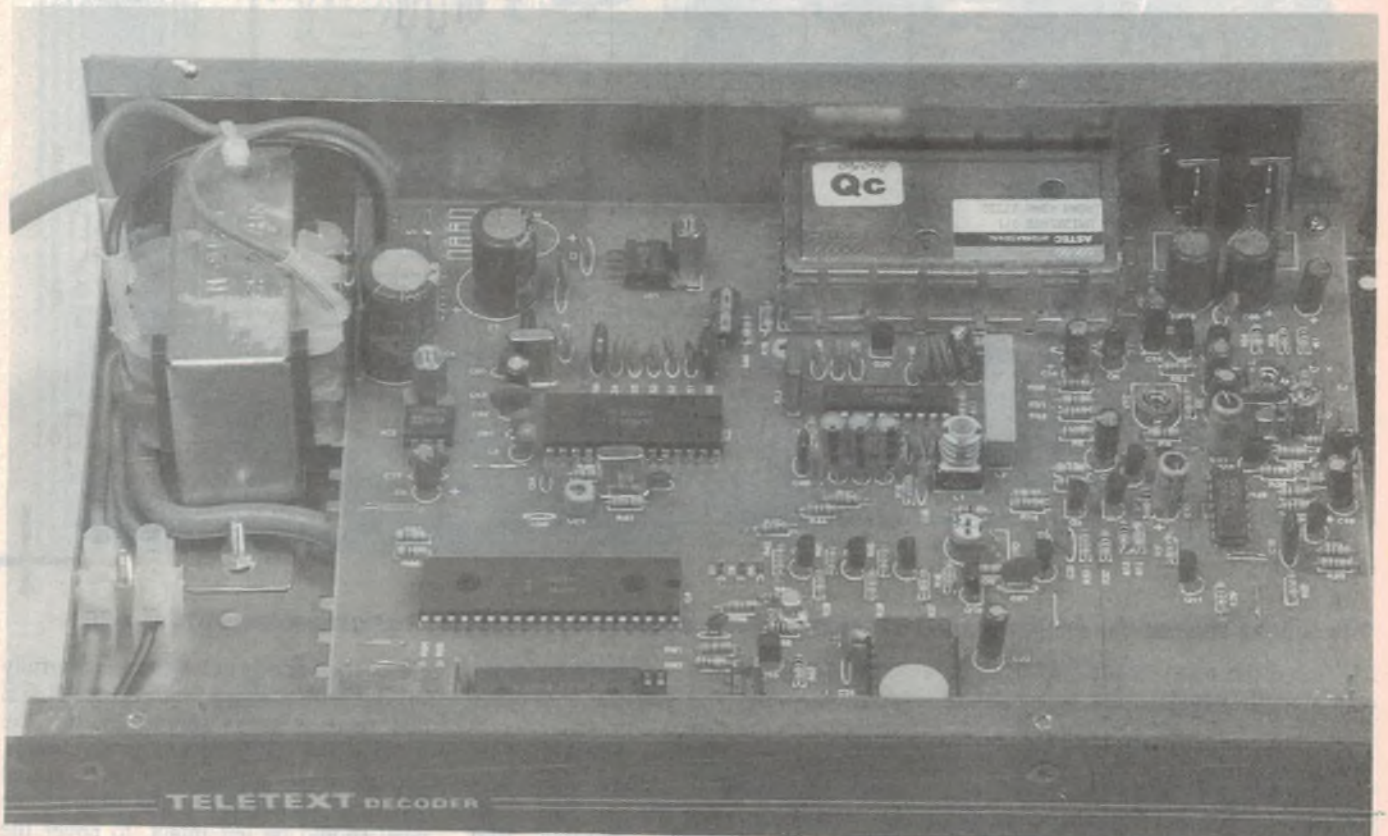
PCB overlay diagram for the remote control unit, which uses a single encoder chip. This also includes scanning logic for the keypad matrix.

The power transformer is bolted into the case immediately behind the mains cord grommet/clamp, using two 1/8" screws and nuts with flat and star washers for locking. A 2-way section of 'B-B' mains connector strip is bolted to the case at the centre of the end of the case, and used to terminate the transformer primary leads.

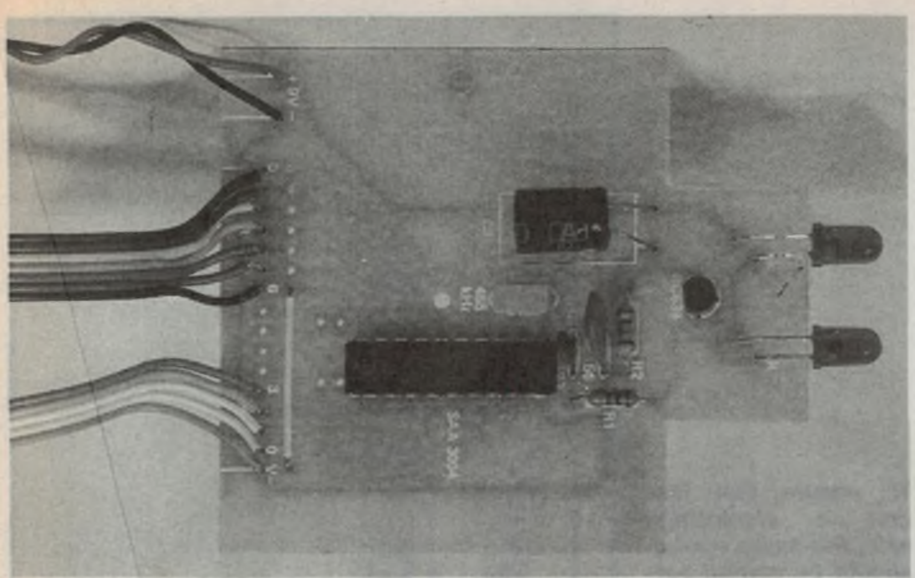
After entry, the mains cord is clamped to the bottom of the case near the front panel, and just underneath the end of the main PCB, using a nylon 'P-clamp'. An 1/8" screw, nut and star washer alongside are used to clamp a solder lug to the case, and this is used to terminate the mains cord earth wire (green/yellow).

Short lengths of red and black insulated mains wire are used to connect the centre pair of lugs on the rear of the mains power switch to the 'B-B' connector strip. For safety, short lengths (about 20mm long) of insulating sleeving are threaded on the wires before they are soldered to the switch lugs, and then after soldering these are slid along the wire to cover the joints.

Similarly the active (brown) and neutral (blue) wires of the mains cord are



An overhead view inside the decoder, showing the location of most of the components on the PCB.



A shot of the remote control PCB when assembled, showing all of the components in place. Two lengths of ribbon cable connect to the keypad PCB.

then taken directly to the two uppermost lugs of the switch, again with short lengths of sleeving to cover the finished joints. Finally, a nylon cable clamp is fitted around all four sleeves, to anchor them in place.

When the leads are run between the PCB and the power transformer secondary, further lengths of sleeving are used to cover the joints at the transformer. Details of the mains wiring are visible in the close-up picture.

Assembly of the remote control unit should be quite straightforward using the overlay diagram and internal photograph as a guide. There are only a handful of parts to fit on the PCB, with the two IR transmitting LEDs mounted on the narrower front section of the board with their leads left reasonably long, and cranked at 90° so they face 'forward'. Two short lengths of ribbon cable are used to connect the PCB to the keyboard assembly.

Adjustments

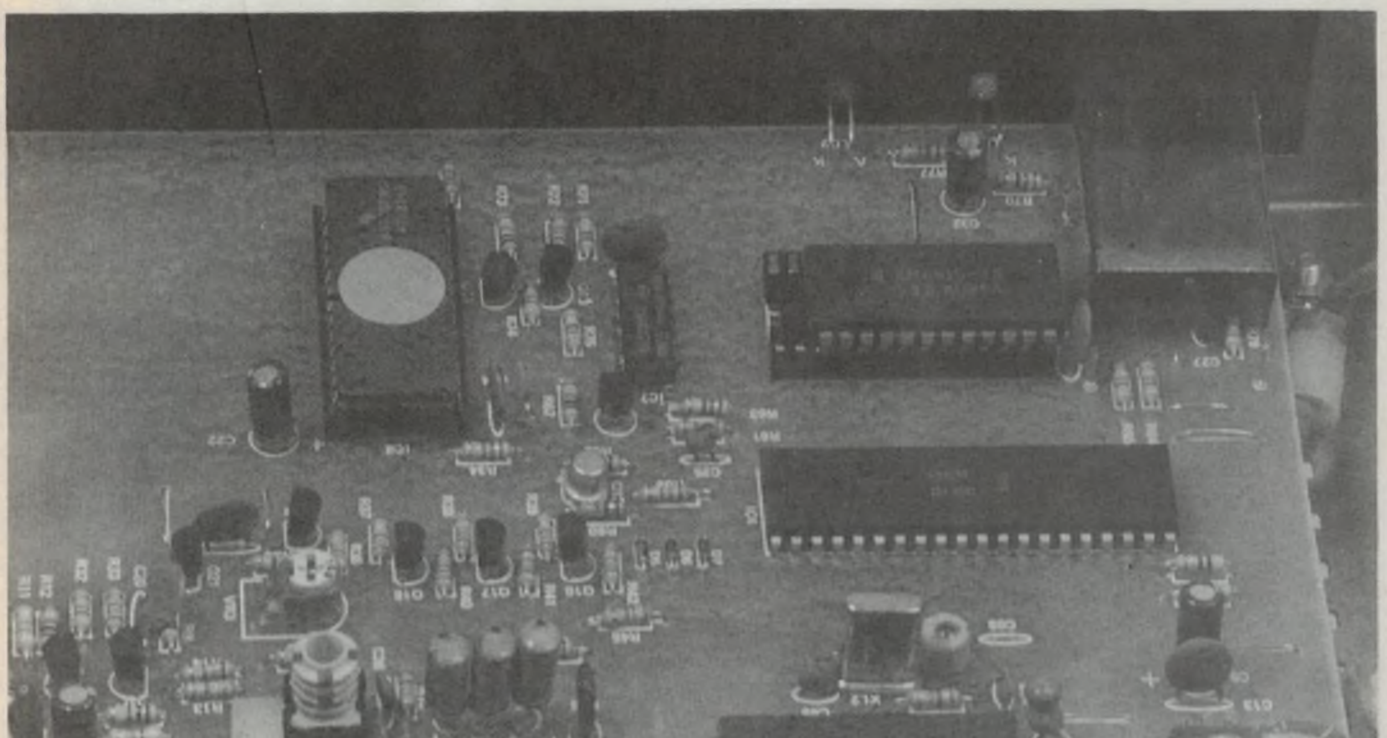
There are a number of adjustments to be made to the decoder after assembly, to ensure correct operation. However none of these is difficult.

Some degree of video gain adjustment can be made by means of trim pot VR1. Ideally VR1 should be adjusted for 0.5V p-p at the modulator video input. If a CRO is not available, initially set VR1 to half-way and then adjust it later for minimum Teletext display errors.

VR2 should be adjusted until there is 2.2V DC before the start of the synch pulses on the video input of the RF modulator (i.e., the emitter of Q5). If no CRO is available, adjust this for best TV picture from the RF ouput of the modulator.

For optimum performance, disconnect any incoming video and while observing pin 17 of the VIP chip (IC3) with a frequency counter, adjust trimmer capacitor VC1 for a frequency of 6,000,200Hz. If a frequency counter is unavailable, adjust VC1 for minimum Teletext display errors on a frequently updated display page.

After the video level has been set up,



Another view inside the decoder case, showing the parts near the front of the PCB.

as mentioned earlier, VR3 should be adjusted to match the Teletext display colour levels to the TV colour. That is, when changing from a TV picture to a Teletext picture, the Teletext colour should not appear harsh or 'too vivid'.

The colour encoder (MC1377, IC9) is driven from the EURO CCT (IC4). The only adjustment required here is VC2. While in a Teletext display mode, adjust VC2 so that the colour turns on.

Adjustment of VC2 can be checked by having a subtitle or newsflash in display A and a normal Teletext display in B, so that when changing between A and B the colour-on action is reliable.

Options

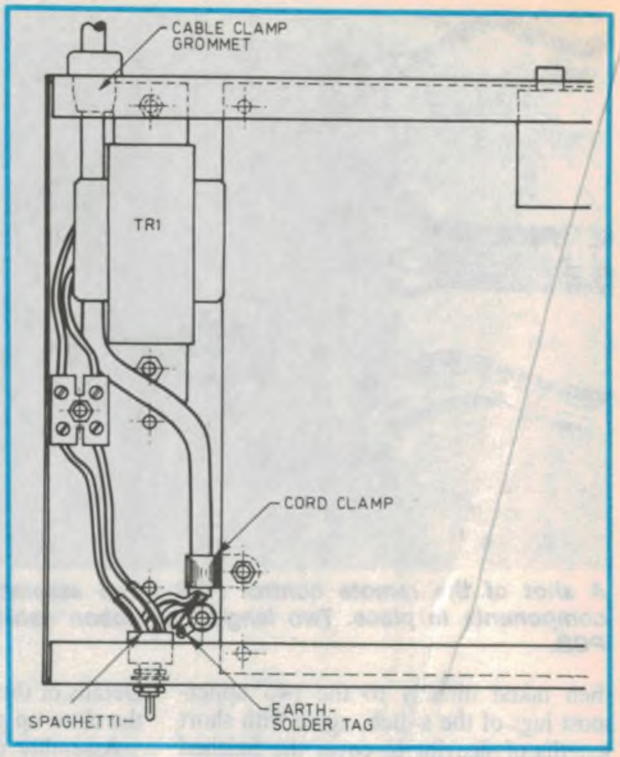
At present the decoder is suitable for use with the video and audio from a VCR. Should a VCR not be available, a TV tuner module is being developed as an add-in option, fitting inside the same case. This will allow a traditional 75-ohm RF connection to be made straight from an aerial.

To cater for the power requirements of the TV-tuner module, the power supply will be complimented by a new transformer beside the existing M-2155 transformer, and with additional rectifier diodes D8 to D11 and capacitor C69. These components need not be populated unless/until the TV-tuner module is added.

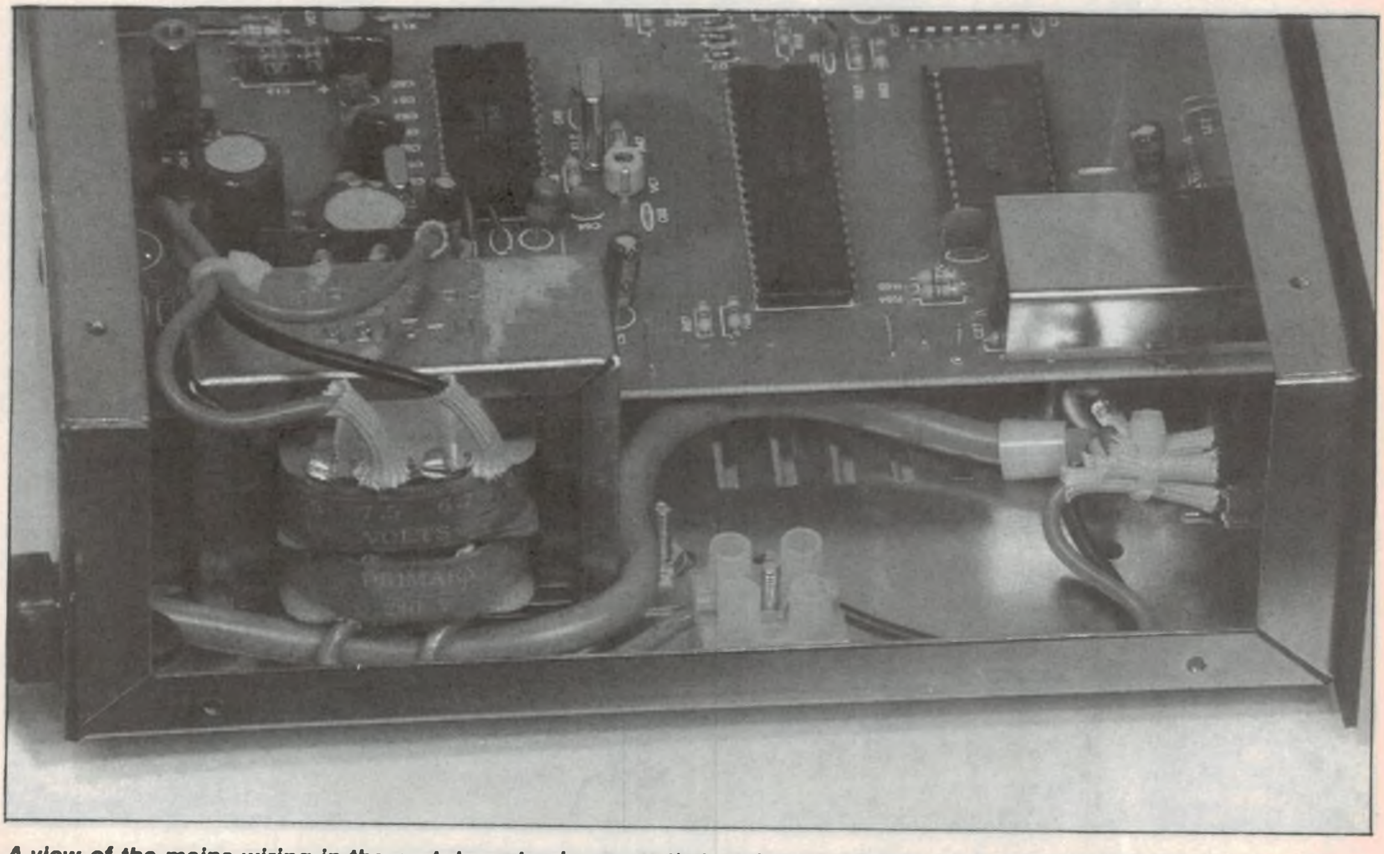
Details regarding the optional TV-tuner module will be given in the third of these articles.

You may note that space is available on the PCB for a 28-pin 6164 static RAM chip at the position for IC5. At present this is a 24-pin 2k x 8, 6116 static RAM, which allows two pages to be held or acquired simultaneously (A & B).

An upgrade to a 28-pin 4k x 8, 6164



To ensure that the unit is electrically safe, the mains wiring should be carried out according to this diagram. Note the 'spaghetti' sleeving over the switch terminals.



A view of the mains wiring in the prototype, to show exactly how it's done.

static RAM will allow 4 pages to be acquired or held simultaneously, but note that the software contained in the CPU will not make use of this possible upgrade at present.

Faultfinding

Hopefully you should have no problems with this project, as the design has been well proven. However should a problem arise, first check the +12V and +5V supply rails. These should be exactly as stated, and the input voltages should be at least +14V and +7V respectively – in each case 2V higher than the regulator's output voltage.

If all seems well in the power supply section, you should now try to isolate the trouble to a particular circuit area, so that you can check again more thoroughly.

Upon power-up, the video source (a TV station from the VCR) should be able to be seen on the TV via channel 1. Pushing TT should put the Teletext unit into Teletext mode, and normal Teletext operation should follow. If the display remains unchanged, check that the activity LED has registered the TT command, by flashing RED briefly. If this doesn't happen, there would seem to be a fault in the link between the IR controller and CPU. With a voltmeter set to a 5V DC range, or a CRO, check that pulses appear at pin 8 of the CPU (IC8), whenever a key on the IR controller is pressed. If this is not the case, check the construction of the IR remote controller and the IR preamp (IC6).

The CPU can be verified to be working, by observing the serial clock signal (SCL) and the serial data signal (SDA), found on pins 19 and 20 respectively of the EURO CCT (IC4). These signals are best observed with a CRO, and both should pulse briefly, about once every 1 or 2 seconds. If either of these are constantly in one state, there would appear to be a problem around the CPU – i.e, maybe no clock pulses from the VIP chip, via Q15 and IC7.

If the teletext unit processes some commands from the IR controller but not others, there is a good chance that there is a fault in the keyboard matrix of the IR controller.

If different Teletext pages cycle on the screen continuously, this would suggest that the VIP chip is deriving the Teletext information satisfactorily, but the EURO CCT is not controlling this operation. In this case check the power supply to the EURO CCT and the CPU, also check that the I^2C bus (SDA & SCL) is connected between those two devices.

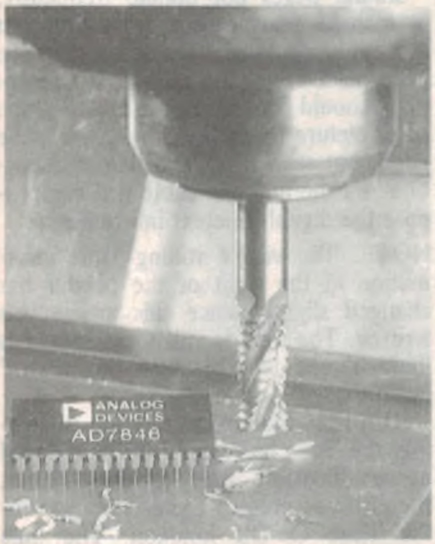
The RGB network from the EURO CCT to the encoder (IC9) can be checked for level and correct colour by finding a test page, (ATN-7 page 294, for example) with colour bars on it. This can help confirm if one colour is missing or not.

Should pages not update frequently, or include many errors, (assuming that the adjustments of VC1 and VR1 have been made) then the general TV reception should be scrutinized. In some cases picture reception can appear to be good, but even slight ghosting or reflections on the antenna cable will compromise the digital Teletext information.

NOTE: The visible rolling Time information at the right of the header has changed slightly since this article was written. The time is still there, but it is 'hidden' and is subject to the 'reveal' button.

Also note that since the time of writing, the Time has ceased to be included in the invisible part of the header, therefore at present there is no use for the Time On/Off function. The time that was there is now transmitted as 00:00.

16-bit DAC has voltage output



A new digital-to-anolog converter (DAC) uses a segmented ladder architecture to ensure 16 bits of both resolution and monotonicity. Fabricated in a BiCMOS process, Analog Devices' AD7846 includes track-and-hold output amplifiers to generate a low-glitch buffered voltage output. Also, the single-chip DAC also incorporates advanced logic features such as data readback and reset to zero.

The combined monotonic operation, readback and reset in the AD7846 allow users to design fail-safe closed-loop servo systems for machine tool and robotic systems. The low 100mW dissipation, double-buffered latches and small 28-pin package also makes the DAC practical for automatic test equipment.

The AD7846 cascades a 16-bit switch matrix and a 12-bit R-2R DAC in a segmented ladder approach. This technique, pioneered by Analog Devices for monolithic 16-bit DACs, guarantees monotonic operation (±1LSB differential nonlinearity) over the full -55 to +125°C military temperature range. Laser trimming of on-chip resistors reduces integral nonlinearity to ±2LSB, ensuring 14-bit accuracy. Fast on-chip bipolar amplifiers deliver a maximum 9us settling time to ±0.003%.

The AD7846 operates from a single +12 to +15V supply or ±12 to ±15V dual supplies. An internal gain-ranging circuit permits the device to generate either a ±5V or ±10V output when supplied with a ±5V reference voltage. In the unipolar mode, the converter generates a 0 to 5V or 0 to 10V output with a +5V reference signal. RESET automatically sets the DAC's output to zero.

For further information contact Parameters, 1064 Centre Road, Oakleigh 3167 or phone (03) 575 0222.

Two port SAW resonator

Murata Manufacturing Company of Japan has recently released a two port surface acoustic wave resonator, the SAR series, for the UHF band.

The SAR series resonators make oscillator design in the UHF band a much simpler process, and increases the power handling ability by about ten times, when compared with earlier single port SAW resonators.

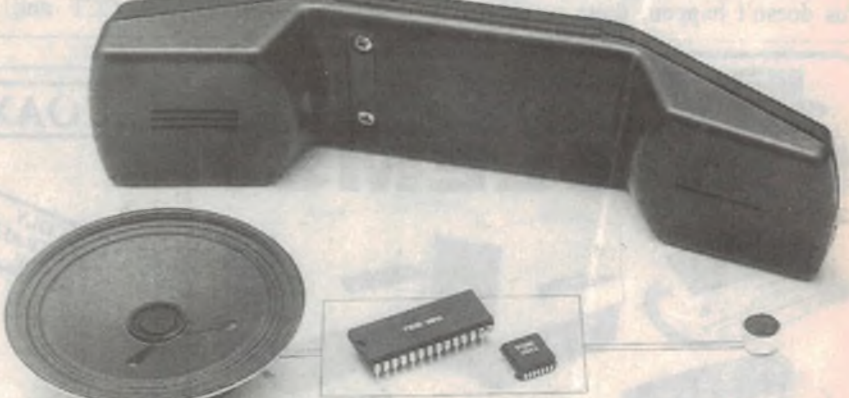
The standard frequency range is currently tailored for CATV, remote control, and security applications, however Murata are prepared to manufacture to specification for other applications.

The SAR series are available in 0° and 180° phase types, for use with bipolar and Mosfet oscillator circuits respectively.

Typical circuit parameters for the series are insertion losses of 5.6dB, loaded Q of 4400, and input and output impedances of 50 ohms.

The small size, and accurate frequency of oscillation of these resonators makes them ideal for use in small remote controllers such as Automotive Burglar Alarms, Garage Door Openers, and Building Access Systems.

For further information contact IRH Components, 32 Parramatta Road, Lidcombe 2141 or phone (02) 648 5455.



Speakerphone circuit

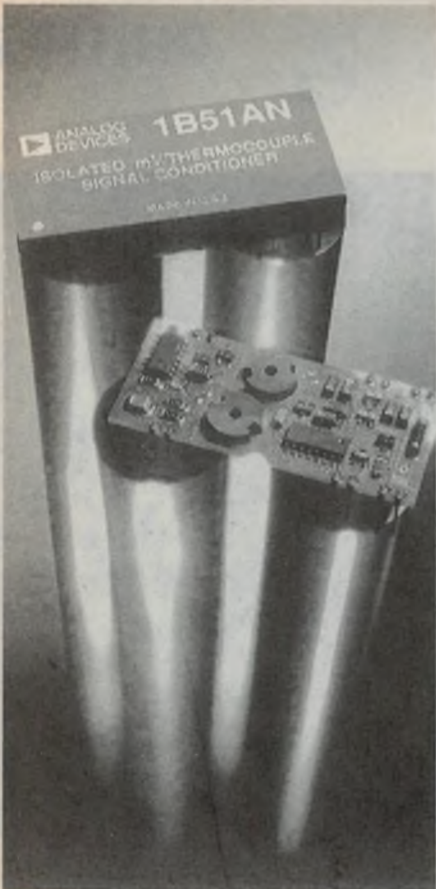
The PBM 3912 speakerphone circuit incorporates all amplifiers, attenuators, digital and analog logic needed to produce a high performance, handsfree speakerphone system. The circuit is based on the digital speech controller PBM 3911.

Key features of the PBM 3912 include digitally controlled switching, giving improved linearity in the time constants compared to fully analog circuits. PBM 3912 offers full accessibility to the control channels. This allows the designer to filter the signal controlling the voice switching, thus improving the acoustical performance to a level required in difficult environment applications, e.g. mobile telephones, intercom systems in factory environments etc.

Main channel attenuation is selectable to 25 or 50dB depending on the characterisitics of the telephone design. PBM 3912 has an intelligent volume control facility, IVC, which means that the control logic ensures a constant total attenuation regardless of switching position and volume control settings.

Independant opening sensitivities and background noise compensation with attenuation of the transmit signal enhance the dynamics of the total system solution.

Further information is available from Ericsson Components, PO Box 95, Preston 3072 or phone (03) 480 1211.



Thermocouple signal conditioner

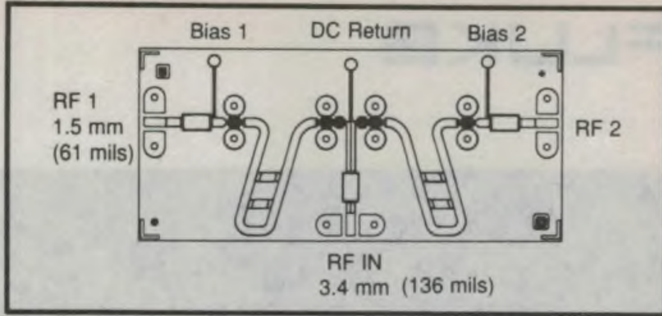
Designed for isolated interfacing of low-level and thermocouple signals to data acquisition systems inputs, Analog Devices' new 1B51 provides a complete, high-performance signal conditioning solution in a small 1.0" x 2.1" x 0.35" plastic package.It includes a chopper-stabilised amplifier, isolation circuitry and low-pass filter.

Unlike more costly solutions requiring separate DC/DC converters, each 1B51 generates both its own input-side power, providing true channel-to-channel isolation, as well as auxiliary isolated power (6.2V at 2mA) for user input-related circuitry.

With an input offset temperature coefficient of +/−0.1uV/°C and nonlinearity of +/−0.035%, the 1B51 is resistor programmable for gains from 2 to 1000. Galvanic isolation to 1500V RMS is provided via transformer coupling: Inputs are protected against continous 240V RMS faults. A 3Hz three-pole active filter reduces line frequency noise with 60dB normal mode rejection: CMRR is 160dB at maximum gain.

For further information contact Parameters, 1064 Centre Road, Oakleigh 3167 or phone (03) 575 0222.

2-18GHz GaAs PIN switch



Across a broadband frequency range (2-18GHz), the ASM218-01 GaAs SPDT monolithic PIN switch provides high isolation (50dB min.), and low insertion loss (1.5dB max.). This is a fast switching speed device (2ns), with I/O DC blocking.

The ASM218-01 is an Alpha Advanced Technology Division, low production cost, MMIC switch. It incorporates one series and two shunt PIN's, in a small size (1.5 x 3.4mm), and offers system design engineers a real alternative to hybrid switches. Custom packaging is available on request.

For further information contact Benmar International, GPO Box 4048, Sydney 2001 or phone (02) 233 7566.

UHF amplifiers

Hewlett-Packard has announced the release of a family of bipolar monolithic amplifiers. These consist of single-stage feedback amplifiers, series and shunt feedback being used to achieve high uniformity from amplifier to amplifier. The devices are ideally suited as 50 ohm building blocks in narrow and broadband RF amplifier applications.

3dB bandwidths of DC up to 3.8GHz and gains of up to 20.5dB at 1GHz are available. The devices are available in metal/ceramic microstrip packages, SOT-143 and chip.

For more information contact VSI Electronics (Australia), 16 Dickson Avenue, Artarmon 2064 or phone (02) 439 8622.

16-bit DSP microcontroller

Texas Instruments and Microchip Technology have announced what is claimed to be the world's fastest digital signal processor (DSP) microcontroller, the TMS320C14, which pairs 16-bit DSP performance with on-chip peripherals. This first time combination is said to offer five to 10 times the performance of traditional 16-bit microcontrollers at a comparable price.

The 320C14's DSP engine provides analog designers with a digital solution that does not require sacrificing precision or performance. System performance can be enhanced through the use of advanced control algorithms such as adaptive control, Kalman filtering and state controllers.

In addition to the greater functionality available through on-chip peripherals, the high-speed central processing unit (CPU) of the 320C14 permits the digital designer to process algorithms in real time instead of using approximate results contained in a look-up table.

Extensive development support and a general purpose instruction set reduce development time on the TMS320C14 while providing the same ease-of-use as traditional 16-bit microcontrollers.

The 320C14 is well-suited to functions which need more performance than a traditional 16-bit microcontroller can supply. Such applications include disk drivers, automotive sub-systems, robotic or motor control and missile guidance and platform stabilisation.

The 320C14 is object-code compatible with the industry standard TMS320C10 DSP. It comes with 256 words of on-chip RAM and 4K words (8K bytes) of on-chip ROM. It can address 4K words of off-chip memory. Most instructions on the TMS320C14 are executed in a single cycle.

The high speed of the 320C14 is made possible by implementing functions like a 16 x 16 multiplier in hardware. The 320C14 uses a Harvard architecture which employs multiple buses internally to further increase the execution speed. To allow greater precision for intermediate results, the 320C14 has a 32-bit arithmetic logic unit (ALU) and 32-bit registers. It also comes with two hardware shifters that allow scaling simultaneously with other operations.

Further information is available from Texas Instruments Australia, 6-10 Talavera Road, North Ryde 2113 or phone (02) 887 1122.

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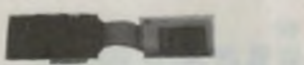

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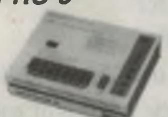

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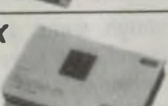

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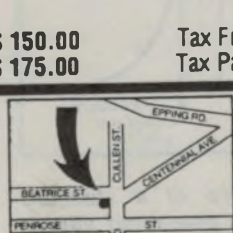

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IF Stages for Advanced Receivers

Continuing our look through the circuits and concepts involved in advanced or 'communications' type superheterodyne receivers, we discuss here the intermediate frequency (IF) amplifier section – in terms of bandwidth, imaging, amplifiers and narrow passband filters.

by BRYAN MAHER

With the signal arriving at the antenna partially drowned by atmospheric noise, radio frequency interference (RFI), and unwanted powerful radio transmissions on adjacent frequencies, a large improvement can be achieved by reducing the receiver *bandwidth*.

Most RFI appears spread over such a wide range of frequencies that any reduction in bandwidth almost always results in less noise heard in the loudspeaker or earphones.

While we are trying to receive and copy some desired transmission, there might be another (unwanted) transmitter on an adjacent frequency. If that interfering transmission is close enough (in frequency) or sufficiently powerful, it too will be heard in the loudspeaker, resulting in confusion and often making it impossible to copy the desired station. Fig.1 illustrates the effect of a powerful unwanted transmission outside the -3dB bandwith, but still very audible if the 'skirt' of the response curve spreads too much.

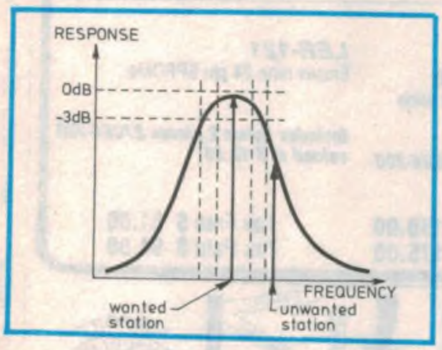

Fig.1: The response of a standard tuned circuit to an unwanted station on a relatively close frequency. It will still be quite audible.

If the interfering transmission is within the -3dB bandwith, then we are worse off still. Either way the road to improved listening lies in:

1. Making the -3dB bandwidth narrower, and
2. Causing the response curve to drop more sharply outside the -3dB points.

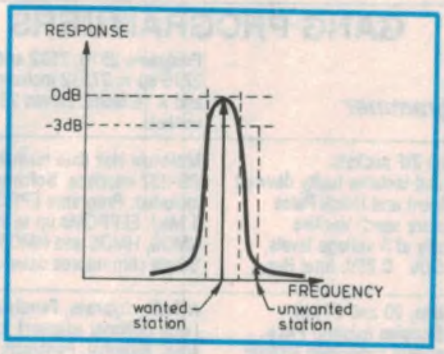

Fig.2: By using a tuning circuit with a narrower bandwidth and steeper 'skirts', the response to unwanted signals is reduced.

Fig.2 illustrates this improved situation, with both a narrower bandwidth and steeper skirt slopes. The unwanted transmission is now way down on the response curve, and its interference with the wanted signal much reduced.

In the case of a very weak wanted station (such as a portable battery operated transmitter) and a powerful interfering transmitter, then there is all the more need to make the response curve as narrow as acceptable, and as steep-sided as possible.

How narrow a bandwidth is acceptable? That depends on the type of transmission we wish to receive.

For reception of hi-fi AM (amplitude modulated) transmissions we would like the bandwidth to be +/-15kHz, or even +/-20kHz, enabling all high notes and harmonics to be faithfully reproduced. But as communications receivers, two-way radios and other point-to-point transmissions usually are interested only in speech or code (either Morse or digital), a much narrower bandwidth is usually perfectly acceptable.

Quite good speech reproduction is possible using a bandwidth limited to +/-3kHz, while for reception and copying of slow Morse code some communications receivers use bandwidth as narrow as 375Hz.

IF amplifiers

The intermediate frequency amplifier section (usually called the 'IF section' or 'IF strip') provides three essential functions in every high quality radio receiver. These are:

1. High gain
2. Control over bandwidth
3. Automatic control of gain

Although some gain is obtained in the RF and audio sections, and perhaps in the mixer, for high sensitivity we rely on the clean, quiet, high gain of the fixed-tuned IF section. To achieve such high gain two IF amplifier stages are usually used.

Again, though the RF amplifier and mixer usually contribute some selectivity, it is in the IF section that a receiver generally achieves most of its selectivity.

As the preceding RF and mixer stages have predetermined the signal-to-noise ratio of the whole receiver, and the IF section is often working on a lower frequency, noise is not such a problem in the IF section. Even so we do use reasonably low noise transistors of high frequency capability.

Because automatic gain control (AGC or AVC) is applied to the IF section, the circuits and transistors used

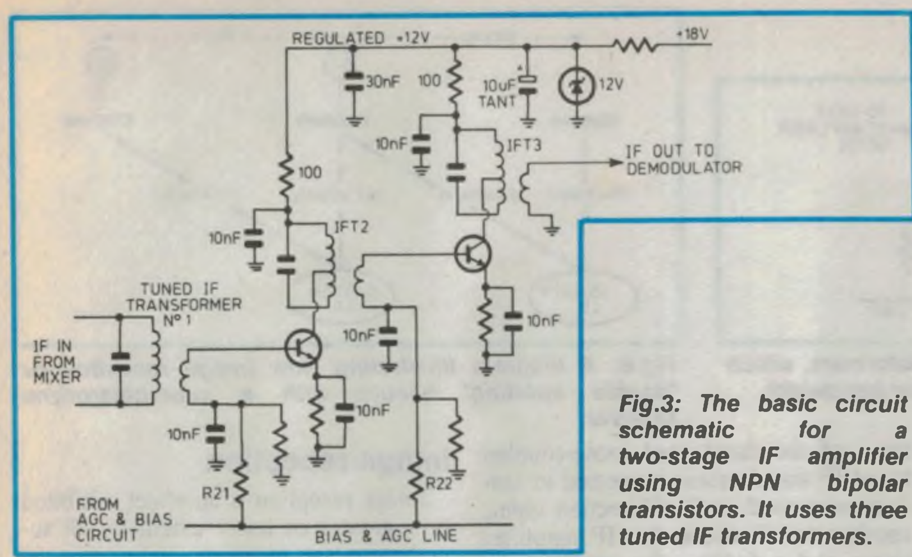

Fig.3: The basic circuit schematic for a two-stage IF amplifier using NPN bipolar transistors. It uses three tuned IF transformers.

must operate as linearly as possible over a range of quiescent operating conditions, so the circuit is designed to rest at an appropriate quiescent current.

IF stage circuits

Intermediate frequency amplifier stages are commonly constructed using junction transistors, FETs or integrated circuits. Fig.3 shows an economical, though quite successful two-stage IF amplifier using any one of a wide range of small high frequency NPN junction transistors, such as those 'low noise transistors' we listed last chapter.

Input and output are coupled using step-down tuned IF transformers, with a third transformer used to couple the two amplifier stages. A high quality receiver would use those two stages, with

The stepped-down impedance ratio (indicated by the transformer winding having fewer turns) gives better impedance matching to the low input impedance at the transistor base.

DC forward bias for the transistors, superimposed on the automatic gain control (AGC or AVC) voltage, is applied to their bases via resistors R21 and R22. This DC control signal for AGC comes from the AGC section, which we will discuss soon.

The full gain needed for weak signals is achieved when R21/R22 are supplied with a +3V DC control voltage. But when the received signal is very strong, the AGC controller changes the AGC voltage down towards +1.0V DC.

This reduced bias applied to the transistors causes their base current to reduce, lowering the gain and preventing overloading of following stages. More importantly the AGC action gives a fairly constant output signal level, when receiving fading or fluttering transmissions.

Under bad reception conditions this AGC automatic control of gain is most important – without it some fluttering and fading signals can be impossible to copy.

The bypassed emitter resistors develop some automatic negative DC bias, to counter temperature-caused variations in transistor current gain. Each stage is supplied from the +12V DC supply via a 100 ohm decoupling resistor and 10nF bypass capacitors.

Tuned IF transformers

The tuned input and output transformers, being fixed tuned to the intermediate frequency, can be made small – as the photo in Fig.4 shows. Because of the fixed tuning it is also relatively easy to achieve a high Q, thus providing a fairly narrow overall receiver passband.

As the tuning capacitor across each transformer primary winding tunes that winding to the fixed intermediate frequency, fixed silver mica or NP0 ceramic capacitors are used. (An NP0 ceramic capacitor has almost zero temperature coefficient of capacitance).

Furthermore being small these capacitors are mounted within the transformer shield can, giving very short leads (low resistance leads raise the transformer Q) and minimising stray coupling between adjacent transformers, or to other sections of the IF circuitry.

Adjusting the IFT's

When a radio receiver is constructed or repaired, the tuning of all the IF transformers or 'IFT's' must be adjusted or *trimmed* to bring all to the exact same frequency. In earlier transformer types each fixed tuning capacitor had a small adjustable trimmer capacitor in parallel for this purpose.

Most modern miniature IF transformers use instead just the fixed capacitor and trim the frequency by inductance adjustment, using a screw-threaded ferrite core or cap accessible from outside the shield can. The screwdriver slot in the threaded ferrite core can be seen in the photo of Fig.4.

When aligning a receiver a non-metal screwdriver is used to adjust these cores. If a commercial nylon screwdriver is unavailable, a good substitute can be made from an 8-gauge or 10-gauge plastic or 'tortoise shell' knitting needle, with one end filed to a screwdriver-blade profile.

Some IF transformers have a hexagon hole down the centre of the ferrite core, rather than a screwdriver slot. The alignment tool for these is a hexagon nylon rod, or again a carefully filed non-metal knitting needle.

The complete shielding afforded by the transformer and capacitor being within a metal can, and the decoupling used on the +12V DC rail isolates each IF stage, enabling two stages as Fig.3 to be used without undue fear of instability, provided sensible layout is followed.

Simple receivers exhibiting excellent characteristics can thus be constructed using readily available components.

Number of IFT's

Receivers designed for broadcast hi-fi music reception, aiming for a +/-10kHz bandwidth to enable all transmitted

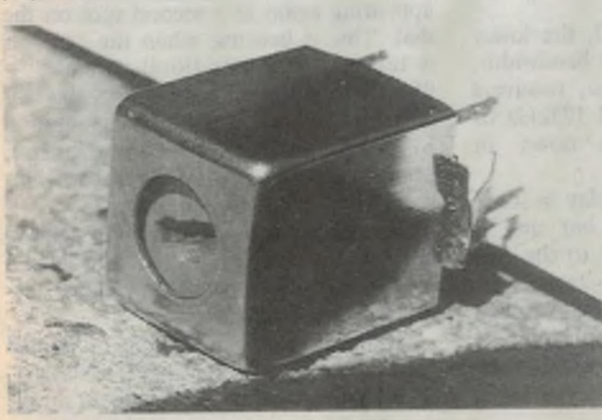

Fig.4: A typical miniature IF transformer, shown here about twice actual size. This type may be adjusted by moving the threaded ferrite core in or out of the windings.

Advanced IF stages

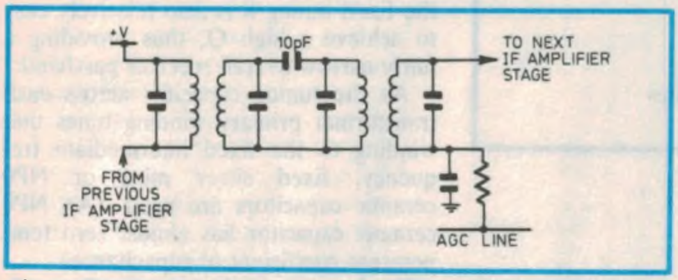

Fig.5: Back-to-back double tuned IF transformers, which can be used to give considerably narrower bandwidth.

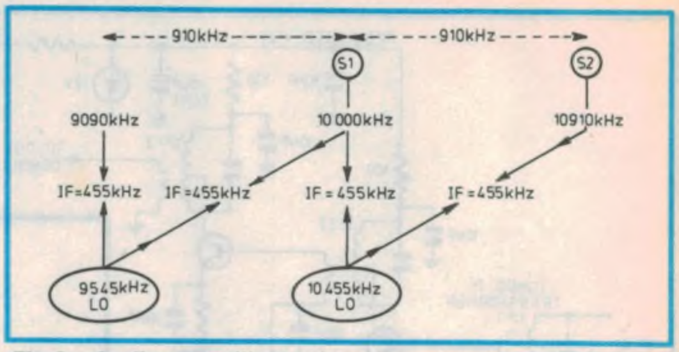

Fig.6: A diagram illustrating how image reception or 'double spotting' occurs with a superheterodyne receiver.

music modulation sidebands to be heard, would generally use one IF stage. As the broadcast station is usually powerful and fairly close, the medium gain afforded by one IF amplifier stage, i.e., half of Fig.3, is usually sufficient.

But in the specialized world of communications, using either AM or Morse code, a considerably narrower bandwidth is usually essential in order to cope with the received signal being weak, buried in noise and partly blanketed by stronger interfering stations close in frequency.

The use of two IF stages with three tuned transformers, as in Fig.3, will typically allow reduction of the bandwidth to about 8kHz (i.e., +/-4kHz), which would cut off the highest music sidebands. But as communications receivers are not usually used on music programs, their inability to copy some parts of music is regarded as inconsequential.

Should interference be so bad that even narrower bandwidth appears necessary, you may say: "Why not just add another IF stage, making three stages, including four tuned transformers?"

True, the extra transformer involved in adding a third IF stage would bring the bandwidth down to about 5 or 6kHz (+/-3kHz), and very high IF gain would result. But the difficulties involved in keeping the IF section stable with such very high gain at the one frequency may well prove insurmountable, unless extraordinary shielding and decoupling techniques are used.

Let us discuss various other methods which are available for the reduction of IF bandwidth.

Back-to-back IFT's

One simple method using ordinary components was used in a communications receiver designed by John Moyle and Neville Williams and described some years ago in *Radio and Hobbies*.

Using a two stage IF section, two (instead of the usual one) loose-coupled tuned IF transformers connected in tandem were used at the IF section input, another two between the IF amplifier stages and a further two coupling the output of the IF section to the following demodulator.

Double-tuned IF transformers were used, as this type can have the narrowest bandwidth, the connections for each pair of transformers is indicated in Fig.5.

The design worked very well; the two amplifier stages gave high gain, but not so high as to be unstable. The six double-tuned IF transformers reduced the bandwidth to about 5kHz (+/-2.5kHz). Your humble author, having built a copy, found this design excellent for the reception of speech and even passably reproducing a little music, logging many overseas radio stations.

Choice of IF

From the earliest days of superheterodyne radio receivers, it was realized that the lower the intermediate frequency chosen, the narrower the receiver bandwidth. This results from the quality factor Q of a tuned transformer, and the equation we met previously:

$$Q = f/(\text{delta } f)$$

Where Q = the quality factor
f = the IF frequency
delta f = the IF bandwidth of that transformer.

For a given achievable Q, the lower the value of f, the lower the bandwidth, delta f. Therefore years ago, receivers were around using an IF of 175kHz or even lower – sometimes down to 64kHz.

Very low IF's are used today in some special purpose receivers, but an IF which is too low (compared to the frequency of the incoming RF station frequency) shows up another disadvantage of the superheterodyne principle, a problem called 'image reception' or 'double spotting'.

Image reception

Image reception is an effect exhibited to a greater or lesser extent by all superheterodyne receivers, and appears in two forms.

Fig.6 shows frequencies in a receiver using an intermediate frequency of 455kHz. First the receiver is tuned to a station S1 on 10,000kHz (10MHz). Thus the local oscillator is on 10,455kHz, giving a difference (10,455 – 10,000kHz) of 455kHz, the IF signal which is amplified by the tuned IF amplifier.

At the same time, if another station S2 on 10,910kHz is strong enough (or if the receiver's RF selectivity is insufficient) the signal from S2 will also beat in the mixer with the 10,455kHz local oscillator to produce the same difference frequency (10,910kHz – 10,455kHz = 455kHz), which will also be amplified by the tuned IF amplifier.

This anomalous effect is called *image reception* because it causes a false 'image' of station S2 to appear in the wrong place on the receiver dial, in this case causing interference with S1.

A second manifestation of the same effect occurs when the receiver tuning is moved from station S1, perhaps looking for other stations in the 9000kHz region. A signal is found when the dial points to 9090kHz, and we think it is a third station.

But it is not! It is in fact station S1, appearing again at a second spot on the dial. This is because when the receiver is tuned to 9090kHz (local oscillator = 9545kHz), if the RF selectivity is insufficient, it can also receive the first station S1 again (10,000 – 9545 = 455kHz), producing a signal exactly right for amplification by the IF amplifier.

This effect of every station appearing in two positions on the dial is called *double spotting*, and is only image reception in another form.

Notice that any narrowing of the IF bandwidth (i.e., increasing IF selectivity) would render no improvement at all, as each case presents the correct 455kHz signal to the IF amplifier! The cure for image reception can take two forms:

1. Increase the RF selectivity – i.e., narrow the bandwidth of the tuned circuits tuned to the incoming RF signal frequency, to give increased rejection of the unwanted image signals. This may mean adding one or two tuned RF amplifiers ahead of the mixer.

2. Use a much *higher* IF. Notice that in each case the anomalous reception occurs at a spot on the dial which is *twice* the IF distant from the correct tuning frequency. If we use a much higher IF, say 10.7MHz, then the 'image station' and/or 'double spot' must occur 21.4MHz (i.e., twice 10-.7MHz) away. At this separation the RF tuned circuits should easily reject the anomalous RF signal, so curing both imaging and double spotting effects.

In high quality receivers, both actions may be taken. We may use one or two RF amplifiers ahead of the mixer, and also an intermediate frequency of 10.7MHz.

But you just can't win! As we've seen previously, the use of a high IF like 10.7MHz results in poor receiver selectivity to adjacent stations, because of the wider IF bandwidth. But nil-desperandum – there is a way!

Our desire to use a high IF like 10.7MHz to reject images is legitimate, but to reject undesired stations on adjacent frequencies we are forced to use one of two approaches in order to achieve enough selectivity. The first is to employ a narrow-band high frequency crystal filter. The second approach, called 'double-conversion superheterodynes' we will discuss in a later chapter.

Ultra-narrow bandwidth

There exist many applications in radio communications today where quite narrow bandwidth is essential to reduce noise and exclude unwanted stations on nearby frequencies. A typical commercial communications receiver for the passing of important messages in the presence of strong interference may use a bandwidth of only 50Hz for the reception of slow Morse code (CW transmissions).

But for readable speech reception, to enable at least some high sibilant harmonics (of speech consonants) to be reproduced, a slightly wider bandwidth about 2.1kHz would be used. Both these values of bandwidth are below the limits achievable by tuned IF transformers, therefore these commercial receivers use special narrow-band IF filters.

Narrow band IF filters come in two distinct types:

1. Crystal high-frequency narrow bandwidth IF filters; and
2. Electro-Mechanical low-frequency fixed-bandwidth IF filters.

We will now look at each of these in turn.

Crystal IF filters

Crystal IF filters use the extremely high Q value of a crystal as a tuned circuit. Whereas tuned IF circuits consisting of coil and capacitor can be produced having a Q value of 10 to about 50, the Q value of a crystal (acting as a tuned circuit) can be as high as 3000! This results in very high selectivity, i.e., an extremely narrow bandwidth.

A high frequency crystal is a slice of natural pure quartz or silicon dioxide. This crystal exhibits a natural *piezoelectric* effect by which any mechanical force applied to the crystal slab results in an electric potential being generated by the molecular-electronic crystal structure. This appears as a voltage existing between opposite crystal faces.

Conversely, a voltage applied between opposite faces causes mechanical distortion of the crystal (to minute degree). When such applied voltage is released, the mechanical distortion force is released, changing the crystal physical shape back to normal and consequently generating a voltage.

This effect is quite analogous to the action of a tuned circuit, and this mechanical deformation and return to normal can occur at only one frequency. That frequency is higher for thinner crystals.

Thus, by face-grinding, crystals can be produced to resonate at any one frequency from around 400kHz up to 30MHz or even 120MHz, the mechanical resonance of the crystaline structure giving the effect of extremely high Q. Electrical connections are made by either silver plating two opposite crystal faces or by gently squeezing the crystal between sprung metal plates.

This latter structure was first used and gave rise to the circuit symbol for a crystal in its holder. Crystals are assembled and sold in a metal/glass or plastic case, with two pins for connections.

Crystal filters

The simplest crystal filter would use one crystal, but would give an asymmetrical frequency response.

Better results are obtained from the balanced 'half lattice' filter of Fig.7, which uses two crystals X1 and X2. The crystals can be chosen to resonate at slightly different frequencies.

If a bandwidth of 500Hz were desired for slow Morse code reception, this could be achieved by choosing two crystals of (500/3)Hz above and below the IF centre frequency. Thus for an IF of 10.7MHz you would use crystals resonating at 10.699833MHz and 10.700167MHz respectively.

If purchased crystals do not quite conform to the above frequencies no problem! It sould simply mean the receiver bandwidth would be slightly different from 500Hz.

The use of four or more crystals in an IF filter circuit is possible, and results in more steep-sided. The amount of dip at the centre frequency 10.7MHz depends

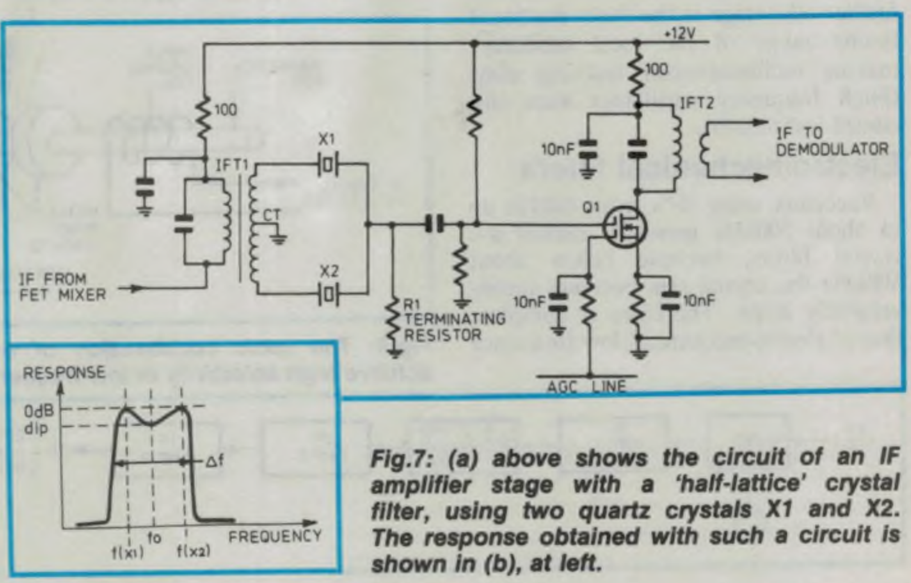

Fig.7: (a) above shows the circuit of an IF amplifier stage with a 'half-lattice' crystal filter, using two quartz crystals X1 and X2. The response obtained with such a circuit is shown in (b), at left.

on the value of R1, the terminating resistor.

For speech reception a bandwidth of about 2000 to 3000Hz is required, so other crystals would be purchased whose frequencies f(X1) and f(X2) are given by the general formula:

Receiver bandwidth = 3(f(X1) - f(X2))/2

i.e., Crystal frequencies = fo +/- (debandwidth)/3

where fo is the IF centre frequency.

Home constructors can purchase such crystals from crystal suppliers or even from disposals stores. A disposals crystal is shown in the photo of Fig.8.

Complete crystal filters are also on the market, designed for centre frequencies from 455kHz to 40MHz.

Up conversion

To utilise the range of very high frequency crystal filters released about ten years ago, and to obtain the greatest possible image rejection over the HF band, some receivers use a very *high* IF frequency.

When receiving say a 28MHz station it would be nice if the image frequency could be greatly separated, say at 106MHz. Under these conditions the RF tuning can easily reject such a widely separated image.

With the local oscillator working on 67MHz and an IF frequency of 39MHz (to make use of available TV components) plus a 39MHz four-crystal IF filter, both the image rejection and adjacent frequency rejection can be excellent.

This is an example of an *up-conversion* superheterodyne receiver, wherein the IF is higher than the RF signal frequency – in contrast with most conventional receivers, where it is lower. A further advantage is the short fractional tuning range of the local oscillator, making oscillator/mixer tracking easy. (High frequency oscillators were discussed last month).

Electromechanical filters

Receivers using IF's from 64kHz up to about 500kHz generally cannot use crystal filters, because below about 500kHz the crystal size becomes inconveniently large. Therefore a complete line of electro-mechanical low frequency IF filters has been on the market for some years.

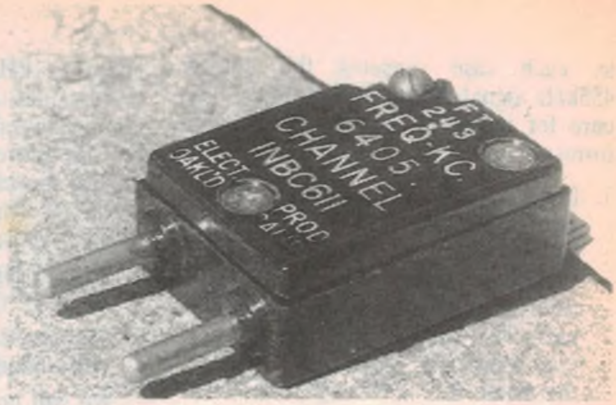

***Fig.8:** An older style quartz crystal, in a disposals FT-243 holder, shown a little larger than actual size.*

Electromechanical filters consist of an input driving coil, a vibrating disk array arranged to mechanically resonate at the IF frequency, followed by an output transducer coil as sketched in Fig.9.

The input to the filter is the IF signal from an IF driver stage following the mixer. The IF driving current in the input driving coil vibrates the rod longitudinally at the signal frequency. This causes the mechanical disks to vibrate in one of their natural resonant modes.

The disk vibration is passed on via the rod to the output transducer coil. The magnetized rod right hand end, vibrating at IF within the output transducer coil, generates an IF signal voltage therein. This output voltage is fed to second and third IF amplifier stages, before passing on to the demodulator as shown in the block diagram of Fig.10.

Because the metal disks will vibrate only at their mechanical resonance frequency, output voltage from the transducer coil can be only at that resonance frequency, chosen as the IF frequency. By making the disks resonate at slightly different frequencies, a controlled narrow passband of frequencies can be transmitted from filter input to output.

The Collins Radio Company of the USA manufactures a range of such electromechanical IF filters, for centre frequencies from 64kHz to 500kHz. These units can be purchased in a range of bandwidths, from 375Hz to 5800Hz in seven steps.

Both input and output coils must be impedance matched within 5% with their respective input driving source and output load. These passive filters (and indeed all types of passive filters) have no signal gain – rather they cause a signal loss of up to 10dB, which must be compensated by a third IF amplifier.

Any tuned LC circuit in the following IF amplifiers will have little effect on bandwidth, as the effective Q of the mechanical resonance is very much higher than the Q of any LC circuit.

How to overcome the image problem when using these very low intermediate frequencies is an interesting topic for our next chapter.

Acknowledgements

Grateful thanks are due to the American Radio Relay League, *QST* magazine and the radio amateurs for valuable data and information used in this chapter.

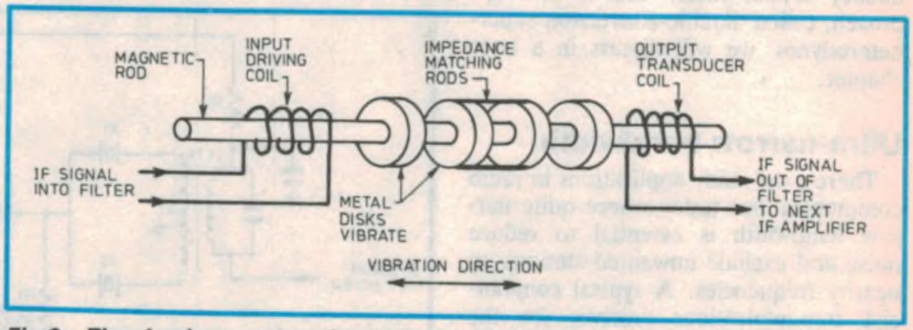

***Fig.9:** The basic construction of an electromechanical filter, as used to achieve high selectivity in low-frequency IF amplifiers.*

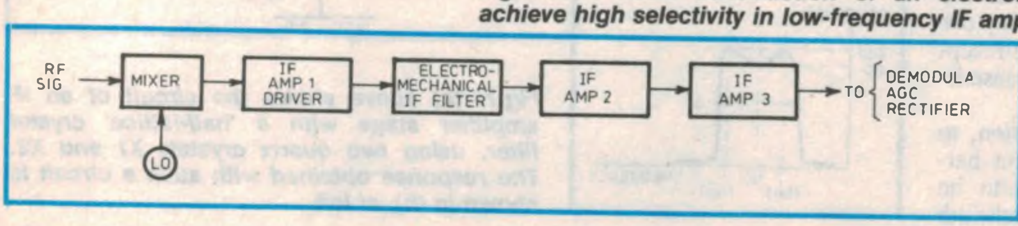

***Fig.10:** The block diagram of a communications receiver 'front end' using an electromechanical filter.*

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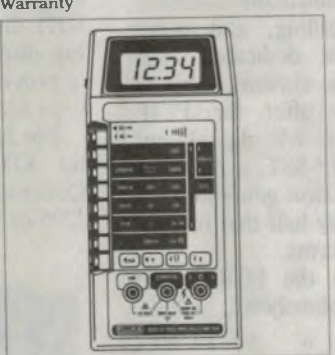
- Relative reference
- One year calibration cycle and Warranty



Fluke 8062A

- 0.05% basic dc accuracy
- True rms ac voltage and current
- Continuity and diode test
- Relative reference
- One year calibration cycle and Warranty

Fluke 8050A

- 4 1/2 digit bench model with 0.03% basic dc accuracy
- True rms ac to 50kHz
- Rechargeable battery option
- dB function with 16 selectable impedances (8Ω to 1200Ω)
- Relative Reference & Conductance

Model	*Inc Tax*	*Ex Tax*
8062A	$706	$617
8060A	$834	$729
8050A	$919	$804

Fluke 70Series Multimeters

73

- Analog Bar Graph
- 3200 count Display
- 0.7% basic dc accuracy
- 10A range
- Autoranging only
- 3 year warranty

75 adds

- 0.5% accuracy
- Autoranging with range hold
- 10A + autoranged mA ranges
- Continuity & diode test beeper

77 adds

- 0.3% accuracy
- Touch Hold™ function

Model	*Inc Tax*	*Ex Tax*
73	$147	$128
75	$238	$208
77	$325	$284

Fluke 20 Series Multimeters

21

- Safety Yellow case
- Fluke 75 features but less 10A range

23

- Safety Yellow case
- Fluke 77 features + fused 10A input

25

- Water and dust-proof, fully sealed
- Charcoal or yellow case
- Analog/Digital display
- 0.1% basic dc accuracy
- 100μV to 1000V ac & dc
- 0.1μA to 10A all fused
- -15°C to +55°C operation
- Touch Hold™ function
- Two year warranty

27

- As 25 but adds
- Relative (difference) mode
- Min/Max recording mode

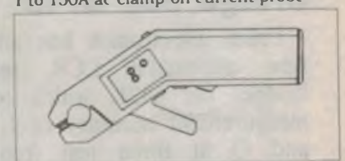
Model	*Inc Tax*	*Ex Tax*
21	$247	$215
23	$329	$287
25	$445	$389
27	$563	$492

Full Range of Multimeter Accessories Available

Here are some of the Fluke range of accessories which are compatible with most brands of multimeter

Current Probes

Y8101
1 to 150A ac clamp-on current probe

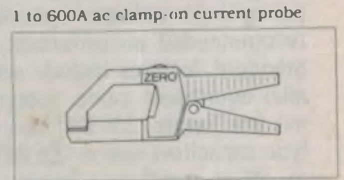


Y8100
Dual range 10A/200A Hall Effect clamp-on current probe

80i-400
1 to 400A ac clamp-on current probe

80i-410
5 to 400A Hall Effect ac/dc clamp-on current probe

80i-600
1 to 600A ac clamp-on current probe



80i-1010
1 to 1000A Hall Effect ac/dc clamp-on current probe

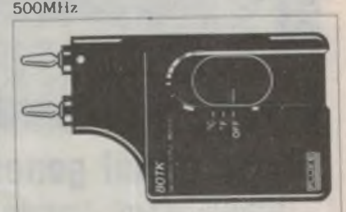
High Voltage Probes

80k6
6000V dc or peak ac voltage probe

80k-40
40kV dc or 28kV rms ac voltage probe

RF Probes

85RF
AC voltage probe from 100kHz to 500MHz



Temperature

80T-150U
Universal temperature probe, -50°C to +150°C. Uses P-N Junction to give ±1°C accuracy

80TK
Type K thermocouple module for use with interhangeable probes. Basic accuracy is 0.5°C. Use with any 10MΩ input multimeter having banana sockets.

Also ask us about a case to protect your investment!

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New Products

LCR component bridge has GPIB

Prism Electronics has announced a new automatic LCR measurement bridge, the 6421, which offers 0.2% measurement accuracy of L, C, R, D and Q at three test frequencies of 100Hz, 1kHz and 10kHz. Full 4 digit resolution is achieved on the high brightness display and full IEEE-488/RS232 talk/listen facilities are available with an optional interface.

Ease of use is ensured with automatic recognition of component type and prompts to indicate operation outside recommended measurement conditions. Standard features include series or parallel equivalent mode, integral 4 terminal test fixture, 2V DC bias for electrolytic capacitors and a 'ZERO C' facility to offset stray capacitance in external connections.

For further information contact Parameters, Centrecourt, 25-27 Paul Street North, North Ryde 2113 or phone (02) 888 8777.

2GHz signal generator

Hewlett-Packard Australia has introduced the HP8657B synthesised signal generator, with 2GHz frequency coverage and good SSB phase noise for receiver out-of-channel measurements, local-oscillator substitution and testing satellite-communication systems.

In addition to AM and FM, the HP8657B has optional pulse modulation with less than 35ns rise/fall times and 70dB to 95dB on/off ratios. These features, along with broad frequency coverage, simulate L-band radar signals. The HP8657B has high stability DCFM, 1Hz resolution, output levels of +13dBm down to −143.5dBm and a phase-adjust capability.

The HP8657B has 100 storage registers for quick-measurement setups. Relative phase adjust permits precise 1-degree steps relative to another stable source for phase-sensitive device characterisation.

Further details from Hewlett-Packard Australia, 31-41 Joseph Street, Blackburn 3130 or phone (03) 895 2895.

PC instrumentation

MetraBytes's Personal Computer Instrument Product (PCIP) family from Novatech Controls is a series of 'board level instruments' that plug directly into any IBM PC/XT/AT or compatible I/O slot. The PCIP family provides bench top/rack mount features, functions and performance without the programming hassles of an IEEE-488/GPIB based system; and at a fraction of the cost.

Cost savings over bench top systems are accomplished through the elimination of the communication interface, display circuitry, cabling, and power supply required for dedicated IEEE-488/GPIB bench/rack systems. This allows MetraByte to offer the PCIP-DMM, a full feature 4-½ digital multimeter, and the PCIP-SST, a high performance 5MHz function generator, for prices that are roughly half that of comparable benchtop systems.

Other products in the PCIP family that will be released shortly will include:

- PCIP-CAL – a +/−19.999V calibrator/reference board
- PCIP-DLA – a 20MHz, 16 channel logic analyser board

These instruments operate in either of two modes; bench emulation or programmed, which simulate IEEE-488 'local' and 'remote' operation respectively. All programming is accomplished through the use of simple 'English' commands. The computer screen is used for all instrument displays. Activated by a user defined hot key sequence, the displays 'pop-up' on the computer screen. When activated, each display occupies one third of the screen, allowing three instruments to be displayed at one time. Functional control is through either the computer keyboard or a 'mouse'.

For more information contact Novatech Controls, Melbourne (03) 645 2377 or Sydney (02) 758 1122.

Network analyser

The Anritsu Network Analyser MS3401A provides an excellent means of quickly and economically assessing the performance of a very wide variety of analog components used in modern electronic equipment such as video tape recorders, compact disc players and video disc players.

The MS3401A produces swept frequency output, to precisely and quickly measure transmission and impedance characterisitics of networks operating throughout the frequency bands of 10Hz to 30MHz. It is easy to use and can be controlled automatically through a general purpose IEEE-488 interface, making it ideal for all stages of manufacture from research and development to full scale production.

The MS3401A uses a crystal oscillator and digital synthesiser to give highly accurate, high speed sweep output. Frequency intervals can be set as low as 0.01Hz and there is a logarithmic sweep function for broadband devices. The CRT display gives digital as well as analog display of measurements and there is provision for output to optional hard copy recording devices.

For further information contact Alcatel STC Measuring Instruments, 58 Queensbridge Street, South Melbourne 3205 or phone (03) 615 6666.

New lugged Bimboxes

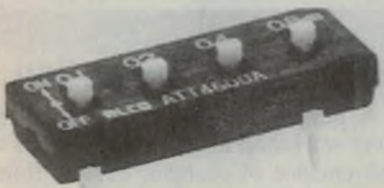
A new range of ABS plastic boxes incorporating 4 external fixing lugs is now available from Boss Industrial Mouldings.

Similar in many ways to the standard BIM2000 range, these new multipurpose boxes are available as standard in grey, will withstand 85°C (180°F) and have close fitting flanged lids enabling full hermetic sealing to be achieved.

Encompassing 3 sizes ranging from 112 x 62 x 21mm to 150 x 80 x 50mm, all of which can be readily drilled or punched, all BIM2000 ABS boxes incorporate slots on all 4 sides for vertically supporting 1.5mm (0.062") PCB's on 5.08mm (0.2") centres.

Four BIMDAPTORS, enabling boards and sub-assemblies to be flat mounted either singularly or sandwich fashion, are supplied with each ABS Box.

For further information contact Crusader Electronic Components, 73-81 Princes Highway, St Peters 2044 or phone (02) 516 3855.



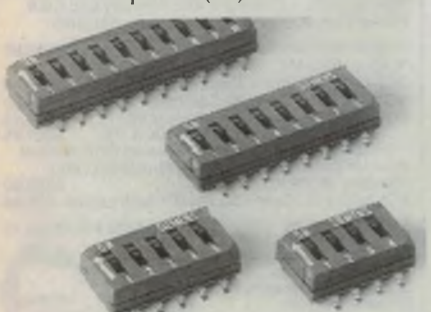
DIP attenuator switch

Just released by Augat/Alcoswitch is the ATT Series DIP Attenuator switch, which has been deisgned primarily for telecommunications and radio/television component applications. Housed in a low-profile package, the ATT Series is well suited to applications where PCB density is critical and expensive.

The new DIP attenuators are available in four-bit or five-bit, 50, 75, 150, 300, and 600 ohm unbalanced 'T' networks. The DIP attneuator switch features a unique ceramic substrate that allows it to survive wave soldering temperatures of 245°C for up to 30 seconds. In addition, the switches have gas-tight contacts (280,000psi) and are aqueous and solvent-cleanable without tape sealing.

These new DIP attenuators are available with custom networks and in auto-insertable versions using Panaset insertion equipment.

For further information contact Augat, Unit 21/26 Wattle Street, Brookvale 2100 or phone (02) 905 0533.

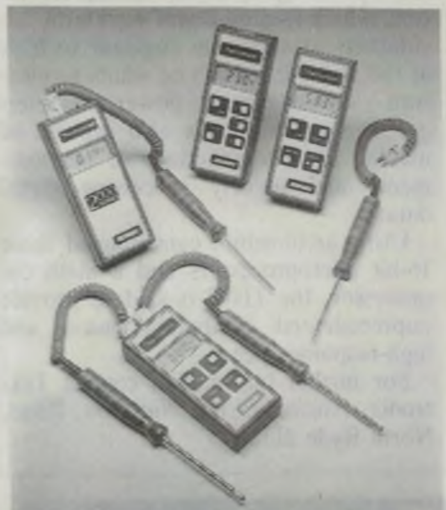


DIL switches for SMT

The benefits of SMD technology, such as higher packing density, improved quality and reliability as well as automated processing, become particularly valuable when all components are adapted to the SMD requirements. To this end, in the development of the new A3000 dual-in-line switch family, Siemens has also established the various types as SMD versions.

Features include an overall height of 5mm; smooth surface, for suction pickup with a vacuum tool; level base of the package for glueing onto PCBs where applicable.

For further information contact the Communications Equipment Department of Siemens, 544 Church Street, Richmond 3121 or phone (03) 420 7308.



DTM with peak hold

A new handheld, digital temperature meter is capable of storing the maximum temperature encountered during a series of temperature measurement procedures.

Introduced as the Jenway Model 2004, this highly compact temperature meter offers three operational ranges which may be selected by the user via the instrument's environmentally proofed touch controls. These ranges are −30 to +199.9°C, to a resolution of 0.1°C; −30 to +750°C, to 1.0°C; and −30 to +1399°F, to 2.0°F.

For further information contact any Elmeasco Instruments office on Adelaide (08) 344 9000, Brisbane (07) 875 1444, Melbourne (03) 879 2322, Perth (09) 470 1855 or Sydney (02) 736 2888.

Peripheral surge protector

An increasing recognition for the need to provide lightning strike transient and frequent power switching protection to computer peripheral equipment has prompted Australian based

manufacturer Component Resources to increase production of its recently developed PSP-232 Peripheral Surge Protector.

The device is designed for simple installation at the peripheral device and dissipates unwanted transient energy while allowing the RS-232C signals to pass unimpeded.

Features include:

- 9 of the 25 pins on the EIA Standard RS-232C are connected
- 8 of the nine pins have a clamp voltage of 33V
- Peak Pulse Power (8 x 20us) of 18.2kW; capacitance of 1000pF is typical
- Pin 7 is clamped to Pin 1 via a low capacitance device to prevent noise being induced onto the Common Return Line
- DC Breakdown Voltage of 90V
- Surge Discharge Current 5000A
- Capacitance of 5pF is typical

Further information is available from Component Resources, Technopark, Dowsings Point 7010 or phone (002) 73 0066.

Alignment tool kit

The Scope CD-10 alignment tool kit provides four tools moulded in tough Duracon plastic to fit 19 different screw head profiles. These include 10 hex, 7 slotted and 2 square.

A slip-on 130mm extension piece is included in the soft PVC pouch pack.

Scope stockists throughout Australia and New Zealand now have supplies of the kit for which the trade price is $5.97.

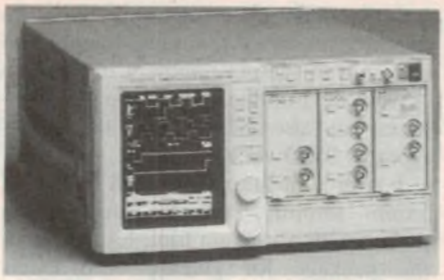
For further information contact Scope Laboratories, 3 Walton Street, Airport West 3042 or phone (03) 338 1566.

Power line filter

The Critec PLF10/X power line filter overcomes the problems caused by mains transients to unprotected business and office equipment such as loss of data, data corruption, physical damage to equipment and unnecessary additional maintenance.

The unit has superior technical specifications, to give high performance surge protection and filtering circuitry and is Australian Electricity Authority Approved, providing 10 amps of continuous load.

Further information is available from Component Resources, Technopark, Dowsings Point 7010 or phone (002) 73 0066.



16GHz digitising oscilloscope

The Tektronix model 11403 is a 1GHz digitising oscilloscope with colour display and up to 14-bit vertical resolution, which uses on-board waveform calculations to allow the engineer to look at the real parameters he wants to measure – such as current, power, and energy. The instrument is also capable of making 24 different kinds of measurements and quickly processing signal data.

Using architecture consisting of three 16-bit microprocessors and a math coprocessor, the 11403 is said to provide unprecedented computing power and high-response speed.

For further information contact Tektronix Australia, 80 Waterloo Road, North Ryde 2113.

60W soldering station

A new soldering station from Scope gives workshop and laboratory users the convenience of changing rapidly from a standard 60W iron to an ultra slimline 30W pencil with its own range of miniature tips.

The required iron is selected by using the two position switch at the front of the console. Heatup takes about 60 seconds and the temperature settings need not be changed.

Apart from the space saving on the bench this new double headed unit saves about 40% of the cost of a second station. Scope also offers a factory upgrading service for owners of existing Scope stations.

For further information contact Scope Laboratories, 3 Walton Street, Airport West 3042 or phone (03) 338 1566.

Sealed panel switch

The Planar Products Division of Industrial Electronics Engineers, Inc. (IEE) has announced a new silicone-rubber booted, 16 position panelswitch line.

The telswitch features high reliability in a completely sealed, one-piece silicone boot. The switch features positive snap action tactile feel, with contacts made from gold-plated etched copper circuitry, and securely affixed, but easily removed legends keys.

The silicone boot is made from a special material which resists solvents, oils and many other chemicals, plus heat, ultraviolet radiation and scratching.

The Telswitch is secured to a panel with six 6-32 UNC threaded posts out of the back-plate of the switch. Output circuit connections are made to 8 plated pins, also at the back of the switch. The switch contacts are in an X-Y matrix configuration with a contact resistant of 0.5 ohms or less (other options are available).

The switch contacts are RFI/EMI shielded against radiation through the front of the keyboard.

For further information contact M B & K J Davidson, of 17 Roberna Street, Moorabbin 3189 or phone (03) 555 7277.

Directional RF wattmeter

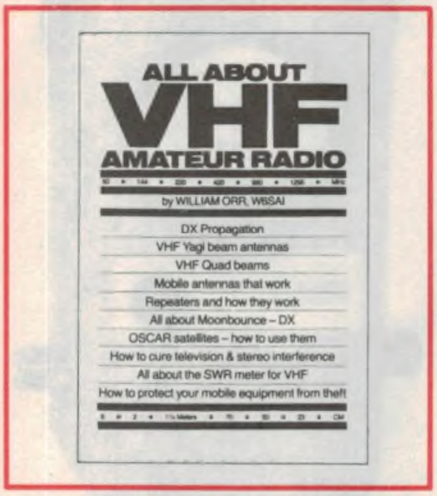
The Bird model 4304A 'Thruline' broadband directional RF wattmeter provides versatility, ruggedness and full coverage on five power scales, from 5 to 500 watts full scale and from 25MHz to 1GHz.

The portable instrument uses a single new broadband, captive measuring element which measures both forward and reflected power levels in 50-ohm systems. This is housed together with a shock mounted meter in a rugged die-cast housing, fitted with rubber mounts on both bottom and rear.

UHF female connectors are used for both in-line connections. Accuracy is +/-6% of FSD from 100-500MHz and +/-7% of FSD from 500-1000MHz, with no corrections required, while that from 25-100MHz is +/-7% of FSD using a corrections chart. Insertion loss is less than 0.10dB from 25-512MHz and 0.15dB maximum from 512-1000MHz. VSWR is 1.08 max from 25-512MHz and 1.12 max from 512-1000MHz.

Further information from RF Devices, 1/9 Lyn Parade, Lurnea 2170 or phone (02) 607 8811.

Books & Literature



VHF guide

ALL ABOUT VHF AMATEUR RADIO, by William Orr, W6SAI. Published by Radio Publications Inc, 1988. Soft covers, 154 x 230mm x 11mm. ISBN 0-933616-10-4. Recommended retail price $17.30.

Don't be put off by this book's somewhat immodest title, and the rather outlandish claims for it on the outside back cover. It is in fact quite a good basic introduction to VHF and UHF amateur radio operating, for those coming to this part of the spectrum for the first time. And I guess that's what you'd expect, from well-known US amateur radio writer Bill Orr.

By the same token, and despite the claims to the contrary, it doesn't by any means 'tell it all'. It really doesn't cover much at all about home-brewing your own equipment, for example, and gives only cursory treatment to antenna matching, VSWR and measurements. For topics like these you'll find much better treatment in publications like those put out by the ARRL and RSGB.

On the positive side, it provides an easy to read and understand explanation of VHF (and to a lesser extent UHF) modes of propagation, repeaters and what they do, moonbounce and satellite operation, and the practical basics of using co-axial cable, connectors and matching networks. It also gives construction details for some useful vertical, mobile and beam antennas, mainly for the lower bands. There's also a section on RFI/TVI and practical techniques for its suppression, and a miscellaneous section at the end covering things like choice of an SWR meter, making a simple dummy load and looking after NiCad batteries as used in hand-held transceivers.

Overall, it seems a handy little book, and although it appears to have been written primarily for the 'VHF appliance operator', this would also make it suitable for the amateur just getting started on the VHF/UHF bands.

The review copy came from Stewart Electronic Components, which can supply the book via its mail order service for the above price. The company's mail address is PO Box 281, Oakleigh 3166, or phone (03) 543 3733. (J.R.)

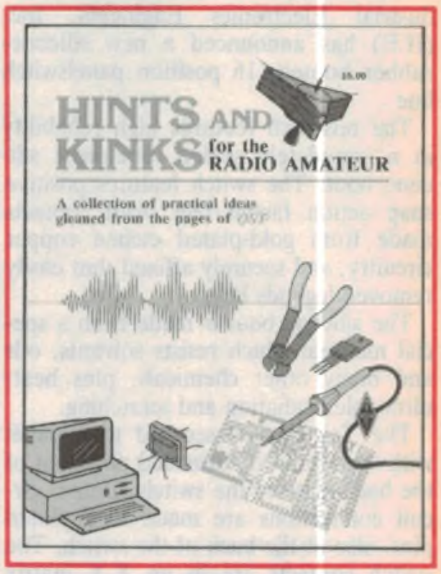
Amateur radio hints

HINTS AND KINKS FOR THE RADIO AMATEUR, 12th Edition, edited by Charles Hutchinson, K8CH and David Newkirk, AK7M. Published by the American Radio Relay League, Inc., 1989. Soft covers, 210 x 277 x 9mm. ISBN 0-87259-712-1. Recommended retail price $10.00.

Way back in 1933, the ARRL brought out a book collecting together a selection of the best *Hints and Kinks* that had been published in its magazine *QST*, under the same title. The book became so popular that it was followed over the years with similar volumes, each bringing together the best hints and kinks sent in by ARRL members since the previous edition. This present book is the 12th in this popular series.

As before the entries are divided into various categories, such as 'In and Around the Station', 'Transmitting and Receiving', 'Antennas and Feed Lines', 'VHF and UHF', 'Portable and Mobile', and so on. There's also a 'Miscellanea' section at the back, together with a handy list of common abbreviations encountered in amateur radio, and their meanings. Up the front there's a couple of data pages with things like circuit symbols and metric conversions.

Inside there's a wealth of handy practical snippets of information, on almost everything from adapting commercial gear for better or more convenient operation, to building small attachments, novel antennas and pieces of simple test gear. There are simple tips



like adding solder inside a tuning knob, to add weight for smoother tuning, all the way through to building complete QRP transmitters and SWR meters.

For the keen radio amateur, it would make a very handy addition to the reference shelf in the shack. And of course the price is very attractive, too.

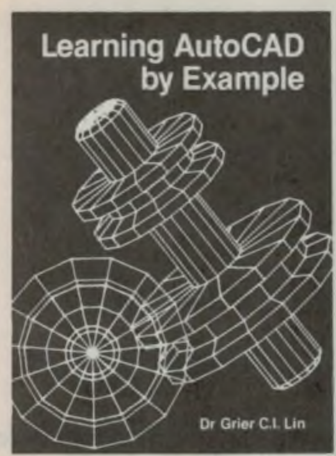
The review copy came from Stewart Electronic Components, which can supply the book via its mail order service. The mail address is PO Box 281, Oakleigh 3166, or phone (03) 543 3733. (J.R.)

AutoCAD tutor

LEARNING AUTOCAD BY EXAMPLE, by Dr. Grier C.I. Lin. Published by Prentice Hall, 1989. Soft covers, 235 x 170mm, 148 pages ISBN 0-7248-70699-7. Recommended retail price $29.95

AutoCAD was first released in 1982, and now, seven years later, it is up to release 10. It is probably the best known CAD program ever written, and brought into being software for the PC which many claimed could not be done.

Because of its sophistication and range of facilities, AutoCAD is not an easy program to learn. As a result, many institutions around the world have set up training courses on AutoCAD, so engineers, draftspersons, architects and individuals can be guided through the intricacies of the program. One such institution is the University of NSW, of which the author of this book is a staff



member. In fact, Mr Lin has had considerable experience teaching AutoCAD, which makes him ideal as the writer of a text on the subject.

The book is for beginners, so as a novice to AutoCAD, and having access to a copy of release 6, I decided to take time off and see what AutoCAD is all about. A quick scan through the book quickly showed me that the emphasis was on mechanical drawings, although I'm told circuit diagrams are also possible with AutoCAD.

The book is laid out in a very clear manner, and uses the tutorial approach. Also included are numerous plots taken from drawings done on AutoCAD, many of which I wouldn't have believed possible. I commenced following the author's example drawing, by following the tabulated key presses, and quickly mastered aspects of the package I would never have discovered otherwise.

This is my kind of book – one that gets on with the job, but leaves nothing out to frustrate you as you work. I believe that most computer users like to *do*, rather than read, and this book is aimed at this type of user. The book is arranged in 12 fairly short chapters, which allows the user to digest AutoCAD in modules.

The content, according to the author, covers only the basics of AutoCAD, and a companion book to be called *Learning Advanced AutoCAD by Example* is soon to be released. Although I have not tried to use any other books on the subject of AutoCAD, this one seems to answer all my needs. It is so straightforward that it almost makes AutoCAD easy.

All I want to know now is how to draw circuit diagrams with this program. And to think that yesterday I couldn't even spell Ortocad! (P.P.)

Surface Mount Feature:

Current trends in chip components

Chip components for use in surface mount technology are getting smaller all the time. The variety of parts available in chip form is also expanding, as this article explains.

by PETER FRANCIS
Murata Products Manager, IRH Components

In this world of constantly changing technology, not many areas have changed as quickly as the electronic components industry.

The market driven requests for engineers to constantly reduce the size, mass, and costs of electronic consumer products and electronic devices generally has seen great changes in both the types of components used and the methods of mounting and assembly.

The swing to SMT (surface mount technology) is now on in this country in earnest, as more and more board assemblers and manufacturers install equipment to take advantage of the benefits derived from surface mounting.

Current status

The era of SMT has arrived with a vengeance in the last 5 years.

In 1985 the market for monolithic capacitors world wide broke down as 69.2 billion pieces, or 72.5% of the total, for leaded capacitors and 26.2 billion pieces, or 27.5% for SMT chip parts. Contrast this with the forecasts done by Murata manufacturing of Japan for 1990, which show figures of 61.2 billion – 43.6% – for leaded caps and 79.2 billion or 56.4% for SMT chip parts.

One Murata factory in Japan currently produces 4 *billion* chip capacitors per month. To give some idea of the world market, Murata claims to have 60% of the chip capacitor market and produces 4.3 billion world wide per month, up from 1.2 billion in early 1987.

With this change in technology has come an even larger change in the methods of board assembly.

Whereas large numbers of boards were hand assembled in the pre-SMT era, almost all SMT boards are now assembled by machine, thus effectively reducing labour costs considerably.

Chip progress

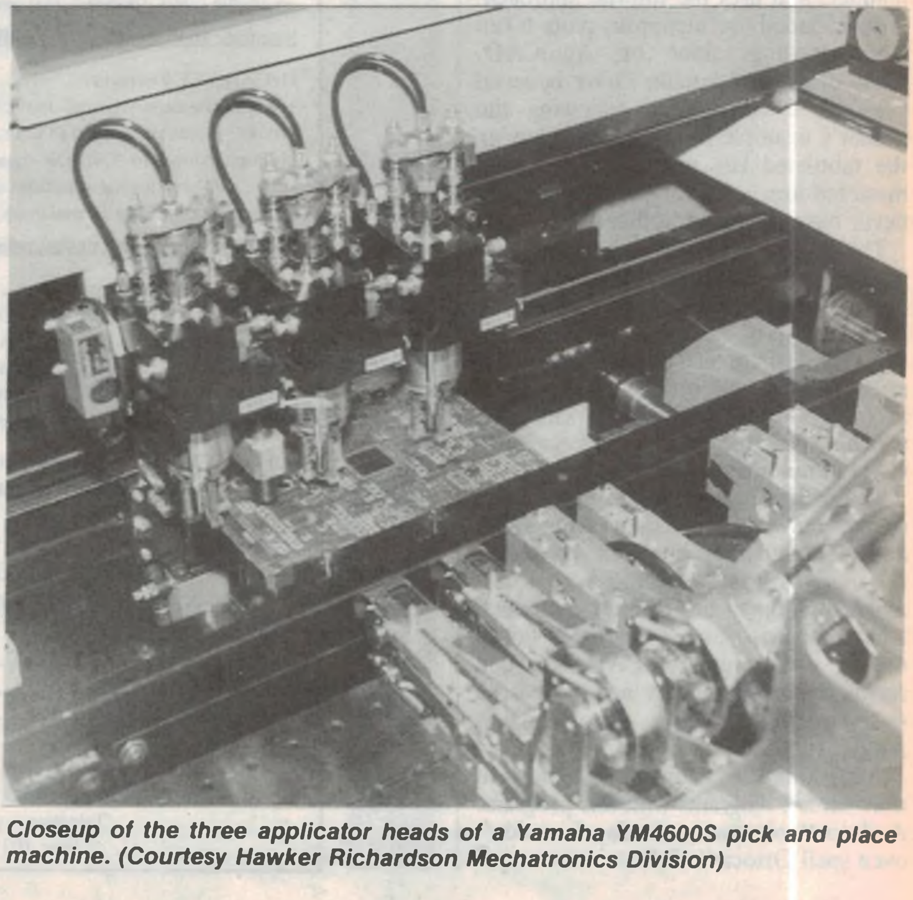
The range of components designed for surface mounting has increased almost exponentially in the last few years, with new devices being changed over to SMT almost daily.

The first components to lend themselves to surface mounting were the simplest of the passive components, capacitors and resistors.

Since that time in the mid 70's the range has expanded to encompass semiconductors, both discrete and integrated circuits.

The range of passive components is huge, including trimmer capacitors, trimpots, tantalum capacitors and aluminium electrolytic capacitors.

The RF area is also well catered for, with ranges of ceramic resonators, discriminators and filters, chip coils, trimmer coils and solid inductors.



Closeup of the three applicator heads of a Yamaha YM4600S pick and place machine. (Courtesy Hawker Richardson Mechatronics Division)

Classification	Component		Shape
Passive components	Fixed capacitor	Ceramic	Rectangular, Cylindrical
		Tantalum	Rectangular
		Aluminum electrolytic	Rectangular, Irregular
		Mica	Rectangular
		Film	Rectangular
	Trimmer capacitor	Ceramic	Irregular, Rectangular
	Capacitor module	Ceramic	Rectangular
	Fixed resistor	Cermet	Rectangular
		Metal film	Cylindrical
		Carbon film	
	Trimmer Resistor	Cermet	Irregular, Rectangular
	Resistor module	Cermet	SOP
	Fixed coil		Rectangular, Irregular
	Trimmer coil		Rectangular
	Filter	Ceramic	Rectangular
	Resonator	Ceramic	Rectangular, Cylindrical
Active components	Diode		SOP, Cylindrical
	Transistor		SOP
	I C		SOP, QFP, PLCC, SOJ, TAB, COB

Above: An idea of the kinds of components now available. (Courtesy Murata)

Hall effect elements have been available for some time, and at last year's Japan Electronics Show, Murata manufacturing released surface mount EMI filters and PTC thermistor temperature sensors.

Structured components such as slide switches, connectors, phono jacks and relays are also available, from several manufacturers.

The reality of the situation now is that there is very little in the way of components that are not available in chip form, for surface mounting.

The packaging of SMT components has also changed markedly in the intervening period, from bulk packaging in plastic bags through magazine packaging to the current almost universal tape and reel format.

TABLE 1

Chip Size code	1982	1987	1990 (Forecast)
0805	35%	75%	60%
1206	60%	20%	20%
0603	5%	5%	15%
Others	5%	5%	5%

Source: Murata Manufacturing Co., Japan

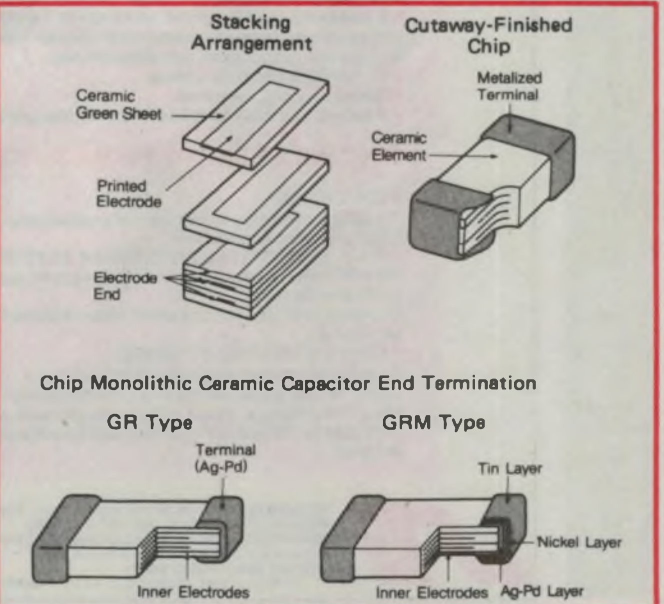
Ever smaller

The EIA (American Electronic Industries Association) has set standards for the sizing of most SMT components. As the EIA size codes for capacitors and resistors are those which tend to cause the most confusion, it should be worthwhile to explain their meaning.

The '0805' size is the most popular size internationally. This nomenclature is derived simply by dividing the metric dimensions for length and width (in mm) by 2.54, converting them back to inches – thus 2.00mm becomes .08" and 1.25mm becomes .05", giving 0805.

The same formula is applied to each EIA size. Simple when you know how – and we all thought the world was going metric!

The trend towards smaller components continues apace, as you can see from the listing of projected international trends in Table 1. The cost structure is starting to reflect these trends, as the costs of the larger and earlier pack-



Right: The construction used by Murata for its GR and GRM chip monolithic capacitors. The latter are suitable for both flow and reflow soldering.

age sizes start to escalate compared with the 0805. This is due to the economies of scale in producing larger quantities of the smaller chips.

In a rush to embrace the new technology, much of the local Australian industry settled on the 1206 size package. This will lead to inevitable cost escalations of finished products in the near future, unless the firms concerned are able to make the transition to the smaller 0805 parts.

Local subsidiaries of the various transnational electronics manufacturers have already embraced the 0805 size devices, as have their parent companies overseas. This tends to make their finished products more cost effective, when compared with other locally produced equipment still using 1206 chips.

It is true that newer designs in the Australian market are starting to show a swing to 0805, as our local manufacturers become more confident with SMT.

In some areas larger package sizes will remain with us however, albeit in smaller quantities, due to the physical size constraints imposed by key parameters. This applies for example in the case of very high value capacitors, due to limitations in the dielectric materials currently available.

The industry is seeing new manufacturers coming into the SMT market place daily, mainly from the developing countries of asia and the Eastern Block.

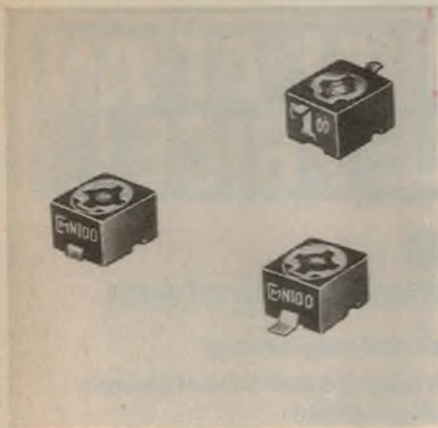
Soldering method

The path to surface mounting is not all easy. There are some difficulties that need to be pointed out at day one, so that they can be addressed. The greatest of these revolves around the soldering process to be used.

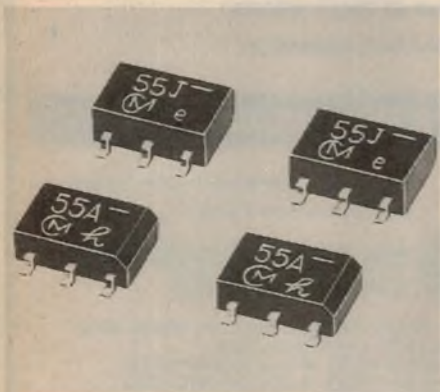
With the several reflow and flow soldering systems available, consideration must be given to the types of components used on the board, as a couple of the soldering systems tend to melt such items as plastic switches and relay cases.

The choice of soldering system can in some cases limit the types and brands of SMT component used, as some brands are manufactured for either flow soldering or reflow soldering, but not both.

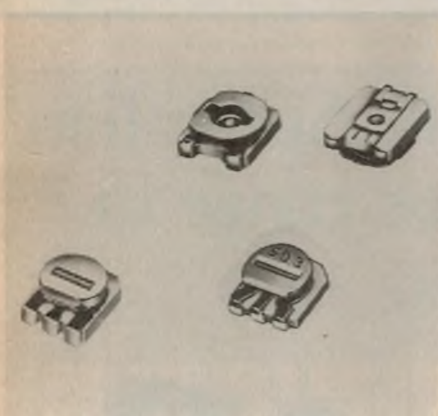
Murata saw the problems involved in this area, as well as the problem of *silver migration* from the silver palladium electrodes used in high quality capacitors. The company accordingly developed a system to prevent this problem, by wrapping a nickel barrier layer around the electrode terminations be-



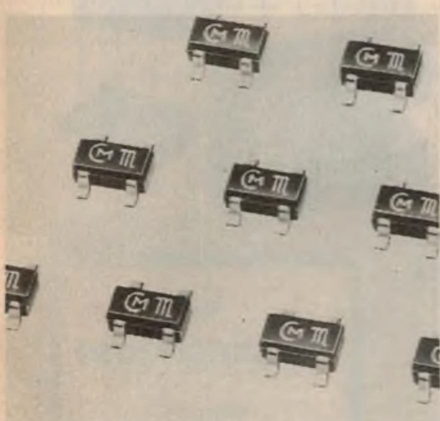
Chip trimmer capacitors (Murata)



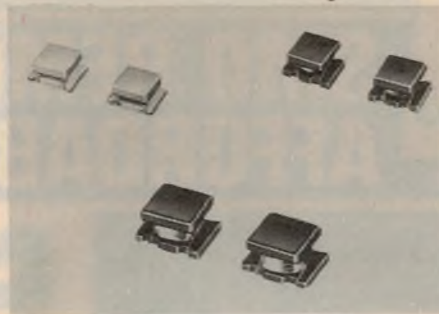
Murata 455kHz ceramic filter chips



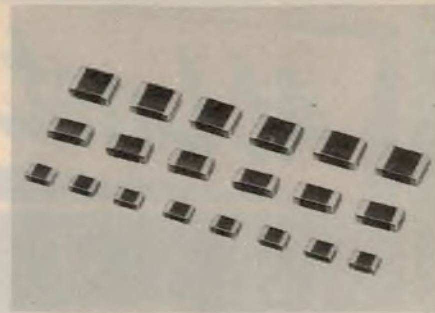
Chip trimpots (Murata)



Murata Hall effect element chips



Chip inductors (Murata)



Murata chip capacitors

fore tin plating them. This development not only stops the silver migration, but also enhances the solder wetability of the components, allowing them to be used on both flow and reflow lines.

The added advantage, to manufacturers that employ both soldering methods, is that much lower stock inventories are needed.

Conclusion

The components marketing sector of the electronics industry has a large responsibility in these times of technological change, because of the way that the industry operates. This responsibility to the industry extends beyond just being able to supply the components.

The responsibility extends to the areas of technical backup, applications information, alerting the industry generally to changing trends, and assisting new users of the technology to come to terms with the changes in production and purchasing procedures.

I hope that this article goes some little way towards providing some of the answers to the questions that you have wanted answered on surface mount technology, and SMT components in particular.

Further information on SMT and Murata chip components is available from the author at IRH Components (A Division of Bell-IRH Limited), at 32 Parramatta Road, Lidcombe 2147 or ring (02) 648 5455.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Applying the right amount of adhesive & solder paste

Precision and accuracy are critical factors in the application of both adhesive and solder paste, for the successful assembly of surface mount components on PCBs. This applies not only for automated assembly, but if anything even more so in the case of manual assembly, rework and servicing.

by RAYMOND de VILLECOURT
SMT Product Specialist, Electronic Development Sales

In a report entitled 'Surface Mount – Critical Issues and Action Plans' the Surface Mount Council of USA has identified an all-too-common SMT problem. The report's findings conclude that "Adhesives and solder paste applications, prior to placement or during the placement process, are perhaps the most critical and least understood steps in the component placement process."

This statement emphasises the need to have precise amounts of solder paste or adhesives in their proper locations. Unfortunately, many people involved with SMT are dealing with inexact and inefficient methods of attempting to accomplish this task. As a result, problems involving the accuracy of these deposits become costly and time consuming.

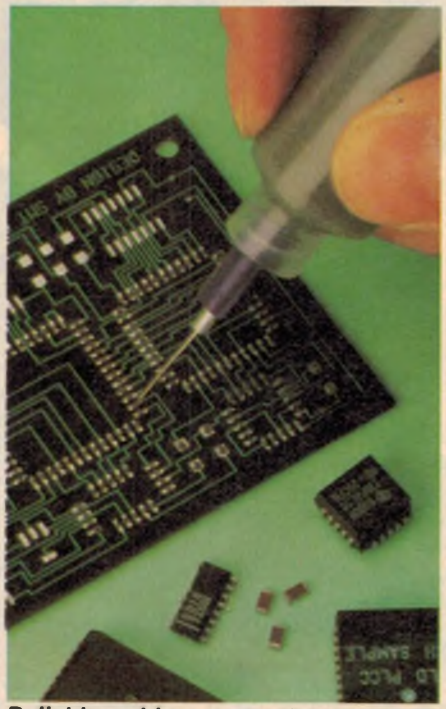
Many hours of engineering time are spent on specifying the proper adhesives and solder pastes. Equal emphasis should be placed on the method of applying these fluids.

Accuracy important

Adhesive deposits must be exact in order to properly bond components during board handling and processing. Applying too little adhesive means the components are either misplaced, or end up in the solder bath. On the other hand if there is too much, the adheseive may flow onto the conductive pads. This can cause serious problems, because the adhesive acts as a dielectric. Excessive adhesive application can also prevent board repair and cause damage to substrates.

For solder paste deposits, consistent application is equally important. Solder paste must be applied in controlled amounts to ensure a reliable joint. Too much paste can result in bridging between pads, which have become smaller and more compactly arranged as SMT technology becomes more advanced.

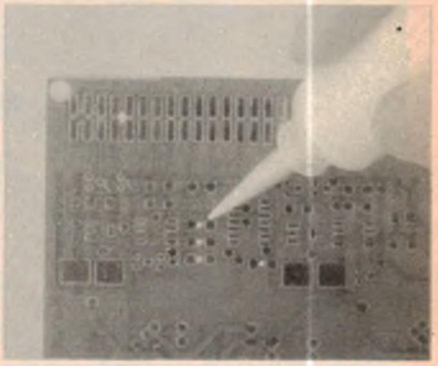
In spite of these facts, many manual SMT operations continue to rely upon simple hand tools – toothpicks, medical hand syringes, and squeeze bottles. Even the most skilled workers have difficulty applying exact amounts of paste or adhesive in their proper locations, using this type of equipment.



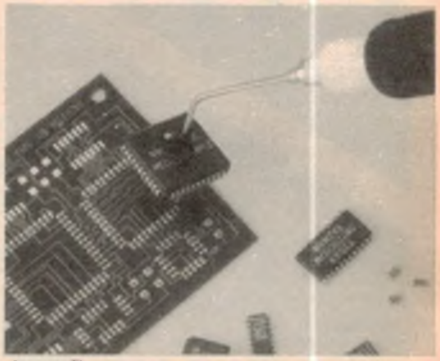
Reliable solder connections with no bridging between tracks depends upon precise application of solder paste.

Air-operated syringes

There are viable alternatives to hand syringes, tweezers and other manual assembly methods. High volume production applications use screening and pin transfer machines. For prototypes, re-



Precise deposits of adhesive are also important, for correct bonding of chip components and no overflow of adhesive onto connection pads.



An adjustable vacuum pickup pencil with a range of tips of various diameters provides reliable and convenient component handling and placement.

pair and limited production, air operated syringe dispensers (sometimes referred to as time-pressure or point-to-point) offer equally precise control in low volume operations.

Automatic air operated syringe dispensers work on the basis of timed air pressure pulses. These pulses displace an exact amount of fluid from the hand-held barrel reservoir – through the dispensing tip – onto the work surface. The amount of material deposited is controlled by regulating air pressure, adjusting the duration of the air pulse, tip diameter, and the viscosity of the adhesive or paste. Less pressure, shorter time and smaller diameter tips result in smaller deposits. Repeating the deposit is as easy as pressing the foot pedal.

Some manufacturers offer the additional feature of a vacuum pick-up pencil. With various sized moulded cups, these pick-up pencils simplify component handling and placement.

Benefits

The benefits of air-operated syringe dispensers for repair, the low volume user and the SMT newcomer are many:

- Various deposit sizes and deposit locations are easily achieved. Deposit size can be changed to allow for various sized components and changing board designs. Unlike screen operations, deposit location changes can be easily accommodated. Precise control is maintained during the entire operation, eliminating mistakes and waste.
- Fluids are efficiently handled. With the availability of prepackaged syringes of solder paste and adhesives, increased efficiency and a cleaner work area are possible. Solder paste can be kept fresh and contamination avoided, by using the appropriate size pre-packaged syringe for a specific job. When the job is completed, store the syringe for future use, or if empty, simply throw it away. changeover is fast and easy.

Applications

The time-pressure dispenser meets applications in all phases of board assembly using surface mount technology. Significant benefits are possible in the following areas:

SMT Evaluation: For those considering SMT, or 'just getting into it,' an entire process line is not cost-justified. The automatic air operated syringe dispenser offers a low cost, economical method to assemble boards during this evaluation period.

Prototypes: As board designs change, so do the requirements for depositing solder paste. With the automatic dispenser, it is simply a matter of adjusting time, air pressure, tip size or a combination of all three, to quickly implement the new designs.

Limited Production: Deposit patterns and requirements for adhesive and solder paste can frequently vary. The SMT dispenser provides a flexible and inexpensive method of maintaining precise application control to meet various short run requirements.

Repair: The dispenser complements fully automatic SMT equipment for board repair. Following inspection, the dispenser can apply additional solder paste to insure reliable solder joints and to attach missing or previously omitted components. Individual component positioning is easily accomplished with the vacuum pick-up pencil.

Conclusion

One of the most critical issues for reliable SMT production is the precise application of solder pastes and adhesives. Inefficient toothpicks and hand syringes are being replaced with accurate timed air pulse dispensers. Coupled with vacuum pick-up pencils, these unique dispensers provide the precise deposit control needed to maintain SMT product reliability.

Further information on adhesive and solder paste application, and on the EFD 1000DV-SMT Automatic Paste Dispenser/Vacuum Pencil shown in the photographs is available from the author at Electronic Development Sales, Unit 2A, 11-13 Orion Road, Lane Cove 2066 or phone (02) 418 6999.

The EFD model 1000DV-SMT surface mount workstation allows precise and consistent air-pulse application of either adhesive or solder paste, together with precise handling and placement of components via a vacuum pickup pencil with multiple tips.

News & New Products

SMT stencil printers

The SSP range of stencil/screen printers has been designed to provide a simple, but reliable and repeatable method of applying solder creams and adhesives to SMT boards and ceramic substrates.

The stencils can be adjusted to X, Y, and Z axes, as well as rotated, by leadscrew and adjustor knob. The stencil is secured by locating holes directly onto the frame to prevent unwanted movement and subsequent adjustment.

An optional vacuum board fixture is available and switches automatically when the stencil or screen is lowered. The printer can very easily be adapted for use with screens as well as stencils.

Squeegees may be ordered separately. For optimum repeatability, stencils should be either electro-eroded or etched.

Further information is available from Electronic Development Sales, Unit 2A, 11-13 Orion Road, Lane Cove 2066 or phone (02) 418 6999.

SMT newsletter

The Australian Surface Mount Technology Association (ASMTA) has published its first newsletter "Pick 'N' Place". Copies are available to individuals and companies interested in joining the association.

For further information contact Dianne Hunt at CIMA Electronics, 2nd Floor, 3 Chester Street, Oakleigh 3166 or phone (03) 563 1699.

Programmable liquid dispenser

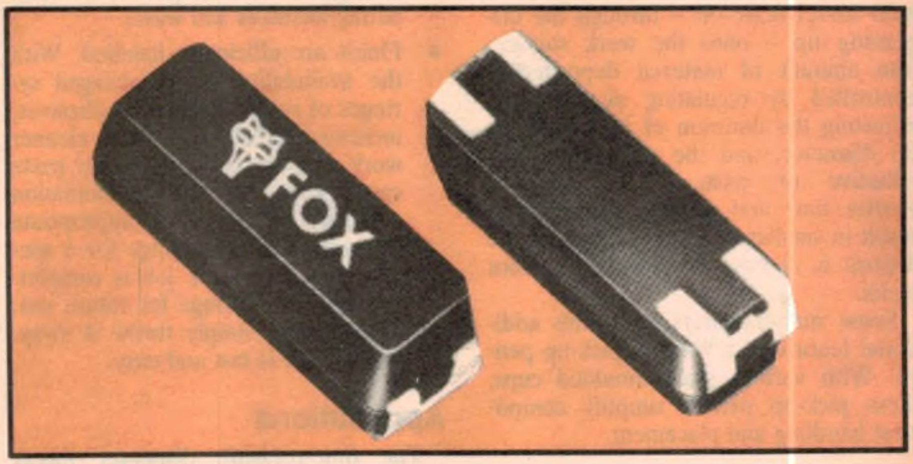
The I&J Model LD1212 is a fully automatic, bench top system that allows any liquid to be dispensed automatically in any sequence of spots, lines, circles or continuous path patterns. Typical materials dispensed include conductive epoxies, die-electric inks and SMT solder paste.

The LD1212 consists of a programmable three axis computer numerical control (CNC) and XYZ gantry positioning system combined with a precision liquid dispensing valve. Programming is fast and easy via a remote joystick using the 'self-teach' digitising mode or with known dimensional coordinates.

The LD1212 can be fitted with a shot valve, pinch valve, positive displacement paste valve and a 2-part meter, mix and dispense system. Multiple dispense heads for increased production are also available.

In operation, the LD1212 dispense head moves over a stationary or tooled part. The gantry arm design allows the user the flexibility of using a simultaneous run-load operation for greater productivity. The compact, bench top design does not take up valuable shop floor space.

For further information contact Electronic Development Sales, Unit 2A, 11-13 Orion Road, Lane Cove 2066 or phone (02) 418 6999.



SM timing crystal

Much of the electronics industry depends upon the 'watch crystal' or 'tuning fork crystal' at a frequency of 32.768kHz to provide correct time in a watch, clock, calender, programme or electronic control system. Fox is now offering this timing crystal in a surface mount package.

This high reliability part is available on tape or reel and built to withstand high temperature soldering techniques such as vapour phase and infrared. The frequency tolerance is +/−20ppm at 25°C.

Full details and technical specifications can be obtained from Clarke & Severn Electronics, PO Box 129, St Leonards 2065 or phone (02) 437 4199.

SMT component kit

A new comprehensive kit of surface mount components has been released by St Lucia Electronics. Suited to both the R & D lab and the maintenance workshop, the kit contains over 1500 components, in colour coded pages, including:

- Resistors – 10 each of 72 values from 1 ohm to 10M.
- Capacitors – 10 each of 48 values from 1pF to 0.1uF.
- ICs – includes common LS, HC, 4000 and linear devices.
- Transistors – most common types.
- Diodes – signal, power, zener.
- LEDs – four colours.

Additionally, the binder that contains the kit doubles as a storage system, with a capacity of up to 100 of each component. Additional vinyl pages containing 12 pockets are also available.

All bags containing components are of good quality re-sealable plastic, and are clearly marked. Each kit includes a pair of tweezers for chip handling.

Comprehensive data is supplied with the kit, plus a cross reference guide from conventional to surface mount components.

Further information from St Lucia Electronics, 24 Campbell Street, Bowen Hills 4006 or phone (07) 252 7466.

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Test Equipment Review:

Metrix MX52 Autoranging DMM

Metrix test instruments have been widely used and respected for some time in Europe, but have only really appeared on the Australian market quite recently. Here's our 'road test' of one of their handheld 3.5 digit multimeters.

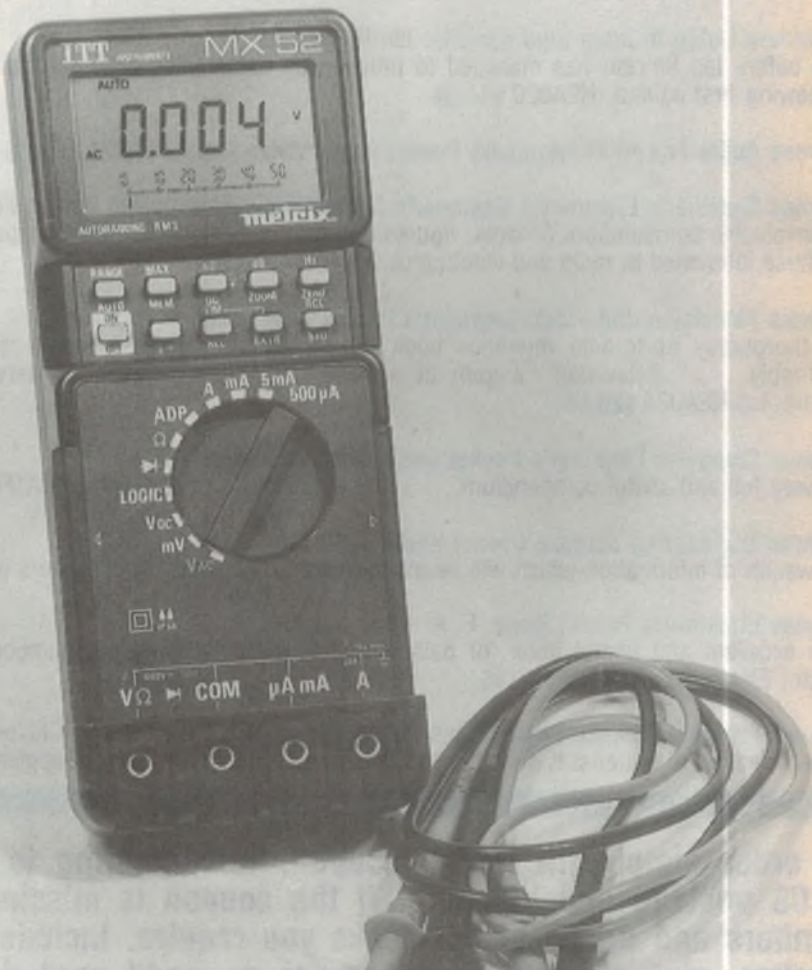
Elmeasco Instruments has recently started importing the Metrix '50 series' digital multimeters. The meters, which are made in France, consist of three models; the MX50, MX51 and MX52. They all share the same basic construction, and differ only in the number of features offered. The model which we examined was the top of the range MX52.

Upon first picking up the meter, one cannot help but be impressed by its solid construction. The overall size is somewhat larger than many of the recent crop of cheaper meters which have rapidly appeared on the market of late, and the overall impression left with this reviewer was one of an instrument which will endure the rigours of field work for many years. The front panel declares that the meter meets IP66, so that the meter is well protected against the ingress of dust and water. The panel also carries four shrouded banana sockets, and when used with their matching plugs, a special locking mechanism prevents accidental removal of the test leads.

Range and function selection is accomplished by a large rotary switch and ten small push-buttons. Some of these buttons have two functions, the second of which is accessed by first pressing the orange '2nd' key, pocket calculator style. The multimeter's major functions are selected by the rotary switch, which has positions for AC and DC volts, ohms, logic, diode test, a combined AC/DC mV range, and four AC/DC current ranges.

Each of these current ranges is actually a pair of two adjacent ranges, which are selected by the auto-ranging function, or manually by the front-panel 'Range' button. The maximum current range is 10A AC or DC, and the meter has HRC fuses for both the low-current ranges and also the 10A range. AC or DC selection on these ranges, and also the mV range, is accomplished by one of the pushbuttons. One neat feature of the mV position of the rotary switch is that it 'remembers' which position the switch was in before being switched to the mV position. If the previous position was AC volts, then AC mV is selected. Likewise, DC mV is selected if the switch was on DC volts previously. All AC ranges show true RMS readings.

When any function is selected by means of the rotary switch, the meter initially goes into auto-ranging mode,



which incidentally is quite speedy in operation. Manual ranging may be selected by pressing the Range/Auto button once, which locks the meter into the range currently selected. Repeated presses of this button then cycles through the ranges one by one, and holding the button down for two seconds switches the meter back to autoranging mode.

In addition to the more usual functions expected of a multimeter, the MX52 also provides a 500kHz reciprocal-calculating frequency counter. This method of frequency measurement allows a resolution of 0.1Hz on its bottom range, while not having to wait 10 seconds for a reading to appear, as would be the case with a conventional counter. Also provided is a decibel function, which can be enabled on any of the AC voltage ranges, and gives readings in dBm.

Operating Modes

Upon first powering up the instrument, one is confronted with a rather dramatic display, while the meter performs a display self-test for about 2 seconds. Accompanying the main 12mm 3.5 digit (5000 count) 7-segment display is a 50 segment bargraph, and several annunciators to indicate what the display is actually showing, and which of the many modes the meter is currently operating in.

The sheer number of display modes available on this instrument really sets it apart from most of the cheaper meters on the market, and also from many not-so-cheap models. The default mode on most functions has the main display showing the selected voltage, current or whatever, as expected, while the bargraph shows an 'analog' version of the same quantity. Annunciators adjacent to the bargraph display indicate whether the bargraph (which is updated faster than the main display) is showing a positive or negative value on the DC ranges.

However, pressing the 'Zero' button puts the bargraph into a centre-zero mode, although this halves the resolution in the process. If you want increased resolution on the bargraph, you can press the 'Zoom' key, which causes the bargraph display to show only one-fifth of its normal range. The display effectively becomes a small window into a much larger 'virtual' display, which slides up and down the range as required. The extremities of this window are labelled using small 7-segment displays.

Yet another mode allows the continuous monitoring of some parameter, while keeping track of the maximum and minimum values, which may be recalled at a later time (provided the power hasn't been turned off). There are also 5 internal buffers (or memories), for storing displayed values for later recall. Each buffer stores the numerical value on the display, plus the units, and the polarity or AC indication, if appropriate.

You can also take relative measurements of just about any parameter that the meter can measure. You simply apply the reference value, and then hit the 'Rel' key. Any measurements taken from that point on are displayed relative to that reference. This feature can be used to measure dB relative to some reference other than 0dBm, or to measure the output droop of a power supply as the load is increased, for example.

During relative measurements, the bargraph continues to show the absolute quantity, so you can make sure that it stays within range. You can also freeze the display (much like a pointer lock in a mechanical meter) if you need to, while the bargraph continues to move with the input.

The meter also has a built-in logic probe, which shows high, low and open states. You can optionally enable the beeper in this mode, with two different tones indicating the two logic levels, and no tone at all indicating an open-circuit. The diode test function is quite conventional, measuring the forward voltage drop of a diode connected across the 'COM' and 'V' terminals. Shorting the 'COM' terminal to either the 'mA' or 'A' terminals while on the diode range tests the 500mA or 10A fuses for continuity.

We found the instrument quite easy to use, in spite of the number of advanced functions present, and for field work, the rugged construction would protect it from accidental abuse which tends to accompany such ventures outside the lab or workshop environment.

The MX52 is priced at $399. The MX51 excludes the dB and frequency counter functions, and does not read true RMS. This model is priced at $320. The MX50, without the relative reading, maximum/minimum, and memory functions, is priced at $275. All prices exclude sales tax, and the meters each carry a four year warranty.

For further details contact Elmeasco Instruments Pty. Ltd., at P.O. Box 30, Concord 2137, or phone (02) 736 2888. (M.C.)

SPECTRUM

Communications News & Comment

Conducted by
DAVID FLYNN

Sydney broadcast tower EIS

Soon for release is the Environmental Impact Statement (EIS) for the proposed new Sydney broadcasting tower.

The tower will replace the existing ABC installation at Gore Hill, and at 270 metres high and 350m ASL will be the city's tallest. It will have an advantage of some 120 metres over the existing tower and will also be strong enough to handle larger and more powerful antennae, greatly improving reception of both ABC and SBS TV. All Sydney FM stations will also be co-sited on the mast, boosting mobile and portable FM reception.

It will also cater for a second UHF TV channel when neccessary, plus the five new FM radio services in Sydney, which commence next year with the conversion of two AM stations and will be followed by the issue of three new FM licences.

The draft EIS will be exhibited at several locations in suburbs adjacent to the Gore Hill site, and revised in the light of any written comments and submissions.

Dial-up access for White Pages

Users of an IBM-compatible PC will soon be able to access Telecom's Electronic White Pages (EWP) service.

EWP is currently only available through a dedicated Austpac link, which suits high-useage customers but prevents lower volume users from tapping into the national directory.

The customer service manager of Telecom's Directory Solutions group, Mr Robert Twentyman, says that the on-line availability of EWP brings us closer to the concept of the electronic office.

"Subscribers only have to key in the name of a person or business, along with basic locality information. The EWP then provides the up-to-date telephone numbers and addresses that best match that information. However the system does not offer silent telephone numbers", said Mr Twentyman.

Telecom envisages that the modems used will be be 100% Hayes compatible, operating at 1200bps and conform to V.22 and V.24 standards, and are currently testing modems for approval prior to the service commencing.

Black art vs black box

Any operator of a 24-hour HF link can tell you that in addition to skill and experience, a dash of mystic 'black art' is required. To date even the most sophisticated transmitter systems cannot display such intuition, or deftly juggle the maximum and optimum working frequencies to maintain contact around the clock.

Enter the tangible wizardry of the computer. Following an eight-month experiment, English researchers have announced that the skilled radio operator can now be replaced by an IBM XT.

Some 80 spot frequencies from 2-25MHz were entered into a special program, weighted towards the lower end of the spectrum, and from these a full band scan is automatically carried out every hour. Using a set of reliable calling frequencies the station at the other end of the link is given a list of five channels shown to be open.

The working frequency is then chosen by computer, and changed on the basis of the lowest error rate. A series of fallback frequencies remains open in the event of contact being lost.

The link has not only proved reliable, but has shown that both lower and much higher frequencies than those predicted are open, partly because the system can safely use channels near the actual MUF instead of the OWF (usually regarded as being 85% of the MUF). It can also take advantages of the many days on which predictions prove conservative.

Of course, an IBM XT can't replace a blown final, either...

Tuning in to 'Trunking'

Although many of the latest scanners are offering coverage of the 800MHz bands, there is little to listen to (legally) with the exception of the Trunked Land Mobile Service operating in Sydney and Melbourne.

Russell Bryant, scanning writer for *CB Action* magazine, offers this hint for scanner enthusiasts. The trunking band is 5MHz wide, being 865-870 (base tx) and 820-825MHz (base rx). In each trunking 'group' (similar to a cell) there are five channels, each of which is always 1MHz above or below its comrades.

So if you hear a trunked radio channel on any given frequency, simply enter the five frequencies 1MHz above and the five that are 1MHz below into your scanner's memory, and scan away. Eventually the other four will become active, and you can eliminate the remainder.

Planning ahead

One of the hottest and most sought-after slices of spectrum, the 'UHF high-band' from 820-960MHz, has been given a clearer direction following the March release of the DoTaC draft bandplan.

The plan was keenly awaited by the local communications industry and major players, who have not been slow to offer their comments to the Department. The action centres on the cellular phone allocations, the potential for CT2 services and the newer 930MHz Private Advanced Radio System (PARS).

DoTaC has taken a dollar each way with the future of cellular, and the only safe bet is that it will of course be digital. The present Mobilenet system is expected to reach an optimum capacity of one million users by 1992, at which stage the Digital Cellular Mobile Telephone Service will be cut-in.

However neither the American nor European digital services has been finalised. So the plan wisely aligned our respective frequency allocations with those of both continents, and will make the choice between systems following further developments, rather than locking us into either one.

Several key players are hoping that the DCMTS will see a private network approved in direct competition with Telecom.

CT2 offers a different picture. While the European-standard CT3 is being finalised, the British have 'fast-tracked'

CT2 at home and have made inroads to Europe. CT3 should be ready by 1992, which is seen as being the deadline for the establishment and entrenchment of CT2.

If the market is ever to be opened up to private carriers, say the industry, this is where it will happen.

Another new twist to the plan is PARS, the 933-935MHz handheld-only trunking system which works as a high-tech personal radio service. The 80-channel PARS is the result of a strong British industry lobby (led by such giants as Motorola) which repossessed this part of the spectrum from the UK's UHF CB radio service, where it was vastly under-used. A similar Japanese system has been working for some years now, but earlier efforts by companies including NEC and Kenwood to establish the service locally were unsuccessful as the PRS used cellular frequencies.

Telecom prepares for CT2 trial

Telecom is presently gearing up for its October test of the CT2 system, in order to fully evaluate the performance of the UK-sourced digital cordless phones, with the recent DoTaC draft bandplan for high-band UHF (see 'Planning Ahead') earmarking 861-865MHz for the purpose.

CT2 handsets use cellular technology, but can only make out-going calls, and must be within a few hundreds metres of a special base station termed a 'telepoint'. Their low power (10mW) and limited range allows for a capacity 200 times that of Mobilenet, and has helped bring the cost of a CT2 handset as low as $300.

The system was launched earlier this year in the UK, with the private sector providing a number of CT2 networks in the most populated areas. Plans are also well advanced for a pan-European CT3 specification using 1.6GHz.

CT2 is one of the key money-spinners in England and is moving towards common-air interface to allow compatibility between the private carrier services, a path which the local communications industry hopes Australia will follow. Telecom is already reported to be resigned to a very competitive multi-carrier system if CT2 gets the nod.

477MHz repeaters for Bathurst, Orange

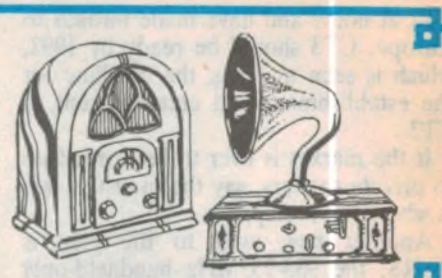
UHF CB operators in the NSW central western region will soon benefit from two new repeater services planned for the area.

The first, in Bathurst, is expected to commence within the next few months. Operating on UHF CB repeater channel 3/33 from Mt Canobolas, tests have indicated exceptional coverage (over 100km) in all directions. The repeater is sponsored by the Central West UHF Repeater Association, which is asking for financial support from local users. The Association can be contacted at PO Box 1062 Bathurst 2795, or telephone CWURA President Bob Fenton on (063) 37 5660 ah.

The Orana Region Amateur Radio Club has been granted a licence for a UHF CB repeater to service Dubbo, using ch 1/31 and co-sited with the club's 2 metre repeater VK2RCC (ch 6800). The club has already received many donations from the public, and hopes to raise the full $6000 required by the end of this year. For further information contact the club c/- Lot 28, Bencubbin Estate, Dubbo 2830.

These two latest services will bring the UHF CB repeater total to almost 250, forming a network which includes major cities, regional centres and towns and stretches along our major highways.

Vintage Radio



by PETER LANKSHEAR

Restoring a classic STC radio – 1

Recently, I overhauled a model 562 STC console radio, fitted with a type 56 chassis and dating from about 1933. This turned out to be a major exercise, involving many of the techniques and problems encountered in the fascinating activity of vintage radio restoration.

When it was found in a classic location, a farm shed, the old 562 was not a pretty sight. Generations of birds had roosted in the rafters above it, leaving heavy guano deposits. The knobs, one control and most of the valves had disappeared. Worse still, the inside of the cabinet was stuffed with a large quantity of straw and litter, a sure indication that rodents had nested in the chassis.

The toilet habits of mice are not very nice, and their urine is extremely corrosive – to the extent that it will even eat through nickel plating. Painted chassis such as those STC used are even more vulnerable. Areas of steel that are attacked soon become heavily pitted with rust, as can be seen in the photograph.

To restore or not?

The poor physical condition raised questions about the viability of restoration. Had the set been a common post war model, restoration would hardly have been worthwhile. However, with its angular shape and strongly patterned veneer, the STC 562 is a good example of *Art Deco* furniture, and as such, warranted a fair bit of effort and trouble to preserve.

In addition, the chassis of the 562 is historically interesting as it comes from a period when the standard 5-valve receiver was still evolving. But a final decision was deferred until the electrical condition of its major components could be ascertained.

Four large coach bolts were removed and the chassis withdrawn. I was surprised to find that the chassis ends were wooden. At least the mice hadn't affected *them*! However, a puddle of congealed wax under the power transformer looked suspicious. This was going to be a key item in the decision making.

With the aid of a vacuum cleaner and a brush, sufficient dirt and rubbish was removed to check the chassis over. The remaining valves were removed and a new power cord temporarily connected to the power transformer.

There was no sign of distress when the power was turned on. The HT voltages were checked at the anode terminals of the '80 rectifier socket and were found to be close to 400V. When loaded, these would be down to about the correct 375V. So far, so good.

Here I should inject some words of caution to those not used to working with valve equipment. This is not to frighten beginners off, but to remind them to make safety their first priority.

Fig.1: When first found, the grain of the wood was barely visible through the dirt and faded polish. But it responded well to basic treatment, as you can see.

Always be alert. Power transformers are capable of delivering lethal shocks. **Check and double check any mains connections, and if you are measuring high voltages or working on a live chassis, keep one hand in your pocket.** A mains isolating transformer is very worthwhile.

After an hour or so with the mains connected, the transformer was barely warm, indicating that it had survived the suspected overheating.

With this encouragement, the windings of the IF transformers, aerial and oscillator coils were checked for continuity. Apart from one of the oscillator coil windings, they were all intact. I wasn't too worried about the open winding, as oscillator coils of this era were usually single layer wound and easily repaired.

The remaining key item was the loudspeaker field winding. Fields were wound with fine wire, which can be open circuited by corrosion, but fortunately this one measured the correct 2500 ohms. Mounted on the speaker was the output transformer, with a primary resistance which should have been about 400 ohms. In this case it was open, but again it was not critical as I had a similar transformer salvaged from another radio. In any event, it would have been reasonably easy to rewind.

Restoration viable

All things considered, restoration seemed to be worth attempting. A close inspection of the cabinet showed that damage was largely superficial, and most of the mess was removed with a good scrubbing with detergent and water.

Although the cabinet refinishing treatment I described in the December 1988 issue of *EA* could have been used, the owner wisely wished to retain an antique appearance, and used methods employed by antique furniture restorers. These revive the original finish as much as possible by blending, reamalgamating and the judicious application of polish.

As can be seen from the photograph of Fig.1, the result was most satisfacto-

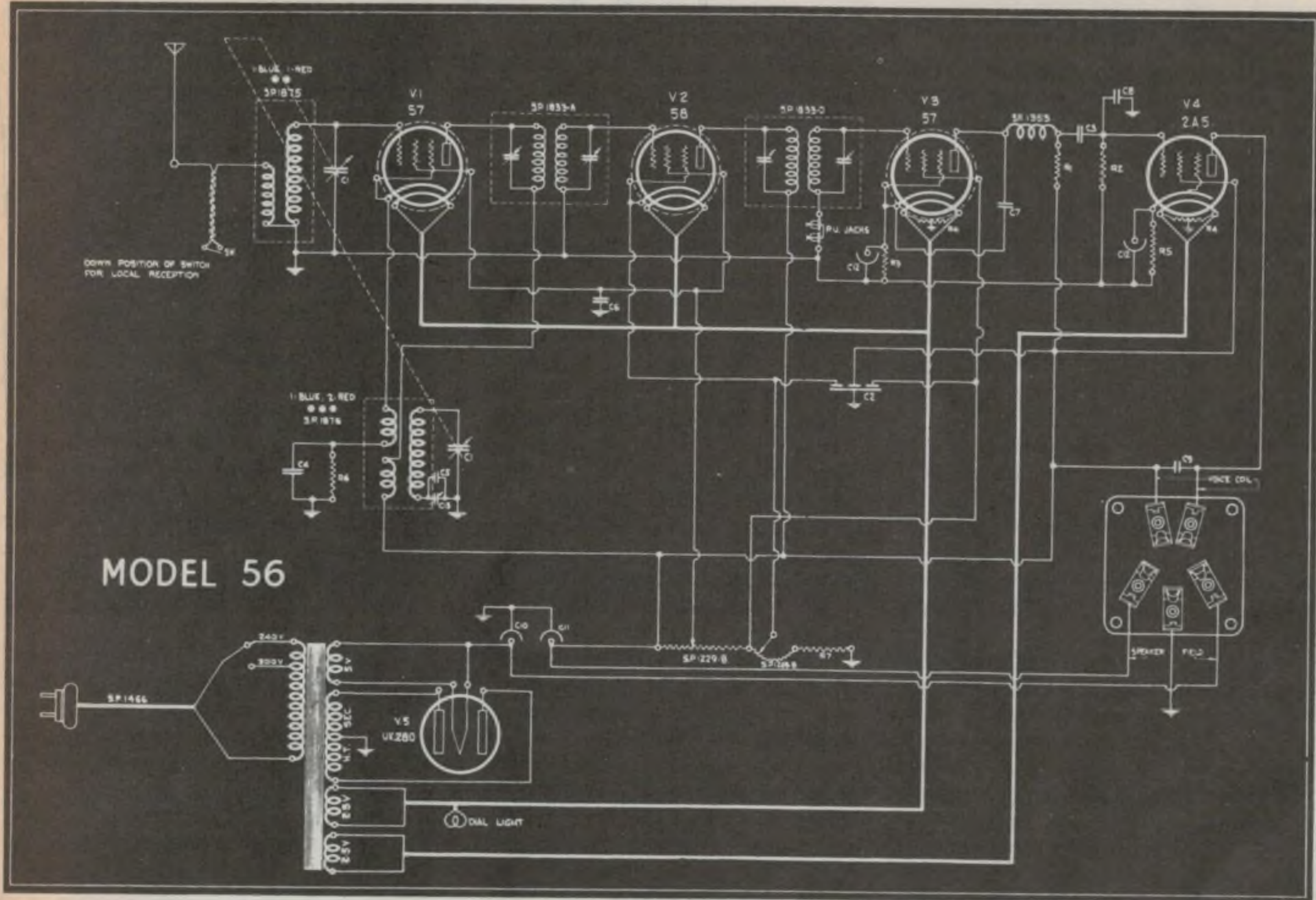


Fig.3: The circuit schematic for the model 56 chassis used in the 562 receiver. It had no AGC, and a switch was used to insert a twisted-wire 'gimmick' capacitor in series with the aerial for reception of strong local signals.

ry. The chassis however needed a lot more work.

Interesting circuit

Before describing the work on the chassis, we will take a good look at the circuit. This is quite different in many ways from those of the more familiar post-mid-1930's receivers.

A 5-valve superheterodyne, the valve lineup is typical of Australian made receivers of the period. Rather than using a pentagrid frequency converter and a combined diode-triode detector, which were only just appearing in the US, this chassis used a pair of 57 pentodes. One was used as a self oscillating mixer, and the other as a biased detector. The intermediate frequency amplifier used their variable-mu companion, the type 58. A 2A5 output pentode driving the loudspeaker and the usual '80 rectifier completed the lineup.

The missing control turned out to have been a single pole rotary on/off aerial attenuator switch, for coping with strong local signals. It simply inserted a small amount of capacitance in series

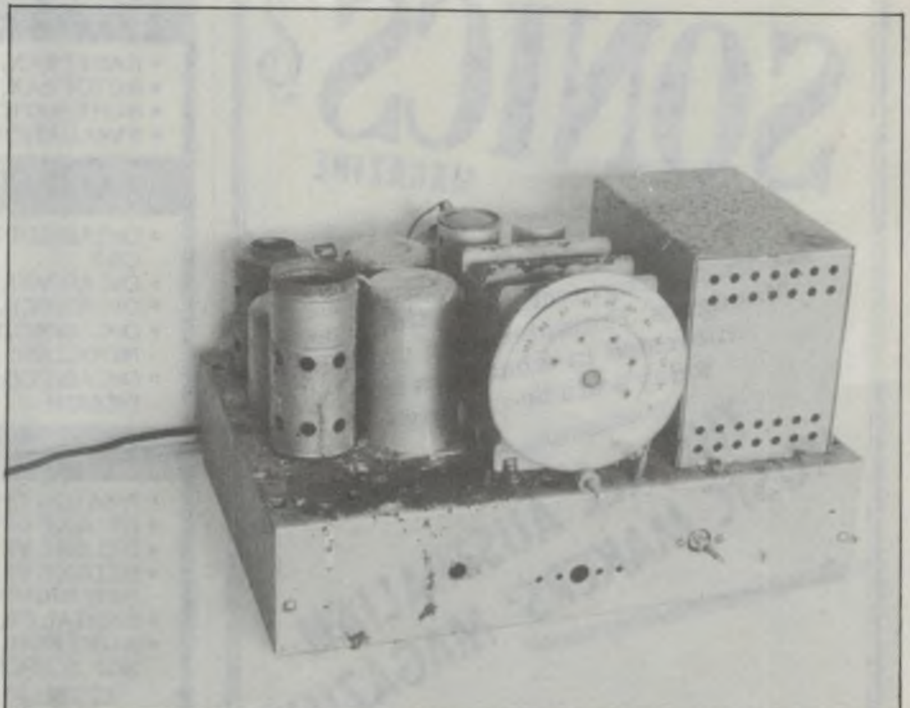


Fig.2: Bad storage and rodents had left the chassis in a very rusty state. But it too was to respond to treatment, as the author explains.

with the aerial. The twisted wires symbol on the circuit indicates that the capacitor was just 3 or four 4 turns of wire around the aerial lead.

Normally, a 5-valve set of this period would have used a three section tuning capacitor, with two aerial tuning circuits to overcome the problem of images resulting from the use of the commonly used low intermediate frequency (IF) of 175kHz. Without preselection, as it was called, a strong signal 350kHz above the desired programme could produce interference.

In this case STC anticipated the radio industry's later universal change to a higher IF, by using 460kHz. This increased the image frequency difference to 920kHz and simplified the model 56 by requiring only a single tuned aerial circuit, and hence a two 'gang' tuning capacitor.

Capable of very good performance on the broadcast band, the 'autodyne' self-oscillating mixer used in the STC was a popular frequency converter during the early 1930's. Basically, the autodyne mixer is a valve biased nearly to cutoff, with tuned oscillator and coupling windings connected between the anode and cathode. Readers familiar with transistor receivers will recognise the similarity of the autodyne to today's mixers.

Related to the autodyne mixer, the biased pentode detector was popular until displaced by combined diode-triode and diode-pentode valves. It is capable of fully driving a pentode output stage with only a volt or so of input signal, but one of its shortcomings is its inability to generate AGC voltages. This requires the volume control to be placed very soon after the aerial.

As the gain of an autodyne mixer cannot be readily varied, the earliest point of control in the STC 56 is the cathode voltage of the 58 IF amplifier valve.

With the prior amplification of the uncontrolled mixer stage, the IF stage gain control cannot cope with strong local signals. This is where the aerial attenuator switch comes in. It works, but is an inelegant solution and contrasts with the progressive use of a high frequency IF.

A method used by many manufacturers at the time, and later by STC, would have made the switch unnecessary. In this the control is divorced from the voltage divider and one end is connected to the aerial. The other end is connected to the cathode of the IF amplifier and the moving arm is earthed. As the bias on the valve is increased, the aerial is also progressively loaded down, resulting in a smooth double acting wide range control.

The output stage was the traditional pentode with cathode bias. Equally conventional was the power supply using the inevitable '80 rectifier.

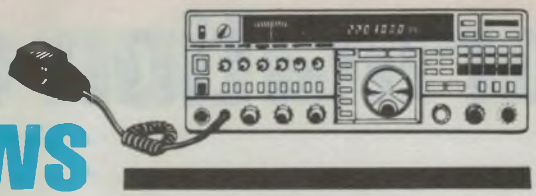
During the 1930's few mains powered receivers used permanent magnet speakers. Instead, electromagnetic fields were standard, with the windings doubling as filter chokes. Many Australasian manufacturers, including STC, favoured fields of 2500 ohms and the resulting voltage drop required power transformers to have HT voltages of about 375 volts.

All low value resistors were wire-wound on small bobbins, whilst the high value types were Australian brand 'Chanex' with ceramic bodies and cast metal ends. The few paper capacitors were again 'Chanex' brand, with C2 (the main bypass block) of STC's own make.

The loudspeaker proved to be interesting, with an unusual frame in front of the cone. Fortunately, the mice had left the cone intact, and apart from replacing the output transformer, the speaker required no attention.

Next month the actual servicing and restoration work on this receiver will be described.

Amateur Radio News



Icom (Australia) not even unwell!

Many amateurs were concerned and surprised when an item appeared recently in the finance columns of the daily press, covering the appointment of a provisional liquidator for 'Icom Ltd'. However it turned out that the company concerned was a subsidiary of Parry Corp, and not related to either Icom (Australia) or its parent company Icom Incorporated in Japan, well-known maker of high quality amateur and other communications gear.

A statement by Icom (Australia) stressed that the company was not connected with the ill-fated Icom Ltd, and was not in any financial difficulty. So from an amateur radio viewpoint, the situation is similar to the premature report of Mark Twain's demise: "The rumours of my death are greatly exaggerated."

Amateur transceiver tariff concession

After much discussion between Australian Customs, the WIA and a local transceiver manufacturer, the December 1988 amended Tariff Concession relating to the importation of amateur radio transceivers (8525.20) has finally come into effect. This means that the existing duty rate of 23% will be reduced to 21% from the first of this month, and by a further 2% per year until it reaches 15% on July 1st, 1992.

For the individual amateur thinking about bringing in a transceiver whilst on a holiday or business trip, the situation is still fairly complicated. The guidelines for assessment of equipment in terms of its applicability for the by-law concession are quite involved, and include technical details such as the ease with which the equipment could be modified to transmit on frequencies outside the amateur bands. In any case the standard fee for inspection of documents and/or the transceiver itself is $155.00 – not a great amount for commercial importers, but a significant amount for a private individual.

In most cases it is therefore likely to be better for the individual amateur to buy direct from an Australian dealer, unless the intention is to buy one of the most expensive models. Local buying also ensures that there is no doubt about warranty and servicing support.

AMSAT newsletter, software available

South Australian amateur Graham, VK5AGR publishes a monthly newsletter on behalf of AMSAT Australia, providing the latest news items on all satellite activities for anyone seriously interested in amateur satellite communications. The newsletter is available via a subscription of $20 per year, from AMSAT Australia, GPO Box 2141, Adelaide 5001.

According to Maurie Hooper VK5EA, writing in his column in *Amateur Radio*, Graham also provides a software service, making available a variety of satellite programs from various sources. Details of the programs available and other AMSAT Australia services may be obtained by sending a stamped, self-addressed envelope to Graham at the above address. The programs themselves are obtained by sending a blank formatted disk, together with a donation of $10 to AMSAT Australia and sufficient additional funds to cover return postage.

Record contact on 6 metres

Harry Atkinson, VK6WZ reports in the May issue of *Amateur Radio* that during a period of particularly high MUF in February, WA amateur Wayne Dowie VK6WD made contact with two Norwegian amateurs on 50.110MHz. This represents an exceptional DX contact on the 6 metre band, and could well be a first for VK6 amateurs working Europe on this band.

VK6WD was apparently using an IC551 driving a home-brew solid state 100W linear, with a 6-element Yagi up 13 metres. But his first contact LA3EQ was putting out less than 20W, while the second contact LA8WF was using only 5W – dramatic evidence as to what can be achieved when the 6m band is well and truly 'open'.

Congratulations to Wayne VK6WD for the exciting achievement.

Information centre

Conducted by Peter Phillips

We stand corrected...

I said I loved an argument. But I forgot to add – providing I win it. Oh well! You can't win 'em all, and this month I have the unfortunate duty of proving myself wrong. As well there are some interesting suggestions for modifying our new low distortion audio oscillator and improving that stalwart of these columns – the Playmaster 60-60 amplifier!

It's fairly usual for this column to get letters requesting information, or offering answers to readers' questions. As well, letters that join in a discussion are now becoming numerous, for which I'm most appreciative. But correspondence offering suggestions on improving a project are not so common, and I'm pleased to be able to include two such letters this month.

But first a bit of recapitulation. If you happen to have the January '89 edition of *EA* handy, you might like to open it up at page 156 and peruse the discussion concerning the presence of resistor R8 in a differential amplifier circuit. My discussion, supported by suitable maths, makes the point that R8 should be 1k, rather than 1.8k as suggested by the correspondent who raised the issue in the first place.

I now have three letters all stating that R8 is in fact unnecessary. I cannot argue with the logic being offered, and I have to agree that R8 is not only redundant, but worse still, can degrade the overall performance of the amplifier.

CMRR and the differential amp

The circuit under question, reproduced herein as Fig.1 to aid the discussion, was originally part of a project titled 'A Multi-purpose Pre-amp board', published in November 1988. Using mathematical logic that seemed watertight, designer Rob Evans included a resistor – the ubiquitous R8, to balance the impedances presented by both inputs of the differential amplifier circuit.

A reader then suggested this resistor should have a value of 1.8k, rather than

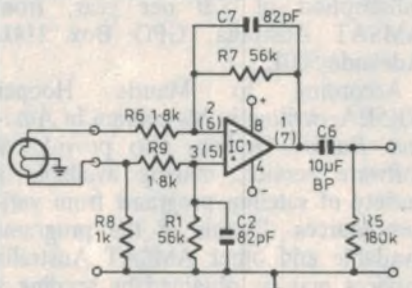


Fig.1

the specified value of 1k. After much research and figuring, I came up with a mathematical proof that supported the 1k value, which was duly detailed with great gusto. Pity I didn't think it through a bit more, as the conditions I applied were not appropriate to the situation.

As readers no doubt know, the main purpose for using a differential amplifier is to reduce the effects of common mode noise and hum. Ideally the output under common mode noise conditions will be zero, which is the appropriate condition that should have been applied when performing the mathematics. I'll let one of the correspondents explain it, and you will see what I mean.

Regarding the discussion in the January issue about the differential amplifier, I submit that the arguments of both your previous correspondent and yourselves are spurious. In fact R8 itself is quite spurious!

With regard to common mode rejection ratio (CMRR), the ONLY thing that matters is the impedance presented to the COMMON MODE source on each input. If this source is to be rejected correctly, there will be no output voltage (of course) and in effect both R7 and R1 return to an earth. The input voltages at the op amp must be equal, thus the ratios of R6/R7 and R9/R1 need also to be equal.

For the impedances presented to the common-mode source to be equal, R6+R7 must equal R9+R1, and R8 MUST NOT be present. So it comes back to R6=R9 and R1=R7; FORGET R8! Since CMRR is the essential determinant, forget whether the microphone is balanced or floating. To load the microphone, if this is important, just put a suitable resistor between the two line input terminals.

Simple, Eh? (P.W. Port Macquarie NSW)

Simple indeed. Why didn't I think of that? It all comes back to keeping in sight the purpose of the circuit. The calculations offered in January are for a differential input, not a common mode input.

But why use a differential amplifier in the first place, if all we want is gain? So when the circuit is analysed with the ultimate purpose in mind, conditions alter, as pointed out by our correspondent. The second letter makes much the same point with a few other comments:

I believe you all lost sight of the problem at hand in the discussion concerning the differential amplifier (January '89). The main purpose of using a differential amplifier is to remove any common mode signals, meaning the common mode rejection of the circuit is of considerable importance.

For the circuit under discussion, if the source and R8 are both disconnected, maximum CMR will occur if R9=R6 and R1=R7, providing the source impedances presented to both inputs are identical. You are correct in saying that the input impedance will not be the same for both the inverting and non-inverting inputs, but this needs to be tolerated if maximum CMR is required. However, assuming R8 is excluded, the input impedances of both inputs will be the same for common mode signals, which is a prerequisite for best CMR.

My references are Horowitz and Hill 'The Art of Electronics', and Graeme, Toby and Huelsman 'Operational Amplifiers: Design and Applications'. These books present various circuits that offer equal impedances under all conditions, but I have never (NEVER) seen a circuit such as yours, even in data sheets. Sorry guys, I think you got it wrong. (P.D., University of Sydney.)

Our third correspondent on this topic provides a lengthy, hand written letter that unfortunately is a little hard to read (sorry to say). I am not totally sure that I got the drift of the text, but there is one point made that is worth airing. It seems the writer is concerned about the gain of an op amp circuit when the impedance of the signal source is considered. Here's the relevant section of the letter:

I now come to a sore point, concerning the basic inverting amplifier configuration commonly used in published circuits (see diagram of Fig.2). It seems

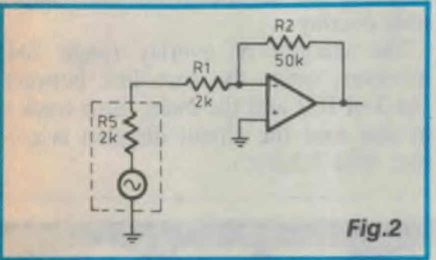


Fig.2

any analysis of this circuit generally overlooks the impedance of the signal source. If the value of R1 is 2k and R2 is 50k, the gain of the circuit is normally stated as being 25. However, if the impedance of the signal source is 2k, then surely this extra value needs to be added to the value of R1, giving a gain of 12.5.

This assumes a purely resistive value for the source impedance, but if the impedance contains a reactive component, then this effect is undoubtedly more complex. (S.W. Nambour, QLD)

The correspondent continues with other points, sufficient to convince me that perhaps his understanding of op amp circuits is a mite lacking. However it is worth discussing the above question, as this one often tricks quite a few players.

The circuit configuration definitely has a gain of 25, regardless of the signal source impedance. In fact it is better to regard the circuit configuration as a black box, having the specifications of a gain equal to 25 and an input resistance of 2k (equals R1). If a signal source is connected, an output signal that is 25 times greater than the input signal will result.

However, the tricky thing is the level of the input signal. If the output level of the signal source is monitored with a measuring instrument, such an oscilloscope, it will be found that the level of its output will vary with the load connected across it.

For example, if the signal source is connected to an oscilloscope, without any other loading, it may be found that the signal level produced by the source is 10mV. If a load is now connected, the signal level will drop due to losses across its own internal source resistance. If the source impedance is 2k, then the output level of the source will fall by half if the load is 2k.

In other words, if this signal source is connected to the amplifier contained within the black box, the output level will not be 25 times 10mV (equals 250mV) – instead it will be 25 times *5mV*, or 125mV. This gives the impression that the gain of the amplifier is 12.5, if one considers that the original (but unloaded) output of the signal source was 10mV. The problem is, the input signal to the amplifier is not 10mV, it is 5mV.

Anyway, thank you S.W. for raising the point – I hope this clarifies it.

Customer complaints

It is hard to sometimes follow the maxim: 'The customer is always right', at least with a straight face, anyway. Imagine the plight of the Telecom technician who was faced with the complaint 'my knees hurt when the phone rings'. It seems a longer phone lead was required to reposition the phone from the floor to a nearby table.

Then there was the omnipotent owner of a TV set who requested that a new picture tube be fitted to solve the problem of no picture. The cause was a blown fuse, fortunately discovered by an ethical technician. How many customers blame the on-off switch for no-go, and the volume control for low or nil sound? Oh that it was that simple...

But the gentleman who asked for two 'short legs' for his TV must take the cake. This inelegant solution was all the owner could think of to correct a situation cause by a picture tube yoke having slipped during a bit of 'user adjustment'. It perhaps beats using a brick to prop up one side, although either solution would create problems for Mum's TV ornaments!

60-60 Playmaster

It seems this amplifier just won't go away! Here is another letter concerning the design of the circuit, but offering some very positive commentary. The writer, from Sydney University Electrical Engineering, has even verified his modification by simulating the circuit with SPICE, a circuit simulation program. His letter is as follows:

I have recently constructed your Playmaster 60-60 amplifier. I am very pleased with the results, however along the way I struck an instability problem which I believe is due to a deficiency in the amplifier's compensation.

The compensation is provided by the 68pF capacitor between the base and collector of Q11. Transistors Q9, Q10, Q11 and Q12 form a differential amplifier, with the input signal applied to both the inverting and non-inverting inputs from 4.7k source resistances. The compensation capacitor provides feedback from the output of this stage to its inverting input.

As far as the inverting input is concerned, the gain of this stage falls off with increasing frequency, approaching zero at high frequencies. For the non-inverting input however, the best that the compensation capacitor can do is reduce the gain of the stage to unity. Since signal is applied to both inputs, the overall gain of this stage never falls below unity.

This is not a problem if the overall loop gain of the amplifier ends up being below unity at high frequencies. The output stage has a gain of approximately 1, so the only remaining gain stage is the Q6-Q7 differential amplifier, which has a gain of about 45.

The feedback network, consisting of the voltage divider feeding the base of Q7, sets the minimum loop gain at high frequencies to about 2.2. This is greater than unity, meaning the amplifier is not unconditionally stable. Whether it oscillates or not will depend on the various stray phase shifts about the place.

In my case it did oscillate (at about 2MHz), and tests confirmed that the mechanism outlined was responsible. Fortunately the cure turned out to be quite simple. What is needed is additional compensation on the non-inverting input of the Q10-Q11 differential amplifier.

This can be achieved by connecting a capacitor in parallel with the 4.7k resistor in the collector of Q7. I used a 10nF capacitor, which produces a pole at about 3kHz, but it is not particularly critical as long as it takes effect well before the 68pF capacitor gives up.

Note that since the inverting and non-inverting inputs effectively form two parallel signal paths, this additional compensation is in parallel with the existing

Information

compensation and does not add an additional pole to the overall response. Rather, it removes the zero which is caused by the high frequency failure of the existing compensation. (J.P., Sydney, NSW)

Answer to last month's Why??

Last month we asked for an explanation of 'skin effect', which is that phenomenon that causes electric current to flow along the outside of the conductor, particularly at high frequencies. The answer lies in the magnetic field surrounding the conductor.

When current flows in a conductor, a circles will be developed around the conductor. The circles will be of diminishing intensity away from the centre of the conductor, and strongest in the centre.

As most readers will probably appreciate, a straight length of copper wire possesses an inductance value, caused by the magnetic field surrounding it. If the flux is strongest in the cenmagnetic field in the form of concentric tre of the wire, it follows that the inductance is highest at this point, and lower around the surface. Inductance is a fixed value, determined by the characteristics of the conductor, but inductive *reactance* varies directly with frequency.

Because the inductance of the wire is greatest at the centre, so too is the inductive reactance, which effectively limits the amount of current that will flow in this part of the wire. So that's why the current tends to flow mainly near the surface, where the inductive reactance is lowest.

At UHF, conductors are usually made from pipes, because virtually all the current flows on the surface and there is no point in using solid copper. Similarly special multi-stranded wire called Litz wire is used for coils and transformers operating at frequencies above a few thousand Hertz.

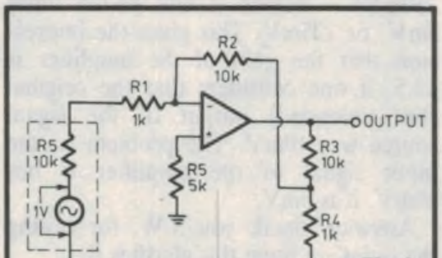


Fig.3

What??

Since the hot topic this month has been the operational amplifier, you might like to try your hand at this little problem. Calculate the output voltage of the circuit shown in Fig.3.

NOTES & ERRATA

LOW COST ADAPTOR FOR TUNING YOUR CAR
(April 1989): The mounting positions for capacitors C2 and C3 are shown transposed in the component overlay. The smaller (180pF) capacitor C3 should be nearest the rotary switch SW1, as shown in the photograph on page 188. The circuit diagram is correct.

LOW DISTORTION AUDIO OSCILLATOR – 2
(March 1989): The circuit diagram on page 101 shows pin 4 of IC1 connected to earth. This should connect to the negative rail as shown on the component overlay.

The component overlay (page 104) however, omits the wire link between pin 3 of IC2 and the main earth track – in this case the circuit diagram is correct. (file 7/Ao/40).

Operational amplifier data

The following data is for the more common types of operational amplifiers. The specifications shown are the worst case values, and have been derived from a number of data manuals. The description attempts to generally describe the amplifier, although manufacturer's notes will vary in their opinion of the IC. For example, most op amps are listed by their makers as being 'high performance'. Many are also shown as 'low noise', and an actual noise figure is the only way to determine if that amplifier is a true low noise device. Different terminology is often used by manufacturers, for example the proprietary term 'BIFET' refers to an op amp that uses both FETs and bipolar transistors. Some amplifiers are listed as being suitable for use with a single rail supply, and have a different circuit configuration to those listed as dual supply only. However, any op amp can be used with a single supply with voltage divider biasing at the input.

Type	Description	Av (min) V/mV	Slew rate V/µs	BW (Av=1) MHz	Ibias (max) nA	Vs V ± min	± max	Is (max) MA
LM301	General purpose — controllable	25	0.5	1	250	5	18	3
741	General purpose audio	20	0.5	1	500	3	18	2.8
TI071	Low noise JFET input	50	13	3	0.2	5	18	2.5
LF351	JFET input	25	13	4	0.2	5	18	3.4
CA3130	MOSFET input-ext comp	50	10	4	0.5		8	15
CA3140	MOSFET input-int comp	20	9	4.5	0.5		18	5.5
NE5534	Low noise — high performance	25	13	10	1500	3	22	8
TL072	Dual TL071	25	13	4	0.2	5	18	5
LF353	Dual LF351	25	13	4	0.2	5	18	6.5
MC1458	Dual 741 — no offset	20	0.8	1.1	500	3	18	6.6
MC4558	Dual general purpose	20	3	1.5	500	3	18	6.6
LM833	Low noise — audio (dual)	30	5	9	1000	5	18	8
NE5532	Dual low noise — high perf.	25	9	10	800	3	20	16
TL074	Quad TL071	25	13	3	0.2	5	18	10
LM324	Quad general purpose	25	0.5	1	250	1.5	16	1.2
LF347	Quad LF351	25	13	4	0.2	5	18	11
RC4136	Quad — similar to 741	20	1	3	500	4	18	13.7
TL075	JFET input Quad 071	25	13	3	0.2	3.5	18	10
LM3900	Quad Norton	1.2	0.5	2.5	200	+4.5	+32	10

Notes:

(1) The TL06, 07 and 08 series are all pin compatible. The 08 series is the standard, the 07 the low noise version, and the 06 series the low power types, in which the supply current is 10% of the 07 and 08 types.

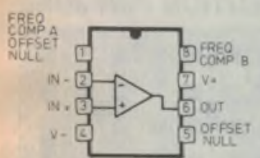
(2) The supply current shown for each type is that required by the IC – not individual amplifiers in the IC.

(3) The input resistance of the LM5532 and LM5534 is very low; minimum specification is 30k ohms.

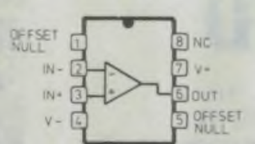
(4) The differential input voltage should never exceed the supply voltage.

(5) In most cases the output voltage swing is within 2 volts of the supply rail.

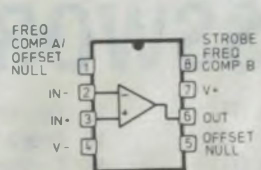
(6) Both the comparator types shown are open-collector and require a pull up resistor.



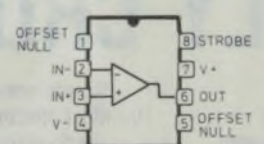
LM301, TL060
TL070, TL080



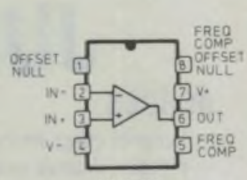
741, TL061, TL071,
TL081, LF351



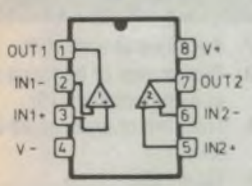
CA3130



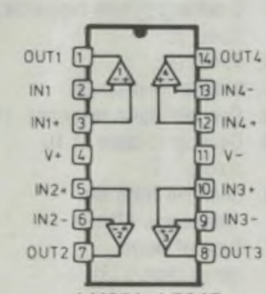
CA3140



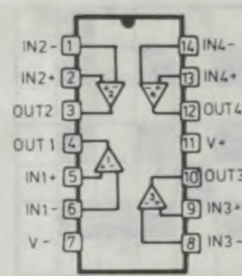
NE5534



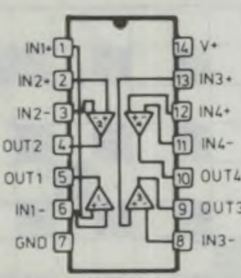
TL062, TL072, TL082
LF353, LM833, MC1458,
MC4458, NE5532



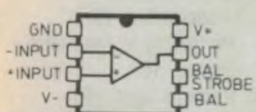
LM324, LF347
TL064, TL074, TL084



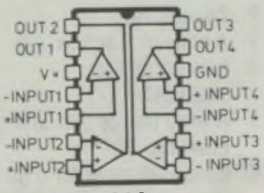
4136,
TL075, TL085



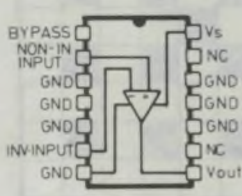
LM3900



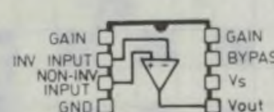
LM311 VOLTAGE
COMPARATOR



LM339
COMPARATOR



LM380 AUDIO
POWER AMP



LM386 LOW POWER
AUDIO AMPLIFIER

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RADIO AND HOBBIES IN AUSTRALIA

July 1939

Simple transmitters assist fire fighters: The use of portable radios for fighting bushfires has been recently tested in Victoria with small, light, portable receiving and transmitting sets.

The sets can because of their lightness be carried on forest officers' backs. They weigh only 15lb, and are about 6 inches by 6 inches by 1 foot in size.

They are equipped with collapsible 'fishing rod' aerials and strung wire aerials, suitable for most terrain.

Their range is 26 miles for speech and 100 miles for Morse, the latter being used when secrecy is necessary.

The Victorian scheme envisages the establishment of a central radio station with sub stations in various districts.

RADIO, TELEVISION and HOBBIES

July 1964

Scientific Fishing: The Fishing Laboratories of the Ministry of Agriculture and Fisheries at Lowestoft are to use a Marconi television camera to study the general behaviour and breeding habits of fish as a step towards understanding their movements and the way in which they may be caught. The equipment is the new Marconi Series 321 camera which is completely automatic in operation, the ON/OFF switch being the only control used in the entire channel once the equipment has been set up.

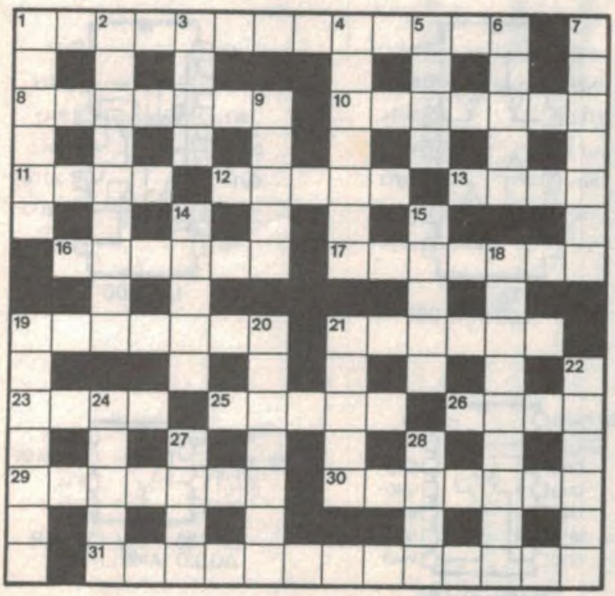
The camera can be inclosed with its control unit in a pressure casing at the bottom of the ocean; in all previous under-sea television work the camera control unit has been installed in a boat and has been connected by cable, and hence the maximum operating depth has been limited to about 1000 feet due to the delay imposed on the essential synchronising pulses which are generated in the control unit.

Magnetic disc: A new approach to radio spot announcement recording, involving a new concept in magnetic recording was recently introduced by Ampex Corporation at the National Association of Broadcasters Convention in Chicago.

Ampex demonstrated an engineering prototype of a new type of solid-state magnetic disc instead of tape reels.

According to B A Olerich, vice-president, Ampex international operations, the new discs can be produced at a low cost and duplicated in quantity without significant loss of fidelity, in contrast with the present common practice of transferring conventional disc recordings to tape cartridges.

JULY CROSSWORD



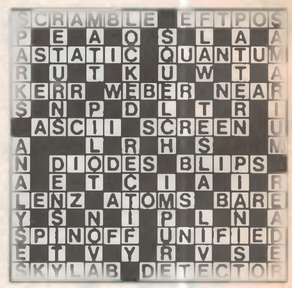
ACROSS

1. Name of effect where pressure induces potential difference. (13)
8. Region after which element 95 was named. (7)
10. Most effective (performance). (7)
11. Animal with antenna. (4)
12. Transient pulse. (5)
13. Connect. (4)
16. Quartz. (6)
17. Dissolved substances. (7)
19. Signal reflected by ionosphere. (3,4)
21. Discharges from high-energy state. (6)
23. Tone. (4)
25. Frequency unit. (5)
26. One with false response. (4)
29. Develop to state of 10 across. (7)
30. Changed from set frequency. (7)
31. Type of power generation. (13)

DOWN

1. State of matter. (6)
2. Charge. (9)
3. A state of 8 across. (4)
4. Inventor of the radiometer. (7)
5. A fixed charge (per unit of quantity). (4)
6. Colloquial name for a group of musicians or hifi units. (5)
7. Passages of time. (7)
9. Designation of brightest star in a constellation. (5)
14. This kind of wave could be a bore. (5)
15. Timer. (5)
18. Silicon-controlled rectifier. (9)
19. Region of intense solar magnetism. (7)
20. Topical prefix coined from Greek word for amber. (7)
21. Old-fashioned, superseded. (5)
22. Pertaining to the metal iridium. (6)
24. Portable light. (5)
27. Flat (as are some batteries!). (4)
28. Element used in dry cell. (4)

SOLUTION FOR JUNE



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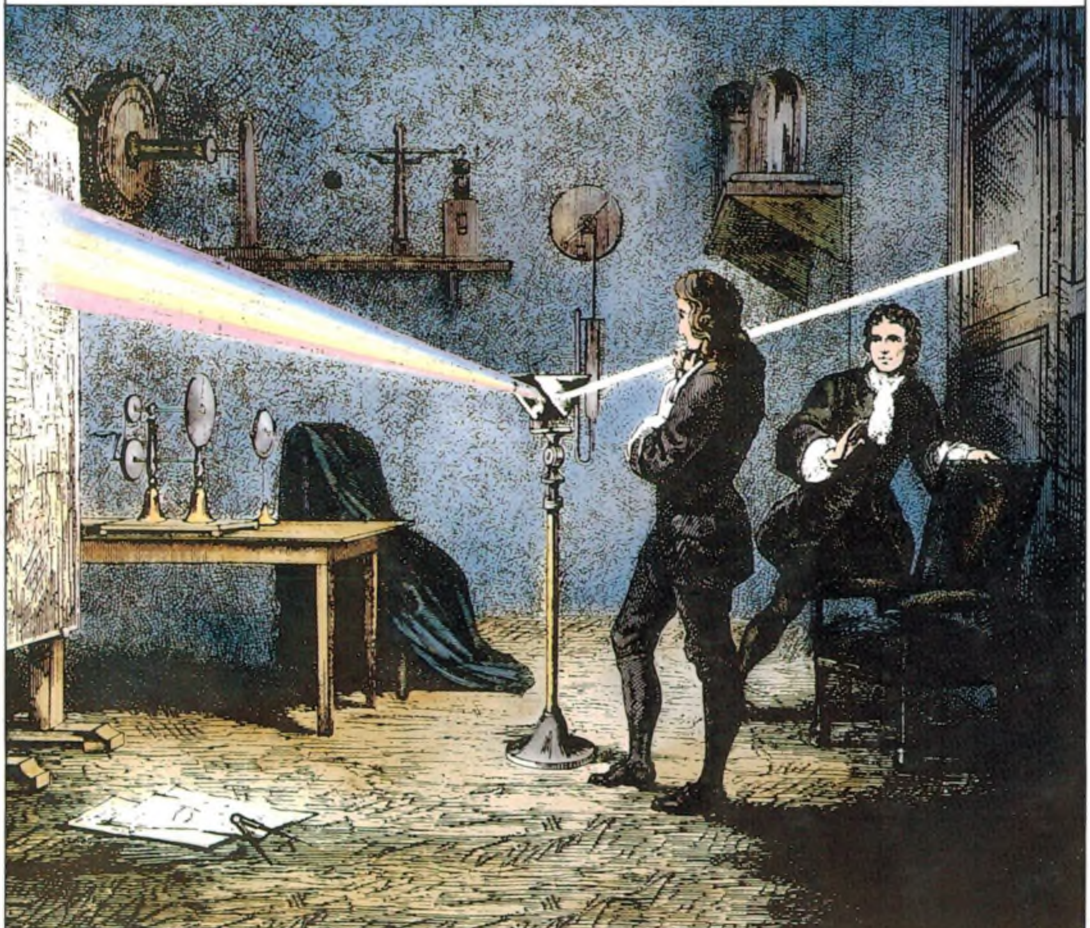

Newton refracts light through a glass prism, circa 1672. "The Bettmann Archive."

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