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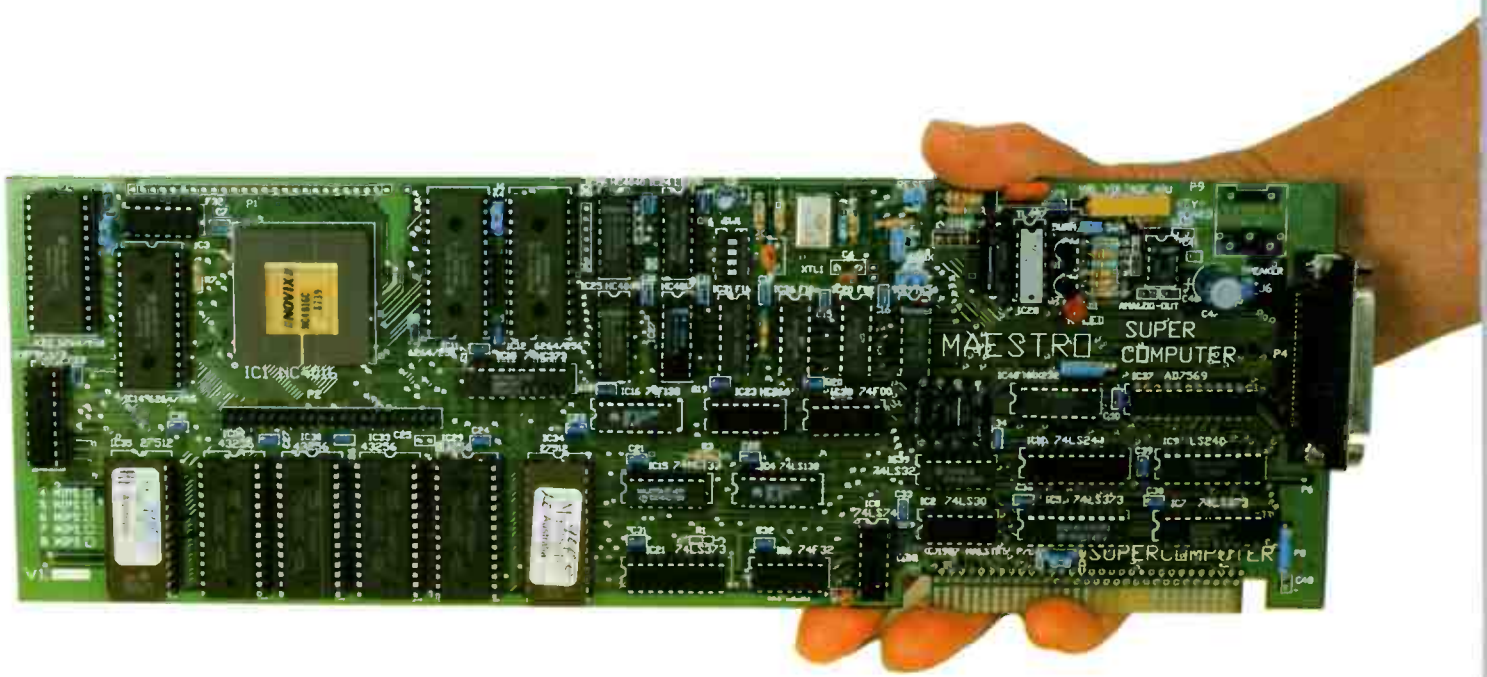

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AUSTRALIAN MADE

WELL, 1988 is shaping-up to be an exciting year from here! This issue we bring you, following strong reader demand, AEM3500 Listening Post software for IBM PCs and compatibles that enables you to decode radioteletype, Morse code and radio facsimile (FAX) transmissions picked-up on a shortwave communications receiver. By far the strongest demand is for the FAX facility, to receive and display or print the weather maps transmitted on FAX by the Bureau of Meteorology's stations AXM in Canberra and AXI in Darwin. The AEM3500, designed by well-known local author Tom Moffat and featured in our first issue, July 1985, has had an extraordinary reception from enthusiasts of all sorts. Project kits still enjoy healthy sales. It's an innovative concept in a project, and we're proud to have brought it to you.

Talking of innovative concepts, this month we get down to the nuts-and-bolts of building the long-mooted Novix "Supermicro" project from the Darling brothers of Maestro. This project is certainly innovative in concept and seems set to encourage constructors to be innovative in adapting it to various applications. We eagerly look forward to find out just where it leads us all – and it has been deliberately designed to encourage constructor feedback.

And while we're on the subject of innovation, we bring you this month what we believe to be the first magazine project designed in Australia featuring surface mount assembly technology.

As I said, 1988 is shaping up to be a good year!

Roger Harrison
Editor

WE HAVE MOVED!

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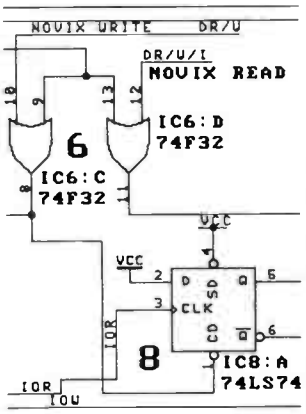

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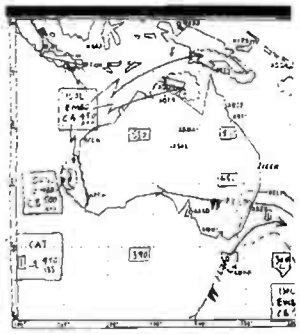

RADFAX – A Program to Decode Radio FAX, Radioteletype and Morse Code with your IBM PC or Compatible 76

By popular request – here's a program to use with our phenomenally popular AEM3500 Listening Post project.

AEM PRODUCT REVIEW The Roland SYA-350 Buffer 95

Aimed squarely at the CAD market, this unique product has some very desirable features.

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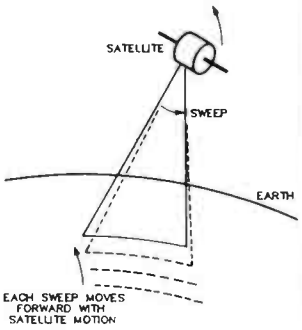
COMMUNICATIONS SCENE



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Use your IBM PC or Compatible to Decode FAX, RTTY and Morse 76

Now you can use our very popular AEM3500 Listening Post project with IBM-style computers.

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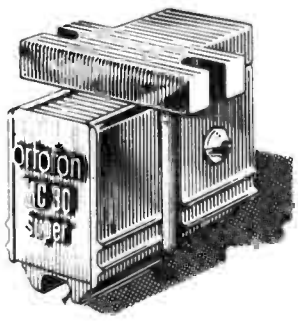

AEM HI-FI REVIEW The Ortofon MC30 Super Cartridge 22

Ortofon has a long and honorable history in the field of high quality sound recording and reproduction. Their earlier MC10 and MC20 cartridges have been well received by overseas reviewers. Bob Fitzell reviews their top cartridge in this range.

Video Joins the Audio on Compact Disc 24

CD-Video was "launched" here in December last and CD-Video players are expected to go on sale sometime this year. Here's a run-down on the gear and the medium predicted not only to boost CD sales, but to bring software prices tumbling down.

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NEXT MONTH!

ASSEMBLING YOUR WEATHER SATELLITE GROUND STATION

Here's advice on how to get it all together, from the antenna on down.

If you've been following our series of space science projects, you won't want to miss this issue!

HOW TO EVALUATE AND SELECT AN OSCILLOSCOPE

Looking around to buy an oscilloscope? You shouldn't miss this! No matter whether your need is for a low-cost, low frequency CRO, or for a sophisticated "no expense spared" instrument – our feature covers the ground rules.

BUILD OUR FM "MINDER" BUG!

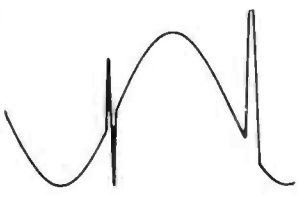
This project is a low power FM transmitter that picks up sounds from nearby wherever it is placed. It is received on any FM broadcast receiver. Use it as a baby "minder" – you can listen-in on the baby sleeping while from another room. Use it as a pool "minder" – placed near the pool, you can keep an ear on the "action" from inside the house.

A SHORTWAVE ANTENNA FOR FLAT DWELLERS

Here's a simple to build, low cost antenna that is easily erected on a window ledge of a flat or unit.

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

FEATURE



Smoothing-out the "Ruffles" on the Mains 8

How to get your electronic and computer gear to cope with spikes, hash, surges and sags.

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Special Broadcasting Service now available unencoded from AUSSAT

The Government ended the encoding of SBS transmissions via AUSSAT on the evening of December 2nd last, permitting owners of small domestic B-MAC satellite receivers in the South Eastern zone of Australia (see map) to receive SBS programs.

People in these areas can already receive ABC programs under the Homestead and Community Broadcasting Satellite Service (HACBSS).

The action also allows people with domestic B-MAC receivers to receive SBS radio programs transmitted by stations 2EA and 3EA, as the SBS recently commenced distributing these radio services by satellite.

The SBS has been using an AUSSAT satellite to distribute programs to its terrestrial transmitters in South Eastern Australia and Perth.

This signal was not actually designed for reception by HACBSS-type receivers, and when it was started in March 1986, the decision was taken to encode the signal as it was though that it would not provide a suitable quality for regional reception.

The B-MAC system has, however, performed even better than originally anticipated, which paved the way for lifting the encoding.

The SBS signal is of lower power than the ABC signal which may at times be affected by heavy cloud or rain. The Minister's statement said, however, that it should provide an acceptable picture at most times in the south east.

The start of unencoded transmissions will not affect the existing terrestrial capital city SBS transmissions, the statement said.

Communities in the target region can set up facilities to receive and locally re-transmit the SBS signal. This is said to be often more cost-effective for communities than the purchase of individual satellite receivers, and permits high quality reception.

The licensee for the Remote Commercial Television Service for the South Eastern zone surrendered its licence on 22nd October.

PC88 moves to March

The PC88, Office Technology 88 and Communications 88 shows will now be held over 20-23 March, not 7-10 February, according to the organisers, Australian Exhibition Services.

The hat-trick event will be held at the new Darling Harbour complex in the same halls booked for the earlier date.

The organisers felt there were risks associated with being the first tenant, and doubts about the availability of all services.

Pacific to be ringed by cables

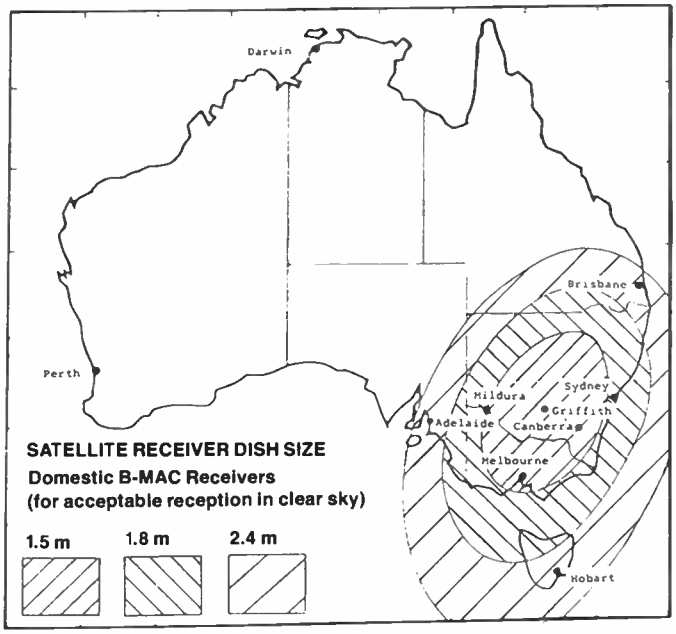
Standard Telephones and Cables P/L and the Overseas Telecommunications Commission signed an agreement on 17 December last to begin work on the TASMAN-2 submarine cable to run between Sydney in Australia and Auckland in New Zealand.

This cable represents phase one of a three-phase plan by OTC to ring the Pacific Ocean with undersea cables, eventually spreading to Hawaii and the US mainland, and to Guam to the north of us, and thence to Japan.

This cable will be an optic-fibre type and STC and its Alcatel member-company, Submarcom, have formed a new company, the Tasman Cable Company (TCC), to manufacture the cable.

The cable will be completed by 1991, the ringing of the Pacific by 1995. The cable repeaters will be made in Australia at STC's existing super clean assembly area at Liverpool in Sydney, while terminal equipment will be built in New Zealand, bringing Australasian participation to 70 per cent, according to the news release.

The Australian Industry Development Commission has invested $10.6 million in TCC. The project is valued at $160 million.



COVERAGE OF SBS SATELLITE TRANSMISSIONS

China to make flat-square TV tubes

A joint venture between Philips and Jiangsu Province in the People's Republic of China will see Philips' flat-square TV tube technology being produced there in mid-1990, with full production to be reached by 1994. Building work will start in 1988.

The factory, to be built at the premises of the China National Huadong electronic tube factory in Nanjing, will have a capacity of 1.6 million tubes per year. About 40 Philips engineers will be temporarily based in Nanjing to transfer know-how and to start up production.

Currently, Philips has joint ventures in China for the production of car radios and radio cassette recorders. Laser optical systems will be manufactured in China next year.

STRONG GROWTH IN SURFACE MOUNT TECHNOLOGY

Surface mount technology (SMT) is enjoying strong growth at present, according to a US-published directory from Info-mation Inc.

The number and type of SMT components has grown some 30 per cent since 1986. Passive SMT components grew the most in 197, there being an increase of 60 per cent. There were 40 per cent more discrete components and 23 per cent more ICs since 1986, says Info-mation.

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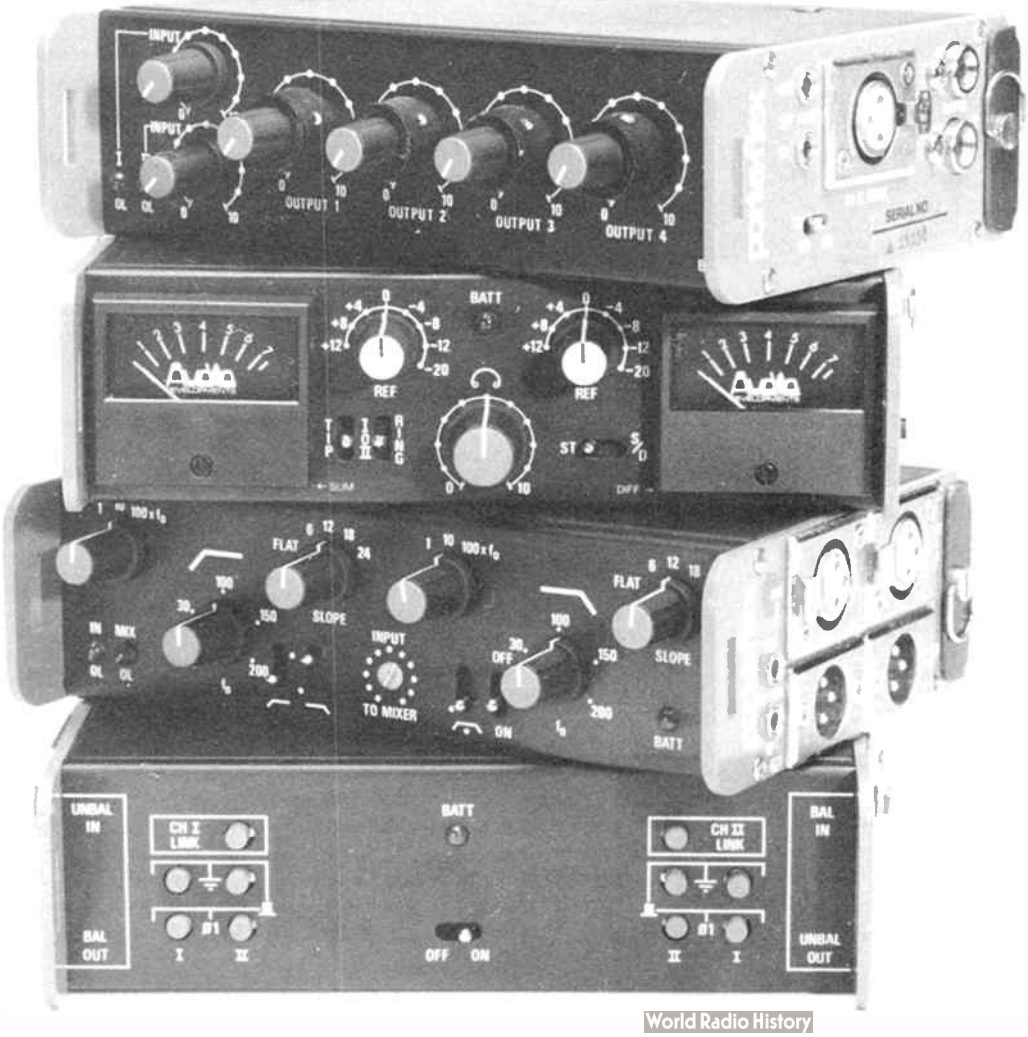

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Smoothing-out the "ruffles" in the mains

Roger Harrison

The 240 Vac mains supply is by no means a "pure" supply source, being plagued by problems that go under various colourful names, such as "spikes", "hash", "surges", "sags", "brownouts" and the like. It all sounds like jargon used by the punks in the "Mad Max" movies. This article de-mystifies the jargon, explains the causes and explores the cures.

AUDIO AND SHORTWAVE enthusiasts have long known of the problems caused by "noise" of various sorts borne on the mains supply. So have the army of TV watchers. Clicks, "plops" and prolonged "bzzzt" sounds overriding the audio output of a stereo, shortwave receiver or television set (in the latter case, also generally accompanied by interference to the picture) are a familiar chorus.

When personal computers came along, the effects of mains-borne interferences appeared in more subtle, but nonetheless noticeable ways – often with disastrous consequences. The spontaneous re-boot (re-starting) of the computer, as if it had been momentarily turned off and on again, is a familiar malady. Noise on the mains may corrupt data held in memory or, worse still, it may corrupt data being written to a floppy disk. In the latter case, corruption of the system tracks, where information about the location of files on the disk is stored, can render the data on the floppy disk inaccessible. If such a disaster befalls a hard disk, containing many megabytes of data, and the "root directory" - containing data on the organisation of the disk and location of files – is corrupted, brother, you're in real trouble!

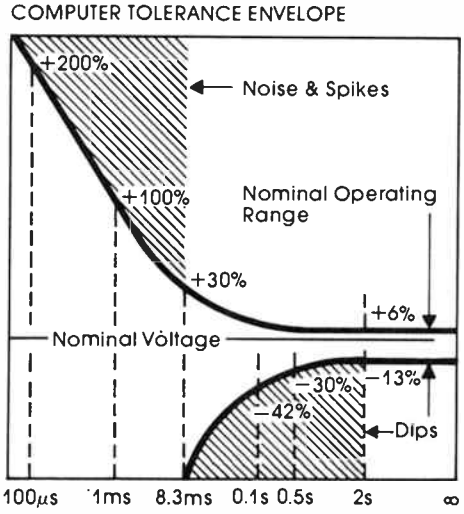
The mains supply is hardly pure, or constant for that matter. A whole spectrum of problems is encountered, ranging from intermittent, short-term effects, to longer-term variations – voltage increases and decreases, through to complete loss of supply. Before we get to the cures, we need to get a grasp of the problems, their causes and effects.

The supply parameters

The supply authorities, and their local distributor, while providing no guarantees, undertake to provide a supply of nominally 240 V, 50 Hz ac within certain tolerance limits.

In New South Wales, for example, the Electricity Commission (Elcom) has a statutory requirement to maintain the supply voltage to the local councils, who distribute to consumers, within ±6%, according to an assistant control engineer I spoke to. Generally, he says, they maintain the supply within ±2%. Now, with local distribution, a variety of factors like distance from the substation, nature of the load etc, the supply may vary from the nominal 240 volts by as much as ±10%. This means that, at your power point, the nominal supply voltage may lie in the range from 216 to 264 volts, although the distributors attempt to maintain the supply within 220 to 255 volts (i.e: about +6%, –8%). In addition, whatever your nominal supply voltage happens to be, the typical variation on that may be some ±2%

The supply voltage will normally vary somewhat throughout the day and during the week, depending on the typical pattern of load demand. Although the tolerance variations at each stage of the supply distribution are not necessarily additive, at your power point the voltage may "sink" as low as 210-215 volts, or rise to as much as 260-265 volts, but these should be considered extremes.



The British Computer Business Manufacturers Association (CEBMA) developed this "computer tolerance envelope" which defines the voltage limits within which computer equipment will operate reliably. The shaded portions shows the problem areas.

Frequency tolerance specifications are quite "tight" as the mains is widely used as a timing reference for clocks (particularly "bundy" clocks in factories) and a legion of automated or semi-automated time-controlled equipment. The frequency is nominally maintained within ± one-tenth of a Hertz. Infrequent disturbances, such as loss of a generator and the necessary bringing on-line of a backup, may cause the frequency to drop to 49.3 or 49.4 Hz, I was told. When this happens, the generator operators will follow with an over-frequency correction for a period to bring the clocks back on time. Generally, the engineer intimated, Elcom maintains clocks within two seconds a month.

So much for the basic specification. Looking at the supply from your end, what do you see? Let's work our way from the longer-term variations through to the short-term transients.

Undervoltage

Often referred to as a "brownout", this is an effect where the mains voltage drops substantially so that it falls below the lower limit of the mains tolerance for an extended period that may last some minutes to hours. Here, a substantial drop may mean some 20% below the nominal 240 V. You could hardly regard 190 V as adequate supply.

This can cause power supplies to misfunction – regulators fail to do their job in linear supplies, for example, and the supply rails within the equipment will show a ripple component that may affect its function – showing up as hum or buzz in an audio system, "shrunken" pictures on TV sets, etc.

A computer system with inadequate supply rail in these circumstances may simply fail to function – and "crash". For-

World Radio History

tunately, so many computers these days incorporate switched-mode power supplies which happily operate over a very wide range of input voltage and brownouts don't seem to be the trouble they once were.

Overvoltage

This is clearly the opposite situation, where the supply may rise a substantial amount (again, say, 20%) from the nominal 240 V, and sit above the upper limit for a period of some minutes to hours. This can stress power supplies which must dissipate the unwanted extra energy. Overheating and subsequent failure may be the result. Filter capacitors have been known to explode, showering adjacent components with corrosive liquid electrolyte! Fortunately, this situation is much less frequently met than undervoltage.

Both undervoltage and overvoltage conditions are readily detected with a good multimeter, either analogue or digital – but it's not a safe idea to "stick the probes in a power socket"! If ever you need to check the mains voltage, it should always be done by attaching the multimeter at the input to the power supply of the equipment, with the mains cord unplugged, and using insulated safety clip-on connectors.

Sags

A drop of at least 20% from the nominal supply voltage, lasting one or more cycles up to a few seconds duration, is termed a "sag". This sort of disturbance often results from a heavy load being turned on – such as a refrigerator or air conditioner compressor, electric heater, etc. The load may be nearby, within your premises and connected to your mains circuit, or it may be external.

Consequences are much the same as for undervoltage, only of much briefer duration.

Surges

A surge is a brief overvoltage condition that, like a sag, lasts a few cycles to several seconds. Generally, surges occur immediately following a heavy load being switched off. Surges may also be caused by load switching on the distribution network and lightning strikes some distance away on the network.

Massive surges, lasting one or two cycles, do occur, though rarely. They can range from tens of volts to hundreds of volts and will result in some destructive effects at worst, or cause "glitches" in electronic equipment of all sorts, and particularly computing equipment.

Sags and surges cannot be detected with an ordinary general purpose multimeter. However, digital multimeters featuring a "peak hold" facility may be used to detect them. In general, special monitoring equipment is required that detects and records such events.

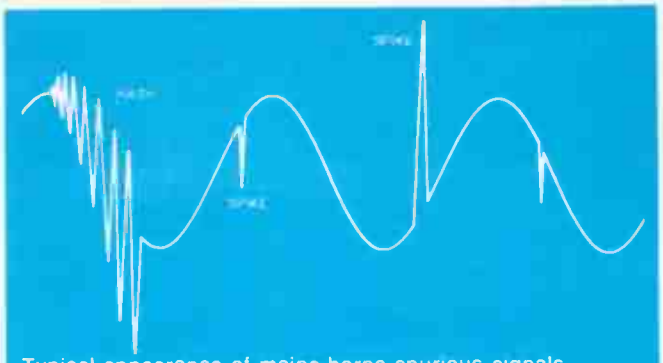
LOCAL MANUFACTURER BREAKS THE U.S. MARKET

Sydney-based Clean Line Systems Pty Ltd will soon be exporting their innovative power management systems to the US following a recent massive injection of funds from Oilmet Investments and the addition of some $1.4 million of their own venture capital. The market for power line management product in America is estimated at US$1.5 billion and Clean Line is confident of capturing at least 5% of this potential.

Spikes and hash are constantly evident on the mains, surges and sags occur, on average, twice a week and complete loss of power can be expected once every two months.

Protecting computer systems against the problems these "ruffles" can generate is mandatory in professional installations. Clean Line Systems' power management systems control the daily highs and lows, eliminate noise and provide continued supply during mains failure.

Clean Line Systems claim an estimated 40% share of the local market for these products. Most of this business has been generated through OEM contracts with firms like DEC and Wang, the company claims. With the new export thrust, they expect last year's $3.5 million turnover to reach $25 million by 1990.



Typical appearance of mains-borne spurious signals. 'Spikes' are generally non-repetitive or one-off events, but can sometimes appear at regular intervals. Spikes are generally high speed and of short duration, and hence have a considerable high frequency contents. 'Hash' is a repetitive type signal and will have a very broad spectrum.

Dropouts

When the mains voltage drops to zero for a period lasting from something less than half a cycle to a full cycle or so, it is called a "dropout". Such events are rarely evident on TV or computer screens, nor do they affect lighting, but a power supply running at or near maximum load may experience a short duration voltage-drop pulse.

Such pulses can really play havoc with logic circuitry, particularly microprocessor equipment, depending on the time relationship between the dropout and internal circuit operations. Ever experienced a "spontaneous reset" on a personal computer? The result can range from minor irritations like loss of a small amount of work in progress, through to destruction of the directory or system tracks on a disk – could be important!. On a compact disk player, for example, it may result in track skipping or restarting play from track one; irritating at the least.

Hash

High frequency signals, with components ranging from as low as 100 Hz right up to tens of kHz, that may be repetitive or seemingly random in form (more like noise) are referred to as "hash". Such signals may be of short duration, a burst of a second or two, bursts of varying duration following in a sequence, or long bursts of minutes to tens of minutes duration.

The brief "bzzzt" you hear from your stereo or on your TV sound for a moment when a faulty light or power switch is operated; the harsh, annoying "baaaartt" that emanates from your stereo or TV (accompanied by flickering lines across the screen) when the Bamix is being used in the kitchen, or when the electric drill is being used next door – that's hash!

Electric motors that employ a commutator – as in the examples of the electric drill and Bamix, generate hash. It arises from the switching action of the commutator, where current is switched to successive coils in the rotor of the motor as it rotates; the commutator is merely a rotary switch. It is the switching action and the resultant tiny arcs that generate the hash signal. The noise voltage generated may range from a volt or so, to tens of volts – and it's superimposed on the mains, propagating back down the line to which the appliance is connected.

Hash is a very common component of the mains supply.

Transients

Strictly speaking, a transient is any momentary, non-repetitive event, so that dropouts, surges and sags could really be ▷

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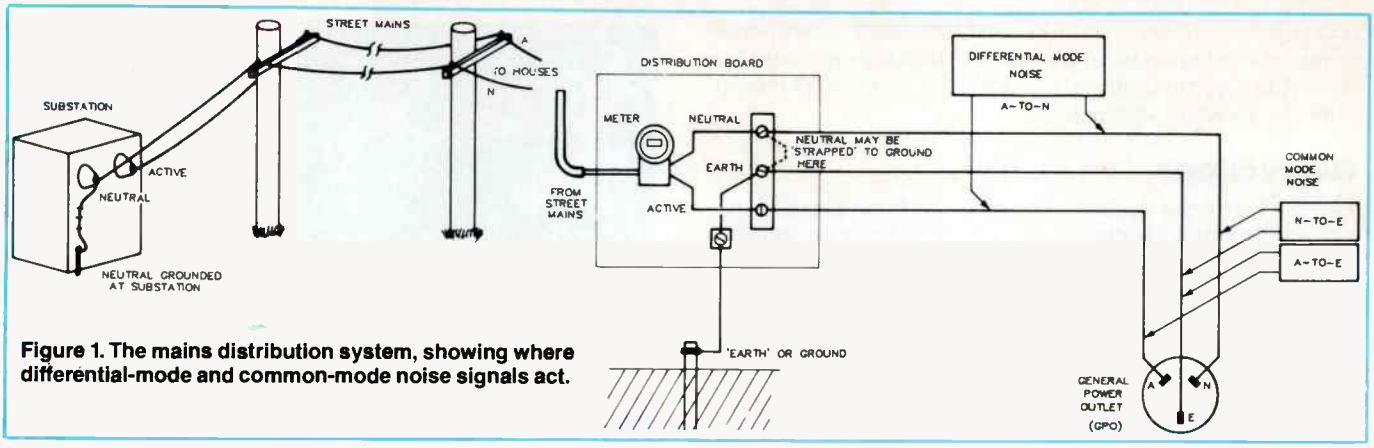

Figure 1. The mains distribution system, showing where differential-mode and common-mode noise signals act.

included as transients. However, if we accept transients as short term (lasting half a cycle or less), more or less "one-off" events, even if such events recur over short, but randomly spaced, intervals, then surges and sags etc do not come under the category of transients.

Transient voltage pulses may be termed variously "spikes", "glitches" or "impulses". They may be a single, narrow pulse or a rapidly decaying oscillation. Their duration may be as short as a few nanoseconds, ranging up to as much as 10 ms – half a cycle. Amplitudes may range from tens of volts to hundreds of volts. If the pulse is positive-going and occurs at or near the peak of the positive half-cycle of the mains, then a tremendously high – and potentially very destructive – voltage peak is generated.

Although the amount of energy contained in such peaks may be relatively low, it is often responsible for causing "punch through" in the dielectric of capacitors used in linear and switched-mode power supplies. While this may not be destructive in itself as modern metallised capacitors have the ability to absorb the transient at the punch-through point by vaporising the surrounding metallisation, some "erosion" takes place with the effect from repeated transients and the capacitor eventually fails.

In a similar way, such transients can cause punch through of the dielectric in mains transformers, causing or contributing to ultimate failure. They can destroy rectifier diodes and regulators in power supplies, disturb logic circuitry and microcomputers in much the same way as dropouts, etc. What a pain!

Like hash, transients are a very common occurrence on the mains.

Power failure

Lastly, there's total supply failure! That means – no power for an unspecified period, ranging from minutes to many hours.

The effects are largely predictable – just turn off your equipment sometime and see what happens!

Just how does it act?

We can readily see how the longer-term effects, like surges and sags, under and over voltage, all affect an item of equipment, but just how do hash signals and spikes enter a piece of equipment? To find out, let us first look at the mains distribution system, as shown in Figure 1 here.

A pair of wires enters your house from the street (in the case of single phase supply, for argument's sake). These come from the output of a transformer at your local substation. The power is delivered between the "active" line and the "neutral" line, entering your premises via a consumption meter located at the "distribution board" on your house.

The third connection on your power outlets is "earth", which is there as a safety measure. Ideally, earth and neutral are the same, but ideal situations rarely exist. Now, the earth connection is usually made to neutral at the local substation. The earth line on your distribution board may go to an earth connection at your premises (either a water pipe or a rod hammered into the ground at the house) and/or be strapped to the neutral line at the tiepoint on your distribution board. The earth is there so that faults do not render the metal housing of electrically operated equipment "live" (and we don't have the scope here to develop that situation further).

Now fluctuations, or noise, on the mains appears as a **differential-mode** signal, **present between active and neutral** - the mains voltage itself is a differential mode signal – or it will be a **common-mode** signal appearing **between both active and neutral together, and earth.** Some examples will clear up the distinction.

When the compressor in an airconditioner shuts off, the magnetic energy in the coils of the motor collapses, generating a substantial voltage which will arc across the switch or relay contacts controlling the compressor. Now, the current was in the process of flowing between active and neutral and so it is between the active and neutral lines that the noise generated by the arcing will appear – a *differential-mode* signal.

Sags and surges are differential-mode signals, just as dropouts and brownouts are.

When hot, dry winds blow in the summer months, they often carry charged dust particles which, on blowing past the distribution lines reticulating the power throughout your neighborhood, will dissipate their charge via the power lines, generating a noise voltage acting between active/neutral and ground. Similarly, during electrical storms, atmospheric discharges involving the power lines will likely dissipate via the active and neutral lines together as they travel together. So a lightning-induced pulse on the mains supply is typically a common-mode signal.

In addition, the earth line may also be a culprit because stray capacitance between the it and the other two lines will induce noise currents in the earth line, which has a finite

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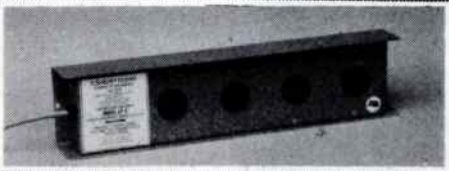

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impedance, and noise signals will appear on the mains earth line.

Attacking the problems

As the problems vary widely in characteristics, it requires different techniques to remove them before they can affect an item of equipment. In addition, some problems can be tolerated, whereas others have a major effect. For example, the occasional click emanating from a TV or stereo sound system is tolerable, but where it causes re-boots in a computer system, it's a danger. Again, the occasional sag in the mains will only have a passing and quite tolerable effect on a TV set (a momentary picture shrink), but it may cause a computer system to crash!

It may seem I'm a little preoccupied with the effects of mains "ruffles" on computer systems – well, I am. With the examples I have included, it is apparent that their effects can be severe. In some instances, recovery is impossible and permanent data loss results. The frustration and time delay occasioned by "down time" following a system crash, even if relatively infrequent, can be avoided.

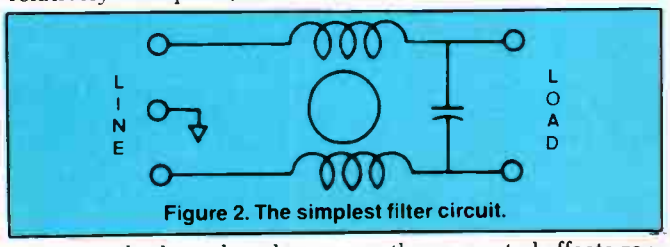

Figure 2. The simplest filter circuit.

One method employed to escape the unwanted effects generated by other equipment connected to the same power circuit is to install a "dedicated line". This is a line run from the distribution board to the equipment, from which no other equipment is powered. Thus problems produced by air conditioners, motors and such like – which tend to affect only the mains circuit to which they are connected, can be eliminated from that line. Such lines cannot, of course, prevent mains variations arising external to the premises from affecting the attached equipment.

Special "isolation" transformers are sometimes employed, generally in an item of equipment, but occasionally as an in-line unit. These are specially constructed transformers which incorporate "Faraday shielding" between the primary and secondary. This is a layer of foil that virtually eliminates capacitive coupling between the windings. They can be very effective in reducing common-mode noise, but have several drawbacks. The have poor output regulation, and in the presence of spikes, the output transient can be larger than the input!

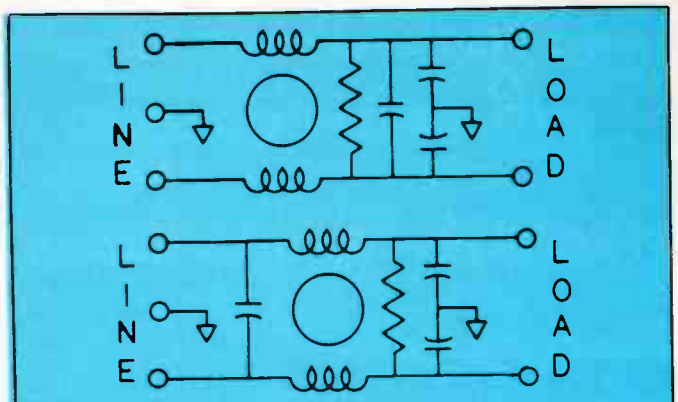

Figure 3. Variations on the simple filter circuit. Additional capacitors from the active and neutral lines to earth effectively places an LC filter in each line providing additional bypassing of common-mode signals. The resistor is there to discharge the capacitors following switch-off if no other discharge path (e.g: through a mains transformer primary) is available.

Filters

By far the most common problems encountered are induced by spikes and hash on the mains, and the widest employed method of dealing with these is the use of filters to attenuate their effects.

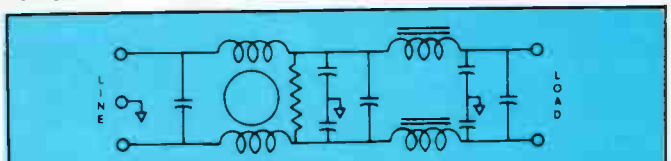

Figure 4. A two-stage filter for attenuating both common-mode and differential-mode signals.

Why can't you just have a filter to get rid of all differential-mode signals above 50 Hz? Well, you could, but such a filter would be impractical from a cost and constructional viewpoint. Capacitor and inductor values would be huge, as would their physical size and cost. In addition, a filter cannot affect the slow variations, such as surges, sags and brown-outs.

Fortunately, most noise signals that appear on the mains have a spectrum that starts well into the kilohertz region which allows components of a more reasonable value and ▷

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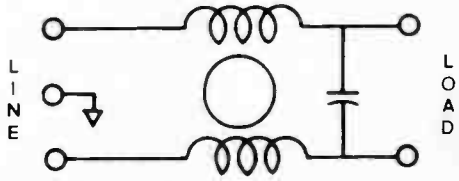

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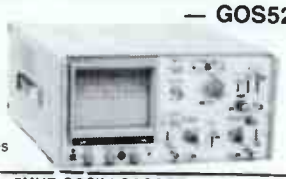

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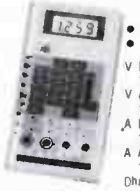

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cost.

The circuit of the simplest filters encountered is shown in Figure 2. It is simply an inductor in each line followed by a capacitor between the lines. It looks like a low pass filter, but the components act separately. The two inductors are wound on the same core and connected such that the magnetic field set up by the line current in the coil in the active line is opposite – and thus cancels – the magnetic field set up by the coil in the neutral line. This ensures that the core on which the inductors are wound will not saturate and thus we can obtain a relatively high inductance in a small space. The inductors are usually wound on a toroid, each winding on one half of the toroid which ensures maximum mutual coupling while keeping the windings physically separate.

As the mains is a differential-mode signal, the fields produced by the two coils resulting from *any other differential-mode signals will also cancel*, passing the signal straight through. Thus the coils are only effective on common-mode signals. The capacitor provides some "shunting" of differential-mode signals, but as the value is usually limited by other concerns its effect is limited to frequencies well into the 100s of kHz region. It's fundamentally an RF bypass.

Variations on this basic filter scheme are illustrated in Figure 3. Filters such as this may also be cascaded – where one filter follows another in the line, or they may be followed by a straightforward LC filter employing separate inductors, as illustrated in Figure 4. As would be apparent, the separate inductors, for practical reasons, will not have very high values and so only act on relatively high frequency signals.

Filters can be quite effective in dealing with the shorter period, high frequency mains disturbances but will have no influence on such problems as sags and surges. Much elec- ▷

SPIKE CLIPPERS

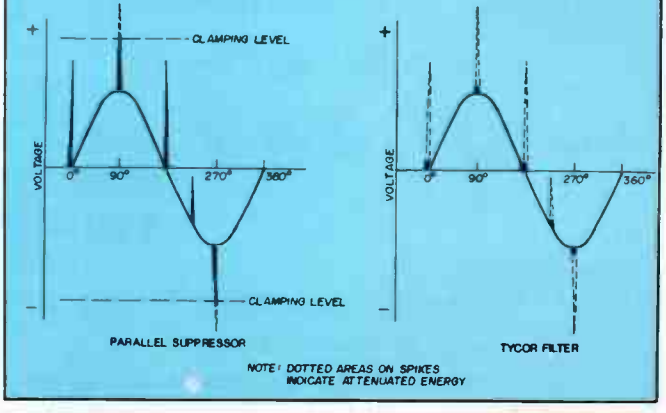
Large amplitude spikes, if they occur at or near the peak of the mains voltage cycle, can wreak considerable havoc, as explained in the main text. To combat the effect of such spikes, a device called a "Varistor" is used. Electrically, it looks like two hefty zener diodes connected cathode-to-cathode. It normally appears as a rather high impedance, but when its voltage threshold is exceeded, it draws current very rapidly and "clamps" the voltage at a fixed level.

Varistors are very fast-acting and capable of dissipating enormous amounts of energy for a brief period. Those rated for mains operation typically act at around 400 V, which is somewhat above the mains peak voltage (340 V for nominal 240 V mains). A Varistor is generally connected at the output of a filter, across the active and neutral lines. Sometimes, additional Varistors are placed from active to earth and neutral to earth.

Varistors are made in disc form by General Electric and Siemens and in typical semiconductor packages by Thomson-CSF, known as "Transil" transient suppressors.

While these devices clip any spikes that exceed the peak of the mains cycle, they will not affect substantial spikes that may occur near the zero crossing point. Such pulses can then be passed on to equipment incurring problems.

Canadian filter manufacturer, Tycor, has developed an electronic filter that clamps spikes no matter what amplitude or what position they occur during the mains cycle.



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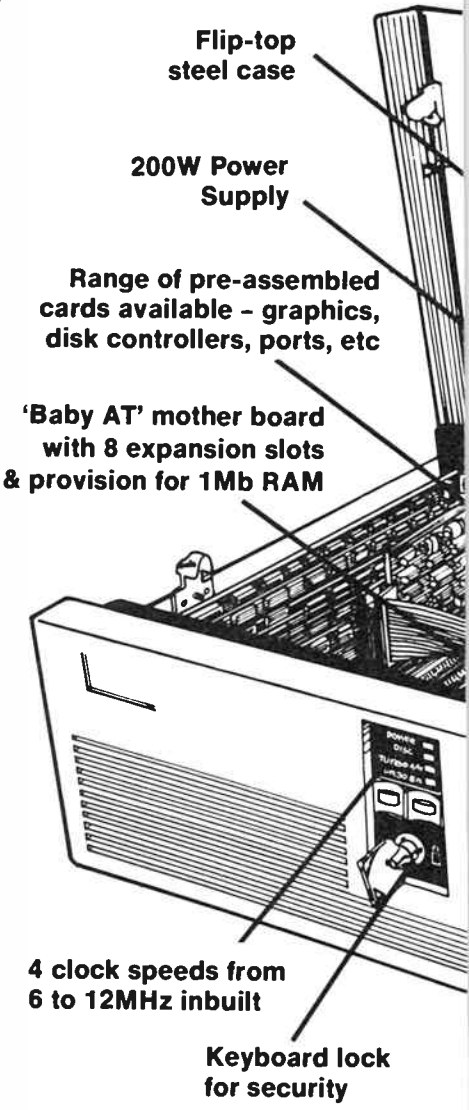

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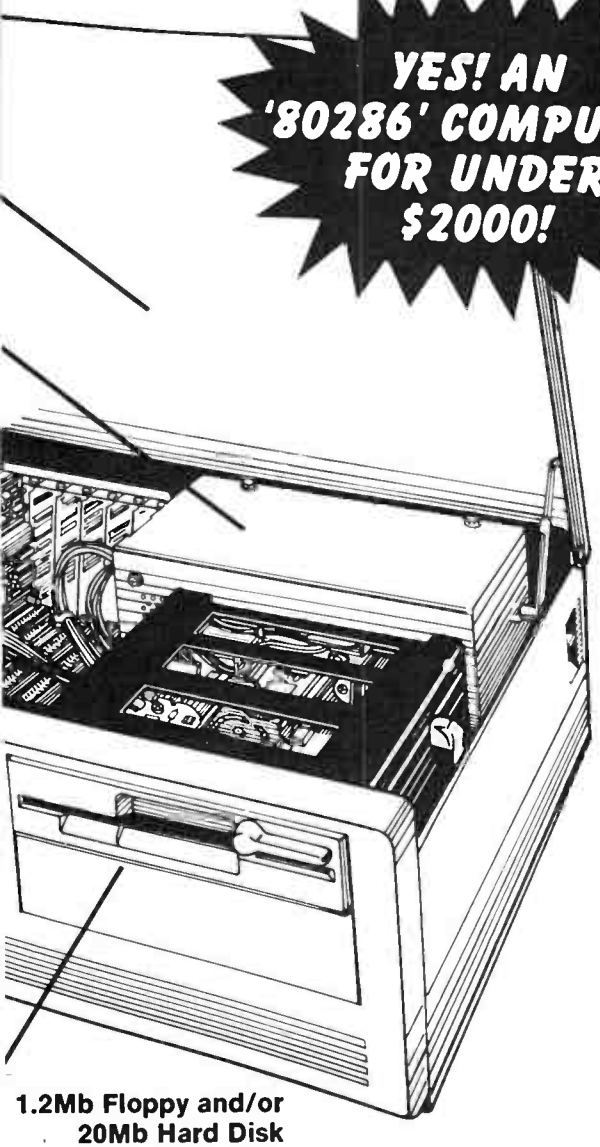

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Footprint just 430mm square, case covered in quality bone crinkle finish. Pre-drilled, slotted, etc as required, complete with front panel. Cat X-1005 — **$175**

200W Power Supply With enough capacity for full expansion, complete with whisper quiet fan, on/off switch and input/ output connectors. Cat X-1010 — **$275**

DISK CONTROLLERS:
Floppy Controller:- Up to 4 360K or 1.2Mb drives. Cat X-2014 — **$129**
Hard/Floppy Controller: Handles 2 of each hard/floppy. Cat X-2008 — **$399**

DISK DRIVES:
1.2Mb Floppy Disk Drive Complete with cables Cat X-2200 — **$269**
20Mb Hard Disk Complete with cables Cat X-2203 — **$795**

PLUG-IN CARDS:
CGA & Parallel Printer: Cat X-2010 — **$129**
MGA & Parallel Printer: Cat X-8141 — **$149**
EGA card with Hercules Compatability: Cat X-2013 — **$399**
Serial/Parallel/Game Port Card: Cat X-2012 — **$139**

KEYBOARDS
84 Key 'IBM' Format Cat X-3820 — **$129**
101 Key Expanded Style: (direction keys and extra function keys) Cat X-3821 — **$149**

MEMORY
Fast (120ns) top quality 41256 RAM chips. 9 required per 256K bank. Cat Z-9313 — **$10.95** (each):
Special price for 18 or more: — **$9.95** (each):

SPECIFICATIONS

Hard/Floppy Disk Controller:
Controls 1 or 2 hard disks
Ind. standard ST-506/ST-412 Interface
Up to 2048 cylinders
Up to 16 read/write heads
Data Transfer rate 5Mb/s

Controls 1 or 2 floppy disk drives
Interface similar to FD-55F minifloppy
Double density 320/360Kb or 160/180kb
High density 1.2Mb
Rated to work up to 12MHz

Graphics Cards:
MGA, CGA & EGA available

Ports:
Keyboard port on motherboard
Parallel, serial & game ports on interface
Monitor port on appropriate graphics card

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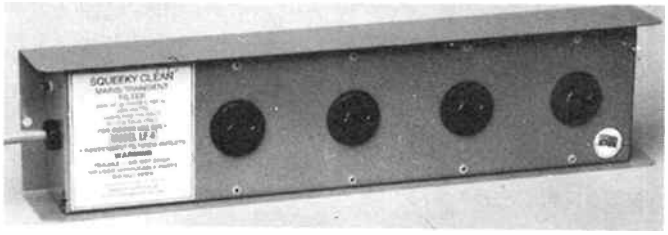
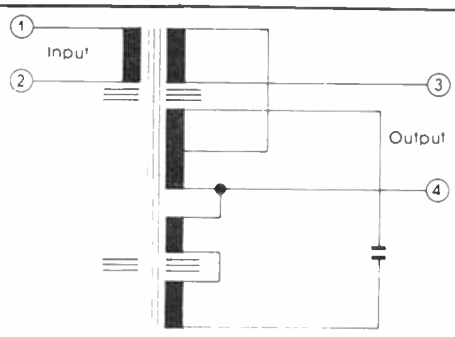


These "in-line" filters from local manufacturer, KCC, are sold under the name of "Squeeky Clean".

tronic equipment these days incorporate a filter at the mains input, often just as much to prevent noise getting from the equipment back onto the mains, as vice versa.

Filters are available as a component, meant to add-in to equipment, in a variety of forms – board mounting, in shield "cans" for chassis mounting, and such like. Mains filters are also available as in stand-alone, in-line form incorporated in a box with a line cord and plug input and one or more sockets on the output.



Typical circuit of a ferro-resonant constant voltage transformer (CVT).

Constant voltage transformers

Generally called CVTs, These have been used since the 1930s to deal with sags, surges and dropouts. There are two forms. One consists of a transformer where the primary coil operates in full saturation. The output is very nearly square wave, being a heavily clipped version of the sine wave input. The other type, termed a ferro-resonant transformer, also operates with a fully saturated primary, but the secondary consists of three or four windings with a special capacitor connected to "tune" the transformer. These have a sine wave output.

Both types provide protection against differential-mode disturbances, but offer no protection against common-mode noise. The simple saturating type offers little protection against dropouts, but the resonant type does because the resonating circuit is able to "fill in" the small gap of a dropout. The square wave output of the simple saturating CVT is not tolerated by the power supplies of some equipment.

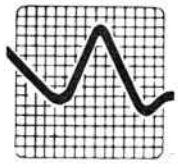
Typically, CVTs will maintain the output within ±3% or as close as ±1% for an input variation of ±15%. The CVT doesn't "stop" outside this range, but the maximum swing is practically limited to ±25%. They are designed to operate over a given load range, so must be selected for the equipment with which they are to be used. They are made in ratings ranging from a low 15 VA (that is, watts where the load is resistive) up to 10 kVA.

One variant of the resonant type combines the features of an isolation transformer, and these can give quite good protection against both common-mode and differential-mode fluctuations. However, should the load fall below 75% of the rating, they offer no protection.

CVTs generate considerable heat and audible noise during operation and this must be taken into account when considering their use.

So-called "line conditioners" generally consist of a ferro-resonant transformer combined with filtering and spike sup-▷

CAN YOU AFFORD NOT TO PROTECT YOUR COMPUTER?



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are estimated to cause up to 90% of all computer and word processor malfunctions

MOST
users do not realise their computer is under constant attack by dirty power

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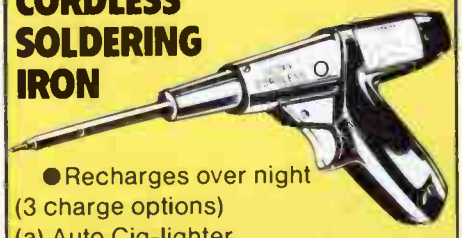

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Operates from car or tractor battery.
- Adjustable heat 200°– 500°C whilst soldering.
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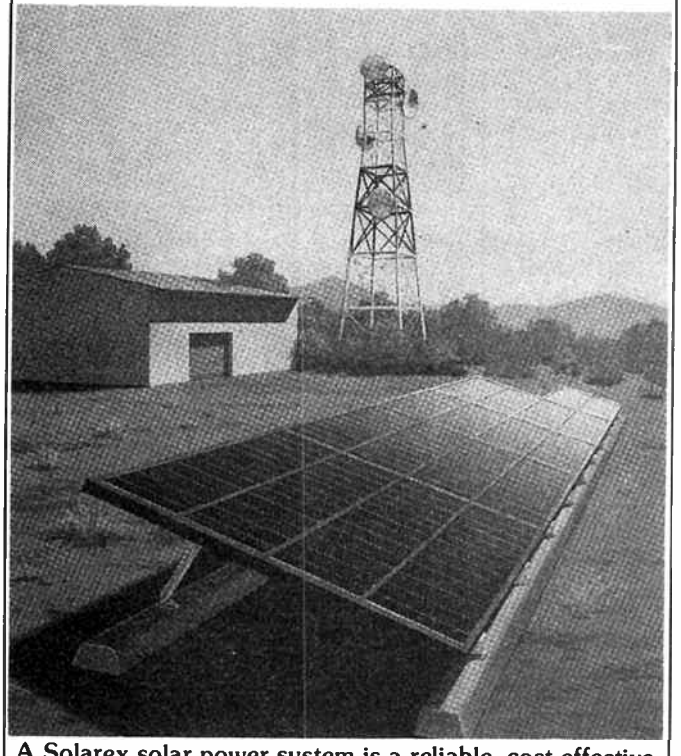
RELIABLE POWER FROM THE SUN

Solarex, world leaders in photovoltaic technology, manufacture solar power systems to operate reliably in the harshest climatic conditons that Australia has to offer. Whether it is in the Gibson Desert or on the summit of a Snowy Mountain Peak, the heart of a Solarex solar power supply system is a bank of Solarex Solartraction batteries providing a constant supply of electricity on demand.
Solarex solar power systems can be found all over the country maintaining Australia's links with the rest of the world. Remote microwave repeaters, radio links, satellite tracking stations, air and sea navigation aids are all powered by Solarex systems.



A Solarex solar power system is a reliable, cost effective means of producing DC power with the option of inverting to 240 volts AC 50 cycles if required.
All system components are manufactured in Australia and are thoroughly tested before leaving the factory to ensure a maximum trouble-free life with little or no maintenance. Solarex Pty. Limited is continually developing solar power systems not only for radio and telecommunications but also to provide power for remote homes, villages and for water pumping and irrigation.

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▷pression.

Uninterruptible supplies

As the name says, such supplies will maintain a continuous ac output when the ac mains supply is interrupted for a period. They comprise a battery-operated inverter, the battery charge being maintained while the ac mains is present, *but the equipment always draws its supply from the battery.* Clearly, this provides virtual total isolation from the mains.

An uninterruptible power supply (UPS) represents the ultimate in protection from mains-borne interference. They provide a well-regulated regulated sine wave output and will maintain supply in the absence of the mains for periods ranging from five minutes to an hour. Generally, overload protection is also provided.

They can be used over a wide range of loads, up to their design rating, and units intended to power one or two personal computers may be more economical than a line conditioner.

Uninterruptible supplies are made with ratings ranging from 150 VA (that is, watts when the load is resistive) right up to 250 kVA!

Conclusion

Clearly, when it comes to dealing with mains-borne interference, it's a matter of "horses for course" when looking for a solution. Cost and effectiveness must be weighed against the effects of occasional, but nonetheless existent, problems. With careful investigation and consideration, you'll find a solution.

This feature was prepared with the kind assistance of A.J. Distributors, Emona Instruments, Clean Line Systems, Electromark and J.A. Severn, to whom we are grateful for supplying information and material.

World Radio History

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DB25 CONNECTOR SPECIALS!

P10884	DE9P R A Plug	$3.65
P10885	DE9S R A Skt	$4.25
P10890	DA15P Male	$2.10
P10891	DA15S Female	$2.25
P10892	DA15C Cover	$1.25
P10894	DA15P R A Plug	$4.25
P10895	DA15S R A Skt	$5.00
P10900	DB25P Male	$1.00
P10901	DB25S Female	$1.20
P10902	DB25C Cover	$1.25
P10904	DB25P R A Plug	$4.50
P10905	DB25S R A Skt	$5.95

CRYSTAL SPECIALS!

These crystals were $4.90 each, this month they're only $2.00 each. Ten or more only $1.50 each!

Description	1-9	10+
4·194304 MHz	$2.00	$1.50
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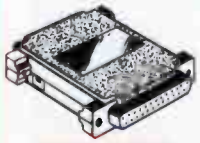


RS232 GENDER CHANGERS

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

Cat X15650 **Male to Male**
Cat X15651 **Male to Female**
Cat X15652 **Female to Female**
Normally $14.95 each
Only $9.95

DB15 GENDER CHANGERS

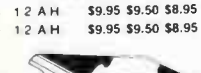
- Saves modifying or replacing non mating DB15 connections
- All 15 pins wired straight through

X15645: Male to male
X15646: Male to Female
X15647: Female to Female
..... **only $14.95**

DB9 GENDER CHANGERS

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

X15640: Male to male
X15641: Male to Female
X15642: Female to Female
..... **only $14.95**



NICADS!

Save a fortune on expensive throw away batteries with these quality Nicads and Rechargers!

Size	Desc.	1-9	10+	100+
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SUPER DELUXE BATTERY CHARGER

- Charges from 1 to 10 D, C, AA, AAA N, and up to 3 x 9V batteries at the same time
- Dual colour LED in first three compartments to designate 1·5V or 9V
- 240V AC/50Hz
- Approval No N10637

Cat M23525 ..... **$59.95**

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Always check our prices before you buy!

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V-20 8MHz	$14.95	$13.95	
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TEA2000	$11.95	$10.95	$9.95
ZN429	$9.95	$8.95	$7.95
ZNA234	$39.50	$37.50	$36.50
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2716	$9.95	$9.50	$8.95
2732	$8.95	$8.50	$7.95
2764	$7.95	$7.50	$6.95
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6264	$6.95	$6.50	$5.95
6802	$5.00	$4.00	$3.75
6821	$2.00	$1.80	$1.70
6845	$5.00	$4.00	$3.75
7406	$0.40	$0.30	$0.25
INS8250	$29.95	$27.95	
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AM/EF7910	$19.95	$18.95	
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741	$0.50	$0.45	

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Genuine Intel chips with manual and data sheets packed in boxes!

8087-3 (4·77MHz)	$269
8087-2 (8MHz)	$385
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80287-6 (6MHz)	$475
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Erase your EPROMs quickly and safely. This unit is the cost effective solution to your problems. It will erase up to 9 x 24 pin devices in complete safety in about 40 minutes (less for less chips).
Features include

- Chip drawer has conductive foam pad
- Mains powered
- High UV intensity at chip surface ensures EPROMs are thoroughly erased
- Engineered to prevent UV exposure
- Dimensions 217 x 80 x 68mm

WITHOUT TIMER
Cat X14950 ..... Normally $119
Special, $99

WITH BUILT-IN TIMER
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Plastic boxes with aluminium tops, and available in four sizes. Very popular for projects and very economical!

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We have millions of diodes in stock!

1-99	100+	1000+
IN4148 Small signal Cat Z10135		
3¢	2½¢	2¢
IN4004 400V 1A Cat Z10107		
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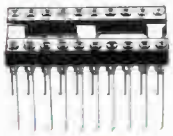

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These quality 3 level wire wrap sockets are tin-plated phosphor bronze

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P10585	16 pin	$1.95	$1.80
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P10590	20 pin	$2.95	$2.70
P10592	22 pin	$2.95	$2.70
P10594	24 pin	$3.95	$3.50
P10596	28 pin	$3.95	$3.50
P10598	40 pin	$4.95	$4.50

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VERO 21070H
0·1" pitch strip board
Size 2·5 x 3·75 inches
H21070 ..... Normally $7·50
SPECIAL, $4.95

VERO 21000F
0·1" pitch strip board
Size 3·75 x 17·9 inches
H21000 ..... Normally $25·00
SPECIAL, $17.95

VERO 21012H
DIP Bread board. The design of this board is similar to that of the plug-in range of DIP Boards, except that it is not provided with gold plated contacts. They therefore offer a cost saving in those experimental applications where a plug in facility is not required. In place of contacts, individual mounting pads for terminal pins are provided.
Matrix 2·54 x 2·54mm
Hole Diameter 1·02mm approx
H21012 ..... Normally $27·95
SPECIAL, $17.95

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Tired of old fashion dialling and re-dialling engaged numbers? These convenient push button diallers include last number redial (up to 16 digits) and instructions for an easy changeover.

Cat A12030 ..... **Normally $19.95**
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(Note: Not Telecom approved)

REGULAR SOLDER SUCKER

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

Cat T11271 ..... **$11.95**

ANTISTATIC SOLDER SUCKER

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

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RCA GOLD PLATED PLUGS AND SOCKETS

For those who need the ultimate in connection. Essential for laser disc players to get that fantastic sound quality

Plug Cat P10151 ..... **$3.75**
Socket Cat P10150 ..... **$2.95**

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Absolute bargains! We've got too many of these leads, so this month we're selling them at the ridiculous price of only $2 each! That's well below half price!
(10 or more, only $1 each!)

5 PIN DIN, MALE TO MALE
Cat P32104 1·2 metres
WAS $4·50 ..... **NOW $2.00**

4 RCA to 4 RCA MALES
Cat P32108 1·8 metres
WAS $6·95 ..... **NOW $2.00**

5 PIN DIN MALE TO 4 RCA MALE LEAD
Cat P32106 1·8 metres
WAS $5·95 ..... **NOW $2.00**

"NO BRAND" DISKS!!

Now you can buy absolute top quality disks that are also the cheapest in Australia! They even come with a 5 year guarantee! So why pay 2-3 times the price for the same quality?

Packs of 10, DIS D/D without boxes or brand name, just their white paper jacket and index labels (5¼" disks includes write protects)

5¼" "NO BRAND" DISKS

10 DISKS	100 DISKS	1000 DISKS
$9·00**	$8·50**	$8·00**

(ALL PRICES PER 10 DISKS)

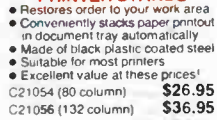
3½" "NO BRAND" DISKS

10 DISKS	100 DISKS	1000 DISKS
$29	$28	$27

(ALL PRICES PER 10 DISKS)

MICRODOT DISKS!

Description	1-9 boxes	10+ boxes
3½" 2S/2D	$33·00	$31·00
5¼" 1S/2D	$12·95	$11·95
5¼" 2S/2D	$13·95	$12·95



PRINTER STANDS

- Restores order to your work area
- Conveniently stacks paper printout in document tray automatically
- Made of black plastic coated steel
- Suitable for most printers
- Excellent value at these prices!

C21054 (80 column) **$26.95**
C21056 (132 column) **$36.95**

QUALITY LEDS

Cat. No.	Description	Price
Z10140	3mm Red	$0.15
Z10141	3mm Green	$0.20
Z10143	3mm Yellow	$0.20
Z10145	3mm Orange	$0.20
Z10150	5mm Red	$0.10
Z10151	5mm Green	$0.15
Z10152	5mm Yellow	$0.15

RITRON 2 MONITORS

Stylish 20MHz, non-glare 12 inch monitors available in green or amber displays and featuring swivel base that tilts forward and back and swivels right to left!

Green Cat X14506 **Normally $235**
Amber Cat X14508 **Normally $239**
SPECIAL, ONLY $159

SAMSUNG 12" 20MHz COMPOSITE MONITOR ONLY $129

FEATURES....

- High contrast, non-glare screen
- High resolution 80 or 40 character display

SPECIFICATIONS....
Picture tube: 12" diagonal and 90° deflection
Phosphor: Available in Green (P39) or Amber
Video input signal: Composite Signal
Polarity: Negative Sync
Level: 0·5V-2·0Vp-p
Scanning frequency:
Horizontal: 15·734 KHz +- 0·1%
Vertical: 60Hz
Video bandwidth: 20MHz
Active display area: 216(H) x 160(V)mm
Display character: 80 characters x 25 rows
Input terminal: RCA Phono Jack
Controls:
Outside: Power Switch, Contrast, Brightness, H-Shift, V-Size
Inside: H-Width, H/V hold, H/V linearity, Focus
Power supply: 110/120V 60Hz, 220/240V 50Hz
Dimensions: 308(W) x 307(H) x 297(L)mm
Weight: 7·3 Kg
Shipping weight: 8·3 Kg

Cat No	Description	Price
X14514	(GREEN)	$129
X14516	(AMBER)	$129

10 OR MORE ONLY $119**

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World Radio History

Digital effects in new VCR provides exciting facilities

Sharp has released a new VHS video cassette recorder featuring digital circuitry that provides facilities such as "picture-in-picture", freeze frame and variable picture speed, the latter being available not only while playing a video tape, but with off-air programs as well.

Dubbed the "Digital Special Effects (FX) Video", Sharp claim it is set to revolutionise home viewing. It could only do that if something were done about the programs, but maybe it's the fun you can have with the features that will bring the consumers to the barricades.

Apparently, as can be seen in the photograph here, you can, using the channel search function, display up to nine channels at a time on your TV screen. This avoids channel jumping and, they say, the necessity for program guides.

Sharp say their "breakthrough" in digital technology will take viewers into the realm of the movie director, allowing you to "interact" with TV broadcasting for the first time.

Funny, I thought that only happened when Clive Robertson offended/insulted/upset some sociological group with a carefully delivered remark of deep perspicacity and the station's switchboard lit up like a Christmas tree with angry callers.

Putting the freeze frame to good use is a doddle, according to Sharp – just freeze the Lotto numbers while you look for a pen. Of course, freeze frame is also good for things like the weather forecasts, football/cricket scores and the like.

With the two-picture function invoked, the usually disgruntled odd-one-out family member who wanted to watch another channel can now be mollified, albeit with a little picture tucked away in one corner.

Incidentally, the second picture can be moved around to suit the least intrusive corner.

Sharp suggest using the secondary picture to view the output of a security camera linked to the VCR, or for watching the kids in the pool, or in bed.

In addition, you get on-screen display of all VCR programming details so mistakes can be avoided, a tamper-proof child lock so recording cannot be interrupted, and a mute-the-screen-to-blue when no signal is received, eliminating screen "snow" and audio noise.

The Sharp Digital FX Video is priced at $1299 recommended retail. See your nearest Sharp dealer.

CD-Interactive

Sony in Japan has demonstrated the power of "CD-I", an interactive video/compact disc system that allows you to control the sound and images recorded on a compact disc with a remote control or joystick.

A TV screen attached to the special CD player displays a series of high quality still colour pictures, full motion cartoon graphics, static texts and snatches of motion colour video.

Because the viewer can interact with the system, Sony expects CD-I to spark off a craze in very sophisticated video games for home consumption, probably like the laser disc games one sees in video games parlours at present.

A 120 mm CD-I disc can store some 600 megabytes of data; that's around 6000 still images or 200 000 pages of text. Data is picked of the disc serially at 175 kbytes/sec and the CD-I player contains 1 Mbyte of RAM, enough to store two high quality colour still pictures.

It takes about 1 s to load one picture, so one half of the memory is used to display a first picture while the other half is storing another. As cartoon graphics require less detail, ten different images can be displayed each second to create the illusion of cinema-quality animation.

The system's biggest problem is that the data rate off the disk is not high enough to display full-motion video. To compensate, the system displays video motion in a small area of the screen only, while a static image appears on the rest of the screen.

The system provides stereo audio and can store up to 16 hours of sound using a technique called adaptive delta pulse code modulation (ADPCM). This measures the difference between samples at either 37.8 or 18.9 kHz, depending on the quality to sound required.

Applications, according to Sony, include in-car navigation systems, portable CD-I for commuters (whatever that is) and backpack versions for bird-watchers and flower spotters.

VHS-C promotion

Six of the world's self-styled "leading manufacturers" of VHS-C format video camera-recorders (camcorders) have joined in a venture to promote the format in Australia, employing a kangaroo with joey to symbolize the compatibility between the small format VHS-C tapes and full-size VHS.

The companies are: Akai, JVC, National, NEC, Philips and Sharp.

Meanwhile, Toshiba has shown a 3D VHS-C camcorder in Japan. About the same size and weight as current VHS-C camcorders, it sports two two lenses and image receptors, filming two images in colour simultaneously. You have to wear special glasses plugged into an adaptor to view the 3D images.

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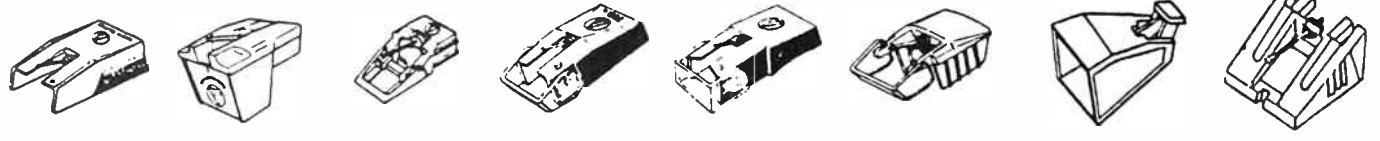

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The stylus can make or break your record collection. A worn or damaged stylus will tear the sides from the record track and can completely ruin a record with just one play.

A diamond stylus can be expected to give around 200 to 300 hours of playing time. This, of course, assumes the pick-up is correctly balanced, anti-skating is set correctly, and so on.

200 hours for the normal user equates to approximately six months, so if you replace your stylus every six months or so, your record collection will say "thanks!"

Needless to say, if the pick-up is dropped the stylus can be damaged, so you should also change your stylus at the first sign of sound distortion, etc.

World Radio History

Ortofon's MC30 Super cartridge

Robert Fitzell AAAC

Interest in the trusty vinyl LP record has not died with the advent of compact disc – most of us have too great an investment, both in terms of money and pleasure, in our collections. Now is the time to consider an upgrade to your system in order to get the most from your investment in the years ahead, and the best place to start is with the cartridge.

UNTIL RECENT YEARS, performance of turntables and cartridges was a very common concern of audio reviewers. Do they track well, is rumble level acceptable, what about wow, etc? The compact disc has, of course, dramatically changed our priorities, although perhaps now that some of the hype is dying the general interest of most reviewers and purchasers is tending back to what it should really concern – does what we listen to really sound as we want it to?

There is ongoing debate, albeit a little lacking scientific research, over the relative qualities of compact disc versus vinyl as a recording medium. (Remember records? Those round black things that warp, collect dust, crackle, but to many ears sound delightful?). A review item that we hope will be of interest to some of those philosophers is the Ortofon range of 'high output' moving coil cartridges, specifically the MC30 Super. This is the newest cartridge extending the already successful MC10 Super and MC20 Super range, both of which have received excellent reviews.

Background

Ortofon is a Danish manufacturer of high quality reproduction cartridges. The company has a long history in sound reproduction, having been founded by two inspired engineers with the specific aim of introducing sound to the then silent film industry. Whilst this must have been a hard act to follow, the company followed with such advances as moving coil record cutter head design, leading to what we all now call high fidelity sound on vinyl discs, followed by moving coil cartridges in 1948 for reproduction that enabled the replay quality to approach the recording quality.

Since that time most of the changes to the Ortofon products have been refinements of design, adapting for example to stereo, and continually reducing cartridge mass. Whilst these refinements may not seem so revolutionary, they have, for example, enabled reductions in tracking force of tonearms from numbers around 20 to 30 grams, to less than 1 gram!

The moving coil principle is one familiar to any of you who has done a little high school physics, whereby a current is generated through a conductive coil as it is moved in a magnetic field. The principal advantage of the system is that the effective moving mass is extremely low. Almost any high school student will have learned something about inertia, and will know that one of the highest design aims in any mechanical system required to move about quickly is to reduce mass. The reduction in moving coil mass enables rapid movement of the stylus thereby providing improved high frequency response.

There is, of course, an inevitable trade off. A problem with moving coil cartridges is the low output level often associated, resulting in the need for a transformer or extra preamplifier to obtain adequate output for most amplifiers. As well as being an extra component in which to suffer losses and distortion, the extra equipment represents a cost penalty.

REVIEW ITEM:	Moving Coil Cartridge
MANUFACTURER:	Ortofon
MODEL:	MC 30 Super
RRP:	Approx $800
DISTRIBUTOR:	Scan Audio, 52 Crown St, Richmond 3121 Vic. (03)429 2199

The MC30 Super

From a marketing and consumer viewpoint, the Ortofon MC30 Super is a high output cartridge, offering the renowned quality of the moving coil principle at a moderate price. A major feature of the cartridge is that it offers high output level – something in the order of three times the output commonly associated with moving coil cartridge designs of the past.

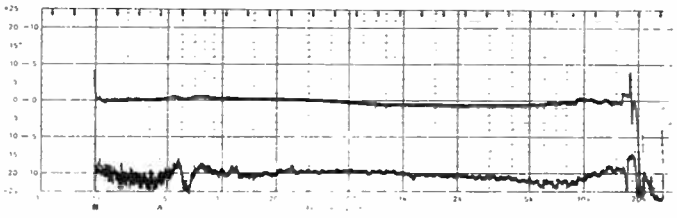
The cartridge is still designed to input to an amplifier provided with a moving coil (MC) cartridge input socket, but claims to remove the need for the step up transformers or preamplifiers used by many audio lovers in the past to gain more signal and improved dynamics.

Objective testing

From a testing viewpoint, reviewing a cartridge is a little frustrating. There is little that can be tested of real substance, although the old stalwarts of frequency response and channel separation are both necessary and informative. We found the MC30 gave a swept tone frequency response from 20 Hz to 20 kHz with good linearity to about 17 kHz, but very messy after that. The test source was a Bruel and Kjaer test record, so the test is reasonably reliable. Channel separation was below specification, being only 20 dB at 1 kHz, although not too bad.

Channel separation may be seen in the swept tone result of Figure 1 in the lower of the two traces, and in the one-third

Figure 1. Swept tone frequency response and separation measured on the MC30 Super. The high frequency end displays some non-linearity, evident on listening tests.



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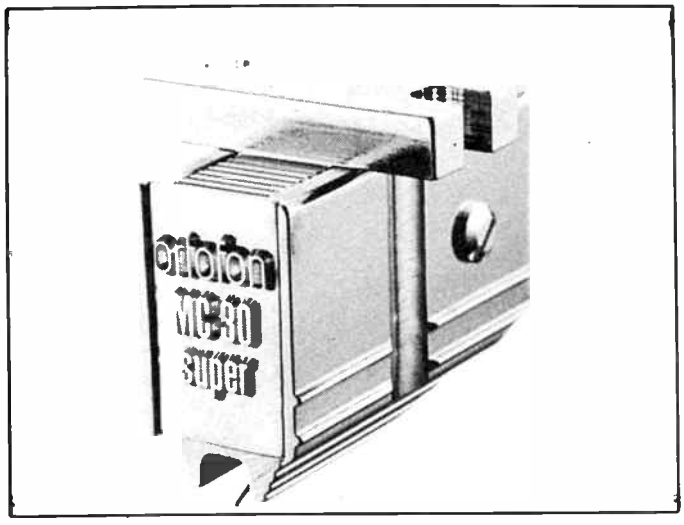


octave spectrum analysis of Figure 2. The latter is a little deceptive in showing a dip in separation at 50 Hz, which should more truly be recognised as mains hum effects. Overall the separation is good, but the frequency response indicates a probability of harshness at high frequencies.

Subjective testing

Listening tests on the MC30 were revealing. Most of our listening was conducted using a Micro-Seiki turntable with a damped tonearm, after an initial run-in time of about 30 hours tracking. Loudspeakers used were the B&W 901 monitors. Source material ranged widely, from rock music, Wyndham Hill recordings of acoustic instruments, to classical and choral.

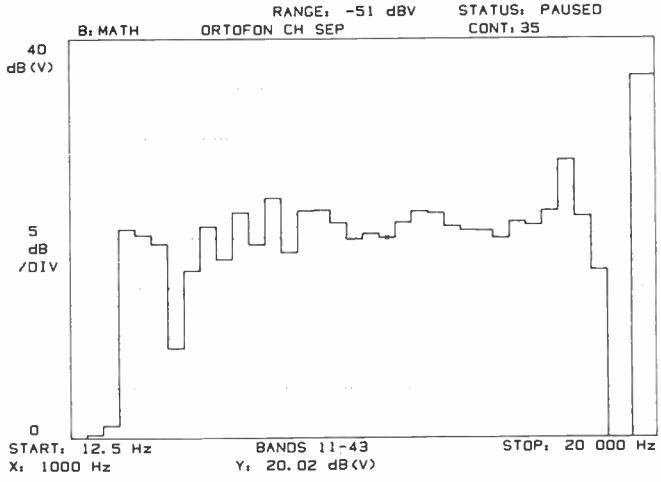
The cartridge is sensitive to input load impedance selection on the preamplifier, and all listening tests were conducted with an input load impedance of one thousand Ohms. A 10 Ohm impedance select led to significant loss of high frequency response from the cartridge, whilst a load of 47k resulted in the cartridge being too strident.

Overall, I found the MC30 to be too strident for my catholic tastes, although capable of exciting dynamics. Bass response lacked tightness and definition, although had my expectations for the cartridge not been so high I would probably be less critical. Bass response overall was certainly not poor, and not inferior to many of its competitors.

Mid range response was very strong, although I felt the image to be a little shallow in the apparent depth of field. Stereo image was good.

High frequency response, particularly with string quality and the areas of performance often lauded for vinyl, was disappointing. I found the cartridge to be too strident, slightly harsh, and lacking the softness of treble necessary from an excellent cartridge. I am not personally familiar with the MC20 Super, so cannot make comparison with that cartridge, although the reviews I have read have have tended to suggest precisely the opposite.

Figure 2. Third-octave analysis of separation, which measures 20 dB at 1 kHz. The 'dip' at 50 Hz reflects mains hum pickup in the measurement.

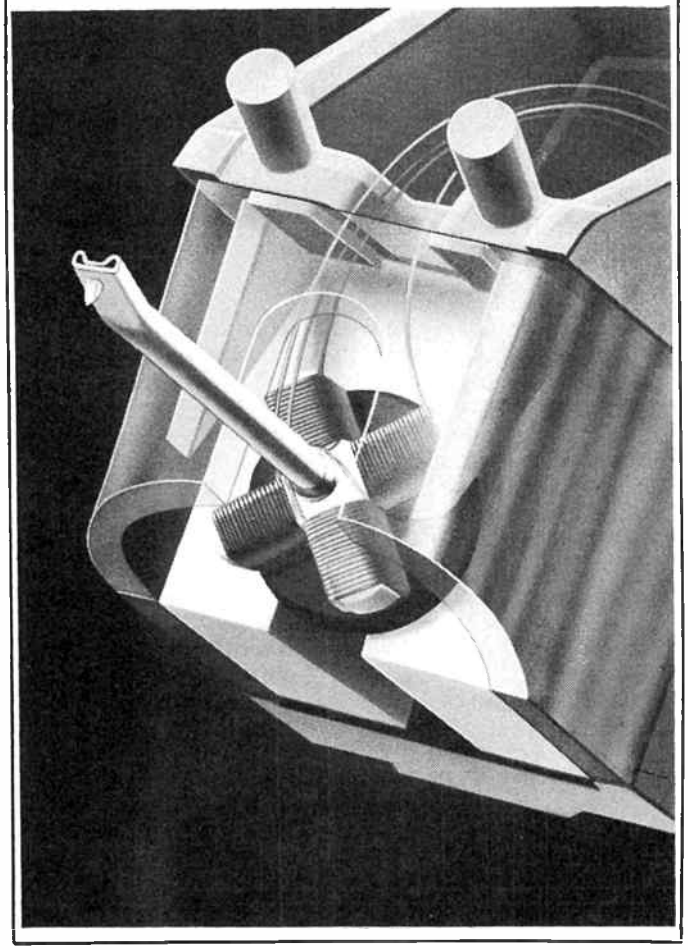


In summary

Whilst my opinion of the MC30 is that it is undoubtedly of top quality, I doubt that it is the best choice for classical music. For rock music and brass, I doubt that you could do better. Frequency response is good, although a little spiky at the top end. Channel separation is adequate and dynamic response is excellent.

The MC30 Super is a cartridge well worth a listen if you are looking at the options for a high quality sound system.

Moving coil cartridge construction, as employed in the Ortofon MC10-20-30 Super range of cartridges.



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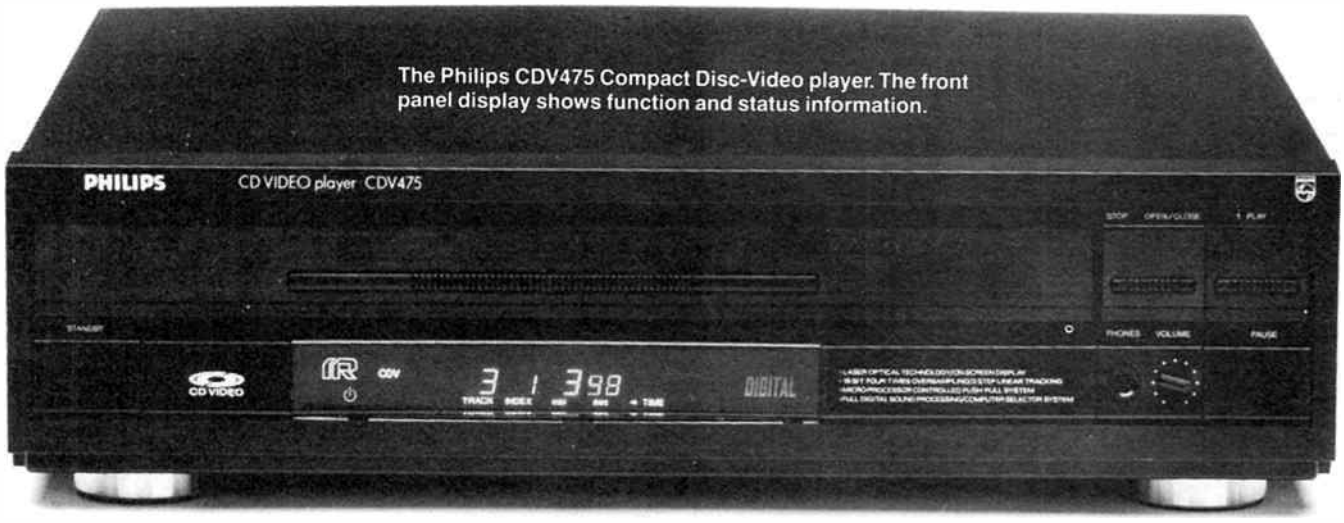

The Philips CDV475 Compact Disc-Video player. The front panel display shows function and status information.

Video joins the audio on compact disc

Roger Harrison

Compact disc video, the fourth major development of the compact disc, will hit the market this year in Australia with two new, larger, disc formats being added to the existing 12 cm compact disc – a 20 cm "extended play" and a 30 cm "long play" disc.

THE COMPACT DISC has enjoyed tremendous market acceptance around the world since its introduction. So much so in fact, that for the first time compact discs produced more revenue – almost US$700 million total – for US record companies last year than the trusty 12 inch vinyl album. Now, the fillip of video is to be added to the CD, but a special player with video decoder is required to obtain the benefits of the new format.

I was privileged to attend the first showing of CD-Video in Australia on December 4th, when Philips, in conjunction with Polygram (a Philips associated company), demonstrated their CDV475 CD-V player to a small gathering of the Sydney press. Pioneer launched their CLD-1050 CD-V player the following week. These players are for use with our PAL television system standard; NTSC-standard (US and Japanese TV system) players have been on the market overseas for some months. Philips demonstrated CD-Video in Amsterdam last March, then at the Chicago CES last June, the Berlin Audio/Video Fair last September and later at the Japan Audio Fair in cooperation with Nihon Marantz, along with Polygram.

The concept of putting video with the audio on a compact disc came to light in the late 1970s with the appearance of the laserdisc. The laserdisc never caught on, probably partly owing to the price of both the software (at least initially) and the hardware, video cassette recorders being substantially cheaper and providing acceptable quality and wide availability of software. Compact disc-video, being an extension of an existing format, is expected to gain much wider public acceptance.

The CD-V system

CD-Video offers digital sound quality with correspondingly high-quality video playback, making it an ideal carrier for music video ("rock video clips") as well as concert performances, feature films, documentaries and other entertainment and educational programmes, according to Philips.

CD-Video discs will come in three sizes initially, offering different features:

1) A 12 cm disc. The same size as the existing compact audio disc, this will contain up to six minutes of video with associated digital sound track, and an additional series of digital audio tracks of up to 20 minutes.

2) A 20 cm disc – the "extended play." This will provide up to 40 minutes of video with digital audio, rivalling the playing time of the vinyl LP (and, no doubt, sounding its death knell well and truly).

3) A 30 cm "long play" disc. This is a two-sided disc with up to 60 minutes playing time per side. The resultant two-hour playing time will make it suitable for the vast majority of movies (complete with "interval" - while you turn the disc over!), as well as operas, concerts, ballets, etc.

There has been some talk in the overseas press about a smaller, 75 mm diameter, CD disc intended for "singles" sales, but we had no information as we went to press as to whether it would carry video.

CD-V discs are coloured gold to distinguish them from the

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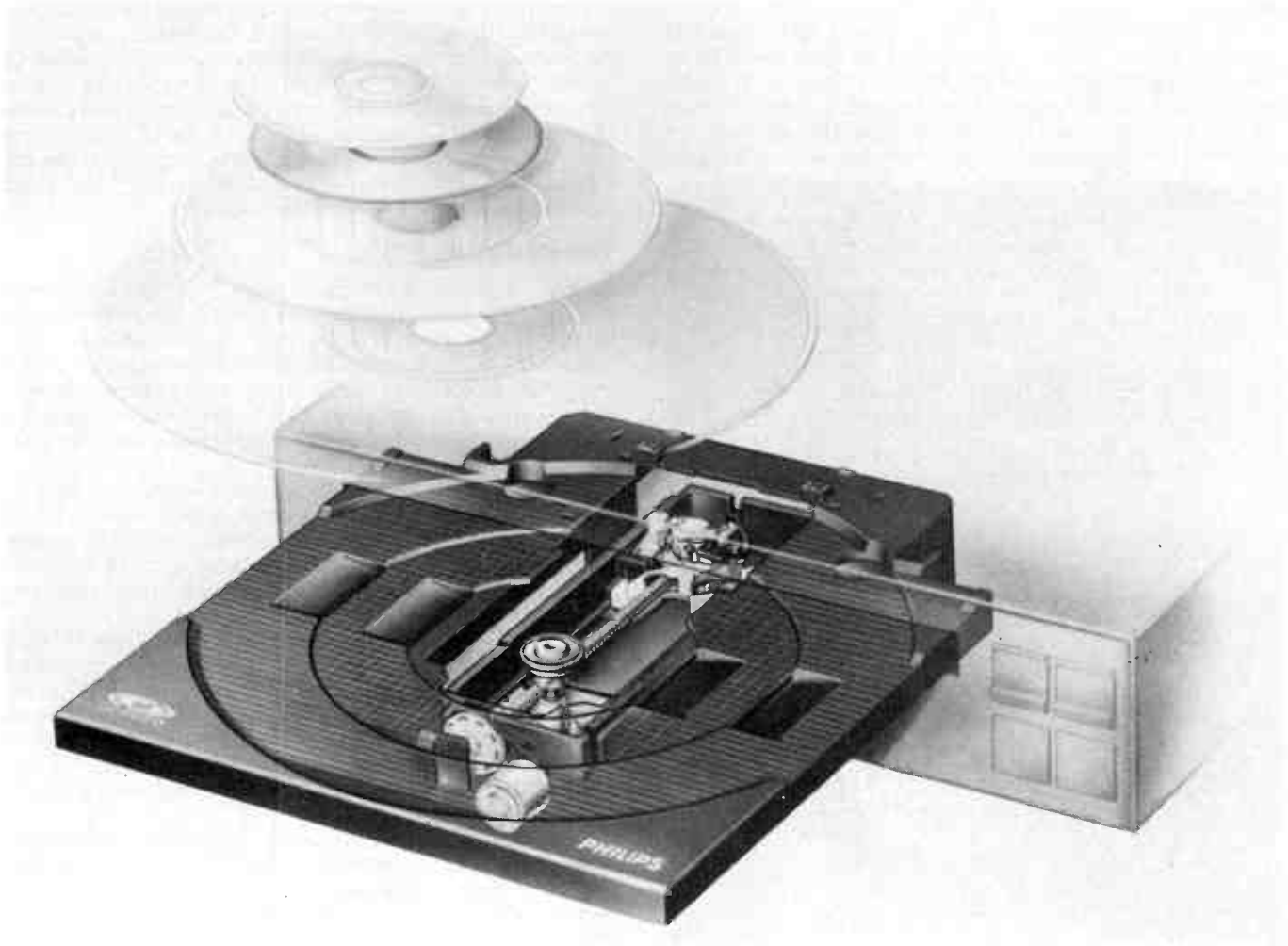
silver audio compact discs. Polygram expect that the 12 cm CD-V discs will largely be sold to young people, while the extended play and long play discs will sell to collectors – movie, opera and ballet enthusiasts – rather than be rented, as is mainly the case with video tapes. The EP and LP discs will likely be priced in the $20-$40 range ($60 for 'special' discs). This would put the price of 12 cm CD-V discs at something under $20, which would suggest a price drop for audio CDs is to come.

The video compact discs have the usual series of 'pits' spiralling out from the centre of the disc, with a video track on the outermost section of the disc recorded, not in digital form, but in analogue FM with the pulse-code modulated audio signal superimposed; a single laser beam can then be used to read-out both signals. This technique leads to very space efficient storage, which permits longer playing times. The video playback quality is said to match the performance of today's best TV receivers and monitors on broadcast signals.

The CD-Video standard allows two types of record/playback techniques. For all compact discs, the first track is located closest to the centre hole and play starts at the innermost track and continues toward the outside of the disc. Control facilities within the player allow you to skip forward and backward between tracks, but the tracks are always played from inside to outside. The rotational speed of the disc decreases progressively as ▷

A motorised disc tray rolls out the front of the Philips CDV475 to accept any of the three disc formats – 12 cm audio and CD-V discs, plus the 20 cm and 30 cm extended play and long play CD-V discs. All functions can be operated through a handheld remote controller. Philips new CDM-6 linear-tracking mechanism, seen under the disc tray in the illustration at right, includes a tilt servo mechanism to keep the laser pickup at the correct angle to the disc.



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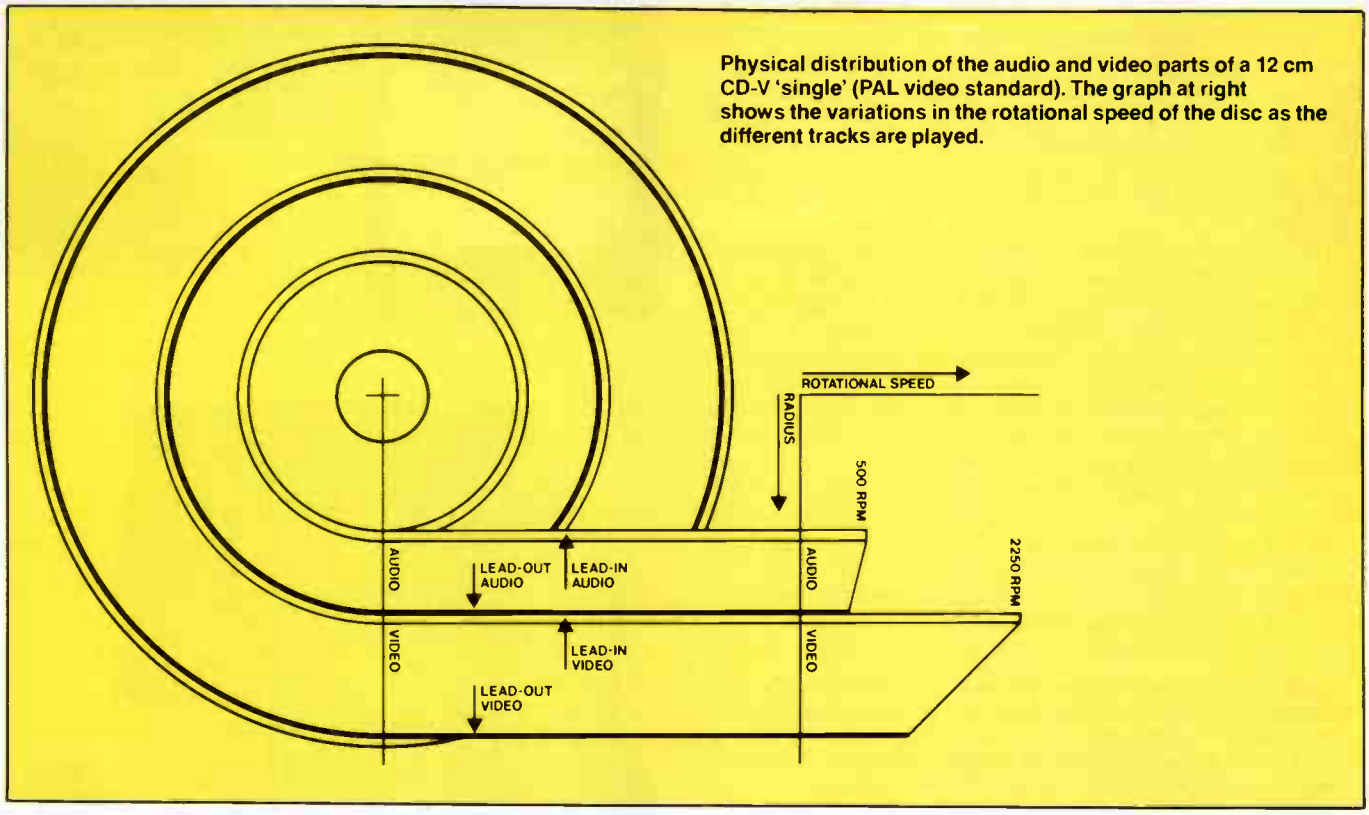
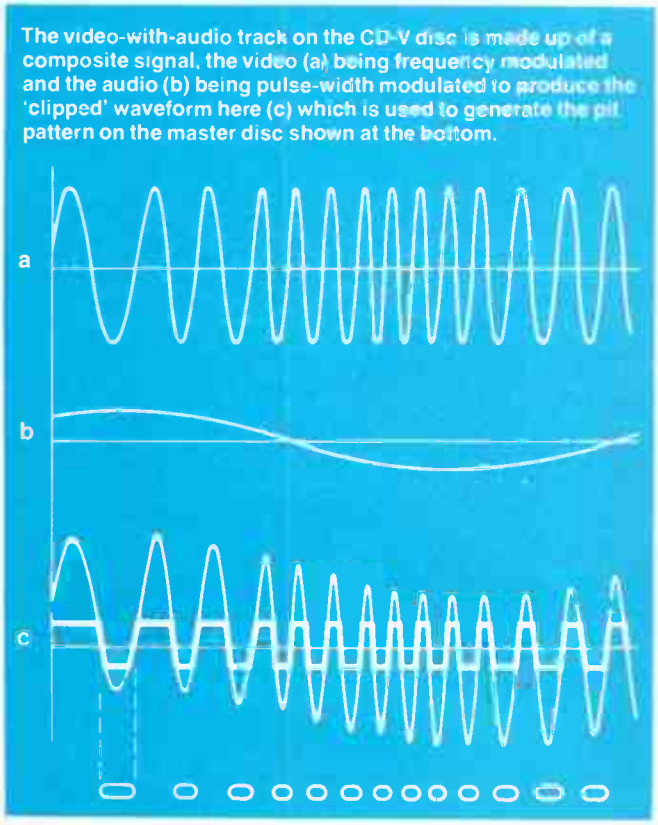


Physical distribution of the audio and video parts of a 12 cm CD-V 'single' (PAL video standard). The graph at right shows the variations in the rotational speed of the disc as the different tracks are played.

the laser pickup moves towards the outside tracks. This maintains a constant linear velocity between the laser pickup and the disc – known as the 'CLV principle'.

The second CD-Video standard is known as 'CAV' – constant angular velocity. This principle is used for discs intended for active replay, permitting features such as still-frame, frame-by-frame replay and fast and slow motion replay in both forward and reverse directions. On discs employing this standard, the rotational speed remains constant during play, and the scanning velocity between the laser pickup and the disc increases towards the outside of the disc.

The choice of which principle is employed for a particular recording will depend on the software producer, according to the way it is intended for the disc to be used – CLV for normal 'linear' replay of the disc or a selection of tracks, and CAV for discs which are intended for "active replay" under user control. Detection of the type of disc is made by the CD-Video player using information encoded on the lead-in track so that the disc will automatically be played in the correct way. The players will also decode and play the older laserdiscs.



The video-with-audio track on the CD-V disc is made up of a composite signal, the video (a) being frequency modulated and the audio (b) being pulse-width modulated to produce the 'clipped' waveform here (c) which is used to generate the pit pattern on the master disc shown at the bottom.

The players

Both the Philips CDV475 and Pioneer CLD-1050 are "Kombi-players", designed to accept and play all three CD-V format discs as well as standard audio compact discs. Detection of the different discs is automatic. A motorized draw comes out of the front of the players and the disc to be played is placed in a recession on the plattern which recedes inside the player when the play function is activated either by pushing the tray front or the play button.

The video and audio are decoded and separated within the player, with outputs going to a stereo amplifier and a TV set. The CD475 has both direct RGB video out (via a SCART connector on the rear) for connection to a monitor or monitor-type TV receiver, as well as RF output for direct connection to a TV set's antenna input

The CDV475 uses Philips' CD-2 all-IC digital audio decoding circuitry featuring their 16-bit four-times oversampling technique with digital filtering plus a dual 16-bit digital-to-analogue converter (DAC). Philips claim this system ensures "outstanding channel balance and separation as well as virtually flat frequency response and a signal-to-noise ratio of over 100 dB." The player uses their CDM-6 tracking laser system for high accuracy tracking.

The CDV475 features full remote control from an infra-red handheld controller, including track selection, advance programming of up to 20 tracks in any order, search for certain audio or video passages etc. In addition, enhanced video functions are controllable from the handset, like still-frame, frame-by-

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frame forward or backward replay and forward or backward slow motion with CD-V discs which support these functions. All functions are, of course, selectable from front panel controls on the player. The CDV475 may be integrated with other remote control Philips products as part of a complete audio/visual system.

An on-screen function display is shown when a disc is loaded, and the background colour of the display indicates the type of disc being played. The display can be called-up onto the TV screen at any time to show the type of CD-V disc being played, as well as information on the disc track selected, index selections and elapsed playing time. The screen display also provides status information when playing audio CDs.

The RGB output gives broadcast quality video pictures, according to Philips, on a suitable monitor or receiver-monitor with RGB input. Composite video is also available on the SCART (Euroconnector) socket. Dual RCA sockets are provided for stereo audio output. In addition, a Cinch socket also provides composite video and stereo audio for receivers and monitors requiring this type of signal input. A built-in headphone amplifier with separate volume control is included for personal listening.

A direct digital output is also available so the CDV475 may be used with an external digital-to-analogue converter or one of the new generation digital amplifiers and control units just appearing on the market.

The Pioneer CLD-1050 player is functionally much like the Philips. It features front panel controls for all functions – scan forward and reverse, track/chapter search, play and pause etc, and a handheld remote control with access to all functions available on each format. Commands and play status are also shown on the TV screen. Like the Philips, the Pioneer player can be integrated into a complete Pioneer remotely controlled system.

The CLD-1050 employs a two-times oversampling digital filter in the audio decoder. In addition, a CX analogue noise reduction system is included for use with the older laservision discs discs which have CX encoded audio. A linear servo-tracking system employing a two-beam laser is used. In this system, one beam – the tracking beam – precedes the detector beam and is used to avoid jumping during playback where dirt or scratches may be encountered on the surface of the disc.

The Kombi players will later be supplemented by different models targetted at specific applications and markets. e.g: a player for 12 cm CD-V singles and audio CDs and portable players, the latter featuring a pop-up liquid crystal display screen according to a US report. Hitachi, Mitsubishi and Sony are reported to be developing CD-Video players, too.

When and how much ?

Philips said they will not be releasing product until there is "sufficient" software available. A Philips spokesman said that that would mean around 250-300 titles across the three formats. Polygram Australia's Managing Director, Michael Smellie, indicated that their inventory would reach that sort of level sometime later this year. He also said they had released some CD-V discs in Britain prior to the hardware being released, as part of a marketing exercise. It's not known whether that will happen here or not.

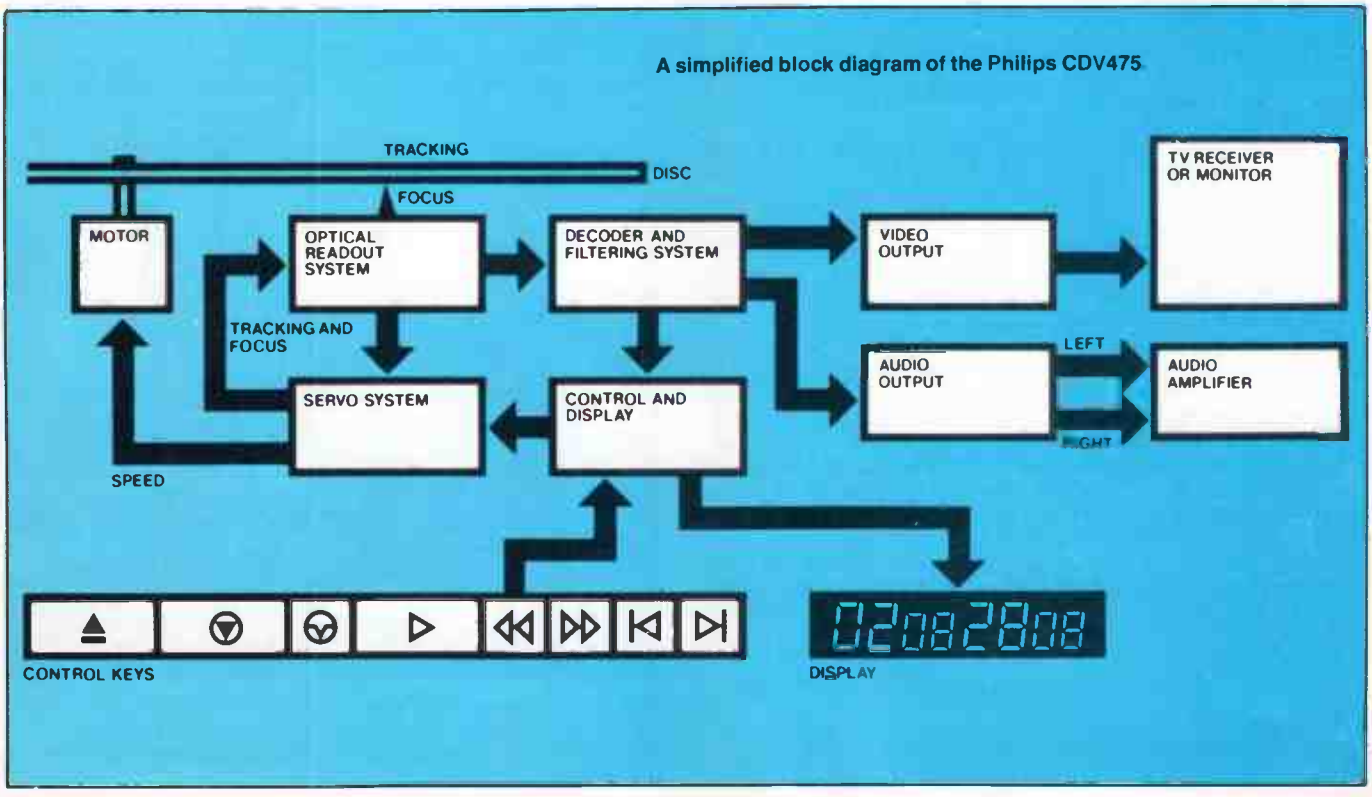
A US press report suggests a price of US$799, which translates to about $1500 here, but they're likely to be more than that for the Kombi players, at least initially. Philips said, at the press release, that the CDV475 would be in the "mid-high price range" of current audio CD players. Like the audio CD players, prices are expected to drop within 12 months of their introduction.

Both Philips and Pioneer only had samples in the country in December, but Pioneer indicated the CLD-1050 would be on-sale in the second quarter of this year.

The quality?

From the limited playings and non-ideal conditions prevailing at the Philips demonstration, it was hard to make an unequivocal judgement, but both sound and video seemed to be of very good quality, the direct (RGB) video to a monitor being marginally better than composite video RF output to a receiver.

A simplified block diagram of the Philips CDV475



World Radio History

Three software companies to scuttle a pirate

Three software distribution companies from three different states have joined forces in a court action against a Sydney businessman alleged to be distributing software in infringement of copyright.

Autodesk of Melbourne, HST Technology of Hobart and Microsoft of Sydney were granted "Anton Pillar" orders by the Federal Court in Sydney on November 9 last.

Following the granting of the orders, the companies' solicitors and technical advisers visited the premises of Mr Charles Cheung at North Ryde in Sydney where they removed some 80 disks of software and related accounting books.

The action was initiated after HST Technology made a claim under its Intellectual Property Legal Expenses Policy through insurance agents, Assurex.

Here's how they found out. Assurex arranged for the purchase of a microcomputer from Mr Cheung and was allegedly given "free" copies of computer software which infringed the copyright of the three companies.

Representatives from the three Companies' firms affirmed they took a serious view of copyright infringement. Ms Linda Graham, Microsoft's managing director, said they would be sueing Cheung for damages for breach of copyright.

Autodesk has previously taken action themselves against Computers Galore in Melbourne in 1985 and Best Instruments in Adelaide in 1986.

Microsoft distributes a large range of software and its MS-DOS operating system – a prerequisite for many other programs. Autodesk is the owner of AutoCAD, the world's biggest selling computer aided design and draughting program for microcomputers (and used here at AEM for our drawings). HST Technology is the supplier of Protel, a design program for producing printed circuit boards.

Super speed-up at low cost

Local manufacture Hypertec has released the "Hyperace 286 Super Plus" – an enhancement board which makes an IBM PC run substantially faster than an IBM AT, they claim, and priced at just $1395 retail.

The Hyperace is an 80286-based board that, when installed, replaces the computer's 4.77 MHz 8088 processor with its own 80286 processor running at 12.5 MHz.

High clock speeds are essential for processor-intensive tasks such as graphics packages, CAD software, sophisticated wordprocessing etc, to avoid frustrating delays in response time during calculations or screen re-writes.

The Hyperace 286 Super Plus was developed at Drummoyne in Sydney, and is one of a group of accelerator boards on which Hypertec has concentrated its research.

Further details are available by calling **Merelyn Kelly** at **Hypertec, (02)819 7222.**

New CAD-graphics distributor

One of the driving forces behind the popularity of AutoCAD in Australia, Mr Bill Kaliviotis, has established a new company specialising in CAD/CAM and graphics peripherals and support systems.

Bill was one of the founding directors of former AutoCAD distributors Entercom, along with Tony Zammit. Autodesk Inc. the makers of AutoCAD, brought out Entercom earlier this year for an undisclosed amount, to establish a direct presence in Australia.

His new company, Kalicom, has already negotiated agreements with Roland Corporation, Hitachi, QDP (USA), International Computer Graphics (USA), and established a nation-wide chain of dealers.

Bill says his company's major objective is to supply dealers and end users with the necessary technical information and support, "well beyond that of sellers and users of commercial systems.

"They need continually updated information on the compatibility of products and, above all, guaranteed reliability."

Matching various releases and versions of both software and hardware products into a compatible system is a key to success. Bill says.

More details from **Kalicom, 325 Koornang Rd, Carnegie 3163 Vic. (03)578 0841.**

Impact powers on

Local high-tech company Impact Systems Ltd continues its well orchestrated strategic development plan, expanding its senior executive team with new appointments from the ranks of some well-known other companies in the industry, and forecasting a domestic sales growth of over 100%

Late last year, Chief Executive John Price announced the appointment of Dr Frank Barr-David, Mr David Ballantine, Trevor Day, Ivan van Selm, Geoffrey Kinghorn, Peter Boulton and John Cochrane.

Three are ex-IBM: Dr Frank David-Barr, Peter Boulton and John Cochrane. David Ballantine had extensive sales and marketing experience with NEC and DEC, and comes from Concurrent Computer. Ivan van Selm joins Impact from Invetech (previously PA Technology). Geoffrey Kinghorn and Trevor Day both had previous associations with Impact.

Their controversial purchase of Microbee Systems was to give Impact a strategic position in the Education market as Microbee holds a strong second place in that market, according to John Price. They believe they can consolidate that position and expect to jump into first place with a move to be made early this year.

Power on board. Impact's senior executive team. From left to right: Ivan van Selm, Geoff Kinghorn, Peter Holms a'Court, John Cochrane, Frank Barr-David, David Ballantine, Peter Boulton and John Price.

World Radio History

"SmartWatch" – install a real time clock in your PC or compatible for under $50!

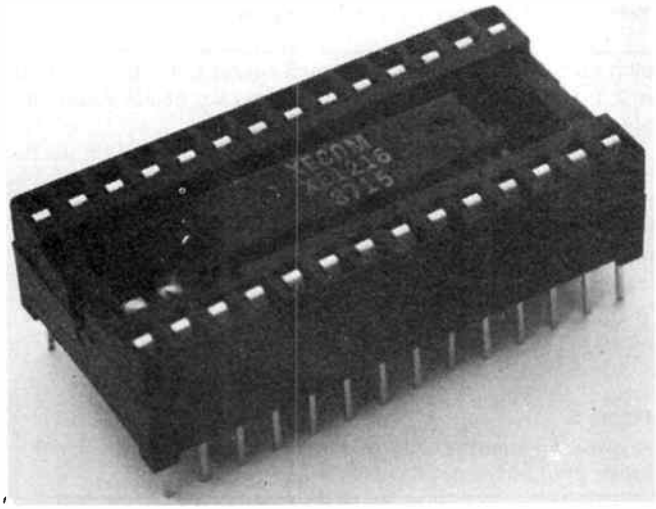
Jamye Harrison

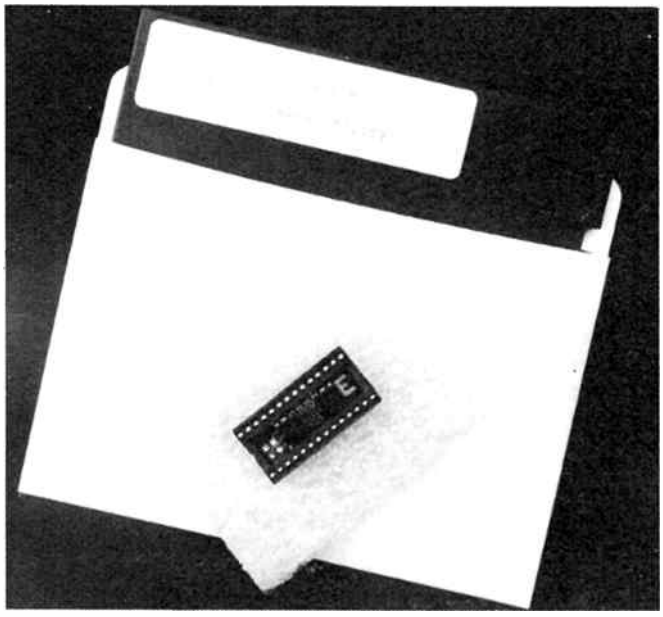
If you own one of the IBM PC group of computers or one of the legion of clones, here's a little add-in that's inexpensive, simple to install and a real convenience – a battery-backed real time clock.

THE POPULARITY of the IBM PC-style of computer is currently unchallenged. A recent innovation – the "bolt-together" PC clone, has rapidly gained ascendancy among the technically inclined, and for clear reasons. It's economical, flexible and versatile. You can arrange a configuration to suit your requirements and/or your budget. In both styles, the ability to expand features and functions with add-in cards is what provides the fillip of flexibility and versatility.

But whatever technical or financial considerations influenced your choice, undoubtedly the driving reason behind your purchase was the application, or applications, for which the computer could be used. And for a great many applications, a battery-backed real time clock (RTC) has such functional convenience that you wonder how you ever got along without one! Some add-in cards come with a real time clock, but you often find that other functions on the card are either unnecessary, redundant or duplicated in your system.

Details on the simplest implementation of a battery-backed real time clock we've ever seen recently arrived here at the magazine, courtesy of Ken Curry of Energy Control from Queensland. The information detailed a recent release from Californian semiconductor manufacturer, Xecom Inc. The device is an integrated CMOS timekeeper module, dubbed the SmartWatch. Revolutionary in design and practicality, the real time clock module resides in the cavity of a 28-pin, 600-mil-wide DIP socket. The unit is simplicity itself comprising just a single chip and a backup lithium battery.





The module is designed to plug straight into any spare or occupied ROM socket in any of IBM-PC series computers, or close compatible. When not in operation the RTC is transparent to the piggy-backed ROM and utilises only eight pins in the package. The internal lithium energy source is reliable for backup purposes for ten years, Xecom claim.

The new chip module is designed around the XE1216E a CMOS technology integrated circuit. This chip, while remaining "transparent" to any resident memory devices, provides many timekeeping functions including; hundredths of seconds, seconds, minutes, hours, days, date, month, years and decades. The SmartWatch may be configured to operate in either 12 or 24-hour format. Adjustment for 30 or 31 day months and for leap years is also provided.

Once the input voltage, Vcc, reaches an out-of-tolerance level the internal battery takes over to prevent data loss. However, the SmartWatch package is extremely tolerant of voltage condition, allowing a 10% fluctuation in operating voltage before switching to its backup energy source.

The utility of SmartWatch was immediately apparent, so we called Ken Curry and told him. He smartly organised a sample which promptly arrived, direct from Xecom in California. The package contained a SmartWatch module in conductive foam, installation instructions, and a disk containing necessary installation software.

Following the instructions supplied, it's a simple matter to install the SmartWatch in your computer. The instructions here have been developed from the instructions supplied with our sample SmartWatch. We have reproduced details from Xecom's data sheet elsewhere in this issue for those readers wanting further technical information.

We have arranged with Energy Control to offer this new device to readers at a special introductory price of $49.95 for a limited period. Full details are given following the end of this article.

World Radio History

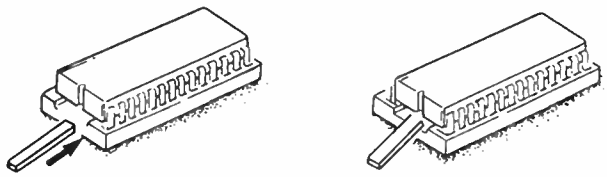


Figure 1. Removing a ROM. If you don't have an IC extractor, use a small, flat-blade screwdriver to prise up each end of the IC alternately. When you pick up the IC, only handle it with your thumb and forefinger, gripping it by the ends, and avoid touching the pins.

Hardware installation

Installation of the SmartWatch is quite straightforward, once you have located an appropriate ROM or volatile RAM space and as long as you are careful. Some safety guidelines need to be understood before the installation procedure may begin.

- The SmartWatch is shipped in anti-static foam and should be left in this until prior to actually installing your device.
- Check that your computer is operating correctly before installing the SmartWatch.
- Because your computer needs to be partially dismantled for the installation process, units with hard disks should have their heads parked by an appropriate program before removing the cover.
- Disconnect all peripheral devices from the computer.
- Disconnect the computer from all power sources.
- Never handle the SmartWatch or any memory device by the metal pins.

Some tools which may be required before you proceed are: a screwdriver appropriate for disassembling your computer's cabinet, a small flat-blade screwdriver, a pair of long-nose pliers, and an IC extractor/insertor.

Consult your owner's manual if you are not familiar with the procedure for dismantling your computer. With the 'innards' exposed, examine the motherboard or main system board and locate the position of the ROMs or ROM sockets. You may need to remove some internal add-in cards or daughterboards to expose them.

Any standard 28-pin ROM socket may be chosen within your computer, however, an unoccupied one may be the best choice because the installation of your SmartWatch will be easier. If

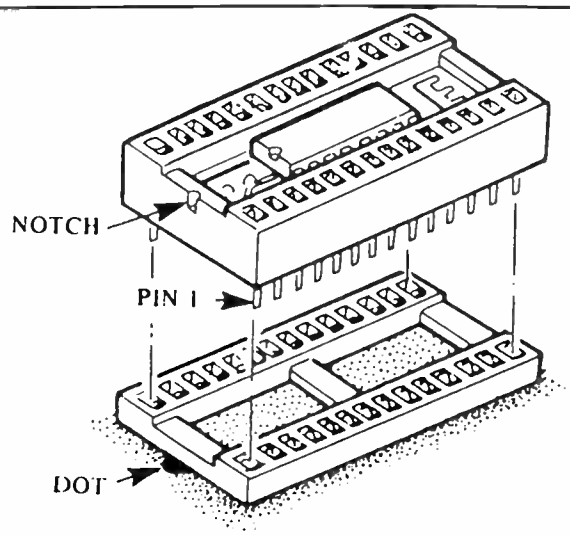


Figure 2. When you install the SmartWatch in the vacant ROM socket, make sure that it's correctly oriented, as shown here.

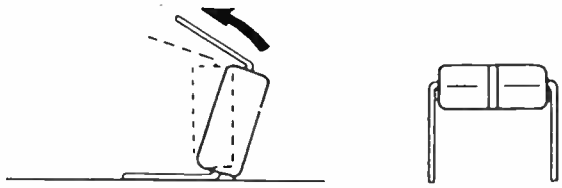


Figure 3. If you install SmartWatch in an occupied ROM socket, the removed ROM will have to be re-installed in SmartWatch's piggyback socket. You may need to straighten the leads of the ROM. To do so, work on a metal surface. Pick up the ROM by the ends, without touching the pins, touch your hand on the metal surface to equalise any static charge between you and the work surface, then lay the ROM down on its side as shown here. Very carefully roll it towards the pins to bend the lower pins into line. Then turn the ROM over and bend the pins on the other side in the same manner.

you have chosen a ROM space which is occupied you must first remove the existing ROM chip. This is best done with an IC extractor but a small flat-bladed screwdriver will suffice. The latter should by used carefully, slowly prising up each end of the IC alternately. Figure 1 here illustrates the general technique.

If the RTC is being installed in an unoccupied ROM space the above procedure can be ignored. Regardless of this, the unit can now be placed inside your computer, making sure to align the

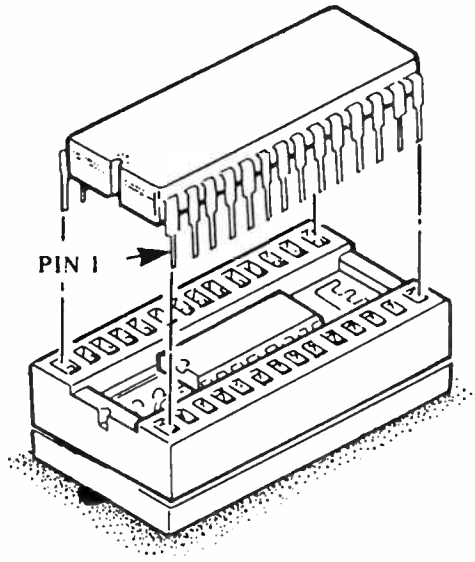


Figure 4. When re-installing a ROM on top of the SmartWatch, take care that you get the ROM the right way round.

notch on the end of the SmartWatch socket with the notch, or Pin 1, marking on one end of the ROM socket inside your computer as shown in Figure 2.

If you have used an occupied ROM socket, the ROM must be now be re-installed into into the piggyback socket on top of the SmartWatch module. Care has to be taken here to ensure that ▷

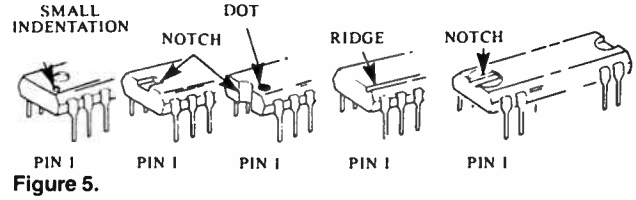


Figure 5.

How to recognise the various identification marks on an IC that locate pin 1 on the package.

World Radio History

the notch on the end of the ROM is aligned with the notch on one end of the RTC module. You may need to first bend the ROM's pins in a little to allow it to slip easily into the piggyback socket. Note that you should take precautions to prevent static damage while performing any of these operations.

Now that the hardware installation has been completed, the computer may be re-assembled, any internal cards being replaced to their original positions and all cables reconneted. Power-up the system and see that it functions normally.

System installation

A disk containing a program called SMWCLOCK.COM is supplied with your clock module. This file should be kept in the root directory of your DOS disk as it is used to read and modify your real time clock.

The software supplied with the SmartWatch has three basic command structures, they are as follows.

SMWCLOCK – This command searches for the memory location of the SmartWatch and displays the date and time.

SMWCLOCK C – The MS-DOS values for the time and date functions, (set by the internal TIME and DATE commands), are transferred to SmartWatch with this command.

SMWCLOCK S – SmartWatch's internal time and date values are transferred to MS-DOS with this command.

The last command should be included in you AUTOEXEC.BAT file so that the time and date is delivered to MS-DOS each time your machine is started-up.

The software supplied is easily linked into MS-DOS by following this six-step procedure:

1) Power-up your computer and boot the MS-DOS operating system.

2) Copy the contents of the entire floppy disk supplied onto your MS-DOS disk or hard drive.

3) Enter the correct time value (take note of daylight saving time) into MS-DOS using the "time" command (consult your DOS manual if you don't know how to do this).

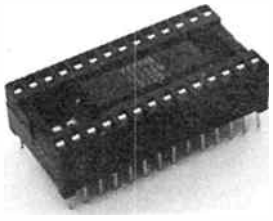
4) Enter the correct date value using the "date" command.

5) Now type SMWCLOCK C and hit return. This will update the Smartwatch with the time and date you have just entered into DOS.

6) To get the correct time entered automatically for you when you boot up your system, it will be necessary to modify your AUTOEXEC.BAT file, or create one if you haven't done so. This is a file sought by MS-DOS each time you boot up, and is used to store a series of commands you wish executed on boot-up. To modify your AUTOEXEC.BAT file, follow the instructions in your DOS manual to add a line which says SMWCLOCK S in the file. With that command incorporated, MS-DOS will run the clock function whenever you boot up.

That completes installation of your SmartWatch!

All in all, the SmartWatch offers a much more cost- and space-effective means of incorporating the power and convenience of a real time clock into your PC or compatible. It's almost as simple to install as an RTC card, yet takes up considerably less space and does not tie up a spare card socket on your computer; the SmartWatch is definitely a consideration for either the new, or established PC user.



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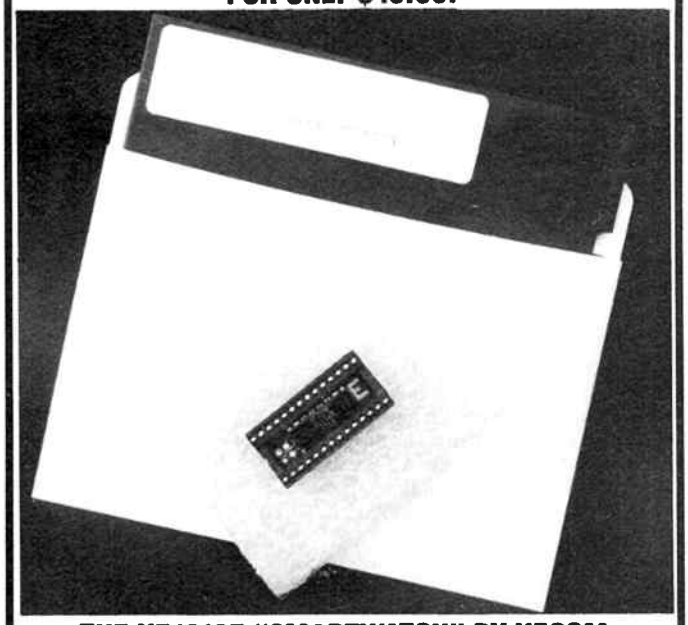
PUT A BATTERY-BACKED REAL-TIME CLOCK IN YOUR PC OR COMPATIBLE FOR ONLY $49.95!



THE XE1216E "SMARTWATCH" BY XECOM

AS SIMPLE AS INSTALLING AN IC!

By special arrangement with the importers, Energy Control, we are able to offer readers the opportunity of obtaining this product at a special price as an introductory offer. This offer is made by Energy Control and the magazine is acting as a clearing house for orders.

THE XE1216E SMARTWATCH JUST PLUGS INTO ANY ROM SOCKET ON YOUR MOTHERBOARD. THE ROM PLUGS BACK IN ON TOP OF THE XE1216E MODULE.

(Not suitable for use in compatibles where an RTC is already included on the motherboard. e.g: Amstrad PC1640).

OFFER EXPIRES LAST MAIL 30 APRIL 1988

Complete the coupon and mail it today, or ring (02)555 1677 and "pledge your plastic".

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Please send me _____XE1216E Smartwatch module(s), as described in the Feb. 1988 issue of Australian Electronics Monthly.

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World Radio History

The Halikan LA10 laptop computer

When you can't bring the task to the computer, take the computer to the task – and on this premise was founded the legion of portable-style computers we see in the market today.

IN THE BEGINNING . . . . there were mainframes. Then came the benchtop computer, the desktop computer, the handheld or pocket computer (useful in a limited way, but few people could take them seriously), followed by the luggable, then the portable and . . . finally, the laptop! Each style has its niche, its protagonists. When you can't use a desktop PC at the point where you require it, you have to resort to some form of portable. Note that, once you get past the bench or desktop computer, the greatest range of competing styles available are all portables.

In so many technical applications, being able to use a portable computer on-site where a desktop is impractical or unavailable is a utilitarian convenience that has to be experienced to be believed. A case in point: being able to run a Thiele-Small loudspeaker design program on-site while tests are run and adjustments made to a speaker box and port tuning. Or, running checks and making changes on an antenna design with a CAD program out on the antenna test range.

It was with these thoughts in mind that we took up the offer of reviewing the Halikan LA10 laptop computer late last year.

An overview

Imported and distributed by Hi-Com Unitronics in Caringbah, Sydney, this laptop is a relatively recent addition to the market here. The processor is an 80286-10, clocked at 10 MHz, making it an "AT-style" machine. It is supplied with 640K of RAM on-board, but this is expandable to 2.64M. The unit reviewed came supplied with two 3.5" double-sided double-density floppy (?) disk drives, though in its 'minimum' configuration it is supplied with just one. The disk capacity is quoted as 720K. We understand a 20M hard disk drive can be added-in, taking the place of one of the 3.5" floppy drives. In addition, the literature that came with the unit mentions an optional 300/1200 bps Hayes-compatible modem option, but we have no idea when that may be available, or whether it's an internal unit or an external peripheral.

The display is one of those new "super twist" liquid crystal types with a resolution of 640 x 200 pixels (80 columns by 16 lines). A contrast adjustment is provided. Also, a connector is incorporated providing output to an external RGB or mono monitor.

The low profile keyboard has 82 keys, including a group of function keys. A numeric keypad is incorporated as an 'extra' on the qwerty keyboard, apart from the usual number keys.

A parallel (Centronics printer) interface and a serial (RS232) interface are provided via connectors on the rear panel. The parallel interface connector is a 25-pin D-type, while the RS232 connector is a 9-pin D-type. A 60-pin expansion connector is also provided so you can connect add-on boards or peripherals. In addition, there is an external keyboard connector (6-pin miniature DIN), a 5-pin DIN external power connector and a 9-pin D-type for the external video output.

It is powered from a 12 V, three amp-hour sealed, rechargeable lead-acid battery. A mains plugpack supply/charger is provided.

Closed, the unit measures 310 mm wide by 380 mm deep by 73 mm high. It weighs 6.5 kilograms. The handbook reports it typically draws 12.2 watts.

The screen folds up to reveal the keyboard. The angle of the screen can be adjusted over a small range to suit your viewing angle. There are four LED indicators: power-low, caps-lock, num-lock and disk-in-use. The two 3.5" disk drives are located on the right hand side, behind the keyboard.

A small Users Manual is supplied, along with two largish books, one on DOS, the other on GWBASIC (which is supplied as part of the package).

In use

At 6.5 kg, the weight is the first thing you notice! However, it's something I guess you'd get used to, though I'd rather not lug it out on an antenna test range and back again too often.

The keyboard has a lighter 'feel' than a standard IBM "clunker", but isn't feather-touch either. In fact, I quite liked it – it's not as fatiguing as the standard IBM keyboard. The cursor control keys mixed up with the qwerty keys "bothered" some colleagues, but I did not find it inconvenient – after all, while you're cursoring your way around a screen or through a file, you aren't using the qwerty keyboard.

I tried using it with a couple of software packages, the LA10 and the software functioned as expected. I felt that disk access was a little slow, but I guess that's a power consumption trade-off – high speed access means higher current/power consumption. Processing speed appeared to be up to expectations, although we were unable to run any benchmark tests to find out. Unfortunately, you're stuck with the 'native' speed of the 80286-10 as a coprocessor cannot be added-in.

The screen was very easily read under a wide variety of ambient lighting conditions and over a very wide range of angles. In fact, my perception is that the screen visibility and legibility is among the best I've seen on a portable.

Battery life is difficult to determine without lengthy cycling tests. However, it seems to be in the vicinity of some four to six hours with intermittent (typical of many situations), but frequent use. It's disk usage that soaks up the amps, so any application requiring frequent disk usage will lessen the battery life between recharges. Exactly how a hard disk would affect battery life is not known.

Balancing the unit on your lap is a relatively tricky exercise as the weight is concentrated toward the rear of the case. This would prove a drawback in some situations – such as trying to use it while seated in a car.

The supplied documentation is a little variable in quality. The Users Manual is brief, but adequate. Fortunately – hallelujah! – for once it's not written in "Chinglish". The other two manuals are voluminous and comprehensive!

The construction is suitably sturdy, if unexciting. Nevertheless, it's not the sort of machine you'd chuck in the back of a ute with a pile of other gear on your way back from the antenna test range. Laptops should be treated rather like you'd treat your briefcase if it contained the Easter's eggs supply.

In summary

The Halikan LA10 is a well constructed laptop that will do the sort of jobs you'd expect to use a laptop for, and acquit itself competently. At $4500 it's not a trivial purchase, but then, any 80286-based machine is in that class.

The laptop market is relatively crowded and hence, very competitive. You might find the Halikan LA10 has a few features and functions that suit your purpose admirably. Give it a close look.

Roger Harrison

Review unit supplied by Hi-Com Unitronics, 7 President Lane, Caringbah 2229 NSW. (02)524 7878.

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Elektor Electronics in AEM

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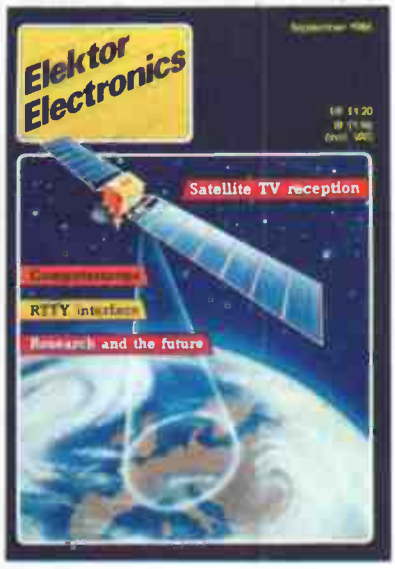

The projects and circuits chosen for inclusion in the Elektor section are selected on the basis of interest, local relevance and component availability. Intending constructors should consult our 'PROJECT BUYERS GUIDE' in this issue for a guide to component sources and possible kit suppliers.

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World Radio History

$13,000 REFERENCE MONITORS

– also available in kit form.

Readers of overseas hi-fi magazines often wonder why imported quality loudspeakers sell for over twice the price in Australia. The answer is simple – but for good reasons not advertised.
Fully imported speakers incur such cost factors as:

- 25-30% freight
- 25% import duty
- 30% sales tax
- 28% handling charges (typically)

Not one of these factors improve the sound – they only contribute to the extremely high Australian price tag.
A pair of fully imported 4-way DYNAUDIO reference speakers is today priced at $13,250 in Australia.
By importing the drivers only and utilising world renowned Australian technology (Thiele & Small), together with local genuine timber craftsmanship, it is now possible to acquire a pair of these speakers fully assembled at less than half this price.

For the technically-minded hi-fi enthusiast further savings are possible by assembling the speakers yourself. Pre-built enclosures and crossovers make this task a mere breeze. A good soldering iron and a Phillips head screwdriver will save you a further 30%. Should you happen to be in the furniture production industry, enclosure plans can be supplied with the kit (drivers and crossovers) for even greater savings.

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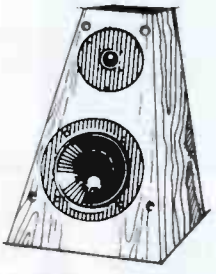

SATELITE-1
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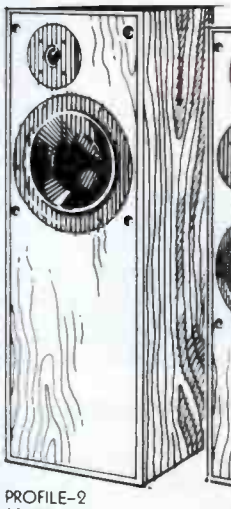

PROFILE-2
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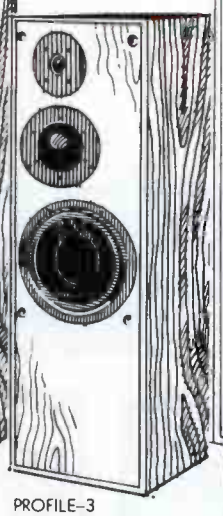

PROFILE-3
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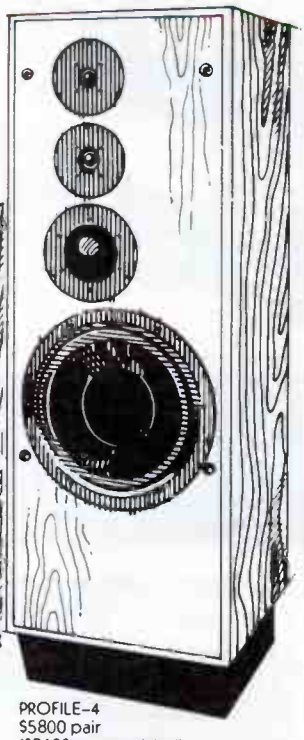

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S&T 4412

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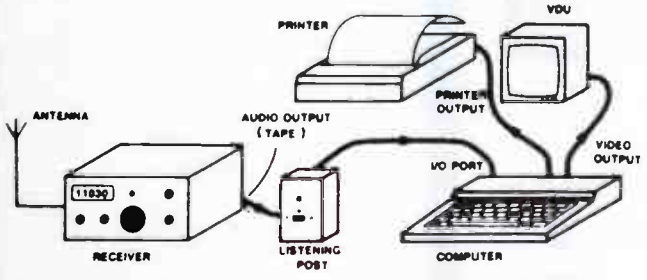
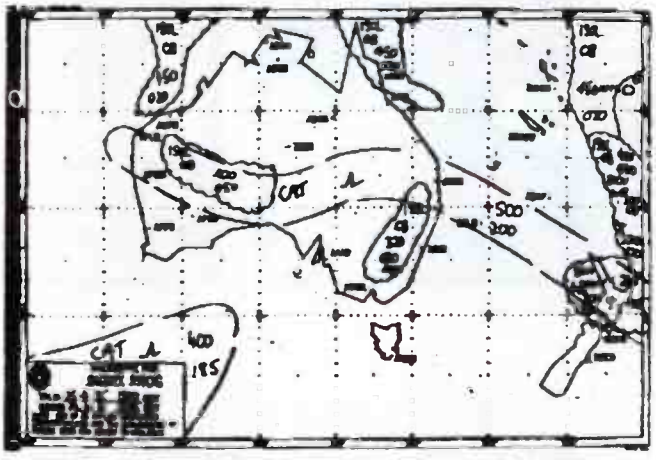


Build the Australian Electronics Monthly "Listening Post" (AEM3500), a simple add-on decoder project – it goes between the audio output of a HF (shortwave) communications receiver and the I/O of your Commodore 64 or Microbee computer; software then decodes the transmissions for you. Print weather maps, foreign news service broadcasts, amateur and commercial radioteletype or Morse transmissions. *

Fascinating! Useful, too.



FAX picture

SOFTWARE ONLY: $25.00
– includes all instructions on the decoder & s/ware.

LISTENING POST "PACKAGE": $35.00
– you get software, quality fibreglass pc board with component overlay and full how-to-build instructions plus software operating details. (Components are widely sourced by electronics retailers).

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World Radio History

STEREO LIMITER

A quality limiter for use in tape recorders, transmitters, public address systems, and discotheques.

A limiter is an electronic volume adjustment circuit in which AF signals are amplified up to a predefined level of the input amplitude. When this level is reached, the gain of the amplifier is reduced to ensure that a fixed, maximum, output level is not exceeded. In other words, the output amplitude remains constant irrespective of fluctuations of the input signal above the limiting threshold. Limiting is, therefore, often referred to as *dynamic range compression*. Figure 1 shows the dynamic response—U_o as a function of U_i—of the proposed limiter.

The design described here is based on a pair of standard gain controlled amplifiers which ensure a dynamic range compression of about 46 dB. The limiting threshold is reached at an input voltage of about 50 mV: the output voltage is then about 670 mV.

Circuit description

With reference to the circuit diagram of the stereo limiter in Fig. 2, opamp A_1 sums the signals applied to the L and R inputs, and provides the gain control signal for the limiter chip Type NE572 in position IC_3. Although it is economical to provide a gain control signal common to both channels, the result is, of course, the likelihood of mutual and inappropriate gain reduction on the stereo outputs. Fortunately, this effect does not raise problems for programme material played at average to loud levels, and the differences in output volume on the channels are certainly tolerable at less than 5 dB.

Both channels in the Type NE572 dual programmable analogue compander (compressor-expander) from Valvo/Mullard comprise a full-wave *rectifier*, a *buffer* and a linearized, temperature compensated *gain cell*. All these operate independently from the corresponding section in the other channel. The rectifier translates the AF signal from A_1 into a direct control current for the buffer, which in turn controls the output current provided by the associated gain cell, marked ΔG in the circuit diagram. The attack and recovery constants of the gain controlled buffers are determined with the aid of external electrolytic capacitors C_8-C_9 (L) and C_{12}-C_{13} (R). The outputs of the current controlled gain cells ΔG are connected to the feedback resistors of opamps A_5 (L; R_5) and A_6 (R; R_{12}). Hence, the output current provided by the gain cells controls the attenuation introduced by A_5 and A_6. In the present application, the operation of the gain cells is, therefore, comparable to that of a current controlled electronic potentiometer. Output opamps A_2 (L) and A_4 (R) are dimensioned for an amplification of about 4.7. The oscillograms of Fig. 3 show the dynamic response of the limiter.

It is evident that the technical characteristics of the proposed limiter are a compromise between what is useful on the one hand, and practical for most applications on the other. This means that the input threshold, the output level, the dynamic range and the tracking(gain dis-

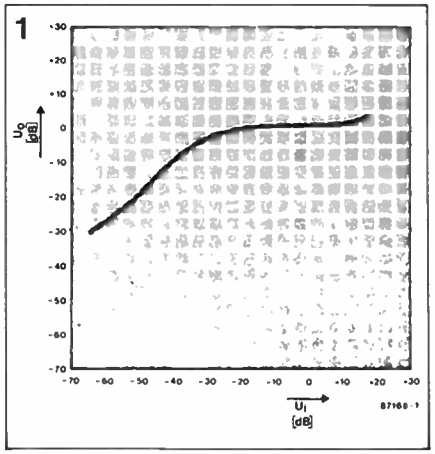

Fig. 1. Dynamic response of the stereo limiter.

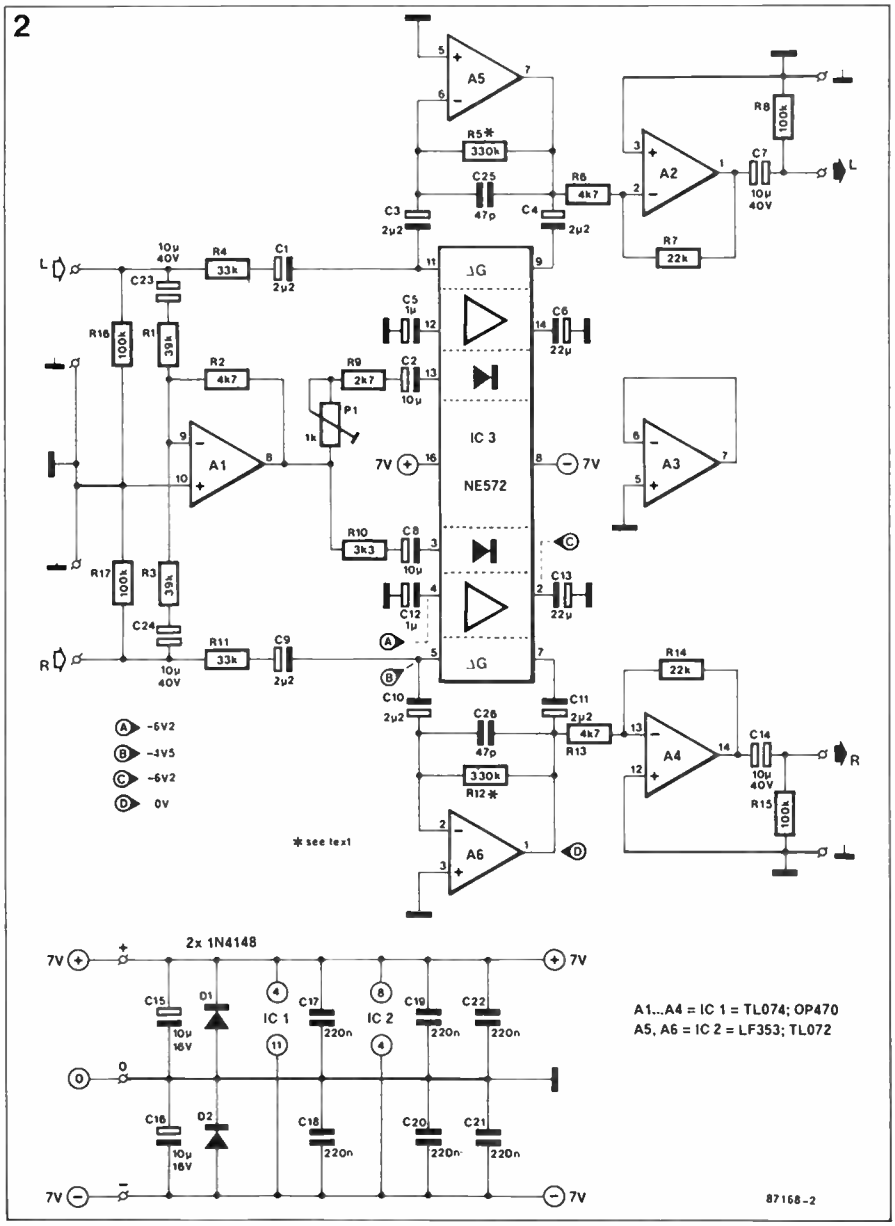

Fig. 2. Circuit diagram of the stereo limiter.

World Radio History

tribution) of the channels are dimensioned such that the circuit is suitable for a wide variety of applications. In some cases, the technical characteristics may need altering, however.

Resistor R_5 (R_{12}) sets the maximum amplification for an optimum signal to noise ratio in the absence of an input signal. The maximum usable resistance is about 680K. The gain cells operate at a bias potential of about −5 V, while the + input of the associated operational amplifier (pin 5; 3) is connected to ground. This means that the maximum drive for A_5 (A_6) is about 1.4 V_{rms}. Both gain controlled opamps function as an alternating voltage amplifier, and do not, therefore, need a coupling capacitor to the associated output driver.

The attack constant is determined with C_{12}; C_5 (R; L), the release constant with C_{13}; C_6 (R; L).

The main point in the dimensioning of the control circuit concerns the selection of the control voltage for the gain cells. In practice, it was found that the drive margin can not be set much higher than −25 dB, corresponding to the already stated 50 mV (0 dB≙1 mW in 600 Ω). The input voltage should, therefore, not exceed 130 mV_{rms} to avoid overdriving the limiter, since this would then operate linearly again, amplifying the input signal. To avoid any risk of this happening, it is recommended to fit presets with a value of, say, 100 kΩ at both limiter inputs.

The tracking (gain balance) of the channels is optimized with the aid of P_1. The correct adjustment is reached after checking, noting and comparing the dynamic response curves of the L and R channel with the aid of a calibrated sine-wave generator, an oscilloscope and a true-rms meter.

In the absence of these instruments, acceptable results are obtained when P_1 is set to the centre of its travel.

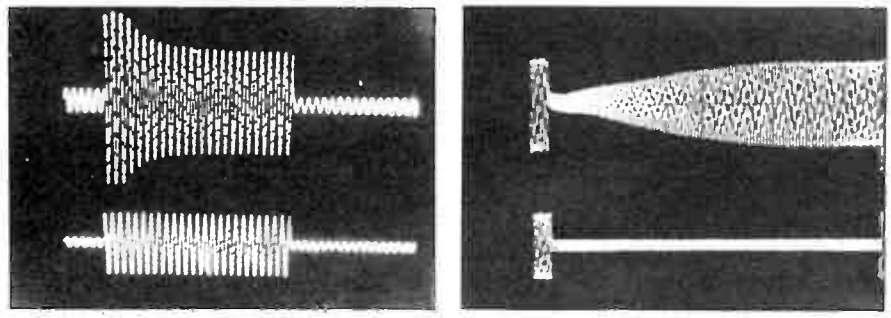

Fig. 3. Automatic level control obtained with the limiter. Small signal response (b) and large signal response (a). Upper channel: output; lower channel: input.

Construction and use

The ready-made printed circuit board for the stereo limiter is shown in Fig. 4.

Construction follows the usual pattern of fitting the components as per the parts list and the white overlay on the PCB. Fit the ICs in sockets, and do not forget the 2 short wire links between C_{20} and C_{21}. The capacitors in the corners of the PCB are bipolar (*non-polarized*) types.

Attention: pin 5 of IC_2 is erroneously left unconnected on the PCB. This is readily amended by running a short length of light insulated wire from pin 5 to the ground connection of C_{20}.

The supply voltages for the limiter can be obtained by stepping down ±10, ±12 or ±15 V rails available in the equipment to incorporate the stereo limiter.

Parts list

Resistors (±5%):
R_1;R_3 = 39K
R_2 = 4K7
R_4;R_{11} = 33K
R_5;R_{12} = 330K
R_6;R_{13} = 4K7
R_7;R_{14} = 22K
R_8;R_{15};R_{16};R_{17} = 100K
R_9 = 2K7
R_{10} = 3K3
P_1 = 1K0 preset H

Capacitors:
C_1;C_3;C_4;C_9;C_{10};C_{11} = 2μ2; 25 V
C_2;C_8;C_{15};C_{16} = 10μ; 16 V
C_5;C_{12} = 1μ; 25 V
C_6;C_{13} = 22μ; 25 V
C_7;C_{14};C_{23};C_{24} = 10μ; 40 V, bipolar *
C_{17} . . . C_{22} incl. = 220n
C_{25};C_{26} = 47p

* e.g. Maplin order no. FB06G, or Cirkit stock no. 04-10613

Semiconductors:
D_1;D_2 = 1N4148
IC_1 = TL074 or OP-470
IC_2 = LF353 or TL072
IC_3 = NE572* (Valvo/Philips/Mullard)

* Available from Universal Semiconductor Devices Limited.

Miscellaneous:
PCB Type 87168 (see Readers Services page)

4

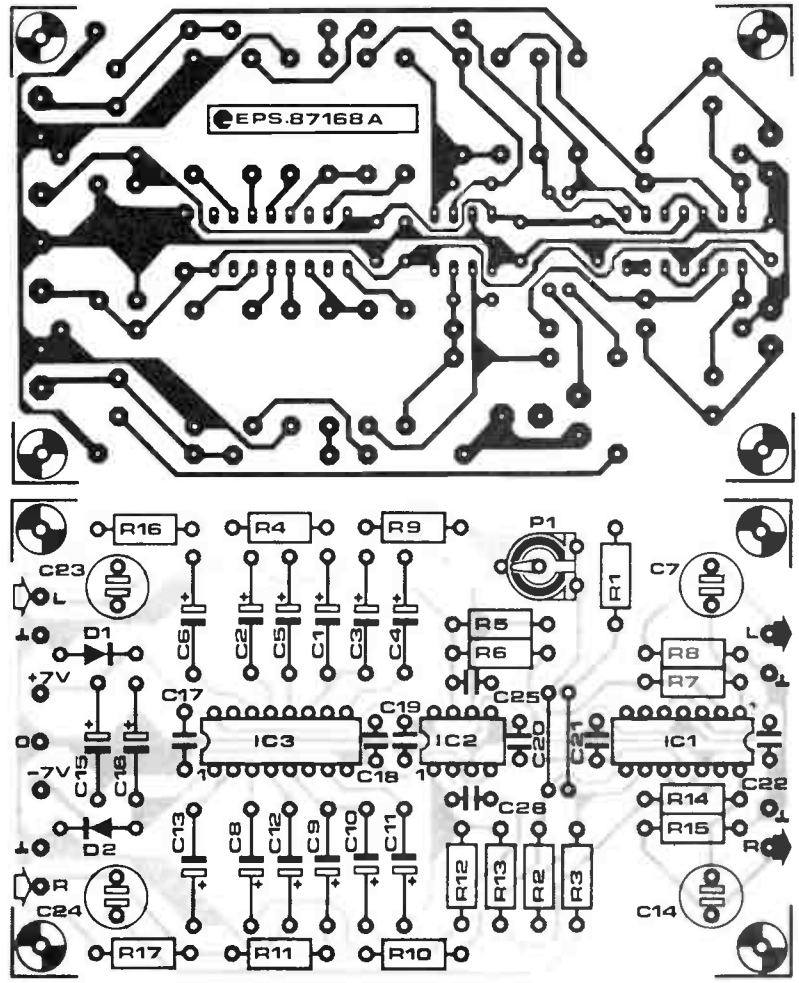

Fig. 4. Track layout and component mounting plan for the printed circuit board.

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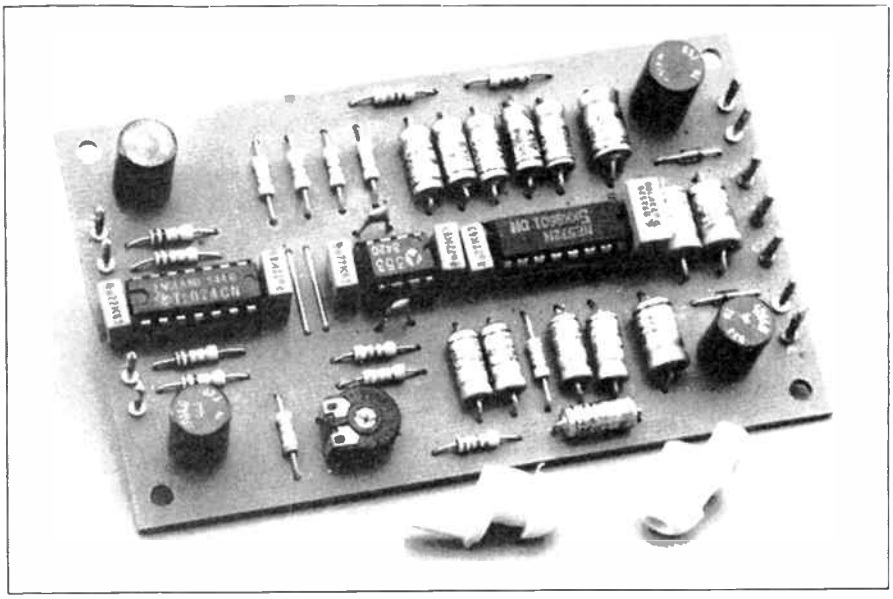

Zener diodes and discrete regulators are equally suitable for providing the regulated ±7 V supply voltage.
The limiter is best connected permanently between the outputs of a line driver or mixer, and the inputs of the power amplifier. After establishing the drive margin of the system, the output and input level presets (if used) are sealed to avoid overdriving the power amplifier and the limiter, respectively.*Gb*

DOUBLE TRACE EXTENSION FOR VLF ADD-ON UNIT

by E Fano

A handful of components and some minor alterations to the VLF add-on unit for oscilloscopes enable this popular unit to be used for two-channel measurements.

Thanks to its versatility, low cost, and ease of construction and use, the VLF add-on unit for oscilloscopes published in reference [1] has become one of the most popular construction projects featured in *Elektor Electronics*. The following description shows that the circuit is readily modified to achieve two-channel operation on a single-beam oscilloscope. The required modification and the extension circuit are useful for many applications involving the simultaneous analysis of 2 slowly varying quantities.

Input multiplexing and 256 bytes more

In the original design of the VLF storage unit, address lines A8 to A10 incl. of RAM IC_2 are kept permanently logic low. This means that only the first 256 of the available 2048 programmable locations in the RAM are used for storage of converted data. The idea behind the present extension is to drive address line A8 with a signal that creates an additional data block of 256 bytes. This block is written to during every second display—conversion cycle, and can thus hold the digitized data for a second input channel. The input signal for opamp IC_1 is, of course, multiplexed accordingly.

The modifications

The bold lines and the shaded area in Fig. 2 give all the necessary details on the modifications and the extension circuit. It is recommended to cut the connection between pins 23 and 22 of the socket that holds RAM IC_2. This modification is performed at the track side of the board, and effectively insulates pin 23—address line A8—of the RAM. Solder a wire to the insulated area that connects to socket pin 23, and run it to pin 3 of IC_{10b} (= output 1QA). Construct the input multiplexing circuit in the shaded area on a small piece of prototyping board, and connect it to the VLF storage unit as indicated by the bold lines. The electronic switches in the 4066 toggle on each pulse from output 1QA. This arrangement ensures that the correct data, i.e., the measurement values for each channel, are stored in the relevant 256 byte area in the RAM. Zener diodes D_A and D_B protect the inputs of the 4066 against overvoltages. To prevent distortion of the displayed image, the signal

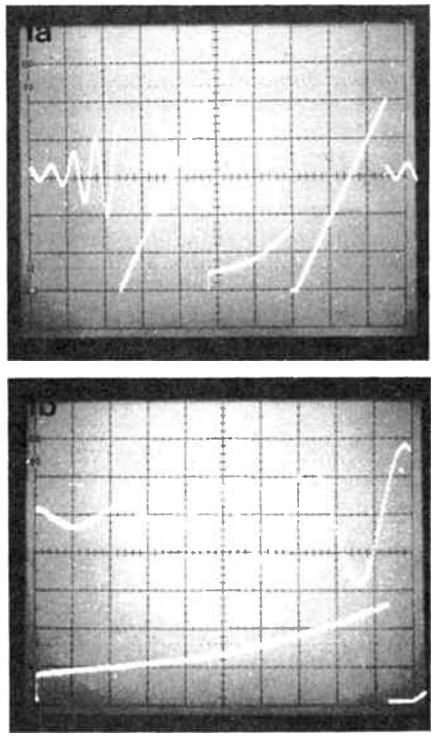

Fig. 1 Output waveform of the 2-channel storage unit using incorrect (a) and correct (b) trigger settings on the oscilloscope.

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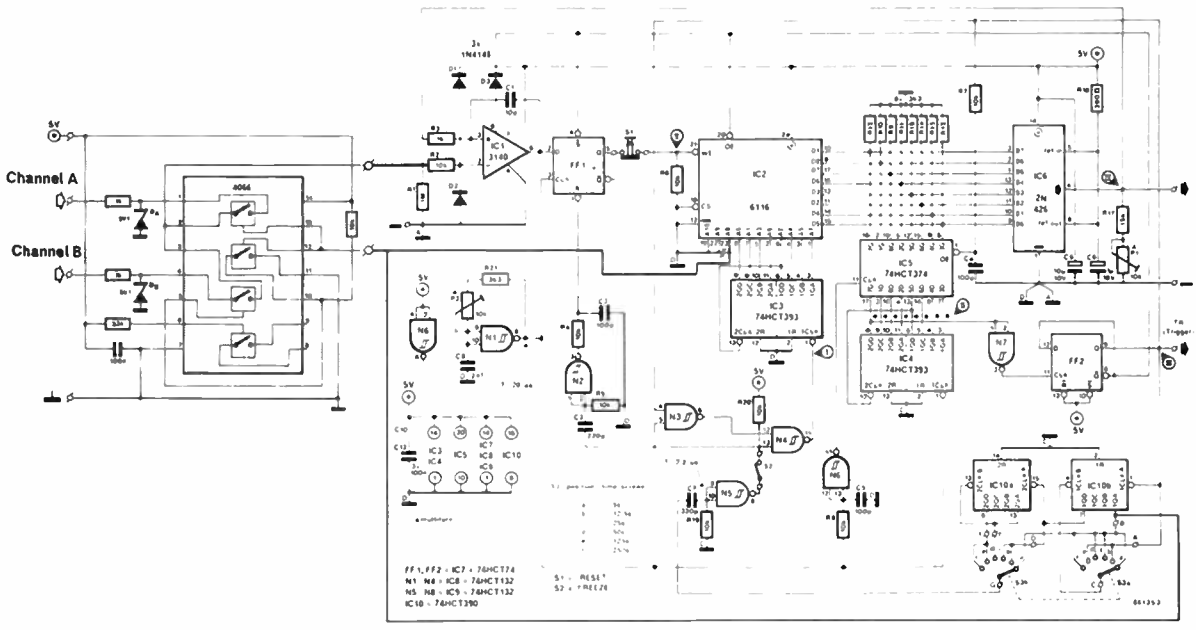


Fig. 2 Circuit diagram of the complete 2-channel unit. The modifications are shown in bold lines, the extension in the shaded area.

applied to input B may not go negative. Figures 1a and 1b illustrate the effect obtained with the modified and extended VLF storage unit.

Finally, some constructors have reported the absence of count pulses on pin 7 of IC_{10} on selecting display range **b** (12.5 s). This effect is probably due to parasitic capacitance blocking the decimal counter, and may be remedied by fitting a 33 kΩ series resistor on the TRIGGER output line to the oscilloscope. This resistor also protects the output of FF_2 against short-circuits on the TRIGGER output.

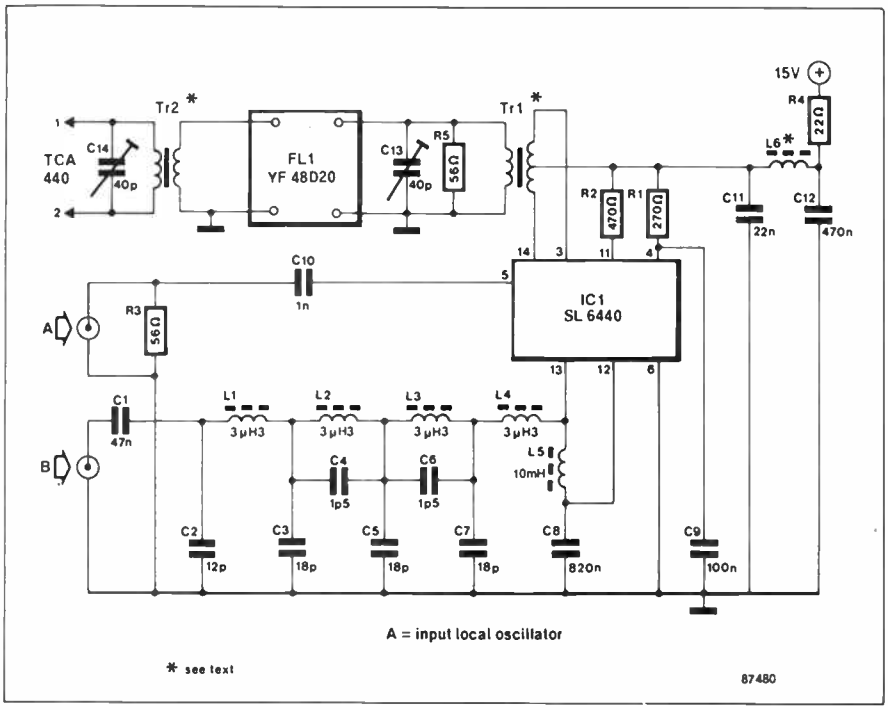
Th

Reference:

[1] *VLF add-on unit for oscilloscopes.* Elektor-in-AEM, March 1987.

FRONT-END FOR SW RECEIVER

There are many conflicting technical requirements for a good-quality front-end in an SW receiver. The noise figure and the intermodulation level should be low, the RF insulation between ports LO, RF and IF should be high, and some amplification is desirable. The Type SL6440 high level RF mixer from Plessey ensures a noise figure of around 10 dB, and offers sufficient suppression of the LO signal. The signal applied to the RF input (B) of the front-end is passed through a low-pass filter with a cut-off frequency of 32 MHz and an output impedance of 500 Ω. The open collector output of mixer IC_1 has a relatively high impedance, which necessitates the use of Tr_1 and R_5 for correct matching to 48 MHz crystal filter FL_1. The fixed impedance of this filter for signals outside its pass-band helps to keep the intermodulation distortion low. Trimmers C_{13} and C_{14} are aligned for a maximum flat pass-band at minimum loss. The mixer's intermodulation characteristics can be optimized by careful dimensioning of R_1 and R_2, provided the amplitude of the local oscillator signal is stable. A third-order intercept point of 33 dBm was achieved in a prototype. The mixer IC gets fairly warm, and should be cooled with a heat-sink.



The RF transformers are wound as follows (use 30SWG enamelled wire):

Tr_1: the primary winding is 10+10 bifilar turns, the secondary is 10 turns, on a Type T50-12 ferrite core.

Tr_2: the primary winding is 2 turns, the secondary 18 turns, on a Type T50-12 ferrite core.

L_6: 6 turns through a ferrite bead.

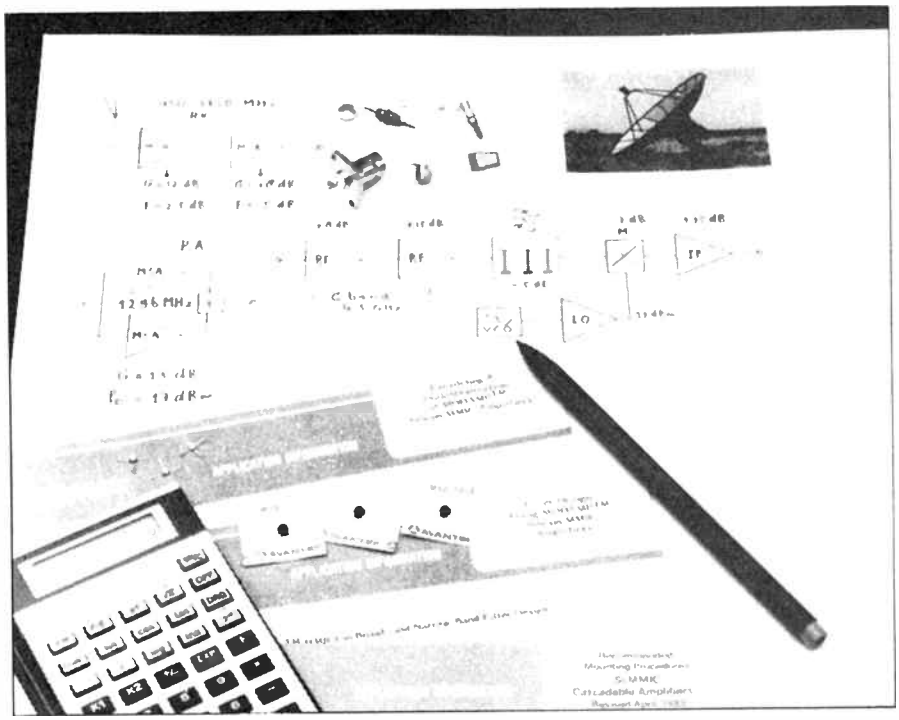
B

World Radio History

MMICS REVOLUTIONIZE WIDEBAND RF AMPLIFIER DESIGN

A small 4-pin device that, together with a few external passive components, can be used for building an unconditionally stable RF amplifier which guarantees a moderate noise figure and high amplification from DC (yes!) to well over 1,000 MHz, without the need of extensive bias circuits, decoupling, and cable matching at input or output.
The latest dream of an RF designer? No, an MMIC from Avantek of Santa Clara.

Recently, Avantek added 4 devices to their existing series of *monolithic microwave integrated circuits* (MMICs). Up to then, MMICs had found applications mainly in the RF sections of professional telecommunication equipment. The new devices are the MSA01xx through MSA04xx, plastic encapsulated—and, therefore, less expensive—versions of the existing ceramic (Micro-X) chips.
The aim of this introductory article is to show that these new devices enable any designer with a reasonable knowledge of applied electronics to build a wideband, high performance RF amplifier with hardly more effort than necessary for getting, say, an LM386 based AF amplifier to work.



What is an MMIC?

Avantek's MODAMP* series of MMICs is essentially a family of silicon bipolar wideband amplifiers that are available in a variety of ceramic and—recently—plastic packages. MMICs are fabricated using nitride self alignment, ion implantation for precise control of doping, and nitride passivization for high reliability. They house an accurately engineered darlington transistor configuration with extremely low stray inductance and capacitance. Internal series and shunt feedback ensures high repeatability from amplifier to amplifier.
The complete family of Avantek MMICs is listed in numerical order in Table 1. It is seen that the devices can be selected for highest amplification, lowest noise figure, and optimum 3rd order interception point, as required for the application in question.
The performance of the MMIC can be deduced from the 4 or 6 digits following the letters MSA in the type number (refer to Table 1):

■ Digits 1 and 2. Electrical performance:

01: Low output power (P_{1dB} = 1 or 1.5 dBm), high gain (18.5 dB), and moderate noise figure (NF = 5 dB).
02: Medium output power (P_{1dB} = 4 dBm), medium gain (c. 11 dB), and moderate noise figure (NF = 6 dB).
03: High output power (P_{1dB} = 10 dBm), medium gain (c. 11 dB), and moderate noise figure (NF = 6 dB).
07: 02 series with lower supply voltage and lower NF.
08: special device optimized for highest gain (30 dB) and lowest noise figure. Medium output power (P_{1dB} = 12 dBm). Requires a non-standard bias decoupling network to ensure stability.

■ Digits 3 and 4. Package style:

04: low cost, 145 mil, round, plastic package.
20: 200 mil, square, ceramic (BeO) package for optimum thermal conductivity.
35: 100 mil, square, Micro-X glass sealed package for minimum parasitic inductance and capacitance.
70: 70 mil, square, gold plated package. for high-reliability applications.
85: low cost, 85 mil, round, plastic package similar to Micro-X.
86: surface mount package; decreased RF performance with respect to style 85.

■ Digit 5. Supply voltage:

1: MMIC has an on-chip series bias resistor, and can be fed from +12 V via a small choke. Device has 1 ground terminal.
2: MMIC requires an external series bias resistor plus choke to ensure an operating voltage of 5 to 6 V. Device has 2 ground terminals.

■ Digit 6. Performance indication:

1: Premium device with extended frequency range.
2: Standard device.

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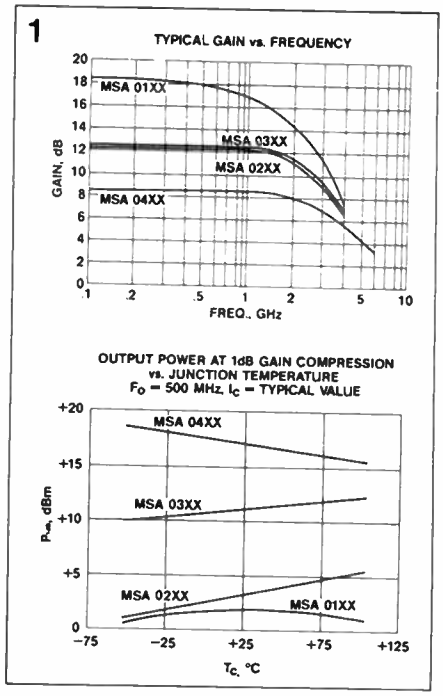

Fig. 1. These curves enable quick selection of an MMIC for a given application.

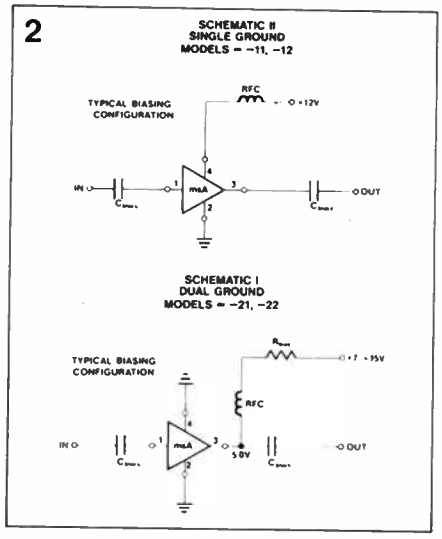

Fig. 2. Basic connection diagrams for MMICs with (a) and without (b) an on-chip bias resistor. The version is indicated by digit 5 in the part number.

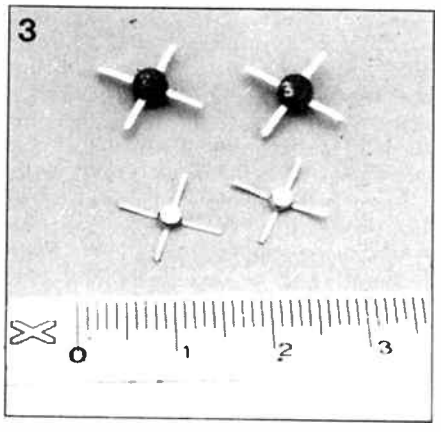

Fig. 3. The new plastic encapsulated MMICs Type MSAXX04 are considerably larger than Micro-X types in a ceramic enclosure.

The photograph of Fig. 3 shows the difference in size between the plastic encapsulated MMICs Types MSA0204 and MSA0304, and 2 MSA0435s housed the Micro-X package. Note the type indication on the plastic MMICS; the Micro-X types are so small that a coloured band around the ceramic body is used for type reference. Fortunately, Avantek supplies all MMICs in separate plastic enclosures with the type indication printed clearly on the back.

The performance of the MMICs in the MSA series, excluding the special 07xx and 08xx types, is shown in Figs. 1a and b. The curves enable ready selection of a suitable device for a given application. The gain of all devices exhibits a remarkable flatness from 100 MHz up to 1 GHz. Types MSA03XX and MSA04XX reach up to 2 GHz with a gain ripple of ±1 dB. In a standard amplifier based on discrete components, this sort of performance is almost impossible to achieve without resorting to eleborate feedback networks and expensive, gain controlled, active devices. MMICs are well suited to cascading in 2- or 3-stage wideband amplifiers with a gain of up to 25 dB. In general, the RF input stage will be dimensioned for lowest noise figure, while the second stage is set up with an MMIC that ensures high gain.

Figure 2 shows the remarkably simple basic configurations of amplifiers based on MMICs. The difference between the circuits is mainly the connection of the chip to the supply voltage, V_{cc}, as discussed above (Digit 5). The value of the bias resistor in the circuit of Fig. 2b is calculated from

$$R = (V_{cc} - V_{MMIC})/I_{MMIC}$$

where V_{MMIC} and I_{MMIC} are the optimum values taken from the relevant data sheet. The resistor is preferably a carbon type to ensure an total reactance of the R-L combination greater than 500 Ω at the frequency of operation. Without the choke, the MMIC would see the supply resistor connected in parallel with the load impedance, because the decoupled positive supply rails is simply ground for RF signals. It is recommended to ensure a mimimum drop of 2 V across the resistor.

The only other components required to make a functional wideband amplifier are suitable RF sockets (BNC, SMA, TNC) and 2 blocking capacitors. One of the most striking characteristics of the MMIC based amplifier is the absence of any form of impedance matching circuitry at the input and output. This obviates the need of difficult-to-make inductors, and decoupling of the bias potential applied to the amplifier input. The input and output impedance of any MMIC in the MSA series is 50 Ω, and the VSWR (reflection coefficient; the voltage standing wave ratio, Z_0/R) is never worse than 2:1 when the device is fed with the recommended supply voltage.

The blocking capacitors should present a reactance of the order of a few ohms, and have good RF properties. Silver mica types can be used with satisfactory results for HF and VHF, but leadless ceramic chip, or SMA, types are a must when frequencies higher than 1 GHz are involved. Due care should be taken to allow for the stray capacitance at the MMIC input and output.

It is, of course, possible to dimension the blocking capacitors such that a low frequency roll-off is created, purposely limiting the bandwidth of the amplifier at the lower end of the spectrum. With $Z_i = Z_o = R = 50\ \Omega$, and C fitted at the input and output of the amplifier, the 6 dB cut off frequency, f_c, is calculated from

$$f_c = 1/(2\pi 50C)$$

Although MMICs work fine below, say, 30 MHz, some discrete or integrated VHF/UHF power amplifiers may require bandwidth limiting capacitors to avoid spurious oscillation due to the high gain-bandwidth product.

Drop-in amplifiers

MMICs are often referred to as *drop-in* amplifiers by virtue of their direct matching to 50 Ω sources and loads, their unconditional stability and immunity to source or load impedance variations (filter drivers!), and the absence of alignment points. Single or cascaded MMICs enable quick and cost effective building of accurately tailored RF and IF sections in VHF, UHF and SHF receivers. In transmitters and transverters, the more powerful MMICs of Table 1 can be used in driver stages and oscillator buffers. A wideband active probe for use with an 1 GHz oscilloscope or a frequency meter is yet another of the many applications that come to mind considering the low cost and ease of use. The simple supply voltage arrangement for MMICs makes it possible to power the amplifier via the coax cable that carries the output signal to the instrument.

More power: more MMICs

Identical MMICs with a high output power compression figure may be connected in parallel to increase the available power output. All MMIC outputs are simply connected and fed from a common RF choke and biasing resistor. This set up requires only 1 output blocking capacitor between the supply

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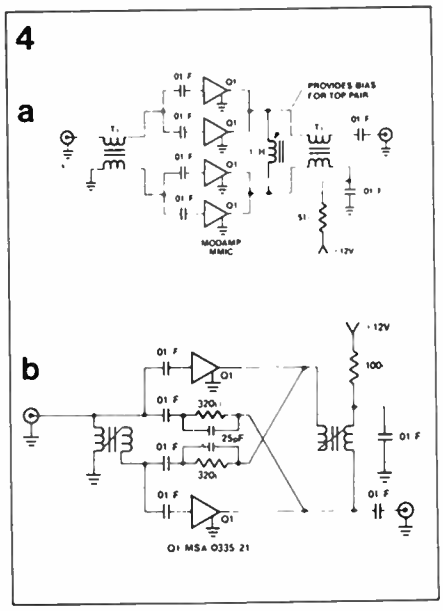

Fig. 4. Connecting MMICs in parallel arrangements to achieve higher output power.

junction and the RF output. Each MMIC input, however, needs its own blocking capacitor to the amplifier input. With *n* MMICs in parallel, the input and output impedance is simply 50/*n* Ω. Figure 4a shows the use of 4 MMICs in parallel, with 4:1 step up baluns (*balance-to-unbalance transformers*) to maintain 50 Ω input and output impedance. It should be noted that the parasitic capacitance of the baluns may have a limiting effect on the overall bandwidth of the amplifier.

Another example of a multi-MMIC amplifier is shown in Fig. 4b. This is the so-called *unilateralized* push-pull amplifier. Unilateralization is a technique in which the imaginary as well as the real term of the feedback elements is cancelled. This creates an amplifier with high isolation between the input and the output. The technique differs from *neutralization* as a means of stabilizing an amplifier. In neutralization, only the *imaginary* terms of the feedback reactances are cancelled because the necessary inverse feedback is provided through a small inductor or capacitor, which does not track the reactance of the inductive or capacitive feedback over frequency. Consequently, the conventional neutralized amplifier is only stable over a relatively small frequency range. In the circuit of Fig. 4b, each MMIC forms the active, negating element in the reactance of the other's feedback circuit. The inductors in the circuit serve the dual purpose of 4:1 impedance transformation and balun. The reason that MMICs are so easily unilateralized is that their internal feedback network is of very low Q compared to that of conventional amplifiers, ensuring a predominantly resistive rather than reactive feedback. It should be noted, however, that unilateralization in push-pull

5

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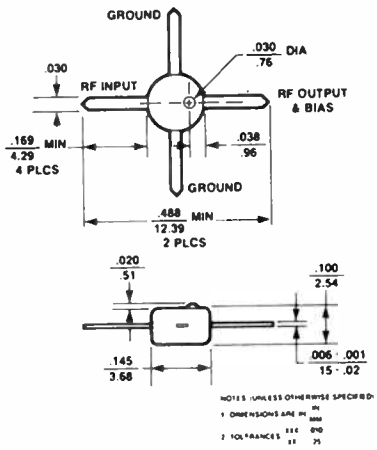
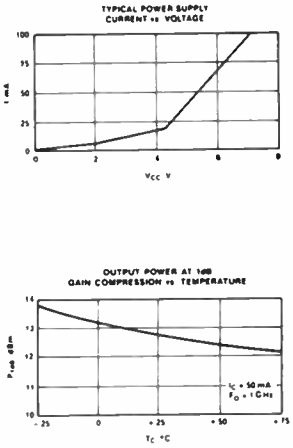
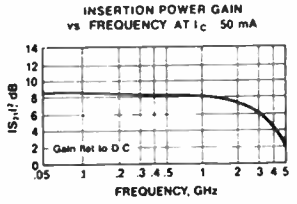
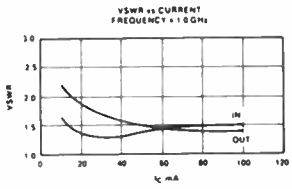
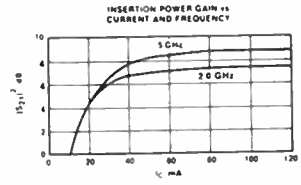


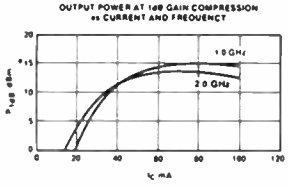
TYPICAL PERFORMANCE CURVES, T_A = 25°C











TYPICAL SCATTERING PARAMETERS

V_{CE} = 5.5V, I_C = 50 mA

Freq. MHz	S_{11} Mag	S_{11} Ang	S_{21} dB	S_{21} Ang	S_{12} dB	S_{12} Ang	S_{22} Mag	S_{22} Ang
100.00	.162	175.8	8.273	174.5	16.140	.8	.118	14.1
500.00	.162	158.9	8.014	153.2	15.990	3.4	.140	59.3
1000.00	.162	142.3	7.960	126.4	15.388	5.6	.201	100.6
1200.00	.165	138.0	7.682	115.1	15.161	6.8	.226	114.6
1400.00	.165	136.4	7.521	106.9	14.724	7.0	.253	126.0
1600.00	.172	132.5	7.269	96.1	14.442	7.7	.281	137.4
1800.00	.177	132.3	7.175	86.2	14.035	6.5	.307	146.4
2000.00	.193	131.6	6.912	76.1	13.744	6.4	.330	156.6
2200.00	.207	129.4	6.791	66.5	13.257	4.3	.356	165.7
2400.00	.230	128.2	6.453	58.3	13.139	3.5	.375	173.9
2600.00	.254	125.5	6.273	49.0	12.638	1.2	.392	177.9
2800.00	.283	123.6	5.818	41.1	12.586	1.2	.410	171.0
3000.00	.317	121.1	5.595	32.3	12.129	3.3	.431	163.6

ELECTRICAL SPECIFICATIONS, T_A = 25° C

Symbol	Parameters/Test Conditions	Typical Volts	Current (mA)	Freq. (GHz)	Units	Min.	Typ.	Max
$\|S_{21}\|^2$	Insertion Power Gain	5.5	50	0.5	dB	7.0	8.5	–
$\|S_{21}\|^2$	Insertion Power Gain	5.5	50	1.0	dB	–	8.0	–
VSWR	Freq. at VSWR 2:1	5.5	50	–	GHz	–	2	–
P_{1dB}	Output Power at 1 dB Gain Compression	5.5	50	1.0	dBm	–	12	–
NF_{50}	50Ω Noise Figure	5.5	50	1.0	dB	–	6	–
IP_3	Third Order Intercept Point	5.5	50	0.5	dBm	–	26	–
HP_2	Second Harmonic Intercept Point	5.5	50	0.5	dBm	–	53	–
f_{1dB}	Frequency at -1dB Gain Point[1]	5.5	50	–	GHz	–	1.5	–

Note 1: Frequency at which gain is 1 dB less than at 100 MHz

88015-5

Fig. 5. Main technical specifications of the Type MSA0404 monolithic microwave integrated circuit from Avantek.

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circuits is only useful for providing slightly higher gain or substantially more isolation between the amplifier input and output.

The main technical specifications of the Type MSA0404 are given in Fig. 5. It is seen that this device provides a virtually flat power gain of about 8 dB from 50 MHz right up to 2 GHz. The noise figure of the MSA0404 makes the device less suitable as an RF preamplifier, but it is ideal for building a wideband signal distribution amplifier for use in, say, CATV or satellite TV systems.

Construction: general considerations

The scope of this introductory article allows only general considerations on the construction of MMIC based amplifiers. The subject will, therefore, be reverted to in greater detail in a forthcoming issue of *Elektor Electronics*.
An experimental HF or VHF amplifier based on MMICs is readily built on a piece of double-sided, unetched glass-epoxy circuit board material. All terminals that require grounding are soldered direct onto the copper surface, and the blocking capacitors are fitted with flying leads between the MMIC and the respective RF socket. The circuit board can be secured in a small aluminium enclosure. A hole is drilled in the circuit board to enable the ground leads of the MMIC to be soldered to the copper surface with the shortest possible length. MMICs have substantial gain at low frequencies, requiring due attention to be paid to the dimensioning of the supply decoupling. A 4.7 μF tantalum bead capacitor and a 1 nF disc ceramic type in parallel should work satisfactorily in most cases. The use of metal film resistors for powering the MMIC is not recommended. Some inductance should be provided, so that a common ½ W or ¼ W carbon resistor gives far better results.
Microstripline techniques are a must for maintaining the correct input and output impedance of 50 Ω when MMICs are used at frequencies higher than 1 GHz. Figure 6 shows the recommended lay-out of an amplifier based on a single MMIC with external bias resistor (types -21 and -22). The PC board material is preferably RTE Duroid®, which ensures a uniform dielectric constant, and low loss at frequencies up to 4 GHz. The bypass and blocking capacitors are leadless ceramic or SMA types, and the rectangular copper areas at the input and output of the MMIC form the 50 Ω matching microstriplines. The centre pins of the RF connectors are soldered straight onto the input and output areas.
The layouts of the printed circuit boards

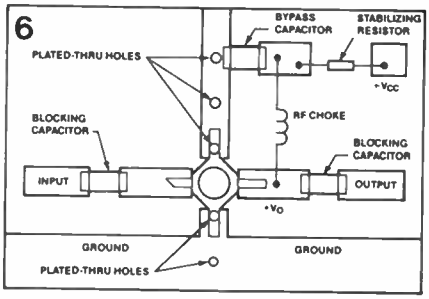

Fig. 6. Component arrangement for an MMIC based RF amplifier in microstripline technique.

in Fig. 7 can be used for building 1, 2, or 3-stage microstripline MMIC amplifiers based on Micro-X devices with external bias networks.

Conclusions

The introduction of the plastic MSA0104 through MSA0404 MMICs is sure to boost the interest in these extremely simple-to-use RF amplifiers, since these are now available at affordable cost, and in an easy to handle package. MMICs are, however, not always the best choice for designing an RF *input* stage. Their noise figure of 3 to 6 dB is still relatively high compared to GaAs FETs (0.5—2 dB) at frequencies higher than about

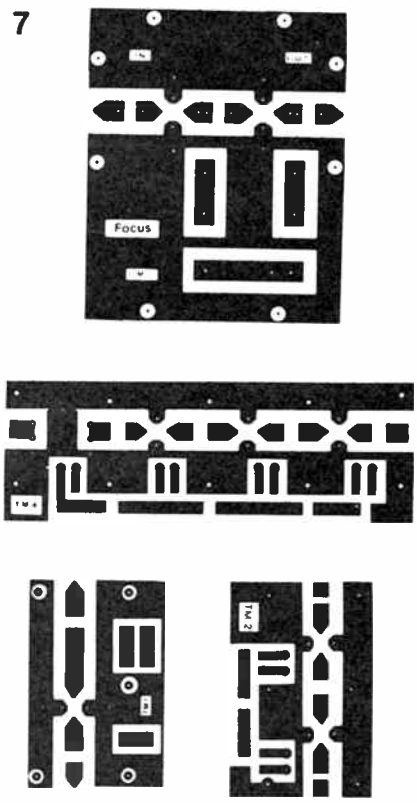

Fig. 7. Suggested PC board layouts for microstripline amplifiers using the MSA0X35 series of cascadable MMICs in Micro-X style.

Table 1

MSA SERIES (Typical Specifications @ 25°C Case Temperature)

Part Number[1]	Maximum Useable Frequency (GHz)	$\|S_{21}\|^2$ Gain @ 0.1 GHz (dB)	$f_{3.dB}$ (GHz)	Noise Figure @ 0.5 GHz (dB)	P_{1dB} @ 0.5 GHz (dBm)	IP_3 @ 0.5 GHz (dBm)	Case Type
MSA-0104	2.5	18.5	0.3	5.5	1.5	15.0	4-Pac plastic
MSA-0204	2.5	12.5	0.8	6.0	4.0	17.0	4-Pac plastic
MSA-0304	2.5	12.5	0.9	6.0	10.0	23.0	4-Pac plastic
MSA-0404	3.0	8.2	1.5	6.5	13.0	28.0	4-Pac plastic
MSA-0420[3]	3.0	8.5	2.5	6.0	19.0	34.0	200 mil BeO
MSA-0135-11	2.0	18.5	0.5	5.0	1.0	14.5	micro-X
MSA-0136-12	1.5	18.5	0.3	5.0	1.0	14.5	micro-X
MSA-0135-21	3.0	19.0	0.7	5.0	1.5	15.0	micro-X
MSA-0136-22	2.5	19.0	0.4	5.0	1.5	15.0	micro-X
MSA-0235-11	2.0	11.5	1.1	6.0	3.0	16.0	micro-X
MSA-0235-12	1.5	11.5	0.9	6.0	3.0	16.0	micro-X
MSA-0235-21	3.0	12.5	1.7	6.0	4.0	17.0	micro-X
MSA-0235-22	2.5	12.5	1.4	6.0	4.0	17.0	micro-X
MSA-0335-11	2.0	11.5	1.1	6.0	9.0	22.0	micro-X
MSA-0335-12	1.5	11.5	0.9	6.0	9.0	22.0	micro-X
MSA-0335-21	3.0	12.5	1.7	6.0	10.0	23.0	micro-X
MSA-0335-22	2.5	12.5	1.4	6.0	10.0	23.0	micro-X
MSA-0435[3]	3.0	8.5	2.5	6.0	13.0	28.0	micro-X
MSA-0735[3]	4.0	13.5	1.7	4.5	5.0	20.0	micro-X
MSA-0835[3]	6.0	33.0	—	3.0	12.5	28.0	micro-X
MSA-0170-11	2.0	18.5	0.6	5.0	1.0	14.5	70 mil
MSA-0170-12	1.5	18.5	0.4	5.0	1.0	14.5	70 mil
MSA-0170-21	3.0	19.0	0.7	5.0	1.5	15.0	70 mil
MSA-0170-22	2.5	19.0	0.5	5.0	1.5	15.0	70 mil
MSA-0270-11	2.0	11.5	1.5	6.0	3.0	16.0	70 mil
MSA-0270-12	1.5	11.5	1.1	6.0	3.0	16.0	70 mil
MSA-0270-21	3.0	12.5	1.9	6.0	4.0	17.0	70 mil
MSA-0270-22	2.5	12.5	1.5	6.0	4.0	17.0	70 mil
MSA-0370-11	2.0	11.5	1.4	6.0	9.0	22.0	70 mil
MSA-0370-12	1.5	11.5	1.1	6.0	9.0	22.0	70 mil
MSA-0370-21	3.0	12.5	1.9	8.0	10.0	23.0	70 mil
MSA-0370-22	2.5	12.5	1.5	8.0	10.0	23.0	70 mil
MSA-0470[3]	3.0	8.5	2.2	6.0	13.0	28.0	70 mil
MSA-0770[3]	4.0	13.5	1.7	4.5	5.0	20.0	70 mil
MSA-0870[3]	6.0	33.0	—	3.0	12.5	28.0	70 mil
MSA-0185[3]	2.5	18.5	0.5	5.5	1.5	14.0	85 mil plastic
MSA-0285[3]	2.5	13.0	1.4	6.0	4.0	18.0	85 mil plastic
MSA-0385[3]	2.5	13.0	1.3	6.0	10.0	23.0	85 mil plastic
MSA-0485[3]	3.0	8.5	2.0	6.5	13.0	27.0	85 mil plastic
MSA-0785[3]	4.0	13.5	1.1	5.0	5.0	17.0	85 mil plastic
MSA-0885[3]	6.0	33.0	—	3.0	11.5	27.0	85 mil plastic
MSA-0186[3]							plastic surface mount
MSA-0286[3]							plastic surface mount
MSA-0386[3]							plastic surface mount
MSA-0486[3]							plastic surface mount
MSA-0786[3]							plastic surface mount
MSA-0886[3]							plastic surface mount

NOTES:
1. Model: -2X Dual Ground—requires an external bias choke or resistor at the output. Refer to schematic drawing.
   -1X Single ground—requires + 12 volts bias on lead 4. Refer to schematic drawing.
2. Dual Ground Only.
3. New Plastic Surface Mount package. Consult your local Avantek Representative for further details or information.

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References:

Avantek product application information:

Recommended Mounting procedures Si MMIC cascadable amplifiers.

Paralleling & unilateralization of MODAMP® silicon MMIC amplifiers.

Filter design using MODAMP® silicon MMIC amplifiers.

Monolithic Microwave Integrated Circuits. By Al Ward, WB5LUA. QST, February & March 1987.

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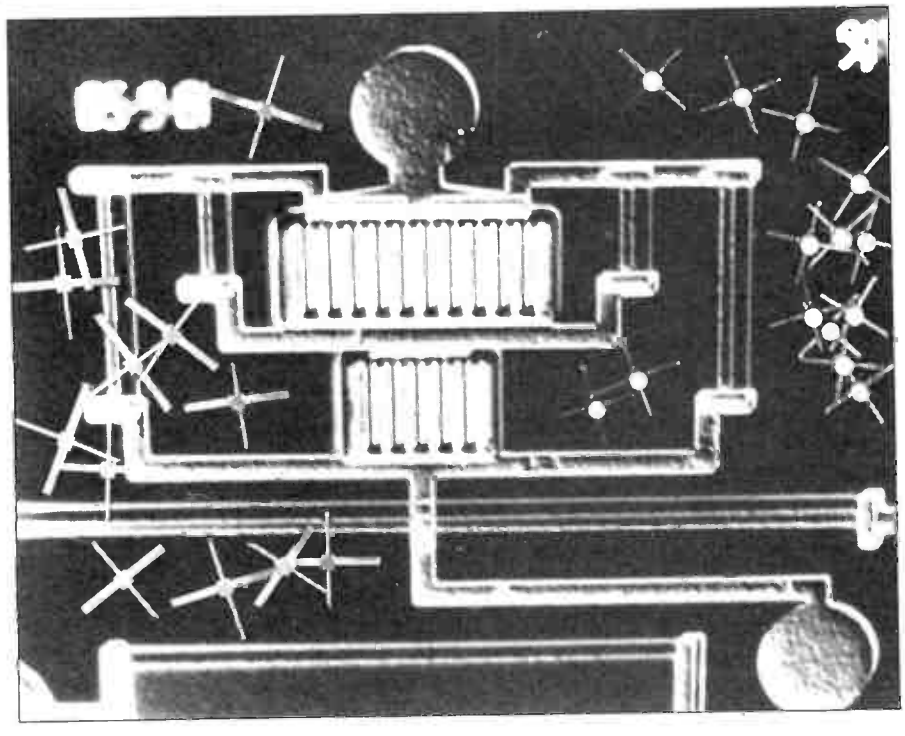

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An important feature is the inclusion of protection from RF interference, so that false triggering won't occur from passing taxis, carphones, CBs, and other RF sources.

The unit has selectable normally-open (N.O.) and normally-closed (N.C.) alarm outputs from a reed relay which provides ultra-quiet operation, and an integral microswitch for "anti-tamper" protection.

For this PIR detector and a range of other bargain-priced alarm peripherals and accessories, contact **Force Electronics, 203 Wright St, Adelaide 5000. (08)212 5400.** Force also has stores in Brighton, Christies Beach, Enfield and Findon.

High quality Velleman kits from Eagle

Eagle Electronics of Adelaide has begun stocking the range of top-quality European produced kits from Velleman. These kits all feature fibreglass pc boards with silk-screen printed component annotation and high quality components.

The range includes kits designed for enthusiasts of all levels, ranging from beginner to the highly experienced. Velleman kits are well known and respected in Europe.

The 50-plus kits in the range include a series of infra-red alarm units, a high quality FM tuner, a 60 watt power amplifier module, a LED VU meter, a "singing" microprocessor doorbell, a tape/slide synchronizer and several microprocessor based timer units.

Further details can be obtained from **Eagle Electronics, 54 Unley Rd, Unley 5061 SA. (08)271 2885.**

RAM bargains

Looking to populate that extra RAM space, or make up an add-on RAM card for your computer? Then you'll be needing lots of RAM chips at the least price available.

Active Wholesale in Melbourne has a decent bargain in 41256 RAM chips at the moment. In lots of 10, they cost $5.95 each ex-tax, normally $7.20 in quantities under ten.

In addition, the old-reliable 6116 is around $4.50 ex-tax, while the 4164 is only $3.25 ex-tax.

Contact **Active Wholesale, 289 Latrobe St, Melbourne 3000 Vic. (03)602 3499.**

Stick it up, with Silastic!

A tube of that handy "elastic" silicone cement and filler, Silastic, so useful for gluing, filling and covering things in electronics construction, should always be kept on hand.

There are two types, useful for various applications: the "acid curing" type (with the pungent odour), known as 732RTV, and the "neutral curing" type, known as 738RTV.

Currently, Dick Smith stores have both types in stock, a 75 gram tube of 732RTV (cat. no. N-1225) costs $4.95, while an 85 gram tube of 738RTV (cat. no. N-1226) costs $12.95. At those prices, it would be a good idea to keep one of each on hand. See your local DSE store or dealer.

Enthusiasts who reside in Melbourne's vast eastern and outer eastern suburbs should be familiar with Ian Truscott's Electronic World at Croydon. If you're not, we urge you to pay a visit and get acquainted. They stock a positively huge range of components, hardware, instruments and other goodies, many not being common at other retailers. They're not far from Croydon railway station, on the corner of Windsor Rd and Lacey St. (03)723 3094.

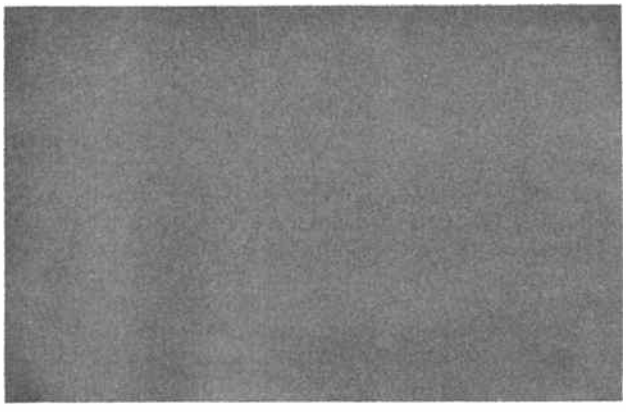
PROJECT BUYERS GUIDE

The AEM4000 Supermicro is available as a complete kit via a special offer from Maestro Distributors by ordering through the magazine. See the article for details.

The AEM3520 VHF Satellite Receiver, of necessity, employs a number of components which are not common, off-the-shelf items. However, several retailers will be stocking kits of this exciting project. Stewart Electronic Components carry all the components in stock and will be stocking a complete kit. They're at PO Box 281, Oakleigh 3166 Vic. (03)543 3733. They should also be able to supply pc boards if your own component resources are such that you don't require a kit. Jaycar will also be stocking a complete kit. They have stores in Sydney, Brisbane and Melbourne.

Parts for the AEM2506 Wideband Instrument Amplifier are relatively easy to get, providing you're prepared to shop outside your local territory. Firstly, the NEC UPC1651 is a stock item at Dick Smith Electronics, cat. no. Z-6008. The 470p ceramic chip, the 10n ceramic plate capacitors and the 1n chassis-mount feedthrough are all available from Stewart Electronic Components at the above address.

In our Elektor section this month, the Stereo Limiter will probably be of wide interest. Based on the NE572, it's quite a useful little device. The NE572, indeed all the components, are available off-the-shelf from Jaycar. The bipolar 40 uF output coupling capacitors are not critical in value and 47 uF ones could readily be substituted. Printed circuit boards should be available from All Electronic Components in Melbourne.



World Radio History

aem project 3520

A VHF receiver for weather satellites

John Day VK3ZJF

Many enthusiasts and educators wish to receive weather satellite pictures. Rather than tying up an expensive piece of equipment such as a scanner, here is a self-contained receiver designed for the job.

BACK IN THE July 1986 issue, Tom Moffat VK7TM presented the AEM3503 Satellite FAX Decoder which enabled anyone with a receiver covering 136-138 MHz to receive and decode, with a computer, the picture output from some types of weather satellites. The most easily received weather satellites are the 'polar orbiting' types. Polar orbiting satellites transmit information collected by a 'scanning radiometer' as they proceed through their orbit, which passes over both the North and South poles; hence the name. The information in its raw state is not terribly sophisticated, but is none the less interesting and these are by far the simplest satellites to receive with inexpensive equipment.

More sophisticated weather satellite information is transmitted in our part of the world by the Japanese GMS geostationary satellite positioned over the equator and forming the local link in a world-wide network. Reception of geostationary satellite signals requires somewhat more sophisticated and thus expensive receiving apparatus as they operate at around 1690 MHz and with much lower signal levels. Although it is not beyond the realms of possibility to build equipment for these 'birds', let's concentrate on the polar orbiters first.

Whilst many people use use scanners such as the AR-2001, and general coverage VHF receivers such as the FRG-9600, for this type of application, many cannot justify the not inconsiderable expense of this class of equipment for this relatively simple application over a narrow range of frequencies. In his July 1986 article, Tom suggested that a stand-alone receiver would be useful. Well, here it is.

Four obvious groups present themselves as potential users for satellites of this type.

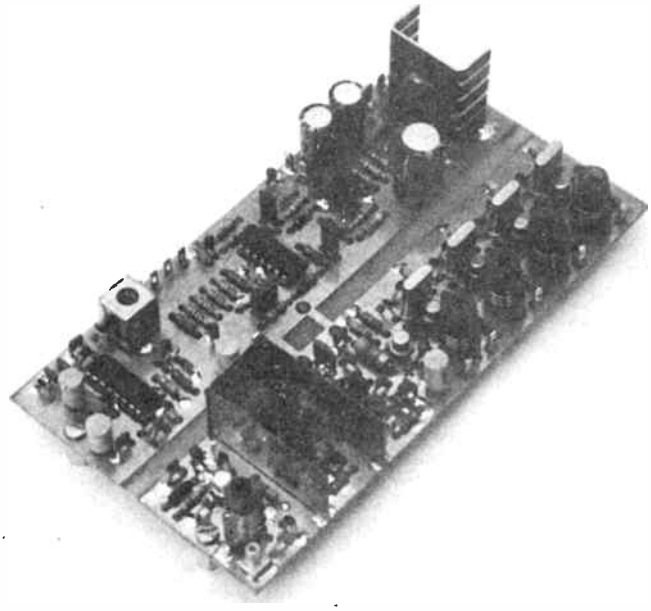
1. Radio Amateurs – for assistance with propagation studies and prediction.

2. Enthusiasts generally – for interest's sake, or so they can say 'look what we can see!' to their friends!

3. Educational Groups – such as schools, Scouting and other outdoor activity groups. For general education, satellite education, computer education and weather pattern observation.

4. Anybody who likes looking at cloud photographs (amateur meteorologists).

It seems only a few of the potential users have much electronics expertise and many will want to use a receiver such as is to be described here in a portable situation. Thus (as our esteemed Editor says), 'Keep it simple Sam' and come up with something that will be all things to all people for ever and cost nothing to build! The final choice of design was for a simple single conversion superheterodyne receiver with four crystal controlled channels which can be operated from a car battery supply or a sealed 12 V lead acid battery for considerable periods.



The receiver is constructed on a double-sided board, the top side being a "groundplane". Pre-wound coil assemblies are employed. Antenna input is at lower left, speaker output at upper right.

One of the most important features of a project such as this is the ability to procure the parts, considerable attention has been paid to this problem in the design of this project and considerable effort has been expended to ensure that you dont get caught with a project you can't finish. Particular attention has been paid to making the receiver easy to assemble. Much use is made of pre-wound coils and the number of adjustments has been kept to a minimum.

Some access to test equipment will be needed to get the receiver working. If you don't have the equipment yourself,

SPECIFICATIONS

Frequency range	136-138 MHz
Receiver type	superheterodyne, crystal-locked local oscillator
No. of channels	four
Sensitivity	0.5 uV to open the mute
Antenna input	50 Ohms
Power supply	12 Vdc (nominal)

World Radio History

then even in a small town someone not too far away can usually help. Try your local radio amateur and see if he can help; if not, the local TAFE or Advanced College probably can. Most areas, even remote ones, have a two-way radio service organisation nearby. If you are prepared to be flexible they may be able to help you at reasonable cost.

No details for assembling the receiver in a particular chassis have been given here as it was felt individual constructors would likely want to choose a case to suit individual needs or circumstances. For constructors needing guidance, a follow-up article on assembling a satellite ground station will provide suitable details on the principles involved.

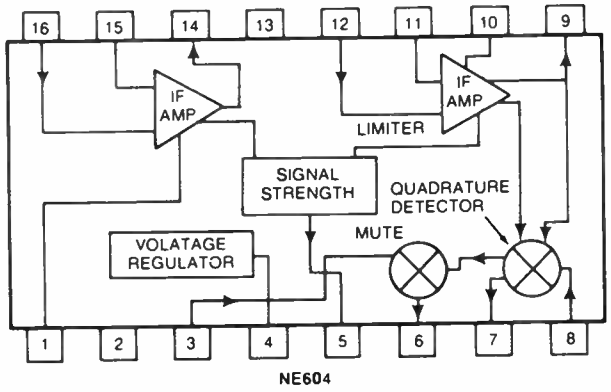
Design aspects

Obviously the design of a receiver such as this should offer reasonable performance as well as simplicity and low cost. Dual-gate MOSFETs are used for the RF amplifier stage and for the mixer. Whilst the DG MOSFET is an excellent amplifier, offering a useful combination of low noise and reasonable large signal handling capability as an amplifier, it is not generally considered to be the best mixer in the world. Double-balanced passive mixers and some sophisticated balanced active mixers achieve much higher degrees of performance but require much higher levels of local oscillator injection which increases cost and power consumption dramatically and adds much complexity.

Whilst the DG MOSFET mixer does not have some of the features of other types, it does have some advantages for us. Firstly, it consumes very little power. Secondly, it has some conversion gain thus allowing us to use a simple IF amplifier system and with its high input impedances we can use a relatively low power injection oscillator.

Crystal oscillators have posed many problems for designers of any radio equipment for years. Many different configurations have been used over the years but the type used here has proven itself extremely reliable in many applications. At this frequency, the crystals should be soldered directly into the board; crystal sockets will introduce too much stray inductance and can cause difficulties. To allow access to a variety of satellites in the 136-138 MHz band, this receiver has been provided with four independent oscillators. Although it is possible to switch crystals in a single oscillator, attempting to do so at this frequency is fraught with problems and expense. So, despite the extra components required, the arrangement used here is actually cheaper and more reliable.

Probably the most difficult part of this receiver to tie down was the IF filter. Most commercial FM filters fall into two categories: broadband ceramic types for FM broadcasting receivers and narrowband crystal types for communications. A receiver for these satellites should have a bandwidth of 30-50 kHz, allowing for the actual modulation bandwidth and an additional 4 kHz either side for Doppler shift. As the satellite goes through its orbit it will appear to be above its specified frequency whilst coming towards you and lower when receding



Pinout and internal circuit of the NE604.

(remember your school physics text and the steam train whistle?).

Intermediate frequencies for VHF receivers are usually at 10.7 MHz or 21.4 MHz with occasionally 45 MHz being used in UHF equipment. Most low-cost IF amplifier and demodulator ICs will not work above 15 MHz, so 21.4 MHz is out, and a 45 MHz IF requires a dual conversion system which adds considerable expense. So let's say we will use 10.7 MHz. A detailed search soon showed that at 10.7 MHz the filters for communications use were too narrow in bandwidth (7.5-23 kHz) and those for broadcasting are very wide at 150-280 kHz.

One other alternative was also investigated. Television receivers use a 5.5 MHz IF for the sound signal and it was found that the filters used in this application have a bandwidth of about 50 kHz. But given that the "image" signal when using this IF is only 11 MHz away was a little disconcerting. Owing largely to availability considerations, it was decided to use the 10.7 MHz broadcasting type filters, which are similar to those used in the "FM wide" position of scanners and use the extra bandwidth to allow some latitude in setting up the receiver oscillators.

After all the excitement of chasing filters, the remainder of the receiver is fairly straightforward, the NE604 IF amplifier and demodulator IC is not yet common in retailers, but is ideal for this job. The NE604N has all the IF amplification necessary, a quadrature type FM detector and a linear signal strength output. The signal strength output is used in conjunction with an IC op-amp to mute the receiver when no signal is present. This muting signal is available externally and could be used to control a tape recorder for unattended recording of the satellite images. (e.g: in conjunction with Tom Moffat's AEM3502 Signal Operated Cassette Switch published in the March 1986 issue).

An audio amplifier is included to allow aural monitoring of the signal quality. The speaker can be turned off with a front panel switch for 'silent running'. The audio output is fitted ▷

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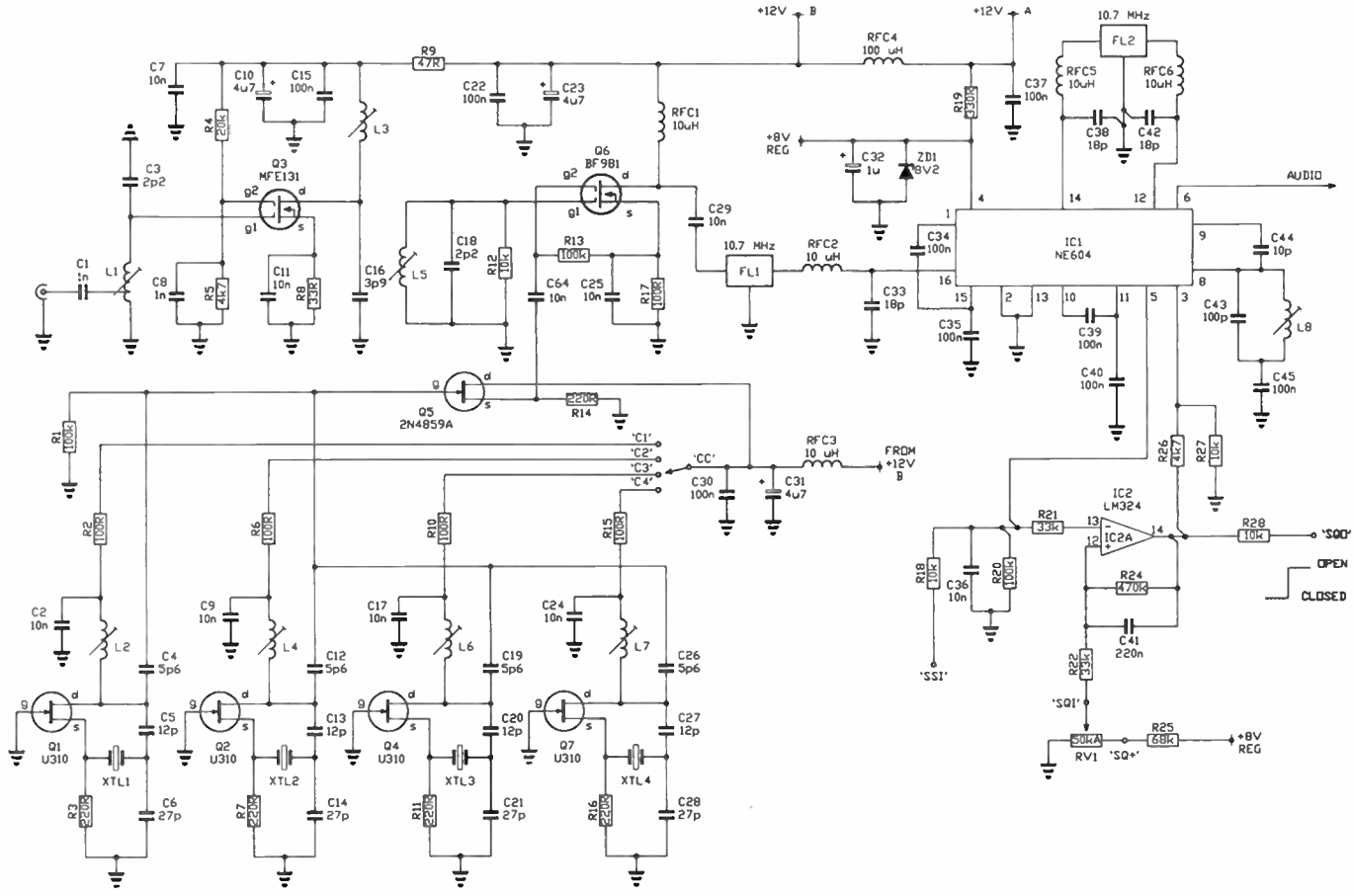
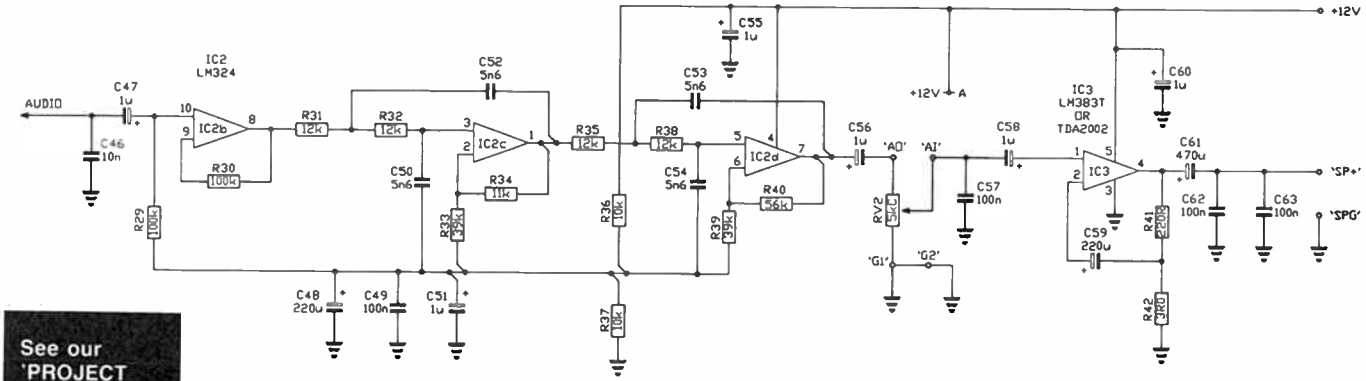
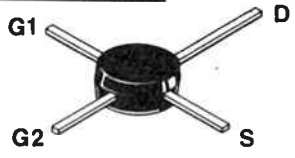
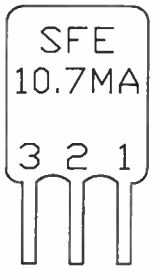


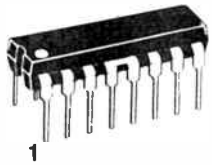


See our 'PROJECT BUYERS GUIDE' this issue for a guide to component sources and kit suppliers.

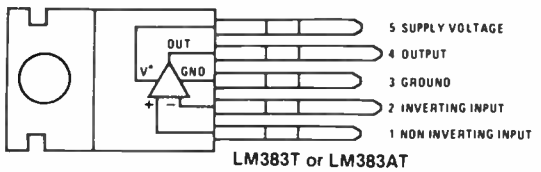


BF981. The writing on the case is uppermost.





Plastic Package



LM383T or LM383AT

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CIRCUIT DESCRIPTION

This receiver belongs to a general class known as "superheterodynes". A superheterodyne receiver mixes the incoming signal with a local oscillator signal thus converting it to an intermediate frequency. The basic selectivity of the receiver is provided at this intermediate frequency. Varying the frequency of the local oscillator has the effect of bringing input signals on different frequencies within the passband of the receiver.

Given that we have a mixer and an oscillator, we in fact have outputs from the mixer over a wide range of frequencies. The provision of a filter at the output of the mixer serves to remove signals other than the IF frequency itself. As the mixer generates both sum and difference product signals at Flo ±Fif, both will appear at the IF frequency. The desired one (and it could be either) and a spurious response (the other one!), which is known as an "image".

Part of the reason for using tuned circuits in the front end of any receiver is to filter out the image. Because of the relatively narrow range of frequencies top be covered it is possible to use a fixed tuned input circuit, unlike say a broadcast receiver where it is necessary to tune the input stages as well as the oscillator.

The input signal from the antenna is coupled via a tap into the first tuned circuit. This network is resonated by the parallel effect of L1 and the 2.2 pF capacitor and the input capacitance of the MOSFET Q1 (MFE131). Owing to the high input impedance of the MOSFET, gate 1 can be connected directly to the high impedance end of the coil. Fixed operating bias for this stage is supplied by the resistive voltage divider connected to gate 2. The parallel combination of L2 and the 3.9 pF capacitor provides a load for the drain of the MOSFET as well as using L2 to feed dc to the transistor.

Coupling of the RF energy from L2 to L3 is due to the physical proximity of the two coils. It is thus necessary to restrict the field by using screens to stop energy reaching L1 and thus introducing feedback, causing oscillation. The gate 1 arrangement of the BF981 mixer MOSFET is similar to that of the RF amplifier stage. The local oscillator energy is coupled into gate 2 of the MOSFET which is also supplied with a small amount of bias from the source via a 100k resistor. Injection from the local oscillator has an amplitude of approximately 2 volts RMS. The drain of the mixer has a 10 uH RF choke as its load which provides a reasonable load for the mixer at the desired 10.7 MHz IF.

When designing a receiver of this type, the local oscillator is the most difficult part. Owing to stability problems, it is not possible to use tunable oscillators and synthesized oscillators are not simple to build. Obviously then, a crystal oscillator will give us the levels of output we need with the desired stability. Discussion of the details of crystal oscillator design is beyond the scope of this article, suffice to say the oscillator design employed here works well. It uses a crystal calibrated at series resonance and operating on its seventh overtone.

In this design the injection frequencies required are from 126 to 127 MHz or so. The crystals are designed to operate directly at that frequency avoiding the necessity of frequency multipliers as would be required with lower frequency 3rd or 5th overtone crystals. Switching of the oscillator crystals is achieved by switching the supply to the individual oscillators. The output signal from the selected oscillator is buffered by a field effect transistor connected as a source follower. This source follower has its output coupled to the gate 2 circuit of the mixer MOSFET described earlier.

In the IF amplifier and detector circuit we have used a Signetics NE604N IC. This part includes two sections of limiting IF amplifier, a quadrature FM detector, an audio mute switch and a signal strength output.

Energy from the mixer is fed via FL1, a ceramic filter to the input of the NE604. The output of the filter is fed via an impedance transforming network consisting of a 10 uH inductor and an 18 pF capacitor. This is necessary because the filter needs to be terminated in 330 ohms whereas the input impedance of the NE604 is 1500 ohms. After being amplified by the first section of the IF amplifier the signal is again filtered by a ceramic filter, FL2, which also has two impedance matching networks. This second filter removes the broadband noise from the signal so it cannot prevent efficient operation of the second limiting amplifier section.

After all this IF amplification, the signal now needs to be detected. This is carried out by a 'quadrature demodulator'. I won't explain how here, but if an FM IF signal is multiplied by a version of itself phase-shifted by 90 degrees, then the result is the audio content originally impressed on the signal at the transmitter. In this receiver, the output of the IF amplifier appears on pin 8 of the NE604. The combination of the 10 pF capacitor between pins 8 and 9 and the tuned circuit between pin 9 and ground provides the necessary 90 degree shift. The other input to the multiplier section is internally coupled for simplicity. A 100 nF ceramic capacitor is provided between the bottom end of the detector tuned circuit and ground. This serves to isolate pin 9 from dc ground whilst effectively earthing it for RF.

Detected audio now appears at pin 7 (not used in this application) and at pin 6 following a muting amplifier stage provided internally. Unfortunately the NE604, like many other modern FM IF system ICs does not have an internal mute generator like the old CA3089 and other early types designed for broadcast FM detection. Most of the newer ICs are intended for use in paging, cordless telephone and cellular radio applications, all of which use external mute controls from the built-in system microprocessor to ensure they don't open the mute on signals not meant for them. This means we must provide some form of muting control externally; a small price to pay.

Most receivers will have some form of audio filtering and amplification present after the detector so we can use, as we have done in this case, a quadruple op-amp such as the LM324. The LM324 has been chosen here because unlike many other op-amps it will happily accept signals very close to the negative supply rail, in this case ground. Although it does not rate well for audio applications when compared with the TL074 or the new National LM837, we sacrifice some audio performance for the sake of avoiding the need for a dual rail power supply.

For the muting we take the Received Signal Strength Indicator (RSSI) output from the NE604 on pin 5. This is also available via a 10k resistor for monitoring purposes at pin 'SSI' on the pc board. A very high gain op-amp stage effectively compares the RSSI voltage to that from the squelch pot appearing at the 'SQI' pin on the board. When the RSSI signal is greater than this preset level the output of the op-amp drives pin 3 of the NE604 high, thus opening the mute amplifier and allowing the signal to pass. An auxiliary mute output is available at pin 'SQO' to drive control circuits if necessary. The 220 nF capacitor across the 470k feedback resistor of the squelch op-amp stops the squelch control line 'chattering' on noise impulses.

Now back to the audio signal. Having used one part of the LM324 we now have three more to use. One will be occupied buffering the audio signal from the NE604. Active filter designs like to see low impedance drive. Unfortunately, the NE604 and many other detector ICs have relatively high output impedances. To overcome this a unity gain, non-inverting follower is used so as to avoid loading the audio output of the NE604 and to provide low impedance drive to the filters. Because the op-amp is running on a single twelve volt supply rail, we have used two 10k resistors to provide bias at ½ Vcc for the op-amp stages.

The active filter section is very simple. It comprises two Sallen-Key low pass filter sections cascaded, the combination being designed for a cutoff frequency of 3000 Hz and having approximately 0.1 dB ripple in the passband. Virtually no gain is provided by the filters. From the filter section, the signal is passed to the volume control. It is at the actual volume control that the low level audio ground is separated from the groundplane ground so as to prevent noise loops in the groundplane around the audio power amplifier. It is best if the 'G1' and 'G2' pins are connected at the volume control pot.

Naturally, the volume control feeds the signal to the audio power amplifier. This stage uses an LM383T or TDA2002 IC, which can deliver up to eight watts of output into an 8 ohm load. In this arrangement, it will deliver 3 or 4 watts with a 12 V supply. It may seem unusual to have a 100 nF capacitor from the input to ground and two 100 nF capacitors from the output to ground. Let me assure you that they are essential as the amplifier will become quite unstable without them, oscillating at several hundred kilohertz and drawing around two amps! With these capacitors in place, it is quite "tame" and well behaved under any circumstances.

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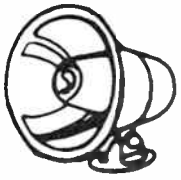

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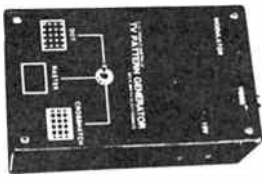

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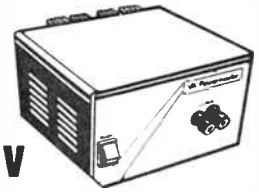

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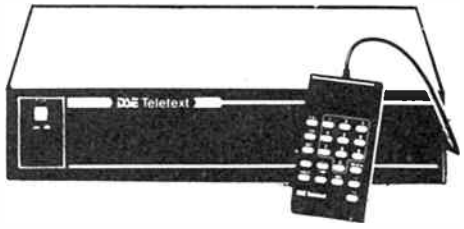

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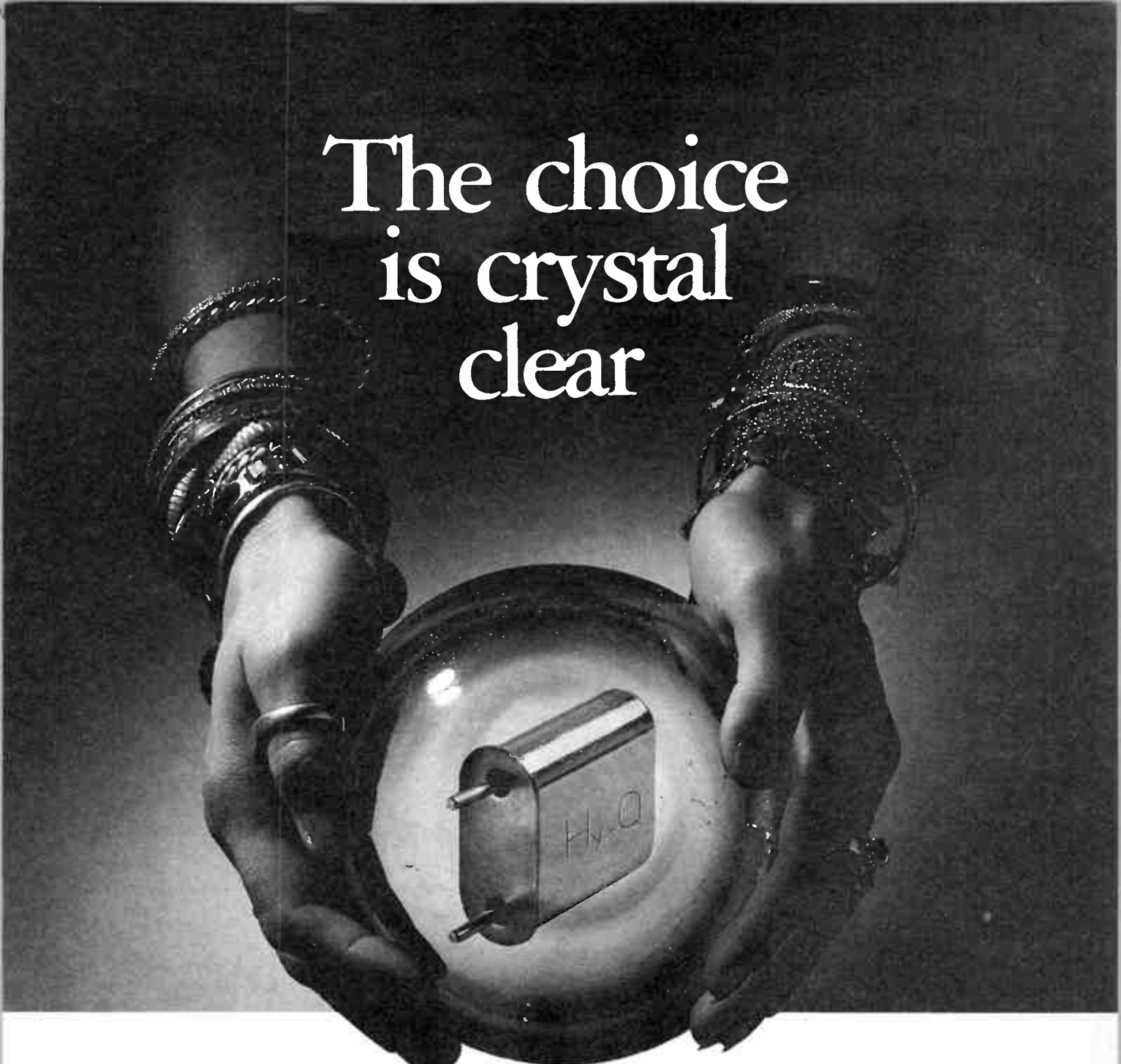

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with a level control so that the audio level can be adjusted to suit a variety of demodulators.

Construction

The printed circuit board for this project may well look a little unusual to many of you. It is what we call a 'groundplane' design. When designing VHF equipment it is absolutely essential to maintain a very low impedance ground interconnection system. To achieve this and to assist in shielding parts of the receiver from each other, the top side of a double-sided pc board is used entirely for ground connections. Openings are placed in the ground plane where component leads pass through and are not to be grounded. Wherever a component lead hole does not have this opening that lead will need to be soldered on the top side of the board.

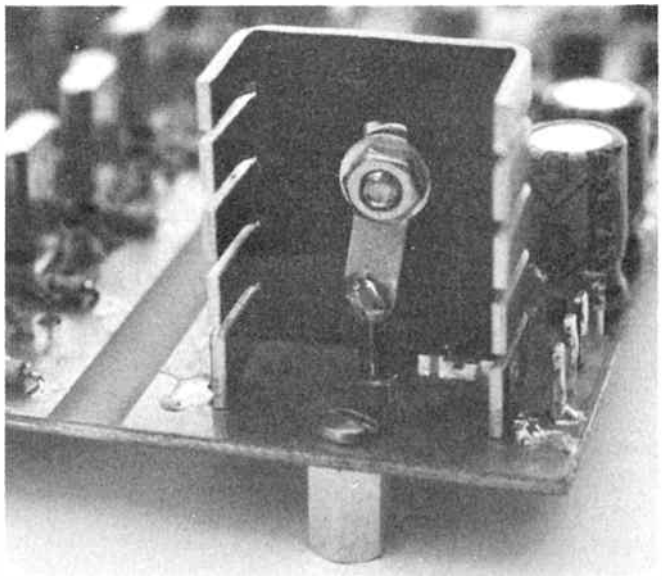
First, a little preparation work is needed on two components. The coils to be used for L1 and L3 both need to have one side grounded. If you look carefully you will notice that the plastic moulding completely surrounds the bottom of the leads. Using a sharp knife remove some plastic material from around the pin at the bottom end of the winding so it can be soldered on the top side of the board. Put these aside for now.

View of the bottom end of a coil, showing where the plastic is cut away to permit soldering to the groundplane.

That done, you should proceed to fit all the resistors into the pc board. Don't do them all at once. Put five or six resistors at a time into the board and flare their leads on the underside so they can't fall out. Then the board can be inverted and the leads all soldered on the bottom side. When that job is complete, trim all the leads on the bottom neatly and flip the board over. Look for those places where a resistor lead does not have a clearance hole in the groundplane, these must now be soldered to the top or groundplane side of the board.

When the resistors are all installed, proceed in the same manner with the diodes and then the capacitors. The three electrolytic capacitors can be left till later, their large size makes it difficult to work around them. Do not fit any of the ICs or transistors yet. Carefully check the board top and bottom for any solder splashes and bits of component lead, they have a habit of being disciples of Murphy and tend not to have a desirable influence on the operation of the equipment!

Now you can fit the remainder of the non-semiconductors to the board. My method of mounting the coils is to put them all in the board at once while the board is upside down! Here's how I do it. With the board top side up, fit all the inductors into their appropriate holes, making sure they are correctly oriented. Place a piece of stiff card or masonite over the top of the inductors. Now, whilst carefully holding the whole lot, invert it and rest it on the bench. Hopefully, the coils will all be



View of the audio output stage showing heatsink mounting and grounding of the LM383 tag.

standing down straight. If not, give them a little encouragement with a pencil. Now solder ONE pin of each coil only.

As the coils are now secured to the board, you can turn it over again. Check that the coils are all doing soldier impersonations (standing at attention) and proceed to straighten them if not. You can re-melt the solder to move them if necessary. This done you can now securely solder the other pin of each coil. As previously mentioned one side each of L1 and L3 need to be soldered on the top side.

Now you can start on the transistors. The four U310 oscillator FETs should be installed first. The layout diagram clearly shows their orientation. When inserted into the board the body should be no more than 5 mm above the pc board groundplane and the gate lead can be soldered to the top side. Proceed similarly for the 2N4859A source follower buffer, except it is soldered on the bottom side only.

The ICs may now be fitted as per the layout diagram. Both the NE604 and the LM324 have pins soldered to the groundplane. Fitting the audio amplifier IC is a little more involved. First, you should fit the heatsink into its mounting holes and solder it in place on the top side of the board. Now smear a small quantity of heat transfer compound onto the back of the LM383T. Line up the pins with the holes in the pc board and push it in until it is about 6 mm above the board. The securing screw is passed through the IC tab on the front side, a solder lug slipped over the screw on the back side and the nut then placed on and tightened. This having been accomplished a small piece of tinned copper wire or resistor lead offcut is passed through the hole of the solder lug and soldered to the ground plane and the lug.

Now is probably a good time to insert the electrolytic capacitors not yet in place.

The RF amplifier MOSFET can now be inserted. Although the pc board was originally laid out for a BF981 device, the same as in the mixer, this was changed when it was found difficult to stabilise the stage at this frequency. Orientation of this part is clearly shown on the layout diagram. Then comes the fiddly bit. The dual-gate MOSFET in the mixer is in what is known as an 'X' pack. You will observe that three leads are the same length and the fourth is somewhat longer. The long one is the drain lead. Grasp the body with a pair of pliers with the type number markings uppermost and bend all four of the device leads downwards close to the body. The drain lead hole is marked with a small triangle shaped void in the ground

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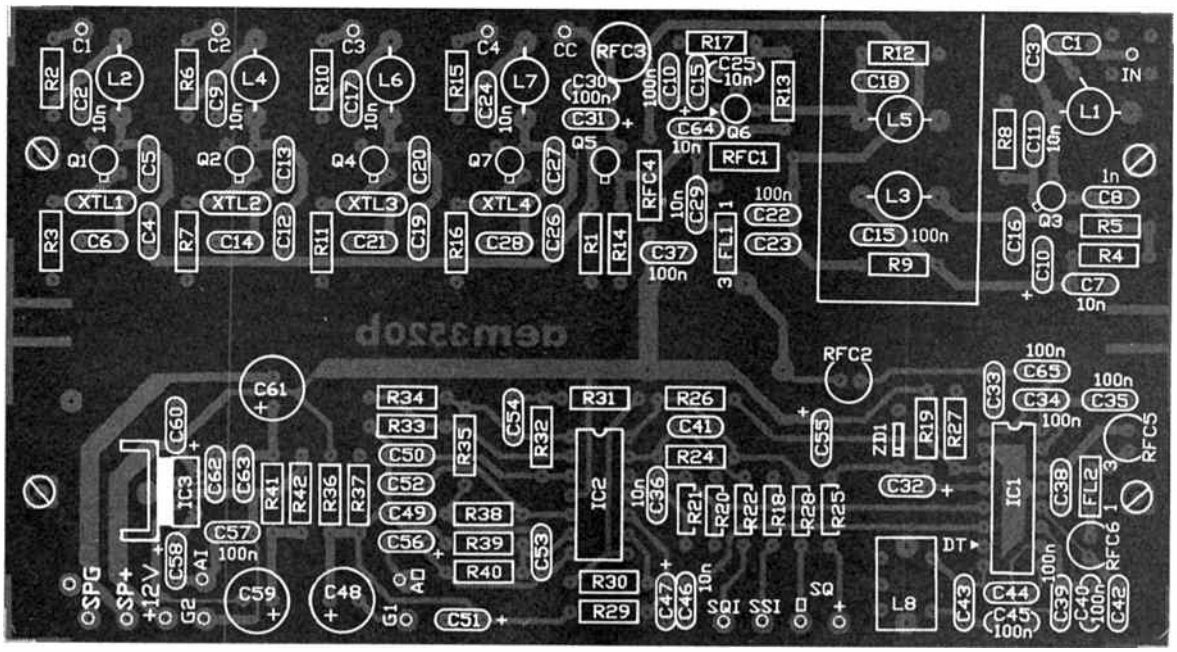

PARTS LIST AEM3520

Semiconductors

Q1,Q2 ..... U310
Q3 ..... MFE131
Q4 ..... U310
Q5 ..... 2N4859A
Q6 ..... BF981
Q7 ..... U310
IC1 ..... NE604
IC2 ..... LM324
IC3 ..... LM383T, TDA2002

Capacitors

C1 ..... 1n plate ceramic
C2 ..... 10n " "
C3 ..... 2p2 " "
C4 ..... 5p6 " "
C5 ..... 12p " "
C6 ..... 27p " "
C7 ..... 10n " "
C8 ..... 1n " "
C9 ..... 10n " "
C10 ..... 4u7/16 V tant.
C11 ..... 10n plate ceramic
C12 ..... 5p6 " "
C13 ..... 12p " "
C14 ..... 27p " "
C15 ..... 100n monolithic
C16 ..... 3p9 plate ceramic
C17 ..... 10n " "
C18 ..... 2p2 " "
C19 ..... 5p6 " "
C20 ..... 12p " "
C21 ..... 27p " "
C22 ..... 100n monolithic
C23 ..... 4u7/16 V tant.
C24,25 ..... 10n plate ceramic
C26 ..... 5p6 " "
C27 ..... 12p " "
C28 ..... 27p " "
C29 ..... 10n " "
C30 ..... 100n monolithic
C31 ..... 4u7/16 V tant.
C32 ..... 1u/35 V tant.
C33 ..... 18p plate ceramic
C34, 35 ..... 100n monolithic
C36 ..... 10n plate ceramic
C37 ..... 100n monolithic
C38 ..... 18p plate ceramic
C39,40 ..... 100n
C41 ..... 220n MKT
C42 ..... 18p plate ceramic
C43 ..... 100p " "
C44 ..... 10p " "
C45 ..... 100n monolithic
C46 ..... 10n plate ceramic
C47 ..... 1u/35 V tant.
C48 ... 220u/25 V RB electro.
C49 ..... 100n monolithic
C50 ..... 5n6 plate ceramic
C51 ..... 1u/35 V tant.
C52,53,54 .... 5n6 greencaps
C55,56 ..... 1u/35 V tant.
C57 ..... 100n monolithic
C58 ..... 1u/35 V tant.
C59 ... 220u/25 V RB electro.
C60 ..... 1u/35 V tant.
C61 .... 470u/25 V RB electro.
C62,63 ..... 100n monolithic
C65 ..... 10n ceramic

Resistors all ¼ W, 5%

R1 ..... 100k
R2 ..... 100R
R3 ..... 220R
R4 ..... 20k
R5 ..... 4k7
R6 ..... 100R
R7 ..... 220R
R8 ..... 33R
R9 ..... 47R
R10 ..... 100R
R11 ..... 220R
R12 ..... 10k
R13 ..... 100k
R14 ..... 220R
R15 ..... 100R
R16 ..... 220R
R17 ..... 100R
R18 ..... 10k
R19 ..... 330R
R20 ..... 100k
R21,22 ..... 33k
R23 ..... not allocated
R24 ..... 470k
R25 ..... 68k
R26 ..... 10k
R27 ..... 4k7
R28 ..... 10k
R29,30 ..... 100k
R31,32 ..... 12k
R33 ..... 39k
R34 ..... 11k
R35 ..... 12k
R36,37 ..... 10k
R38 ..... 12k
R39 ..... 39k
R40 ..... 56k
R41 ..... 220R
R42 ..... 3R0

RV1 ..... 50k/A pot (squelch)
RV2 ..... 5k/C pot (volume)

Inductors

L1,3,5 . 181-278 nH adjustable coil, Miller 48A227MPC
L2,4,6,7 . 99-122 nH adjustable coil, Miller 48A117MPC
L8 ... 1.44-2.94 uH adjustable coil, Miller 9108

RFC1,2,3,5 ..... 10uH
RFC4 100uH

Miscellaneous

FL1,FL2 .. Murata SFE10.7MA ceramic filter
XTL1,2,3,4 .... crystals to suit (see text)

AEM3520 pc board; single-pole, four position switch; four 12 mm tapped standoffs; 18 x 1 mm pc pins; one solder lug; one TO220 pc mount (solder-in) upright heatsink; 8 Ohm speaker; antenna connector to suit; hookup wire; case to suit.

Estimated cost: $120-$130.

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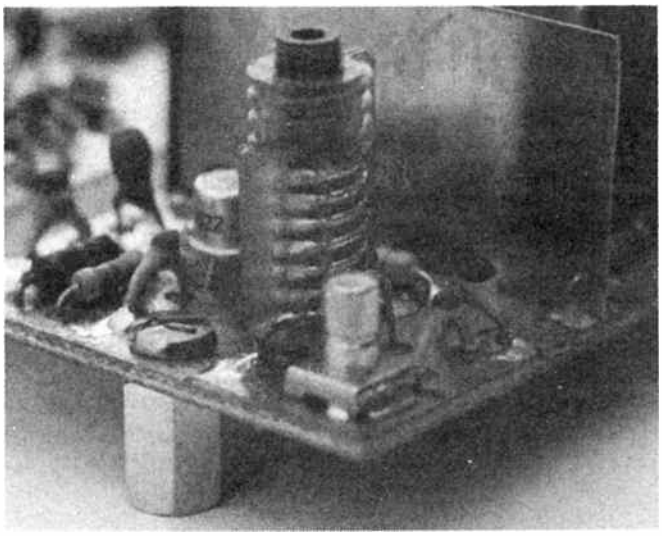


View of the RF amplifier, showing grounding of the lower end of the coil, just to the left of the input socket. Note the standoff for supporting the board in a case.

plane near the hole, place the long lead into that hole and then carefully align the others and with a light but firm pressure, push the device down until it is firmly seated on the board and solder it into circuit.

All that now remains is to solder the screening panels in place. These panels can be cut from double-sided printed circuit board or brass. Many 'hobby shops' sell one-inch wide brass strip which does an excellent job. You will need three pieces, two 38 mm long for the cross-mounted partitions, and another that fits between these two as seen in the photograph. The position of the panels is clearly marked on the board. You will see small rectangular voids in the groundplane where the layout drawing requests a screen. These voids are to help you line up the panels. I usually tin two corners on one surface of the screen. Whilst holding the screen with a pair of pliers in its correct position, solder one corner to the board. The panel can now be carefully moved into its correct position and the other corner soldered. Only now should you attempt to solder a fillet along the whole edge.

At this stage, you can temporarily wire-up the switch and the potentiometers, followed by the speaker, and test and align your receiver. Or, you can elect to mount it in a suitable case and wire-up the external components. The wiring diagram shows the details.

Power supply

A special power supply for this receiver has not been described. All it requires is a nominal 12-14 Vdc at a current of around 200 mA or less. "Plugpack" supplies are ideal and low in cost. The common "CB" power supplies, designed to power mobile CB radios, are also suitable. In general, they deliver 13.8 Vdc at several amps and would thus be more than adequate.

Alignment and testing

Now that you have it all together lets see if it goes. If you intend to build a multi channel unit and have ordered more than one crystal, solder ALL of the crystals in place.

Set the slugs of L1, L2 and L3 roughly 2 mm above the top of their formers. Oscillator inductors L4, L5, L6 and L7 should have the slugs set so the bottom of the slug as seen through the body of the inductor is just below the top turn of the coil. The

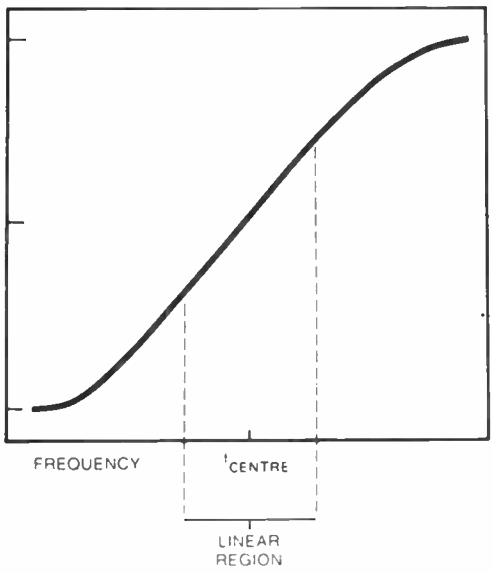
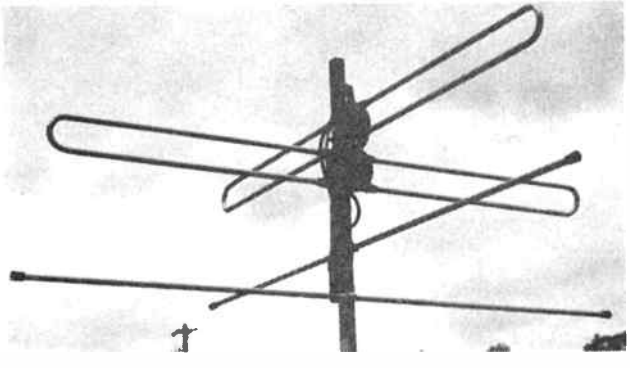


Figure 1.

volume control should be at mid-scale and the speaker switched on, set the squelch control fully counter clockwise.

When you apply power, you should hear some noise from the speaker. Turn the squelch control clockwise and the noise should cease. Remove power and connect the input of a frequency counter to the source lead of the 2N4859A buffer transistor. The counter should be able to operate to at least 130 MHz. If you don't have a counter, connect a multimeter RF probe (diode detector) to this point. Whatever you use must be capacitively coupled as there is dc on this point.

With power re-applied, adjust the slug of each of the oscillators in turn until they are all on the frequency marked on their crystal or until the slug is in the middle of the range of output if you are using the probe method. The bandwidth of this receiver is such that, if the oscillator is running you will probably have the satellite in your passband. If you have access to a signal generator, couple some 10.7 MHz IF signal at a reasonably low level (say 100-200 uV) into the IF test point through a small capacitor. Adjust the slug of L8 through its range with a dc voltmeter connected to the point marked 'DT' on the circuit. You will notice that there is a distinctly 'S-shaped' response curve as shown in Figure 1. The slug should be adjusted so that the voltage at the 'DT' test point is approximately 1.8 V. If you dont have a signal generator, just leave the core 1.5 to 2 mm below the top of the former.



The prototype crossed dipole antenna developed by ZZV Antenna Farm. We'll have more to say on this antenna in an up-coming issue.

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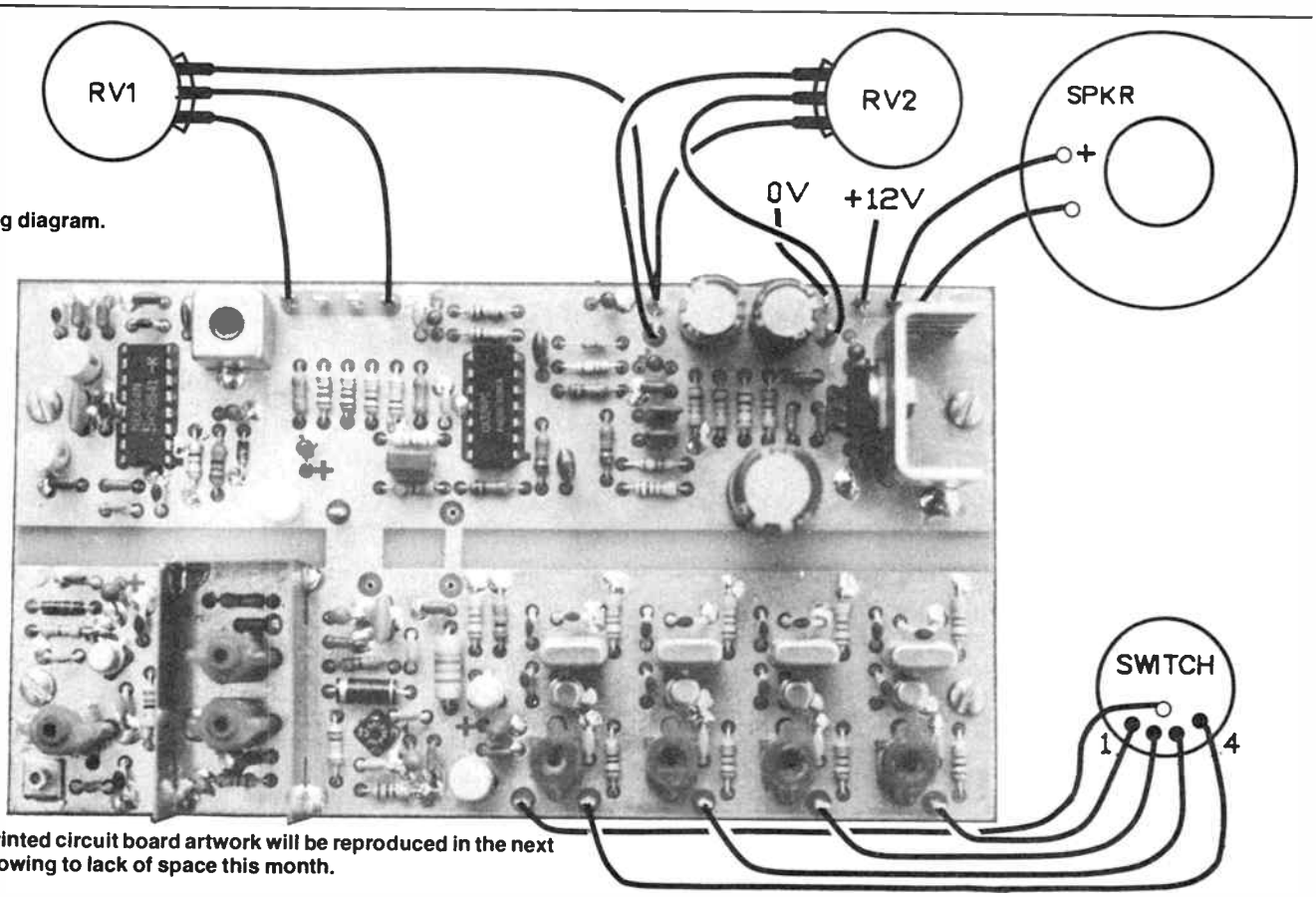

Wiring diagram.

The printed circuit board artwork will be reproduced in the next issue owing to lack of space this month.

Now all we need to do is to align the "front end" (the RF and mixer stages) and we're in business. Advance the volume control a little and then set the squelch control to "un-mute" the receiver so that you hear some noise. Set the volume control so that you can hear the noise at a comfortable level.

If you have a signal generator, set it to the signal frequency (that's the crystal frequency plus 10.7 MHz). Adjust L1, L2 and L3 for best sensitivity – reducing the output of the signal generator as the sensitivity improves until no more gain in sensitivity is obtained.

If you don't have access to a signal generator, then connect the receiver to an antenna – such as the types depicted in Roger Harrison's article in the July 1986 issue. The noise level should rise slightly. Adjust L1, L2 and L3 in turn for maximum noise. If it doesn't rise when you attach the antenna, then adjust the slugs in turn until an increase in noise is heard and then proceed to peak them as before.

Note that, to adjust the coil slugs, you should always use a *plastic* aligning tool.

Antennas

Whilst the antenna you use for APT satellite reception need not be sophisticated, you will be best served by an antenna designed for this frequency range.

In the June 1986 edition of AEM, Roger Harrison presented details of the construction of groundplane and crossed half-wave dipole (turnstile) antennas. Either of these should serve you well.

Local antenna manufacturer ZZV Antenna Farm, of PO Box 160, Cardiff South 2285 NSW (phone 049 54 8688), has produced a low-cost prototype crossed dipole antenna for the APT satellite frequency band which they intend to manufacture.

Some final thoughts

Close attention should be paid to the constructional instructions given in this article. They are not there just for the sake of it. As I have stressed, RF layout and construction is a very different game to low frequency techniques. Slap-happy construction techniques will not work at VHF, but if you have patience and follow the instructions you should have very few difficulties.

As a parting comment the prototype unit achieved a sensitivity of 0.2 uV for reliable data recovery using a signal generator modulated by a slow scan TV test generator. Reliable mute operation could be achieved at 0.2-0.5 uV signal levels with some mute drift due to temperature. This did not prove objectionable and it was not felt that the expense of temperature compensating the mute would be justified.

The project can be readily modified to operate on the two-metre amateur band for reception of the UoSAT satellites, but we should leave that for a subsequent article.

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aem project 2506

A wideband 'instrument' amplifier using surface mount assembly

Roger Harrison

Here's an ideal way get experience in surface mount assembly (SMA), and make a useful addition to your workshop instruments, no matter whether it's for the service shop, electronics lab., or enthusiast's workbench.

IT WAS INEVITABLE that surface mount assembly techniques would be employed in a project we described, sooner or later, we pondered when we prepared a feature on an introduction to surface mount technology back in the October 1985 issue. Well, this is it. Surface mount assembly is usually employed where space and bulk is at a premium, but here the reason is different. As this amplifier operates into the gigahertz (1000 megahertz) region, surface mount components and construction techniques are *essential* to its operation. 'Normal', common-or-garden, components have unpredictable characteristics when used at frequencies well into the tens-to-hundreds of megahertz region – a subject covered in detail in our accompanying feature on *Component Considerations in VHF and UHF Construction*.

This project offers a useful wideband amplifier with applications in a variety of areas: for boosting the sensitivity of high performance frequency/period counters, in doing the same for a spectrum analyser or RF field strength meter, or lifting oscillator levels in RF development work, etc. It's the sort of project that, once you have it, it finds uses for itself!

Aspects of the design

The design actually came to us via a colleague well-known in the communications industry in Sydney. It employs a specialised single-chip wideband amplifier device manufactured by NEC, the UPC1651G. It's one of a class of amplifier devices known as MMICs – *monolithic microwave integrated circuits*. These are designed to slot into a 50 Ohm transmission line system, having 50 Ohm input and output impedances. It makes incorporating them into a circuit an easy matter as 50 Ohm impedances are standardised in so much RF circuitry right across the frequency spectrum.

Internally, MMICs consist of a multiple device bipolar amplifier having special characteristics imparted during the fabrication process, giving the device the required specifications. They are housed in a special 'X' package with four leads – input, output, ground and supply – arranged at 90 degree intervals in a single plane, radiating from a central 'slug' of either ceramic or plastic. The UPC1651 is housed in a macro-X plastic package.

SPECIFICATIONS

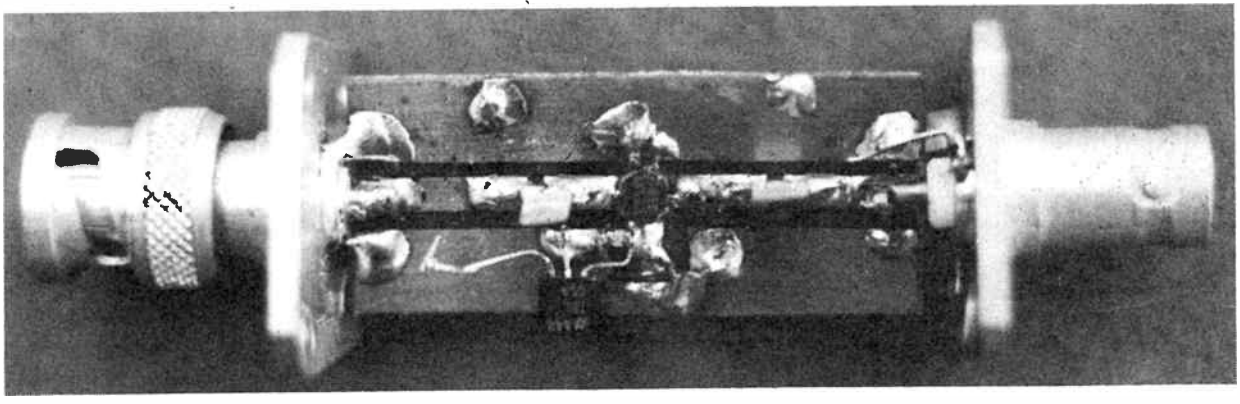
Bandwidth	100 kHz to 1000 MHz
Gain	20 dB
Input & Output Impedances	50 Ohms
Maximum input level	+5 dBm
Supply	+7 to +25 volts

LEVEL

We expect that constructors of an

INTERMEDIATE

level, between beginners and experienced persons, should be able to successfully complete this project.



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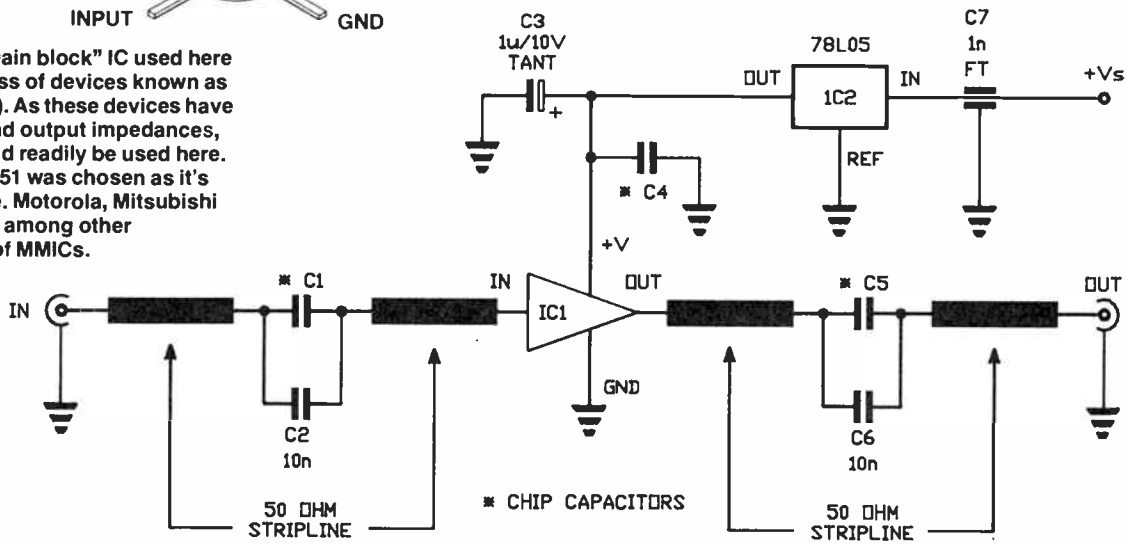
While quite a variety of MMIC devices are available, the UPC1651 was settled-on for this design because it's cheap and readily available from several retail electronics suppliers. Dick Smith Electronics list it as cat. no. Z-6008, priced at $1.95 each.

The circuit is quite straightforward. The input and output to the UPC1651 is effected with short strips of 50 Ohm "microstrip" transmission line etched onto the component side of the double-sided fibreglass printed circuit board. The input and output are decoupled for dc by series capacitors. These each comprise two capacitors in parallel, a small 10n plate ceramic capacitor in parallel with a leadless, surface mount "chip" capacitor of much lower value. This arrangement ensures very low impedance ac coupling of signals right across the frequency range as we're working in a 50 OHm system. The 10n plate ceramic has a low impedance from around 100 kHz right into the VHF region, while the chip capacitor has a low impedance from around 100 MHz to 1 GHz.

The UPC1651 is supplied with 5 V regulated dc from a low power three-terminal regulator, a 78L05. The supply pin of the UPC1651 is bypassed with another chip capacitor, along with a 1u tantalum. This arrangement ensures good bypassing from very low frequencies well into the UHF region and the tantalum capacitor also serves to stabilise the 78L05. The external dc input to the three-terminal regulator is taken through the ▷

The UPC1651 is housed in a small "macro-X" package. With the device orientated as shown, with the longest leg to the right, the writing is uppermost.

The UPC1651 "gain block" IC used here belongs to a class of devices known as MMICs (see text). As these devices have 50 Ohm input and output impedances, other types could readily be used here. The NEC UPC1651 was chosen as it's readily available. Motorola, Mitsubishi and Avantek are among other manufacturers of MMICs.



STRIPLINE

A 'stripline' consists of a thin conducting strip spaced from a 'groundplane' by a layer of dielectric material, as the figure here shows. Microstrip can be understood by either an evolution of the coaxial line or a modification of a parallel wire line. Propagation down the line, in the case of a single uniform dielectric and a lossless conductor, is via the transverse electromagnetic (TEM) mode. In this mode the electric and magnetic fields are at right angles to each other and at 90° to the direction of transmission. However, in a practical stripline the field lines are not entirely contained within the substrate, generally occupying a region of the groundplane approximately three times the strip width for large width:height ratios.

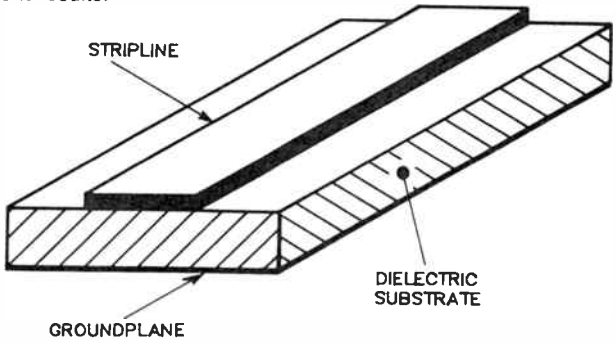
Striplines came about from the development of printed circuits which sharply accelerated after World War II. In 1949, Robert M. Barrett of the US Air Force Cambridge Research Centre, proposed the adaptation of printed circuit techniques to transmission line applications. Interest accelerated in the early '50s and in the spring of 1952 Sanders Associates, Inc, began investigations into a dual groundplane, solid dielectric form of transmission line called "triplate". Around the same time other investigators were working with different configurations. Airborne Instrument Laboratories developed techniques using air dielectric called "stripline" while ITT introduced a single groundplane, solid dielectric called "microstrip".

By 1955, a wide range of strip and microstrip components had appeared in microwave and UHF applications. Improvements had also been made in line dielectric materials. Early materials such as Teflon, fibreglass and rexolite were complemented with Teflon fibreglass, beryllia, quartz, alumina, sapphire and magnesium titanate.

Development of miniature coaxial connectors and stripline transistor packages that were compatible with the flat nature of strip transmission lines, were major breakthroughs. They permitted low VSWR transitions and easy mechanical construction.

Tri-plate is used extensively in directional couplers and other VHF/UHF circuits were shielding is paramount, while stripline has found application in high power VHF/UHF amplifiers and FM broadcast transmitters.

Microstrip has found applications in matching networks, filters, mixers, frequency counters and solid state amplifiers. It has the advantages of low cost and ease of manufacture, yielding consistent results.



Stripline or microstrip transmission line consists of a thin conductor placed on one side of a dielectric substrate having a groundplane on the other side. The characteristic impedance of such lines is a function of the ratio of the strip width to the dielectric thickness.

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unit's housing via a feedthrough bypass capacitor which prevents spurious pickup of signals via the dc power lead passing through the box.

Construction

The input and output connectors are an integral part of the unit's construction, so the housing is a major consideration unless you're considering building the amplifier into another piece of equipment.

It is essential that the input and output connectors are mounted in-line to effect good mechanical and electrical matching to the input and output transmission lines on the pc board. 50 Ohm BNC connectors are employed as they are commonly used on a wide variety of RF equipment, although other types could be used if you so wish.

The connectors have to be mounted 50 mm apart, flange-to-flange. A small diecast box, measuring 100 x 50 x 25 mm (such as the DSE H-2221) may be used, mounting the two connectors on the opposite long sides of the box.

However, the *ideal* housing was found in the inventory of RS Components, a national distributor of components with outlets in Perth and Sydney. It's their "In-Line Module Case", cat. no. 456-201. This is a housing featuring a male BNC at one end and a female BNC at the other. It's 25.4 mm square (same as the connectors' flanges) and measures 50 mm between the connectors' flanges, 92 mm overall. The housing is extruded aluminium and splits into two pieces. Long brass bolts, threaded at the ends, pass the length of the case and through the flange mounting holes of the connectors, secured with cap nuts on the bolt ends.

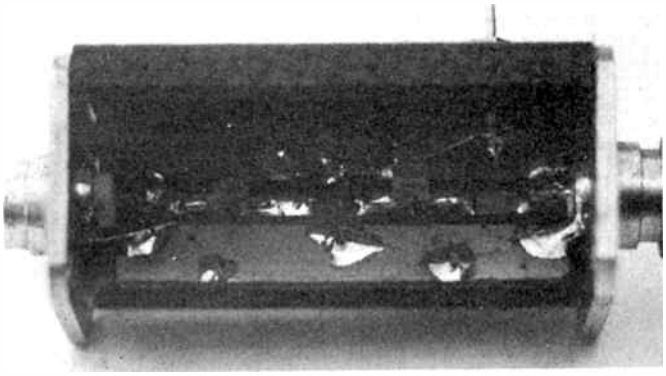
The circuit, as mentioned earlier, is constructed on a piece of 1.6 mm thick double-sided printed circuit board 45 mm long by 20 mm wide. A 3.5 mm hole in the centre accommodates the UPC1651's encapsulation so that its leads seat flat on the circuit board's "top" (etched) side. The only track work on the board is the two 50 Ohm input and output "striplines". The input and output decoupling capacitors are mounted across small breaks in the lines.

Either side of the striplines are two large areas of copper extending to the edges of the board. These and the complete copper area on the other side form a "groundplane" which provides a low impedance signal return path. The topside and bottomside groundplanes are connected together by eight links passing through the board.

Irrespective of the housing, the ends of the board must be soldered directly to the BNC connectors as can be seen in the accompanying photographs.

Assembly is best commenced by first inspecting the pc board. See that there are no burrs around the single hole and that the copper areas at the edge of the hole are smooth and flat. Identify the input and output striplines and the UPC1651's supply lead pad so that the device can be correctly orientated. It's a wise idea to thoroughly clean the pc board just before commencing construction so that you obtain bright, clean copper that is easy to solder to. At all times avoid handling the copper surfaces of the board as perspiration and skin oils will cause slight oxidation of the copper, making soldering difficult. You could spray the cleaned board with a light coating of "pc lacquer" which prevents oxidation and is readily soldered through.

Solder the eight top-to-bottom links on the board in place first. Lightly "tin" the board around each hole by applying the tip of the soldering iron to first heat the area of copper adjacent to the hole and then, after some seconds, apply the solder to the board until it "wets" a small area around the hole, moving the iron tip around so that the area is covered in solder. Do not leave



Internal view of the unit.

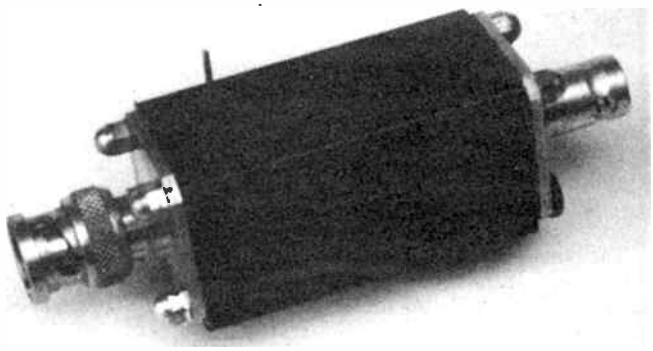
a 'blob' of solder here. Pass a length of tinned copper wire through the each hole, keeping it straight, then apply the iron tip so that it touches both the wire and the copper Heat the joint for a few seconds, then apply the solder to the joint and see that it flows properly, forming a tangent to the wire and the groundplane. Do this with each link on each side of the board.

The board should be soldered to the BNC connectors before any components are mounted. The RS Components case permits one half of the enclosure to be taken off, leaving the rest assembled, and this makes it easy. The module comes with two G-shaped grounding lugs, which can be seen when you dismantle half of the enclosure. See that they remain secured by the other half the solder tag on each will be soldered to the underside of the pc board. Lightly tin the BNC's centre pins and the flange area immediately adjacent, where the flange "dimples up" around the Teflon insulation.

Place the board in the module with the plane of the board at a bit of an angle and the solder tags of the module grounding lugs beneath the board. Make sure you place the input stripline to the female BNC, output to the male BNC. Stuff something, such as small blocks of polyurethane foam packing, beneath the board to hold it in place against the centre pins of the connectors and solder the centre pins to the striplines. Using short pieces of tinned copper wire (20 or 22 g), bridge the groundplane on the board immediately adjacent to the stripline ends, to the BNCs at the flange dimple. This can be seen in the photographs. A heavy duty iron with a large (say, 6 mm) wedge tip should be used for this job. Solder the grounding lug tags to the underside of the board. You should now have a secure assembly. Take the packing out of the enclosure.

Before placing any components on the board, lightly tin the copper areas where components will be soldered. These can be

The completed prototype unit is quite small and fully shielded by the unique enclosure in which it was built. Note the feedthrough capacitor for the positive power supply lead. The negative side of the supply is made via the 'ground' connection of either of the BNC connectors, from the equipment to which the unit may be attached.



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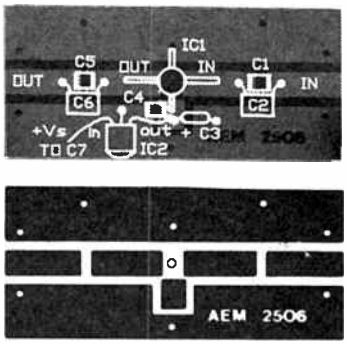


Close-up view, showing chip capacitor mounting.

A chassis-mount feedthrough capacitor

AEM2506 PARTS LIST

Semiconductors

IC1 ..... UPC1651G
IC2 ..... 78LO5

Capacitors

C1, C4, C5 .... 470p chip caps
C2, C6 ..... 10n/50 V plate ceramics
C3 ..... 1u/10 V tant.
C7 ..... 1n feedthrough

Miscellaneous

AEM2506 pc board; RS Components In-Line Module cat. no. 456-201, or metal box and 2 x BNC flange-mount connectors – one male, one female.

Estimated cost: $28-$38.

identified from the component overlay diagram. Do not leave blobs of solder on the board, just a thin patch of bright solder. There is no point in covering the entire copper surface of the board with solder yourself. Commercially-made boards may be supplied already roller tinned. You can't emulate that with your soldering iron and a hundred grams of resin-cored solder!

Take the UPC1651 and identify each lead; it's placed on the board first. With the writing uppermost, and the longest lead to your right, the lead on the left is the input, then going clockwise you have the +ve supply lead, the output (long lead) and ground towards you. It is not a CMOS device so no special handling precautions are necessary, other than take it gently. The ground lead needs to be cut to a length of 2 mm so that it clears the adjacent top-to-bottom link.

Making sure you orientate it correctly place it on the board with the writing uppermost. A small pair of needle-nose tweezers is useful here and will come in handy later, also. Place the tip of your iron on top of the UPC1651's ground lead and let it heat up, watching for the tinning beneath to melt. When it does, apply solder to the joint and see that it flows well, properly wetting the area. Don't apply too much solder, just sufficient to flow on the area is enough. Lift off the iron and let the joint cool for a few seconds until the solder solidifies. Then do the same for the +V lead, the input and output leads in turn. An extra pair of willing hands would come in handy during construction.

Now the chip capacitors can be soldered in place. These are *really tiny*, just 1 mm x 1 mm x 2 mm. You'll need your tweezers. Place C3, the positive supply bypass, in place and apply the tip of the iron to one end so that it touches both the capacitor's metallisation and the tinning on the board. Watch for the tinning to melt and then remove the iron, holding the chip in place till the solder solidifies. Then repeat it for the other end. The other two chip capacitors are mounted in the same way. The 10n plate ceramic capacitors are mounted directly over the top of the input and output line chip capacitors. Bend the leads outwards, away from the body of each capacitor and cut them down to about 3 mm. Place them in position and quickly solder them to the board. The 1u tantalum is the last capacitor to solder in place on the board. Trim its leads back to about 3-4 mm.

The 78LO5 can now be mounted. Trim its centre lead to about 6 mm long and bend it down, away from the flat of the package, in a "dog's leg" so that its end can be soldered to the topside groundplane as seen in the overlay diagram and photograph. Splay the other leads out left and right of the package, then solder the centre lead in place on the board. Trim the left hand (5 V output) lead to a suitable length, then bend it down and solder it in place. Leave the input lead "flying" for the moment.

Now determine a position on the enclosure where you need to drill a hole for the feedthrough capacitor. See that it won't foul the lips on the inside of the extrusion. Mark out, centre punch and then carefully drill the clearance hole. Some idea of the positioning can be ascertained from the photographs. Its size, and exact position, will be dependant on the actual size of the component used as they do vary from make to make. Clean off all burrs around the hole and bolt the feedthrough capacitor in place. Solder the input lead of the 78LO5 to the terminal of the feedthrough capacitor. Just make a careful check of everything and then you can re-assemble the enclosure. Your amplifier is ready to go!

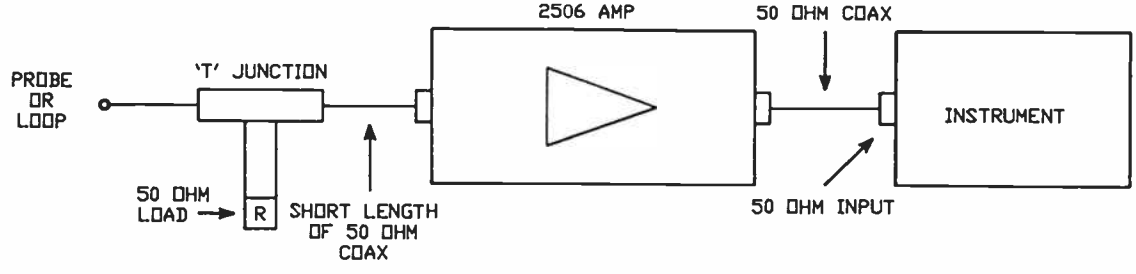
Using it

The amplifier requires both the input and output terminated in 50 Ohms. If the input, particularly, is left unterminated or terminated in a "strange" impedance, the amplifier may be unstable. Fortunately, it's generally easy to comply with these requirements.

The unit may be plugged directly onto the input socket of an instrument, or hooked up via a length of 50 Ohm coaxial cable. The power supply requires an unregulated dc voltage of something between about 7 V and 25 V.

Where the unit is used in an application such as boosting the sensitivity of a frequency counter or spectrum analyser, it's wise to terminate the input, as shown in the accompanying diagram, either with an in-line attenuator or with a BNC T-junc-

to 96 ▷



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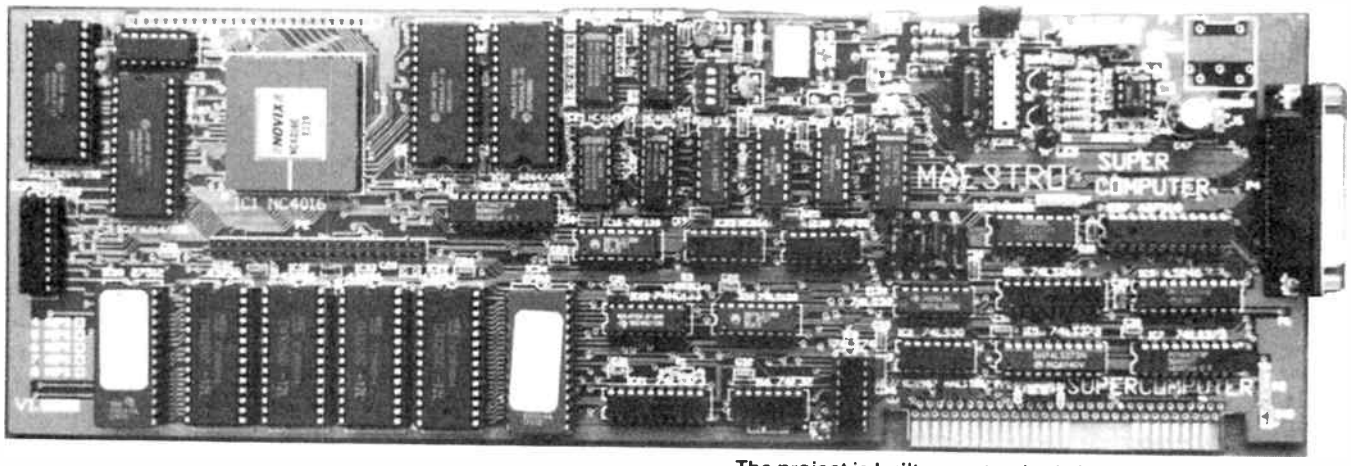

The project is built on a standard sized IBM add-in card. For all its power, it is not hugely complex or difficult to build.

The "Supermicro" computer project

Roy Hill

Now that you have gleaned an outline of the project, this month you can get down to building it! We'll get into a detailed description of the circuit operation later, as it's easier to learn-by-doing with a working project.

BEFORE COMMENCING on the description of how to assemble this project, I will need to explain several subtle changes that have taken place in the few weeks since writing Part 1 and tackling this article – the project has undergone a little 'evolution'. A project such as this, of necessity, undergoes several prototyping stages, and even when you think you have a 'final' prototype, improvements suggest themselves. If you compare Figure 1 in Part 1 with the board layout here, you will notice that the top right hand area of the board, previously reserved for other uses, now has some circuitry there.

It was realised that an analogue-and-audio output would be a desirable and convenient addition, so an LM386 (IC41) was added, along with a speaker connector to provide sound output. At the same time IC28 (a TL497 switchmode converter), which generates the EPROM programmer 'burn' voltage, was moved into this area, too, and a trimpot for setting the burn supply voltage was also incorporated. Once the additional circuitry was prototyped and proofed, it was a comparatively simple matter to modify the board artwork – such is the power and convenience of computer-aided pc board design.

Incidentally, Protel-PCB, a CAD package developed in Tasmania, was used to lay out the printed circuit board and component overlay for this project. We have not reproduced the printed circuit board artwork here as the board, of necessity being double-sided with plated-through holes and having tracks only 0.01-inch wide, is virtually impossible for the enthusiast to manufacture with the usual facilities available. In addition, copyright on the board design has been retained by Maestro.

Construction

The Supermicro board is going to take about three to four hours to assemble, depending upon your construction experience. Ensure that you have a decent soldering iron, suitable for fine printed circuit tracks. A temperature controlled unit, such as a Royel or a Weller, is ideal. Remember, too little heat will not 'wet' the joint sufficiently and too much may lift the pads or fine tracks. Remember to touch the iron to the joint and then the solder to the heated joint. Also, remember *NOT TO ROTATE* the iron whilst making a join – you'll lift off the pads, which are, of necessity on this board, quite small.

You will need the usual assembly tools, such as 0.71 mm (20 gauge) 60/40 solder a magnifying glass, a mini sidecutter or transistor 'nipper', a small pair of needle-nosed pliers, a hand-held electric drill or access to a drill press, and four to five litres of patience. A de-soldering tool may come in handy, for use in emergencies.

Patience is a most necessary ingredient, as this board is one of the most ambitious kit projects ever undertaken. Take your time – check your work – have a break from time to time. Above all else, if you don't feel confident to tackle the project, then don't!

A project such as this should be tackled methodically for the best chance of success. Hence, while it might seem a little like "painting by numbers", I have set out the construction in a series of steps.

Check off the parts against the parts list and ensure that all components are present. There are several CMOS devices used in this board, including the NC4016. Use normal CMOS handling precautions when installing these components. Separate the components into groups, as they will be installed in the board in groups.

STEP 1:
This principally involves assembling all the IC sockets to the board. First, determine the type of socket supplied for the NC4016. It is a 'low insertion force' (LIF) type, but either of two ▷

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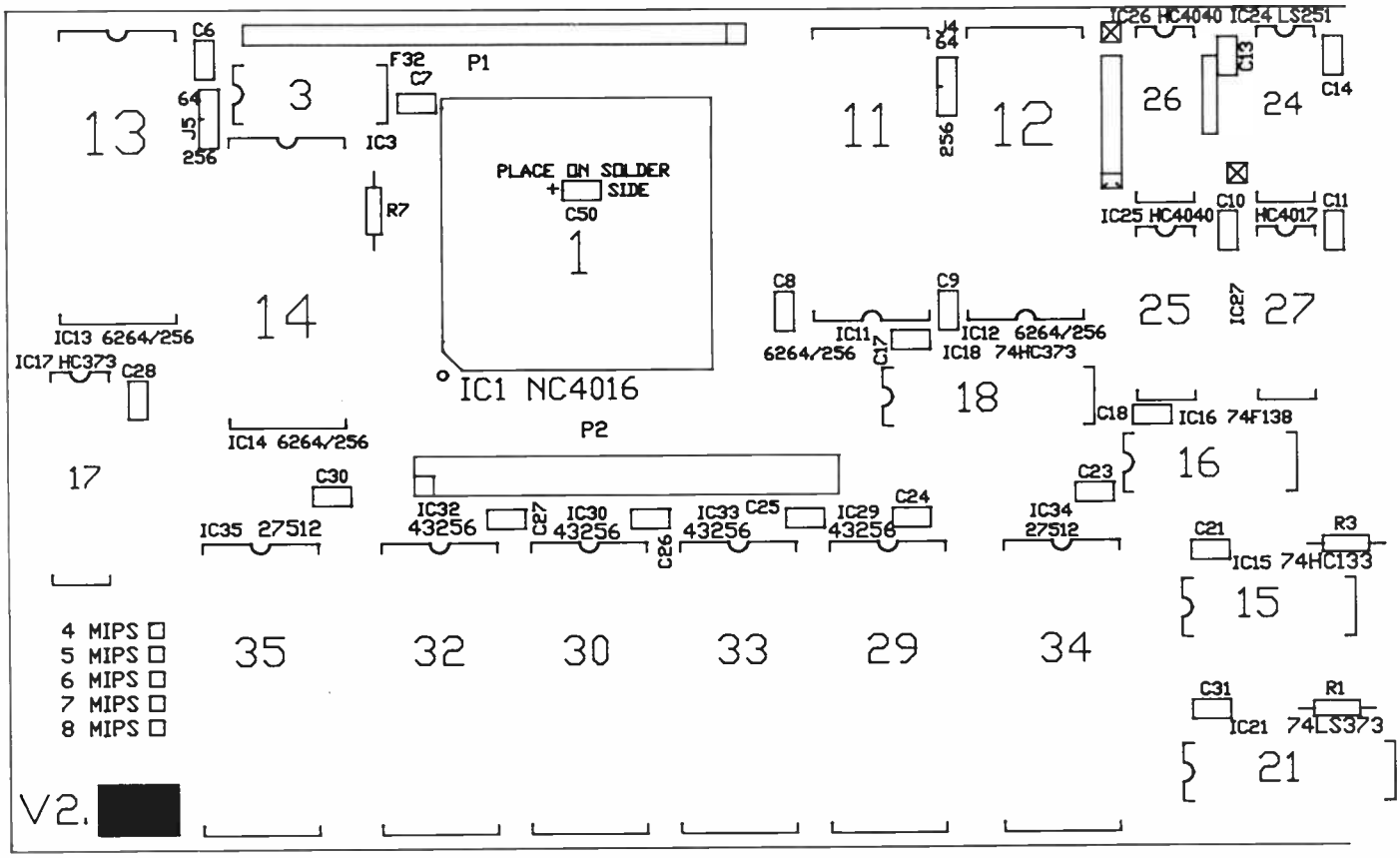

versions may be supplied – one hollow in the centre and the other not. Depending on the type of LIF socket supplied, C50 (a 2.2 uF tag tantalum) may be mounted on either the front or back of the board. Install C50 at this point, as it will be impossible to determine its orientation once a solid outline LIF socket has been installed. A "+" sign has been provided on the reverse side of the board (in copper) to enable correct orientation to be accomplished. Make sure that you get the correct polarity for this capacitor. *DOUBLE CHECK*. Everything OK? Good, now *CHECK IT AGAIN!!!* If this capacitor (or any other tag tantalum or electrolytic) is installed with reversed polarity, the board MAY appear to work correctly for several minutes and THEN...!

For all construction steps, I will mention "TOP, BOTTOM, LHS and RHS" of the board. This refers to having the board on the bench, with the overlay correctly oriented for reading (the edge connector should be in the BOTTOM RHS).

Install and solder all IC sockets. Use a piece of stiff cardboard (or polystyrene foam) to hold the socket in place, whilst turning the board over for soldering. Install the NC4016 socket last. Check this socket very carefully after soldering – it's easy to have solder bridges on the very close pin spacings of this socket. By the time you get to it, all of your old soldering skills will have returned if they're a bit rusty from under-use, and the job should be simple.

Proceed in a logical fashion. Start in one corner of the board and pick the first socket to install. Place the socket in position and check that pin 1 of the socket (indicated by a dot, a notch or a cut-away) lines up with the pin 1 site on the overlay. Check also that all of the pins of the socket have protruded through the board. Tack two diagonally opposite pins of the socket and then check that it has been installed with the correct orientation. *DOUBLE CHECK!* Solder the remaining pins of the socket and then check your work. It's very easy to miss soldering pins if you don't proceed in a repetitious fashion. When you are satisfied, proceed to the next socket.

For those constructors who wish to take advantage of the EPROM programming capabilities of the board (best used in the EXTERNAL MODE), we suggest you purchase two low-profile 'zero insertion force' ZIF sockets and use these instead of the supplied 28-pin sockets. This will enable EPROMs to be readily removed and replaced on the board. The overlay positions of these two sockets are IC34 and IC35. It is not practical to use the EPROM programming facility of the board once it's installed inside an IBM or compatible.

THREE IMPORTANT POINTS

POINT 1: The socket for IC17 is installed at the far LHS of the overlay. The two pins at the RHS are vacant and are used as "vias" (passing a track from one side of the board to the bottom).

POINT 2: The socket for IC8 is installed closest to the bottom of the board. Note that there is no second pin at the top position. It should be impossible to insert this socket in the WRONG position, however . . .

POINT 3: The socket for IC37 (the ADC chip) may be provided as either a "skinny-DIP" socket or as strip socket. Leave this until just before the NC4016 socket to install.

Now install the four-position DIP switch. When installing this, please note that Switch 1 is in the top position.

Stop and check your work. Have you missed any pins? (I missed three in my initial round). Are there any solder bridges? Check with your magnifying glass. Good? Now go and have a well-earned break.

STEP 2:

Now it's the turn of the capacitors. Install the three remaining tag tantalum capacitors, C46, C48 and C49 (remember?, you've already installed C50). *Make sure that you get their polarity correct*, as explained above. Note that the *positive lead* of C48 is towards the top of the board. Install the "Blue Chip" monolithic

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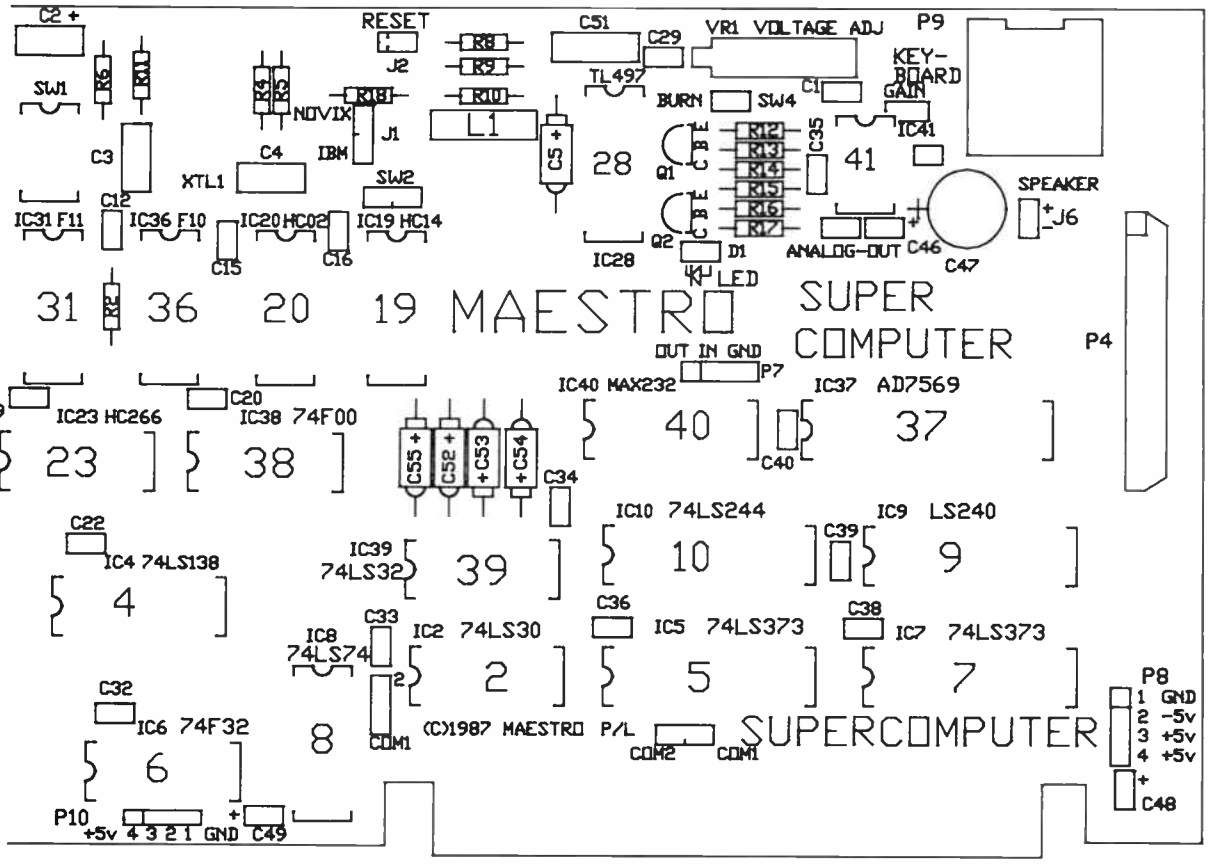

Component overlay – the tracks are not reproduced here as it would confuse the diagram. This drawing is reproduced on the component side of the pc board to assist assembly.

SPECIAL OFFER

If you are interested in obtaining a kit of this project, turn to the special offer advertisement on the inside back cover of this issue.

LEVEL

We expect that constructors of an

INTERMEDIATE

level, between beginners and experienced persons, should be able to successfully complete this project.

PARTS LIST AEM4000

Semiconductors

IC1 ..... NC4016
IC2 ..... 74LS30
IC3 ..... 74F32
IC4 ..... 74LS138
IC5 ..... 74LS373
IC6 ..... 74F32
IC6 ..... 74LS373
IC8 ..... 74LS74
IC9 ..... 74LS240
IC10 ..... 74LS244
IC11-14 ..... 6264 or 43256
IC15 ..... 74HC133
IC16 ..... 74F138
IC17,18 ..... 74HC373
IC19 ..... 74HC14
IC20 ..... 74HC02
IC21 . 74LS373 (Fairchild only)
IC22 ..... not used
IC23 ..... 74HC266
IC24 ..... 74LS251
IC25,26 ..... 74HC4040
IC27 ..... 74HC4017
IC28 ..... TL497
IC29,30 43256
IC31 ..... 74F11
IC32,33 43256
IC34,35 27512
IC36 ..... 74F10
IC37 ..... AD7569
IC38 ..... 74F00
IC39 ..... 74LS32
IC40 ..... MAX232, ICL232
IC41 ..... LM386
D1 ..... Red LED
Q1,2 ..... BC548

Capacitors

C1 ..... 1n ceramic
C2 ..... 10 uF/16 V
C3 ..... 33p ceramic
C4 ..... 22p "
C5 ..... 47u/50 V/50 V
C6-34 ..... 100n monolithic
C35 ..... 4n7 greencap
C36 ..... 100n monolithic
C37 ..... 4n7 greencap
C38-40 ..... 100n monolithic
C41-45 ..... not used
C46 ..... 2u2/16 V tant.
C47 ... 220u/25 V RB electro.
C48-50 ..... 2u2/16 V tant.
C51 ..... 470p ceramic
C52-55 .. 10u/25 V RB electro.

Resistors all ¼ W, 5%

R1 ..... wire link
R2,3 ..... 4k7
R4 ..... 10M
R5 ..... 470R
R6 ..... 10k
R7 ..... 4k7
R8 ..... 1R2, 1 W
R9 ..... 10k
R10 ..... 1k2
R11 ..... 4k7
R12 ..... 2k2
R13 ..... 10k
R14 ..... 2k2
R15-17 ..... 10k
R18 ..... 330R
VR1 ..... 10k, 10 turn preset

Miscellaneous

Super Computer (AEM4000) pc board; L1 – 100 uH RF choke; IC sockets – 1 x 121 pin (IC1); 10 x 28 pin (ICs 11,12,13,14,29,30,32,33,34 & 35); 1 x 24 pin (IC7 – "skinny" DIP or strip socket); 7 x 20 pin (ICs 5,7,9,10,17,18 & 21); 8 x 16 pin (ICs 4,15,16,24,25,26,27 & 40); 12 x 14 pin (ICs 2,3,6,8,19,20,23,28,31,36,38 & 39); 1 x 8 pin (IC41); 1 x 4 position mini DIP switch; 1 x 44 pin DIP expansion connector; 1 x 26 pin SIP expansion connector; 1 x DB25S right-angle PCB connector; 1 x 16 MHz HC18U crystal (for faster memory chips a 17 or 19 MHz crystal may be used); 3 x 2 way, 6 x 3 way and 3 x 4 way jumper/strip connectors; 7 x 2-position shorting lugs; 1 x power connector; 1 x short length of plastic tube insulation (for possible use with C5 – depending on its working voltage); 1 x IBM backplane connector; 1 x 4 position power connector; 1 x 2-position speaker connector; 1 x 3 – 3.5" 4 to 8 ohm speaker; 1 x plastic strip for DB25S connector port; 6 x connector pins for power and speaker connector.

Cost: $700

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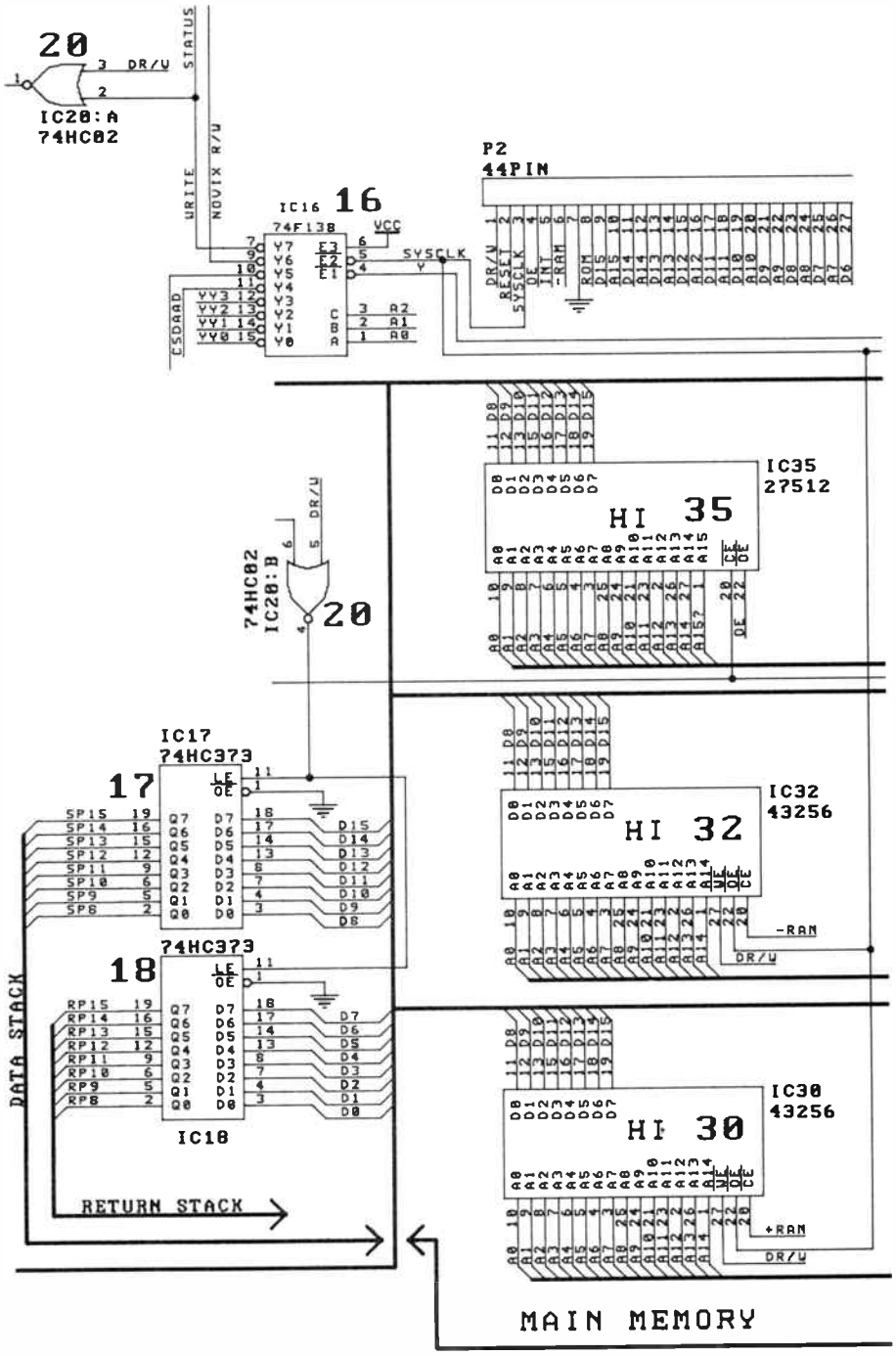
Portion of the circuit diagram of the Super Computer. This shows the processor and memory sections. The other portions will be reproduced in the next issue when the circuit operation is discussed.



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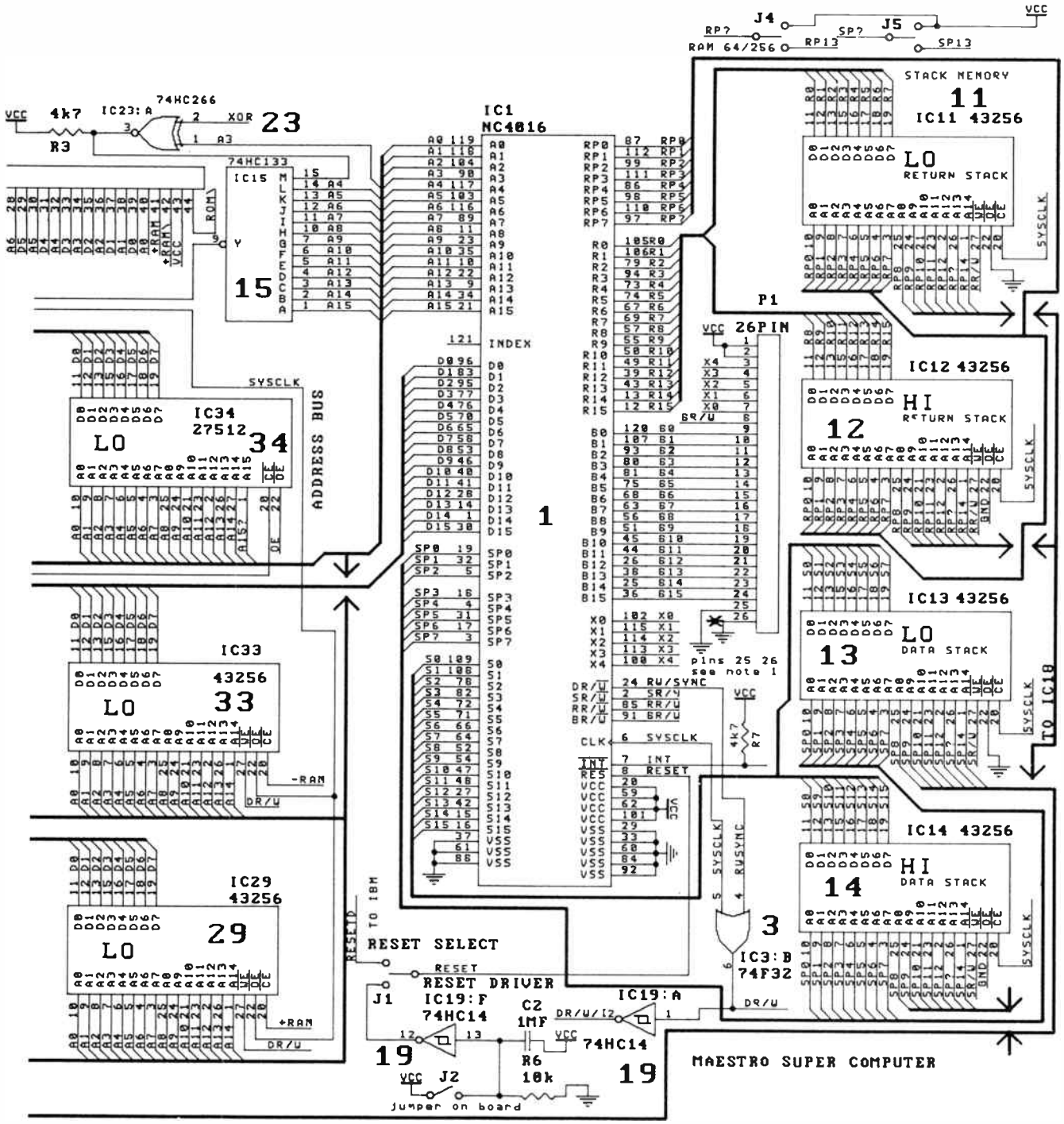

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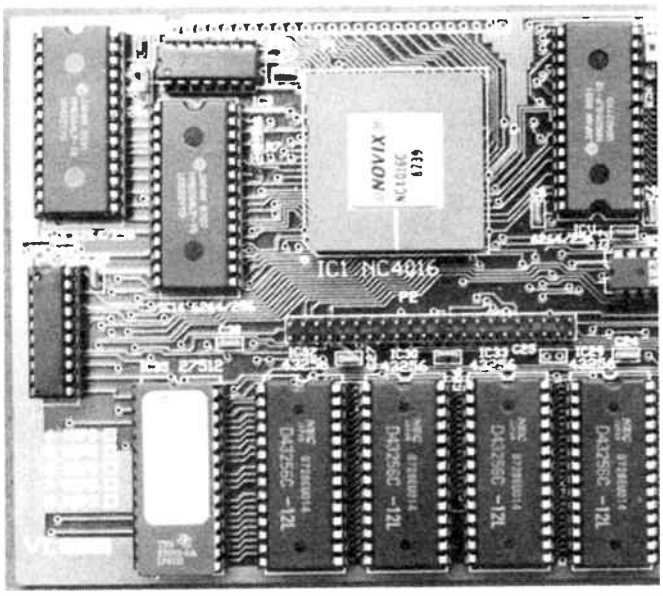


View of the left hand end of the board.

100n (0.1 uF) bypass capacitors (note that these are not polarised). There are 33 of these and they are used to remove "glitches" from the power supply. The numbering for these (to assist with their location) runs, roughly, from LHS to RHS and from TOP to BOTTOM. Check that there are 33 of them installed. Trim off any excess lead with the nippers, after soldering them into position.

Install the electrolytics and ceramics as well. Note that the positive lead of C2 is placed towards the RHS of the board. *Watch carefully the polarities* of C52 to C55. C52 and C55 have their *positive leads* towards the top of the board and C53 and C54 have their *positive leads* towards the bottom of the board. Also, don't bend the leads of the components over. The tracks on the reverse side of the board are very close together and it allows the leads to short out the tracks. Also, it makes it far easier to remove them if they eventually fail.

STEP 3:

Now's the time to tackle the resistors. Locate them all and check off the values against the parts list. Install them in the board and dress them correctly. That is, ensure that the tolerance bands all face the the same direction. It doesn't improve performance, just the looks of the board. Note that R1 is a wire link and that VR1 is a 10k, 10-turn preset.

STEP 4:

Now for the bits and pieces. Patience, we're almost there! Firstly, the LED. The longer pin (negative pin) goes towards the LHS. Check with the overlay if there's any doubt. Install the two transistors (Q1 and Q2), followed by the choke. L1. Now the crystal. Solder it in place leaving about 3-4 mm of lead between the crystal's base and the board. Then it may be laid over flat, but take care not to short the case against any of the tracks above it.

Follow by installing all of the jumper and strip pins and the three expansion connectors (one 26-pin SIP, one 44-pin DIP and one DB25S right-angle PC-mount). The SIP and the DIP will require a modicum of force to insert. Don't overdo it, however, as we don't want to destroy the board, do we? Gentle pressure in a wooden-jawed vice may assist. Another useful idea is chop the connectors (NOT THE DB25) up into smaller lengths, if you find them overly difficult to insert. A little gentle filing (with a points file) may also help.

Now place the shorting lugs on the jumpers (described further on in this article series). Under no circumstances should you connect the shorting lug to the jumpers marked 'burn'(SW4). Use of this jumper will be described in the next article. Keep the shorting lug for this jumper aside for the time being. The reason for not installing it at this stage is fairly simple – if when you eventually do fire-up the board and there's a fault in it which causes the "BURN" signal to be asserted, then your existing EPROMs will go into meltdown. Hmmm!! The shorting lugs should be placed as follows:

SW2 – On the LHS
SW3 & J3 – as described earlier
J1 – on the top two lugs
J4 – on the top two lugs
J5 – on the top two lugs

Install the IBM board retainer metalwork. A plastic strip is provided to cover the 25-pin connector. It will be necessary to drill two holes through this to allow the two hex screws to be re-installed.

Remove the two hex screws from the DB25 connector, place the frame over the connector, followed by the plastic strip and re-install the two hex screws. PLEASE REMEMBER – this connector IS NOT a serial port. DO NOT CONNECT A SERIAL CABLE to this port – you'll damage the board if you do.

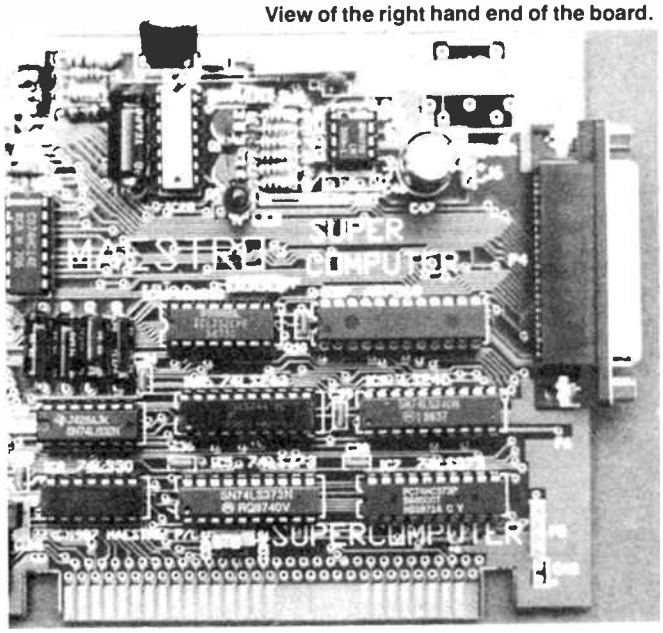
CONGRATULATIONS – it's done! You'll need a normally open, momentary contact pushbutton for a reset line (see earlier warning). Note that the IBM-type keyboard connector (at the TOP RHS of the board) is not supplied as part of the kit. Set switch number 2 of SW1 to the "ON" position. Ensure that all other switches on SW1 are in the "OFF" position. Power is supplied to the board through P8. The very top pin is the GROUND pin and the very bottom pin is the +5 volt supply. The speaker is connected via J6. The polarities of the speaker connector are shown on the overlay diagram. The serial connector at P7 should be wired as discussed in Part 1.

Double check

Check all the soldering and orientation of the components. Check all the tag tantalums and electrolytics for their polarity. Check that you know which way the power connector is mounted. DON'T FORGET WHICH WAY IT GOES ON. AT $300 EACH, NC4016 CHIPS AREN'T CHEAP.

At this stage, you'll notice that we haven't installed any of the ICs. *DON'T DO IT!* Once again – don't install any ICs at this stage. We have to perform a series of multimeter checks on various parts of the board prior to the installation of any of the ICs. And that's where we'll leave it, until next issue.

View of the right hand end of the board.



World Radio History

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KENWOOD

NEW RZ-1 WIDEBAND RECEIVER
"THE SCANNERS DELIGHT"

COVERS 500 KHz TO 905 MHz RANGE

The new KENWOOD Wideband Receiver is a multipurpose receiver that covers the 500KHz-905MHz range. Its advanced features are made possible through the use of advanced microprocessor technology.

Features Wideband Frequency Coverage (500KHz — 905MHz), including FM Stereo Broadcast and Multi-Channel Television Sound. 100 Easy-To-Operate Multi-Function Memory Channels with Message Capability. 10-Band Programmable Capability. Keyboard Frequency Selection. Auto-Mode and Auto-Step Operations. Multi-Scan Function. Easy-To-Read Large LCD Display. Compact and Lightweight. Auto-Selectable Dual Antenna Terminals. Built-in speaker. Front-mounting phones jack. Easy-to-operate, illuminated keys. Accessory terminals are Line Out/Video Out/External Speaker Terminal. Squelch circuit for FM (narrow) mode. UP/DOWN Keys for VFO and memory channel.

Specifications Frequency Range: 500KHz — 905MHz Mode: A3[A3E] (AM), F3[F3E] (FM) Circuitry: AM, FM(N) = Triple conversion system FM(W) = Double conversion system Sensitivity: AM (S+N/N = 10dB) = Less than 5 uV (BC band 10uV). FM (N) = 12dB SINAD less than 6uV (500KHz — 60MHz) less than 3uV (60 — 905MHz). Operating Temperature: -10° - +60°C. Audio Output Power: 2W (at 8 ohms load 10% distortion). Current Drain: Less than 1A (audio power output 1W). Antenna Impedance: 50 - 300 ohms. Power Requirement: 13.8VDC ± 15%. Dimensions: 180(W) x 50(H) x 158(D) mm. Weight: 1.5kg.

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World Radio History

Philips' Australian cellular carphone a winner!

Philips' FM9010 cellular carphone, developed by a joint Australian-Danish team, has not only won a contract to supply Telecom, but has won type-approval in Canada opening the way for this Australian product to be marketed there.

Samples of the FM9010 cellular carphone are being shipped to Philips Electronics Ltd in Canada so it can be introduced to major dealers and distributors.

Carl Acorn, manager for mobile radio with Philips Canada, says he is very impressed with the performance of the unit and expects wide and favourable distributor acceptance.

Made at Philips' Clayton plant in Victoria, the FM9010 was launched onto the market in September last year. The first export orders were from New Zealand.

When Telecom announced in 1985 that its choice for the proposed cellular radio phone system would be the North American Automatic Mobile Phone Service (AMPS), Philips did not have a product to the AMPS specification.

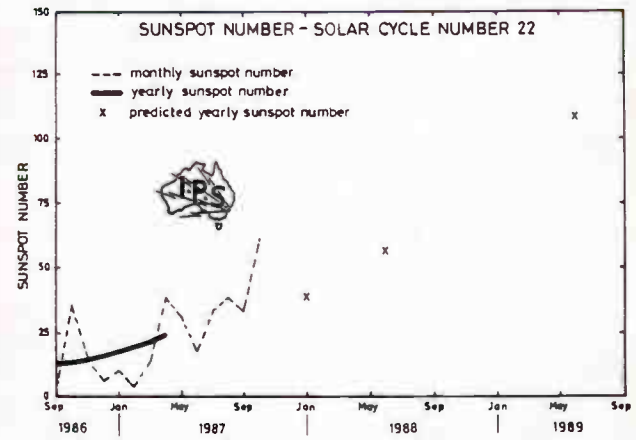
New electronic design work was commenced at Clayton to meet the requirements, drawing on the company's European experience in cellular radio.

A small team of Australian engineers then went to Philips Denmark to further the design. Danish engineers, expert in the mechanical detail of mobile phones, gave their assistance and the FM9000 series was born.

The FM9000 series makes extensive use of surface mount technology, allowing massive space reductions, essential in equipment such as this. Philips specially equipped their Clayton plant for SM manufacture. One of the FM9000 series is marketed as the Telecom 'Traveller'.

The Clayton plant was made an 'International Product Supply Centre' by Philips last year, and is now responsible for the design and manufacture of all AMPS-compatible phones made by Philips worldwide.

As the AMPS system is used in Canada, Hong Kong, the USA and New Zealand, this opens a vast potential market for the Australian product.



SUNSPOTS FAST RISING

The latest report from IPS Radio and Space Services indicates that they are now almost certain that the solar minimum was passed in September 1986 when the yearly smoothed sunspot number dropped to 12.4.

Cycle 22 is well and truly under way and the sunspot number has risen strongly since late 1986, reaching a smoothed value of 24.2 by April 1987.

There have been bursts of solar region growth in October 1986, in April-May 1987, in July through September 1987 and again in October last year.

Packet radio satellite possibility

On November 8, the US Amateur Satellite Corp (AMSAT) board of directors learned from Vice President of Engineering Jan King W3EGY, that it may be possible for AMSAT to develop and provide an amateur packet radio satellite much more quickly than previously thought – a project not scheduled until the 1990s, originally.

The AMSAT board responded by authorising an extraordinary program to take advantage of any one of several "target of opportunity" launches that may present themselves within the next 24 months.

Meanwhile, AMSAT North America has begun discussions with the University of Surrey to determine if a joint approach to the UoSAT-C project is possible.

(Courtesy AMSAT Aust. Newsletter)

Portable microwave analyser

Hewlett Packard Australia has released a low-priced (for them) microwave spectrum analyser, the model HP 8592A, extending the company's offering of portable RF and microwave analysers to four models.

The new analyser covers 50 kHz to 22 GHz and sports an amplitude range from –109 dBm to +30 dBm. An internal preselector reduces multiple and image responses and a built-in "comb" generator enhances frequency accuracy to ±2.7 MHz at 22 GHz, HP claim.

The unit weighs 15 kg and measures 213 x 366 x 406 mm. It comes with a tilt-bail carrying handle and an optional front panel cover for protection against moisture and impact.

Three digital interface options – HP-IB (IEEE-488), HP-IL and RS232C provide full external programming capability.

The HP 8592A is designed for field servicing of communications equipment as well as lab-bench testing, manufacturing and electromagnetic radiation testing.

Further details from **Hewlett Packard, 31-41 Joseph St, Blackburn 3130 Vic. (03)895 2895.**

World Radio History

Component considerations in VHF and UHF construction

Roger Harrison VK2ZTB

When it comes to electronic construction where radio frequencies are involved, components sometimes don't behave quite as you're used to them behaving at audio frequencies or dc. Hence, components used in circuits operating at very high or ultra high frequencies (VHF or UHF) either have to be carefully chosen for their characteristics or specially designed for the application.

YOUR COMMON-OR-GARDEN passive components – resistors and capacitors – don't quite behave as you'd expect once you put them in a circuit operating in the VHF/UHF range. A simple 100k ½ watt carbon film resistor begins to look like quite a complex little network at 50 MHz, misbehaving in strange ways at three times that frequency. Capacitors too, take on complex forms when used at VHF or UHF. Use the wrong type of capacitor in a particular application and it won't behave like a capacitor at all – more like an inductor! Then again, you can make it look like a short circuit of lower impedance than its value would dictate. And what about RF chokes – surely they're made for RF use and should behave? Well, there have been occasions when I could have cheerfully throttled some I've come across!

Active devices, too, require special packaging and lead termination techniques at these frequencies in order not to hinder the advantages bestowed by the semiconductor device's characteristics.

The fabrication and encapsulation methods employed in making components add unwanted "stray" inductance and capacitance which affect the component's operation adversely or in unpredictable ways.

Leads and lead length

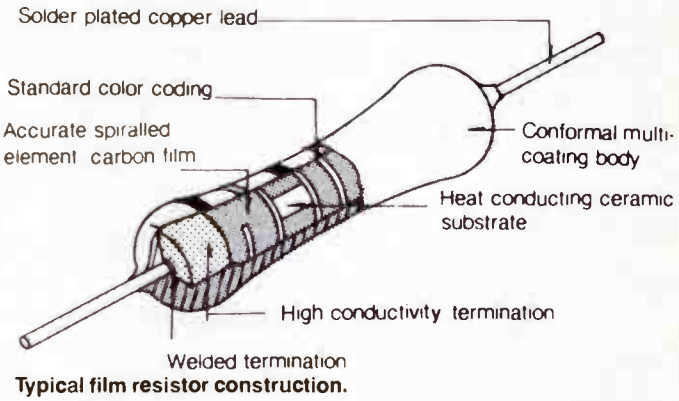
One of the main culprits in introducing unwanted strays is a component's leads and lead attachments. Now, a straight piece of wire has inductance. You're probably used to thinking that only coils have inductance – but remember they're just straight pieces of wire wound up to take up less space! Yes, winding it into a coil provides more inductance than any other shape, but straight wires, strips or plates – all have a finite inductance, small though it may be. At VHF and UHF, this inductance can have a major effect.

Consider this: a 5 mm component lead length at 150 MHz represents 0.25% of a wavelength (which is 2 m). At 1 MHz (which is in the middle of the AM broadcast band), 0.25% of a wavelength (300 m) is 750 mm. Now, you wouldn't conceivably wire-up a broadcast tuner with components having leads that long (assuming you could get them)?; somehow you realise that that would be asking for trouble. Well, 5 mm lead lengths at 150 MHz is sure asking for trouble!

Components specially designed for use in VHF/UHF circuitry employ a variety of techniques to reduce or eliminate leads or the effects of lead lengths. For printed circuit mounting components, leads can be reduced to vanishing point and by mounting the component directly on the copper track surface of a pc board – known as *surface mounting*. Indeed, the first surface mount components were developed specifically for VHF/UHF applications. In some instances, the leads are made to form part of a transmission line in an effort to turn adversity to advantage.

Resistors

Modern 'film' resistors generally consist of a ceramic body with a thin film of resistive material deposited on it. Lead connections are later attached and the resistance value set by cutting away some of the resistive material in a spiral. Carbon and a special metal are the common resistive materials used.



Typical film resistor construction.

Now, obviously, that spiral cut in the resistive material must act like a coil with a certain amount of inductance – only small, but an inductance nonetheless. The higher value resistors have a longer spiral and hence will exhibit more 'self inductance' than lower value resistors.

The resistive material used for metal film resistors can be deposited in extremely thin layers of quite high intrinsic resistance, much thinner than carbon film. Hence, the higher value metal film resistors will exhibit less self inductance than equivalent value carbon film types.

Typical self inductance values for common film resistors vary from a fraction of a nanohenry to tens of nanohenries. The lead attachment will contribute a little capacitance that is effectively in parallel with the (inductive) resistance. Hmmm, it's starting to look like a parallel-tuned circuit (but a bit lossy, due to the resistance). The resistor's leads will also add a little inductance, depending on the length.

Carbon film resistors up to several thousand ohms are usable up to 200 MHz, providing the leads are kept to no more than 2-3 millimetre. Metal film resistors up to 10k or so are usable up to the 400-500 MHz region, depending on individual construction. What's more, they're a lot less noisy than carbon types and are recommended in low noise applications (like in receiver front ends).

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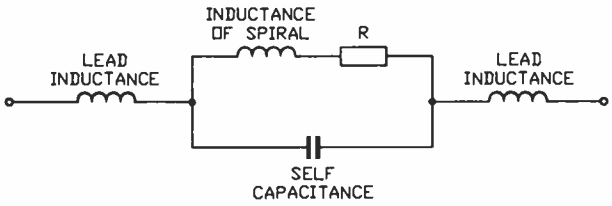
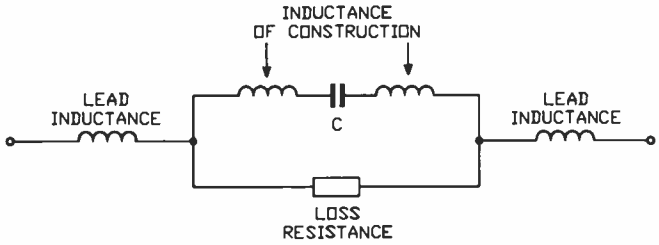


A resistor doesn't look too much like a pure resistance when you take its construction into account at VHF.

Surface mount "MELF" resistors are cylindrical in shape and have no leads, just tinned "caps" at each end. Leadless "chip" resistors are box-like with metal plating at each end. The self inductance of MELF and chip resistors is some 10 to 1000 times less than common film resistors. Nice, if you can get them, but they aren't an off-the-shelf item at electronics retailers (– yet).

Capacitors

Capacitors come in a whole host of construction styles. The construction and the leads of all capacitors form an inductance which is effectively in series with the capacitance of the component. The combined effect forms a series resonant tuned circuit. The self resonant frequency of this tuned circuit, being mainly dependent on the length of the leads, the particular construction and the way the capacitor is mounted.



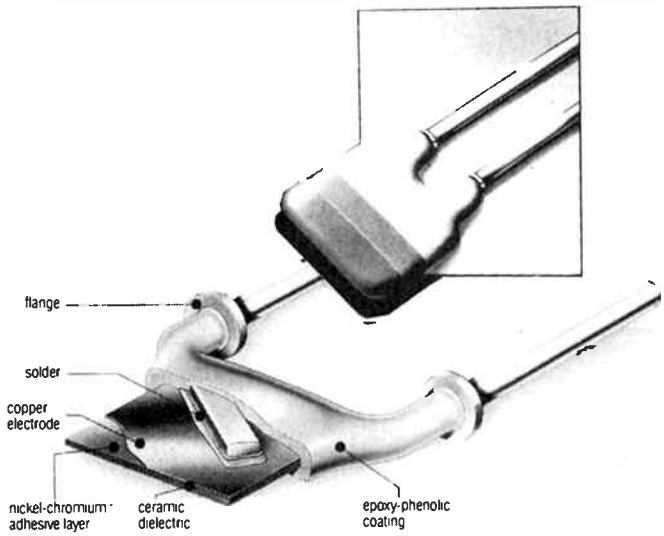
Capacitors, too, don't look much like a pure capacitance once you consider the characteristics at VHF.

Common 'greencaps' consist of a plastic film having a film of metal deposited on both sides, with leads attached, wound up and encapsulated. That makes it pretty inductive. The self resonant frequency of a 1 nF greencap with 5 mm long leads is typically 60-65 MHz. A 10 nF greencap has a self-resonant frequency around 15-18 MHz with 5 mm long leads, a bit over 20 MHz with 1 mm long leads. Forget greencaps at VHF – except, say, for values 1 nF (1000 pF) and below used as bypasses in the lower VHF region below 80 MHz.

Modern miniature metallised polycarbonate and polyester film capacitors (MKPs and MKTs) do somewhat better in this regard, particular the "radial lead" types manufactured specifically for vertical mounting in a pc board. Typically, a 10 nF MKP or MKT has a self resonant frequency around 20 MHz, mounted such that the thickness of the board substrate determines the lead length (1.6 mm on commonly used pc boards).

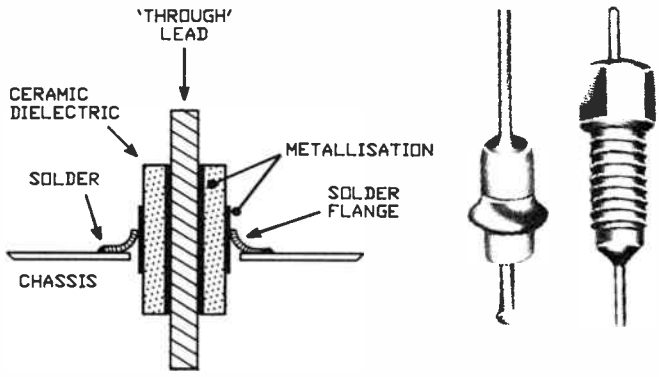
Ceramic capacitors generally comprise a small ceramic plate (disc or square) with metallisation on both sides. Leads are attached to the metallisation. Higher capacitance ceramics may have several plates stacked with the alternate metallisation layers connected together.

This sort of construction makes for pretty low self inductance, typical values being below 10 nH. A commonly available 100 pF disc ceramic with 1 mm leads will typically resonate around 200 MHz. The common 5 mm diameter 1 nF disc ceramic will typically resonate around 80-90 MHz with 1 mm long leads. Miniature plate ceramic capacitors, such as the Philips 2000 series, have self resonant frequencies well into the VHF range (depending on value), much higher than disc ceramics.



Construction of a plate ceramic capacitor (courtesy Philips).

Tubular ceramic capacitors are rare these days, except as "feedthrough" capacitors, most often used in bypass applications. These comprise a ceramic tube with metallisation deposited on the inside and outside. A flange is soldered to the outside, for soldering the capacitor to a shield, chassis or groundplane. Some types have a screw thread and nut arrangement so they can be bolted down. Connecting lugs at either end provide connection through the body, hence the name "feedthrough".



Construction of a typical solder-in type feedthrough capacitor. Pictures of a solder-in and a bolt-in type are shown alongside.

These capacitors are used to bypass leads that pass through a shield or chassis. Typically, a 500-1000 pF feedthrough will have a self resonant frequency, depending on its construction, of between 250 and 500 MHz.

Leadless ceramic capacitors were among the first surface mount components developed. Generally known as "chip" capacitors, they have no leads. They simply consist of a ceramic body with metallisation planes through it, alternate planes being connected by metallisation on the chip ends.

Chip capacitors are tiny rectangular or square shaped objects, with metallised ends and measuring around 2 x 1 mm, or even smaller! Their self resonant frequency is rarely a consideration, except with the higher values (above 470 pF) and larger sizes. Typically, self resonant frequencies of chip capacitors lies in the hundreds of megahertz to 1000 MHz (1 GHz) range. Their upper frequency of operation is limited by their geometry creating serious impedance "mismatches" when used as part of a transmission line on a pc board (known as "microstrip").

Circular-type chip capacitors are seen, rather like 'naked' disc ceramics. They have metallisation on the two faces of the disc and were principally developed for UHF TV tuner applications. ▷

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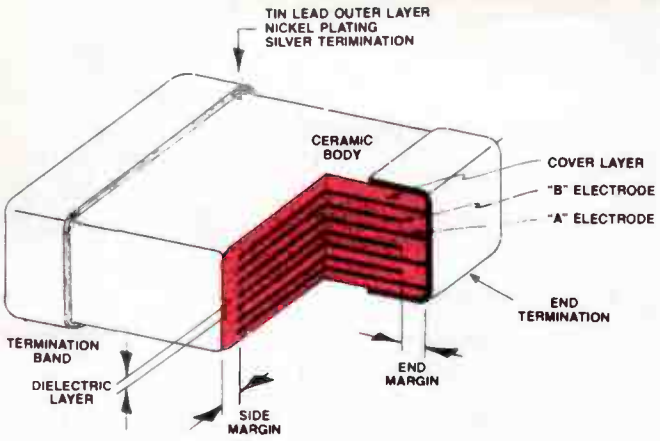
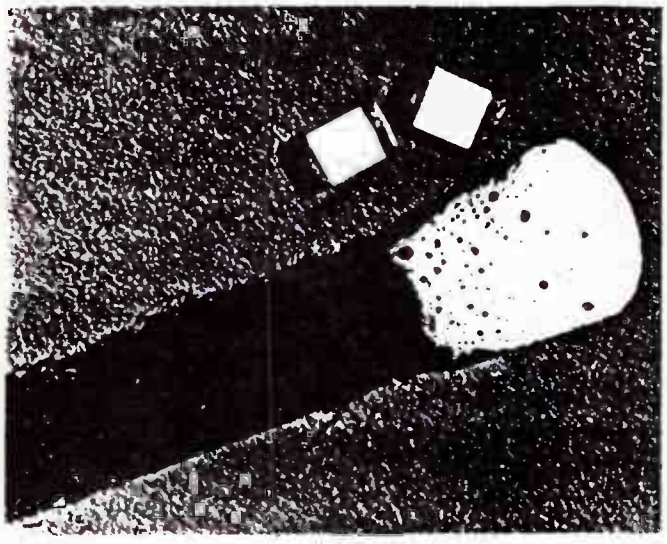


Construction of a ceramic multilayer chip capacitor. (From SFE, courtesy J.A. Severn).

Unlike you'd expect, chip capacitors are generally not expensive. They may cost more than greencaps or disc ceramics, but are generally cheaper than many electrolytics. Also, chip caps will withstand considerable RF currents, despite their small size. Most values over 10 pF will withstand over an amp at 400 MHz – that's over 50 W in a 50 Ohm system.

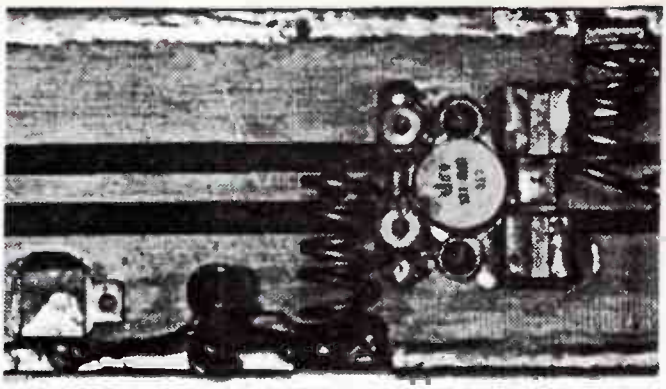


Chip capacitors compared to a match-head.

Mica capacitors, though as old as the hills, offer a low inductance construction. Mica is a naturally occurring mineral that separates into very thin leaves. Mica capacitors consist of metal foils separated by thin leaves of mica, the alternate metal foils are connected to form the plates of the capacitor. Some types have metallisation deposited on the mica leaves and interconnected in the same way.

"Dipped" mica capacitors, widely used in RF applications, have the plate foils soldered or crimped to a lead and the assembly dipped in an epoxy encapsulation. Typically, these have self inductances in the nanohenries to tens of nanohenries range. A 100 pF dipped mica capacitor with 5 mm long leads may resonate around 120-130 MHz.

Metal-clad mica types, rather than leads, have an encircling metal clamp which not only holds the assembly together, but provides connection to one set of plates, too. The other set are brought out to a heavy tag. They are meant for surface mounting on a pc board or soldering direct to a chassis. Typically metal clad micas have self-inductance values under 1 nH and a 200 pF value might have a self-resonant frequency around 500 MHz. They can withstand tens of amps of RF current and relatively high voltages and are often employed in VHF/UHF RF power amplifier applications.



This illustration shows two metal-clad mica capacitors used in an RF power amplifier (right). A third, just soldered to the board, is shown at left clearly showing the metal body (one connection) and the tag (the other connection).

"Button" and "disc" mica capacitors are also produced, but rarely seen these days, so-called because of their shapes. They have very low self inductance values and self resonant frequencies in the upper UHF region.

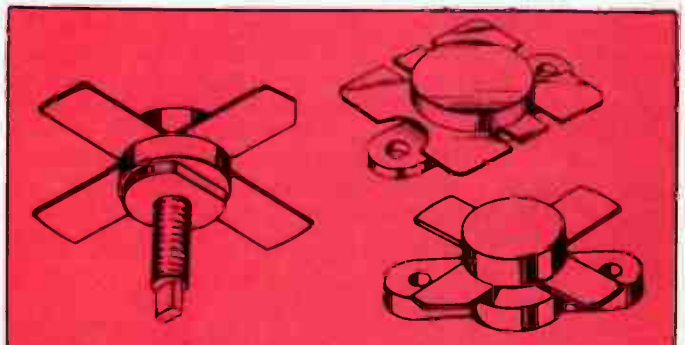
In bypass applications where a circuit operates at a single frequency or over a narrow range of frequencies, it is possible to achieve a more effective bypass by using a capacitor at or near its self resonant frequency where that corresponds to the frequency of operation. With leaded capacitors, cutting the lead lengths so that it resonates at the desired frequency is a handy trick. When using capacitors in a tuned circuit, it is wise to ensure that its self resonant frequency is at least three to five times higher than the frequency of operation.

RF chokes

By definition, RF chokes are used to prevent (hence, 'choke') the passage of RF energy while allowing dc or lower frequency signals (e.g: audio) to pass. Principally, RF chokes are used in decoupling applications.

As you'd expect, they comprise a coil. Depending on the inductance required and the application, RF chokes for VHF/UHF applications are generally solenoid wound and may consist of one to several layers wound on a bobbin former. This may be an insulator or a magnetic material (ferrite or powdered iron), depending on the inductance value required. Simple air-wound coils are also used as RF chokes.

Commercially-made RF chokes are generally available in values from around 100 nH (0.1 uH) to 200 uH or so. Values below 10 uH are generally wound on a non-magnetic bobbin, or air-wound and encapsulated. Powdered iron and ferrite bobbins are used for chokes between 5 uH and 100-200 uH.



A variety of stripline opposed-emitter (SOE) transistor packages, generally used with RF power transistors. This construction is essential at VHF and UHF to reduce lead inductance as well as to physically and electrically interface to pc board transmission lines used in circuits at these frequencies.

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The self capacitance of the construction effectively places a capacitance in parallel with the inductance. Some resistance will be apparent also, effectively in series with the inductance. All this makes for quite a complicated network.

RF chokes will exhibit two primary resonances – a series and a parallel resonance. The impedance of the choke rises with frequency until the parallel self resonance is reached, after which it falls. The choke will appear inductive up to this point, capacitive immediately after it. The impedance continues falling until the series resonance is reached. These cycles of parallel resonance/series resonance etc, repeat with increasing frequency, the overall impedance falling after the initial cycle.

RF chokes should not be used within ±20-30% of their series resonance, nor more than about 1.5 times that. They exhibit their greatest impedance around their parallel resonant frequency – but watch out this doesn't fall close to any other frequencies encountered in a circuit. The lower the self capacitance of a choke, the higher its self resonant frequency and thus the broader the range over which it can be used.

Naturally, RF chokes have a limit to the amount of direct current they can pass, and this should always be kept in mind. Manufacturers specify a maximum dc current for their chokes.

RF cokes are generally meant to have a low Q. Some types are wound on a low value resistor in order to deliberately obtain a low Q.One type of RF choke often seen in VHF applications comprises a length of wire wound through a number of holes running longitudinally in a small, cylindrically-shaped piece of ferrite. This achieves a low Q, relatively high inductance with low self capacitance that is effective over a very broad frequency range.

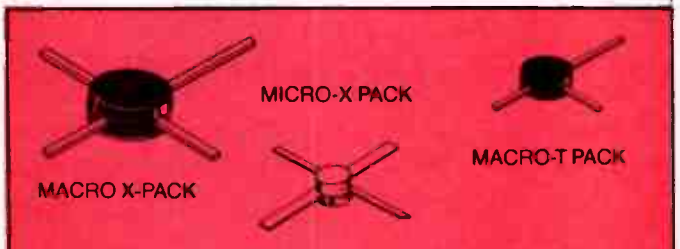
Semiconductors

The packaging of semiconductors intended for VHF/UHF applications is important. A wide variety of packages have been developed, primarily intended for surface mount applications and physical/electrical interfacing to pc board transmission lines.

The 'X' pack, and its derivatives the 'macro-X' and 'micro-X' packs, are commonly employed with small signal devices, where the chip is encapsulated in a small circular plastic or ceramic 'slug' having four flat leads coming out the sides so that the device mounts flat on a pc board, with a hole beneath the central bead. The leads clearly form a cross, or X, hence the name. The 'T' pack is similar, only it has just three leads.

With RF power transistors, and some small signal devices, the "stripline opposed-emitter" (SOE) package is used. A "stud" of ceramic holds the chip, with broad, flat copper leads radiating from it, two opposite each other being the emitter connection. This considerably reduces the emitter lead inductance which would otherwise severely affect performance. A threaded bolt or a flange arrangement on the bottom of the package serves to secure it to a heatsink.

Conventional TO-series plastic or metal-can packaging is OK well into the UHF region, provided leads are kept as short as practicable.



These 'X' and 'T' packages are used with small-signal VHF and UHF devices, the central 'slug' being just a few millimetres across. The flat leads reduce lead inductance and physically and electrically interface to pc board transmission lines also, similarly to the SOE packages.

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World Radio History

"RADFAX", a program for IBM PCs and compatibles to use with our Listening Post

Jamye Harrison

At last, it has arrived!; software for the IBM PC and compatibles to use with our popular Listening Post project (AEM3500, July 1985). Now IBM-PC owners can have the pleasure and practicality of being able to receive, display and printout Morse, radioteletype and radio facsimile transmissions courtesy of the patience, perseverance and genius of reader, Michael Delahunty.

THIS ARTICLE serves not to go over details of constructing the AEM3500 Listening Post project, which featured in our first issue, but to outline the operation of the software and the necessary computer hardware requirements to receive radio transmissions of Morse code, radioteletype (RTTY) and radio facsimile (FAX) with your IBM PC or compatible.

Firstly, the hardware requirements. You will need a completed Listening Post project, a shortwave receiver capable of stable single sideband (SSB) reception, the software (dubbed "RADFAX") and – as a minimum – a PC or compatible computer configured like so:

- IBM PC or PC/XT or close compatible running PC DOS 2.10 or later or MS DOS 2.1 or 3.1, fitted with a colour graphics adaptor (CGA) and a conventional joystick port at either 200 or 300 hex, and at least 512K of RAM.

Clearly, you only need a what would be described as a 'base level' machine. The program is specifically configured for machines running at 4.77 MHz and/or 6.667 MHz ("turbo" XT); software adjustments are incorporated to compensate for differing clock speeds and RADFAX can be adjusted to work even on an AT or AT clones running at 8.00 MHz or 10.00 MHz. The program requires at least 256K of RAM, plus whatever the DOS uses to run.

To print the decoded transmissions, you will need an IBM or Epson double-density dot-matrix printer, such as the FX/MX/LX series, or an Epson-compatible, such as the Star Gemini 10, Brother M1109, C.Itoh Super F+ III, etc.

The Listening Post hooks into the computer's joystick connector as follows:

- The 'RTTY/FAX' output connects to pin 2 (bit 4)
- The 'MORSE' output is connected to pin 7 (bit 5).
- The '+5 V' input is connected to pin 1.
- The 'GND' (0 V) is connected to pin 4.

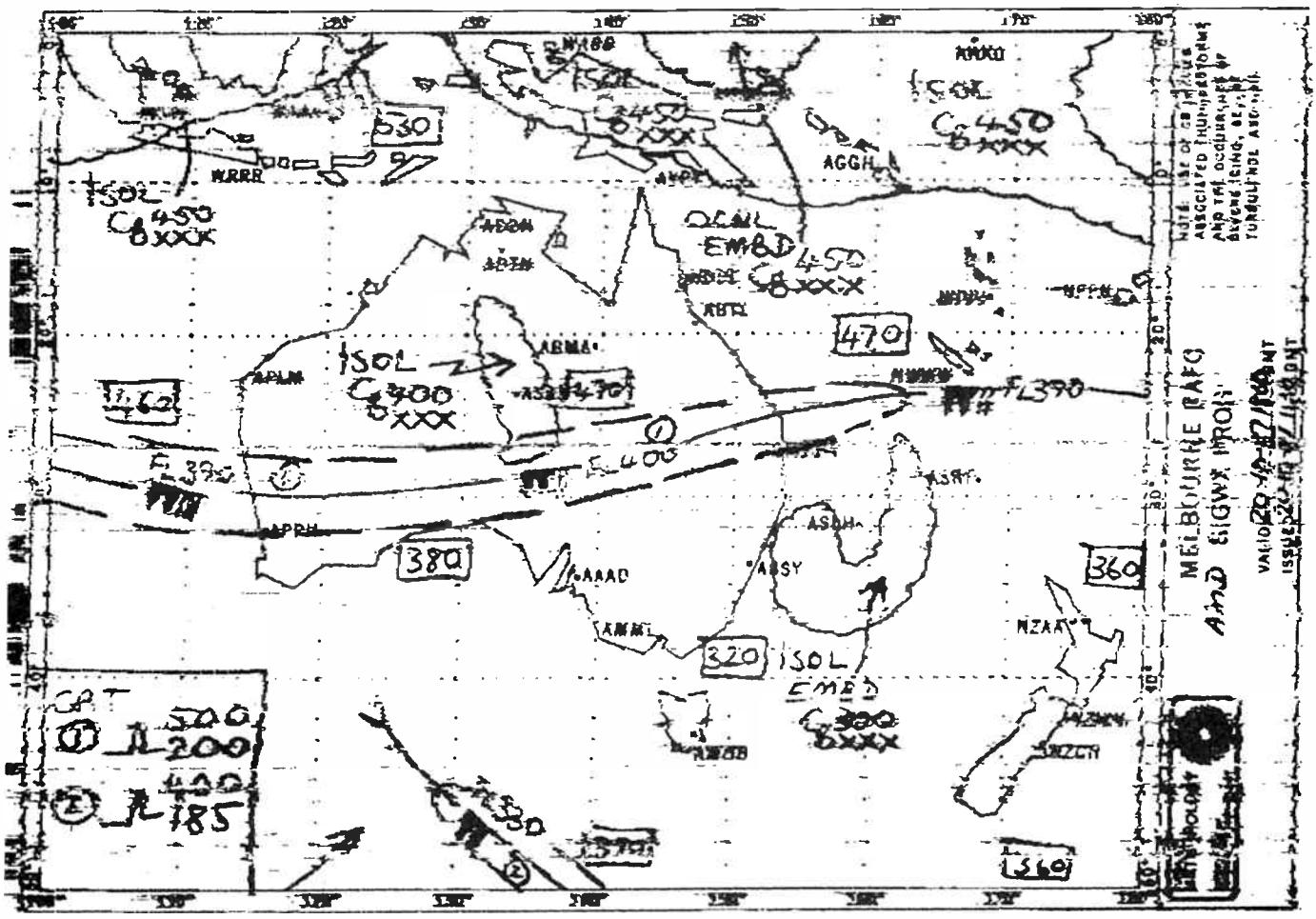
```
MENU & FUNCTION LAYOUT

M <----> RECEIVE WINDOW
:
A <----> RE-ALIGN WINDOW <->
:
I <----> VIEW WINDOW <----->
:
N <----> MAGNIFY WINDOW <-->
:
:
M <----> PRINT SUB-MENU
:
E <----> FILES SUB-MENU
:
N <----> SETTINGS SUB-MENU
:
U <----> TELETYPE & MORSE
:
-------> EXIT TO DOS
```

```
MAIN MENU
=========
<A> AUTO -START ON PHASE
<B> BEGIN RECEIVING

<R> RE-ALIGN FAX

<V> VIEW FAX
<M> MAGNIFIED VIEW

< 1 - 3 > CHANGE BUFFERS

<P> PRINT SUB-MENU

<F> FILES SUB-MENU

<S> SETTINGS SUB-MENU

<T> TELETYPE & MORSE SUB-MENU

<X> EXIT TO DOS
```

```
RECEIVE MENU
============
<A> AUTO - START ON PHASE
<B> BEGIN AGAIN
<C> CLEAR SCREEN & BEGIN
LEFT & RIGHT ARROWS
HOME & PGUP KEYS
<Q> QUIT

VIEW & MAGNIFY MENU
===================
NUMERIC KEYPAD KEYS
<E> ERASE BUFFER
<I> INVERT BUFFER
<W> WASH BUFFER
<U> TURN UPSIDE DOWN
<Q> QUIT

RE-ALIGN MENU
=============
ARROWS KEYS
SPACE BAR
```

```
F I L E S   M E N U

<S>  SAVE FAX BUFFER IN A DISK FILE

<F>  FASTER AND SMALLER SAVE OF FAX BUFFER

<L>  LOAD FAX BUFFER WITH A DISK FILE

<T>  SAVE TELETYPE & MORSE BUFFER

<A> <B> <C>  CHANGE DISK DRIVE

<D>  DIRECTORY

<R>  RUN A COMMAND FILE

<Q>  QUIT TO MAIN MENU

P R I N T   M E N U

Suitable for IBM, Epson MX/FX/LX80, Star Gemini 10

<1>   SMALL FAX PRINTOUT

<2>   LARGE SIDEWAY FAX PRINTOUT

<3>   PRINT TELETYPE & MORSE BUFFER

<Q>   QUIT TO MAIN MENU
 Press any key to stop during printing
```


World Radio History



Sample FAX printout from RADFAX. Photo-reduction doesn't do justice to the resolution obtained.

The software

Now, the software. The RADFAX program, as it is called, was written by reader Michael Delahunty, of New Farm in Brisbane, and offers many features not seen before in any previous Listening Post Software packages. What makes the RADFAX program exceptional is the features it provides above that of just receiving and decoding a FAX, RTTY or Morse transmission. Unlike the previous software we've published for the Listening Post, RADFAX is quite a large program comprising several files, the main file being the best part of 20 kbytes long, which is impractical to publish as a listing. Hence, we are making it available on disk in a similar manner to the earlier Listening Post programs. Details for obtaining it are given at the end of this article.

RADFAX exploits well the graphics handling and memory facilities of the PC and compatibles, particularly useful in the FAX mode. FAX pictures received can be displayed immediately on-screen, you can magnify or invert the display, or the picture can be 'cleaned-up' to reduce noise interference. Received transmissions can also be saved to disk and later loaded again. High resolution hard copy of received FAX pictures can be dumped to the printer.

For reasons that will become apparent shortly, the program cannot be run in any multi-user or multi-tasking environment as RADFAX thinks it owns all the available memory. In addition, it cannot be operated with any memory resident ('background') programs (e.g: Sidekick, Alarm etc) as they upset timing for the FAX program and clash with RAM space used by the program for buffers. In any case, such programs are unnecessary while the computer is used for the purposes RADFAX provides.

Operational features

The program is menu driven, making operation simple and relatively foolproof. All the necessary commands are usually displayed on screen and the various functions of the program accessed through different menus. The various program menus are reproduced here.

Any received signals are held and modified in a number of different buffers. FAX transmissions are serviced by three separate buffers, allowing three different pictures to be held in memory at any one time. Morse and RTTY transmissions are handled in a separate RAM buffer to that of the FAX buffers.

FAX facilities

Once a FAX picture has been tuned on your receiver, the BEGIN or AUTO-START commands – selected using the B or A keys, respectively from the MAIN menu – will commence reading in a FAX signal from the Listening Post. The BEGIN function commences reception immediately while the AUTO-START command will wait to be triggered by a phasing signal (part of the FAX transmission) first. The BEGIN function is useful when "fiddling" around, while AUTO-START is good for unattended or otherwise 'hands-off' operation.

It is always best to use the AUTO-START option if possible as this correctly aligns the incoming picture on the screen. However, if the BEGIN command was used then a mis-aligned picture can be aligned using the RE-ALIGN window.

The VIEW & MAGNIFY menu allows you to view the stored FAX picture on the screen and perform a number of operations with the picture. Whilst viewing a picture, pressing the **M** key will **magnify** the picture approximately twice its original size. The cursor keys are then used to move the display around so that all parts of the picture can be seen. This may seem a drawback, but, using this method means that you are not limited to just the size of your screen and a FAX picture may be displayed at full resolution, enabling you to examine fine detail.

The **I** key toggles the picture between black on white (normal), or white on black (inverted). The features on some FAX pictures are more clearly viewed when inverted.

An interesting feature of the software is the "wash" function. Pressing **W** while viewing a picture **cleans-up** a poorly received ▷

World Radio History

```
2/3/1 T/5/6/7VV^VV VVV VIX 2/3/4/# #(VVV DE FUM VVV DE GUM VVV DE FUM VVV DE FU
M VVV DE FUM VVS DE U UM VVV DE FUM VVV DE FVM VVV SE FUM VVV DE FUN VVV EE FUM
S VV DE FUM V4V DE FUM VVV DE FUH VVV DE GUM V# B FUM VVV DE FUM VVV DE FUM VVV
```

Sample Morse printout from RADFAX. Note the # characters which means an unrecognisable character has been received and the ^ characters showing "short" spaces. The signal sent here is a "channel occupying" call.

FAX picture that may be smeared with noise. This enhances the image quite a lot, improving readability. The **U** key, as can be seen from the reproduced menu, turns the received FAX picture upside-down. This sometimes helps in viewing particular pictures, especially polar or hemispheric (half Earth) views.

RADFAX provides a number of buffers for FAX operations. If you have 640K of RAM in your computer (and no memory resident programs installed) then three buffers are available to work with. Each buffer is capable of holding 1200 lines of FAX at 120 bytes per line – i.e: each buffer has a capacity of 144K. The main menu prompt will indicate what your maximum choice will be.

A normal FAX picture is about 1000 lines long, so there is spare capacity. You change buffers from the main menu by pressing a number key (those above the QWERTY keys, not the numeric keypad). The present buffer is displayed at the bottom left hand side of the main menu.

The SETTINGS sub-menu allows you to setup the parameters for FAX reception. You can set the lines/minute (LPM) parameter to a value ranging from 60 to 360 at 30 lines/min. intervals for the PC's standard 4.77 MHz clock, and to 60, 90 or 120 lines/min for a 6.667 MHz clock rate. The number keys are used to select the appropriate FAX reception rate. These can be re-assigned if you wish.

In addition, this sub-menu provides two functions called DELAY and FINETUNE which provide adjustment of appropriate software timing loops allowing you to compensate for differing clock speeds or any memory resident programs that interfere with FAX reception through increasing the amount of interrupt processing done, resulting in "leaning" FAX pictures. If you're using one of the "turbo" XT or AT compatibles, or an IBM AT, you can get correct FAX reception by compensating for the higher clock speed using the DELAY and FINETUNE facilities.

Also from the SETTINGS sub-menu, you can change the number of FAX picture lines saved in a buffer, between a minimum of 600 lines and a maximum of 1200 lines, using the '+' and '–' keys.

All changes made under the SETTINGS sub-menu can be saved to disk in a special file which automatically reloads them when next you start-up the RADFAX program.

RTTY and Morse

Radioteletype and Morse code reception are selected from a sub-menu (U). From this sub-menu, pressing the **B** key will start the process of decoding Murray-Baudot code used in RTTY transmission. You can select the usual "letters shift", "figures shift" plus options like "unshift on space" which toggles off and on the letters/figures shift when a space is received.

Pressing the **A** key allows reception of 7-bit ASCII code transmissions with either one or two stop bits (toggled by the S key).

When RTTY or ASCII transmissions employ inverted shift, the **I** key toggles a software "invert data" switch, permitting correct decoding.

The incoming baud rate, on both RTTY and ASCII, is selected from the number keys and the baud rate indicated on-screen. Nine rates are available, including all the common/popular ones. You can clear the screen during reception by pressing the C key, and you can quit to the sub-menu by pressing – you guessed it, **Q**.

Morse code reception is effected with the **M** key from this sub-menu. As both machine-sent and hand-sent Morse is encountered, the dot/dash ratio and sending speeds can vary widely. If you're getting incoherent garble on-screen, you can "look" at the incoming Morse using the L key. This allows you

```
    NOTANT QUE LE PEUPLE ET LES JEUNES ET ELEVEZJ D.)9$.3
LUTTENT POUR LE DEVELOPPEMENT D'ENSEMBLE DU PAYS ET LA
SECURITE EN EUROPE ET LA AIX MONDIALE SOQS LA DIRECTION DU
PARTI OUVRSDZG4?4 FBMLONAIS AYAOE A SA TETE LE RESPECTE
CAMARADE WOJCIECH JARUELSKI.

-   REPLYING TO QUESTIONS, THE SOVIET FOREIGN MINISTRY SPOKESMAN
ZSAID THAT THE GENERAL SECRETARY OF THE CPSU CENTQAL COMMITTEE
ZWOULD ADDRESS THE CELEBRATION SESSION WITH A REPORT ON THE
HISTORICAL PATH COVEREKLTHEVUIET UBUFB JRLPRESSING
WPROBLTMS % SOVIET SOCIETY AND KEY INTERNATIONAL PROBLEMS.
```

Top: a sample RTTY printout – in French.
Bottom: English RTTY transmission from one of the international news services. Poor reception with interference produces the garble seen in the text.

to adjust the decoding parameters to get sensible text.

The program provides indications of incomplete reception; # characters indicate an unrecognisable character has been received, while ^ characters are a symptom of "short" spaces and lots of "spaces" indicates long spaces between dots and dashes.

You can capture Morse, RTTY and ASCII transmissions in a 30K buffer (in ASCII form). This is separate to the FAX buffers. You can scroll through the contents of this buffer as you wish, print the contents, save them to disk, or erase them.

Provision has been made to tell the program the machine's clock rate so that it operates correctly. Clock rates of 4.77 MHz, 6.667 MHz, 8.00 MHz and 10.00 MHz are provided for so the RTTY-Morse facility will operate with "turbo" XTs and ATs.

Other functions

A number of options may be selected from the PRINT sub-menu. Referring to the reproduced menu, 1 will rapidly print out a small print of your FAX picture, 2 outputs a large picture to the printer, rotated 90 degrees, and 3 outputs the contents of the RTTY and Morse buffer.

A small FAX printout is often useful for quick check-plots, using only one-third the resolution of the original picture. Either a small or large, or normal or inverted printout will be reproduced according to their state in the memory buffer, i.e: if you have inverted your picture you will get a white-on-black picture reproduced on the printer.

From the FILES sub-menu a directory of the current disk can be displayed, buffer contents saved to a diskfile and pictures loaded from disk.

Summary

As you can see, it's quite a comprehensive program, loaded with features – and all the options and functions haven't been covered here! Because of the flexibility and huge variety of facilities offered, the author has compiled a small "operations manual" to accompany the program.

You can order a copy of RADFAX through our software service. It costs $29.95, including sales tax, post and handling. Just send us a 360K 5.25" disk, already formatted, and include a cheque, money order or your credit card details, to: **RADFAX, PO Box 507 Wahroonga 2076 NSW.** We'll have the program copied to your disk and return it, along with a copy of the "operations manual".

Complete kits for the AEM3500 Listening Post are obtainable from Jaycar stores in Sydney, Brisbane and Melbourne, from All Electronic Components and Ritronics in Melbourne, from Eagle Electronics in Adelaide and from Altronics in Perth. The circuit is very simple, based on the XR2211 phase-locked loop IC, and takes but an afternoon to construct. If you have a well-stocked workshop, or are keen enough to gather your own components, we can supply a pc board, all instructions and the software on your disk for a total cost of $37.95. Just ask for the "RADFAX package".

REFERENCES

1. AEM Project 3500, *The Listening Post*, by Tom Moffat VK7TM, AEM July 1985.

2. *A Guide to Non-voice Transmissions on Shortwave*, by Roger Harrison, AEM July 1987.

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Tek releases portable digital 'scope

Tektronix has released a new portable 300 MHz digital oscilloscope featuring automatic setup and measurement sequence capabilities, and at the same time dropped the price on their popular 2430A digital 'scope.

The new portable, model 2432, also boasts 100 megasamples/sec capability, plus dual-channel acquisition, 2 ns glitch capture, full programmability and 8-bit vertical resolution.

With Autosetup, unknown signals can be captured and displayed with the push of one button. Tektronix say this feature automates and simplifies setups for measurements such as rising edge, falling edge, pulse width and period.

With the 2432's Autostep facility, you can build-up and run measurement sequences – with or without a controller. The test sequence is built up using menu-selected functions, knob settings and changes, etc – complete front panel setup, stage by stage for a test sequence. In addition, test sequence facilities include wait, print, self-calibration, self-test and repeat commands.

The Autostep sequences can be uploaded to a controller via the 2432's GPIB port for execution or storage, and they can be cross-loaded to another 'scope.

The 2432 can simultaneously display up to 20 single-channel parameters in one "snapshot" of a display using the unit's Waveform Parameter Extraction facility. Measurements include amplitude, frequency, risetime, falltime, pulse width and propagation delay.

A pass/fail test decision, dubbed "Save On Delta", is also included for automated, unattended testing.

Full details from **Tektronix Australia Pty Ltd, 80 Waterloo Rd, North Ryde 2113 NSW. (02)888 7066.**

New MD for Schlumberger

Leading CAD/CAM and automated test equipment supplier, Schlumberger Systems Australia, has Appointed 30-year old Philip Andrews as Managing Director.

Andrews was transferred from Singapore, where he was in charge of operations for the ASEAN countries.

He has been with Schlumberger for five years, three being spent in Singapore. Andrews holds a degree in Electronics and Communications, and started as an automated test equipment (ATE) design engineer and has given many papers on the subject at international conferences.

The Dynamite solution

American Valley International has released a compressor/limiter expander gate, dubbed the "Dynamite", which they claim was not only designed to perform these multiple tasks, but to do each function better than dedicated purpose instruments.

The Dynamite offers two channels, each capable of performing 18 operating modes – including the basic ones of compression, limiting, expansion and noise gating. It may be coupled for stereo operation, also.

External input allows the Dynamite to be used for vocal stressing, frequency conscious noise gating and voice-over applications, as well as curing such problems as "loose" drum sounds, track leakage, etc.

The Dynamite has balanced inputs and will interface correctly to low level, high impedance devices. Further details from **Karl Seglins, Amber Technology, Unit B, 5 Skyline Place, Frenchs Forest 2086 NSW. (02)975 1211.**

"Pyropen" cordless iron

According to the George Brown Group, demand has forced them to purchase Weller's entire allocation of Pyropen Junior butane operated soldering/brazing irons for Australia out to June this year.

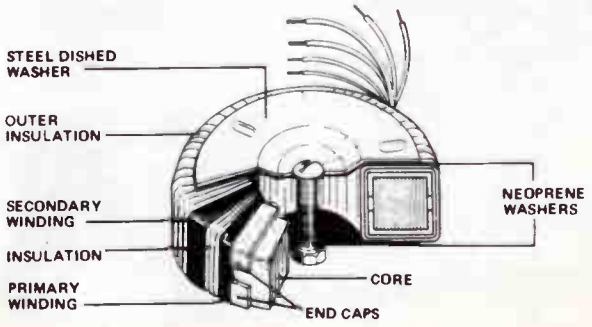
Toroidal tranny Telecom approved

Sydney-based importer and distributor Electromark can now supply the popular ILP toroidal transformers in a configuration which is Telecom approved.

These transformers are similar in output characteristics and size to the standard range of more than 150 types which are stocked by Electromark.

The new trannies are built meet AS 3108 primary to secondary insulation standards providing 3.5 kVac isolation. The secondary windings provide insulation up to 5000 Vac, according to Electromark.

Further details from **Electromark Pty Ltd, PO Box 184, Mortdale 2223 NSW. (02)570 7287.**



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The Pyropen Junior features three temperature ranges of approximately 200-450 degrees (Celsius) for soldering, a "hot blow" of 430 degrees C and "Torch" feature of about 1300 degrees C maximum.

The Pyropen is small (170 mm) and lightweight. The longlife tips last 10 times longer than conventional tips, according to Weller. Quick refills are available with the Weller BR200 Butane aerosol.

George Brown have the Pyropen Junior available at an introductory offer price of $71.82 (plus sales tax if applicable).

Contact your nearest George Brown Group outlet, or the **George Brown Marketing Division, 456 Spencer St, West Melbourne 3003 Vic. (03)329 7500.**

Shure b'cast cartridges

Shure Brothers of America recently released three new phono cartridges designed specifically to withstand the rigours of professional radio use.

Known as the Shure BC Series, the BC70, BC80 and BC90 are, Shure assure us, a new generation whose lineage boast the famed Shure V15 Series and the professional SC35C cartridges.

BC70

BC80

BC90

These cartridges boast unparalleled ruggedness, Shure claim, to withstand constant backcueing, and deliver high fidelity sound.

A "uniquely engineered" cue guard design stabilises the stylus shank and prevents it from bending backwards or snapping off when backcueing. A high stiffness stylus shank is employed to ensure stability and longevity in heavy duty use.

A wraparound stylus grip limits lateral stylus movement (another Shure exclusive, we're told), helping prevent accidental damage to the stylus should the tonearm be dropped on or slid across the record.

As stylii inevitably wear out, Shure has packaged each BC Series cartridge with two replacement stylii in addition to the one mounted in the cartridge.

A range of tracking forces, stylus geometries and mounting styles is offered with each cartridge. The BC80 and BC90 track from one to 1.5 grams and have elliptic stylus tips. The BC80 is P-mount, the BC90 a half-inch mount.

The BC70 tracks from 2.5 to 3.5 grams, has a spherical stylus tip and a half-inch mount.

Full details from the Australian agents, **Audio Engineers Pty Ltd, 342-344 Kent St, Sydney 2000 NSW (02)29 6731.**

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Practical filter design — without fears or tears

Part 5 – Active elliptic filters

Jack Middlehurst

Elliptic filters offer quite a few advantages over other types. e.g: they use fewer components for a given set of characteristics. In addition, you have several variables that you can trade off in order to obtain the required characteristics to deal with just about any filter problem. And the computer program here makes it all so easy.

AS WITH Butterworth and Chebychev filters, active elliptic filters of any order can be constructed without any restrictions about equal source and load resistances, or on the amount of ripple that you are prepared to accept in the passband. Because of the need to generate the notches, more components are needed per filter block than with Butterworth or Chebychev filters. However, to make a filter with a given steepness of cutoff, the total number of components and ICs in an elliptic filter is less than in any other.

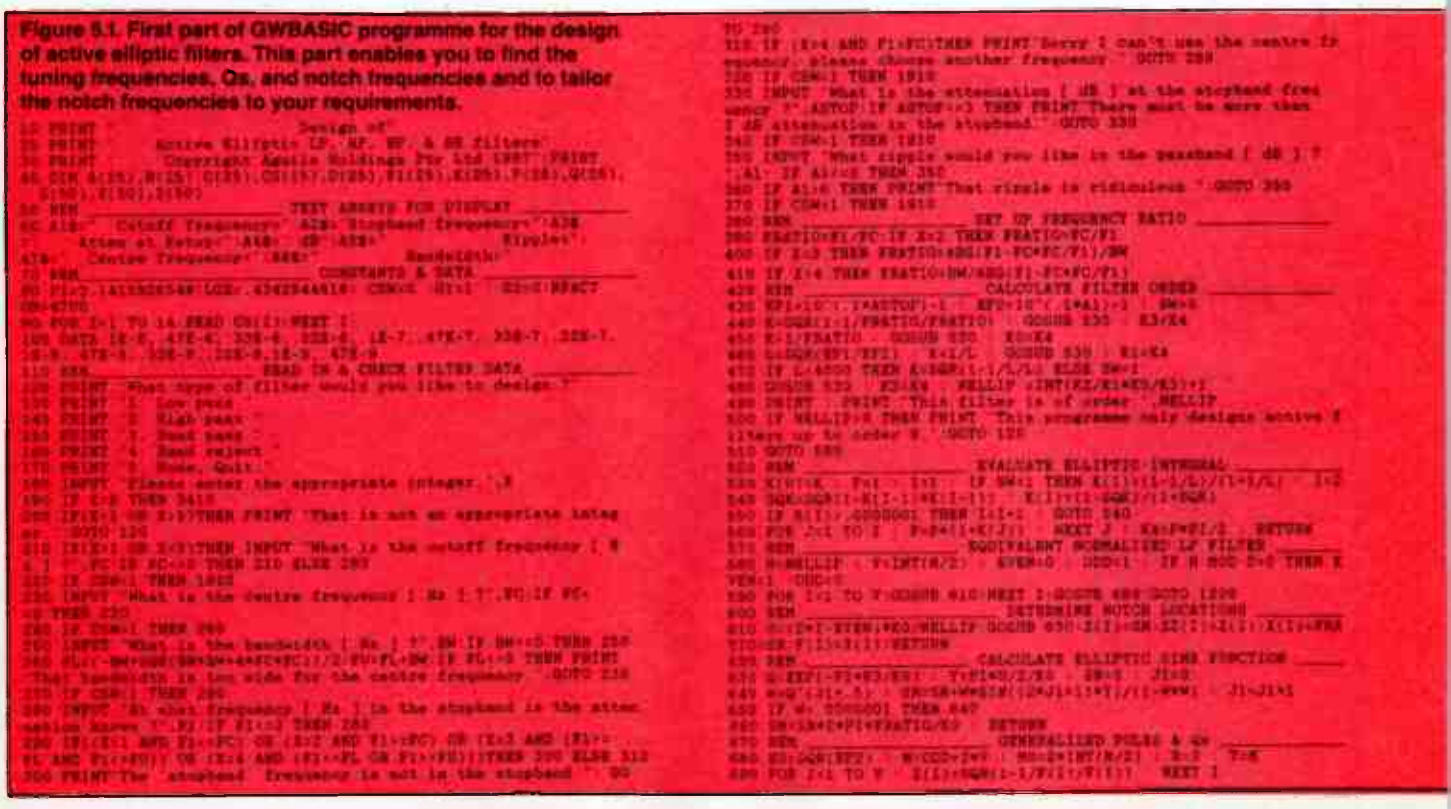
Many of the cookbooks use the extended version of the standard filter tables and calculate the components for active filters from the real and imaginary parts of the pole and zero frequencies. This suffers from two defects. Firstly you really have to know what you are doing, and secondly the filter that you want isn't in the tables. Williams gets over the first problem by doing some of the calculations for you and giving you tables of component values for selected filters in his book (see references in Nov 1987 AEM). There still remains the second problem.

Because of the importance of active elliptic filters in the audio range of frequencies, it is essential to be able to design filters with a complete range of values for the passband ripple. The allowable ripple has a marked effect on the design of the filter, particularly on the Q of the tuned circuits. For this reason, we present later an a extensive computer program that allows you to design any form of active elliptic filter.

When using active elliptic filters you will find that, as well as being steeper than other filters, the stopband shape has an additional virtue that can be used to advantage. Suppose that you have built yourself a good quality AM receiver that includes a simple notch filter to remove the 9 kHz beat frequency between adjacent stations. You find two things that you don't like: the beat frequency seems to come and go, and at night time there is considerable "monkey chatter" caused by the modulation from stations on adjacent frequencies. Most of these stations can only be received at night.

It is possible to design an elliptic filter that has a negligible passband ripple, a cutoff frequency of 8 kHz, and a steep cutoff slope, and at the same time has one of its notches at 9 kHz, so eliminating the beat frequency. In addition the filter can have an attenuation of 30 dB or more above 9 kHz to reduce the monkey chatter. Unfortunately, none of the cookbook charts and tables will allow you to do this type of design; it can only be

Figure 5.1. First part of GWBASIC programme for the design of active elliptic filters. This part enables you to find the tuning frequencies, Qs, and notch frequencies and to tailor the notch frequencies to your requirements.



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done using a computer.

Even so, there is no procedure that this author knows that will enable you to design such a filter straight off. The only way is to design one that you think will do the job, look at the location of the notches, alter one of the variables and see what this does to the location of the notch, and keep doing this until you get the notch where you want it. This is quite fun to do and there is a considerable sense of achievement when you succeed.

If you really want to work into the wee small hours, try putting two notches where you want them; they needn't be adjacent notches. You will see when you do this that the notches are not harmonically related, so you can't eliminate a signal and its second harmonic at the same time using adjacent notches. Also, since the frequencies of all the notches are mathematically related, it may not be possible to put more than one where you wish.

Active elliptic filter program

Figure 5.1 is the first part of a two-part GWBASIC program that does the complete design of active elliptic filters. This first part enables you to start the design. After you enter your filter requirements, it displays the filter order and a list of the tuning frequencies and Qs of those parts of the circuit that influence the response in the passband, together with the locations of the notch frequencies in the stopband. This starting program is necessary so that you can do the preliminary modifications to try and get the notches where you want them.

You will find that small changes in the stopband frequency or bandwidth have quite a large effect on the location of the notches. You will also find that this program does not give the same answers as the program for the LC design. This is because it is not necessary to complicate the mathematics even further by insisting on a minimum inductor design, since with active filters the number of "inductors" is not of such great importance.

Nonetheless, the program represents a massive amount of work for the computer. After some preliminary calculations, the elliptic integral is used to calculate the filter order, and then the elliptic sine function has to be evaluated to get the notch frequencies. The values of these frequencies are used to develop the complete equations for the shape of the frequency response. The program then solves these equations by finding the real and complex parts of the roots of the equations, and uses these to calculate the tuned circuit frequencies and Qs.

All of this takes time. On a 64-bit PC such as the Hewlett Packard 86B (which doesn't need the safety switch in the elliptic integral) getting the filter order and notch frequencies takes about 20 seconds, and the tuning frequencies and Qs take about three minutes for a 6th order BP filter.

A really fast 16-bit AT such as the Osborne AT Turbo with maths co-processor takes about one second for the order and notches, and three seconds for the rest in single precision mode. The HP machine gives answers accurate to about 10 significant figures, the AT only to five. The reason for the apparently poor accuracy is the enormous number of iterations (repetitive calculations) that have to be done, each one of which can lose one least significant bit of a computer number. For most purposes four significant figures is quite adequate, and indeed the display of results has been arranged with this in mind. If you feel that you have an application where higher accuracy is absolutely essential you can consider converting all the variables to double precision. This will improve the AT result to about eight figures, so to put more significant digits on the screen you will have to alter the program lines controlling the output display.

As examples of the kind of results that one can get, let us design a low pass and a high pass filter. For the low pass we will choose the following requirements: Fc = 3.0 kHz, 40 dB attenuation by 4.0 kHz, 0.25 dB ripple in the passband. The tuning frequencies, Qs and notch frequencies are shown in the table in the centre columns of Figure 5.2. For the high pass filter we select Fc = 300 Hz, 40 dB attenuation by 225 Hz and 0.25 dB passband ripple. The results for this filter are shown in the left hand columns of Figure 5.2.

The reason for choosing the particular characteristics for these filters is that they can be put in series to make a 'wideband' bandpass filter with a passband from 300 to 3000 Hz suitable for an audio filter for amateur use. For comparison, the ▷

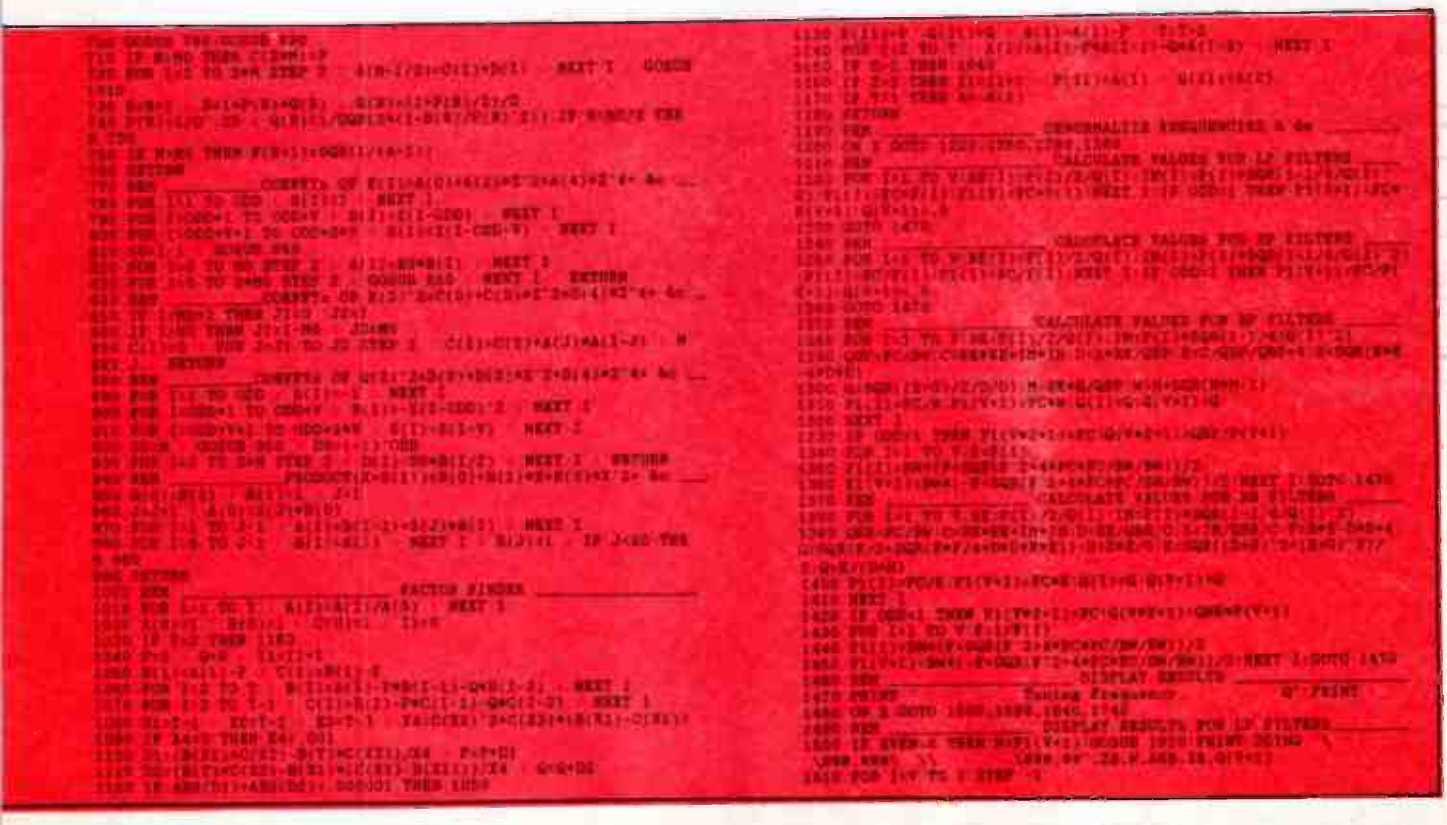

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Figure 5.2. Wideband BP filter:
1. Made up as LP + HP filters.

LP filter Fc=3kHz, 40 dB down at 4kHz, ripple=0.25 dB

HP filter Fc=300 Hz, 40 dB down at 225 Hz, ripple=0.25 dB

Left hand columns:Tuning frequencies, Qs, and notch frequencies for the HP part of the filter.

Centre columns: as above for the LP part.
2. Filter designed as a true BP filter

Fc=948.683 Hz, 40 dB down at 4kHz and 225 Hz, ripple=0.25 dB

Right hand columns:tuning frequencies, Qs, and notch frequencies for the filter calculated as a BP filter.

HP	LP	BP
Tuned Circuits		
289.997 Hz Q = 6.21		291.672 Hz Q = 7.02
359.423 Hz Q = 1.25		360.650 Hz Q = 1.57
540.742 Hz Q = 0.5		
		948.683 Hz Q = 0.65
	1.664 kHz Q = 0.5	
	2.504 kHz Q = 1.25	2.496 kHz Q = 1.57
	3.104 kHz Q = 6.21	3.086 kHz Q = 7.02
Notch Frequencies		
149.625 Hz	152.152 Hz	
217.654 Hz	218.019 Hz	
4.135 kHz	4.128 kHz	
6.015 kHz	5.915 kHz	

right hand columns of Figure 5.2 contain the values that one gets from using the program to design a bandpass filter with Fc = 948.7 Hz (SQRT(300x3000) remember), BW = 2700 Hz (3000-300) and 0.25 dB passband ripple.

You can see that there is very little difference in the values given by the two different design procedures. The two RC circuits have been combined into one and the Qs are a little higher, but otherwise the two designs are the same. The slight differences come about because the LP filter has a slight effect on the HP filter and vice versa. You can get away with this summing of LP and HP filters if the bandwidth is large compared to the centre frequency. If it is not, simply use the BP design part of the program which makes allowance for the interaction between the LP and HP parts of the filter.

In the same way, you can make a wideband BR filter by having an LP filter with a lower cutoff frequency and a HP filter with a higher cutoff frequency and summing their outputs in a summing amplifier in the same way that was used for Butterworth filters in Figure 2.6d of Part 2 of this series. To design a narrowband BR filter, simply use the BR part of the program.

After you have experimented with part 1 of the program for a while, you will notice that the Qs of the tuned circuits depend markedly on the passband ripple. The larger the passband ripple, the higher the Qs become (and the steeper the cutoff slope). You will also find that the Qs of BP and BR filters are higher than those of LP and HP filters. Also, the narrower the passband of BP and BR filters, the higher the Qs become. Indeed, if you try a filter with Fc = 1000 Hz, BW = 200 Hz, attenuation of 80 dB at 1150 Hz and 1 dB passband ripple, the required Qs go up over 200. Of course, this is a razor sharp filter so one must expect there to be a price to pay.

For comparison, it would take a 24th order Chebychev filter to get a cutoff as sharp as this and that filter would need Qs up to about 400 (and be almost impossible to tune !). It is perhaps fortunate that in audio work, low values of passband ripple are desirable, since this automatically leads to low Q designs.

Active elliptic filter blocks

Having decided on the tuning details of the particular filter that you want, the next decision is how to implement it in hardware. The problem is how to get the notches in the frequency response using IC amplifiers. Figure 5.3 shows the two special circuits that have been developed by filter engineers to achieve this for low pass filters and Figure 5.4 shows the two equivalent circuits for high pass filters.

Contrary to the Sallen and Key circuit that we have used before, these circuits usually need a gain different from unity.

```
1520 W=P1(I):GOSUB 1850:PRINT USING "\            \###.###\  \\
     \##.##";Z$,W,A6$,Z$,Q(I):NEXT I
1530 PRINT:PRINT "                    Notch Frequency":PRINT
1540 FOR I=V TO 1 STEP -1 :W=F1(I):GOSUB 1850:PRINT USING "\
     \###.###";Z$,W,A6$:NEXT I
1550 PRINT:GOTO 1900
1560 REM _____________ DISPLAY RESULTS FOR HP FILTERS_________
1570 FOR I=1 TO V
1580 W=P1(I):GOSUB 1850:PRINT USING "\            \###.###\  \\
     \##.##";Z$,W,A6$,Z$,Q(I):NEXT I
1590 IF EVEN=0 THEN W=P1(V+1):GOSUB 1850:PRINT USING "\
 \###.###\  \\        \###.##";Z$,W,A6$,Z$,Q(V+1)
1600 PRINT:PRINT "              Notch Frequency":PRINT
1610 FOR I=1 TO V :W=F1(I):GOSUB 1850:PRINT USING "\
\###.###";Z$,W,A6$:NEXT I
1620 PRINT:GOTO 1900
1630 REM _____________ DISPLAY RESULTS FOR BP FILTERS_________
1640 FOR I=1 TO V
1650 W=P1(I):GOSUB 1850:PRINT USING "\            \###.###\  \\
     \###.##";Z$,W,A6$,Z$,Q(I)
1660 NEXT I:IF ODD=1 THEN W=P1(2*V+1):GOSUB 1850:PRINT USING "\
      \###.###\  \\        \###.##";Z$,W,A6$,Z$,Q(2*V+1)
1670 FOR I=2*V TO V+1 STEP -1
1680 W=P1(I):GOSUB 1850:PRINT USING "\            \###.###\  \\
     \###.##";Z$,W,A6$,Z$,Q(I):NEXT I
1690 PRINT:PRINT "                    Notch Frequency":PRINT
1700 FOR I=V+1 TO 2*V:W=F1(I):GOSUB 1850:PRINT USING "\
 \###.###";Z$,W,A6$:NEXT I
1710 FOR I=V TO 1 STEP -1:W=F1(I):GOSUB 1850:PRINT USING "\
     \###.###";Z$,W,A6$:NEXT I
1720 PRINT:GOTO 1900
1730 REM _____________ DISPLAY RESULTS FOR BR FILTERS_________
1740 FOR I=V TO 1 STEP -1
1750 W=P1(I):GOSUB 1850:PRINT USING "\            \###.###\  \\
     \###.##";Z$,W,A6$,Z$,Q(I)
1760 NEXT I:IF ODD=1 THEN W=P1(2*V+1):GOSUB 1850:PRINT USING "\
      \####.###\  \\        \###.##";Z$,W,A6$,Z$,Q(2*V+1)
1770 FOR I=V+1 TO 2*V
1780 W=P1(I):GOSUB 1850:PRINT USING "\            \###.###\  \\
     \###.##";Z$,W,A6$,Z$,Q(I):NEXT I
1790 PRINT:PRINT "                    Notch Frequency":PRINT
1800 FOR I=2*V TO V+1 STEP -1:W=F1(I):GOSUB 1850:PRINT USING "\
     \###.###";Z$,W,A6$:NEXT I
1810 IF ODD=1 THEN W=FC:GOSUB 1850:PRINT USING "\            \##
#.###";Z$,W,A6$
1820 FOR I=1 TO V:W=F1(I):GOSUB 1850:PRINT USING "\            \
###.###";Z$,W,A6$:NEXT I
1830 PRINT:GOTO 1900
1840 REM _____________ SUBROUTINE FOR CONVENIENT FREQUENCY UNITS _
1850 IF W>=1000000! THEN W=W/1000000!:A6$=" MHz":GOTO 1880
1860 IF W>=1000! THEN W=W/1000!:A6$=" kHz":GOTO 1880
1870 A6$=" Hz"
1880 RETURN
1890 REM _____________ DISPLAY CURRENT VALUES OF FC, BW, &C___
1900 INPUT "To go to the next part of the programme press ENTER.
",SS$:PRINT
1910 IF X=3 OR X=4 THEN 1960
1920 W=FC:GOSUB 1850:PRINT USING "\                  \###.###\  \
";A1$,W,A6$
1930 W=F1:GOSUB 1850:PRINT USING "\                  \###.###\  \
";A2$,W,A6$
1940 PRINT USING "\              \###.###\ \";A3$,ASTOP,A4$
1950 PRINT USING "\              \###.###\ \";A5$,A1,A4$:
GOTO 2020
1960 W=FC:GOSUB 1850:PRINT USING "\                  \###.###\  \
";A7$,W,A6$
1970 W=BW:GOSUB 1850:PRINT USING "\                  \###.###\  \
";A8$,W,A6$
1980 W=F1:GOSUB 1850:PRINT USING "\                  \###.###\  \
";A2$,W,A6$
1990 PRINT USING "\              \###.###\ \";A3$,ASTOP,A4$
2000 PRINT USING "\              \###.###\ \";A5$,A1,A4$
2010 REM _____________ WHAT NEXT ? _____________
2020 CSW=1 :PRINT: PRINT "Would you like to :"
2030 PRINT "1. Quit ?"
2040 PRINT "2. Proceed to the next part of the programme ?"
2050 PRINT "3. Calculate the notch & tuning frequencies & Qs ?"
2060 PRINT "4. Alter the value of the passband ripple ?"
2070 PRINT "5. Alter the value of the stopband attenuation ?"
2080 PRINT "6. Alter the value of the stopband frequency ?"
2090 IF X=1 OR X=2 GOTO 2120
2100 PRINT "7. Alter the value of the bandwidth ?"
2110 PRINT "8. Alter the value of the centre frequency ?": GOTO
2130
2120 PRINT "7. Alter the value of the cutoff frequency ?"
2130 INPUT "Please enter the appropriate integer.",XX
2140 IF XX<1 THEN 2170 ELSE 2150
2150 IF (X=1 OR X=2) AND XX>7 THEN 2170 ELSE 2160
2160 IF (X=3 OR X=4) AND XX>8 THEN 2170 ELSE 2180
2170 PRINT "That is not an appropriate integer.":GOTO 1910
2180 ON XX GOTO 3410,2200,390,350,330,280,2190,230
2190 IF X=1 OR X=2 THEN 210 ELSE 250
2200 REM
3410 PRINT "End of programme.":END
```


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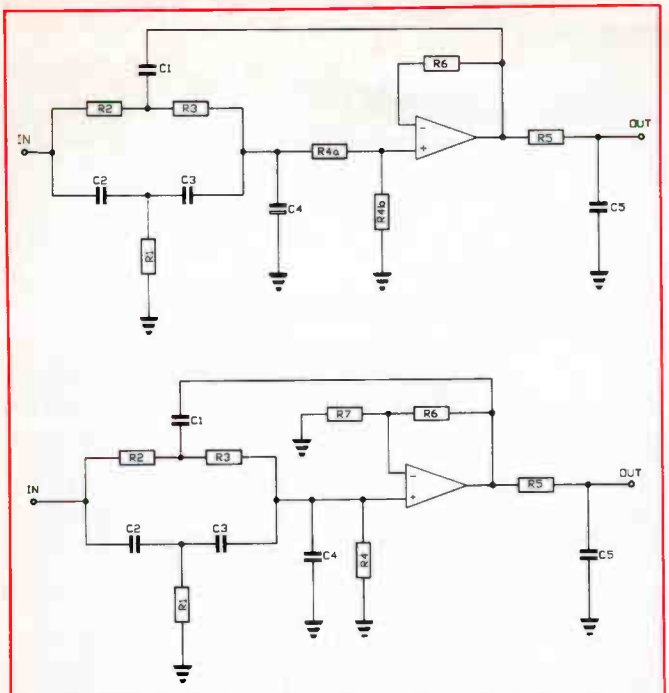

Figure 5.3. Circuits for LP filter blocks that can produce a tuned circuit with a notch. Top: for a gain less than 1, bottom: for a gain greater than 1.

This is why there are two circuits for each type of filter, one for a gain of less than unity and one for a gain greater than unity. For odd order filters, in the same way as we found for previous active filters, a special circuit is needed. In the case of this form of elliptic filter, this simply takes the form of an RC filter (for LP) or CR filter (for HP) at the output of the last stage.

In fact, this RC (or CR) filter should be used at the input of the main filter, but this would mean that it would have to be followed by an amplifier with a gain of +1 to get the necessary low impedance to drive the rest of the filter. Consequently, even though it is not good practice, most designers save the amplifier and put the RC part at the output. If your design has a spare amplifier left over in a four amplifier (or quad) IC, for example, then put the RC circuit first, followed by the spare amplifier with 100% negative feedback to give it a gain of +1, and take the output of this amplifier to the input of the rest of the filter.

The circuits in Figures 5.3 and 5.4 are related to the Sallen and Key circuit in that the input goes to the positive IC input (non-inverting) terminal and there is only one feedback loop. This feedback is via a circuit that looks rather like a parallel-T network but doesn't work in that way. As far as the negative feedback is concerned it is a phase shifting network. Also, the incoming signal goes through a phase shifting network. At one particular frequency the sum of the input and phase shifted output signals is exactly zero, giving a notch in the frequency response. To achieve the designed value of Q, each circuit block is required to have a particular gain that is part of the design procedure. The overall gain of the filter is obtained by adding together the gains (in dB) of each filter block.

These circuits are satisfactory for filters in which the Q is not greater than about 20. This means that they can be used for many LP and HP filters and low order BP and BR filters. For BP and BR filters in particular, where the Qs tend to be higher than in LP and HP filters, these circuits tend to have problems with the rise time of the ICs for filter orders greater than four unless the passband ripple is low.

Even so, it is essential to use ICs with the widest possible frequency response and greatest dynamic range, such as the LF356 and LF357, or if you are really keen, LH0024 or LH0032. These latter two are expensive, so you would only choose to use them for critical applications. Since there is no restriction on the relative placement of the notch with respect to the resonant frequency in the LP circuit, the circuits of Figure 5.3 can also be used as the basis of BP and BR filters. This fact is used in the second part of the program.

The second part of the GWBASIC program is set out in Figure 5.5. This does the calculations for the component values for the blocks of the filter using the circuits of Figure 5.3 or Figure 5.4. You will notice that the last two lines of the program of Figure 5.1 are overwritten by the first two lines of this part of the program. The reason for this is that the first part of the program is used as the beginning of several programs that we will be presenting in this series, so the program has been made universal. It is worthwhile making several copies of it.

Part 2 of the program lists the component values for each circuit block together with the gain. The tuning frequencies and Qs have already been displayed by the first part of the program so they are not repeated. In designing this class of active filter there are some quite stringent rules governing the order in which the individual filter blocks have to be assembled. In addition there are rules about which notch is coupled to which tuned circuit in each filter block. These rules have been incorporated into the program to ensure that the filter will not overload in the way that can happen if the blocks are assembled in the wrong order, a problem that we have already encountered with other active filters.

The program has been made to adjust the values of resistors R6 and R7 so that, not only is their ratio correct (to set the gain) but the resistance from each of the amplifier input terminals to earth is the same. This reduces problems with dc drift if you use ICs that do not have FET input amplifiers. If there is no R7, R6 need only be a 5% resistor having the nearest E12 value.

Bandpass filters

Active elliptic bandpass filters really consist of LP and HP filters specially designed to allow for their interaction. The filter can be built in three ways. The complete LP and HP filters can be assembled and connected in series, or the BP filter can be built up of blocks that are alternately LP and HP filter sections, or the filter can be made of LP sections connected as bandpass filter blocks. There is nothing to prevent you designing a wide- ▷

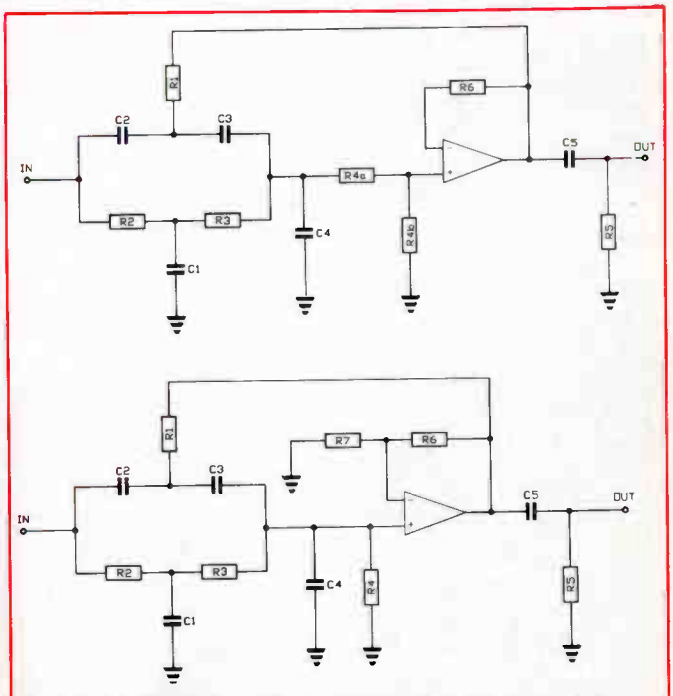

Figure 5.4. Circuits for HP filter blocks that can produce a tuned circuit with a notch. Top:for a gain less than 1, bottom: for a gain greater than 1.

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band BP filter by running the program twice, once for the LP part and once for the HP part. For narrowband BP filters it is best to let the program design the filter as a BP filter, in which case it will design a set of BP filter blocks.

Odd order bandpass filters need a special circuit tuned to the centre frequency of the passband, but without a notch. This can be made up of a Sallen and Key block, but it is more convenient for these filters to use the circuit shown in Figure 5.6. The program displays the component values for this circuit and it is made the first block of the filter since it invariably has the lowest Q.

There is no law that says that a wideband BP filter has to use the same type of filter at the low frequency and high frequency ends of the passband. It is quite in order to design such a filter with an elliptic LP filter and a Chebychev or Butterworth HP filter, or indeed any other combination that you like to choose.

If we consider the 300-3000 Hz filter for amateur use mentioned above, the sharp cutoff is definitely needed at the high frequency end of the filter, so we need an elliptic LP filter for that. However, we would be quite happy with a much less steep cutoff at the low frequency end. If we settle for 20 dB attenuation at 100 Hz, we can use a third order Chebychev filter for the HP part of the bandpass. This considerably simplifies the design since we can use a standard Sallen and Key circuit for this part of the filter.

The essence of good filter design is to use only as much filter power as you really need, anything more than this is wasting time, components and money, and is unnecessarily complicating the design. The general rule is always to use the simplest filter possible and to use the lowest possible filter order.

Practicality

Just because the filter program can calculate the properties of a filter does not mean that it is a practical filter to build. The computer doing the calculations is unfortunately quite dumb and wouldn't know a good design from a disaster. The responsibility for the design is yours.

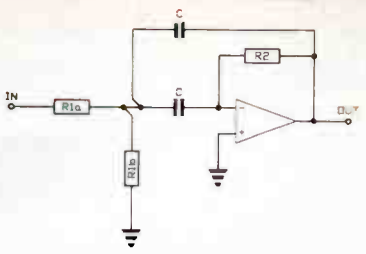


Figure 5.6. Special tuned circuit without a notch needed for odd order BP filters.

A good example of an impractical design is that of the following filter. Suppose that you are forced to live where there is a lot of pickup of 50 Hz in your audio system and the continual hum drives you mad. A good idea is to insert a 50 Hz band reject filter to remove the hum. So you decide that you would like the passband ripple to be 0.1 dB so as not to reduce the HiFi nature of your equipment, you decide to make the bandwidth 2 Hz so as not to put too wide a hole in your frequency response, and you think that you would like the attenuation to be at least 60 dB within 0.1 Hz either side of 50 Hz.

Sounds reasonable enough. When you run the first part of the program it produces the following results: The tuning frequencies are 49.29, 50.00, and 50.72 Hz and the notches are at 49.914, 50.000, and 50.085 Hz. The tuning frequencies are not too bad, but just look at the frequencies of those notches! You have to have components that are stable enough to remain at frequencies that are separated by less that 0.1 Hz. Also, your frequency meter has to be able to read to 0.002 Hz at worst, not to mention being accurate to that degree for you to be able to tune the thing in the first place.

Such a design is really impossible in practical terms. The solution is to relax your bandwidth and stopband requirements until you get a filter that you could reasonably expect to be stable enough to keep working for a long time. It may make a bit of a hole in your audio response, but that is the price you have to

Figure 5.5. Second part of GWBASIC programme. This part calculates the values of the components for Figures 5.3 and 5.4.

```
2200 REM _____ CALCULATE COMPONENT VALUES _____
2210 ON X GOTO 2230,2270,2310,2370
2220 REM_____ LP _____
2230 CFACTOR=.5/PI/FC/RFACTOR
2240 PRINT:FOR I=1 TO V:PRINT USING"Filter block number #";I:PR
INT
2250 J=V+1-I:K=I:GOSUB 2430:GOSUB 2930:GOSUB 3010 :NEXT I:GOT
O 3240
2260 REM_____ HP _____
2270 CFACTOR=.5/PI/FC/RFACTOR
2280 PRINT:FOR I=1 TO V:PRINT USING"Filter block number #";I:PR
INT
2290 J=V+1-I:K=I:GOSUB 2530:GOSUB 2930:GOSUB 3010:NEXT I:GOTO 3
240
2300 REM_____ BP _____
2310 IF ODD=1 THEN GOSUB 2630
2320 PRINT:FOR I=1 TO V:PRINT USING"Filter block number #";I+OD
D:PRINT
2330 J=V+1-I:K=V+I:GOSUB 2810:GOSUB 3010:NEXT I
2340 FOR I=1 TO V:PRINT USING"Filter block number #";V+I+OD
D:PRINT
2350 J=2*V+1-I:K=I:GOSUB 2810:GOSUB 3010:NEXT I:GOTO 3410
2360 REM_____ BR _____
2370 PRINT:I=0:GOSUB 2810:PRINT "Filter block number 1":PRINT:G
OSUB 3010
2380 FOR I=1 TO V:PRINT USING"Filter block number #";I+1:PRINT
2390 J=V+1-I:K=V+I:GOSUB 2810:GOSUB 3010:NEXT I
2400 FOR I=1 TO V:PRINT USING"Filter block number #";V+I+1:PRINT
2410 J=2*V+1-I:K=I:GOSUB 2810:GOSUB 3010:NEXT I:GOTO 3240
2420 REM _____ SUBROUTINE FOR LP COMPONENTS _____
2430 C1=RE(J)*RE(J)+IM(J)*IM(J):A=2*RE(J)/SQR(C1):B=F(K)^2/C1
2440 B1=B+1:RL(1)=B1/4.5:RL(2)=B1/3/B:RL(3)=2*RL(2):RL(4)=B1
2450 CL(4)=B/B1/SQR(C1):CL(1)=4.5*CL(4):CL(2)=CL(1)/1.5/B:CL(3
)=CL(2)/2
2460 K1=B1*(2.5-A)/1.5/B:GAIN=B*K1/B1:R234=RL(4)*(RL(2)+RL(3))/
(RL(2)+RL(3)+RL(4))
2470 IF K1>1 THEN RL(6)=K1*R234:RL(7)=RL(6)/(K1-1)
2480 IF K1=1 THEN RL(6)=R234
2490 IF K1<1 THEN RL(7)=K1*RL(4):RL(4)=(1-K1)*RL(4):RL(6)=RL(7
)*(RL(2)+RL(3)+RL(4))/(RL(2)+RL(3)+RL(4)+RL(7))
2500 IF (X=1 OR X=2) AND ODD=1 THEN RL(5)=1:CL(5)=1/F(V+1)
2510 RETURN
2520 REM _____ SUBROUTINE FOR HP COMPONENTS _____
2530 C1=RE(J)*RE(J)+IM(J)*IM(J):A=2*RE(J)/SQR(C1):B=F(K)^2/C1
2540 B1=B+1:CL(1)=4.5/B1:CL(2)=B*3/B1:CL(3)=.5*CL(2):CL(4)=1/B1
2550 RL(4)=B1*SQR(C1)/B:RL(1)=RL(4)/4.5:RL(2)=1.5*B*RL(1):RL(3
)=2*RL(2)
2560 K1=B1*(2.5-A)/1.5/B:GAIN=B*K1/B1:R234=RL(4)*(RL(2)+RL(3
))/(RL(2)+RL(3)+RL(4))
2570 IF K1>1 THEN RL(6)=K1*R234:RL(7)=RL(6)/(K1-1)
2580 IF K1=1 THEN RL(6)=R234
2590 IF K1<1 THEN RL(7)=K1*RL(4):RL(4)=(1-K1)*RL(4):RL(6)=RL(7
)*(RL(2)+RL(3)+RL(4))/(RL(2)+RL(3)+RL(4)+RL(7))
2600 IF (X=1 OR X=2) AND ODD=1 THEN CL(5)=1:RL(5)=F(V+1)
2610 RETURN
2620 REM _____ SUBROUTINE FOR BP TUNED CIRCUIT _____
2630 NN=1:IF FC>100000! THEN NN=14:GOTO 2670
2640 IF FC>10000 THEN NN=9:FF=FC:GOSUB 2750:GOTO 2670
2650 IF FC>1000 THEN NN=5:FF=10*FC:GOSUB 2750:GOTO 2670
2660 IF FC>100 THEN NN=1:FF=100*FC:GOSUB 2750
2670 CC=CS(NN)
2680 R2=Q(2*V+1)/PI/FC/CC:R1A=R2/4:R1B=R2/2/(2*Q(2*V+1)^2-2)
2690 PRINT:PRINT "Filter block number 1.":PRINT "Tuned circui
t without notch.":PRINT
2700 R=R1A:GOSUB 3330:S=R:S$=R$:R=R1B:GOSUB 3330
2710 PRINT USING "R1a=###.###\    \    , R1b=###.###\    \";S,
S$,R,R$
2720 R=R2:GOSUB 3330:C=CC:GOSUB 3270
2730 PRINT USING " R2=###.###\    \       C=###.###\ \";R,R$,
C,C$
2740 RETURN
2750 IF FF<=20000 THRN NN=NN+1:GOTO 2790
2760 IF FF<=30000 THEN NN=NN+2:GOTO 2790
2770 IF FF<=50000! THEN NN=NN+3:GOTO 2790
2780 NN=NN+4
2790 RETURN
2800 REM _____ SUBROUTINE FOR BP & BR COMPONENTS _____
2810 IF I>0 THEN 2840
2820 R(4)=2*RFACTOR:R(2)=R(4)/3:R(3)=2*R(2):R(1)=R(4)/4.5:C(1)=
.75/PI/FC/R(2):C(4)=C(1)/4.5:C(2)=.5/PI/FC/R(2):C(3)=C(2)/2
2830 K1=4*(2.5-1/Q(2*V+1))/3:R234=R(4)*(R(2)+R(3))/(R(2)+R(3
)+R(4)):GAIN=K1/2:GOTO 2870
2840 R(2)=RFACTOR*(F1(K)^2+P1(J)^2)/3/F1(K)^2:R(3)=2*R(2):R(1
)=RFACTOR*(F1(K)^2+P1(J)^2)/4.5/P1(J)^2
2850 R(4)=4.5*R(1):C(1)=.75/PI/P1(J)/R(2):C(4)=C(1)/4.5:C(2
)=.5*P1(J)/PI/R(2)/F1(K)^2:C(3)=C(2)/2
2860 K1=(2.5-1/Q(J))*(P1(J)^2/F1(K)^2+1)/1.5:R234=R(4)*(R(2)+R(
3))/(R(2)+R(3)+R(4))
2870 IF K1>1 THEN R(6)=K1*R234:R(7)=R(6)/(K1-1)
2880 IF K1=1 THEN R(6)=R234
2890 IF K1<1 THEN R(7)=K1*R(4):R(4)=(1-K1)*R(4):R(6)=R(7)*(R(
2)+R(3)+R(4))/(R(2)+R(3)+R(4)+R(7))
2900 IF X=3 OR I=0 THEN 2920
2910 GAIN=K1*F1(K)^2/(P1(J)^2+F1(K)^2)
2920 RETURN
2930 REM _____ DENORMALIZE LP & HP _____
```


World Radio History

pay to get rid of the hum.

A more practical design could be a filter with Fc = 50 Hz, BW = 10 Hz, 40 dB down at 51 Hz, and a passband ripple of 0.1 dB. For this filter the notch frequencies are 49.148, 50.000, and 50.867 Hz, much easier to set up and much less likely to affect the frequency response seriously if they drift by 0.1 Hz.

Construction of active elliptic filters

Constructing active elliptic filters is the same as constructing active Chebychev filters in that you design your layout as if you were constructing a high gain audio amplifier. For example, you need to keep all signal leads as short as possible, keep output leads away from input leads, put 100n (0.1 uF) ceramic capacitors from each power supply pin to earth on each IC, and use 100n ceramic plus 1000 uF electrolytic capacitors to bypass the power supply leads where they enter the filter.

Since active filters cannot be used above about 100 kHz, there is no need to use double sided printed circuit board unless you end up with lots of crossovers or long links in your layout, in which case it may be more convenient to put some of the tracks on the component side of the board.

AM radio filter

At this stage it is worthwhile to do the complete design of a couple of active elliptic filters to make sure that you have copied the program correctly and to point out a few details of the procedure. The first filter is the one to remove the 9 kHz beat frequency and the "monkey chatter" from the output of an AM radio. We decide as a first try to use Fc = 8 kHz, passband ripple of 0.1 dB, and 30 dB attenuation at 9 kHz. The program of Figure 5.1 tells us that the order is 6, the highest Q is only 12, and of the three notches, one is at 9.138 kHz. This is the notch that we will move to 9 kHz. After some experimentation we find that moving the stopband edge to 8.873 kHz and changing nothing else produces the design frequencies and Qs shown at the top of Figure 5.7.

```
2940 FOR J=1 TO 4
2950 R(J)=RL(J)*RFACTOR:C(J)=CL(J)*CFACTOR
2960 NEXT J
2970 IF ODD=1 THEN R(5)=RL(5)*RFACTOR:C(5)=CL(5)*CFACTOR
2980 R(6)=RFACTOR*RL(6):R(7)=RL(7)*RFACTOR
2990 RETURN
3000 REM _____ DISPLAY SUBROUTINE _____
3010 C=C(1):GOSUB 3250:R=R(1):GOSUB 3330
3020 PRINT USING "C1=###.###\ \       R1=###.###\    \";C,C$,R,R$
3030 C=C(2):GOSUB 3250:R=R(2):GOSUB 3330
3040 PRINT USING "C2=###.###\ \       R2=###.###\    \";C,C$,R,R$
3050 C=C(3):GOSUB 3250:R=R(3):GOSUB 3330
3060 PRINT USING "C3=###.###\ \       R3=###.###\    \";C,C$,R,R$
3070 IF K1>1 THEN 3100
3080 C=C(4):GOSUB 3250:R=R(4):GOSUB 3330:S=R:S$=R$:R=R(7):GOSU
B 3330
3090 PRINT USING "C4=###.###\ \      R4a=###.###\    \    R4b=#
##.###\    \";C,C$,S,S$,R,R$:GOTO 3120
3100 C=C(4):GOSUB 3250:R=R(4):GOSUB 3330
3110 PRINT USING "C4=###.###\ \       R4=###.###\    \";C,C$,R,R$
3120 IF ((X=1 OR X=2) AND (ODD=0 OR I<V)) OR X=3 OR X=4 THEN PRI
NT "There is no C5 or R5.":GOTO 3150
3130 C=C(5):GOSUB 3250:R=R(5):GOSUB 3330
3140 PRINT USING "C5=###.###\ \       R5=###.###\    \";C,C$,R,R$
3150 R=R(6):GOSUB 3330:S=R:S$=R$:IF K1>1 THEN R=R(7):GOSUB 3330
3160 IF K1>1 THEN 3170 ELSE 3180
3170 PRINT USING "R6=###.###\    \    R7=###.###\    \";S,S$,R,R
$:GOTO 3190
3180 PRINT USING "R6=###.###\    \    There is no R7.";S,S$:GO
TO 3190
3190 IF X=3 THEN 3210
3200 G=8.686*LOG(GAIN):PRINT USING "The gain of this block is #
#.## which is ##.## dB.";GAIN,G:G1=G1*GAIN:G2=G2+G
3210 INPUT "To continue, press ENTER.",SS$
3220 PRINT:RETURN
3230 REM _____ OVERALL GAIN _____
3240 PRINT USING"The overall gain of the filter is ###.## whic
h is ###.## dB.";G1,G2:GOTO 3410
3250 REM _____ SUBROUTINE FOR CAPACITOR UNITS _____
3260 IF C>=1 THEN C$=" F"
3270 IF C>=.001 THEN C=C*1000!:C$=" mF":GOTO 3310
3280 IF C>=.000001 THEN C=C*1000000!:C$=" uF":GOTO 3310
3290 IF C>=1E-09 THEN C=C*1E+09:C$=" nF":GOTO 3310
3300 C=C*1E+12:C$=" pF"
3310 RETURN
3320 REM _____ SUBROUTINE FOR RESISTOR UNITS _____
3330 IF R>=1000000! THEN R=R/1000000!:R$=" MOhms":GOTO 3360
3340 IF R>=1000! THEN R=R/1000!:R$=" kOhms":GOTO 3360
3350 R$=" Ohms "
3360 RETURN
3410 PRINT "End of programme.":END
```

```
Tuning  frequencies                Q

   6.234 kHz                     0.65
   7.739 kHz                     2.42
   8.221 kHz                    13.18

         Notch frequencies

           9.000 kHz
          10.620 kHz
          20.286 kHz

Filter block number 1
C1= 22.934 nF        R1= 16.898 kOhms
C2=  1.007 nF        R2=  1.670 kOhms
C3=503.640 pF        R3=  3.340 kOhms
C4=  5.096 nF       R4a= 23.233 kOhms
                    R4b= 52.808 kOhms
There is no C5 or R5
R6= 18.401 kOhms     There is no R7
The gain of this block is 0.65 =-3.72 dB

Filter block number 2
C1= 12.860 nF        R1=  3.011 kOhms
C2=  4.553 nF        R2=  2.399 kOhms
C3=  2.276 nF        R3=  4.797 kOhms
C4=2.858 nF          R4= 13.550 kOhms
There is no C5 or R5
R6= 10.011 kOhms     R7=  8.859 kOhms
The gain of this block is 1.39=2.87 dB

Filter block number 3
C1= 10.105 nF        R1=  2.296 kOhms
C2=  5.621 nF        R2=  2.874 kOhms
C3=  2.810 nF        R3=  5.748 kOhms
C4=  2.246 nF        R4= 10.333 kOhms
There is no C5 or R5
R6= 13.933 kOhms     R7=  7.092 kOhms
The gain of this block is 1.62=4.17 dB

Overall filter gain is 1.46=3.32 dB
```

Figure 5.7. Tuning frequencies, Qs, notch frequencies and component values for the AM radio filter.

Now we are happy with this design we move on to part 2 of the program which presents us with the values for the components for the first filter block and pauses so that they can be printed out or copied down. Pressing ENTER displays the second block and so on. The values are shown in the bottom part of Figure 5.7, and the final circuit is in Figure 5.8. The series and parallel combinations of components were calculated using the resistor and capacitor programs given in an article in the November 1987 issue of AEM.

The complete circuit shows all the components that are needed for the filter. This emphasises one of the main steps in practical filter design. Before starting a pc board design, you have to know how you are going to make up each resistor and capacitor. There is still some leeway if you are not happy with your board layout in the design stage. It is often possible to change from two resistors or capacitors in series to two in parallel (or vice versa) and still get the value within tolerance, and at the same time improve the layout of the copper tracks.

Audio filter for amateur radio

The requirements for the 3 kHz wideband BP filter for amateur use are much less stringent than those for the AM radio filter. There is no particular frequency that we wish to remove so we don't mind where the notches are. Using Fc = 3 kHz, passband ripple of 0.25 dB, and 40 dB attenuation at 4 kHz for the LP filter together with a 3rd order Chebychev HP filter for the low fre- ▷

World Radio History

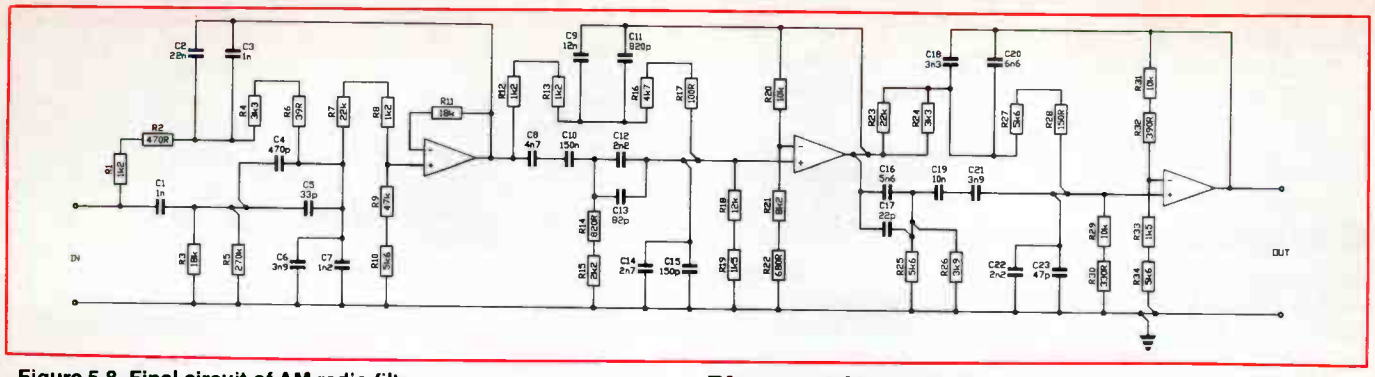


Figure 5.8. Final circuit of AM radio filter.

quencies gives the tuning frequencies shown in Figure 5.9. The final circuit is in Figure 5.10 in which the Chebychev filter has been put first.

The RC circuit at the output makes it essential for the following stage to have a high input impedance. If you use two LF353s for the filter, you could put the RC filter first, followed by the spare amplifier connected with a gain of +1, and feed the output from this amplifier into the input of the Chebychev part of the filter. Alternatively, you could put the spare amplifier after the RC filter. The choice is yours.

Elliptic LP	
Tuning frequency	**Q**
1.664 kHz	0.50
2.504 kHz	1.25
3.103 kHz	6.21
Notch frequency	
4.135 kHz	
6.015 kHz	
Chebychev HP	
489.905 Hz	0.50
324.865 Hz	1.51

Figure 5.9. Tuning frequencies, Qs, and notch frequencies for the audio filter for amateur radio.

Attenuation of elliptic filters

The calculation of the attenuation of an elliptic filter can only be carried out after the tuning frequencies, Qs, and notch frequencies are all known. These were all calculated in part 1 of the active filter program (Figure 5.1), so the program of Figure 5.11 has been written simply to be attached to the end of Figure 5.1. The program only works for LP and HP filters. If you wish to go a stage further, you can add your own subroutine to plot the attenuation as a function of frequency.

Phase shift and delay

The program of Figure 5.11 also includes the necessary code to calculate the phase shift and time delay of elliptic LP and HP filters. The phase shift of elliptic filters in the passband is similar to that of Chebychev filters, since their frequency response is similar.

As we already know, the time delay of a filter is mathematically related to the phase shift, so one would expect there to be some fluctuations in the slope of the time delay-vs-frequency curve, and indeed there are.

This has given elliptic filters something of a bad name in audio circles, but the examples shown in Figure 5.12 put the facts into perspective. In the Figure are the time delay curves for a Butterworth, Chebychev, and elliptic filter, each having Fc = 1 kHz, 40 dB attenuation at 1.5 kHz, and, in the case of the Chebychev and elliptic filters, 0.1 dB ripple in the passband. To achieve this degree of attenuation, the Butterworth filter has to be of order 12, the Chebychev of order 8, and the elliptic of order only 5.

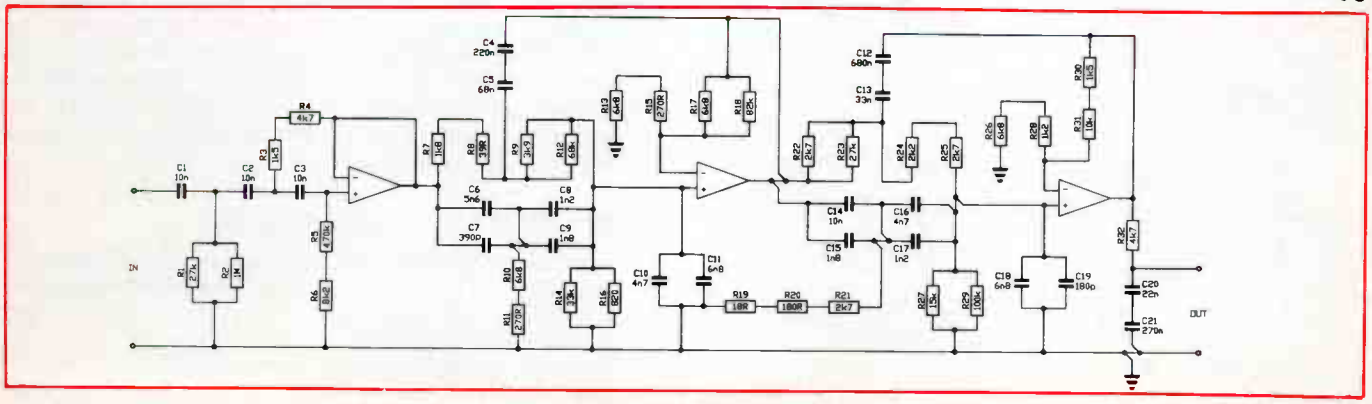
At low frequencies the amount of delay is related to the order

to 93 ▷

Figure 5.11. GWBASIC programme to calculate the attenuation, phase, and time delay of elliptic LP and HP filters. This programme adds on to the end of the programme of Figure 5.1.

```
2200 IF X>2 THEN PRINT "This programme can only do calculations for LP and HP fi
lters. ":GOTO 120
2210 IF X=1 THEN:S=1:FOR I=1 TO V:W(I)=2*PI*P1(I):NEXT I:IF ODD=1 THEN W(V+1)=2*
PI*P1(V+1)
2220 IF X=2 THEN:S=-1:FOR I=1 TO V:W(I)=2*PI*FC*FC/P1(I):NEXT I:IF ODD=1 THEN W(
V+1)=2*PI*FC*FC/P1(V+1)
2230 INPUT "At what frequency [ Hz ] would you like the attenuation, phase, and
delay ?",F:W=2!*PI*F:FF=F/FC:IF X=2 THEN FF=FC/F
2240 IF FF=1 THEN Z=0 ELSE Z=SQR(ABS(1-1/FF/FF))
2245 FOR I=1 TO V:Z(I)=SQR(1-1/F(I)/F(I)):IF Z(I)=Z THEN PRINT "The attenuation
at this frequency is infinite.":ATTEN=999.99:GOTO 2270
2250 NEXT I:IF FF>1 THEN L=((Z+1)/ABS(Z-1))^(N0/2):FOR I=1 TO V:L=L*(Z*Z(I))/(Z-
Z(I)):NEXT I:ATTEN=4.343*LOG(1+.25*EP2*(L+1/L)^2):GOTO 2270
2260 B=.5*N0*ATN(-2*Z/(Z*Z-1)):IF B<0 THEN B=PI+B
2263 FOR I=1 TO V:B1=ATN(-2*Z*Z(I)/(Z*Z-Z(I)*Z(I))):IF B1<0 THEN B1=PI+B1
2265 B=B+B1:NEXT I:ATTEN=4.343*LOG(1+EP2*(COS(B)^2)):IF ODD=1 THEN ATTEN=4.343*L
OG(1+EP2*(SIN(B)^2))
2270 PHASE=0:FOR I=1 TO V:P=ATN(W*W(I)/Q(I)/(W(I)*W(I)-W*W)):IF P<0 THEN P=PI+P
2280 PHASE=PHASE+P:NEXT I
2290 IF ODD=1 THEN P=ATN(W/W(V+1)):PHASE=PHASE+P
2300 D=0:FOR I=1 TO V:D=D+W(I)*(W(I)^2+W^2)/Q(I)/((W(I)^2-W^2)^2+(W(I)*W/Q(I))^2
):NEXT I:IF ODD=1 THEN D=D+W(V+1)/(W(V+1)^2+W^2)
2310 GOSUB 2330:PRINT USING "Atten=###.## dB   Phase=####.## degrees   Delay=##
#.##\    \";ATTEN,PHASE*180/PI,D,DD$
2320 INPUT "Would you like to try another frequency [ Y or N ] ?",ANS$:IF ANS$="
Y" OR ANS$="y" THEN 2230 ELSE 3140
2330 IF D>=1 THEN DD$=" sec ":GOTO 2360
2340 IF D>=.001 THEN D=D*1000!:DD$=" msec ":GOTO 2360
2350 D=D*1000000!:DD$=" usec "
2360 RETURN
3140 PRINT "End of programme.":END
```

Figure 5.10. Final circuit of audio filter.



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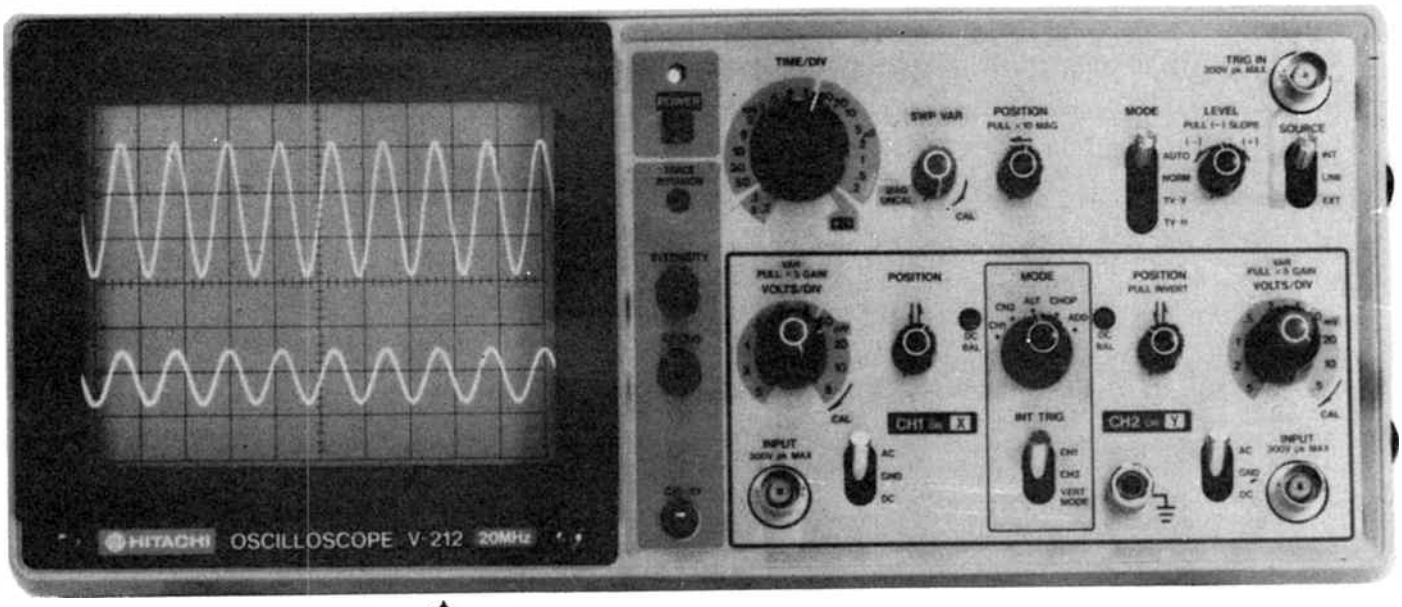

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Accelerating Potential	2 kV.
External Intensity Modulation	Voltage: 5V or more. Effective bandwidth: DC to 2 MHz. Max. input voltage: 30V (DC + AC peak).
Vertical Deflection	
Sensitivity	5mV/div to 5V/div in 10 calibrated steps ±3%. 1mV/div, 2mV/div ±5% when using x5 magnifier. Uncalibrated continuous control between steps 1 : < 2.5.
Bandwidth	DC to 20 MHz (–3 dB). DC to 7 MHz (–3 dB) when using x5 magnifier.
Rise Time	17.5 ns. 50 ns when using x5 magnifier.
MAX. Input Voltage	300V (DC + AC peak) or 500Vp-p AC at 1 kHz.
Input Coupling	AC, GND, DC.
Input Impedance	1MΩ approx. 25 pF.
Display Mode	CH1, CH2 (normal or invert), ALT, CHOP, ADD
CH1 Vertical Signal Output	Voltage: approx. 20mV/div into 50Ω Bandwidth: 50 Hz to 5 MHz (–3 dB) into 50Ω.
X-Y Operation	CH1: X-axis. CH2: Y-axis.
Sensitivity	5mV/div to 5V/div. 1mV/div, 2mV/div when using x5 magnifier.
Bandwidth	DC to 500 kHz (–3 dB).
Phase Difference	3° or less from DC to 50 kHz.
Horizontal Deflection	
Sweep Time Range	0.2 μs/div to 0.2s/div in 19 calibrated steps ±3%. 100 ns ±5% when using x10 magnifier (20 ns and 50 ns uncalibrated). Uncalibrated continuous control between steps 1 : < 2.5.
Trigger	
Trigger Mode	Automatic (sweep runs in absence of a triggering signal and for signal below 30 Hz). Normal (sweep runs when triggered), TV-V, TV-H.
Trigger Source	CH1, CH2, V-MODE, External, Line.
Trigger Sensitivity	20Hz to 2MHz: CH1 and CH2: 0.5 div; External: 20mV. 2MHz to 20MHz: CH1 and CH2: 1.5 div; External: 800mV.
Trigger Coupling	AC.
Trigger Slope	+ or –
Calibrator	Square wave. Voltage: 0.5V ±3%. Frequency: Approx. 1kHz
Power Supply	Voltage 100/120/220/240 V ±10%. Frequency 50/60/400 Hz. Power consumption : approx. 30 W.
Ambient Temperature	Rated range of use: +10 to 35°C. Limits of operation 0 to 50°C. Storage and transport: –20 to 70°C.
Dimensions	310(W) x 130(H) x 370(D) mm. 12.2 x 5.1 x 14.6 in.
Weight	Approx. 6 kg/13.2 lb.
MTBF	20,000 hours for target value.
Accessories Supplied	Two AT-10AJ1.5 probes, Fuse, Power cable, Operation manual.

World Radio History

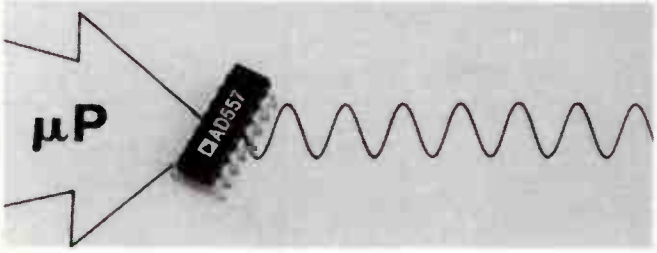
The transistor is 40!

THE WEEK this column was prepared, the device which ushered-in the solid-state revolution, the transistor, turned 40. It was born on December 23 1947, the work of three parents – John Bardeen, Walter Brattain and William Shockley, working at the AT&T Bell laboratories in Murray Hill, New Jersey USA.

Dubbed Bell Labs' "Christmas gift to the world", the transistor was born when the team first demonstrated the "transistor effect" – the amplification of a voice signal by a semiconductor crystal in a circuit.

A colleague, John Pierce, coined the term transistor, from the device's ability to **transfer resistance** from one wire contact to another. He was later credited with the idea of the first practical communications satellite, a project that could never have been realised without the invention of the transistor.

Shockley, Bardeen and Brattain received the 1956 Nobel Prize in Physics for their achievement. It spawned the worldwide semiconductor industry, the core of today's burgeoning electronics, communications, computing, entertainment, medicine, space technology and related industries.



Digital-to-analogue converter with microprocessor interface

It seems that digital-to-analogue and analogue-to-digital converters (DACs and ADCs) are "hot" devices these days, with many distributors and retailers reporting good demand for a variety of products.

Market leader, Analogue Devices, has specialised in DAC and ADC devices for many years, releasing a steady flow of interesting products. Among a whole sheaf of DAC and ADC product releases to fall out of the mail bag this month is their AD557, an economical chip that is a complete digital-to-analogue converter and interface.

Powered from +5 V, it is an 8-bit device with an on-board voltage reference, output amplifier and a double-buffered microprocessor interface. It offers true 8-bit performance without the external trims and components required by other similar types. It dissipates only 75 mW and comes in a 16-pin DIL package.

Further details from the distributors, Parameters Pty Ltd, PO Box 261, North Ryde 2113 NSW.

New Era in high current regulators

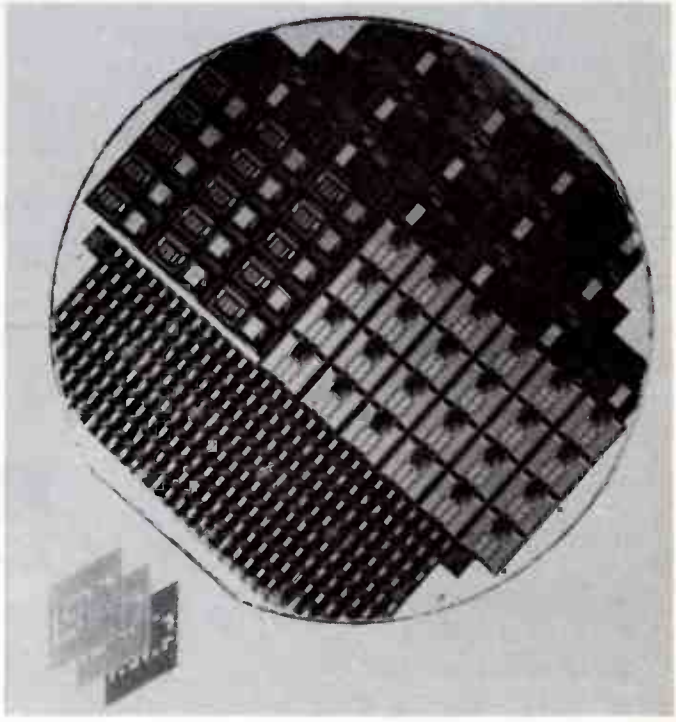
New Era Electronics manufactures a line of high current regulators in both fixed voltage and variable forms. They have 5 V and 12 V positive three-terminal regulators in a 10 amp rating featuring built-in protection facilities such as output short circuit current limiting, thermal overload and safe operating area protection. The device simple shuts down, protecting itself and the load circuit until the fault is removed.

The 5 V/10 A device is known as the 78P05. The 12 V/10 A device is, you guessed it – the 78P12. Both have a low dropout voltage of typically 2.5 V at 10 A.

New Era also make the 78PGA, a positive four-terminal adjustable voltage regulator. It can deliver a rated continuous load current in excess of 10 A over an output voltage range of 5 to 24 volts. Like the others, it features built-in protection and a low dropout voltage, also typically 2.5 V at 10 A.

All three come in a TO-204 metal package. Similar versions rated at 5 A are also available.

See your local George Brown outlet (in all states), or write to The George Brown Group, Marketing Division, 456 Spencer St, West Melbourne 3003 Vic.



Success for local high-tech chip designer

Australia's first specialised "Multiproject Wafer" (MPW) IC prototypes were packaged and shipped from local high-tech Adelaide chip designer Integrated Silicon Design in December last. Processed at ORBIT Semiconductor Inc of Sunnyvale, California, some 15 separate IC designs were incorporated on a single wafer, 14 being Australian designs, and one from the UK.

The process employs a "two micron, double metal CMOS" process and performance specifications released showed characteristics were some 20% better than published specifications. This was a special bonus to customers who had received their chips in a record nine weeks after submission, with actual process turnaround time of only 14 days, according to ISD.

ISD claim the overwhelming success of this inaugural two micron double metal MPW process has established a new standard of world-class microelectronics technology in Australia.

Fast, low power RAMs

IDT has released two 16K static RAMs which feature low power consumption and fast access times, both fabricated in IDT's high performance, high reliability CEMOS technology.

World Radio History

The IDT6167 is a 16K x 1-bit RAM featuring access times as fast as 15 ns and a maximum power consumption of only 550 mW, the makers claim. In standby mode, it consumes typically less than 10 microwatts! A low power (LA) version is also available, ideal for battery-backed RAM applications as it consumes only one microwatt from a 2 V supply!

IDT's equivalent to the industry standard 2K x 8-bit 6116 is the IDT6116SA, featuring access times as fast as 30 ns and a power consumption of just 495 mW. The low power (L) version typically consumes only one to four microwatts from a 2 V battery in battery-backed applications.

The inputs and outputs of both devices are TTL-compatible and they both operate from a single 5 V supply.

Contact your local George Brown Group outlet, or the George Brown Group Marketing Division, 456 Spencer St, West Melbourne 3003 Vic.

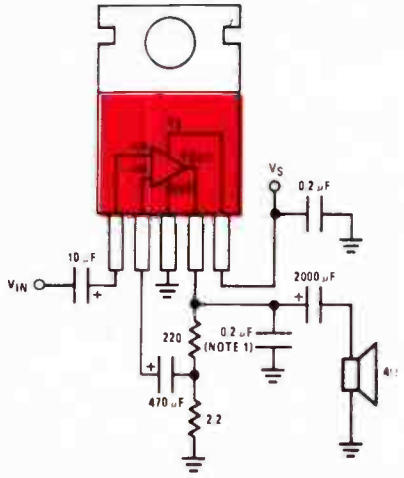
Flat pack audio amp

Amongst National Semiconductors positively gi-normous range of ICs, you'll find a comprehensive set of audio amps, the LM380 and LM386 being widely known. However, looking a bit deeper into their range, one finds the LM383, a 7 W output audio amp housed in a convenient TO-220 flat-pack.

Designed primarily for automotive applications (i.e: car radios), it has a high 3.5 amp output current capability to drive low impedance loads at relatively low distortion levels. It's cheap, too, being available retail for around $5 to $6.

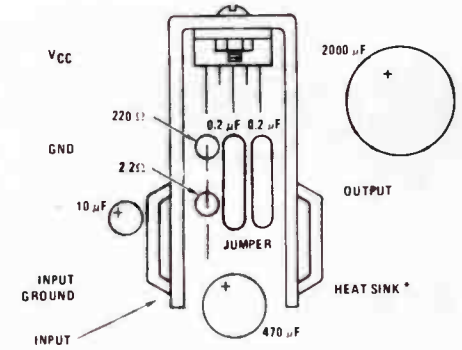
The LM383 features current limiting and thermal overload protection, so it's difficult to blow up – ideal for the enthusiast. The output is ac short-circuit protected and it exhibits no turn-on transients ("thump"). You can set the gain with external components and it has enough sensitivity to avoid the necessity of a preamp. It requires very few external parts, as the accompanying applications circuit shows and is easily attached to a heatsink with a single bolt. This is great as you can use common pc-mount heatsinks, or bolt it to a chassis for heatsinking. It's used as the audio amp in this issue's VHF Satellite Receiver project.

Typical Application

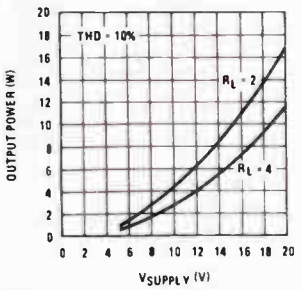


The 0.2 uF (200n) capacitor from the output pin to ground in the applications circuit should be placed as close as possible to pins 3 and 4 for stability. A typical pc board layout is shown here, too.

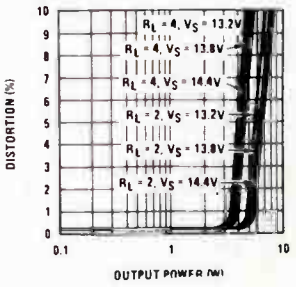
You can get the LM383 at Geoff Wood Electronics in Lane Cove, Sydney, Ritronics in A'Beckett St in the City and High St in Northcote, Melbourne and Stewart Electronic Components down in Huntingdale. Tandy stores carry it as a stock line (LM383/TDA2002 – cat. no. 276-703).



Output Power vs Supply Voltage



Distortion vs Output Power



The TLC548 A-D converter revisited

Having expounded at length on the virtues of this marvellous little device in our first column in September last, we've had a number of calls about where it might be obtained. Well, we've got some good news for you.

Tandy's 1988 catalogue lists it as a stock item, down on page 107, cat. no. 276-1796. It comes with data and at $12.95 would have to be good value. See your local Tandy store.

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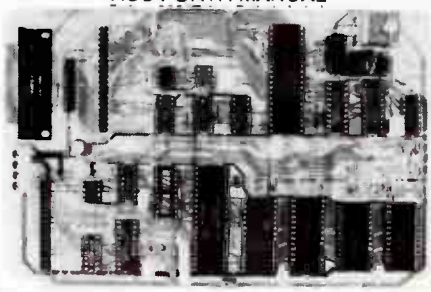

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World Radio History

XE1216E SMARTWATCH

FEATURES

- SmartWatch keeps track of hundredths of seconds, seconds, minutes, hours, days, date of month, months and years
- Adds timekeeping to any 28-pin JEDEC Byte Wide memory location.
- Embedded lithium energy cell maintains calendar time for more than 10 years in the absence of power.
- Timekeeping function is transparent to memory operation.
- Month and year determine the number of days in each month.
- Proven gas-tight socket contacts.
- Full 10% VCC operating range.
- Operating temperature range 0°C to 70°C.
- Accurate to within 1 min./month @ 25°C.

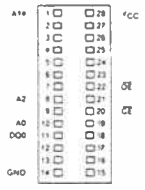
DESCRIPTION

The XE1216E is a 28-pin, 600-mil-wide DIP socket with a built-in CMOS timekeeper function and an embedded lithium energy source to maintain time and date. It accepts any 28-pin bytewide ROM or volatile RAM. A key feature of the SmartWatch is that the timekeeper function remains transparent to the memory device placed above. The SmartWatch monitors VCC for an out-of-tolerance condition. When such a condition occurs, an internal lithium energy source is automatically switched on to prevent loss of watch data. The SmartWatch uses pins 1, 8, 10, 11, 20 and 22 for timekeeper control. All pins pass through to the socket receptable except for pin 20 ($\overline{CE}$) which is inhibited during the transfer of time information.

The SmartWatch provides timekeeping information including hundredths of seconds, seconds, minutes, hours, days, date, month and year information. The date at the end of the month is automatically adjusted for months with less than 31 days, including correction for leap years. The SmartWatch operates in either 24-hour or 12-hour format with an AM/PM indicator.

PIN CONNECTIONS

XE1216E



Pin 1 A14 · Address Bit 14 ($\overline{RESET}$)
Pin 8 A2 · Address Bit 2 (READ/$\overline{WRITE}$)
Pin 10 A0 · Address Bit 0 (Data Input)
Pin 11 DQ0 · I/O0 (Data Output)
Pin 14 GND · Ground
Pin 20 $\overline{CE}$ · Conditioned Chip Enable
Pin 22 $\overline{OE}$ · Output Enable
Pin 28 VCC · +5 VDC to the Socket

All pins pass through the Socket except 20.

OPERATION

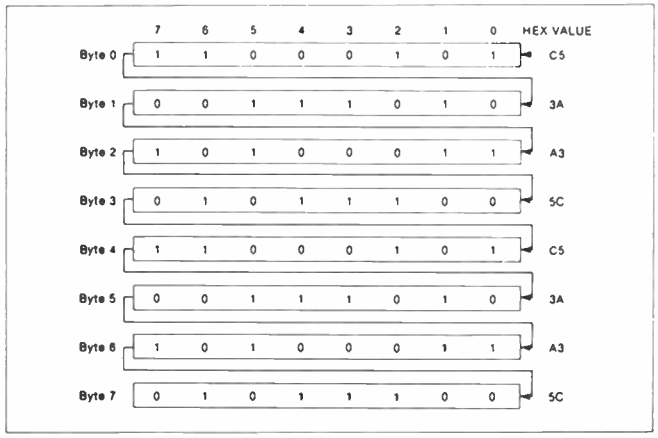
A highly structured sequence of 64 cycles is used to gain access to time information and temporarily disconnect the mated memory from the system bus. Information transfer into and out of the SmartWatch is achieved by using address bits A0 and A2, control signals $\overline{OE}$ and $\overline{CE}$, and Data I/O line DQ0. All SmartWatch data transfers are accomplished by executing read cycles to the mated memory address space. Write and read functions are determined by the level of address bit A2. When address bit A2 is low, a write cycle is enabled and data must be input on address bit A0. When address bit A2 is high, a read cycle is enabled and data is output on data I/O line DQ0. Either control signal ($\overline{OE}$ or $\overline{CE}$) must transition low to begin and high to end memory cycles which are directed to the SmartWatch. However, both control signals must be in an active state during a memory cycle. Communication with the SmartWatch is established by pattern recognition of a serial bit stream of 64 bits which must be matched by executing 64 consecutive write cycles, placing address bit A2 low with the proper data on address bit A0. The 64 write cycles are used only to gain access to the SmartWatch. Prior to executing the first of 64 write cycles, a read cycle should be executed by holding A2 high. The read cycle will reset the comparison register pointer within the SmartWatch insuring the pattern recognition starts with the first bit of the sequence. When the first write cycle is executed, it is compared to bit 1 of the 64-bit comparison register. If a match is found, the pointer increments to the next location of the comparison register and awaits the next write cycle. If a match is not found, the pointer does not advance and all subsequent write cycles are ignored. If a read cycle occurs at any time during pattern recognition, the present sequence is aborted and the comparison register pointer is reset. Pattern recognition continues for a total of 64 write cycles as described above, until all the bits in the comparison register have been matched (this bit pattern is shown in Figure 1). With a correct match for 64 bits, the SmartWatch is enabled and data transfer to or from the timekeeping registers may proceed. The next 64 cycles will cause the SmartWatch to either receive data on Data In (A0) or transmit data on Data Out (DQ0), depending on the level of READ/$\overline{WRITE}$ (A2). Cycles to other locations outside the memory block can be interleaved with $\overline{CE}$ and $\overline{OE}$ cycles without interrupting the pattern recognition sequence or data transfer sequence to the SmartWatch.

An unconditional reset to the SmartWatch occurs by either bringing A14 ($\overline{RESET}$) low, if enabled, or on power up. This $\overline{RESET}$ can occur during pattern recognition or while accessing the SmartWatch registers. $\overline{RESET}$ causes access to abort and forces the comparison register pointer back to Bit 0 without changing registers.

NONVOLATILE CONTROLLER OPERATION

The XE1216E SmartWatch performs circuit functions required to make the timekeeping function nonvolatile. First, a switch is provided to direct power from the battery or VCC supply, depending on which voltage is greater. The second function provides power fail detection. Power fail detection occurs at typically 4.25 volts. Finally the nonvolatile controller protects the SmartWatch register contents by ignoring any inputs after power fail detection has occurred. Power fail detection also has the same effect on data transfer as the $\overline{RESET}$ input.

SMARTWATCH COMPARISON REGISTER DEFINITION — Figure 1



NOTE:
The pattern recognition in Hex is C5, 3A, A3, 5C, C5, 3A, A3, 5C. The odds of this pattern being accidentally duplicated and causing inadvertent entry to the SmartWatch is less than 1 in 10^{19}.

SMARTWATCH REGISTER INFORMATION

The SmartWatch information is contained in 8 registers of 8 bits each which are sequentially accessed one bit at a time after the 64-bit pattern recognition sequence has been completed. When updating the SmartWatch registers, each must be handled in groups of 8 bits. Writing and reading individual bits within a register could produce erroneous results. These read/write registers are defined in Figure 2.

Data contained in the SmartWatch registers are in binary coded decimal format (BCD). Reading and writing the registers is always accomplished by stepping through all 8 registers, starting with bit 0 of register 0 and ending with bit 7 of register 7.

AM-PM/12/24 MODE

Bit 7 of the hours register is defined as the 12- or 24-hour mode select bit. When high, the 12-hour mode is selected. In the 12-hour mode, bit 5 is the AM/PM bit with logic high being PM. In the 24-hour mode, bit 5 is the second 10 hour bit (20–23 hours).

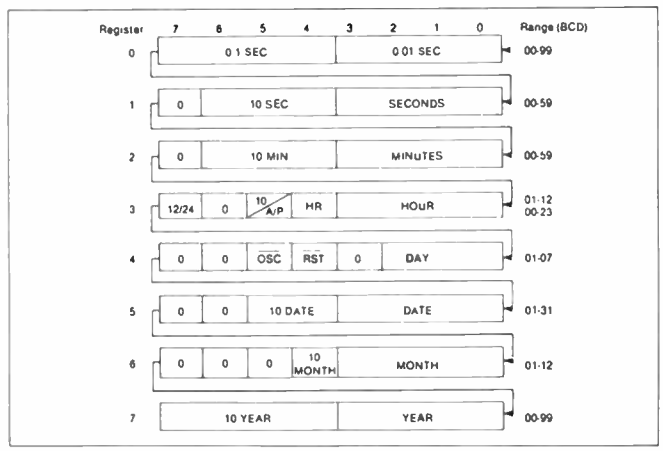
OSCILLATOR AND RESET BITS

Bits 4 and 5 of the day register are used to control the $\overline{RESET}$ and oscillator functions. Bit 4 controls the $\overline{RESET}$ (pin 1). When the $\overline{RESET}$ bit is set to logical 1, the $\overline{RESET}$ input pin is ignored. When the $\overline{RESET}$ bit is set to logical 0, a low input on the $\overline{RESET}$ pin will cause the SmartWatch to abort data transfer without changing data in the watch registers. Bit 5 controls the oscillator. This bit is shipped from XECOM set to logical 1, which turns the oscillator off. When set to logical 0, the oscillator turns on and the watch becomes operational.

ZERO BITS

Registers 1, 2, 3, 4, 5 and 6 contain one or more bits which will always read logical 0. When writing these locations, either a logical 1 or 0 is acceptable.

SMARTWATCH REGISTER DEFINITION — Figure 2



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ABSOLUTE MAXIMUM RATINGS*

Voltage on any Pin Relative to Ground	-1.0V to + 7.0V
Operating Temperature	0°C to 70°C
Storage Temperature	-40°C to 70°C
Soldering Temperature	260°C for 10 Sec.

*This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operation sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods of time may affect reliability.

RECOMMENDED D.C. OPERATING CONDITIONS (0°C to 70°C)

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS	NOTES
Pin 28L Supply Voltage	V_{CC}	4.5	5.0	5.5	V	1,3
Logic 1	V_{IH}	2.2		V_{CC} + 0.3	V	1,6
Logic 0	V_{IL}	-0.3		+0.8	V	1,6

D.C. ELECTRICAL CHARACTERISTICS (0°C to 70°C, VCC = 4.5 to 5.5V)

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS	NOTES
Pin 28L Supply Current	I_{CC}			5	mA	3,4
Input Leakage	I_{IL}	-1.0		+ 1.0	uA	4,6,10
Output @ 2.4V	I_{OH}	-1.0			mA	2
Output @ 0.4V	I_{OL}			4.0	mA	2

CAPACITANCE (t_A = 25°C)

PARAMETER	SYMBOL	MAX	UNITS	NOTES
Input Capacitance	C_{IN}	5	pF	
Output Capacitance	C_{OUT}	7	pF	

A.C. ELECTRICAL CHARACTERISTICS (0°C to 70°C, VCC = 5V ± 10%)

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS	NOTES
Read Cycle Time	t_{RC}	250			ns	
$\overline{CE}$ Access Time	t_{CO}			200	ns	
$\overline{OE}$ Access Time	t_{OE}			200	ns	
$\overline{CE}$ to Output in Low Z	t_{COE}	10			ns	
$\overline{OE}$ to Output in Low Z	t_{OEE}	10			ns	
$\overline{CE}$ to Output in High Z	t_{OD}			100	ns	
$\overline{OE}$ to Output in High Z	t_{ODO}			100	ns	
Address Set Up Time	t_{AS}	20			ns	9
Address Hold Time	t_{AH}			10	ns	8
Read Recovery	t_{RR}	50			ns	
Write Cycle Time	t_{WC}	250			ns	
$\overline{CE}$ Pulse Width	t_{CW}	170			ns	
$\overline{OE}$ Pulse Width	t_{OW}	170			ns	
Write Recovery	t_{WR}	50			ns	7
Data Set Up Time	t_{DS}	100			ns	8
Data Hold Time	t_{DH}	10			ns	8
$\overline{RST}$ Pulse Width	t_{RST}	200			ns	
$\overline{CE}$ Propagation Delay	t_{PD}	5	10	20	ns	2,5
$\overline{CE}$ High to Power Fail	t_{PF}			0	ns	

(0°C to 70°C, V_{CC} < 4.5V)

Recovery at Power Up	t_{REC}			2	ms	
V_{CC} Slew Rate 4.5 -3V	t_F	0			ms	

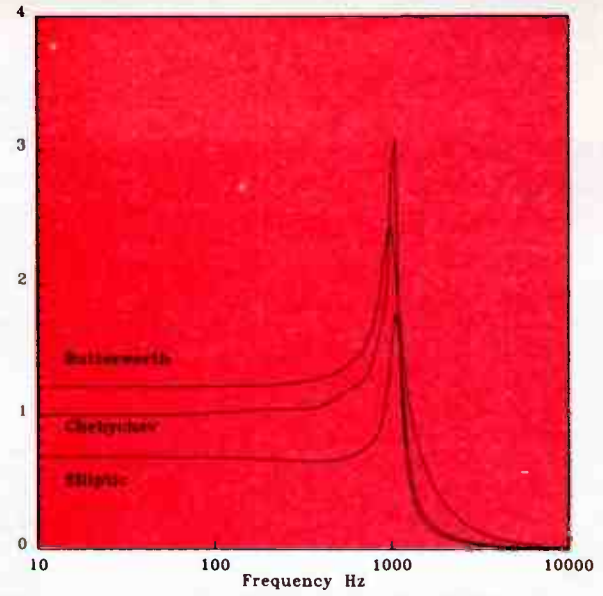

Figure 5.12. Time delay of Butterworth, Chebychev, and elliptic filters, each having Fc=1 kHz, 40 dB attenuation at 1.5 kHz, and in the case of the Chebychev and elliptic filters, 0.1 dB ripple in the passband.

(in this case the number of filter blocks). As the frequency gets near cutoff, the Butterworth delay rises smoothly to a peak of about double the low frequency delay. The Chebychev develops some kinks as the frequency approaches cutoff and the delay rises to about three times the low frequency value. The elliptic filter has a smooth transition to a peak about double the low frequency value. So the elliptic is actually better than the Chebychev. The reason is simply that the elliptic is only a 5th order filter whereas the Chebychev has to be 8th order.

Figure 5.13 shows the phase shifts of the three filters described above. The phase shift starts at zero at low frequencies and falls smoothly to 90 x N degrees, where N is the filter order. The slopes of the curves change with frequency, and it is the slope that determines the time delay.

For comparison, Figure 5.14 shows the time delay of the same filters but with a ripple of 1 dB for the Chebychev and Elliptic filters. The Chebychev filter now need only be of order 7 instead of 8. To help separate the curves and emphasise the detail, the frequency range of the graph has been reduced. The

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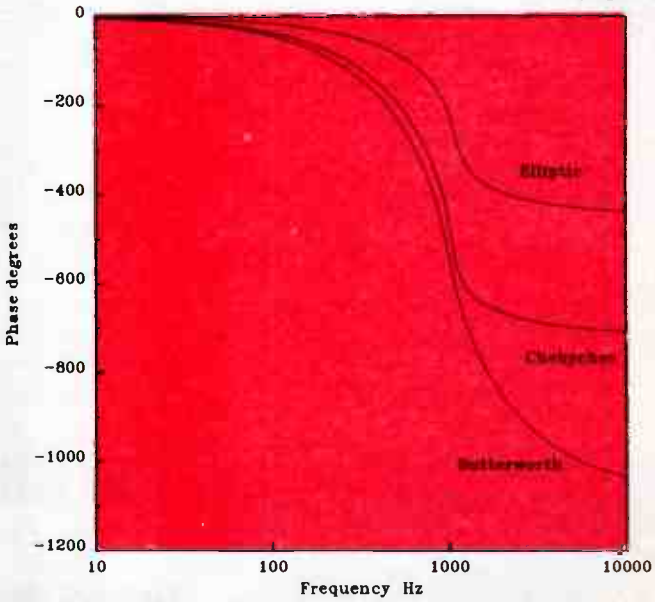


Figure 5.13. Phase shift of the three filters described in Figure 5.12

letters

Inspiration

Dear Roger,

I would firstly like to congratulate you on your very fine magazine.

I started out with a C64 eighteen months ago and no inclination towards radio whatsoever. But thanks to the inspiration generated by your publication, I now have my combined radio amateur callsign and am up and going on packet radio, listening to AMTOR and RTTY and dreaming of satellites.

I have found that there is no need for me to buy several magazines per month now as AEM is enough to keep up with. I can appreciate how difficult it must be to keep the magazine alive and interesting. It looks as if the days of re-hashed whistling egg timers and singing door chimes are gone, and I for one won't miss them!

Please keep up the good work. It's appreciated.

George Harris VK2KET,
Maclaen, NSW

An enthusiast

Dear Roger,

I have every issue of AEM since Number One, and have found them all interesting reading, with articles and constructional projects to suit all shapes, SWRs and sizes.

You seem to be able to consistently pull out of the barrel a magazine with enough theoretical articles and news to satisfy an RMIT Electronics student (I heard you say, "been there, done that!") and enough practical material to suit both myself and, I would imagine many others; with a minimum of advertising too! Elektor in AEM is an excellent idea (I hope the industry continues to supply esoteric components and printed circuit boards to suit same projects). The Semiconductor Scene is a column to look closely at.

Now, apart from the occasional late, late issue, keep up the quality!

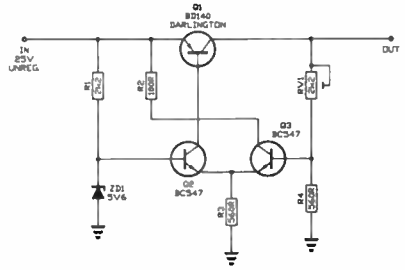
Philip Gargano,
Northcote, Vic.

We certainly aim to keep up the quality and we've fixed the "late, late" issue problem, as no doubt you're already aware. We don't aim to maintain the advertising too "minimum", as it pays for all those good projects and articles, better quality paper and binding, etc! But we don't intend to crowd-out the editorial material with advertising, either.

High voltage regulator

Dear Sir,

Recently, I had to design a regulated supply to operate from a 120 volts unregulated input. A single chip regulator was either impossible at such a high voltage or too expensive. So I had to build it discrete. I designed a circuit and tried it at low voltages to see if it worked. And it did! Here it is:



At Vout = 10 V and Iout = 300 mA, the output ripple was 55 mV, a ripple rejection of 40 dB. Though not an impressive figure, it can no doubt be improved. A problem though was drift: the output dropped 40 mV in one minute, so a matched pair device would be recommended for the differential pair.

The beauty of this circuit is simplicity, and hence speed. Its transient response should be quite good.

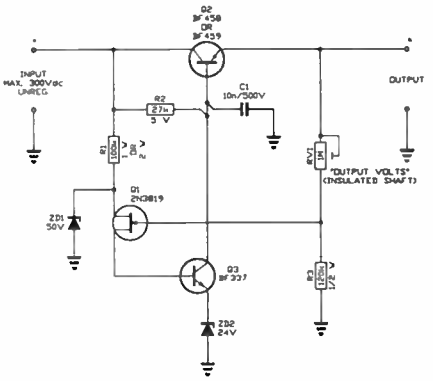
Hey, how about a pure Class A hi-fi amplifier, for purists to build? Nelson Pass had a 20 W design in February 1977 Audio magazine. The design is very simple, the output stage consists of three parallel transistors and three parallel current sources. How about a lower power version so we can compare the sound of pure Class A with Class AB?

How about an expose on amplifier topologies, from classical Class A, differential pair and feedback, feed forward, nested diff' loops, and Nelson's Pass secret STASIS topology? Just how does he keep current through an active device constant?!

Could you please explain how one goes about designing amplifier inputs for minimum noise? Do you have any radical ideas for input stages for ultra-low noise amps for biological data acquisition? I would most appreciate some help here.

Fabio Barone,
Marsfield, NSW

Your circuit for a regulator is quite "standard", and I'm not surprised it drifts. You'd be better off using an op-amp instead of the pair of BC547s. But that won't help for a high voltage circuit unless you use a special op-amp or more complicated circuit. The circuit won't translate very well to high voltage application, either.



The circuit here, which employs a FET and transistor feedback or "error" amplifier will do the job. A BF458 series-pass transistor would be adequate for your application with 120 V input, while a BF459 is preferred at higher voltages, otherwise you'd be sailing 'close to the wind' on the Vceo rating using a BF458. The series-pass device should be mounted on a small, insulated heatsink.

We'll certainly consider your suggestions on hi-fi amps and see what can be done.

The design of low-noise audio and low frequency amps is a subject too lengthy to go into here. However, you might look at the AEM6010 Low Level preamp (Oct. 1985) and the Electromyogram (Mar. '86) for some suitable working designs.

The Bit Stream Flyer

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World Radio History

The Roland SYA-350 data buffer

Data buffers are legion in the marketplace. The choice is positively huge. Roland entered this crowded market niche last year, but avoided releasing a "me too" product by incorporating some highly functional and unique features aimed squarely at the CAD market.

IN LATE 1987 the Roland Corporation, a company well-known in the computing industry for its range of plotters and monitors, released a unique new product – the SYA-350 Data Buffer. The product is set apart from other data buffers principally by the inclusion of a 3.5" floppy disk drive, on-line and off-line operation and both serial-parallel and parallel-serial interface conversion. The SYA-350 is aimed at the CAD/CAM market as it is clearly intended as a plotter buffer, though its features would be well appreciated in other applications.

On first examination it is definitely an impressive device, just judging by features alone.

If you operate a CAD system, as we have done here at the magazine from production of the first issue, you'll appreciate one of their major limitations – the time taken in plotting. The computer is tied up for the time it takes to plot, particularly with large, complex drawings.

Our CAD system comprises an IBM PC/XT (the genuine article!) with twin 360K floppies and 10M hard drive (at around three years old, getting a little long in the tooth, but an "upgrade path" is under active consideration). The primary CAD package is AutoCAD and our output device is a Houston DMP42 "sweet lips" or roller-type pen plotter. We use A2-size special plotter paper for circuit drawings and the like, and special (expensive!) draughting film (A2, again) for pc board plots.

We surveyed the time taken in plotting here at the magazine during a typical(?) production month. We do at least one check plot and one final plot for each drawing, or group of small drawings, sometimes four or more check plots with the more complex drawings. A complex, detailed drawing taking up a large proportion of an A2 sheet takes around 20-40 minutes to plot. With around 150 hours (maximum) of draughting time available in a month, when the count of plotting time approached 30 hours (20% of maximum available time, more when you consider average "lost time") a few eyebrows were raised!

What about spooling it through RAM? A good idea for word processing, but CAD drawings can be very memory intensive, not to mention the "memory overhead" required for the program itself; a resident 640K, even 1M, becomes insufficient. In a word, impractical (else the practice would be widespread). Hence, a buffer, installed between the computer's output port and the output device, is the ideal solution. The name of the game is improved productivity.

Features and functions

The SYA-350 features 640 Kbytes of RAM, a double-sided, double-density 3.5" disk drive and both Centronics parallel and RS232 serial inputs and outputs, four connectors in all.

The unit is supplied with system disk, containing the system software; a formatted data disk, ready for use; an ac power cord with IEC line socket; an operation manual and a vinyl dust cover. The manual is surprisingly well written and comprehensive (I say surprisingly, because it's rare in the computer trade). It includes all the necessary pin-outs and specifications for the various interfaces used and gives a detailed and clearly written description of the software commands.

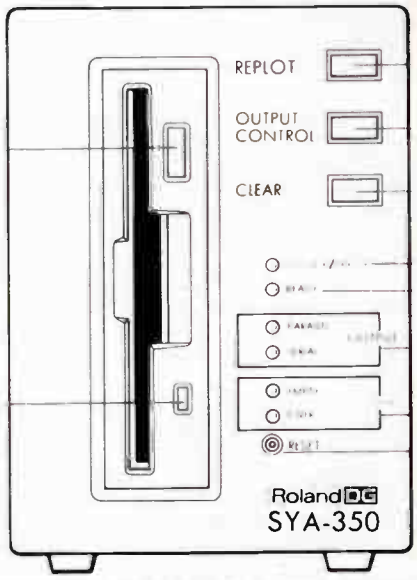
The front panel contains three pushbuttons and six LED indicators, ranged to the right of the 3.5" disk drive. The three pushbuttons are: REPLOT, which activates a replot of a drawing stored previously; OUTPUT CONTROL, which turns the output on or off; and CLEAR, which clears the buffer RAM. The indicators are: POWER/ERROR, which goes on at power-up and blinks when there's an operational error; READY, which goes on when the buffer's ready for use; two output LEDs which show parallel or serial operation of the output port in use; and two buffer LEDs – one showing buffer EMPTY, the other (OVER) blinking when data on the disk exceeds 580K, staying on when it exceeds 640K.

In addition, a RESET switch is accessible through a small hole in the front panel. The disk drive also incorporates a LED that comes on when the drive's head is moving.

The four connectors for the serial input and output and the parallel input and output ports are found on the rear face of the unit, providing for a neat installation where all the leads may be dressed out of the way, and making for unimpeded operation in contrast to those buffers we've seen where the input connector is on the front of the cabinet and the output lead on the back.

Set into the base of the unit and accessible through a slot are three sets of DIP switches which control the configuration of the input and output ports, baud rates and handshaking required.

As would be obvious from the number of



connectors on the back of the unit, the SYA-350 allows for both serial and parallel buffering. However, an exceptional feature is the buffer's ability to accept incoming serial data (at a preselectable data rate) and output it to the parallel port, and vice versa. A point to note here is that, for serial input and output, bit rate conversion is available, enabling you to take in data at the maximum rate (9600 bps) and output it at a rate to suit your plotter. Serial input/output data rates selectable are: 150, 300, 600, 1200, 2400, 4800 and 9600 bps.

Another useful feature of the Roland SYA-350 is the ability to queue a number of files in the buffer memory or on its 3.5" disk. This means that the host computer could send, say, three drawings that were generated on a CAD package one after the other out the serial port at 9600 bps. Then, assuming your plotter accepts data at only 2400 bps, the buffer could happily deliver your data to the plotter without tying up the computer for the length of time to transfer at 2400 bps and the computer is freed for further use. In addition, each piece of equipment in your system can be configured for the most productive arrangement, and when it comes to draughting, productivity is a prime concern.

The ability to "replot" previously output information is also a great time-saving feature of the Roland buffer. Consider this situation: you are in an office, using your PC and you are ready to plot an important drawing, however the plotter is not working at present and the serviceman is still working-out the problem. This would present no difficulty to you as the drawing could be output to the buffer and stored on the data disk. Later on, when the plotter is working again, all that needs to be done is the buffer and plotter connected together and the REPLOT button on the buffer pressed. This is all done without tying-up the computer or wasting time waiting for the plotter to be fixed.

Why wouldn't saving to a floppy in the computer achieve the same result? While saving to a floppy is relatively quick, when it comes to plotting later, the computer is tied up during the plotting process. ▷

World Radio History

Operation

The operation of the buffer can be controlled either from the front panel, or by embedded software commands providing a flexible, easy to use system.

Overall operation is quite straightforward after the input and output configuration has been decided upon. Initially the three sets of DIP switches on the base of the unit need to be set. The first of these instructs the buffer as to the format (parallel or serial) and the speed of the incoming data (if serial). The second of these DIP switches informs the buffer of the format for the outgoing data. The third is used to setup the handshaking method, whether it be software or hardware handshaking.

After the DIP switches have been set, the cables then need to be connected to the back of the unit at the appropriate connectors. The connectors are all industry standard, with the serial connections being terminated with DB25 sockets, and the parallel inputs and outputs using Centronics standard 36- and 14-way sockets respectively.

The next step to installing the buffer involves preparing the data disk. Being a sophisticated buffer it requires special system software to be loaded from the data disk each time it is turned on. Preparing new disks is simple but a little time-consuming. The buffer comes with a master disk which contains the software necessary for formatting and initialising blank disks.

Once these installation procedures are carried out, the buffer is ready for operation. In its simplest form, all that need be done is the buffer turned on and the data disk inserted in the drive. After about thirty seconds the system software is finished loading and data can then be accepted as if the operator were outputting direct to the peripheral device.

One important option available at this point is the ability to dump the outgoing data onto the data disk *and* to the peripheral device, or *only* onto the data disk. This useful feature allows you to store data on the data disk for later printing or plotting, thus freeing-up the computer. This operation is selected from a button on the front panel.

As mentioned earlier, the SYA-350 buffer can be controlled through simple software instructions. These are in the form of Escape codes sent from the host computer. Commands usually sent from the computer are transparent to the buffer and are ignored. However, a set of reserved commands are used to control the operation of the buffer.

It would be too lengthy to detail them here, but the software commands offer greater control over the operation and configuration of the buffer, allowing you to change the handshaking codes used, alter the size of the handshake and data buffers and a host of other functions affecting the way the buffer operates. This feature affords the user a lot of control over the inner workings of the buffer, making for a very powerful and flexible system.

Did it save us?

The consensus is that that 30 hours of "lost" time while plotting could be safely divided by a number ranging between four and ten. It depends to some extent on how you use the buffer's facilities.

You're probably asking "what's the draughtsperson doing while a plot's going on?" It's a fair question. Nothing, or trivial tasks ("make work" housekeeping – unfortunately, time out for the comfort station and time for a plot rarely coincide). Sure, some work allocated for pen and paper on the conventional drawing board could be (and was) usefully done while a plot was in progress, but as typically only around 5%-10% (one to two days) of draughting hours in a month is spent this way, a significant amount of time is still lost waiting while plotting.

In summary

In conclusion, the SYA-350 buffer offers features which are unique in its price range. The inclusion of floppy disk storage is a feature we've not seen before in a buffer of this type. The memory capacity seems well suited to the application, matching the "standard" memory capacity of many computers (e.g: PCs and compatibles) used for CAD systems.

The flexibility of the I/O arrangement is worthy of special comment, particularly the availability of bit rate conversion on the serial ports permitting otherwise incompatible devices and software to communicate successfully. However, a top baud rate (at least for input) of 19,200 bps would have been a good idea.

The manual supplied with the SYA-350 is exceptionally well written and overflowing with useful information for interfacing the various ports and *detailed* pinout descriptions for all the necessary connectors.

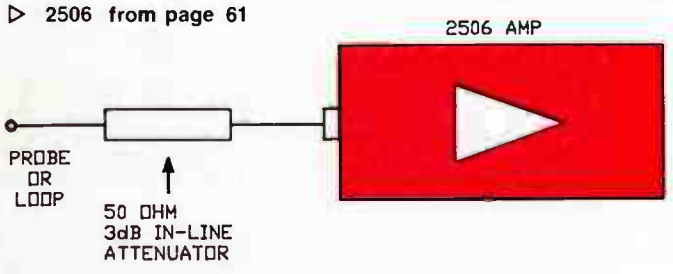
The Roland SYA-350 buffer offers striking features unique to the buffer world and unheard-of for the price. As it retails at around $1200, the money saved in productivity improvement makes it a modest investment indeed.

Particularly suited to the rapidly growing CAD market, the SYA-350 would certainly streamline any computer system using today's advanced CAD software and ink-pen plotters. We found it irresistible.

Jamye Harrison

The review unit was kindly supplied by Roland Corporation Australia Pty Ltd, 50 Garden St, South Yarra 3141 Vic. (03)699 8488.

▷ 2506 from page 61



tion having a 50 Ohm dummy load (termination) plugged into the leg of the T. If you're using an in-line attenuator, only a small amount of attenuation is necessary to 'tame' the amplifier, 1 dB to 3 dB is fine. There's plenty of gain, so the trade-off is not a disadvantage. If you wish, you could modify the pc board to accommodate a pi-section attenuator of 1-2 dB in each of the input and output striplines, using chip resistors.

When 'sniffing around' low level circuits at UHF with a frequency counter, a good input lead is a length of coax with a small loop at one end and a BNC plug at the other. Expose a length of the inner conductor and dielectric, say about 20-30 mm long. Cut off a few millimetres of the outer sheath to expose the braid, and expose about 5-6 mm of inner conductor. Tin them lightly. Bend the inner conductor/dielectric around and solder the exposed inner conductor to the outer braid.

If connecting the unit directly to a circuit, ensure that the input level of +5 dBm (about half a volt RMS) is not exceeded.

Our Second Birthday Contest winner, Mr W. M. Schumaker, was presented with his prize, a Philips PM2618X/01 digital multimeter, by Graham Blanchett of Philips Scientific & Industrial last December. The contest results were announced in the December issue.

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Notes on the AEM3505/AAPRA C64 packet modem

The AEM3505 packet modem project for the Commodore 64 computer has proved to be extremely popular and with so many of the projects being built, it is inevitable that some constructors will experiment with the circuit in an effort to improve the operation or overcome minor problems.

Fortunately, some of those experimenters have provided some feedback and given us details of modifications and changes which we can share with our readers.

The first modification involves changing the value of capacitor C5 from 1n5 to 4n7. This change will result in the amplitude of the two tones in the signal applied to the XR2211 being closer to each other than was previously the case and thereby giving improved demodulator performance.

The second modification involves the change in value of resistor R18 from 22k to 10k. Some constructors have experienced problems with the relay failing to switch correctly and this modification overcomes the problem. Whilst on the subject of the PTT relay, some constructors have elected to leave the relay out of the circuit and use the "alternate PTT" signal to switch the transceiver. It is important if using this method to also remove the protection diode D1 or incorrect circuit operation will result.

The final suggestion involves a problem with the computer inexplicably "hanging up" when the modem is left connected. This was a sticky problem and was initially thought to be a software "bug". The problem was eventually tracked down to the 5 V supply from the 7805 regulator when it was realised that the fault did not occur when the computer's 5 V supply was used to power the project.

It would appear that the majority of 7805 regulators available do not actually output exactly 5 V, but a slightly higher value of around 5.25 – 5.3 V. Whilst this value is within specifications for TTL circuitry and should not normally be a problem, it seems that the 6522 interface chip used in the Commodore computer is very intolerant of the higher voltage.

There are two possible solutions to the problem, either of which can be used. The most obvious cure is to use the 5 V supply from the computer itself. Simply lift the output leg of the 7805 regulator and connect the vacant pc board pad to the 5 V supply from the computer available on pin 2 of the expansion connector. The second method which can be used to lower the voltage from the 7805 is to connect a diode in series with its output. The output pin of the 7805 regulator should be lifted free of the board and the diode connected with the anode to the output pin and the cathode to the pc board pad. By using a silicon diode such as a 1N4001, the output from the 7805 regulator will be reduced by around 0.5 volts due to the voltage drop across the diode junction.

In addition to the suggestions and modifications outlined above, there were a couple of minor errors in the circuit diagram published in the July 1987 issue, page 75. In the modulator circuit, the signal marked "audio in" which is connected to pin 2 of the XR2206 should read "audio out". Also, in the same diagram, the trimpot RV2 is incorrectly shown as 4k7. The correct value for RV2 is 47k as indicated in the parts list.

▷ from page 93

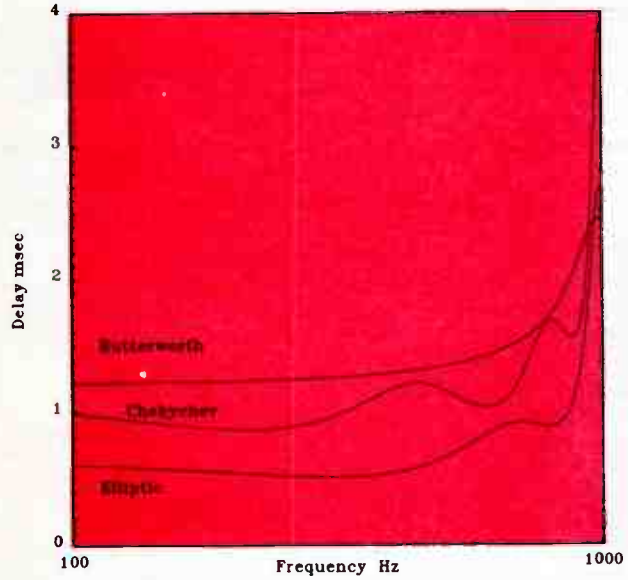

Figure 5.14. Time delay of the three filters described in Figure 5.12, but with the passband ripple increased to 1.0 dB.

shape of the Butterworth curve has not changed, but you can see the considerable increase in the magnitude of the kinks in the curves for the Chebychev and Elliptic filters. Again the Chebychev is the worse because of its higher order. All of this simply means that for audio work, it is essential to keep the ripple in the passband as low as possible consistent with the desired cutoff slope. One of the advantages of elliptic filters is that you have several variables that you can trade off to get the filter to cope with just about any problem.

The good things about Elliptic filters are:

- Steepest possible slope near the cutoff frequency
- Same ripple in the passband as Chebychev filter
- Steepness of cutoff can be traded against passband ripple
- Least number of sections needed for a given cutoff slope and hence
- Cheap
- Lower Qs needed than in a Chebychev for equivalent cutoff slope
- Less phase shift and time delay than Butterworth or Chebychev for the same cutoff slope
- Easy to tune
- Standard filters easy to design from tables

The not so good things are:

- Passband response not as smooth as Butterworth
- Ripples in the phase shift and time delay, particularly for high values of passband ripple and high order
- Difficult to design non-standard filters without a computer.

THE PROGRAMS published in the first three parts of this series, plus the programs for obtaining non-standard resistors and capacitors from standard values (published in November '87) are available on 5.25" disk (MS-DOS) ready to run on an IBM PC or close compatible, for just $29.95, post paid. Send your orders to: AEM Software Service, PO Box 507, Wahroonga 2076 NSW.

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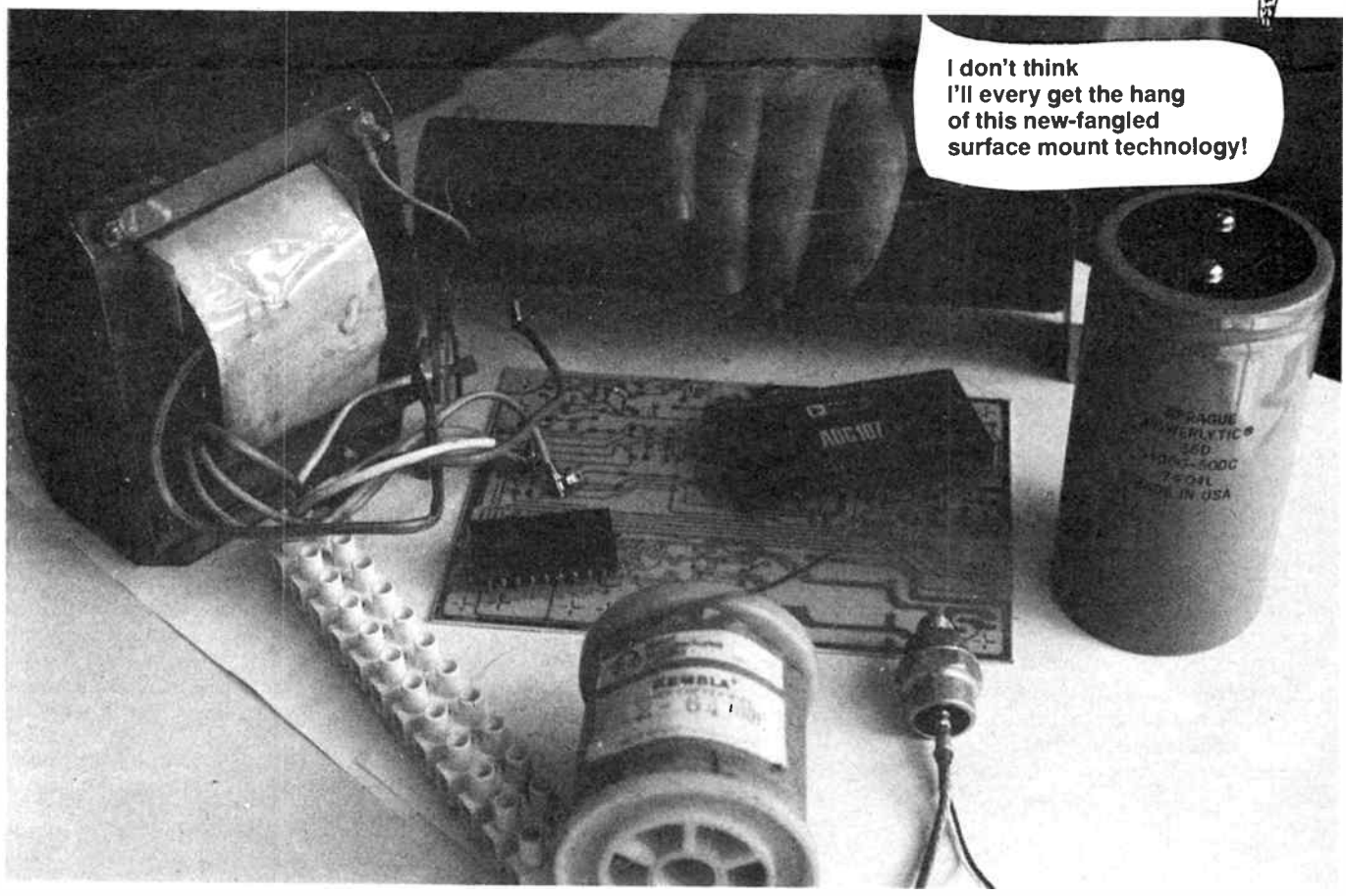
The Last Laugh



ROY grew up in a dog-loving household. Towards the end of primary school, he started to tinker with crystal sets and old radios. Then, moving on to high school, he graduated to record players and amplifiers, light organs and, around HSC, he got into microcomputers. He once built a little device that kept track of the family dog by means of a little 'transponder' tied onto the canine's collar. A box of tricks hooked up to the I/O port on his computer sent out a series of timed pulses that were repeated by the transponder. The computer measured the round-trip transmission time, computed the distance and drew a radius on a neighborhood map on the computer's monitor. Very trick.

Ever the tinkerer, he gained a deserved reputation of being able to ". . .fix anything electronic". It seemed a natural, then, that he went to work in the service department of a large, well-known electronics company and attended the local TAFE part-time doing a course in electronics.

With his very first pay packet, he bought a pair of fashionable new shoes during lunch hour. Naturally, he wore them to work. He cautioned his workmates not to scuff them, spill their coffee/tea/Coke on them, or to splash molten solder on them as they were wont to flick their irons floorwards to clear excess solder from the tip. One of his ebullient workmates, Eric, broke into a rendition of that old Elvis R&R classic, "Blue Suede Shoes". Roy was but mildly amused and underlined his caution.

He needn't have worried.

In the early hours of the next morning, the family pooch blotted its copy book by sneaking into his bedroom and, to satisfy some primeval canine urge, knawing on the toes of his new brogues. Roy was **definitely** not amused!

That day, his workmates could not contain their amusement when they spied the state of Roys new shoes. Perhaps out of loyalty to the family fido, or pique, or just plain embarrassment at the situation, Roy refused to divulge how his new shoes had befallen such a fate.

"Who's been biting on your brogues, then?", one jeered, which brought guffaws from the gallery. Encouraged, he went on with "Who put the rebate in your Reeboks, Roy?"

Scowling, Roy turned to his workbench, thrusting his feet well under, planting them firmly on the edge of the low shelf that ran beneath the row of benches. In so doing, he disturbed the corporate cat that had found a pleasant place to sleep in the cleaning cloths stored under there.

Miffed, the cat jumped out and stalked off to find more secure lodgings.

Spying the miffed moggie, Eric leaped forward and, to the tune of a well-known jazz number, broke into:

"Pardon me Roy, is that the cat that chewed your new shoes?"!

Silly Season Contest

Wow! The response to our Silly Season Contest (this page, December '87 issue), has been just fantastic!. Given an appropriate (?) challenge, we're hugely pleased at just how inventive you can be. Many of the entries are tremendously amusing and very clever, using technical facts to weave a farcical tale in answer to the questions. Great stuff!

We'll bring you some of the (publishable!) replies over the next few months, and announce the winner in March (assuming we can adequately judge it in time!).

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SPECIAL OFFER TO AEM READERS

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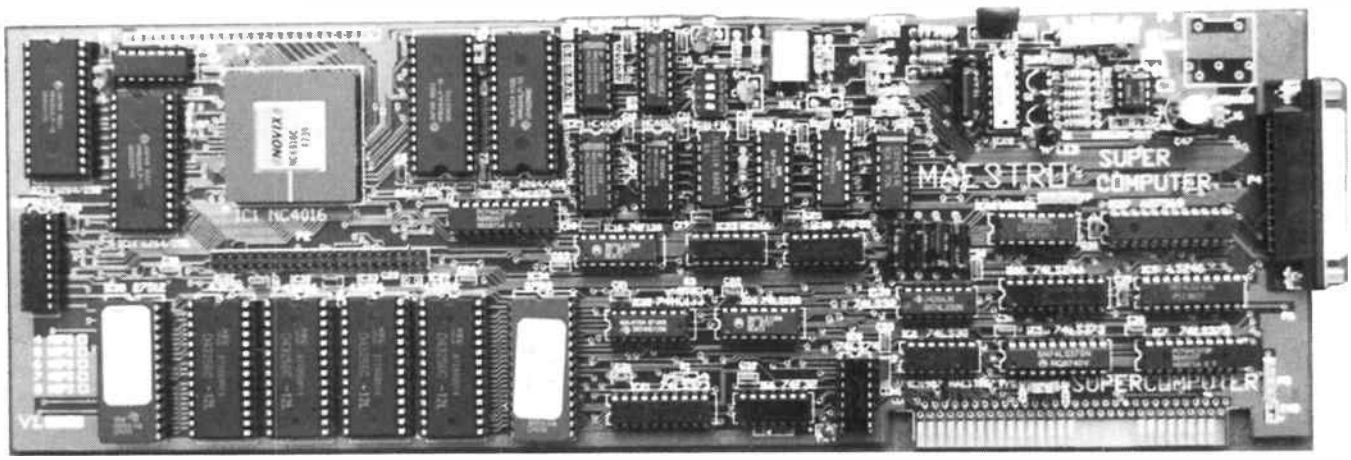

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