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RADIO & ELECTRONICS WORLD SEPTEMBER 1983

RADIO & ELECTRONICS WORLD

85p

THE COMPLETE COMMUNICATIONS MAGAZINE

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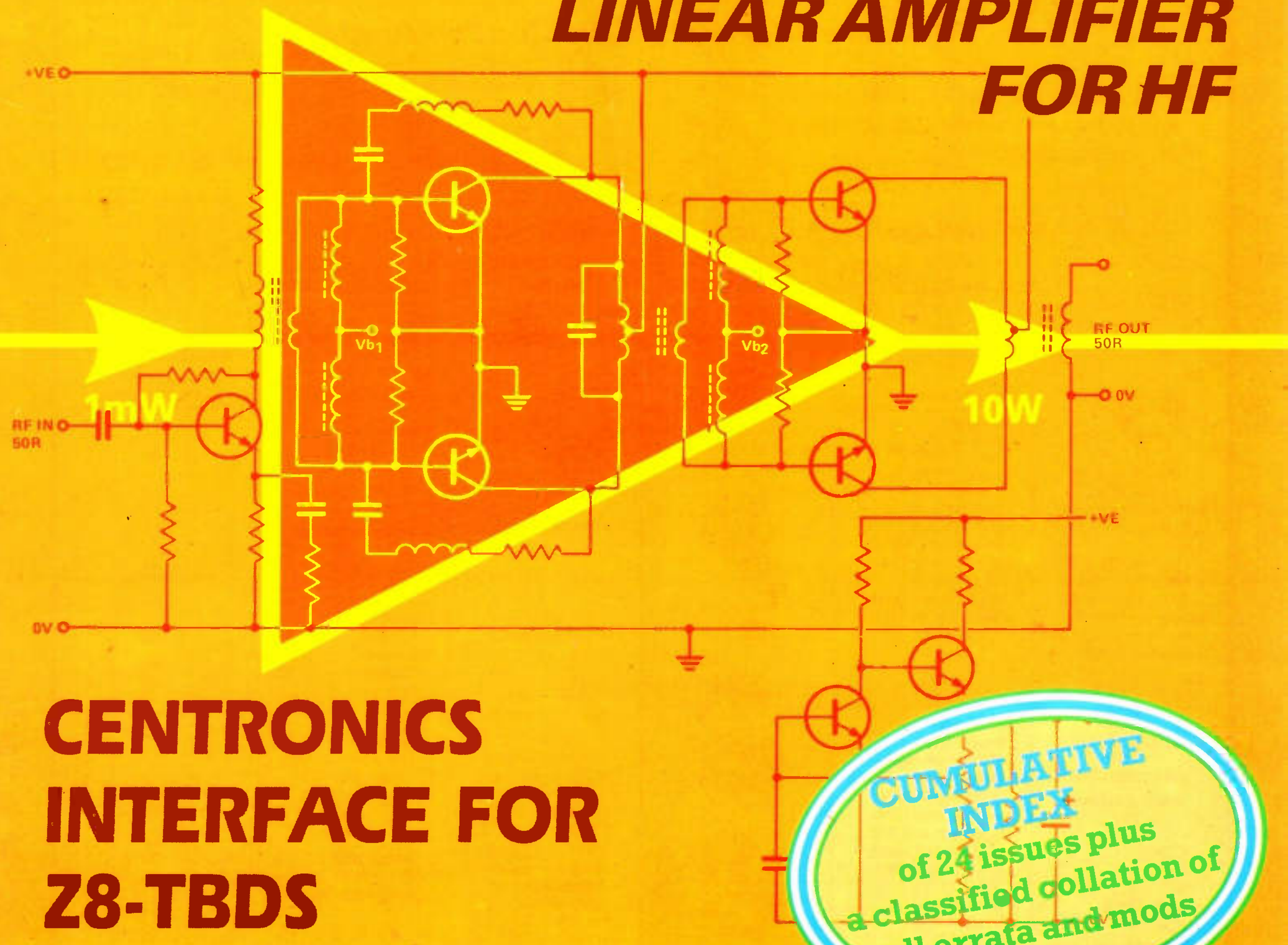

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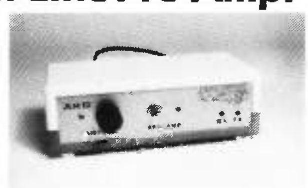

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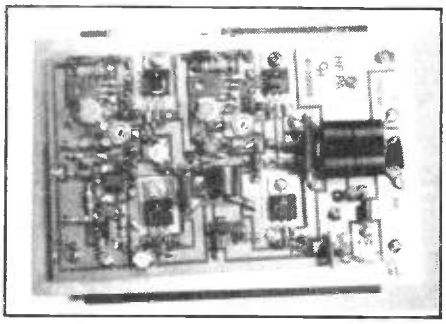
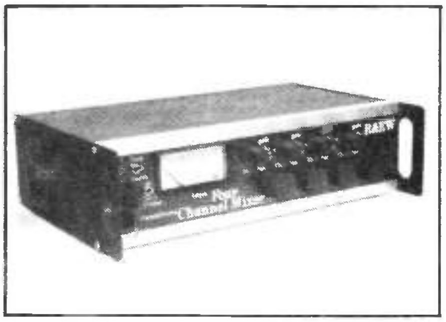
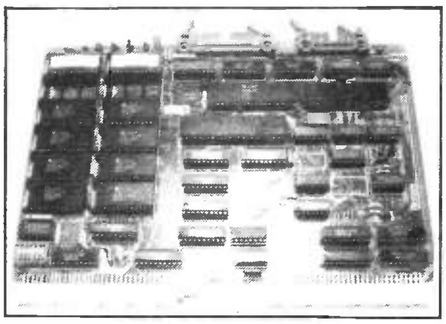
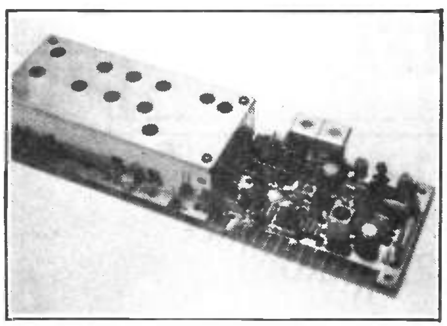
RADIO & ELECTRONICS WORLD

SEPTEMBER 1983









CONTENTS

Projects

Features

News

Complete index to volumes one and two appears on pages **45—48**.
See page **89** for details of back numbers and subscriptions
ZILOG COMPETITION — see page **56** for details

Note: Unfortunately pressure of space has forced us to omit the article on Noise Blanker Techniques featured on the cover. We shall be publishing this NEXT MONTH.

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BULLETIN BOARD

★ ★ ★ Nota Bene ★ ★ ★

This month we throught we would draw readers' attention to the results of an analysis recently published by Benn Electronics Publications. This concerned the performance in 1981/2 of the so-called 'Top 100' European Electronics Companies — that is those 'leading electronics groups' monitored in the Mackintosh European Electronics Companies File. The factors of interest in this analysis were the sales of electronic equipment within Europe, the Profit Before Tax as a percentage of these sales and the Sales per Employee, and the data were collected from the individual companies' reports published for periods ending between September 1981 and June 1982.

Overall, the picture is not good, with many companies suffering reductions in both turnover and profitability and overall sales falling by about 4% from $100.3bn in 1980/81 to $96.7bn. The major factors at work here are seen to be the low national economic growth and the general decline in industrial output that pervade the whole of Europe — as well as the strength of the US dollar against the various European currencies. However, it is instructive to look at some of the figures in more detail. It is also an opportunity to give Britain a bit of a pat on the back, for while the Germans and the French both suffered a halving of their average profitability and significant drops in sales, the British companies studied retained an average pre-tax profit margin of 6% and increased their sales from $12.3bn to $13.6bn. On the other hand, both the sole French indigenous mainframe computer manufacture, CII-Honeywell Bull, and the sole British one, ICL, both had a loss of trading over the year. Mind you, the ICL report must have reflected the serious upheavals going on in that company around 1981.

Another facet of the analysis is to compare the performance of purely European enterprises with that of Japanese-owned and American-owned companies operating in Europe. Not surprisingly, Japanese sales were up — their productivity in terms of sales/employee stands at $128400, c.f. IBM's $81900 and the average British figure of $48000 — and these figures could well be understated through the Japanese habit of not consolidating the results of foreign subsidiaries within group performance. However their average profitability was down to 7.1% from 9.3% (pre-tax).

RAE courses

Couses to prepare students for the Radio Amateurs Examination are starting up again in September all over Britain. Details of those that have been brought to our attention are as follows:

Derby/Nottingham. Classes held at Sandiacre Adult Education Centre on Tuesdays at 7.15pm starting 20th September. Enrolment is on 13th September. For details, contact H.G. Crowther at the centre.

Durham. Classes will again be held on Friday evenings starting on 23rd September. For details, contact J.F. Greenwood, G3ZJY, tel. Durham 66773.

Hendon. Enrolment for classes held at Hendon College of Further Education is on 13—14th September. For details, contact Chris Holford or A.M. McDonagh on 01-202 3811 ext. 7.

Leamington Spa. Classes held at Mid-Warwickshire College of Further Education on Thursdays (7—9pm) starting 22nd September. Enrolment 8—9th September. For details, contact the college on Leamington Spa 311711.

Loughborough. Classes held at Loughborough Technical College on Tuesday evenings starting 13th September. For details, contact the college on Loughborough 215831.

Newquay. Classes held at Tretherras School, Newquay on Mondays (7—9pm) starting 26th September. Enrolment is on 21st September or by post. For details, contact the course tutor, Bob Lawrence (G4LDA), on Wadebridge 3649.

Princes Risborough. Classes held at Adult Education Centre on Wednesdays (7.30—9.30pm) starting on 21st September. For details contact the course tutor (G3INN) or Mrs S. Wallace on Princes Risborough 4977.

International Events

This year's International Audio and Video Fair is being held once again within the Berlin Exhibition Grounds, adjacent to a local landmark — the Radio Tower ('Funkturm'), a 500 foot edifice completed in 1926. The dates are 2—11th September. The focus for this year's event is on digital technology which is seen as making major inroads into consumer electronics. As a result, visitors will see a demonstration involving OTS-2 of the use of telecommunications satellites for high quality data transmission, as well as displays on advanced fibre optic technology as evidenced by the German wideband integrated fibre optic telecommunication network which has the appealing acronym 'BIGFON'. Of course, buzz words like 3-D colour TV, dummy head stereophonics and digital recording will not be out of place either. In putting all this together, the organisers have drawn on wide range of German insitutions for advice and assistance from the broadcasting networks, ARD and ZDF, to the Technical University of Berlin and the insitutes for broadcasting technology and telecommunications, not to mention the society for Promoting Research and Exploration into space.

The largest Digital exhibition (i.e. show of Digital Equipment's products) ever to be presented in Europe (or so it is belived) will be held at the ETH Zentrum (federal College of Technology) in Zurich on 30th August—3rd September. The event is being hosted, of course, by the Digital Equipment Computer Users Society (DECUS). Highlights of the show include a 11/780 VAX cluster configured system, served by two HSC-50s controlling RA60 and RA81 disks (the whole being an implementation of the ETHERNET concept) and the MICRO/PDP-11 that runs UNIX — one of the company's most recently announced products. Other features of the event will be the wide range of applications software demonstrations — covering office automation, personal computing and engineering, in particular — that are to be staged and the symposium of over more than 150 technical sessions and workshops that is being run alongside the exhibition. (Decus UK & Ireland is on Reading 387725, if you would like further details.)

SNIPPETS

Monolithic Memories — and Motorola

These two companies have recently signed a cross licence agreement with the aim of becoming the source of the broadest range of alternately-sourced subnano-second logic devices in the market. The agreement covers Motorola's ECL logic devices — for example, its MECL 10KH circuits and its MCA600ECL, MCA1200ECL macrocell arrays — and Monolithic Memories' programmable array logic (PAL) circuits and its 74LS series of buffers and dynamic RAM drivers. They also plan to exchange technical information and mask databases.

— and Cypress Semiconductor

In this case, the arrangement is that Cypress will develop a 1.3um, high performance, nonvolatile programmable CMOS process technology using Monolithic Memories' facilities in California and, in return, the latter company has been given a non-exclusive licence to employ the technology that is developed. In fact, Cypress was formed specifically to develop, manufacture and market CMOS components. Both firms believe that small-geometry CMOS will be an important technology in the latter part of this decade.

The aim is to bring out the first products of the new process technology later this year, and to be able to market second generation devices earlier than would have been possible if Monolithic had continued its development of CMOS technology on its own.

Microdevelopment Systems

Microsystem Services (MSS) has been appointed as exclusive UK distributor for the American company of Emulogic. The latter, formed in 1980, has designed and developed a broad range of interfaces and software appropriate to the development of micro-based systems, all based on the PDP-11 as it was felt that this machine contained hardware of sufficient power and that it was both readily available and of proven reliability. MSS will now be marketing Emulogic's full range of universal microdevelopment systems, including the relatively new ECL 3211 which offers high speed in-circuit emulation and is compatible with all the common CPUs. This is, of course, in addition to its own range of circuit analysers and high/low temperature test and cycling equipment.

Resistor Link-up

The Norfolk-based firm of Mann Components, which manufactures wire-wound resistors, has teamed up with Vishay Resistor Products (UK), which fabricates precision resistors using bulk metal foil technology at its plant in Swindon. The product of this merger — Vishay-Mann — has been operating since 1st August.

READERS LETTERS

Facts and opinions; Yours and Ours

Talking RF Shop

Dear R&EW,
Firstly, I'd like to congratulate you on your magazine, and the enterprise of those whose idea it was. May you grow from strength to strength!

My next point is that a few months back you wrote an article which was in essence about how the very large Japanese corporations are very little known in England, something I heartily agree with. In that article you mentioned that tuning 'spin wheels' were available at modest cost... but you neglected to mention where they could be obtained. I would dearly love to obtain a few of these.

I've recently come to this country (South Africa) from Rhodesia, where I was lucky to have had a factory producing industrial electronic equipment. As I came here with nothing, I have been working for others until the wheels fell off the last organisation that I was with, so I've decided to try and go it alone again. My main lines are inverters, large switch-mode battery chargers and line filters, but I'm also trying to provide some gear for the other local radio hams. At the moment these comprise various power amplifiers, but I'd like to broaden this spectrum if the demand exists.

At the moment I'm developing (between the other things) a 2M set, using the Plessey synthesiser chips. It's going quite well. But a major hassle is getting the information into the synthesiser. This is one reason that I'd like to get the 'spin wheels'. I've also written a flow chart for uP control, but will have to get someone to actually write the machine language program, as I'm not sufficiently proficient (or interested in micros) to do it myself. At the moment I'm using a circuit using ordinary CMOS... it's amazing the functions one can do with 4029 dividers! But it's inelegant. The next step is to make the set also cover 6M and 70cm. I intend to try and market the sets as complete kits, in an elegant box that will look as good as the Eastern equipment. By using silicon rubber moulds one can cast very nice epoxy parts such as the front panel at not too high a cost. Whether I have judged correctly that there is a demand or not I just won't know for a while. But I want to build my own equipment anyway.

When the firm I was with went bang, I was offered a job near here with the firm that makes those now famous frequency hopping HF sets, either in that division or the uP-controlled ATU division. I visit the place fairly frequently as I've a friend there who heads the switchmode PSU division. A very interesting joint, indeed! Although I'd like to discuss aspects of RF design with the guys involved, they are rightly reluctant to talk shop to outsiders. So I wondered if you know anyone who'd be interested in corresponding on this subject? It's a rather esoteric one, I'm afraid, and there are not many people here whom one can talk to who do not think you're being some sort of industrial spy!

Thank you again for producing an interesting magazine which I enjoy very much.

Charles Frizell, ZS6BYB
Johannesburg.

The Editor replies:
It's difficult to suggest how to get involved in discussions on general RF design since most commercial organisations are likely to be suspicious. The manufacturers of the components are the best bet where you have a reasonably well defined requirement — and for general trawling for ideas, you can do worse than keep a collection of the latest handbooks and circuits of the commercial gear.

Once upon a time being a radio amateur was good enough to get engaged in all sorts of technical discussions, but that was before the ready made hambox took over. Perhaps this letter will attract one or two technically minded folk to get in touch directly.

*Don't forget that we are pleased to accept features from anywhere, and that our rates are generally reckoned to be good. Even if you don't want to divulge your more commercial activities, there is a good chance that you can document the intermediate activities for the benefit of **R&EW** readers. It's also a very good way of getting engaged in all sorts of correspondence with like-minded individuals.*

CB..CB..CB..!

Dear R&EW
In the past, you promised lots of 'add-ons' which would be available for CB rigs in general. We've had the Selcall (in which I am not interested) and the noise squelch (which is super). But where are the rest? Are they still in the pipeline or has this programme been abandoned. I am still buying the magazine waiting for these things to appear.

Another thing with regard to CB which you have already commented on is the poor quality of the IF-filters provided in rigs. An article which answered some of the following questions would be most welcome. If not I personally would like them answered.

1.) How exact does matching of impedance need to be when replacing filters with a different terminating impedance?
2.) Are the input and output matchings of equal importance?
3.) In the case of the Uniden board (and others) where the Ist IF filter is strapped across two transformers, with no other matching components, is it enough to retune the transformers or should they be replaced (or rewound) to achieve the correct matching?
4.) With regard to the 8-pole 10-695 crystal-filter, as this will not fit directly onto any board I know of, how do you recommend mounting it?
5.) What are the relative advantages of improving
   a) The first IF filter(s)?
   b) The second IF filter(s)?
   c) Both IF filters?
6.) What sort of insertion loss is acceptable when changing these filters before it is necessary to introduce some reamplification?
7.) I would be prepared to spend quite a bit of money to get the maximum improvement. Where is the point reached when no further improvement in blocking and cross modulation can be obtained by filter replacement?

As you have made comments before on the poor quality of the 1st mixers in some CB rigs, perhaps you might consider a project on the replacement of 1st and 2nd IF filters and their associated mixers etc. With comprehensive details for installation in rigs (as per noise squelch). Or are the different rigs too different for this to be practical?

Another of your early suggestions was that your design of CB rig would be modifiable to other (legal) frequencies. There certainly seems to be a demand for modifying 11 metre rigs for 10 metre QRP operation. This is nice and easy with, say, the Icom and Telecomm, but I had assumed more difficult in rigs with the 7137 PLL (or other UK dedicated chips). However, one of my local radio shops has a Rotel 240 modified to 10 metres; so, presumably any rig can be modified without too much trouble. How about a project?

Also, whatever happened to 934MHz? You did suggest a design at the time of the illfated rig design. How about digging it out?

That should about fill your magazine up for the next year.

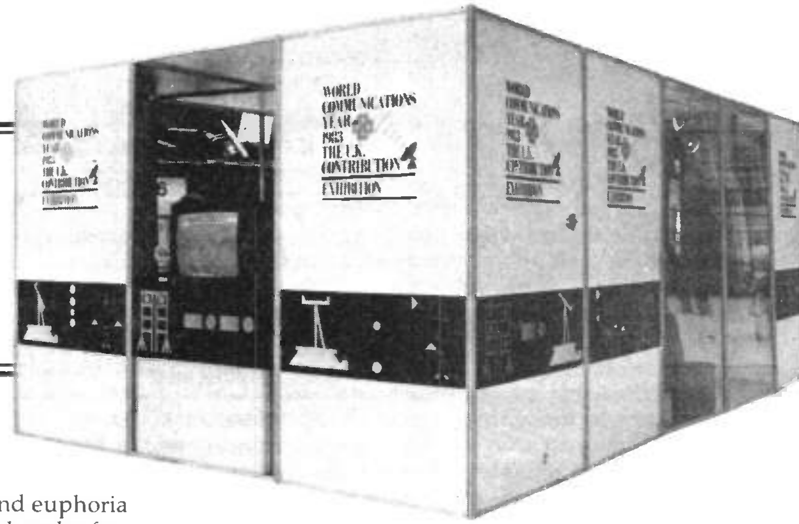
Henry Dudley
Guildford

The Editor replies:
IF filtering: here are some general points to note:
1.) The Ist IF is the most important, although for reasons of cost the 2nd IF usually contains the best shape faceter and passband.
2.) Matching the impedance of the input is generally more important than the output, although you must always endeavour to match both accurately to avoid ripple in the passband.
3.) When properly matched, insertion losses should be no more than those specified for the filter used, only 2dB or so for crystal filters, and no more for ceramic types. It's a function of 'Q' of the resonator material. The loss of a few dB at IF is really quite insignificant since the sensitivity of the set should have been fixed at the input stage, where IF gain is mainly included for limiting and raising the signal to a demodulatable level.
4.) Discerning users of 8-pole crystal filters must solve individual mounting problems, but the basic rule is to keep leads short, and to earth as directly as possible. Place a screen of PCB or tin across the base of the filter, or the full 90dB adjacent channel selectivity will be compromised by the output and input seeing each other.
5.) Matching is an individual exercise. Maybe we'll publish examples if readers send in circuit diagrams.
6.) 934MHz CB is generally beyond the scope of a DIY construction feature for CB enthusiasts. We got into enough trouble at 27MHz !

BACKGROUND NEWS

★ WORLD TELECOM YEAR
★ SUPPORT FOR INNOVATORS
★ WHATEVER HAPPENED TO CB?

It's World Communications Year



IF YOU have managed to survive the dynamism and euphoria of *Information Technology Year*, the chances are that the fact that 1983 is *World Communications Year* will not have escaped you.

WCY is a government inspired contrivance, on a global scale, to bring about public awareness in the importance of – you've guessed it –communications. Those of you who travel via Waterloo Station in London will perhaps have chanced upon the WCY display booth. In the words of the official newsletter: 'A Communications Centre will be appearing in the following places during the course of the year.....' It sounds a bit too much like Doctor Who's inimitable Tardis. If any reader has the occasion to sight the actual re-materialisation of the CC at the following locations, would they please let us know:

Gatwick Airport; 11th July to the end of September
Dover Ferry Terminal; 8th August to the end of September
Piccadilly Station, Manchester; 3-14th October
Waverley Station, Edinburgh; 3-14th October
Birmingham, New Street Station; 17-28th October
Glasgow Central Station; 17-28th October
Paddington Station, London; 31st October to 11th November

The materialisation at Paddington is somewhat cryptically qualified by the phrase *'to be confirmed'*. Perhaps there's an England/Scotland football match scheduled between the 17th and 28th of October, and the McDaleks might strike if provoked.

On show are the latest examples of telecommunications equipment from BT, so why not pop along and see how the DTI is spending your money?

Preserve us from the Communicar

Those of us who confess to being of Amateur Radio persuasion must be reasonably impervious to the mobile communications laboratories that litter the car parks of the various events that take place associated with this hobby. But even if the roving Communications Centre wasn't enough to test the mettle of hardened Communications Enthusiast, you might also be set upon by a specially communications-equipped talking Maestro. It's fitted with a direct dial Radiophone, a 27MHz and 934MHz CB – and a BBC Model B computer with a 16" Ferguson teletext TV on the back seat.

Questions radio engineers might like answered include those relating to the mutual compatibility of a colour TV set, sensitive communications equipment and a car with a veritable cornucopia of electronic frippery. Perhaps the voice synthesiser can be programmed to handle a conversation on channel 14 whilst the driver is engaged upon a game of space invaders before the dangerously blocked airways through the BBC's PSU area cause the whole thing to go up in flames.

Support for innovators

Some time ago, we reported on the various government schemes that set out to encourage people to 'do' things by offering cash incentives in the form of various grants and other assistance. The rather dry and terse documentation surrounding these efforts has subsequently been updated by a rather jolly brochure issued last April, titled 'How to Make Your Business Grow'.

Unlike the philosophy of a certain industrialist who apologetically claims to make more money by investing his organisation's cash mountain in money market transactions than through investing it in endeavours of technological and industrial daring do, HM Government would prefer to have us all believe that there is still a living to be made from enterprise, effort and hard work.

The same rules apply to the assistance schemes, namely that you will only get help if you haven't yet started the project in question, and that the said project should look like so much of a long shot, that you wouldn't have the nerve to carry it through unless the DTI stump up some of the place money anyway.

Once again the application forms and questions are all undeniably good sound business procedures and disciplines; but once again the chances are that after taking a realistic view of the *true* costs of being an innovator in British industry, you may understand rather better why a firm with over a billion pounds worth of cash floating around the money markets prefers to keep it that way.

Brave souls who want to find out more about the schemes applicable to electronics industries, write to:

Information Technology
29 Bressenden Place
London SW1E 5DT

Good luck, and do please tell us of your experiences.

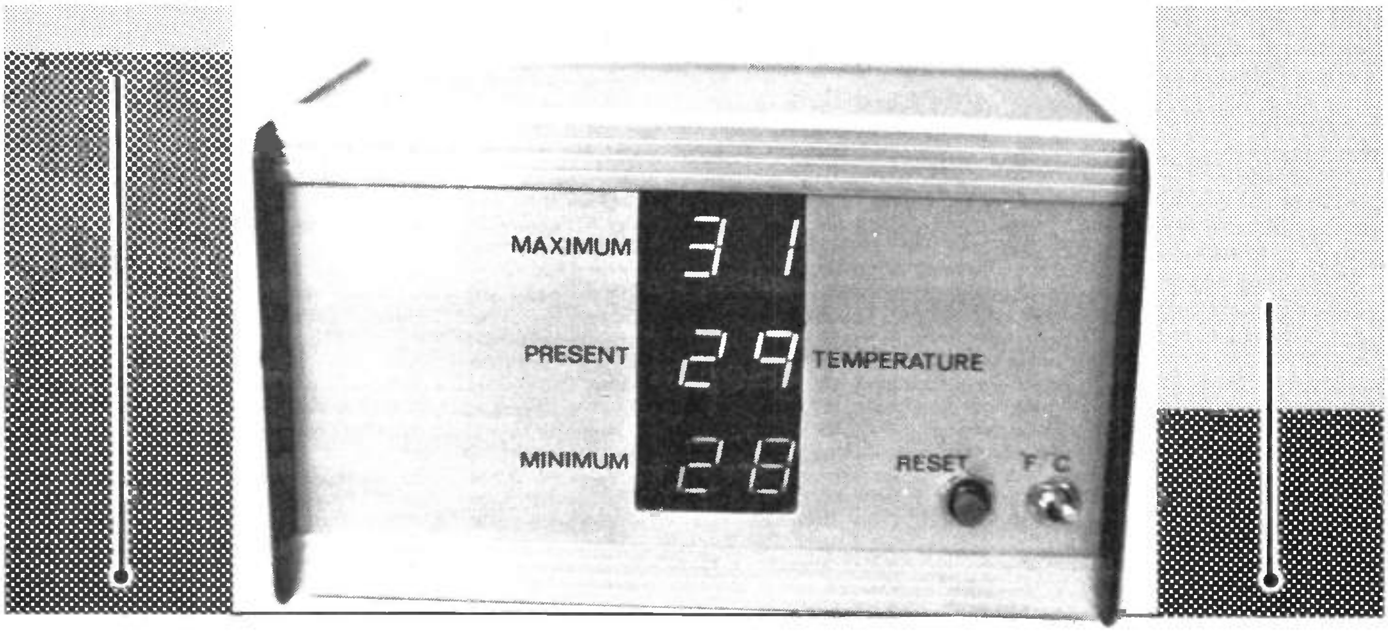
Man of technological moment, Trade Secretary The Rt.Hon Cecil Parkinson MP, in a WCY Communications Centre — considering radio telephones... not CB!

Whatever happened to CB?

Now that most of the CB magazines have disappeared from the bookstalls and the trade has largely followed suit, it is quite difficult to find out what's happening in the world of CB. Some may find this a blessed relief after the over-exposure of the subject prior to and post that fateful day when it all began.

We'd like to hear from readers if any good has managed to come from the grand catastrophe – particularly how many CB enthusiasts have carried on to become radio amateurs and devotees of the practical aspects of the 'amateur' communications technologies. The fact that CB is alive and still carrying on can be confirmed by a brief check of the airwaves – and one of the best ways of actually attracting the species into the open is to park a car with a fancy 2m 7/8th wave antenna in a public place overnight.

The surplus of equipment has provided a valuable substitute for the passing of things like the 19 sets that so many of the present generation of Radio Amateurs had to cut their teeth on, and we would welcome features on some of the more daring conversions that have been carried out on the equipment.



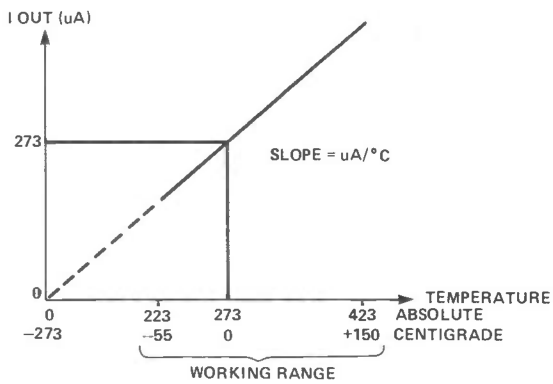
MAX/MIN THERMOMETER

A sophisticated, yet practical unit for monitoring temperature.

Design by Steve Kirby, York Electronics Centre.

Is it chilly out in the greenhouse? Don't fancy the stroll down the long cold garden path to check on the thermometer? Then build this electronic maximum and minimum thermometer. The unit has a 6 digit multicolour display which shows the probe temperature in either degrees Celsius or Fahrenheit, with a 1° accuracy over the range −10°C to +40°C (if it's hotter or colder than that in the greenhouse, the petunias have had it anyway!). The rugged probe is at the end of a two core screened cable, that can be up to several hundreds of feet long. This allows the readout box to be placed indoors to save you braving the Arctic blizzard that passes for a British spring.

The thermometer can be used for monitoring tropical fish tanks, your central heating (or deep freeze) or for simply keeping a record of the weather. It can easily be interfaced to an 8 bit computer I/O port, which along with the Windspeed and Direction Indicator (**R&EW**, August 1982), would make the basis of an automatic logging weather station.



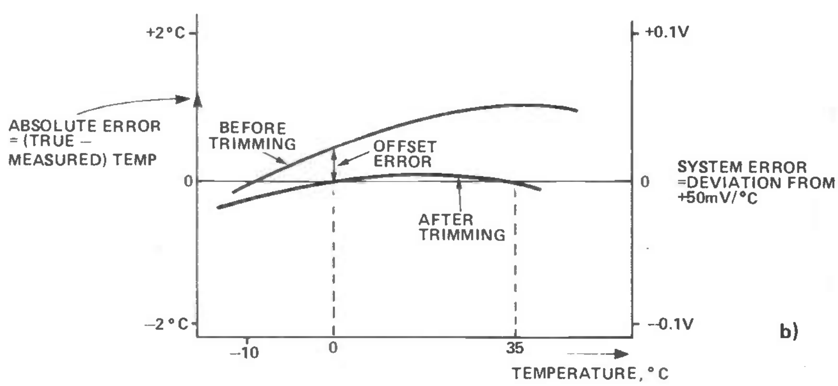


Figure 1a: Current versus temperature through IC1. Figure 1b: Adding and trimming current so that the output from IC2a is zero.

Circuit Description

IC1 is a linear, absolute temperature-to-current converter (see ***Ref. 1***) with a laser trimmed gain of 1μA/°C — at 0°C a current of 273μA flows through it (***Fig. 1a***). The IC looks like a high impedance current sink to the −5V rail, whose current changes very little as the supply voltage across it alters (0.2μA/V). The IC can is connected to the earthed cable screen to shield the sensor from stray HF signals. Any modulation of the IC's supply voltage by mains hum is strongly rejected in the output current, which means that it can be put on the end of a long cable (provided the cable resistance is low enough to give at least +4V across the device). A larger −15V negative supply rail could be used for extremely long cable runs.

The current output of IC1 is converted to a voltage by the JFET op-amp IC2a (see circuit diagram, ***Fig. 3***). The difference between an ideal straight line characteristic of +1μA/°C and that of a typical AD590 is shown in ***Fig. 3***. To minimise the zero error, an adjustable offset trimming current is added (from V_{ref} via R1 and RV1), which exactly balances IC1's current at 0°C, so the output of IC2a is zero. The gain (μA to volts) is set to a nominal 50mV/°C by R2 and RV2, trimmed so the absolute error at a known calibration temperature is zero. The remaining curvature of IC1's characteristic is fundamental to bandgap reference type temperature sensors, but there are five grades of AD590 available, with maximum non-linearity errors of between 3 and 0.3°C.

To hold the maximum and minimum extremes reached by $V_{present}$ over periods of perhaps several days, is a little beyond even the best diode peak catcher. Luckily the commonly available ZN425 counter/DAC can be configured to make a digital peak follower, which can hold counts representing the maximum and minimum temperatures indefinitely. The voltage output of IC4, the positive peak follower (MAXIMUM temperature), is buffered by differential amplifier IC2b, which also subtracts +0V5, derived from the internal reference voltage generator in IC4. The output of IC4 has a range of 0 to +2V56. $V_{present}$ and the output of IC2b, V_{max}, are compared by comparator IC3a. If the present temperature is less than the maximum as held in the counter, IC3's output is low, gating off the clock pulses coming into IC1 1a so the count in IC4 remains stable. When the present temperature exceeds the maximum, IC3's output goes high, allowing the IC4 counter to be clocked up. This continues until V_{max} once again equals $V_{present}$, that is, the positive peak has been captured. The +0V5 offset means the count in IC4 is zero at −10°C, when $V_{present}$ = −0V5; the maximum count is 250 at +40°C.

The negative trough follower, IC5, works on the same principle, but its output is subtracted from +2V by differential amp IC2c such that the count increases and V_{min} decreases. The comparator, IC3b, is connected up to allow clock pulses through only when $V_{present}$ falls below V_{min}. C6 and 9 'slug' the response of the fast comparators to ensure that overshoot due to crossing point noise pulses being counted, is eliminated. C7 and 8 filter out any noise from DAC glitches. 1°C corresponds to a change in the held count of 5, so the non-linearity of the DACs is relatively unimportant.

The counters are reset by pressing SW1, they then ramp back up and down so both hold $V_{present}$. To interface with a microcomputer, the two eight bit counter outputs can be taken from pins on the ZN425s to a rear panel socket, together with the outputs of IC3, to act as data stable strobes.

The thermal inertia of the probe construction smooths out sudden temperature changes caused by wind gust etc, and the slow speed of the clocking pulses (4Hz) ensures any noise on $V_{present}$ is ignored, so the unit will only follow true long term changes in temperature.

The voltages $V_{present}$, V_{max}, V_{min} are sequentially measured by a scanning voltmeter, whose output is latched into three sets of driver-decoders, IC13-18, and displayed on three, two-digit seven segment displays, D1-D6, and sign-indicating rectangular LEDs, D7-D9.

The DVM (***Ref.2***) has a ±1.99V FSD and the second two digits (.99) are used to display the temperature (ie, 0.01V = 1°C). The x5 reduction from 50mV/°C is done by IC2d for the °C scale. The conversion to °F = 9/5°C +32. This is performed by simply selecting a different scale reduction factor with SW2, and adding an offset in from V_{ref} via R24, RV4. The inversion of voltages by IC2d doesn't cause any problems – the minus sign on the displays are turned on when the output voltage of IC2d is positive.

The voltages are steered through to the 3 ½ digit DVM IC7, by IC6, a dual four-to-one multiplexer, each input being selected in turn by binary counter IC8. An end of conversion pulse from the DVM clocks IC8, so a new input is selected after every fourth conversion (see timing diagram, ***Fig. 2***). Two conversion periods are allowed, to give time for the outputs of the DVM to settle before two successive conversions are latched into the drivers. This ensures a stable flicker-free display. Output, O1, of IC8 is steered through to enable each pair of display driver latches in synchronism with the voltages going into the DVM. The conversion rate is about 4 times a second, giving a reading update every 4 seconds – suitable for following temperature changes.

The DVM's BCD output is multiplexed onto a common bus, taken to all the latches (the data for each digit is qualified by a digit select line). The digit select for a pair of LED's is only passed through the NAND gates when their select lines, from IC6, go high. Each conversion is latched and held in the correct display. The minus sign appears on the multiplexed BCD bus during the D1 period and is held in separate D type latches of IC12,19, also selected via AND gates by IC6. The Q output is used to drive the rectangular minus sign LEDs when the measured temperature is negative.

Current limiting resistors for the displays are in packages of eight separate resistors, lower values – used for the green display – give an equal perceived brightness. The mains power supply uses a PCB mounting transformer, with the voltage regulators mounted on a heatsink – the +5V current is around 0A7. A zinc oxide VDR across the transformer input will clamp any spikes coming down the mains cable, which might reset the counters. The unit is designed to be left running continuously so a mains switch is omitted.

Construction

The unit is best constructed using two double sided PCBs. One holds the analogue circuitry and power supply, the other, mounted vertically behind the front panel, the voltmeter, digital logic and displays. The PCBs have many through connections, most easily made with the snap-off pins, soldered in on both sides according to ***Figs. 5 and 6***:

Add the IC sockets, then the discrete components, switches, transformer and connectors (note the 'hooks' on K5-7 go over the edge of the PCB and K3-4 are soldered in facing backwards). The resistor networks can be soldered in directly. Finally, solder the few interconnecting wires necessary. The cathodes of the three rectangular diodes are soldered on both top and bottom of the PCB (their legs may need gently bending to line up wth the seven segment displays). Test all the sockets for correct power supplies before inserting the ICs.

The analogue PCB mounts onto the base

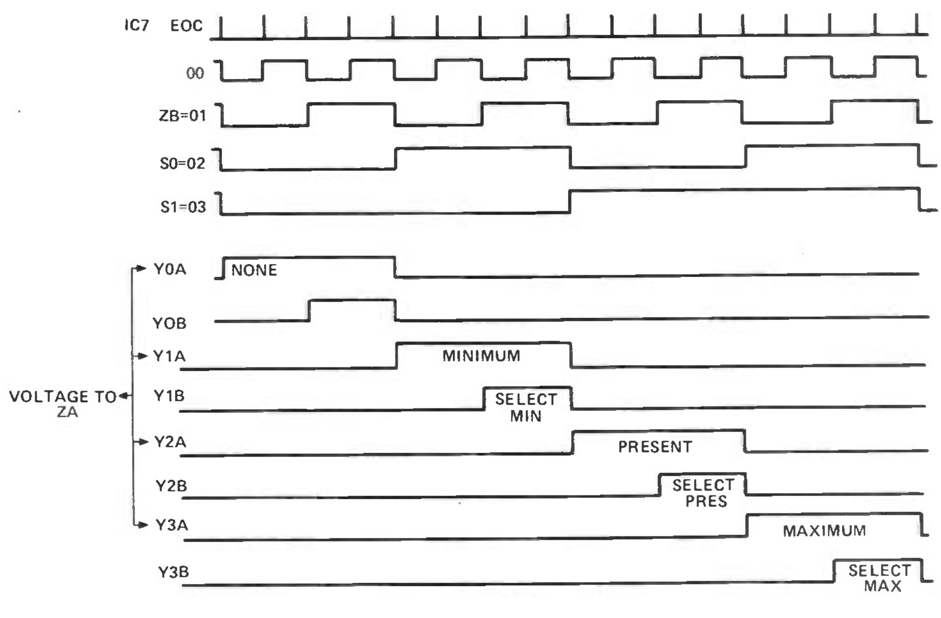


Figure 2: Timing diagram for IC1/8

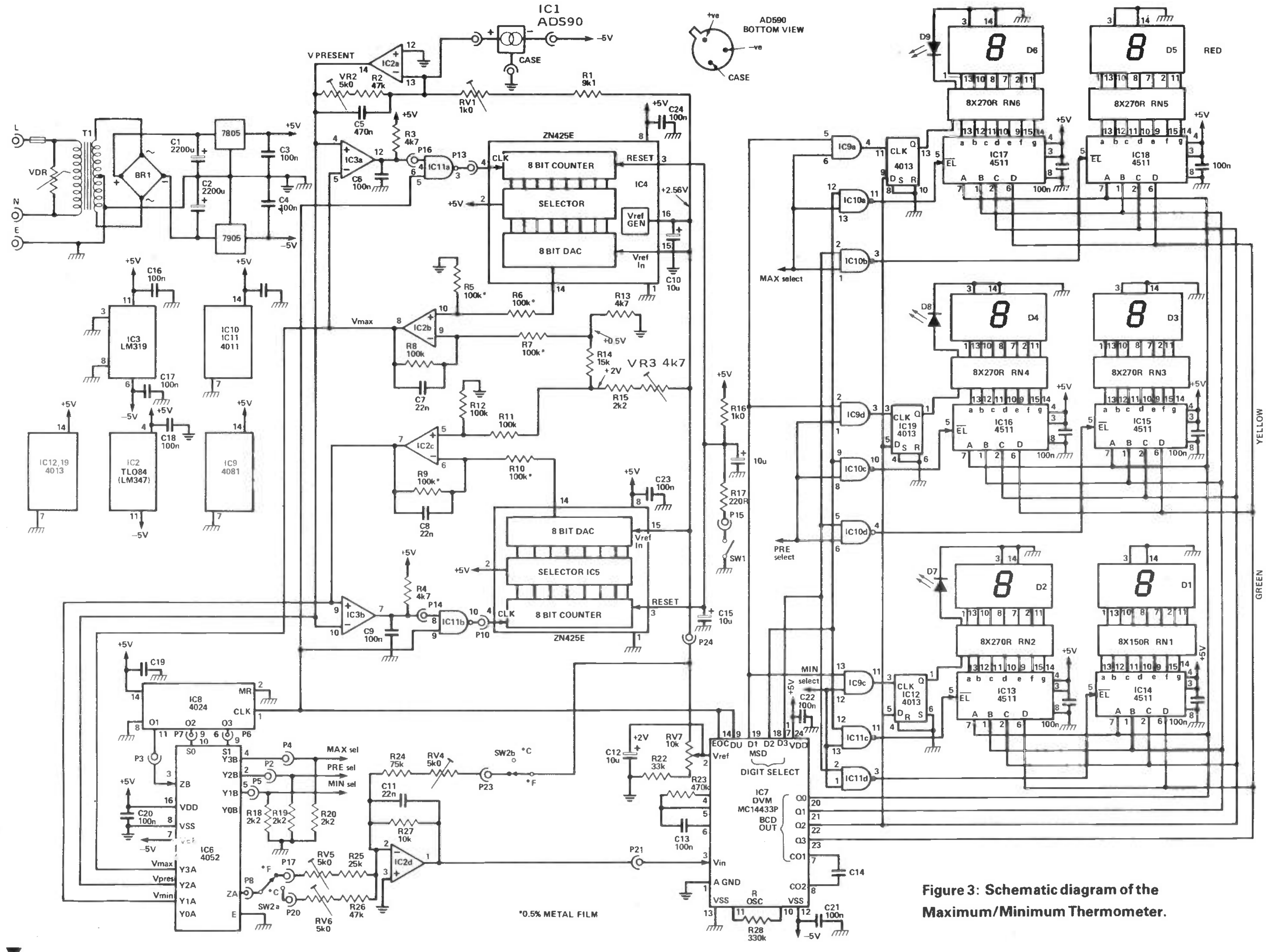


Figure 3: Schematic diagram of the Maximum/Minimum Thermometer.

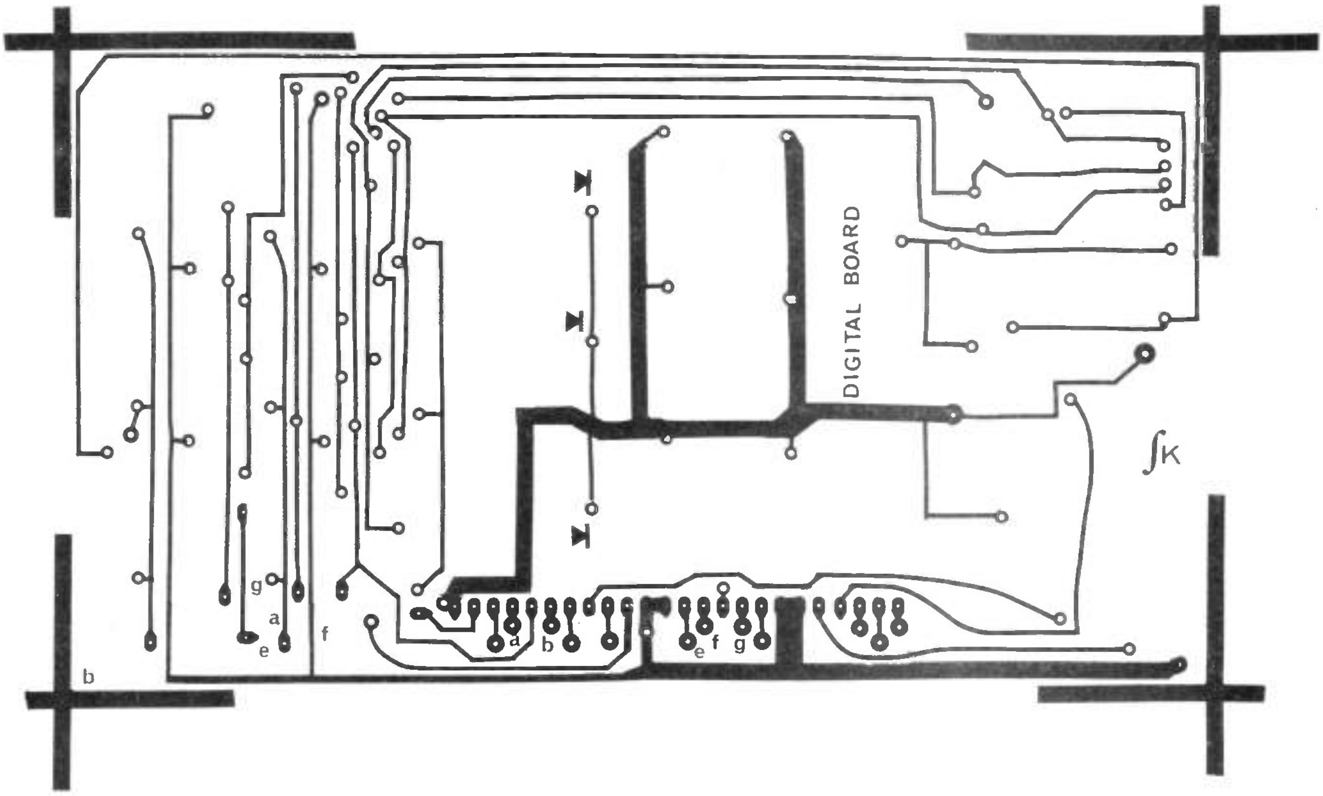


Figure 4a: Digital board foil pattern (front).

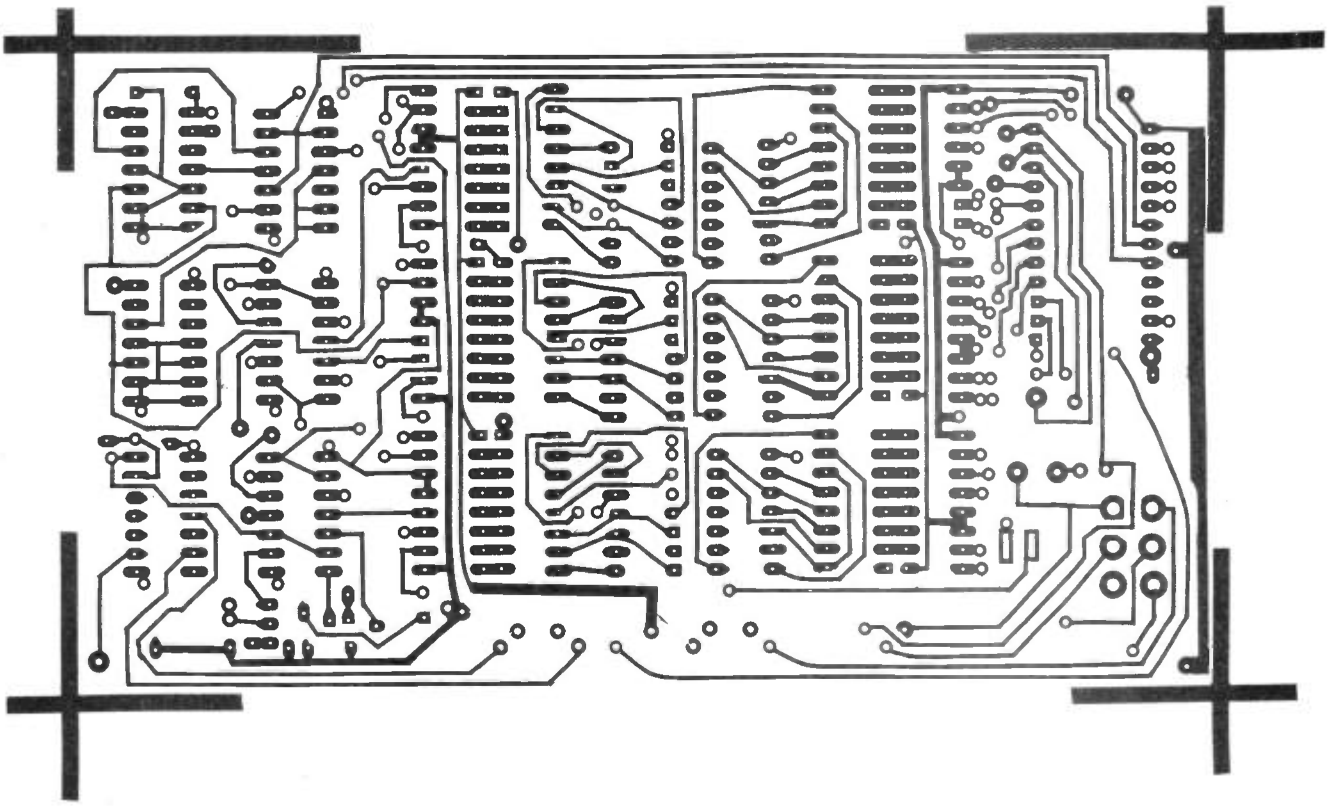


Figure 4b: Digital board foil pattern (back).

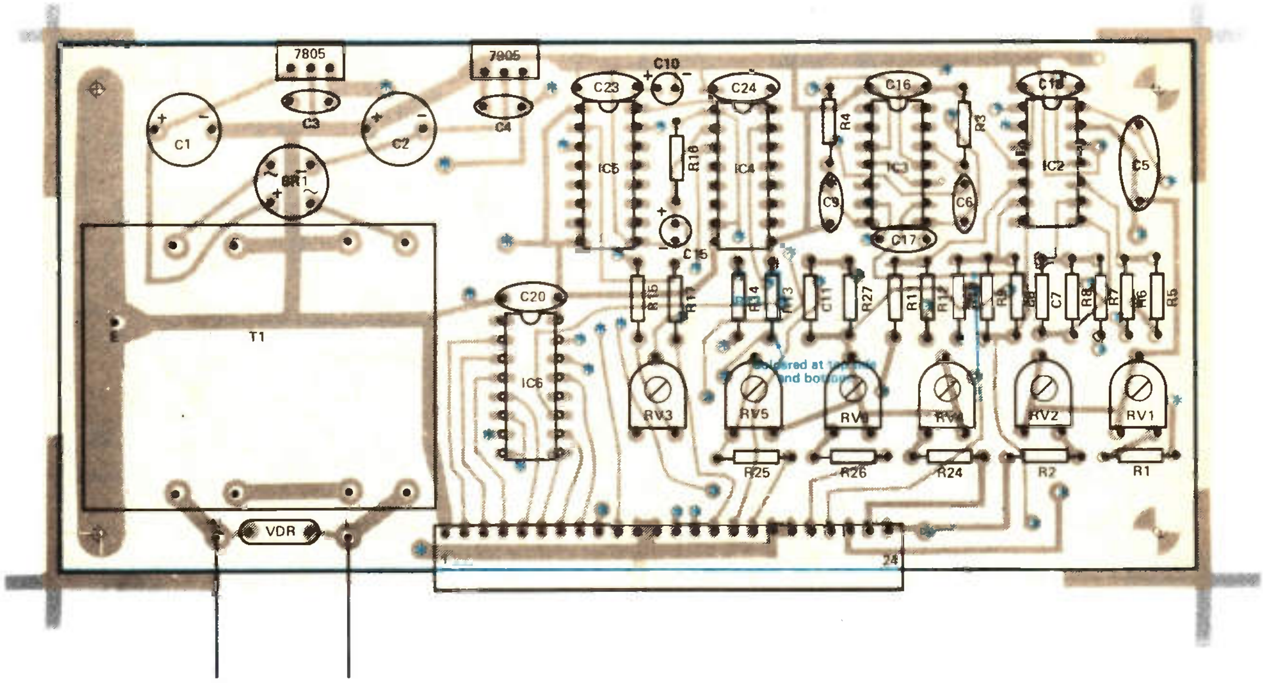
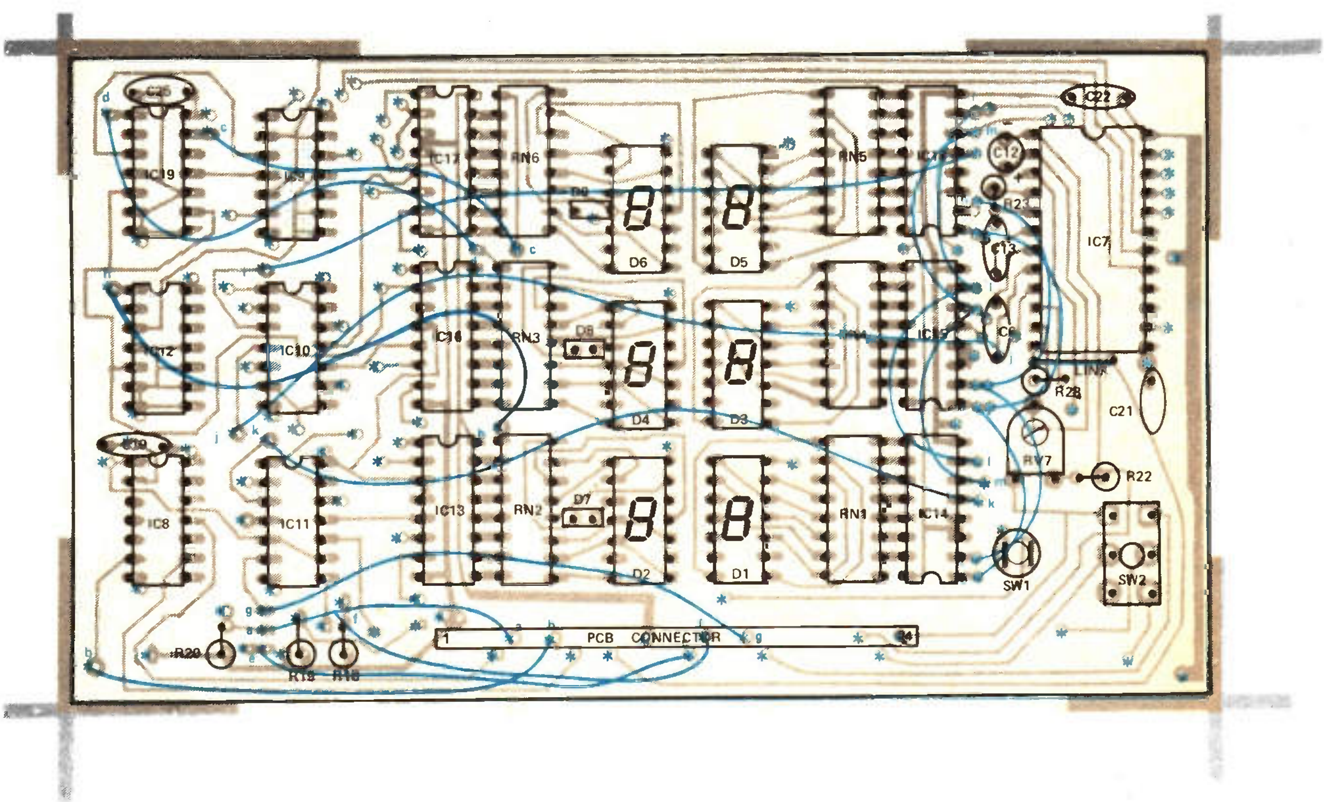


Figure 5: Component placing on the analogue board (above) and the digital board (below). Note that through-board links are shown in blue



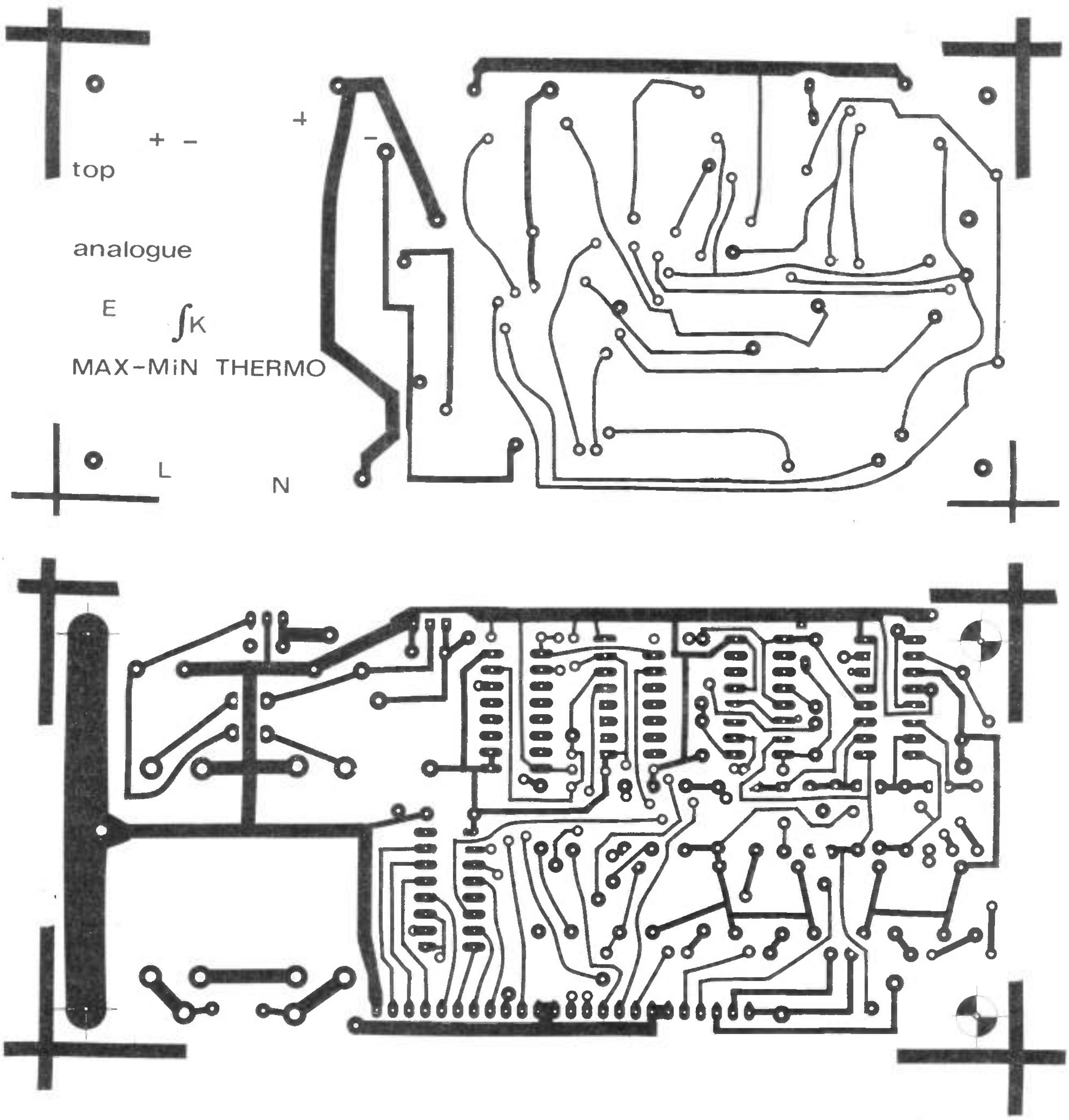
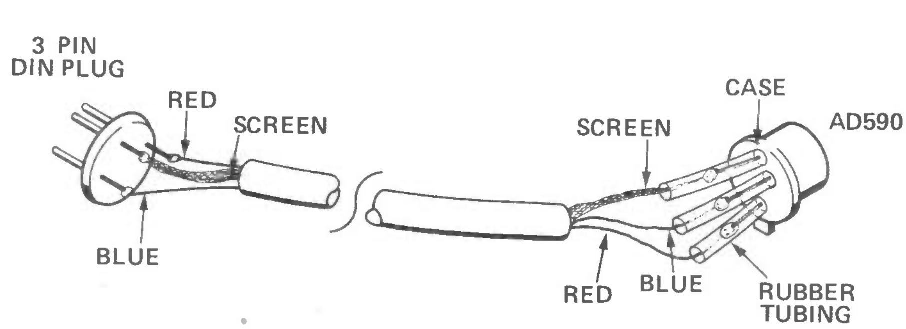


Figure 6: Analogue board foil patterns. Above, front; below, back.

panel with four 3mm countersunk bolts, using two nuts as spacers between board and steel panel. The heatsink is a simple strip of 16 gauge aluminium, held by two L-shaped brackets at the ends, fixed on top of the PCB by the rear mounting nuts and bolts. Mount the regulators using mica washers and insulating bushes.

The Probe

The recommended probe cable is a twin oval screened type. The readout end has a three pin din plug connector, wired up as in ***Fig. 7***. The AD590 sensor is soldered on with 1.5cm of rubber tubing covering the joints.



Now for the difficult bit. Take 6cm of 6.4mm diameter heatshrink tubing and mix up a small amount of fast curing epoxy

Figure 7: **Wiring up the sensing probe.**

adhesive. Liberally coat the sensor and screened cable end, making sure the glue fills all the spaces in and around the joint. Slip the heatshrink tubing over the whole sticky mess until the sensor is about 1.5cm from the open end. Apply more epoxy down the ends; it helps to warm everything slightly wth a hair dryer so the epoxy runs freely. When full, take a few minutes break to clean yourself off and let the epoxy partially set. Use the hair dryer at its hottest setting to shrink the tubing down (not too tight) over the sensor and joint – the excess epoxy will ooze out. The safest course now is to leave everything to dry for an hour. Then using a sharp knife trim off the excess tubing and epoxy to make a neat and water-proof sensing probe.

PARTS LIST

Resistors

R1	9k1
R2,26	47k
R3,4,13	4k7
R5-12	100k (0.5%)
R14	15k
R15,18,19,20	2k2
R16	1k
R17	220R
R22	33k
R23	470k
R24	75k
R25	25k(100k para 33k)
R27	10k
R28	330k
N1,2	150Rx8 network
RN3-6	270Rx8 network
VDR1	275V RMS, 8.5J

Presets

RV1	1k
RV2-6	4k7
RV7	10k

Capacitors

C1,2	2200u 16V min radial
C3,4,6,9,16-25	100n ceramic
C5	470n mylar
C7,8,11	22n polyester
C10,12,15	10u 16V ultramin elect
C13,14	100n mylar

Semiconductors

IC1	AD590KH
IC2	TL084
IC3	LM319
IC4,5	ZN425E
IC6	MC4052
IC7	MC14433P
IC8	4024
IC9	4081
IC10,11	4011
IC12,19	4013
IC13-18	4511
IC20	7805
IC21	7905
BR1	1A 50V bridge rectifier
DISP1,2	GL8R04 red
DISP3,4	GL8R04 yellow
DISP5,6	GL8R04 green
LED1	CQX10 red LED
LED2	CQX12 yellow LED
LED3	CQX11 green LED

Miscellaneous

T1 6-0-6 volt 1A transformer.
SW1 push-to-make switch.
SW2 DPCO min toggle.
Case (Ambit 21-06011), 5 pin DIN socket, 3 pin DIN plug, 12-way MOLEX plug (2 off), 10-way MOLEX socket (2 off), 6-way MOLEX socket, 105 x 35mm filter (Farnell), fuseholder, fuse, 14-pin socket (8 off), 16 pin socket (7 off), 24 pin socket, wire, solder, PCBs etc.

Calibration

Despite the number of pots, calibration of the unit is relatively straightforward. You'll need a voltmeter, preferably digital, another thermometer, two bowls, some warm water and some ice cubes. The carbon film resistors used in the unit have a small but appreciable temperature coefficient, so it is as well to let the unit warm up to it's working temperature for half an hour before attempting calibration. Leave the top and front panels of the case out to adjust the trim pots.

First adjust RV7 on the digital board to give +2V on pin 2 of IC7, relative to the analogue ground, pin 1. Next, make a slurry of approximately equal volumes of crushed ice cubes and cold water in a bowl, leave it in a fridge for five minutes to allow the water to cool down to freezing point. Put the probe in the middle of the bowl and leave it to settle down to the water temperature, this can take several minutes. Adjust RV1 until the voltage at pin 14 of IC2 is 0V, having previously set RV2 to mid scale.

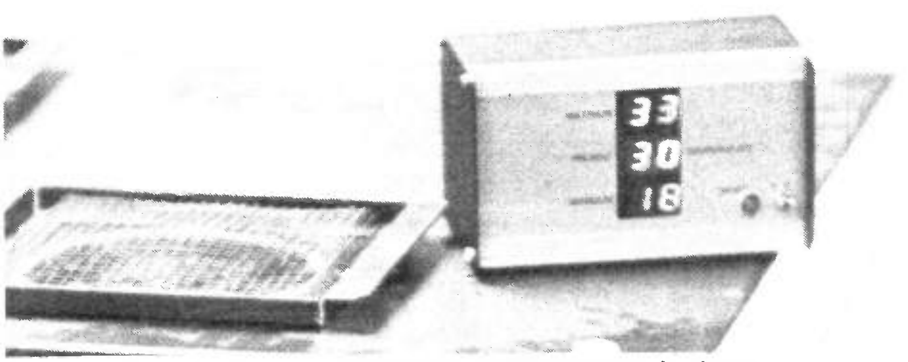
Adjust RV3 until the voltage at the junction of R13 and 14 is nearly +0V5, and that at R15,14 +2V. Some compromise in the exact setting is necessary and will not affect the accuracy of the temperature readings. Press the reset button and you should see the maximum and minimum voltages on pins 8 and 7 of IC2 ramp respectively up and down to settle at 0V. Mix warm and cold water in the bowl until your reference thermometer reads approximately +35°C. Put the probe in and leave it to warm up for a few minutes. Now adjust RV2 until the voltage at pin 14 of IC2 reads (50mV x thermometer temperature in °C). Check the 0V reading back in the freezing water.

Next, with SW2 up (°C setting), and the probe and thermometer in the warm water, adjust RV6 until the 'PRESENT' (middle) LED display reads the same as your reference thermometer. Turn SW2 down (°F setting), put the probe and reference in the freezing water and adjust RV4 for a '32' PRESENT reading. Lastly, with the probe and thermometer back in the warm water, adjust RV5 so the PRESENT display reads the same as the thermometer in °F.

If you put the probe in the fridge freezer compartment, the minus sign (LED D8) should come on to denote a negative reading, as should that of the MINIMUM display which will follow and hold the lowest probe temperature. Below −10°C, the count in the MINIMUM sample and hold DAC IC5 reaches full scale and overflows 255 back to zero. The MINIMUM display will read incorrectly. Similarly, at temperatures above +40°C, the MAXIMUM display will cease tracking. The PRESENT display, however will work from +75°C. Here the output of IC2 saturates down to −55°C, the lower working limit of the AD590 (for °F the range is +99 to −67°F). There will be some loss of accuracy at the lower extreme because of the curvature in the AD590's characteristic.

Press RESET to re-initialise the max and min displays (no more fiddling with little magnets!), which will ramp up and down from the negative and positive extremes. Don't worry if a display right hand digit flickers, it means the temperature is nearly half way between one degree and the next, a switch to °F, which has nearly twice the scale length of °C, can cure this. Now everything is ready for proper operation.

■ R&EW



One application for the thermometer is near to sensitive computer hardware.

References

1. Analog Devices Data Acquisition Integrated Circuits Databook, Vol 1, 1982, pp9-3 to 9-12.
2. Motorola European CMOS Selection Databook, 1979, pp9-272 to 9-283.

A Four-Channel Audio Mixer

Here are the details we promised last month of the Multi-Option Professional Mixer from our audio designer, David Strange. Development by Adrian Barnes.

This stereo mixer has been designed for making quality recordings both on the move and in fixed locations. The basic features are shown in the block diagram (*Figs 1 and 2*). The input sensitivity can be continuously varied on each channel making it possible to use both microphone and line input levels. All four inputs, which are balanced, may be panned across the 'stereo stage'.

Other features of the mixer include rechargeable batteries with a mains charge/operation option, stereo limiters, peak reading meter, balanced and unbalanced outputs at +80dBm, line-up oscillator, and stereo headphone monitoring.

In the following description, all circuit components are referred to by the references used in the circuit diagrams shown in *Figs 3—11*.

Mechanical Design

Beyond straightforward drilling and filing of the panels, the mechanical construction should be quite easy as it consists mainly of slotting things together.

All inputs and outputs have been placed either on the side panels or front panel to give the mixer the added versatility of being able to be used slung over the shoulder or face up on a table. The input and output sockets that matter, i.e. signal path sockets, are all XLR types because these are far more rugged than the cheaper and somewhat less reliable jack or phono sockets. Cheaper alternatives can be substituted but it should be noted that the panel drilling data to be published next month are for XLRs.

The case chosen for the mixer is all metal (for screening purposes) and it has handles through which a carrying strap can be passed, if required. The handles, which are extensions of the side cheeks, also afford protection to the front panel with its controls.

Signal Paths (*Fig. 2*)

The input amplifiers have a balanced input and can accept inputs from −80dBm (80uV) to −34dBm (15mV) as a continuous variable. For line inputs greater than 15mV we recommend the inclusion of a balanced switched input attenuator close to the input sockets.

Following the input amplifier, the signal is low pass filtered and then applied to the channel fader through the panning potentiometers. The signal level at this stage is −30dBm (24mV). With the panning potentiometers in their central position, the signal is applied equally to both left and right mixing amplifiers which have a gain of 12dB; so the signal is lifted to −18dBm (97mV).

The output of the mixer amplifiers is taken via a switch to the main faders so that an oscillator can be introduced when line-up is required. The oscillator is set to run at 1kHz and its output can be continosly varied in level by use of the main faders. When the oscillator is de-selected from the output, its power supply is also cut to prevent break-through onto recordings.

The main faders are followed by the meter drive amplifier and limiters. Metering is put in at this stage because this is the last point in the mixer where the signal can be increased linearly until all the power supply headroom is used. A meter placed after the limiter, by definition, will not be able to indicate that the mixer is being over-driven.

The limiters, which have a gain of 20dB, may be switched into a linear mode if limiting is to be removed. At the outputs of the limiters the signal is at +4dBm (1.2V) and it is next applied to the output amplifiers and via a volume control to the headphone amplifiers. The output amplifiers each have two outputs, one

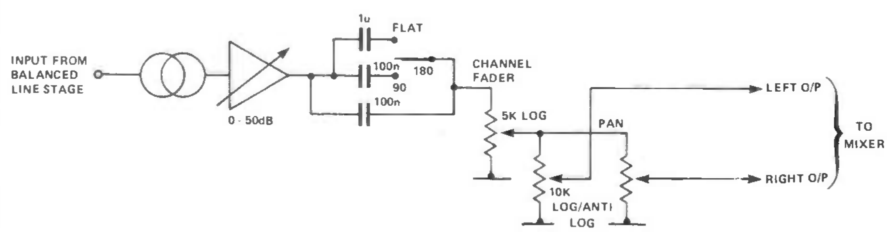


Figure 1: One of the four input amplifier stages.

unbalanced at +4dBm and one balanced at +8dBm. The headphone amplifiers, which are capable of driving low impedance phones, have a gain of 4dB.

Audio Circuits

Input Amplifiers (*Fig.3*)

The amplifiers are capable of giving a gain of up to 50dB, this being varied by RV1 which is a preset accessible through the front panel of the mixer. Transistors Q1 and Q2 are operated open loop at the input stage to give a fully floating differential input. The current sources, Q3 and Q4, set the operating current of the input pair. The bases of the current pair are set to 1V2 by D2 and D3. In operation, Q1 and Q2 convert the differential input voltage at their bases into a differential output current at their collectors. This voltage is fed to the LF351 which is set in differential mode to obtain an unbalanced or single ended output. Gain is set by the ratio of R9 plus RV1 and the r_e of Q1 and Q2 to the sum of R10 and R11.

A filter made up of L1, L2, C10, C11, C12 and C13 is placed close to the input socket of each amplifier to prevent radio frequency interference. The common mode rejection ratio of the amplifiers is in the order of 60dB over the audio frequency spectrum.

At the output of the LF351 there are three capacitors and, with SW1 in its centre position, only C5 is in the signal path to RV2. The low frequency roll-off in this position starts at about 180Hz. When C4 is switched in parallel with C5 the roll-off is pushed back to 90Hz, and when C3 is in circuit the roll-off is removed.

Following the channel fader, RV3a and RV3b – a log/antilog pair – provide left and right panning.

Although the input amplifiers are balanced, unbalanced sources are acceptable simply by grounding the unused input leg to 0V. Each input

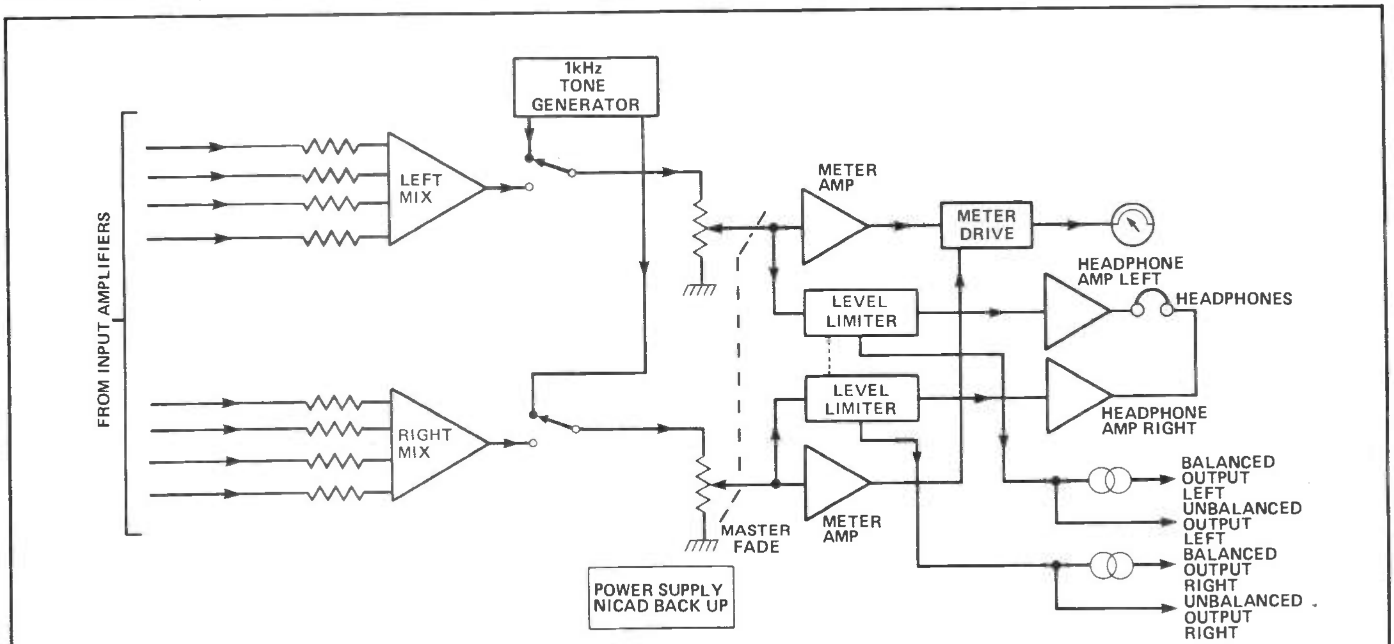


Figure 2: Block diagram of the four-channel mixer.

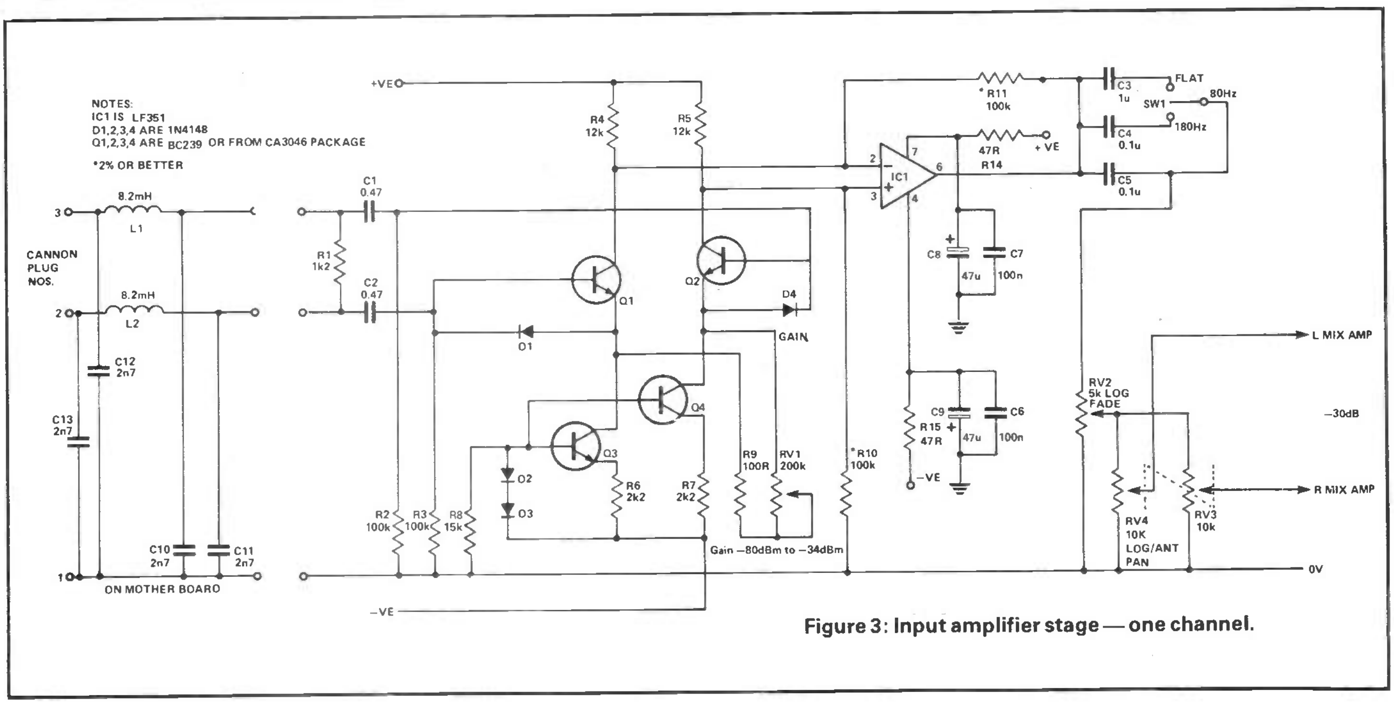


Figure 3: Input amplifier stage — one channel.

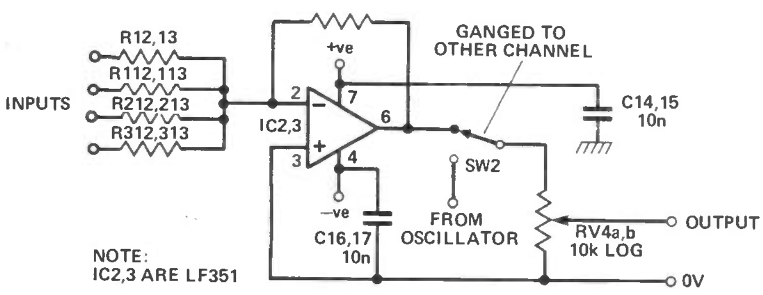


Figure 4: Mixing amplifier.

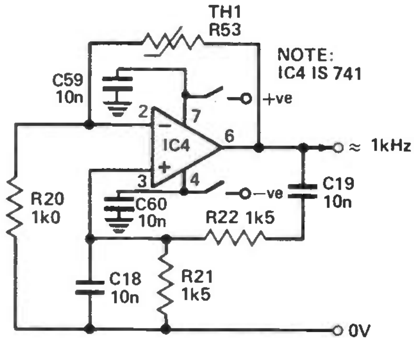


Figure 5: 1kHz tone generator.

amplifier stage is selfcontained on an individual PCB; everything else included in the mixer design is mounted on the main mother board.

Mixing Amplifiers (*Fig.4*)

There are two mixing amplifiers and these are quite simple in design each consisting of a LF351 (acting as IC2, IC3) in a summing amplifier configuration so that there is no interaction between faders. Each amplifier has a gain of 12dB. When SW2 is operated the outputs of the mixing amplifiers is removed from the channel faders RV4a,b to be replaced instead by the 1kHz line-up oscillator.

Oscillator (*Fig.5*)

The 1kHz oscillator consists of IC4 with frequency selective positive feedback configured from C18, C19, R21 and R22. IC4 gain is adjusted by negative feedback through thermistor TH1 to maintain oscillation. The supply is removed from IC4 when SW2 selects output from the mixer amplifiers.

Limiters (*Fig.8*)

The limiters follow the main faders and have no reference to 0V: instead they use a single rail supply referring the the negative rail as their 0V and positive as their HT+. The circuit is based on the dual channel NE570 chip (IC7a and b).

The signals are taken to the inverting inputs of the NE570 (pins 5 and 12). Before a level is reached when limiting takes place, the NE570 behaves as a normal linear operational amplifier. However, connected internally between pins 5 and 3 and pins 12 and 14 is the equivalent of voltage controlled resistors. The resistors are referred to as delta gain cells, and control voltage to the cells is applied through pins 1 and 16. The delta gain cells are connected in parallel with R41 and R42 respectively – via C32 and C33 to avoid any DC offset problems.

IC8 is configured into two window comparators each comparing its respective limiter output with DC fixed potentials derived from R47 and R43 and from R46, R48 and R44. When the peak value of the signal exceeds the fixed potentials, Q7 is turned on by the comparator and C34 is charged via R49. The voltage on C34 is fed back to the control voltage ports (pins 1 and 16) of the delta gain cells and the gain of IC7a and b is reduced proportionally.

In order to make the use of the limiter optional, SW3 has been inserted into the voltage feedback path so that a fixed voltage instead of control voltage can be applied to the delta gain cells. The fixed voltage is derived from RV7 and the line-up of this control will be dealt with next month.

Meter Amplifiers and Drive Circuit (*Figs.6,7*)

The meter amplifiers are connected to the input of the limiters (for the reasons explained above). Although the left and right channels share a single meter movement, the signal on each channel is processed separately.

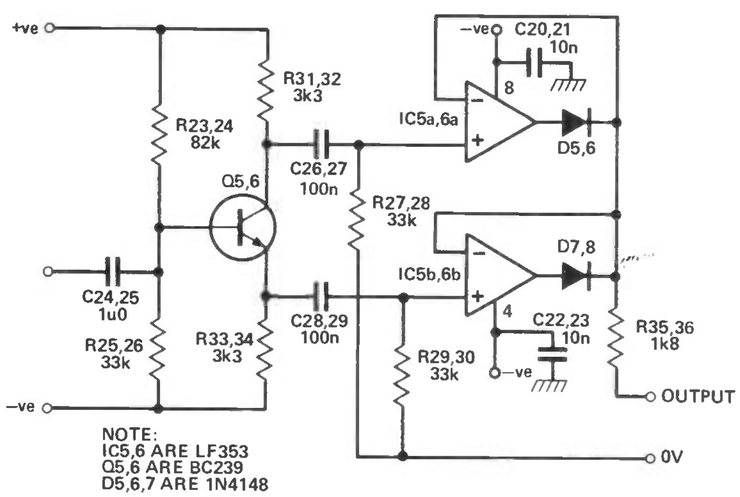


Figure 6: Meter amplifier.

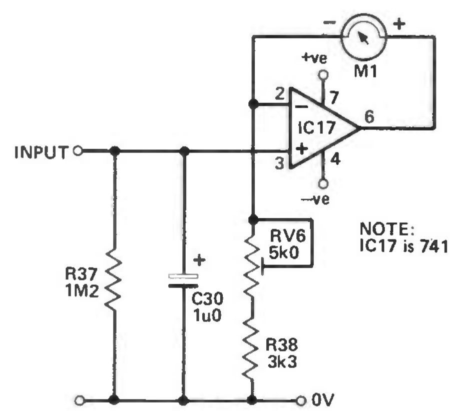


Figure 7: Meter drive circuit.

Each signal is fed to transistor Q5 or Q6 and use is made of the collector signal being 180° out of phase with the emitter signal to obtain phase inversion. IC5 or IC6 are used as dual positive peak detectors, but in conjunction with Q5 and Q6 they constitute a full wave 'perfect diode' rectifier because of the phase inversion. The rectified signal is used to charge C30 via R35 or R36, and R37 provides a discharge time constant.

The voltage on C30 is applied to the non-inverting input (high resistance input) of IC17, the meter drive amplifier. The meter is placed in the feedback path of IC17 to obtain a tighter ballistic response. The sensitivity of the meter is set by RV6. The actual movement chosen as an indicator is reasonably priced, low specification VU meter with its rectifier diodes removed, but any quality meter with good ballistics would suffice. We shall look at the modification of the meter movement next month.

Headphone Amplifiers (*Fig.9*)

The input to the headphone amplifiers is taken via a dual volume control RV8a, b from the output of the limiters. In order to provide amplifiers with good drive characteristics, transistors Q8 and Q10/Q9 and Q11 are used and heavy feedback is applied round IC9/IC10, respectively. The outputs are taken to a stereo 1/4 jack socket on the front panel.

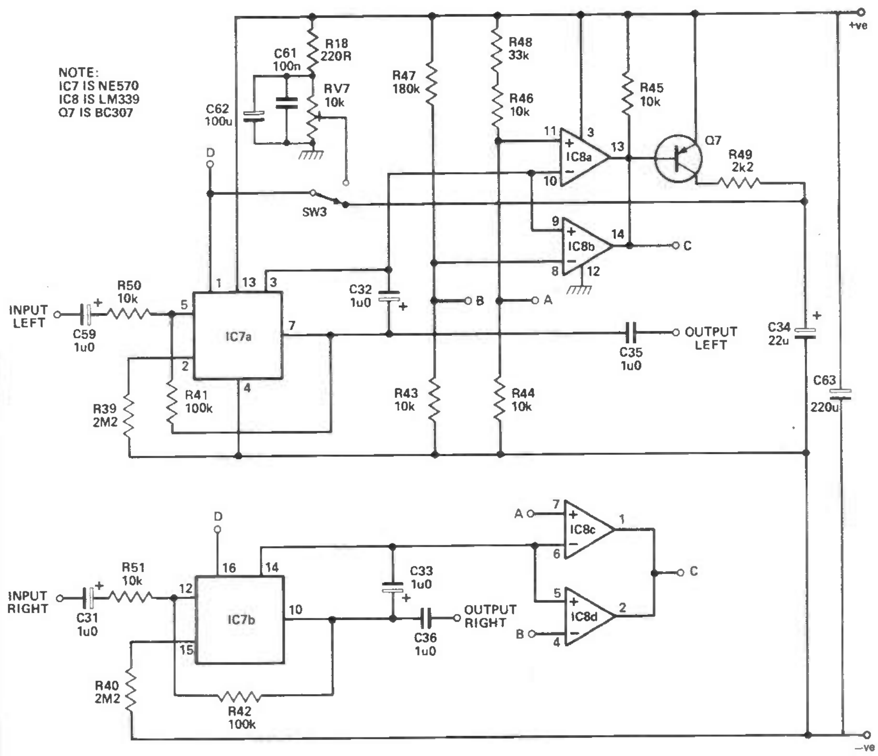


Figure 8: Level limiter.

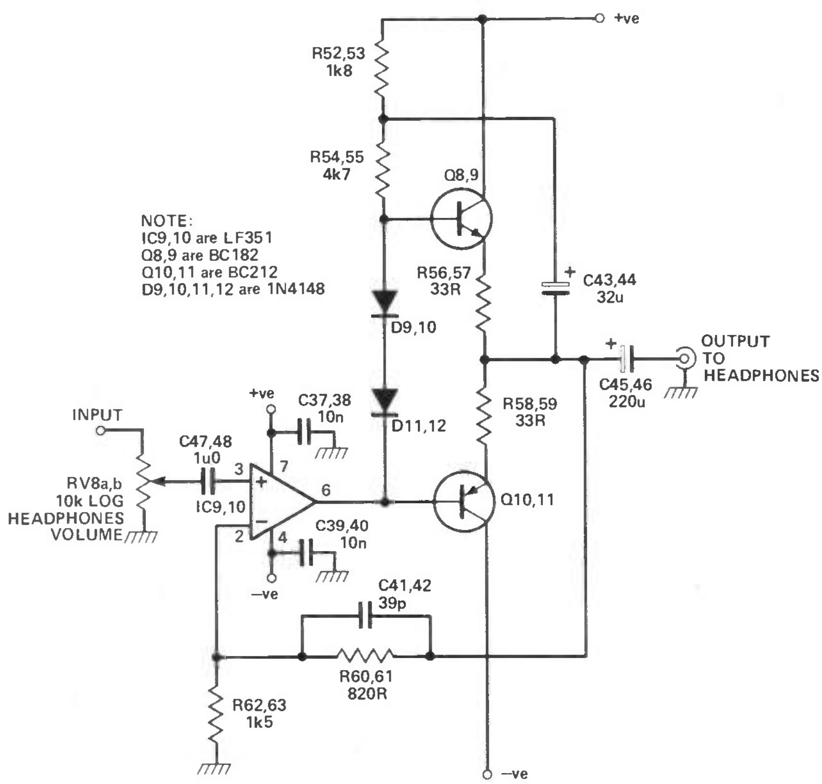


Figure 9: Headphone amplifier.

Output Amplifiers (*Fig.10*)

There is a choice of either a balanced or unbalanced ouput from the output amplifiers. IC11 and IC12 are basically unity gain inverting buffers and their outputs are protected by R84 and R85. The balanced section of the output amplifiers have, in addition to their nomal negative feedback, positive feedback but inverted from the opposite output leg so that the signal output level is held if one leg is grounded. This way they behave like transformers.

Power Supply Mains and Battery Charger (*Fig.11*)

There are no stringent requirements other than very low ripple from the power supply. Because the supply is symmetrical we shall only consider one half – the positive side. After rectification the DC is smoothed by C55 and then applied to the collector of Q14. Q14 is turned on by the potential divider made up of R96 and R94 but any AC is taken to 0V by C57. The overall effect of this is to obtain extra smoothing at Q14 emitter.

The roughly smoothed DC is also applied from C55 to the emitter of Q12 via R92. Q12 has a constant voltage on its base from the drop in potential across D13 and D14. A constant current for charging the NiCad pack is derived from Q12

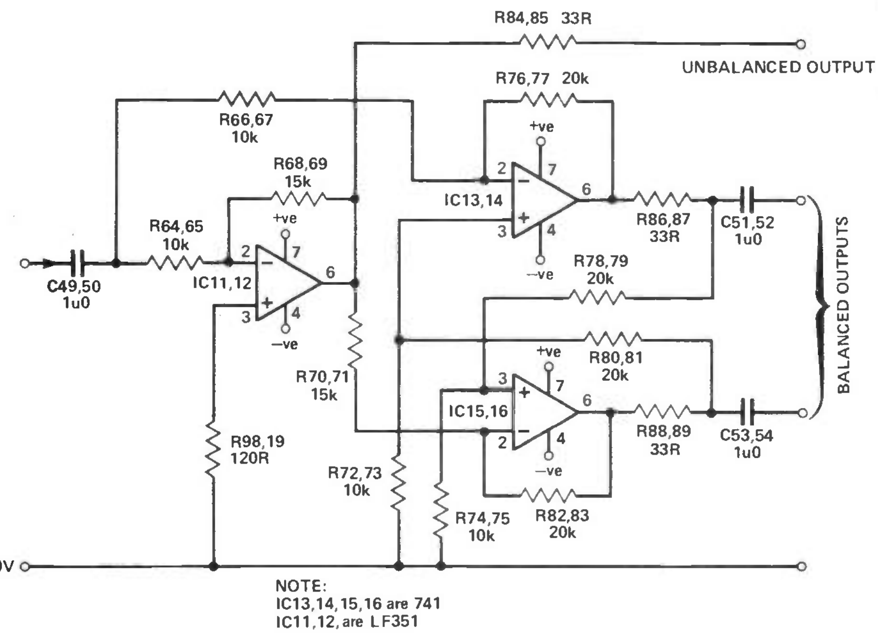


Figure 10: Balanced line output stage.

collector. D22 ensures that no current is taken from the battery pack by Q12 when the charging current is turned off, while D19 ensures that no battery power is taken by Q14 under any circumstances. D17 becomes reverse biased when mains power is in use due to the fact that the output voltage of Q14 is contrived to be at least one diode voltage above that of the NiCad battery pack. The charging current for the battery is around 12mA and each supply is required to give somewhere in the region of 40mA to power the mixer.

No mains on/off switch is used; instead the DC supply is switched. No mains voltages need be present therefore on any controls inside the mixer. Also note that NiCad charging will occur if the mixer is left connected to the mains supply. As an added safety feature an encapsulated mains transformer unit is specified for this project that contains a fuse and IEC mains connector in a sealed unit.

Construction

Next month we will look at the detailed construction and alignment of the mixer. This will include PCB layouts and full parts list. We shall also publish the full technical specification for those who wish to look before leaping!

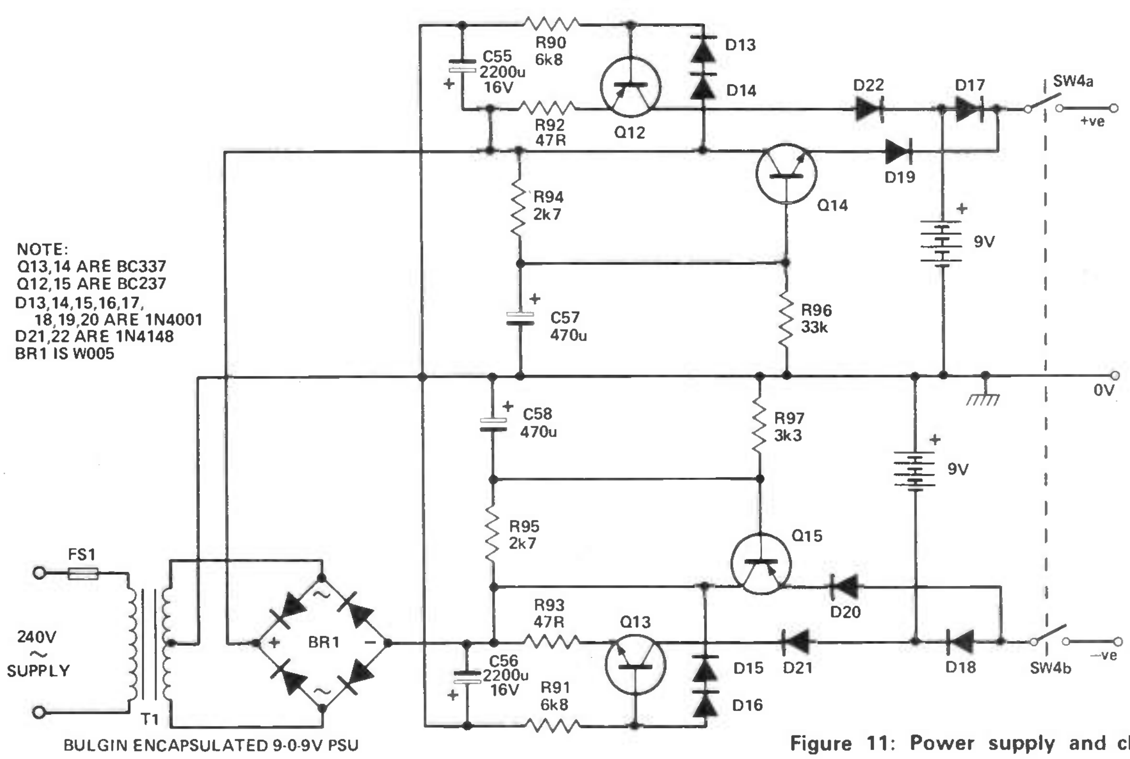


Figure 11: Power supply and charger.

■ R&EW

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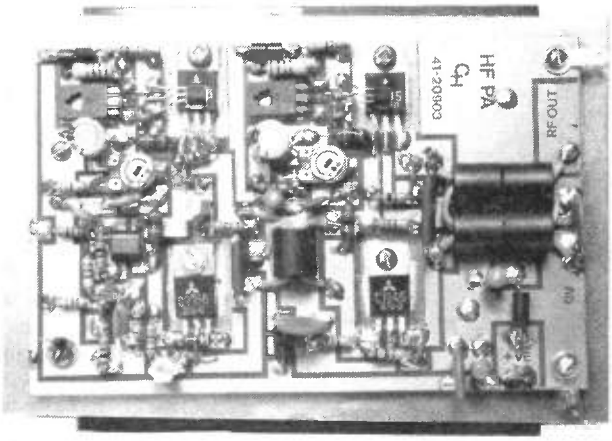

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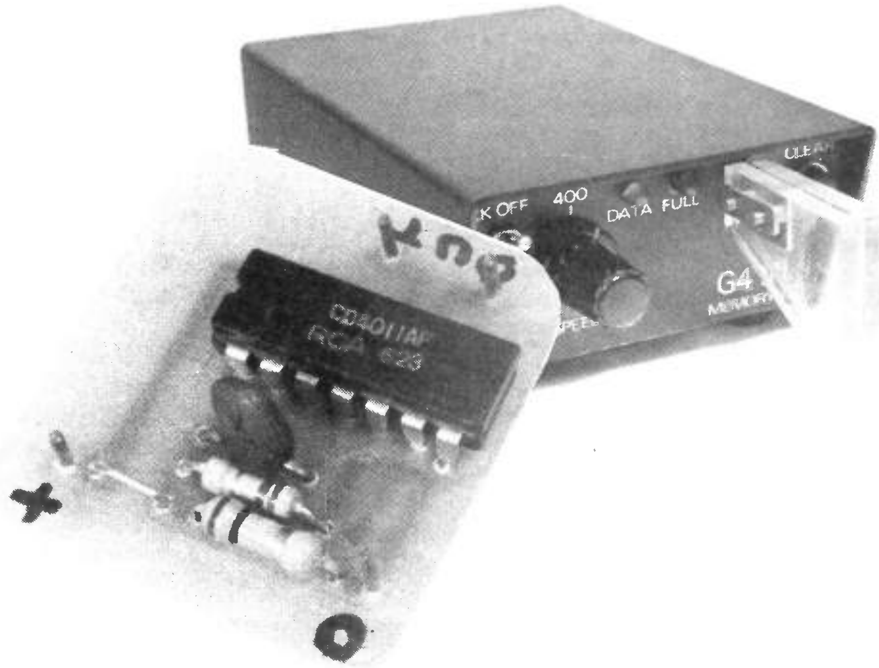
Our series of projects, designed by Stephen Ibbs, that can be built, tested and working in one evening, continues this month with a Morse Key Oscillator.



Radio amateurs who have passed the RAE can use the VHF, UHF and microwave bands, but to use the HF bands they have to take and pass a morse examination as well. The morse test requires you to listen to a three-minute passage of plain language morse sent by the examiner, and write it down, followed by a passage of numbers. You then have to show proficiency in sending morse. To practise the latter you need a morse key and some means of producing a sound. The introduction to this series of articles (in the August issue of ***R&EW***) said the designs would be simple and cheap, and the circuit below achieves this, using only four components plus a transducer. It does not even need an on/off switch.

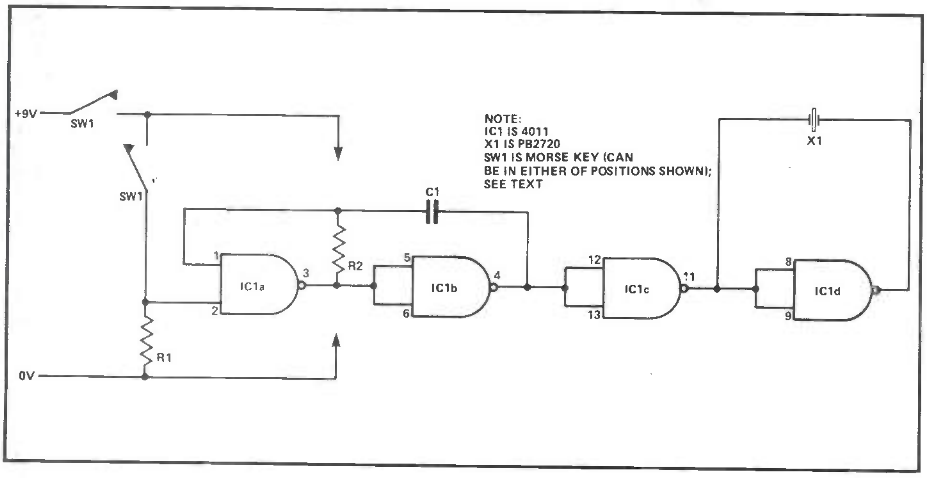


Figure 1: Schematic diagram of the morse key oscillator

Circuit Description

IC1a and b are connected as an astable multivibrator operating in the audio range. This means that the output switches between high and low at a very fast rate, generating a square wave that we can hear. The transducer can be connected between pin 4 and earth, and it will function perfectly well. However, that leaves two gates spare, and if connected as shown the output volume will be much greater. In fact, for reasons we won't go into here, there will be four times the power. The key can either be connected between the battery and the circuit, in which case insert the wire link shown in ***Fig.3***, or between +ve and pin 2. Either way the resultant sound from the PB2720 should be clean, with no nasty spikes or extraneous noises at the start and end of each dit or dah.

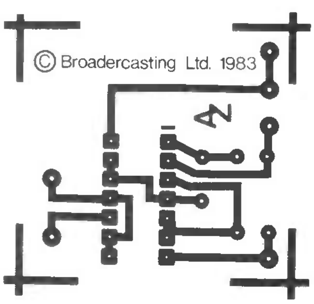


Figure 2: Foil pattern

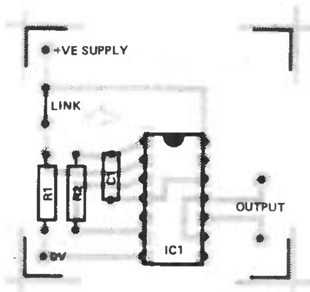


Figure 3: Overlay

Construction

This can either be on veroboard or a PCB, a design for which is given in ***Figs.2 and 3.*** The only point to watch is to make sure the IC is inserted the right way round. In the prototype the key was mounted on a small piece of plywood, with the circuit, transducer and battery mounted alongside with the aid of sticky pads. Connect up as shown and start practising for that class A licence.

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TYPE 9067 20 MHz.-200 MHz. 20 watts .... £120+£5 p&p
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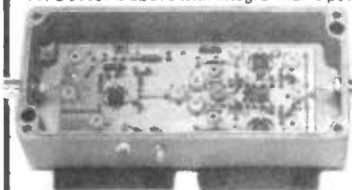

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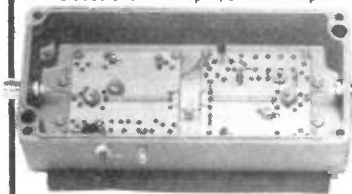

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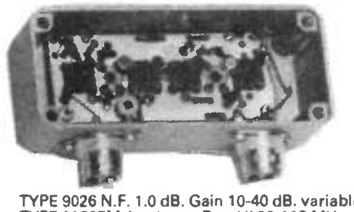

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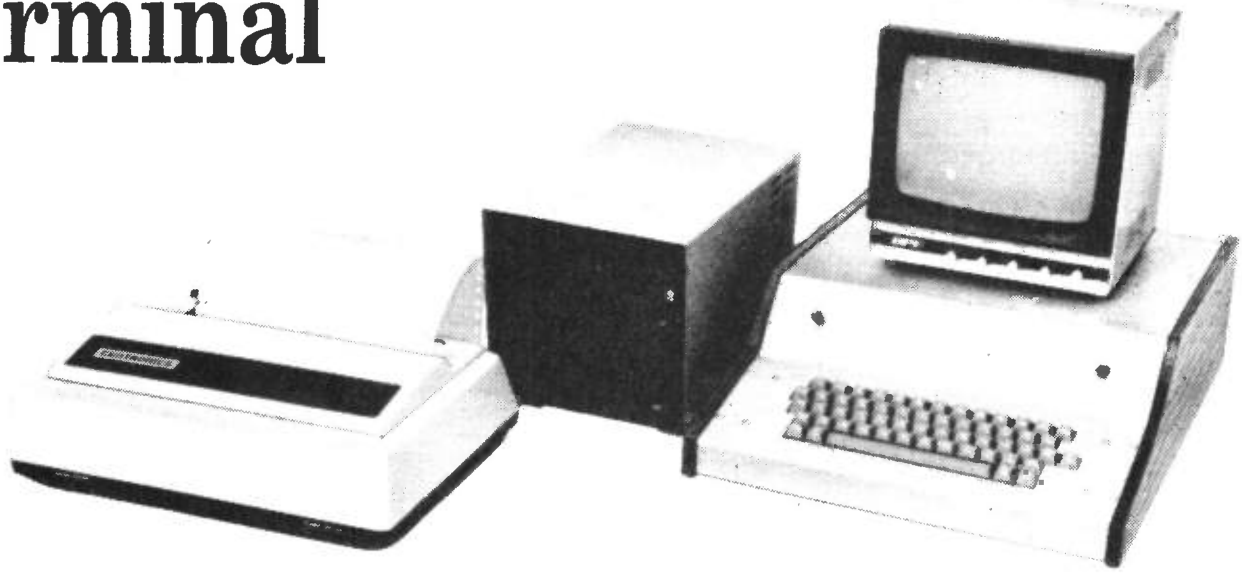


Chris Honey describes how to configure your Nascom 1 or 2 so that it performs as a full duplex RS232 terminal suitable for accessing databases such as REWTEL.

Nascom microcomputers were amongst the initial offerings to the personal computer enthusiast (i.e. in the good old days when it was an enthusiast market rather than the consumer business it has rapidly developed into), and they were arguably a good example of a technology that had arrived before the market was ready to appreciate it fully. In other words, the engineering outstripped the marketing. (Nascom Computers, you will recall, ceased trading in its original format until resuscitated by an infusion of money and enthusiasm from the Lucas group a couple of years ago.)

Yet although they have been with us for a long time, they can still out-class some of the latest personal computers in terms of benchmark performance and facilities, thus making their application in novel areas a rewarding exercise. This article describes how to configure a Nascom 1 or 2 as a full duplex terminal, by using the NAS-SYS 1 or 3 monitor programs – a terminal that could be plugged into REWTEL.

A full duplex terminal operates by sending any characters typed on the keyboard, but displaying on screen only those characters *received* through its serial port. The program presented here achieves this by making use of the powerful methods of input and output control provided by the NAS-SYS monitor programs.

Each time an input or output is requested in NAS-SYS, a special routine calls each of a number of input/output handling routines in turn. These handling routines have 'routine numbers' and there is a table of routine numbers for input, and another for output. These tables can be dynamically allocated anywhere in the memory by changing the addresses which point to them — addresses that normally point to tables in the NAS-SYS ROM. The program we look at here operates by changing the addresses of the input and output tables and using suitable input/output routines.

Program Description

Figure 1 shows the program listing which is assembled to run at 0C80H.

The first part of the program initialises the variables used by NAS-SYS.

Lines 460–470 set up the serial port for odd parity, and to omit sending line feeds after a carriage return on output. This makes the terminal compatible with both the **R&EW** Z8-TBDS system and REWTEL.

Lines 490–570 set up the input/output table addresses. The input table looks at the Nascom keyboard and serial port, while the output table calls the user output and serial routines. Note that bit 7 of the location $NOPT (0C28H) is set after a serial input. This signals the serial output routine not to echo the character, and is also used by the user output routine to display that character on the screen.

Lines 660–670 contain the main program. Line 660 flashes the cursor on screen whilst waiting for an input from either the serial port or the keyboard. After an input, the character is either displayed on screen or sent to the serial port by calling each of the output routines in turn.

The user output routine (lines 790–990) is called first. A test is made to determine if the output character has emanated from the serial port or keyboard. If it came from the latter, then that routine ends and the following routine in the table outputs the character through the serial port. But if the character was input from the serial port, then it is displayed on screen and the serial output routine ignores it.

Lines 830–860 overcome the problem of the Nascom display ignoring input line feeds, and also causes carriage returns to behave properly.

A more detailed understanding of how the program uses the input/output routines of the NAS-SYS monitor may be gained from studying the NAS-SYS operating guide.

By the way, NAS-SYS 3 users may wish to change KBD (61H) to RKBD (7DH) and have a repeating keyboard.

The Hardware

Whilst the software can be used with NAS-SYS 1 or 3 on either a Nascom 1 or a Nascom 2, I am unfortunately unable to provide any information about the hardware in the former micro (though this can of course be found in the Nascom 1

```
ZEAP Z80 Assembler - Source Listing

*                 ; ****************************************
                  ; *                                      *
                  ; *   Full Duplex Terminal Software.     *
                  ; *   For NAS-SYS 1 or 3.                *
                  ; *   Version 2.0    JUNE 1983.          *
                  ; *   Written by CHRIS.HONEY. for R&EW.  *
                  ; *                                      *
                  ; ****************************************
                  ;
                  ;             SUBROUTINE CALLS
                  ;
5B9C 0072         ZNIM    EQU  72H     ;Sets up input table
5B9C 0071         ZNOM    EQU  71H     ;Sets up output table
5B9C 0063         INLIN   EQU  63H     ;Does input/output
5B9C 0065         CRT     EQU  65H     ;Displays on screen
5B9C 006E         XOUT    EQU  6EH     ;Outputs to serial port
5B9C 0075         UOUT    EQU  75H     ;Outputs through User
5B9C 0074         XKBD    EQU  74H     ;Scans serial input port
5B9C 0061         KBD     EQU  61H     ;Scans Nascom keyboard
                  ;
                  ;             MEMORY POINTERS
                  ;
5B9C 0C78         $UOUT   EQU  0C78H   ;User ouput address
5B9C 0C28         $XOPT   EQU  0C28H   ;X option store
                  ;
                  ;             CONSTANTS
                  ;
                  ;  For XOPT    BIT 0 = 0 Parity EVEN
                  ;              BIT 0 = 1 Parity ODD
                  ;              BIT 4 = 0 LF sent after CR
                  ;              BIT 4 = 1 Only CR sent
                  ;
5B9C 0031         XOPT    EQU  31H     ;X option
5B9C 000D         CR      EQU  0DH     ;Carriage Return
5B9C 000A         LF      EQU  0AH     ;Line Feed
5B9C 0017         CH      EQU  17H     ;Moves cursor to line start
                  ;
                  ; ****************************************
                  ; *                                      *
                  ; *    Set up NAS-SYS parameters.        *
                  ; *                                      *
                  ; ****************************************
                  ;
0C80                      ORG  0C80H
0C80                      ENT
                  ; Set up EXTERNAL option
0C80 3E31                 LD   A,XOPT
0C82 32280C               LD   ($XOPT),A
                  ; Set up pointers to Input table
0C85 21B70C               LD   HL,INX
0C88 DF72                 SCAL ZNIM
                  ; Set up pointers to Output table
0C8A 21B40C               LD   HL,OUTX
0C8D DF71                 SCAL ZNOM
                  ; Set up User Output routine address
0C8F 21990C               LD   HL,USOUT
0C92 22780C               LD   ($UOUT),HL
                  ;
                  ; ****************************************
                  ; *                                      *
                  ; *      End of initialisation.          *
                  ; *    Main program loop follows         *
                  ; *                                      *
                  ; ****************************************
                  ;
0C95 DF63         TERM    SCAL INLIN   ;DO I/O Processing
0C97 18FC                 JR   TERM
                  ;
                  ; ****************************************
                  ; *                                      *
                  ; *   USER Output routine.               *
                  ; *  Checks for Input from SERIAL        *
                  ; *                        or KEYBOARD   *
                  ; * If SERIAL then displays on screen    *
                  ; *                                      *
                  ; ****************************************
                  ;
                  ; OUTPUT to screen if BIT 7 SET
0C99 21280C       USOUT   LD   HL,$XOPT
0C9C CB7E                 BIT  7,(HL)
0C9E C8                   RET  Z             ;BIT 7 is RESET so ignore
0C9F F5                   PUSH AF
0CA0 FE0D                 CP   CR            ;Carriage Return?
0CA2 2808                 JR   Z RETURN      ;If so jump
0CA4 FE0A                 CP   LF            ;Line feed?
0CA6 2808                 JR   Z LFEED       ;If so jump
                  ;
                  ; Display on NASCOM VDU
0CA8 DF65         OUT     SCAL CRT
0CAA F1                   POP  AF
0CAB C9                   RET
                  ;
                  ; Convert CR to CH
0CAC 3E17         RETURN  LD   A,CH
0CAE 18F8                 JR   OUT
                  ;
                  ; Convert LF to CR
0CB0 3E0D         LFEED   LD   A,CR
0CB2 18F4                 JR   OUT
                  ;
                  ;  OUTPUT TABLE
                  ;
0CB4 75           OUTX    DEFB UOUT    ;USER O/P routine
0CB5 6E                   DEFB XOUT    ;SERIAL O/P routine
0CB6 00                   DEFB 00
                  ;
                  ;  INPUT TABLE
                  ;
0CB7 74           INX     DEFB XKBD    ;SERIAL I/P routine
0CB8 61                   DEFB KBD     ;Scan Nascom keyboard
0CB9 00                   DEFB 00
```

Figure 1: The assembled program listing.

0C80	3E	31	32	28	0C	21	B7	0C
0C88	DF	72	21	B4	0C	DF	71	21
0C90	99	0C	22	78	0C	DF	63	18
0C98	FC	21	28	0C	CB	7E	C8	F5
0CA0	FE	0D	28	08	FE	0A	28	08
0CA8	DF	65	F1	C9	3E	17	18	F8
0CB0	3E	0D	18	F4	75	6E	00	74
0CB8	61	00	00	00	00	00	00	00

Figure 2: The tabulated op-codes, type these in from 0C80H.

manual). However, I can give details of the hardware operations that need to be carried out on a Nascom 2. This micro has the necessary hardware for running at 110, 300, 1200 and 2400 baud, and the instructions relevant here naturally depend on the chosen rate. The details are as follows:-

110 baud

Set link switch 2 to the following:-–

LSW2/7 UP
LSW2/6 DOWN
LSW2/5 UP
LSW2/3 DOWN
LSW2/2 UP

2400 baud (and higher)

This is the fastest baud rate possible unless an external clock running at sixteen times the baud rate is used.

Connect the external clock input test points TP5 and TP4 together, and these can then go to the external oscillator, or, for 2400 baud to TP20.

Set link switch 2 to the following:–

LSW2/7 UP
LSW2/6 UP
LSW2/5 UP
LSW2/3 UP
LSW2/2 UP

300 baud

Link switch 2 is set as for 2400 baud. However there is no test point providing the 300 baud clock. The solution is to solder TP4 and TP5 to IC31 pin 9.

1200 baud

The same problem as for 300 baud applies. Set link switch 2 as for 2400 baud and solder TP4 and TP5 to IC31 pin 12.

Running the Program

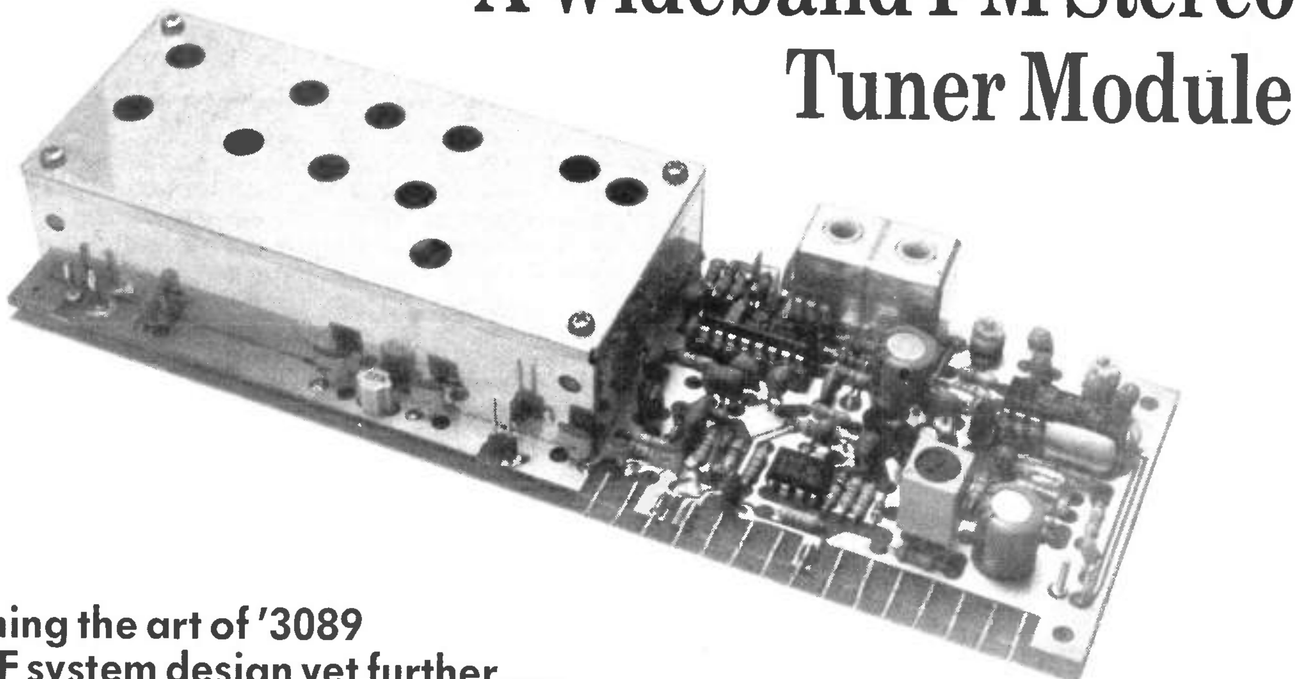
There are two options open to the user for entering the program. The first is to type in the op-codes tabulated in ***Fig.2*** at the relevant addresses, using the NAS-SYS 'MODIFY MEMORY' command. The second applies to those Nascom owners that have a ZEAP assembler. This assembler was in fact used to develop the program, and with ZEAP, the program ***Fig.1*** can simply be typed in and assembled. The execution address may then be changed so that, for instance, the code could reside in EPROM –whereupon the program might become a useful firmware feature.

Once the program has been entered, it can be run by executing (the 'E' command in NAS-SYS) from 0C80H (or the assembly address chosen when re-assembling using ZEAP). The program may only be halted by pressing the reset switch.

With 300 baud selected, plug your 300 baud full duplex Modem into the RS232 port, and you are only a 'phone call away' from REWTEL and other fine databases and bulletin boards!!

■ R&EW

A Wideband FM Stereo Tuner Module



Refining the art of '3089 FM IF system design yet further......

William Poel and Derek Frost survey the fruits of over 10 years of the world's most popular IC shortcut to FM tuner design.

The CA3089 and its descendants have provided enough material to cover many pages in the electronics press over the past ten years. Once upon a time, building your own FM stereo tuner was an obligatory pastime for adherents to the hobby. Latterly Messrs. Japanese have been getting the upper hand in such things by providing such an array of delights on the shelves of your local *Comet* that this most instructive aspect of the hobbyist's development has been overwhelmed.

And thus not only do 'they' destroy our trade balance, they see to it that we no longer encourage the skills that might cause us to compete in the long term.

So we cautiously offer you an approach to an FM tuner design that hopefully combines the elements of performance and value in a way that does not immediately imply surrender when placed alongside the offerings of Pioneer, Akai *et alia*. It's a brave designer who feels he has something to contribute in this market.

And with a bit of luck, we might rekindle that spark of enthusiasm for RF design and experimentation that is nearly extinct, having been extinguished by an avalanche of packaged Hi-Fi products and diverted by a preoccupation with all things digital.

The sound's the thing

If you can't face the Japanese in open warfare on the battlefield of the discount Hi-Fi retailer, then the alternative is to start up a rearguard guerrilla action by invoking the powers of darkness in the shape of *subjective appreciation*. The poor Japanese, being very scientific and objective in their reasoning, seem unable to accept that many Western ears prefer (or think they prefer, or are *told* that they should prefer) the sound that comes from low-volume (quantity-wise) specialist manufacturers who just happen to have the right book of spells and incantations. Even if their technologists did appreciate this, the Nipponese accountants would quickly tell them not to bother, since the market represented by those bewitched by the 'eye of newt, tooth of hen' reasoning of the subjective audio press is very much a minority anyway.

Nevertheless, there remains a sufficient, if unscientific, 'no man's land' where fact and fantasy are inseparable, and even the most cynical and clinical of observers is forced to confess that two pieces of equipment providing similar standard measurements are able to provide totally dissimilar listening satisfaction. FM tuners are a particularly fertile area for the subjective audio analysts, since they add a couple of new and not generally very well quantified aspects to the mixture in the shape of de-emphasis, separation, multipath, broadcasters and all sorts of ultrasonic paraphernalia related to the 19kHz pilot tone, and 38kHz DSB difference channel information.

Great Joy. A tuner can measure quite indifferently when set against the conventional wisdom of amplifiers, but still 'sound' quite sweet to the golden ear of the subjective devotee.

It's like this, see

The sound of the tuner is almost exclusively determined by the decoder and allied audio channel processing parts, the ideal for which has (by popular agreement amongst reviewers of British audio equipment, for once) come to mean the HA11225/KB4441 IF amplifier subsystem (a derivative of the CA3089, of course), the KB4437 PLL stereo decoder and the KB4438 muting stereo preamplifier subsystem. The RF and IF processing will affect the sonic performance only to a limited extent – and any problems in this area that significantly affect sound performance are rather obvious and easily measured.

The contribution of the RF stage is simply to pluck the weakest signals from the ether, and amplify them without introducing noise. The question of linearity does not apply in the FM system where all irregularities are removed by limiting, and the only thing to watch out for is that the phase response of the filter stages is linear across that portion of the bandwidth occupied by the wideband FM signal.

Now let's take a look at an FM receiver system and the various stages of the signal in ***Fig.1***:

The Circuit (*Fig.2*)

You may be forgiven for having felt that you've seen this before. Actually you haven't, but it's certainly true that, since its introduction, the CA3089E has tended to cause many tuner circuits to look similar.

The circuit is a derivative of the Larsholt Electronics 7255 tunerset, and our thanks to them for their cooperation in producing this feature. The major differences are that the tunerhead contains an additional RF tuned stage, buffers the oscillator with a

MOSFET to feed the mixer, and has a JFET to feed the outside world of frequency counters and displays.

The oscillator is carefully isolated and loaded in such as a way as to produce the purest of signals at gate 2 of Tr2. The problems of spectrally impure local oscillators tend to emphasise the spurious response that occurs at a distance of half the IF from the RF signal. eg:

RF signal = 100MHz
Half IF response occurs at 105.35MHz
LO at 110.7MHz
Twice LO = 221.4MHz
Twice the sprog = 210.7MHz
Difference = 10.7MHz
Result = birdies and warbles.

In England, cases where this phenomenon arise are few and far between in average domestic listening. Not so elsewhere in the world, and not so if you use a beam of reasonable proportions.

The tunerhead is available as a ready-made item (ALPS FD618), but we shall be covering the constructional aspects in an issue or two's time since it lends itself to being built comparatively readily for specific frequency bands in the range 30–200MHz. The first MOSFET can be substituted by whatever device happens the flavour of the month, although you won't be able to spot the difference between a 3SK88, BF981 or BF963.

The first IF filter sits at the output of the tunerhead. It is not entirely desirable that the filter should be fed from the coil secondary, since it's a great deal easier to foul up the matching of such a filter when reactance is involved, as opposed to pure resistance. The filter types tried (so far) that work are the TOKO CFSE, CFSD, and Murata SFEML. Others exhibit an asymmetrical passband, which does not enhance the linearity, and thus leads to loss of separation and distortion.

Without the filter on the base of Tr6, the tuner exhibits de-sensing when tuning to weak stations in the presence of strong signals, since Tr6 saturates. Fitting the filter in front of the stage produces a strangely different impression of the band, with all those very weak intermediate signals squeezing through, courtesy of the superb noise figure and gain of the RF stage.

Horses for courses

In an ideal world, you wouldn't need the gain of Tr6. The data sheets imply that the frontend and the IF can do the job on their own – but the HF breakthrough around 10.7MHz makes this impractical. So Tr6 is provided to raise the level of general 'noise' to swamp out the attempts of Radio Moscow to creep in, the resistive termination it provides for the filters is most welcome – and it makes a convenient place to include a switchable narrowband filter for more purposeful DX'ing.

Placing an extra switched filter in a circuit where linear phase response is so crucial is a dicey business at the best of times: following it immediately with another is definitely dicing with death! But the results bear out the fact that this 180kHz bandwidth (–3dB) filter works well, and does not sacrifice much by way of distortion or separation.

There isn't much left to be said about the HA11225/KB4441 IF subsystem. The width of the mute window is determined by the resistance between pins 7 and 10 (4k7–10k produces the right results), and the noise floor (and the rate at which the IF radiates harmonics) is largely determined by the quality of the decoupling at pin 10.

Any component that slows up the response of the deviation muting signal at pin 12 is bad news. This output must respond instantaneously to catch any

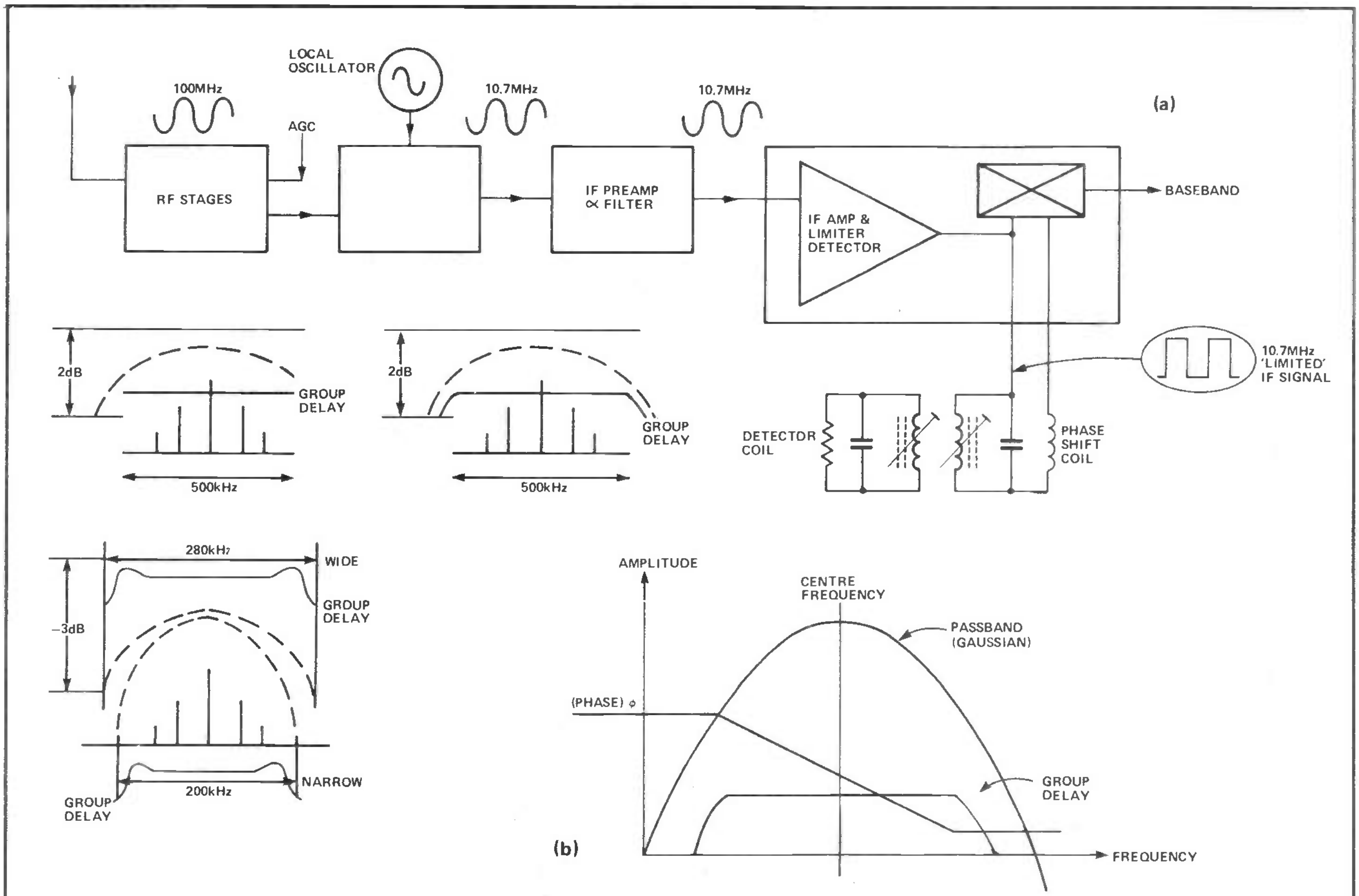


Figure 1: a) An FM signal traced through the various stages of selectivity in the tuner. b) The relationship between bandpass, phase and group delay.

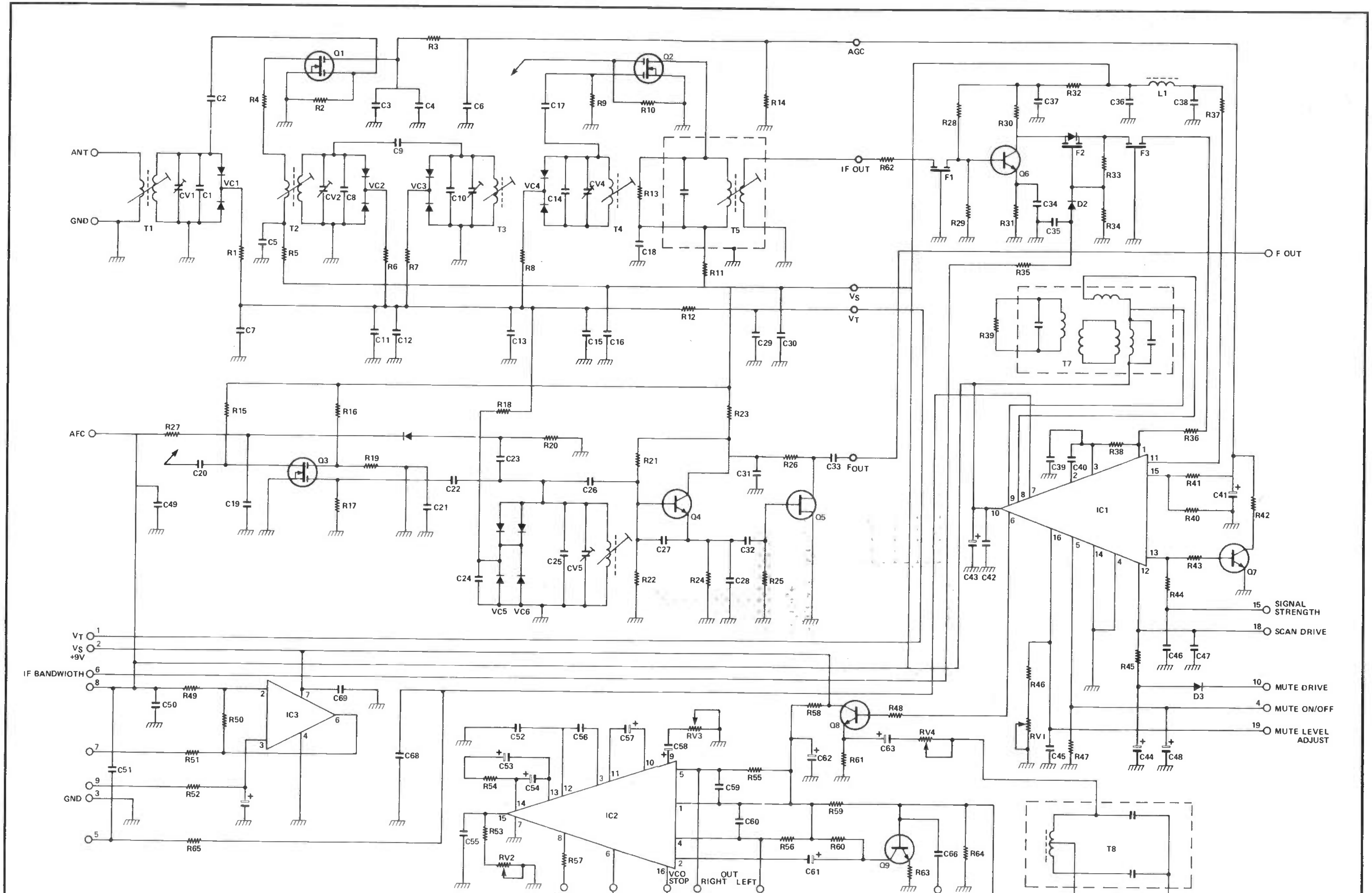


Figure 2: Circuit Diagram.

passing synthesiser 'scan stop' input. One of the more subtle problems encountered in this circuit is the need to keep the capacitor on pin 7 of IC1 to a compromise between actually decoupling the audio adequately and avoiding slugging the mute output unduly. Too little decoupling can cause the deviation mute to trip out on modulation peaks.

(By the way, C68 should be increased to 4u7 if the tuner module is used with manual tuning and not a synthesiser.)

The mute operation level is adjustable at pin 16. The module also provides access to this pin for remote control, if the user should wish to select only strong local signals with the aid of the panel control. AGC is optimised by combining the logarithmic response of the signal strength meter output with the rather stepped function of the AGC output (***Fig.3***).

AC coupling to the signal strength output provides a good indication of multipath distortion – the pernicious form of antenna-borne phase distortion that can afflict even apparently good antenna systems and results in unexplained noise

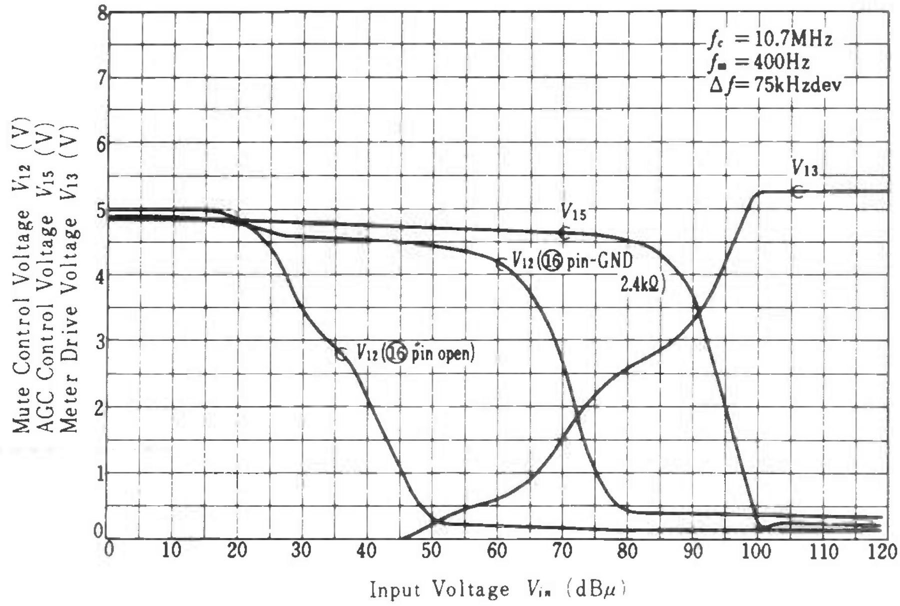
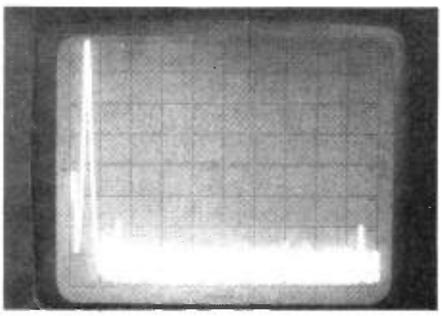
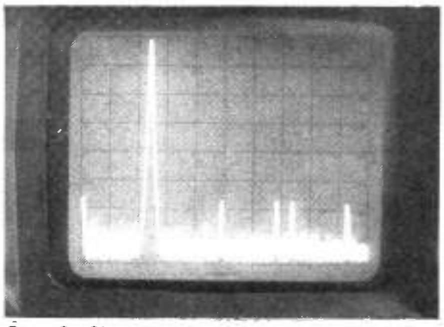


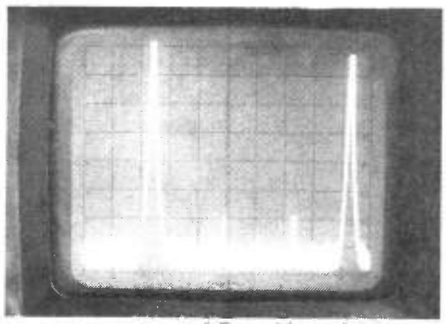
Figure 3: Mute control voltage, AGC control voltage and meter drive voltage vs. input voltage.



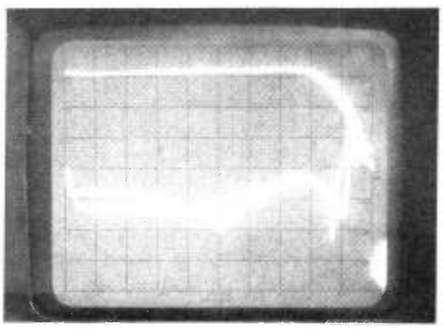
Scan 0-20kHz. Overall output with 1kHz test modulation (40%). Y =2kHz, X=10dB



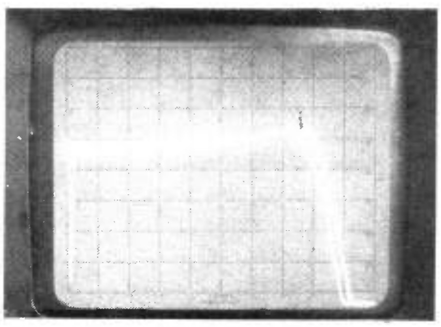
Scan 0-20kHz. Overall output with 5kHz test modulation (70%). Y=2kHz, X=10dB



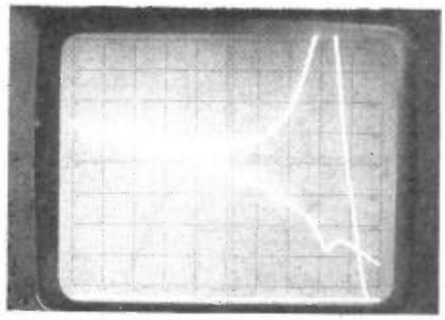
0—20kHz 5kHz, 70%, 10dB. Generator output



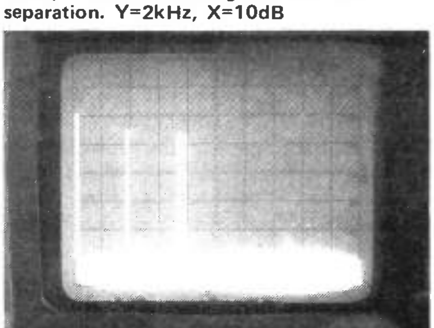
Sweep 0-20kHz showing L-R and R-L separation. Y=2kHz, X=10dB



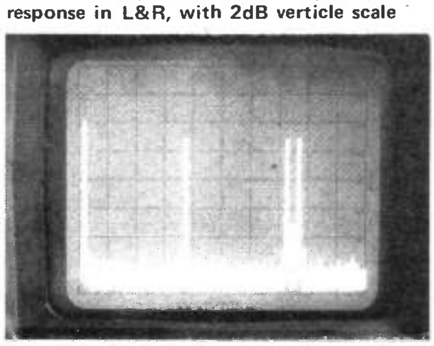
Scan 0-20kHz, overall audio frequency response in L&R, with 2dB verticle scale



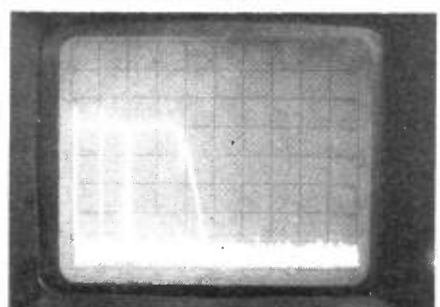
Scan 0-100kHz. Before and after the 'birdy filter'. Y=10kHz, X=2dB



0-100kHz sweep. View of the composite signal after the birdy filter stage.(10dB)



Scan 0-50kHz. View at the detector output of the composite signal. Note 19kHz and 38kHz DSB. (10dB)



0-200kHz scan, viewing the composite input to the decoder, with birdy filter response superimposed

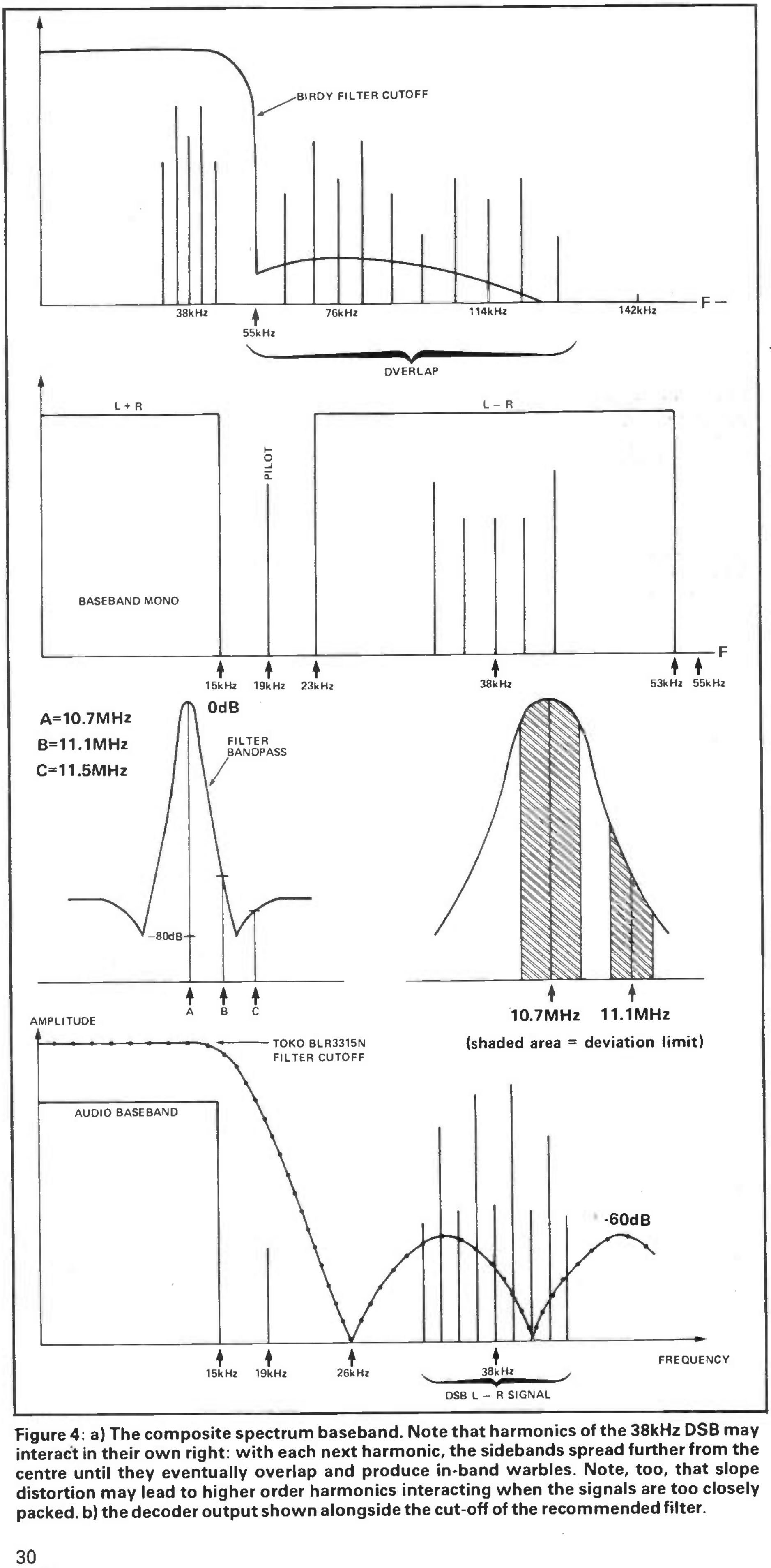


Figure 4: a) The composite spectrum baseband. Note that harmonics of the 38kHz DSB may interact in their own right: with each next harmonic, the sidebands spread further from the centre until they eventually overlap and produce in-band warbles. Note, too, that slope distortion may lead to higher order harmonics interacting when the signals are too closely packed. b) the decoder output shown alongside the cut-off of the recommended filter.

and (certain signals, even though the signal strength indicates that there is enough signal. The cure is to adjust your antenna until it goes away – or to remove the antenna from the proximity of offending reflective objects like water tanks and gas holders. It's the audible equivalent of ghosting on a TV picture.

Tweet and twitter

Unpleasant and undesirable things lurk beyond 55kHz in the signal that emanates from the detector – see *Fig.4*. Multiples of 38kHz can conspire with signals unknown (usually from adjacent stations) to pervert the course of Hi-Fi. Since it is not desirable to reduce the IF bandwidth much below 250kHz at the −3dB points, the next best place to add selectivity is in the path of the composite signal from the detector. Since the multiplex signal expires at 53kHz (38kHz+15kHz), the low pass filter notionally takes effect after 55kHz – although one has to take care not to disturb the phase response below 53kHz, since it is vital that the 19kHz sub-carrier and the 38kHz DSB signal should be decoded with the correct relationship. Errors in the timing of the switching signal between left and right result in an overlap which reduces separation.

Like all good filters, the input and output impedance of this stage must be clearly defined – here it uses the emitter resistor in Tr8, together with R61. Incorrect termination results in reflections (simple AC theory), and reflections result in ripples in the passband (not so simple filter theory).

Tr9 raises the level into the decoder to achieve the best signal to noise ratio compatible with minimal distortion, whilst C66 is available to undo all the good work on phase linearity earlier in the circuit, thereby reducing the separation and thus the perceived noise level on weaker stereo transmissions. Experimenters can place an FET between C66 and ground and have variable high blend driven from the signal level control output. The possibilities are endless.

The stereo decoder (IC2) uses the conventional PLL system to regenerate the pilot tone. The VCO is determined by the components on pin 15 – and the other trimmable adjustment on pin 9 sets the operating point of the pilot cancelling system.

The subtle bit in the decoder concerns the audio output stages which are open collectors. And like any open collector audio stage, the noise and hum content of the voltage applied to the far end of the collector load resistor will appear at the audio output. R58 and C62 decouple any problems – but note that the supply voltage is +14V, since the drop across R58 is enough to reduce a 12V supply below the point at which the output stages clip on full signal.

The output signal may have lost its

19kHz signal, but it's brimming with 38kHz and other ultrasonic nasties. You still need a filter – but at least it's one where the effect of the roll-off (and consequent phase errors) occurs after the 15kHz audio base band.

AFC and all that

IC3 provides the means of including the AFC error signal derived from detector 'S-curve' in the main tuning voltage of the front end. One input to the op-amp is fed by the AFC reference derived from the main IF reference voltage at pin 10 of IC1. To obtain AFC action, the other input is fed from the AFC source itself (minus the audio content), the result being used to control the overall tuning voltage.

Purists believe AFC can act to the detriment of the signal, since it is very difficult to reach a happy compromise between enough capacity to completely decouple all audio frequencies from the AFC voltage, and a time constant that makes it nearly impossible to tune when the AFC is operating. The usual compromise results in the sacrifice of separation at very low frequencies.

One solution is to employ slope control of the AFC signal, which is a grandiose description of a technique that applies AFC in proportion to the signal level. This effectively turns off the AFC until the tuning has settled on a signal for long enough to believe that the operator has stopped tuning, whereupon a large and very highly decoupled AFC voltage is applied to prevent the tuning meandering any further.

The only thing that can then upset the tuning is drift in the detector stage, but since we've been careful to choose the best available assembly, and one that is matched for thermal drift as well as having the most linear phase, all is well. (A quadrature detector coil is nothing more than a high stability, high Q double tuned coil stage optimised to give the most linear phase response when damped with the resistors shown.)

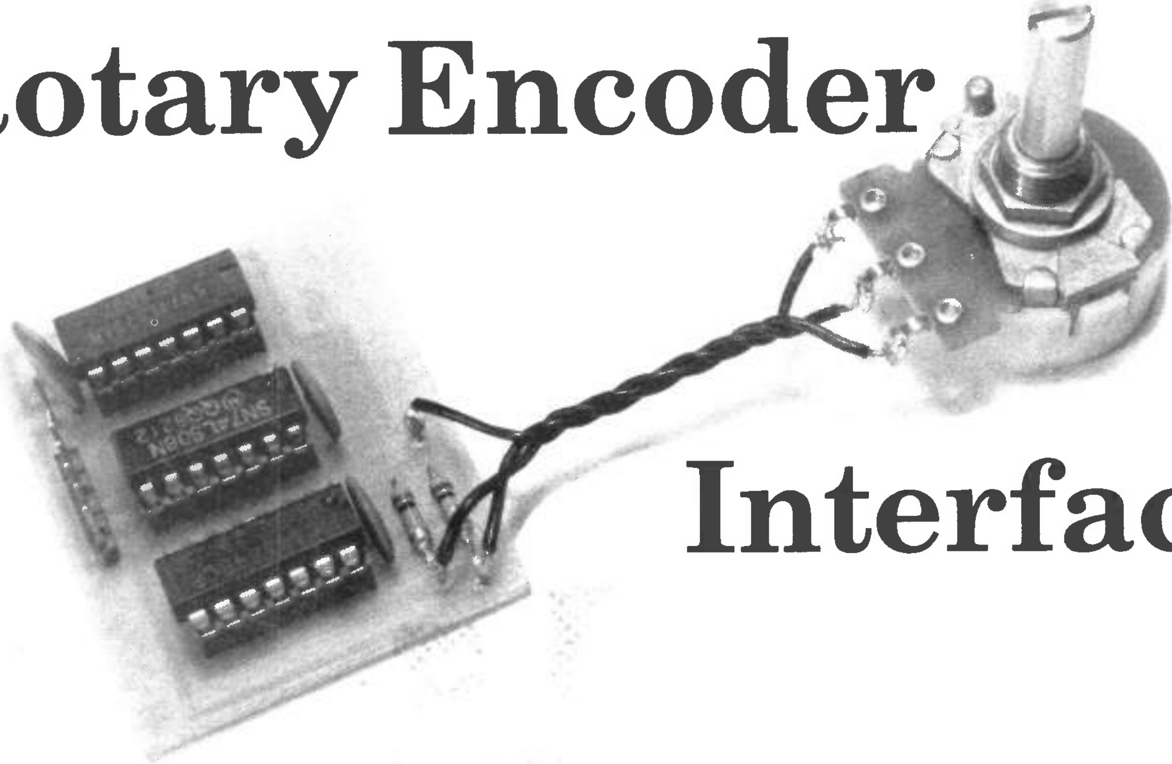
Next month

In the final section of this feature, we'll be covering all the constructional details, including setting up with the minimum of test gear (a multimeter). It must be said that the best results will only be obtained if you have access to a signal generator and a wobbulator (best of all, an audio spectrum analyser), although an oscilloscope and the Radio 3 test tone schedule are nearly good enough.

Also included will be a slope controlled AFC drive system, and a filter/preamp stage.

■ R&EW

Rotary Encoder Interface



Adrian Barnes describes the construction of a simple and reliable interface that converts the output from a continuous rotary encoder into a form that could readily be used to control TTL logic.

There are many different applications where some form of fine control over a digital circuit is needed – for example, synthesised communications transceivers and computers. A stepped BCD/binary output encoder such as a CB channel selector switch has very limited use since it has just one full revolution in which to present all the available codes. The rotary encoder, however, overcomes this problem by outputting a stream of pulses characteristic of the distance through which the selector is turned. Such a system is obviously not limited to any specific number of turns or parts of a turn; in other words, it is essentially continuous. Moreover further information is readily available because the pulse widths are directly related to the rotation rate.

Getting the sense

However, in most applications, it will be necessary to know not only at what speed the shaft is turning and how far it has gone, but also in what direction it is moving. The way this is achieved on incremental encoders, such as the LA226 used in this project, is through the emission of two streams of pulses identical in form but out of phase with each other by 45°, which stream leading depending on the sense of the rotation (*see Fig.1*). Thus as the shaft turns in one direction (counter clockwise in the example illustrated in the diagram) A will be low (logic 0) at the time B changes from low to high, whereas when it is turned the other way, A will be high (logic 1) as B changes from low to high.

This difference in phase can be decoded by a flip-flop to give a high output when the shaft turns one way and a low one when it turns the other way. In applications where a reasonable speed is maintained, this can be achieved with a D-type flip-flop where the output changes to the state of the D (data) input when the clock input goes from low to high. However, this can cause glitches at low speeds, so a J K type is the better one to use.

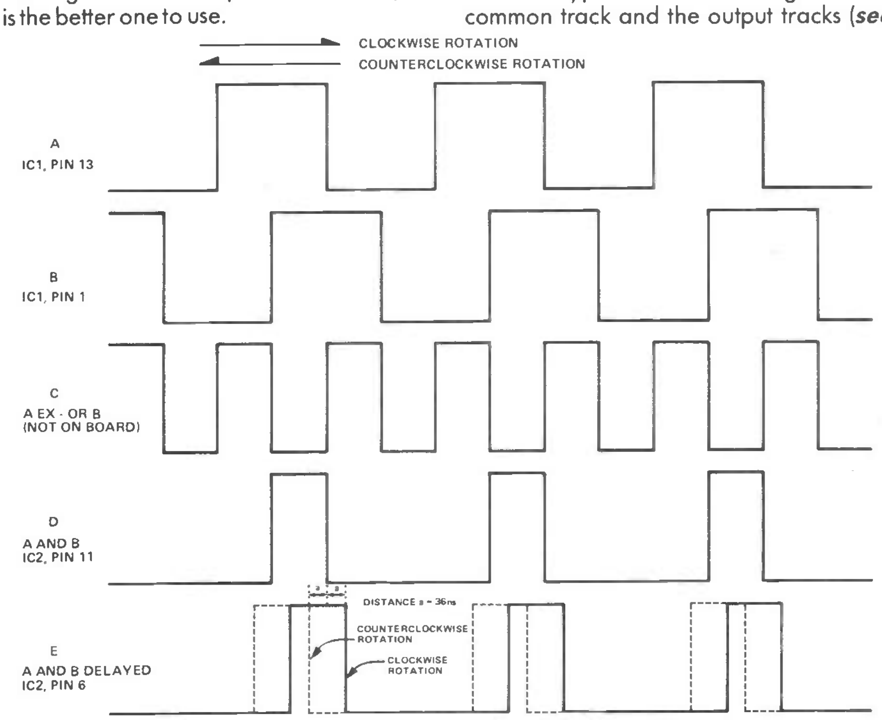


Figure 1: Timing diagram. Note that the pulse widths vary with the speed of rotation.

LA226 Specifications

The LA226 has a very low rotational torque – less than 100gcm – and a rotational life of 100,000 cycles, which is why it is more suited to computers and the like than to car speedometers. Maximum current is 50uA per output at a voltage rating of 5±½V.

The construction of the unit is based on a brush type contact shorting out the common track and the output tracks (*see*

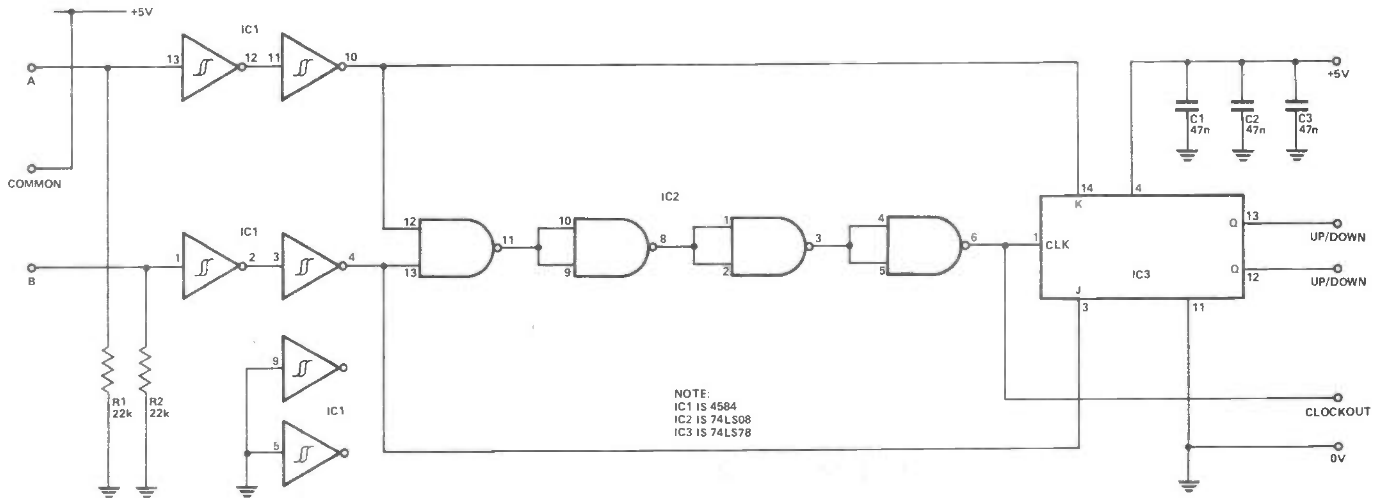


Figure 3: Schematic diagram.

Fig.2). The area of contact between the brush and the tracks must be very narrow in the radial direction because otherwise one pulse would run into the next and there would be no output pulse train. This is why higher resolution encoders cost more and are larger; their fabrication has to be precise. The resolution of the pulse train (and hence the number of codes available for each complete revolution of the encoder) can be doubled, however, by combining signals A and B with an exclusive OR (EX-OR) gate. This has the effect of producing an output that is high only when its two inputs are different (output C of *Fig.1*) which has twice the resolution of either A or B. However, this has not been included in the design for this project.

How It Works

The operation of the interface is best understood by referring to the schematic diagram shown in *Fig.3*. The output signals from the encoder are formed by the common connection a +5V giving the highs, and the pull-down resistors R1, R2 creating the lows when the output is not high. Four gates from the inverting Schmitt triggered IC1 (a 4584) are used to square up the input and to buffer the signals.

The signals then take two routes. The first takes A and B to the K and J inputs of IC3 respectively: this sets the latter up. The second route goes via IC2 which ANDs the two signals together to produce the clock signal D on the timing diagram (*Fig.1*). The remaining gates of IC2 are used as buffers that delay the clock pulse to IC3 by about 36ns (signal E of *Fig.1*), which is just enough time to allow IC3 to be set up before the clock pulse comes along. The clock pulse determines when the output should change and the J and K inputs determine what it should change to. The truth table for this is shown in *Fig.4*.

Figure 2: Photograph of LA226 showing its construction.

From this truth table and the timing diagram of *Fig.1*, the following can be deduced:–

Travelling in the clockwise direction

When E is first high A and B are both high, but towards the end of the E pulse A goes low and B stays high, D going low. Less than 20ns afterward the J and K inputs are set up i.e. the IC has received the data. About 16ns after this, the delayed version of D – the E signal – goes low which 'clocks' the flip-flop. Thus E acts as the clock input and on the high to low – or negative – edge of this signal, the flip-flop output will change according to the settings of J and K. In the case being considered here, the truth table shows that these will cause a high output at Q.

J	K	CLOCK	OUTPUT Q
0	0		Stays same
0	1		0
1	0		1
1	1		Changes to opposite

Figure 4: Truth table for operation of flip–flop.

Until the next clock pulse negative edge arrives, the output will stay in this state. Obviously, when the next pulse arrives, J and K will be as before and so all the while the shaft rotates clockwise the Q output will be high.

Under counter-clockwise rotation

The details here are essentially exactly the same, except that when the negative going edge of E arrives, A will be high and B low, and thus the Q output will be low. Of course the $\overline{Q}$ output will then be high.

Construction

The construction of this interface is very straightforward on the **R&EW** PCB, which also includes decoupling capacitors on each IC. The foil pattern and the overlay

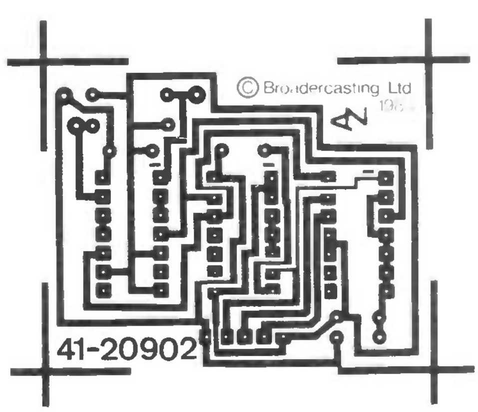


Figure 5: PCB foil pattern.

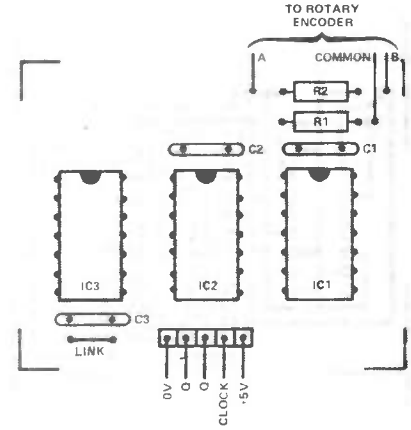


Figure 6: PCB overlay.

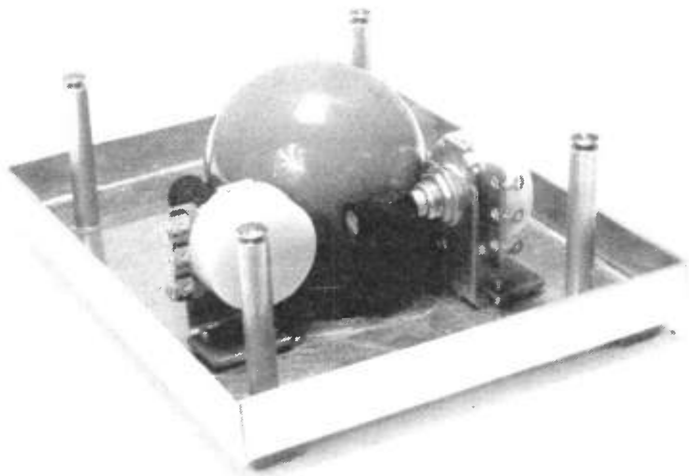


Figure 7: A rolling ball control — a possible application for the interface. Note the two rotary encoders at right-angles.

PARTS LIST	
Resistors all ¼ watt 5%	
R1,2	22K
Capacitors	
C1,2,3	47n ceramic disc
Semiconductors	
IC1	4584
IC2	74LS08
IC3	74LS78
Miscellaneous	
3PC half pins, 3 14 pin IC sockets, 5 way molex connector. PCB etc. Rotary encoder LA226.	

are shown in *Figs.5 and 6*. Obviously which way round the connection of the LA226 is made is not important so long as the common connection is correct, since both the output and its complement can be used.

Moreover, this circuit will operate with other types of rotary encoder that give two signals with a phase difference — for example, those of a higher resolution.

Another option is to use an encoder with a click-stop action, though this might be off-putting in a joystick or rolling ball type of application (*see Fig.7*).

Control Application

The interface described here thus gives a positive output in one direction and a negative one in the other, together with a stream of pulses the number of which is proportional to the length of travel and their width proportional to the speed.

The usual application of such information streams is in driving an up/down counter so that a binary or BCD output is given that is related to the position of the shaft, even after many revolutions. However, an up/down counter has not been included on the board for this project because the different applications to which the interface will be put may require BCD or binary outputs, or even several counters cascaded to give a wider range of control.

■ R&EW

Centronics Interface for Z8-TBDS

Chris Honey describes a full feature parallel printer interface for the Z8 series of computers.

Despite the Z8671's extensive RS232 terminal support, it is unable to control any form of hardcopy printer. However the on-chip parallel I/O port is ideal for interfacing Centronics-type printers, for with the hardware aspects of the interface taken care of, a little software allows Z8 BASIC 'output' to be directed to just the programming terminal, or the hardcopy printer or both the terminal and the printer. All of this is possible due to the manner in which Z8 BASIC 'output' is vectored (directed) to I/O devices via 'jump' tables in RAM.

Before examining the printer interface in detail, it is instructive to take a look at the procedures involved in handling input and output with the BASIC/DEBUG interpreter inherent in the Z8671.

The INs and OUTs

The BASIC/DEBUG interpreter in the Z8671 normally uses the on-chip full duplex UART (Universal Asynchronous Receiver Transmitter) for input and output processing. Each time this BASIC/DEBUG interpreter requires a new INPUT character, a test is performed on the Interrupt Mask Register (IMR, R251). The contents of the IMR are effectively ANDed with 88H and, if the result causes either of the sign or the zero flags to be set, then BASIC/DEBUG takes a look at the external memory location 1012H for a JUMP instruction to a user-supplied input driver. The same test on the IMR is done for all BASIC/DEBUG outputs, the only difference being that the JUMP instruction to the external output driver is then found at 1015H.

The facility mentioned above of interfacing external input/output drivers directly to BASIC allows the use of devices other than the internal UART and the execution of other application-specific I/O tasks. For example, input could be obtained from an ASCII keyboard and output sent to ASCII LCD display configured as part of the memory map.

Using external I/O drivers automatically allows the PRINT statement in BASIC to output to the user-supplied device. Similarly the INPUT statement will obtain characters from the user-supplied source. With such a facility, there is no call for cumbersome programming in order to get I/O to the right place. In the normal way, outputting a text string to an ASCII display on port 2 would, for example, require sending each character separately.

The flowchart in ***Fig.1*** illustrates how the external I/O drivers 'fit in' with the internal serial drivers of BASIC/DEBUG. Assuming that the external I/O drivers are not active, the usual sequence of events is that any input request waits for a serial character, stores it in register 19, and then proceeds to echo it back by going on into the serial output routine. This procedure is ended by a RETURN instruction. If however the external I/O drivers are active, the serial I/O routines are never seen, as a jump is made to an external routine. The outcome of this is that any echoing of input characters must be performed by the external routine (e.g. from the keyboard to the display) and that the external routine must contain a RETURN instruction to bring it back into BASIC/DEBUG.

There are, in addition, some other points to adhere to whilst using external I/O. Firstly, the routines must pass each single ASCII INPUT or OUTPUT character through register 19; secondly, the parity bit (bit 7) of all input characters must be set to zero; and finally the register pointer, which is set to point to R16–31 during an I/O request, must also have this setting when returning to BASIC/DEBUG.

Table 1 summarises the requirements on using external I/O drivers.

1Ø12H	Jump to INPUT driver.
1Ø15H	Jump to OUTPUT driver.
RP (Reg Pointer, R253)	Set to R16-31.
R4—15, R22—32	Must be preserved.
BIT 7 of INPUT characters	Must be 0.
USER FLAG 2	Preserved.
USER FLAG 1	Set for 'ESCAPE'.
Return to BASIC/DEBUG with RETURN instruction.	

Table 1: Parameters for external I/O.

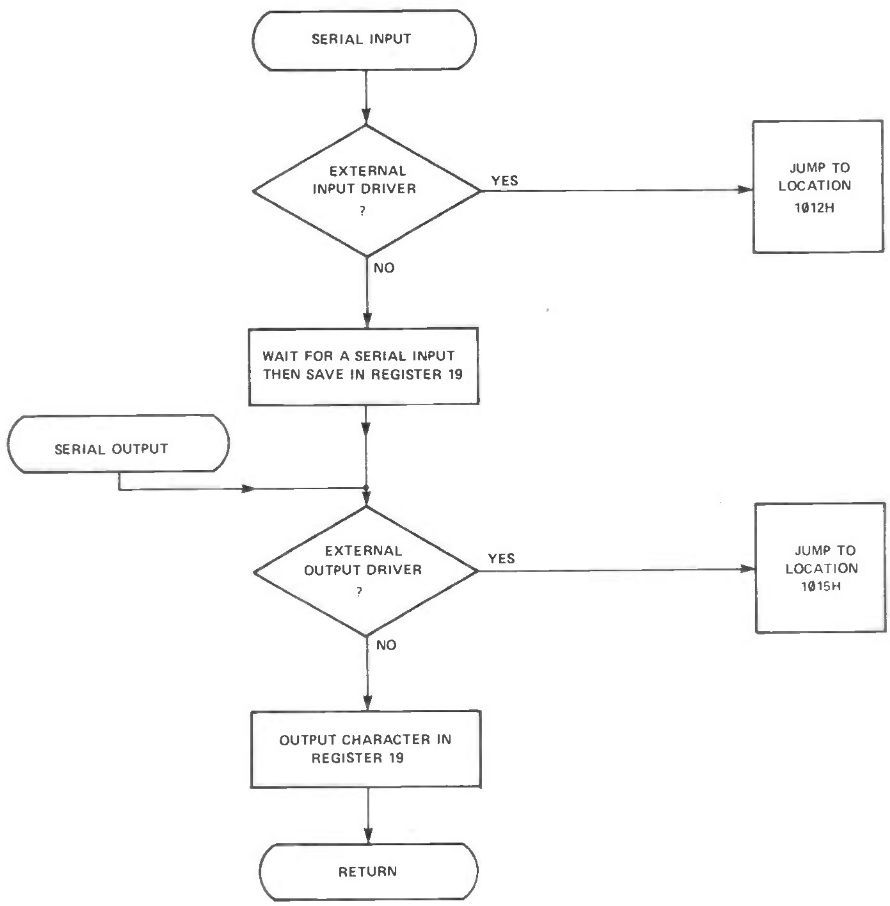


Figure 1: BASIC/DEBUG serial I/O flowchart.

Planning an Escape

There is another part of the BASIC/DEBUG interpreter that checks the IMR for external I/O – that part concerned with responding to an ESCAPE character. Normally, BASIC/DEBUG tests for an input 'ESCAPE' character at the end of each program line during program execution. If an 'ESCAPE' is found, user flag 1 (Bit 0 of FLAGS, R252) is set and program execution is halted. However, when external I/O is enabled, the test is ignored: thus the task of detecting 'ESCAPE' characters falls to the external I/O drivers. Their routines must therefore ensure that user flag 1 is set upon an ESCAPE character being input. In some applications, this can be turned to advantage, through the 'ESCAPE' key being made inactive or changed to any other ASCII character.

Centronics Interface

The interface described here, which allows a Centronics-type printer to be controlled transparently from BASIC/DEBUG, illustrates the use of external I/O drivers attached to a Z8671. Centronics' pioneering spirit in the field of printers led to its name becoming synonymous with a standardised method of transferring parallel data to printers.

Before venturing into the realms of the required Z8 software, we take an instructive look at the hardware and the timing of a Centronics interface.

The Timing

Unlike serial interfaces, Centronics interfaces make use of handshaking on every data transfer; ***Fig.2*** outlines the methods used. There are two fundamental types of printer, each with a corresponding handshake.

Most printers accept data without printing it until they receive a carriage return or a line feed character, whereupon the previous line is printed. When these printers accept data, normal transfer handshaking is used as in ***Fig.2a***: when printing, the printer goes into *Busy* status and thus uses the *Busy* handshake shown in ***Fig.2b***.

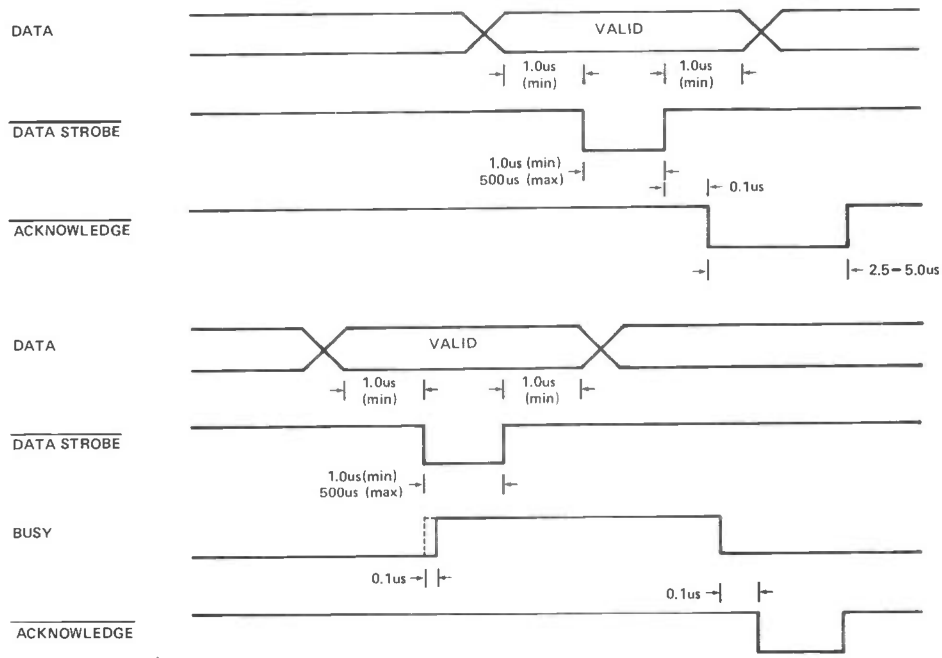


Figure 2: Centronics Interface timing. a) Normal data transfer; b) Busy data transfer.

Other types of printers (such as the ALPS X/Y Microprinter) print data on a character by character basis and have a print buffer a few characters long. These mainly use the *Busy* type of handshaking.

The program presented here only uses the *Data Strobe* and *Acknowledge* signals for handshaking, the *Busy* signal being ignored since it is always followed by an *Acknowledge*. (Indeed, some programs make use of the *Busy* line to store print information in a software buffer and thus increase data throughput but this has not been done here.) A typical sequence of events in this particular Centronics Interface is therefore to ouput a parallel data byte to the printer, toggle the *Data Strobe* signal to show that a new print character is ready and then wait for the *Acknowledge*.

The Hardware

Since all the Centronics signals are TTL compatible, port 2 is used to output the data while port 3 provides two control lines. The *Data Strobe* signal comes from $P3_5$ configured as an output, while the *Acknowledge* comes from $P3_2$ configured as an input. The actual output drive available from the Z8 does not allow for much capacitance on the output lines, and thus the lead length to the printer is restricted to less than one metre. Longer leads can be used if some type of TTL line driving buffer is incorporated.

The actual connections to a Centronics printer are shown in ***Fig.3***, while ***Fig.4*** gives the Z8-to-printer wiring. The signals used pass along the connections shown in the latter diagram, each of which is wired by twisting with an earth lead.

Pin	Signal	Pin	Signal
1	DATA STROBE	19	GND
2	DATA BIT 0	20	GND
3	DATA BIT 1	21	GND
4	DATA BIT 2	22	GND
5	DATA BIT 3	23	GND
6	DATA BIT 4	24	GND
7	DATA BIT 5	25	GND
8	DATA BIT 6	26	GND
9	DATA BIT 7	27	GND
10	ACKNOWLEDGE	28	GND
11	↑	29	↑
12		30	
13	Not used	31	
14	on this	32	Not
15	Interface	33	Used
16		34	
17		35	
18	↓	36	↓

Figure 3: Centronics Interface connections. The connector is Amphenol type 57-40360 36 way.

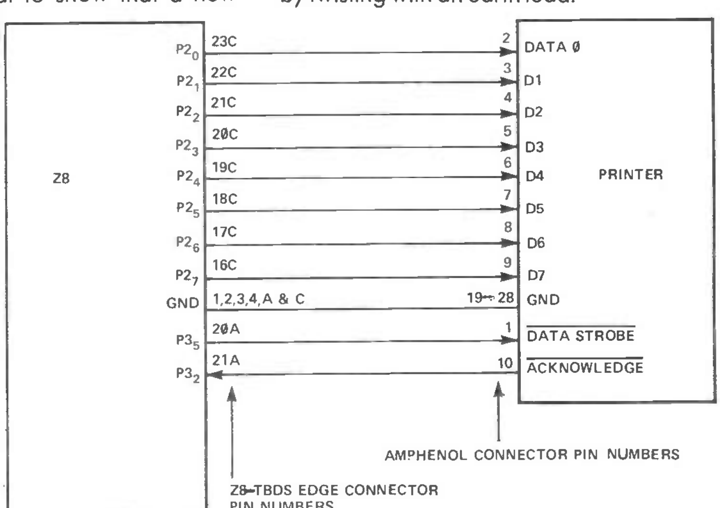


Figure 4: Z8-to-Printer connections. ▶

Program Description

As I described earlier, the starting point is to set up the JUMP instructions to the external I/O drivers: both jumps have to be specified whether a routine is supplied or not. Another look at the flowchart of ***Fig.1*** brings out an interesting point in this connection. Whenever the BASIC/DEBUG interpreter receives an input character, it is always echoed and hence the input can be trapped in the serial output routine. This is made use of in the program by employing the serial I/O as before but appending the Centronics routine as part of the serial output.

Figure 5 shows how this works in practice. This diagram is essentially the original flowchart but it includes the jumps to the external I/O drivers. The addresses in brackets refer to addresses in the BASIC/DEBUG interpreter. Since there is no external input driver, the jump at 1012H simply jumps back into the serial input routine at 005AH. A serial output will jump to the Centronics program and then jump back to 006CH, as if nothing happened, prior to sending the character to the UART.

The details of the procedure for setting the JUMP instructions at 1012H and 1015H depend on whether EPROM or RAM is located at these addresses. The easier to deal with is EPROM, as for instance in the **R&EW** Z8-MCS board; you merely have to ensure that the correct bytes are blown into EPROM. In assembler the code needed is:-

```
1012H     JP  005AH
1015H     JP  PRINT
```

Where PRINT is the address of the Centronics routine. If RAM is present, as on the **R&EW** Z8-TBDS board, then you need to ensure that these bytes are loaded into the correct locations. The method adopted here is to set up some internal registers with the required bytes and then to copy the registers to RAM. This must be done before enabling external I/O.

By the way, always ensure that the start of program pointer (R8,9) is set to 1020H or above; otherwise the JUMP instructions may be overwritten by the user's program.

Once the JUMP instructions have been set up and the interrupts disabled, the IMR can be loaded with the byte that enables external I/O. In this case 08H is used. However, if you intend using interrupts (for example, Z8 EXEC uses interrupts for the real time clock) and the Centronics routine simultaneously, then this will have to be changed. However, details cannot be given here as they depend upon precisely which interrupts are being used.

Reverting I/O handling back to normal simply requires the IMR to be changed to disable external I/O (in this case 80H is used) or the reset button to be pressed.

The Centronics routine PRINT checks for ESCAPE characters and uses control P (^P) to toggle the print state. Register 33 bit 0 is used as the flag for the latter. Initially register 33 is cleared to disable printing and pressing ^P on the keyboard, or setting bit 0 of R33 early on in the program, will cause all output characters to be printed. Pressing ^P again or resetting R33 bit 0 will turn off the printer.

Another point to note is that the PRINT routine is relocatable and the only constraint is that the jump instruction at 1015H must be set to point to it. The program listing in ***Fig.6***, which includes initialisation for the Z8-TBDS board, is assembled for 2000H.

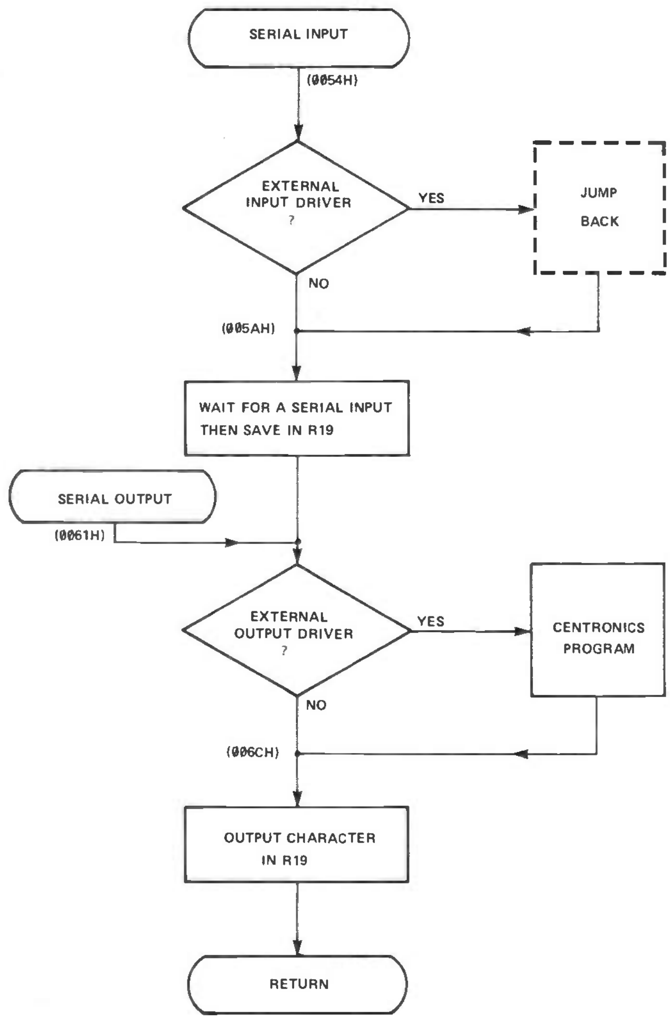


Figure 5: External I/O flowchart.

The program in use

The program as presented is designed for use with a Z8-TBDS. To load it, one merely needs to type in the assembled code using the Modify Memory Utility. External I/O is then initialised by

GO@ %2000,

while external I/O is completely disabled by

GO@ %202A.

These calls may be used either in immediate mode or as part of a program.

When initialised, typing a ^P will turn the printer on, and subsequently any further characters to be typed in should appear on the printer. A ^P can be typed at any time in immediate mode to flip the printer status.

To turn the printer on in a program, @33=1 is used while @33=0 is used to turn the printer off.

Single characters are sent to the printer by using:

GO@ %61, DATA

where DATA is any byte. Similarly the statement:

GO@ %61, %10

will act as a ^P and flip the printer status. Control P is thus the only character that cannot be sent to the printer.

As I pointed out earlier, the listing given in ***Fig.6*** has been written for a Z8-TBDS board, but after studying it, the reader should be able to deduce the changes needed to implement it on a Z8-MCS board.

Example Program

This program for the Z8-TBDS, for which the code in ***Fig.6*** is located at 2000H, will initialise external I/O and output the text in line 30 on the printer. But, while the text in line 50 won't be sent to the printer, both the print lines will appear on the VDU screen.

```
10 GO@%2000
20 @33=1
30 "THIS SHOULD APPEAR ON THE PRINTER."
40 @33=0
50 "THIS DOESN'T"
60 STOP
:
:RUN
THIS SHOULD APPEAR ON THE PRINTER.
THIS TEXT WAS PRINTED USING THE CENTRONICS PROGRAM.
```

Final Note

Version 2 utilities do not use the serial I/O routines in BASIC/DEBUG and so cannot output to the printer. If you need to display memory and get a copy, use version 1.

If the printer does not acknowledge for some reason, press the reset button but note that this also disables the external I/O.

```
                *       INITIALISATION. SET UP VARIABLES.
2000            ORG     2000H
2000 70FD       INIT    PUSH    RP
2002 3120               SRP     £32

                *       SET UP INPUT/OUTPUT ADDRESSES IN R4 TO R9

2004 1C06               LD      R1,     £6              ;BYTE COUNT
2006 2C10               LD      R2,     £10H            ;PUT 1012H IN R2,R3
2008 3C12               LD      R3,     £12H
200A 4C8D               LD      R4,     £8DH            ;JP OPCODE
200C B0E5               CLR     R5
200E 6C5A               LD      R6,     £5AH            ;005AH NOW IN R5,R6
2010 7C8D               LD      R7,     £8DH
2012 8C20               LD      R8,     £HI PRINT
2014 9C2F               LD      R9,     £LO PRINT       ;PRINT ROUTINE ADDRESS IN R8,R9
2016 AC24               LD      R10,    £36             ;POINTS TO R4

                *       TRANSFER R4 TO R9 TO MEMORY FROM 1012H

2018 D3A2       MOVE    LDCI    @RR2,   @R10
201A 1AFC               DJNZ    R1,     MOVE
201C 50FD               POP     RP

                *       SET UP PORTS AND PRINT FLAG

201E B021               CLR     33                      ;DISABLE PRINT
2020 B0F6               CLR     P2M                     ;PORT 2 TO OUTPUT
2022 E6F741             LD      P3M,    £41H            ;PORT 3 MODE

                *       ENABLE EXTERNAL I/O DRIVERS

2025 8F                 DI
2026 E6FB08             LD      IMR,    £8

                *       END OF INITIALISATION. GET BACK

2029 AF                 RET

                *       THIS ROUTINE REVERTS I/O BACK TO NORMAL

202A 8F         NORMAL  DI
202B E6FB80             LD      IMR,    £80H
202E AF                 RET

                *       CENTRONICS PRINT ROUTINE. RELOCATABLE.

                *       P32 IS ACKNOWLEDGE FROM PRINTER.
                *       P35 IS DATA STROBE TO PRINTER.
                *       SETTING BIT 1 OF REGISTER 33 WILL ENABLE PRINT
                *       MODIFIES REGISTER 16
                *       ^P TOGGLES PRINTER ON/OFF

202F 56FCFE     PRINT   AND     FLAGS,  £0FEH           ;RESET ESCAPE FLAG
2032 A61310             CP      19,     £10H            ;IS IT A ^P ?
2035 EB07               JR      NZ,     CHECK           ;JUMP IF NOT
2037 B62101             XOR     33,     £1              ;FLIP PRINT STATUS
203A B013               CLR     19                      ;MAKE TRANSPARENT TO BASIC
203C 8B27               JR      DONE

                *       CHECK IF PRINT ENABLED

203E 762101     CHECK   TM      33,     £1              ;IS PRINT ON ?
2041 6B14               JR      Z,      ESCAPE          ;IF NOT JUMP
2043 E41302             LD      2,      19              ;TRANSFER CHARACTER

                *       TOGGLE DATA STROBE

2046 5603DF             AND     3,      £0DFH           ;DATA STROBE LOW
2049 FF                 NOP                             ;KEEP IT LOW
204A 460320             OR      3,      £20H            ;DATA STROBE HIGH

                *       WAIT FOR ACKNOWLEDGE

204D 660304     ACKLO   TCM     3,      £4              ;IS ACK LOW ?
2050 6BFB               JR      Z,      ACKLO           ;IF NOT WAIT

2052 760304     ACKHI   TM      3,      £4              ;IS ACK HIGH ?
2055 6BFB               JR      Z,      ACKHI           ;IF NOT WAIT

                *       CHECK FOR AN ESCAPE CHARACTER

2057 E4F010     ESCAPE  LD      16,     SIO             ;GET LAST INPUT
205A 56107F             AND     16,     £7FH            ;STRIP PARITY
205D A6101B             CP      16,     £1BH            ;ESCAPE CHARACTER ?
2060 EB03               JR      NZ,     DONE            ;IF NOT JUMP
2062 46FC01             OR      FLAGS,  £1              ;SET ESCAPE FLAG

                *       END OF ROUTINE. NOW ECHO CHARACTER THROUGH SERIAL PORT

2065 8D006C     DONE    JP      006CH
2068
```

Figure 6: The program.

■ R&EW

BUSINESS DIARY

High Frequencies in High Places

R&EW, as we have always said, is being read in all the right places. A provocative aside in the recent R2000/R70 review feature (June issue p46) prompted an amused riposte from no less than Plessey Radio Systems of West Leigh, Hants – not to be confused with that other Plessey establishment in Wiltshire ('the county that's full of meat' according to that rather curiously worded commentary in the sausage and pork pie advert).

Indeed, Mike Thomas of PRS, who spotted the wry comment relating Plessey and a hankering for mechanically tuned HF receivers, took the occasion to remind us that PRS receivers have been well and truly synthesised down in Hants for a good while. Furthermore, PRS was about to hold a press launch to christen the new PR2280 HF bus-controllable receiving system, so your editor was invited to come and bear witness to the state of the art for himself.

A word of caution: Plessey is one of those firms which publish its consolidated balance sheet with almost all the figures in millions of pounds. The PR2280 is not for the faint of wallet, but who's to say that it won't one day find itself in the hamshack by the same process as the HRO, AR88 *et alia* ?

After all, the AR88 probably cost the equivalent of the PR2280's '£8K'ish' in 1940.

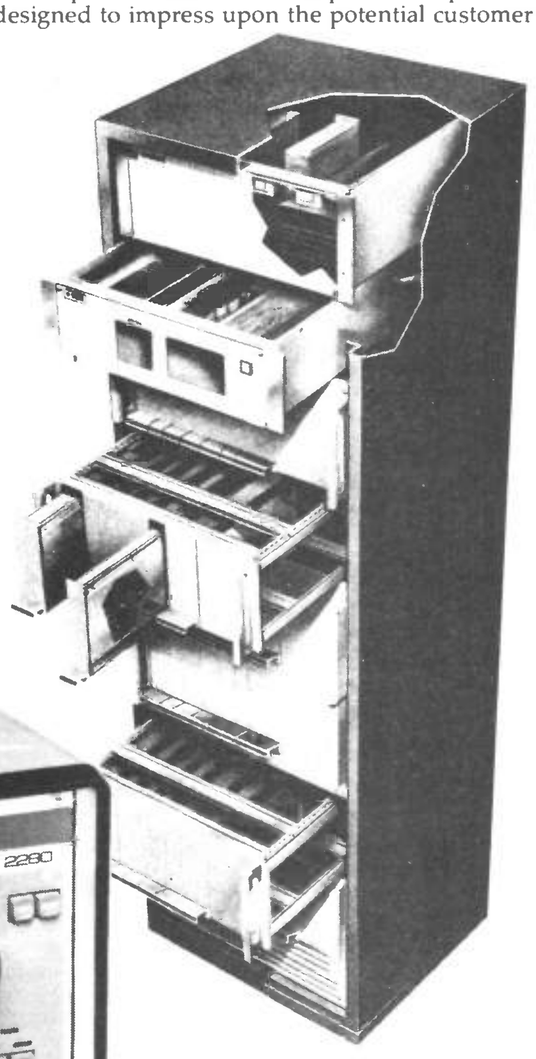
A3J and tonic, please

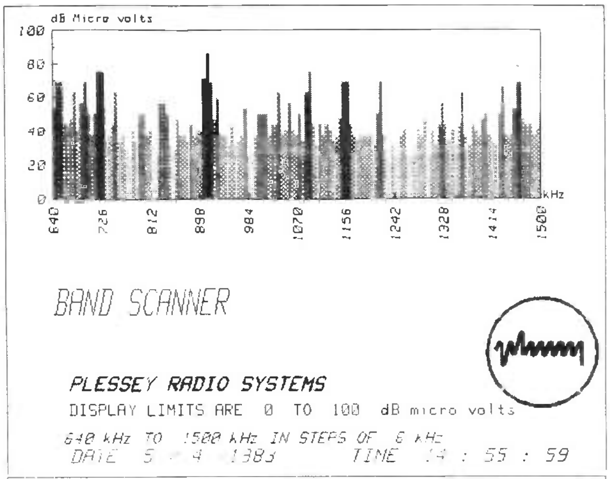
The presentation of the PR2280 was a low key affair, where many of the guests soon found themselves in difficulties when called upon to utter the word 'synthesiser', let alone when required to consider the finer technical points of such a device. Your scribe was evidently in the presence of one of those most wonderous products of our technological age – the sort for which those buying and selling can know about as much about what goes on inside as you or I know about glass blowing in Upper Volta.

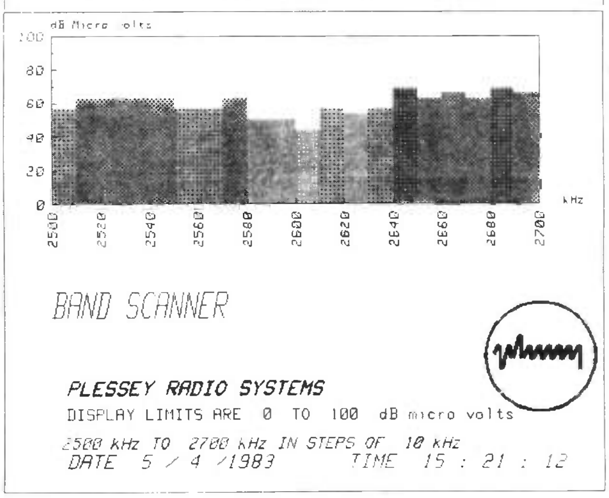
'Have a drink' someone said with an air of bonhomie that put the whole affair into perspective. The main business of an occasion such as this is not to discuss double balanced mixers, 20 pole crystal filters or intermodulation. Selling the wares of the UK communications industry is about putting on a show to rival the legendary hospitality of people like Racal.

'Have another G&T old man', and some military attaché or other willingly submits to a gentle sales patter that would not have strained the technical resources of a young mother buying her offspring a 'Speak and Spell' at Dixon's.

The audio-visual presentation that accompanied the product launch was designed to impress upon the potential customer







Data Summary

Frequency range
10kHz—29.99999MHz in 10Hz steps, synthesiser controlled. (Tuning speed 50msec).

Modes of operation
CW, AM, USB, LSB, ISB, F.SK

Frequency stability
Short term:

1in 10^7 over temperature range (0°C to + 50°C)

Long term:

1in 10^6 per year
(Provision for external 1MHz + 10dBm input)

Selectivity
Standard equipment:

	3dB points
8kHz	+ 4kHz
1.2kHz	+ 600Hz
300Hz	+ 150Hz
100Hz	+ 50Hz
USB	+ 250Hz to + 3.25kHz
LSB	− 250Hz to -3.25kHz

A maximum of 11 customised filters can be accommodated.

Sensitivity

Mode	Input level emf 100kHz to 30MHz	Input level emf 10kHz	Bandwidth	S + N/N
CW	1μV	10μV	300Hz	18dB
Am	3μV (60% Mod)	30μV	8kHz	9dB
SSB	1μV	10μV	2kHz	14dB

AGC range —
less than 4dB change in output level for 120dB change in input level relative to a.g.c. threshold

AGC Timeconstant —
for 40dB input level change.

	Attack	Decay
Short	10mSec	200mSec
Medium	10mSec	2 Sec
Long	10mSec	10 Sec

Manual RF gain control — range 100dB.

RF input
Impedance 50ohm nominal
VSWR 3:1 over range 100kHz to 30MHz
VSWR 4:1 over range 10kHz to 30MHz

Input protection (optional) —
allows input of 175v rms to be applied without damage.

Aerial re-radiation —
in band is less than 5uV into 50 ohm.

Intermodulation products
Out of band — interfering signals frequency related to produce 2nd and 3rd order inter-modulation products situated more than 25kHz from the tuned frequency shall have an amplitude of not less than 32uV emf (90dBuV) to produce a product equivalent to an input of 1uV emf.

Cross modulation —
an unwanted signal at least 20kHz away from the tuned frequency shall have an amplitude of at least 500uV emf.

Blocking —
an unwanted signal at least 20kHz away from the tuned frequency shall have an amplitude of at least 1v emf to reduce the output level due to a 1uV emf signal by 3dB.

IF rejection —
greater than 100dB

Image rejection —
greater than 80dB.

BFO
Variable BFO on CW Mode + 3kHz.

Pre-set frequency offset on FSK mode + 8kHz in 100Hz increments.

Environment
Operation -20 to + 50°C, 95% RH
Storage: -40 to + 70°C, 95% RH

Power requirements
Input voltage 120/240V (50-400Hz)

Consumption 90VA maximum depending on version

Dimensions (stand alone version)
19 inch rack mounting

7.5 inches (4u) high

483 x 189 x 380(mm) W x H x D

Weight — 18kg

that Plessey is a) very big, b) very clever, and c) dedicated to making the world a finer place to live in. The musical soundtrack of this expensively produced piece of marketing was quite delightful, and when I jokingly asked for a copy of the soundtrack LP, a Plessey salesperson (who was taking it all rather too seriously) asked if I wanted a transcript of the voiceover. Heaven preserve us!

I noted that the frequencies on the display of the receiver in the film were all BBC MW broadcast channels. Perhaps Plessey were mindful of the conditions of their broadcast reception licence, and the restrictions it places on receiving 'unauthorised' signals. Or maybe they are mindful of the fact that the Beeb at Caversham is likely to be one of their most fruitful hunting grounds, and a little flattery never did anyone's sales prospects much harm.

Notwithstanding that this was an event for those empowered to spend a Great Deal of taxpayers' money rather than for perspiring scribes seeking to thrust their readers' knowledge of the boundaries of communications technology a step further ahead, the PR2280 is still a thing of joy. Not too many frills (no noise blanker, no PBT, no FM demod), just good old dynamic range and stability. From the rather incongruous knobs reminiscent of an Eddystone front panel to the delightfully free spinning shaft encoder, the PR2280 is a workhorse for the professional listener. Much is made of the modular construction with each of the various sub-assemblies sporting its own processor (reputed to be 6800 based) to sit on the RS232 or IEEE interface.

A fearsomely expensive HP desktop computer was demonstrated using the superb high-def colour graphics to illustrate the remote programmability and information aquisition functions of the system. The man said that a program had been developed for a PET as well, and if you got it, flaunt it, as they say.

The work of the devil

The Band Scanner print out from the HP system presented here displays fearsome prospects for the capability of the combinations of computer and communications receivers, and perhaps should put to shame those radio amateurs who still dismiss computing as the work of the devil where communications is concerned. It doesn't take too much imagination to sketch out an approach to do (nearly) the same with an R70's data connector and a BBC microcomputer.

The spec of the receiver is reproduced for your edification: despite spotting the deliberate error that quoted the 3rd order intercept as 32uV emf instead of 32mV, we weren't given one as a prize. Most notable feature in my book is the AGC performance. The RF performance is little changed from the earlier generation devices; most of the innovation lies in the control functions and versatility.

A final sobering thought: the optical shaft encoder used on the manual version of the front panel costs more than a R2000 on its own. I wonder if the BBC will be evaluating the Icom R70 thoroughly before spending another £7500 of our licence money on this delightful, but expensive, box of tricks? Maybe I'd feel a shade more charitable towards PRS if it had the nerve to adapt its skills in producing excellence, to developing a mass-market receiver after the likes of the Trio, Yaesu and Icom offerings.

I don't doubt that there are engineers aplenty within the organisation brimming over with the enthusiasm to give such a project a crack. How about it before we all forget how to mass produce good radios in this benighted land?

Further info:
Plessey Radio Systems, Martin Road, West Leigh, Hants PO9 5DH.

■ R&EW

DESIGNER'S UPDATE

This month, Michael Graham looks at the memory devices expected to dominate in 1984 and, in particular, at those products offered by INMOS.

INMOS as a company has been getting a far amount of press coverage of late, although much of it in the pages of the Financial Times rather than the technical press. As **R&EW** is part of the aforementioned technical press, I shall not comment too much on the company's commercial plans or on the Government's involvement with INMOS, but instead I will concentrate on the products that the company is pinning its hopes on in 1984.

INMOS's major product area is memory – not the most glamorous of products but certainly a vital element of the computing industry. The devices due to become the top sellers for 1984 are 64K DRAMs, 16K fast statics and non-volatile EEPROMS. These products between them accounted for only £0.4b of the £2.5b memory market back in 1980 and by 1982 still represented less than 25% of memory sales. Next year, however, it is predicted that these three types of memory will take more than half of the total memory market. INMOS is well placed to take advantage of this growth area and it is strongly represented in these major product areas, as we shall see.

IMS1400

The IMS1400 is a 16K×1 fully static RAM. The device is offered as either a 45ns or a 55ns access time version and it has a powerful requirement of 660mW (110mW in Standby mode). In addition, a process variation during production leads to lower power versions of the device with 70 or 100ns access times.

Major areas of application include video stores and MMUs (Memory Management Units) in minis and some novel systems based on 16-bit micros.

The block diagram of the device is shown in *Fig. 1*.

IMS1420

The IMS1420 is very similar to the 1400 but it is configured as a 4K×4 static device. The IC is again offered in 45 and 55ns access time versions with a 600mW power requirement when active and 165mW in Standby mode.

This device's block diagram is shown in *Fig.2*.

IMS2600

The IMS2600 is a standard pin-out 64K×1 dynamic memory device. It is offered in 100ns and 120ns versions and features *On-Chip Refresh*. ***Figure 3*** shows the block diagram of this device.

The IMS2600 also provides for *Nibble Mode* access which allows 4 bits of information to be read every 55ns. Nibble Mode operation is possible because, although externally configured as a 16K× 1 device, the 2600 is internally organised as a 16K ×4 array. In Nibble Mode, a block of four bits selected by the eight row addresses and the six most significant column bits are loaded into a set of registers. The two low order column bits are then used to select the first of the four bits to be read. When this bit has been accessed, taking $\overline{RAS}$ high will terminate the cycle while toggling $\overline{CAS}$ in the sequence shown in ***Fig.4*** will read out the remaining bits at a speed equivalent to a 55ns rate for the four bits.

This technique is useful in memory READ-MODIFY-WRITE operations and video stores.

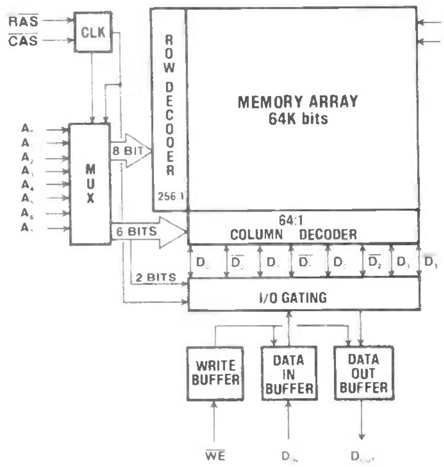


Figure 3: IMS2600 block diagram.

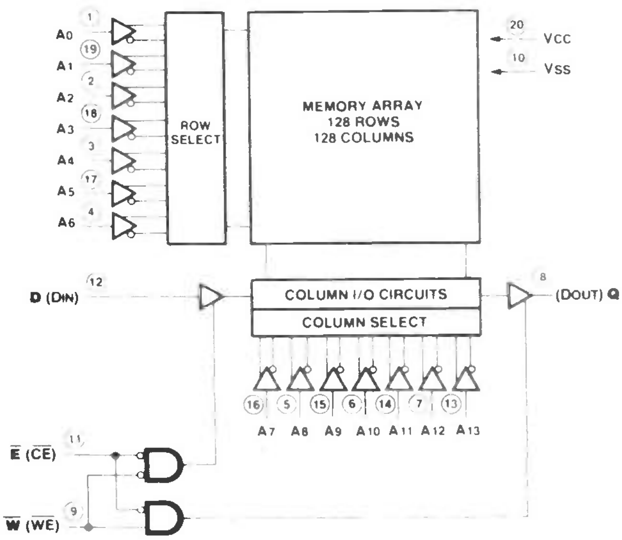


Figure 1: IMS1400 block diagram.

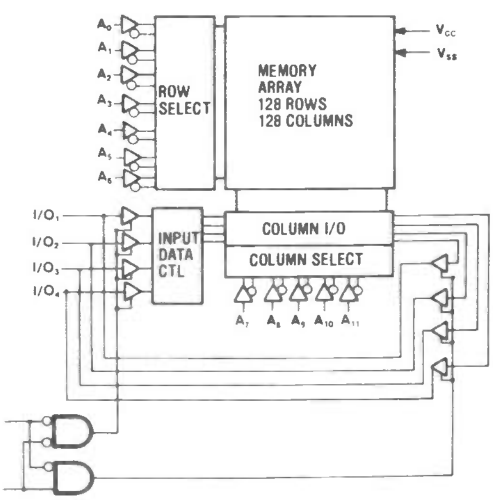


Figure 2: IMS1420 block diagram.

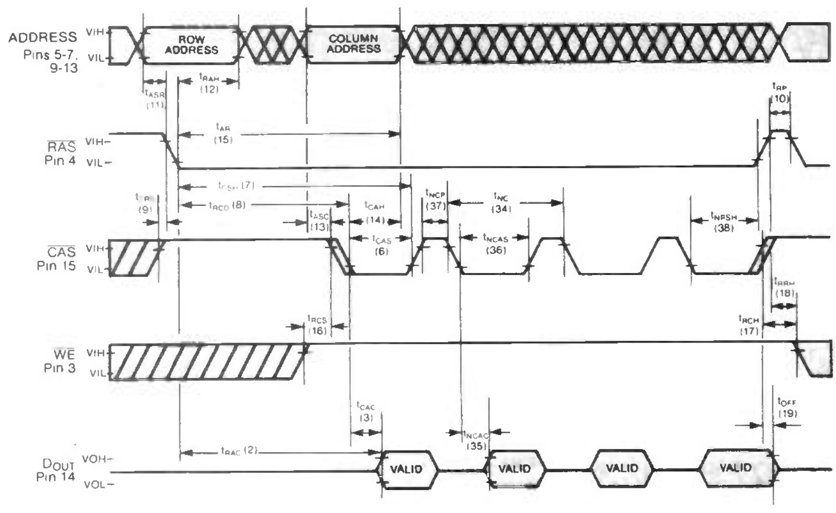


Figure 4: IMS2600 Nibble Mode Read Cycle.

IMS2620

The IMS2620 is a 16K×4 dynamic memory that comes in three access time versions (100, 120 and 150ns). The device is similar to the Texas TMS4416 but offers a refresh counter which means that improvements in bus usage can be achieved. Its block diagram is shown in ***Fig.5***.

IMS2630

The IMS2630 is a massive 8K×8 dynamic RAM that, by virtue of its bytewide design, offers EPROM interchangeability. On-Chip Refresh, single 5V operation and full TTL compatability, make the 2630 a very versatile device. ***Figure 6*** shows this device's block diagram.

IMS3630

The IMS3630 is perhaps the most impressive of the INMOS devices reviewed here, being an 8K×8 EEPROM. This IC provides 64K of non-volatile, but alterable, storage in a standard 28-pin DIL package.

Figure 7 shows both the pin-out and the block diagram of the device, which demonstrate that the IC only requires a single (5V) rail for operation: all voltages required for erasing and programming are generated on-chip.

An on-board micro controller makes interfacing the device to a micro system a straightforward matter. It also controls the various READ/WRITE operations.

These INMOS products are either available now or will be in the near future. Some of them will not be cheap but they will be available as one-offs from INMOS distributors. Experimenting with them should be a rewarding experience and it will mean that you will be familiar with the technology of finished products that probably will not reach the market for another year or so.

Finally, I would like to thank INMOS for their permission to reproduce the data shown on these pages.

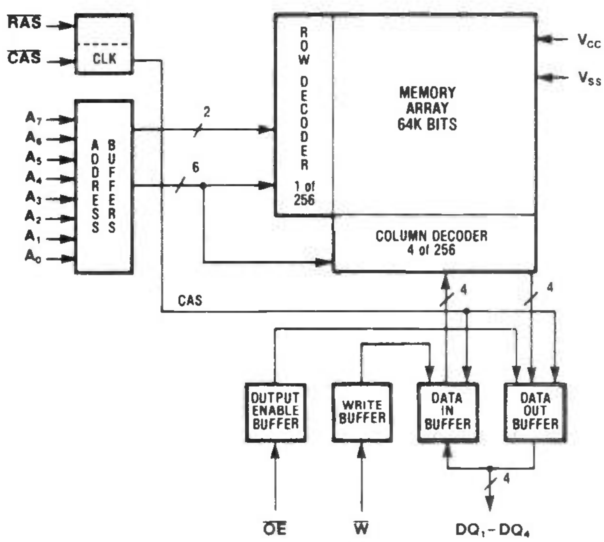


Figure 5: IMS2630 block diagram.

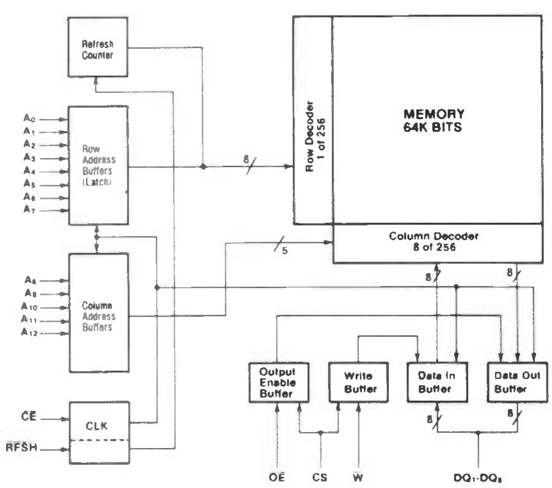


Figure 6: IMS2630 block diagram.

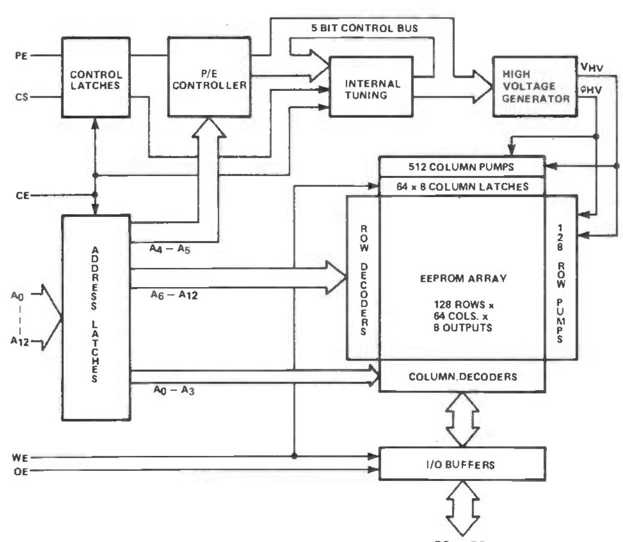
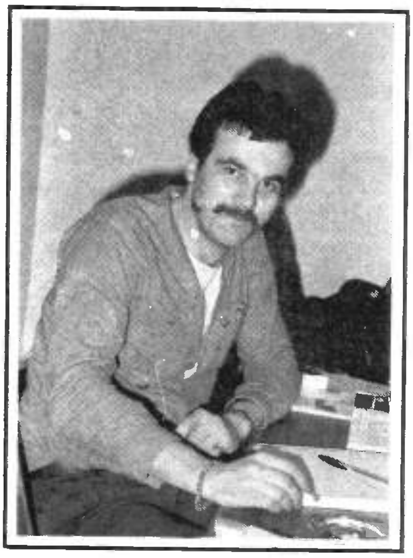


Figure 7: IMS3630 block diagram.

VIDEO NEWS

Peter Luke with a few guesses as to what Hi-Fi Sound is all about, along with news of the latest crop of new releases.



The reason behind the fact that Panasonic's latest two top-of-the-range machines did not feature the in-vogue option of Stereo Recording with Playback Capability has just been revealed. It looks as if the company plans to upstage the Beta system by making the first machine to offer Hi-Fi Sound. The company is said to have decided that it would be unfair to market a stereo machine as its flagship model, only to replace it after a very short period of time.

Details of exactly how Panasonic is to implement Hi-Fi Sound are a little sketchy. The non-technical PR handouts that are available tend to suggest that the company has mounted two audio heads on the same drum as the video heads while, it appears, also retaining the standard audio heads. The rotating audio heads will provide the high effective tape speed that is essential for good quality recording.

The Slant Azimuth Recording system adopted by both the VHS and Beta formats has, however, done away with the guard bands between adjacent tracks found on the old Philips format. (This was done to provide a higher recording density and is achieved by magnetically 'polarising' adjacent tracks during recording and similarly orientating the playback heads so that each only responds to the required signal, ignoring the information recorded on the adjacent track.) This leaves little or no room between tracks in which the audio information can be recorded. The assumption is that the audio is recorded on a frequency modulated carrier of a far lower frequency than that used for the video signal. (Recording the audio in the same way as a conventional audio recorder is probably impossible owing to the physical constraints placed upon a head that is to be mounted on the helical drum.) The fact that the two FM carrier signals are far apart in frequency and that the audio and video heads can be made to respond only to the signal which is intended for them is the reason that the audio information can be squeezed onto the tape when, superficially, there is no room available for it.

I'll try to get hold of more detailed technical information in the near future but until then, that's my best guess as to how the Hi-Fi Sound will be achieved.If so, it's a shame – because in these days of Digital Recording techniques, it is a pity that a *digital* solution to the problem of high quality sound tracks could not have been found.

Sure a digital system would have posed many problems: the bit rate of a CD player being over 4MHz – greater than the bandwidth of a video recorder – would have been just one of the hurdles to overcome. Broadcasting organisations have been using a system of digital sound in sync for some time now, and a domestic version of this would have been an elegant solution to providing Hi-Fi Sound.

Presumably the companies developing the recorders looked at a digital system but decided that, in order to be first to the market place with a Hi-Fi Recorder, the analogue approach should be adopted. We will probably have to wait a few more years before we see the application of digital techniques in video recorders.

Back to the Panasonic machine – it is already on sale in Japan and should be here before Christmas, at a price that has yet to be fixed. Whether the VHS machine will beat the Beta system to the High Streets depends on how well Sony and Sanyo are getting on with their recorders. Both the latter companies are working on Hi-Fi Sound systems but, at present, they are keeping very quiet about naming launch dates.

Shoal of Sharps

Sharp has recently revamped its entire range of video recorders. From the bottom up, its range now consists of the VC381, a basic £500, seven-day, one-event machine with picture search, still frame and a wired remote unit. The next is a stereo machine – the VC386: This has Dolby NR, a 14-day five-event timer and the usual range of trick effects. The price is around £600. About £770 will buy the VC388, which is a neatly styled top-of-the-range recorder.

Two more recorders feature in the revamped range: the VC3300H, a transportable machine offering a resonable

either mains or battery operation (price around £700); and, lastly, Sharp has announced a two-speed recorder with a five-event, 14-day timer at the attractive price of around £650.

While on the subject of two-speed recorders, it would be nice to see a Hi-Fi Sound system incorporated on these machines as soon as possible. This would compensate for the fact that, while picture quality is still quite acceptable on most two-speed recorders operating at half speed, the sound quality becomes very poor when the tape is slowed down.

Symbolic Launch

JVC's new recorder – the D120 – has a front panel layout that sets it apart from the crowd. Gone are the anonymous square-shaped buttons of the past; instead each control is shaped according to its function. The launch should be in the Autumn and the price around £500.

Aside from its unusual styling, the recorder has a basic one-event, 14-day timer specification and it incorporates a version of the Panasonic OTR (One Touch Recording) facility.

Palace's Progress

The Video Palace has just moved from its Kensington High Street shop to a new store at 100 Oxford Street. The Video Palace is one of the larger software houses and it has over 7000 titles in stock. From its Oxford Street site it will be able to offer a comprehensive service both to callers and to those who prefer to have their tapes delivered, covering most of central London.

INDEX 1981-1983

PROJECTS

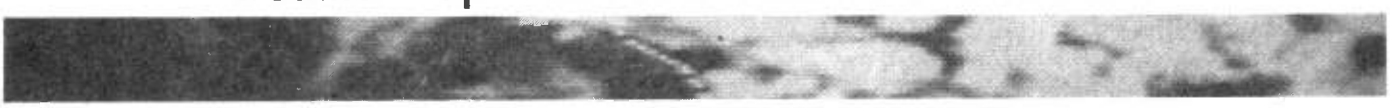
FEATURES

REVIEWS

Design and Data Updates

Weather Facsimile Reception

Keith Mitchell describes the use of a digital scan converter to decode weather maps other than those from METEOSAT



There is a worldwide network of stations transmitting meteorological data in various forms and one of the most useful formats 'is facsimile pictures of weather maps and charts. Reception of the signals has usually been quite straightforward, but the production of a facsimile machine to 'draw' the charts has been difficult for the amateur communications enthusiast.

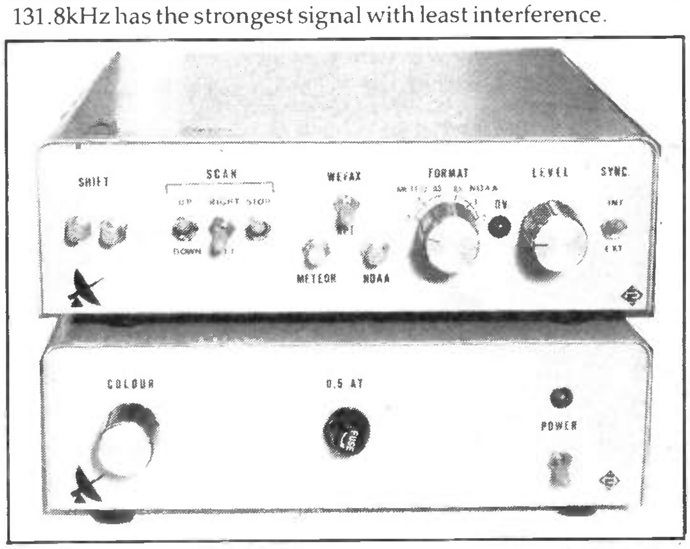
The digital scan converter designed by Matjaz Vidmar (YU3UMV) for the reception of weather satellite pictures – see **R&EW** June 1983 p57, August 1983 p52 – appeared to be a perfect electronic answer to the problem and after a minimal amount of experimentation, good quality pictures were being received from the VLF Paris transmitter on 131.8kHz.

The standards of the FAX transmissions are usually a line frequency of 120 lines per minute (2Hz), with an index of co-operation of 288 or 576. The index of co-operation is a measure of the line spacing of the picture, low definition pictures (288) being transmitted at twice the rate and twice the line spacing of high definition pictures (576). To arrive at the index, the length of one line of the transmission is multiplied by the number of lines per unit length of picture.

Modulation of the signal is FM and there are two standards. For very low frequency transmissions in the band 90kHz to 150kHz, white level is at plus 150Hz and black is minus 150Hz – while for HF transmissions, white is plus 400Hz and black is minus 400Hz.

At the commencement of each picture a start tone is transmitted. This is 300Hz for a 576 index of co-operation and 675Hz for a 288 index of co-operation. At the end of the chart there is a stop tone of 450Hz.

The traditional method of demodulating these signals has been to use a communications receiver switched to SSB with the BFO giving a high audio tone for white and a low tone for black. Most professional FAX machines have a built-in decoder to accept these signals – but I decided to take advantage of the advances in FM receiver technologies, and attempt direct FM demodulation of the signal. The result is a very simple but effective receiver using the ULN3859 IC. The circuit was adapted from the MSF Rugby receiver designed for John Robinson's *Rewbichron* MSF time code clock (see **R&EW** April 1982 p54), and it is geared to the reception of VLF transmissions. In the UK, the Paris-National transmission on 131.8kHz has the strongest signal with least interference.



The digital scan converter featured in the June issue of R&EW.

The input to the digital scan converter is in the same form as the demodulated satellite signals – a 2.4kHz signal, amplitude modulated with the picture (greyscale) information. The scan converter uses the 2.4kHz signal as its reference frequency for deriving the line synchronization, and this system has the added advantage that the signal can be recorded on a cassette tape recorder with no synchronization problems due to tape speed fluctuations.

The signals from the VLF receiver (low level for white and high level for black) are converted into a form suitable for the scan converter in a simple module containing two CMOS integrated circuits; a 4011 and a 4040. The video output of the scan converter is a composite video signal suitable for feeding a monitor: in order to feed an ordinary television set, an Astec VHF modulator was stuck on the back panel of the scan converter and fed from a 2kO preset potentiometer across the composite video signal. Power for the modulator was taken from the +5V pin in the centre of the rear edge of the memory board.

As the scanning rate is only 120 lines a minute, half the 240 lines a minute satellite rate, the magnification using the Format switch is 1 in the 0.5 position, 2 in the 1 position and 4 in the 2 position. Most charts are transmitted sideways, but when one is transmitted horizontally, it is *usually* the right way up with the two scan switches in the down and left positions, causing the picture to scroll from bottom to top. It has been suggested that mounting the television set on gimbals would save a lot of neck strain when viewing the charts!

In use, the 'Format' switch on the scan converter should be on the METEO side for 288 index charts, and on the NOAA side for 576 index charts. The METEOSAT start and stop tones are the same as those for the 576 index charts and automatic start and stop occurs when the WEFAX-APT switch is in the WEFAX position. Using a further tone decoder and a sprinkling of CMOS analogue switches it should be possible to automatically start, stop and switch between modes whilst also providing a signal to start and stop a recorder. Work on this aspect is already in progress, but I am reluctant to commit too much butchery to an already well designed circuit board.

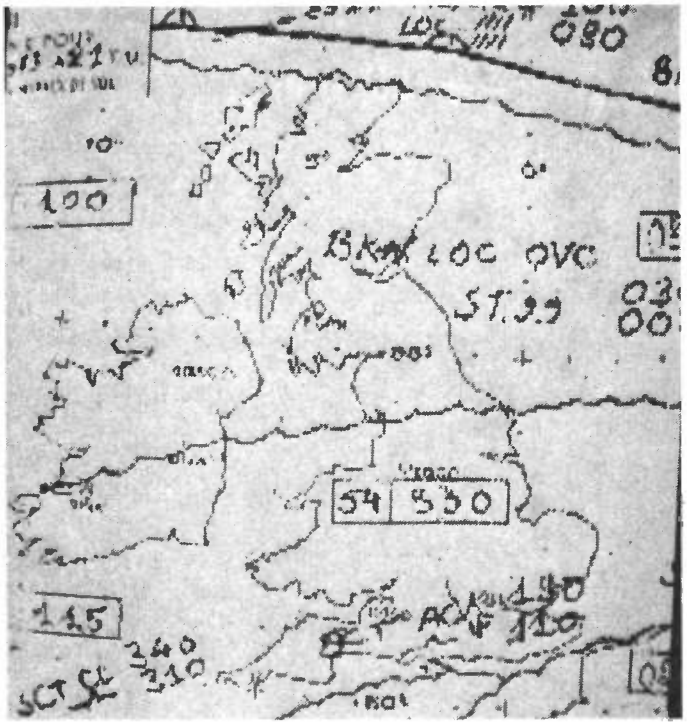


Photo 1: Forecast of significant weather from Paris-National

The VLF Receiver: Circuit Description

A ferrite rod aerial with a long wave coil on it is tuned to the required frequency by the 470pF capacitor and by the position of the along the aerial. Fine tuning is accomplished by the 0–60pF trimmer. To maintain a high Q in the aerial circuit, it is buffered by the 2SK55 JFET in a source follower circuit.

The output from this passes through a low pass filter to pin 18 of the ULN3859. The oscillator of the ULN3859 is used as a Colpits oscillator tuned by L1 to 455kHz above the required frequency. For greater stability and reliability in a fixed

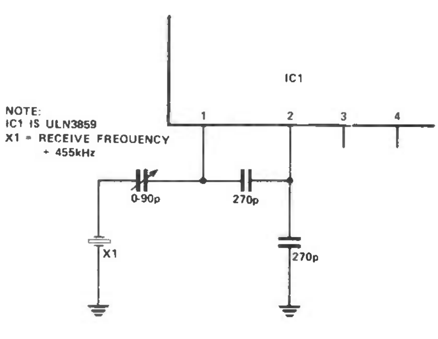


Figure 1: Circuit for crystal control of the VLF receiver.

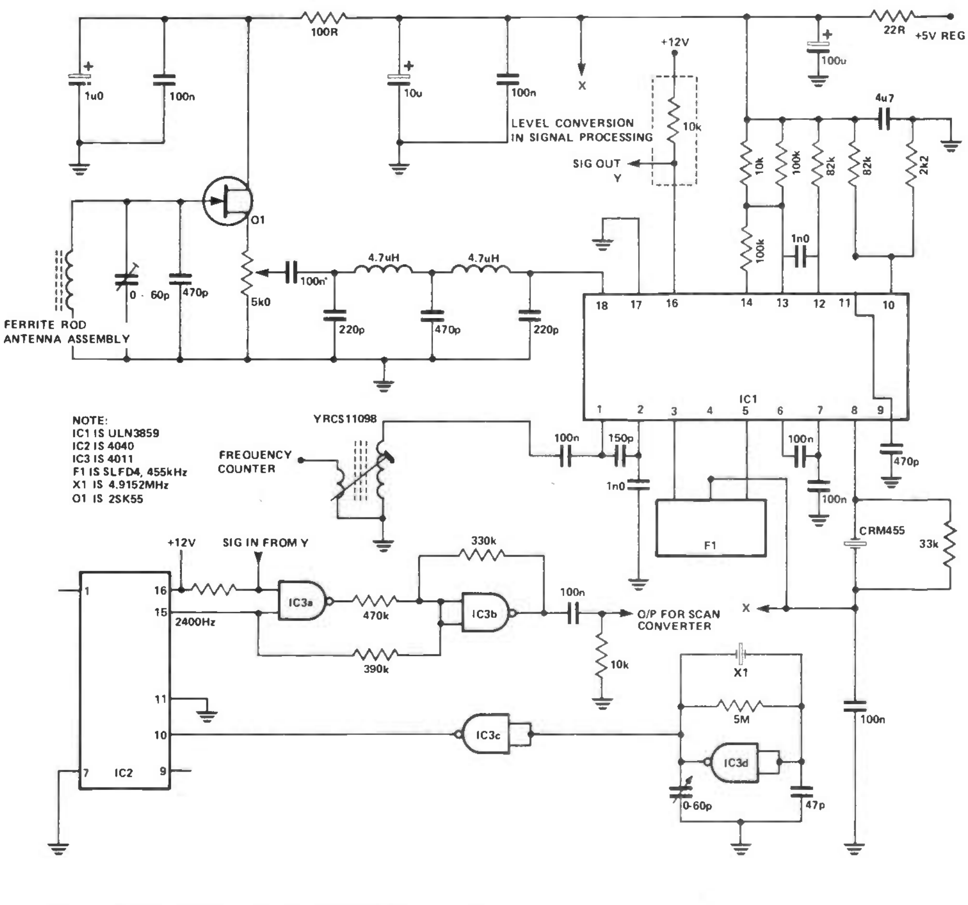


Figure 2: Circuit diagram for the VLF receiver.

Photo 2: Atlantic 72-hour forecast chart.

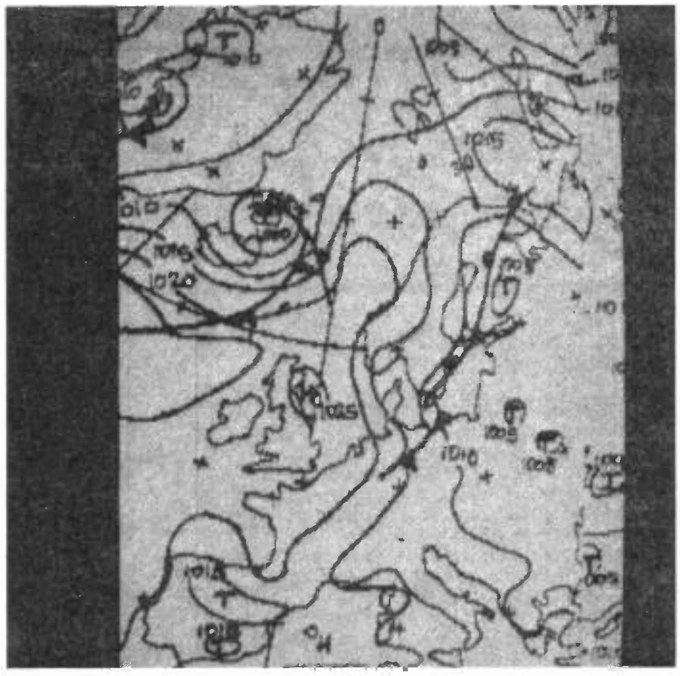


Photo 3: Surface analysis for Europe from Offenbach.

frequency mode, a crystal oscillator would be desirable, but custom fabricated low frequency crystals are rather expensive. The 455kHz output from the limiting IF amplifier is filtered by a narrow bandwidth filter between pins 3 and 5 and instead of a tuned circuit as the quadrature element at pin 8, a 455kHz ceramic resonator is used which gives a greater output with the relatively small deviation involved.

Connecting pin 9 to pin 11 doubles the output available at pin 10 and the 470pF capacitor removes the higher frequencies. The inverting amplifier between pins 12 and 13 of the ULN3859 is used as an active low pass filter, rather than in its originally intended guise as a bandpass tuned circuit. This then feeds the trigger input of the muting gate which is used to convert the signal to logic levels suitable for feeding the converter input module. The circuit is supplied with a regulated 5 volts supply from an 78L05 regulator.

Input Module

Two gates (N1, N2) of the 4011 are used as a 4.9152MHz crystal oscillator and buffer. This is fed to the 4040 binary divider and an output of 2.4kHz is taken out at pin 15. This signal is gated in N3 by the FAX receiver signal and inverted to give bursts of 2.4kHz which when added at N4 to the original 2.4kHz signal cancels most of the signal, giving the modulated output. As no intermediate grey levels were required, this digital method was simpler and cheaper than using a multiplier or OTA for amplitude modulation.

Beware!

As regular readers of **R&EW** will be aware, receiving anything much more technologically stimulating than the Jimmy Young Show or the transmissions on the various amateur and broadcast bands is subject to a number of "restrictions" presided over by our friends in the Home Office that reside at Waterloo Bridge House. If you wish to make certain that whatever it is you want to do is not likely to run you foul of the Wireless Telegraphy Act, or the Official Secrets Act for that matter, write to the Radio Regulatory Division and ask for their guidance. They are notoriously busy folk, and may take a while to respond.

Photo 4: Picked up from METEOSAT.

The View from the Ether

Photo 1 illustrates the results from Paris-National on July 5th at 16.35, showing the forecast of significant weather for 21.00GMT. ***Photo 2*** shows the corresponding Atlantic 72-hour forecast, while ***Photo 3*** is of the surface analysis for Europe for 1200GMT on July 11th. The latter was picked up at 16.59 that day from Offenbach, a German station transmitting on 134.2kHz. The remaining pic is from METEOSAT using a converted **R&EW** UOSAT VHF receiver after the SHF converter, which produced such surprisingly good results for a fraction of the cost of the pukka satellite receiver that we were all....err....surprised! Watch this space for a feature on the same.

■ R&EW

Lesson 5

Zilog

Z8000 Course

INSTRUCTION-SET DETAILS

OPERAND ADDRESSING MODES

The Z8000 has been designed to include a wide range of instructions, some of which are only found on mini or large computers. When coupled with other architectural features, such as the potential for separating system and user memory space, this puts an unusual amount of power in the hands of a Z8000 programmer.

A desirable feature of any computer – micro, mini or large – is *architectural regularity*. In the Z8000, this is reflected in the programmer's ability to use almost all registers in the machine interchangeably. For example, any register but R0 (and RR0) can be used as a stack pointer, and any register may be an accumulator.

True architectural regularity extends into the instruction set and to the ways in which instruction operands may be accessed. (Refer to Lesson 1 for a detailed description of the Z8000's addressing modes.) For obvious technological reasons, not all instructions in the Z8000 are capable of using all addressing modes; only the LOAD instruction can do so. However, the five most important *addressing modes* (IM, R, DA, IR and X) are available in most instructions:

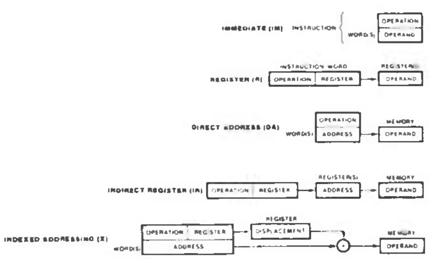


Figure 1
Z8000 Addressing Modes

The latter three modes (DA, IR and X) address data in memory that may be separate from program space if memory-control hardware uses the ST3:0 output lines to form that distinction. Immediate data, of course, is part of an instruction and resides in program space. Indirect Register (IR) mode is explicitly used in the Z8000's PUSH and POP instructions.

Another less important feature relating to processor regularity is the ability to combine operand accessing modes in all possible combinations in all instructions. Again, because of technological reasons and the lesser importance of this ability, the Z8000 has restrictions on the ways that addressing modes can be combined within a multioperand instruction. For instance, memory-to-memory transfers are possible only in the block-transfer instructions that move blocks of data from one memory area to another.

All issues of regularity in the Z8000 hinge on what is practical from the microprocessor-design standpoint and what is most important from the programmer's standpoint. Thus, though current technology has limited the Z8000 to less than full regularity, its instruction set and architecture attempt to optimize its usefulness to the programmer.

The five basic modes of accessing operands as immediate (assembly-time), register (runtime) or memory (runtime) data are extended for some Z8000 instructions by *three more modes* (BA, BX and RA):

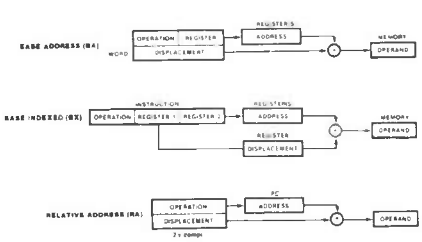


Figure 2
More Z8000 Addressing Modes

As does indexed (X), base address (BA) and base indexed (BX) modes allow the running program to compute an operand's address on the fly, depending on the variable content of one or two registers. Indexed (X) mode is useful for table (array) indexing, where the base of the table is known (at least for purpose of relocation) before the program runs; Base Address (BA) is useful for accessing like parts of parallel, complex data structures, where the index is known beforehand but the particular table is selected on the fly by changing the content of the base-address register.

Base Indexed (BX) simply combines the variable features of both X and BA modes to allow both the table base and the index to be computed as the program runs. BX may be used with the LOAD instruction to place operands in registers for manipulation by all instructions that lack this mode. When used this way, BX allows the production of fully relocatable code, because no memory addresses need be known for the operands at assembly/compilation time.

Relative Addressing is analogous to BA mode except that 1) the program counter serves as the variable base address and 2) the Z8000 does *not* emit data status but feigns instruction fetch (IFn) status when performing RA memory cycles. In the Z8000, relative addressing is the only way data values may be accessed from program memory space, if hardware makes that distinction. Relative Address (RA) mode is typically used for JUMP and CALL instructions. Note that some instructions subtract the signed displacement from PC, while others add it to PC. Thus a negative displacement can mean a forward reference.

In any of the addressing modes that require a memory address, either segmented or nonsegmented addresses may be used. The choice depends on the processor (Z8001/Z8002) and, in the Z8001, the setting of the SEG bit in FCW. Two forms of segmented address, short and long, exist in the Z8001; but the short form may only be used when it appears within the instruction, as it does in DA and X modes. Short-segmented addresses may not be used in registers and thus may not be used in IR, BA or BX modes.

In the Z8001, because full segmented addresses occupy two words, some economy of space can be gained in DA and X modes if accesses are confined to one segment at a time. The SEG bit can be cleared after the first reference to the desired segment; this causes the machine to enter nonsegmented mode. The segment lines (SN6:0) will remain fixed, however. This will allow continued access within that segment with 16-bit addresses. However, since the segment lines are fixed, care must be taken to avoid stack references if the stack is not located in the current segment.

THE Z8000 INSTRUCTION SET

The Z8000's instructions may be classified as: *transfer, arithmetic, logical, shift and rotate, control, search and input-output* (I/O). Transfer instructions (e.g., LOAD) move data around, arithmetic instructions (e.g., ADD) compute values and set flags (in FCW), logical instructions (e.g., AND) manipulate bits and set flags, shift and rotate instructions (e.g., SRA) move bits and set flags, control instructions (e.g., JUMP) use flags or manipulate system parameters, search instructions (e.g., CPIR) peruse memory tables, and I/O instructions (e.g., OUT) communicate with peripherals or special devices, such as the Z8010 memory manager.

Transfer Instructions

The most common *transfer instruction* is *LOAD*, which takes several forms in the Z8000; the basic form is able to use any addressing mode:

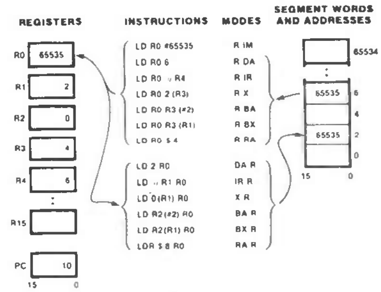


Figure 3
Load Instructions

The above examples assume that no code versus data distinction is made and, therefore, that the LDR instructions shown actually reside in memory just above the data (at location 8). Furthermore, only nonsegmented addresses are used for simplicity and the notation is that of the Z8000 PLZ/ASM assembler designed for the Z8000. The destination operand follows the instruction's mnemonic (LD), numbers are addresses by default, and the other symbols mean:

#	-	Immediate Mode
@	-	Indirect Register Mode
( )	-	An Index
$	-	The Current PC

Additional members of the LOAD (LD) family are:

LDB	-	Load Byte
LDL	-	Load Long Word
LDK	-	Load a 4-bit Constant
LDM	-	Load Multiple
LDA	-	Load Address
LDAR	-	Load Address Relative
LDR	-	Load Relative Word
LDRB	-	Load Relative Byte
LDRL	-	Load Relative Long Word

A few of these deserve special mention.

The *LDK instruction* provides a quick, one-word instruction for loading a 16-bit register with a small (0 to 15) value. The higher bits of the destination register are cleared. LDK R #xx takes five clock periods, while LD R #xx takes seven.

The *LDM instruction* allows up to 16 of the Z8000's registers (R0 through R15) to be moved to or from memory in one uninterruptible series of memory cycles. The instruction wraps around from R15 to R0 if desired. LDM 1000 R12 #5 will, for instance, save R12 at word location 1000, R13 at 1002, and so on, until R0 is finally saved at 1008.

The *LDA and LDAR instructions* allow addresses to be loaded from data or program memory into registers in proper format and in either segmented or nonsegmented mode.

Obviously, the size of the data transfer needed in a Z8000 instruction is indicated by the instruction's assembly - language mnemonic. The default is a *word* transfer, because that is the nominal width of the data bus linking the Z8000 to memory and other external devices. A word transfer thus requires exactly one memory or I/O cycle. (I/O cycle timings were described in an earlier lesson.) Byte operand instructions are indicated by a B suffix, while double-word (long) instructions carry an L. Naturally, LDL to/from memory requires two memory cycles. LDB requires the same timing as LD, because a full word is always transferred on the Z8000's bus. The Z8000 selects a byte from the half of the data bus established by an internal bit normally related to A0; thus, it is important for immediate byte mode instructions to have the desired byte duplicated in both halves of the data word assembled with the instruction.

Other data transfer instructions provided by the Z8000 are as follows:

CLR, CLRB	-	Clear a word or a byte in memory/register
EX, EXB	-	Exchange memory/register with a register
PUSH, PUSHL	-	Push one or two words
POP, POPL	-	Pop one or two words
LDD, LDDB	-	Block Move: Load memory to memory and decrement pointers and counter
LDI, LDIB	-	Like LDD, but increment pointers
LDDR, LDDRB	-	Load, decrement, and repeat until count is zero
LDIR, LDIRB	-	Load increment, and repeat until count is zero

Of special interest are *PUSH* and *POP*. These allow the programmer to use any register (other than R0 and RR0) to hold a *stack pointer* and to manage the pointer automatically every time data words are pushed or popped. PUSH decrements the register first, while POP increments it after removing data from the stack. IR mode is used. PUSH@R2 #37.

One of the Z8000's powerful abilities is exemplified in the *block transfer instructions* (LDIR, etc.). These can move as many as 65,536 bytes from one area or segment in memory to another. Two register pointers must be set up to locate the source and destination areas. Also, a byte /word count is loaded into a third register.

```
LD R1 #1000
LD R2 #5000
LD R3 #100
LDIR @R1 @R2 R3
```

In this case, 100 words are moved automatically from location 5000 to location 1000. These instructions are all interruptible at the end of each data transfer, in order to provide good interrupt response. The interrupt routine must save any registers used by the block move instruction.

Arithmetic Instructions

Arithmetic Instructions in the Z8000 also provide processing power which was previously unavailable in microprocessors. Multiply and divide are now included:

ADD, ADDB, ADDL	-	Add register and immediate/ register/memory
ADC, ADCB	-	Add including the carry flag
SUB, SUBB, SUBL	-	Subtract
SBC, SBCB	-	Subtract using carry as borrow
MULT, MULTL	-	Multiply
DIV, DIVL	-	Divide
INC, INCB	-	Add 1 to 16 to register/memory
DEC, DECB	-	Decrement by 1 to 16
NEG, NEGB	-	Negate
EXTS, EXTSB, EXTSL	-	Extend sign of a register
CP, CPB, CPL	-	Compare immediate/ register with immediate/ register/memory
DAB	-	Decimal adjust using DA and H flags

Of particular interest are *ADC, SBC and EXTS*, which allow multiple-byte precision in simple arithmetic. The carry flag can be used after a preceding operation (e.g., an ADD) to link a low-order sum to a higher order sum computed with ADC. Similarly, the borrow from a preceding subtraction can be communicated to a higher order SBC via the carry flag in FCW. EXTS simply allows small signed values to be expanded to the next larger precision—a byte to a word, for instance. Twos complement notation is used for all Z8000 arithmetic operations (-1 = all ones).

The *DIV and MULT instructions* are unusual because they must deal with registers twice as long as their mnemonics indicate. This is because both quotient and remainder must be stored by DIV, and because MULT must have room in its destination for a product that is twice as long as its operands. Thus, DIV and MULT use double registers (RR0, RR2, . . .) as destinations, while DIVL and MULTL use quadruple registers (RQ0, RQ4, . . .). It is, in fact, improper to use odd values for destination register designators. For divisions, the first half of the destination (R0, R2 . . .) will receive the remainder and the second half (R1, R3 . . .) will receive the quotient. The source can be any odd or even register designation: DIV RR4 R1. As with other arithmetic instructions, DIV and MULT set flags in FCW, particularly when division by zero or overflow occur.

The *comparison instructions* (CP) are in one sense logical because they manipulate flag bits without changing their operands. But they are also arithmetic because they do a virtual subtraction of their two operands in order to set the flags. CP is often used, for instance, before JUMPs to establish control conditions:

```
CP POINTER #BUFFEREND
JR ULT LOOP
```

ULT means "unsigned less than" and combined with JR it means that a jump to LOOP occurs only if the value in pointer is less than the immediate value represented by the assembly-time symbol BUFFEREND.

The DAB (Decimal-Adjust Byte) instruction formats a BCD pair of integers by using the *DA and H flags* in FCW. This is useful for dealing with data in BCD format (from external test equipment, for example). Thus a DAB instruction will normally be executed after each arithmetic operation (ADD or SUB) on BCD data to restore it to BCD format. 10 base sixteen is 16 base ten and represents 10 base ten in BCD format; hence, a 10 base sixteen (A, or 1010 in binary) needs 6 added to it to convert it to 10 in BCD. DAB decides what to add or subtract from a byte to leave it in BCD format by looking at the H flag, which indicates a carry from the right four bits of a byte, and the DA flag, which indicates whether subtraction or addition was done last.

Logical Instructions

Logical Instructions in the Z8000 are closely related to arithmetic instructions. These instructions also set flags in FCW for possible later use in program control:

AND, ANDB	-	Bitwise AND of register with register/memory
OR, ORB	-	Bitwise OR
COM, COMB	-	Bitwise complement
XOR, XORB	-	Bitwise exclusive OR
SET, SETB	-	Set a register/memory bit
RES, RESB	-	Clear a bit
BIT, BITB	-	Test a bit and set/reset Z flag accordingly
TEST, TESTB, TESTL	-	OR register/memory with zero and set flags accordingly
TSET, TSETB	-	Test and set a semaphor in register/memory
TCC	-	Map a flag condition into a register bit

Of these instructions, TEST is frequently useful in program control, because it sets the flags in FCW:

```
TEST R3
JP NZ LOOP
```

The *TSET Instruction* is specially designed to allow multiprocess (not multi - Z8000) sharing of some resource—for example, an I/O device like a disc. When executed, TSET reads the leftmost bit of its operand into the S (sign) flag and then immediately turns on all bits in that operand. Thus S being set means the shared device is busy to all processes that want to use it; S = 0 means it's free. In that situation an inquiring process can, with one instruction, know whether the device is free and set the operand to all ones. Now that process will definitely own the device in the eyes of all other processes, so long as they also use TSET to look at the same semaphor operand.

The *TCC Instruction* can be used to map a series of condition codes (flag combinations) into a bit that will later show whether one of the TCC operations found a true condition. This is useful in constructing Boolean variables and monitoring a series of operations, all of which must complete properly. The mapped bit is only set by TCC if the condition code is true; otherwise it is left alone. The *BIT testing* instructions might be combined with TCC in typical cases:

RES R0 #0	-	Clear R0 bit zero
TCC EQ R0	-	Set bit zero of R0 if flags indicate EQ condition
TCC LT R0	-	Similarly for LT
BIT R0 #0		
JR Z CONDITIONSFALSE		

Rotate and Shift Instructions

Various standard *rotate and shift instructions* are also part of the Z8000 instruction set:

RLDB, RRDB	-	Rotate BCD digits left/right
RL, RLB, RR, RRB	-	Rotate left/right
RRC, RRCB, RLC, RLCB	-	Rotate left/right through carry
SDA, SDAB, SDAL	-	Shift dynamic arithmetic
SDL, SDLB, SDLL	-	Shift dynamic logical
SLA, SLAB, SLAL, SRA, SRAB, SRAL	-	Shift left/right arithmetic
SLL, SLLB, SLLL, SRL, SRLB, SRLL	-	Shift left/right logical

The Z8000 contains instructions for rotating *BCD digits* (half bytes). RLDB and RRDB allow easy multiplication and division of BCD values by powers of ten. They may also be used for the packing and unpacking of four-bit data chunks.

The normal rotate and shift instructions move bits left and right, but do so for bytes, words or, only in shifts, double words. Furthermore, the *carry flag* in the FCW may be included in various ways. In *rotate* instructions, the carry may be considered an additional bit on the left (RLC) or right (RRC) end of the operand being rotated. The instruction name thus means: rotate left or right through the carry. The carry, in other rotates, is simply used to hold the *last* bit just rotated out of the operand's end by RL or RR.

Instructions to rotate left and rotate right are, in fact, distinct Z8000 instructions, but *shifts* left and right are simply distinguished by the sign of the shift value in the assembled instruction. The distinguishing feature of shifts is whether they are *arithmetic or logical*. That is, do they preserve the leftmost bit for two's-complement signed values or not. In any case, the bit last shifted out (left or right) can be found in the carry flag. Because of the otherwise simple nature of shifts, the shift-left-logical (SLL) and shift-left-arithmetic (SLA) instructions are identical except for the setting of the flags. Z8000 shifts also allow the running program to calculate the shift amount (bits) in a register so that a subsequent *shift-dynamic* instruction (SDA or SDL) can be executed. Some of the various shifts and rotates are illustrated below:

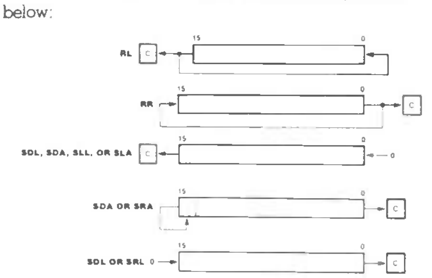


Figure 4
Shift and Rotate Instructions

Control Instructions

Control Instructions in the Z8000 comprise a fairly standard set of decision-making tools (such as JUMP on a condition), plus special instructions that manage the Z8000 and its relationship with certain outside devices (such as other Z8000s or extended-processor units):

JP, JR	- Transfer execution by changing the PC
CALL, CALR	- Push current PC on default stack (system/normal) and change PC
RET	- Restore the PC saved by CALL or CALR
SC	- Use PSAP and the system-call status to change FCW and PC while saving the old values on the system stack
IRET	- Restore status (FCW and PC) saved during a trap, interrupt or system call.
DJNZ, DBJNZ	- Decrement a LOOP counter (byte/word) and exit the LOOP if the count is zero.

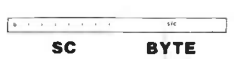
The *JP* (JUMP) and *JR* (JUMP relative to PC) instructions, along with the procedure (subroutine) return (RET), allow either conditional or unconditional transfers of execution. Conditional transfers are based on *flag settings* in FCW, as hinted earlier. One of several mnemonics, called condition codes, may be included in these instructions:

mnemonic	meaning	flag settings
blank	always true	none
F	always false	none
Z	zero	Z = 1
NZ	nonzero	Z = 0
C	carry	C = 1
NC	no carry	C = 0
PL	plus	S = 0
MI	minus	S = 1
NE	not equal	Z = 0
EQ	equal	Z = 1
OV	overflow	V = 1
NOV	no overflow	V = 0
PE	parity even	P = 1
PO	parity odd	P = 0

mnemonic	meaning	flag settings
GE	signed greater than or equal	(S xor V) = 0
LT	signed less than	(S xor V) = 1
GT	signed greater than	(Z or (S xor V)) = 0
LE	signed less than or equal	(Z or (S xor V)) = 1
UGE	unsigned greater than or equal	C = 0
ULT	unsigned less than	C = 1
UGT	unsigned greater than	((C = 0) and (Z = 0)) = 1
ULE	unsigned less than or equal	(C or Z) = 1

A blank condition always means JUMP or return, as in: JP LOOP. Note that some condition code mnemonics happen to be the same as the name of the flag they test (like Z). Some conditions are, in fact, redundant. Overflow and parity are the same bit in FCW, and so the meaning of the corresponding conditions depends on what instruction was previously executed (e.g., overflow is meaningful for ADD). All these mnemonics are determined by the particular assembler used to generate Z8000 object code.

The *SC Instruction* allows those Z8000 systems which segregate user (normal-mode) activity from system activity to give users (tasks) access to system features, such as I/O. An SC acts like a trap, because it is serviced by a dedicated routine whose starting address appears in the status area pointed to by the PSAP register. The operand for an SC is essentially an immediate byte that appears on the system stack when the service routine runs:



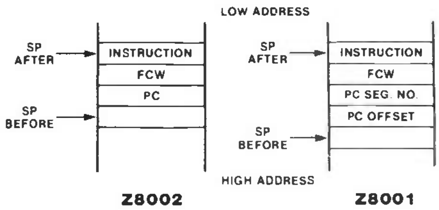


Figure 5
The System Call Instruction

Thus, an SC routine can be asked directly to perform any of 256 services for a user, and other data may be passed in the registers. The SC routine, like all traps/interrupts, runs in system mode. So, data transferred in user mode memory must also be accessible somehow to the routine in system mode, if memory hardware so distinguishes.

Any routine that is entered by a change of status using the PSAP (a trap, interrupt or SC) should be terminated by an *IRET Instruction*. This allows the system stack to be cleared properly and the old, pushed FCW and PC to be restored. IRET, therefore, terminates SC, interrupt and trap routines. In the Z8001, it must be executed in segmented mode (SEG = 1 in FCW) to restore the stack properly. This is because the SC, trap or interrupt was automatically handled in segmented mode, even if the new FCW had set nonsegmented mode:

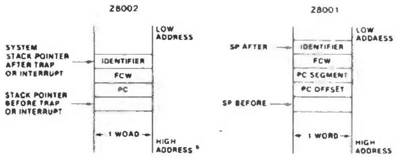


Figure 6
System Stack for an Interrupt or Trap

IRET is one of many *privileged instructions* which can be executed only in system mode. IRET does not communicate the end of service to peripheral devices, as RETI does in a Z80. Therefore, to signal end-of-service to a peripheral, some explicit I/O must be done—for example, writing to a control port in the peripheral—before IRET is executed.

The *DJNZ Instructions* make control of short iterative loops simple and fast. A byte or word register is initialized with the loop pass count. DJNZ (or DBJNZ) is placed at the bottom (high end) of the loop; there it decrements the count and does a relative jump back to the top of the loop if the count is still nonzero. Otherwise it simply falls out to the subsequent instruction.

Other Z8000 control instructions deal with the operating mode of the machine itself, with extended processors, or with other Z8000s in a bus/resource-sharing environment:

LDCTL, LDCTLB	- Manipulates FCW and other special registers
LDPS	- Changes FCW and PC
EI, DI	- Enable/disable interrupts
NOP	- Do nothing
HALT	- Stop execution
SETFLG, RESFLG, COMFLG	- Manipulate FCW flags
MBIT	- Test the micro-in line
MSET, MRES	- Alter the micro-out line
MREQ	- Execute the multi-micro sharing algorithm

The *LDCTL Instruction* is most often used to set up the REFRESH register, the PSAP and, perhaps, the normal-mode stack pointer when a system starts up:

```
LDCTL REFRESH R3
LDCTL PSAPSEG R4
LDCTL PSAPOFF R5
LDCTL NSPSEG R6
LDCTL NSPOFF R7
```

In the Z8002 only nonsegmented values are appropriate For PSAP and NSP. The FCW can also be accessed with LDCTL for making wholesale changes, but the flags may be accessed independently as bytes:

```
LDCTLB RH0 FLAGS
```

The VI and NVI bits are also accessible in another way via *EI and DI*:

```
DI VI
DI NVI
```

The FCW and PC are most easily changed or initialized at once with LDPS. This reads a new status pair or quadruple (depending on the SEG bit in the present FCW) from *data* memory. Note that LDPS cannot read the status areas pointed to by PSAP if memory hardware distinguishes program from data space. LDPS is a good way of switching *context* from system to normal-mode tasks.

The *HALT Instruction* simply allows execution to terminate and await an interrupt while refresh activity continues (if refresh is enabled). Recall a special feature of HALT: it may head up a dedicated interrupt routine that can be entered if an interrupt line is active for exactly one $\overline{AS}$ (address-strobe) interval. This precludes normal interrupt acknowledge and the use of IRET, but it guarantees fast response in dedicated applications.

Several Z8000s can share a resource by using the micro-in ($\overline{\mu I}$) and micro-out ($\overline{\mu O}$) lines. This multi-micro feature of Z8000 is suppported by atomic instructions MBIT, MSET and MRES to test $\overline{\mu I}$ and change $\overline{\mu O}$. The programmer can thus design his/her own sharing-algorithm, or use MREQ. The MREQ instructions checks $\overline{\mu I}$ to see if the resource is busy. If it is not, the MREQ instruction makes a request by pulling $\overline{\mu O}$ low. It then waits a time period defined by the programmer before rechecking $\overline{\mu I}$ to see if its request was acknowledged. If it was, the S flag is set and subsequent instructions can proceed accordingly. Failure at either $\overline{\mu I}$ test can be detected by examining the S and Z flags. The MREQ instructions is useful in single Z8000 systems too, because it generates uninterruptible delays (up to 90 mS with a 4MHz clock). It decrements a 16-bit register at clock/7:

```
LD R0 #490
MREQ
```

This will generate a one-millisecond delay at 4 MHz.

All control instructions are privileged *except* those that manipulate the lower byte of FCW (flags) and NOP. Privileged instructions may be executed *only* in system mode (S/$\overline{N}$ = 1 in FCW). If executed in normal mode, they cause a trap to the privileged instruction routine listed in the status area. That routine could, of course, try to recover or even interpret such an attempt by a normal (user) program.

The remaining control instructions appear in Z8000s with extended architecture. Six sets of instructions are designed to work with external processors (EPUs), such as floating-point devices. These will observe the memory bus as the Z8000 fetches instructions and will recognize those instructions they are to execute. The Z8000 can then continue executing regular instructions until the EPU is done or until a new extended instruction is fetched. The EPU can use the $\overline{STOP}$ line to maintain synchronism with the Z8000:

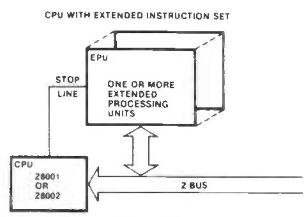


Figure 7
EPU's in a Z8000 System

These instructions are unimplemented if the EPA bit (bit 5) in FCW is not set.

Search Instructions

The Z8000 provides several extensions of the elemental comparison instruction and some sophisticated table translation and scanning instructions:

CPD, CPDB	- Compare a byte/word register with each cell of a memory table, decrementing the table pointer each time
CPI, CPIB	- Compare and increment the pointer
CPDR, CPDRB	- Compare, automatically repeating the decrement until a condition is met
CPIR, CPIRB	- Compare, automatically repeating the increment
CPSD, CPSDB	- Compare two tables of bytes/words decrementing both table pointers
CPSI, CPSIB	- Compare two tables and increment
CPSDR, CPSDRB	- Compare two tables automatically decrementing until a condition is met

CPSIR, CPSIRB	Compare two tables automatically incrementing
TRDB, TRIB	Translate a byte in a table of bytes using an indexed key table
TRDRB, TRIRB	Translate all bytes in a table
TRTDB, TRTIB	Scan a byte in a table of bytes to see if it indexes a nonzero value in a key table
TRTDRB, TRTIRB	Scan a whole table, stopping when a nonzero value is indexed in the key table.

Like the block transfers, the repeating forms of these comparisons and translations may be interrupted after each comparison or indexing of the key table. All the CP instructions do more than check for a match; they allow any flag combination to halt the repetition or be mapped into the Z flag. A comparison of two character strings, for instance, can be easily constructed with the assumption that a shorter string comes before a longer one, even if they match otherwise:

```
    CP R3 R4
    JR ULE R3SHORTER          (test lengths)
    EX R3 R4                  (swap if necessary
    EX R1 R2                  to avoid comparing
                              garbage)
  R3SHORTER: CPSIRB @R1 @R2 R3 ULT
      JR Z R1BEFORE R2
      .
      .
      .
      JP SOMEWHERE
  R1BEFORER2: . . .           (a character in
                              string pointed to by
                              R1 is earlier
                              alphabetically than
                              that pointed to by
                              R2)
```

The *TR Instructions* allow convenient, quick translation of byte buffers from one coding to another. An ASCII buffer, for instance, can be translated into EBCDIC. This is done simply by placing each EBCDIC character into the key (translation) table at an index which is above the table's base and is the ASCII value of the character. Each destination-table byte is thus changed to the byte it indexes in the key.

The *TRT Instructions* provide simple command-language support for user interfaces and compilers. The functioning of TRT instructions is similar to that of the TR instructions, except the key table holds arbitrary zero and nonzero values. When a destination table byte indexes a zero in the key, the scan continues. When it indexes a nonzero value, the instruction places that in register RH1 and terminates. Thus, nonzeros can be placed at key locations corresponding to delimiters in the command language—for example, space, return, etc. The legal command characters, such as alphanumerics, are made to index zeros. The scanning of the destination buffer thus stops at the end of each command word. This allows subsequent code to implement or compile that command.

Input/Output Instructions

The final Z8000 instructions of interest are input/output. Two classes exist, special and regular, which allow two I/O address spaces to be defined by the ST3:0 outputs. Special I/O instructions are the means for communicating with such CPU support devices as the Z8010 memory manager. They are identical to regular I/O (except for the ST3:0 outputs) and their mnemonics are simply prefixed by an S. All I/O instructions are privileged, executable only in system mode. Repeating forms, analogous to memory block transfers, provide considerable programming efficiency:

IN, INB, OUT, OUTB	Transfer a word/byte between register and peripheral
INI, INIB, IND, INDB	Input and increment or decrement a count
OUTI, OUTIB, OUTD, OUTDB	Output similarly
INIR, INIRB, INDR, INDRB	Input and repeat until count exhausted
OTIR, OTIRB, OTDR, OTDRB	Output and repeat

Special I/O between a Z8000 and a Z8010 can in fact make good use of the repeating instructions, by loading/reading an entire MMU in one instruction. The Z8010, however, requires use of only the upper bus byte for data transfers and thus should be read with A0 = 0 (even address) to guarantee reception of the byte. Writing is no problem because the Z8000 duplicates an output byte on both halves of the bus, as it does for memory accesses.

The Z8000 thus implements many instructions, some of which are otherwise found only on large machines. Except for the repeating instructions, all are interruptible by bus requests ($\overline{BUSRQ}$) or the common interrupt inputs ($\overline{NMI}$, $\overline{VI}$ and $\overline{NVI}$); memory or I/O data transfers may be extended by assertion of the $\overline{WAIT}$ input.

Note that interrupts are acknowledged only *after* an instruction (or a repeat cycle) has completed. But bus requests are acknowledged after any machine cycle, whether a fetch, a transfer, or an internal/refresh cycle. This is of concern only when memory refresh is enabled. If bus requests or wait delays are allowed to go on for too long, memory errors will occur, because no refresh cycles can be started. This is an important design consideration when direct-memory-access (DMA) devices are used. If the REFRESH rate counter times out during a bus request, the Z8000 will immediately refresh memory when it resumes control of the bus. It can in fact remember up to two such time outs, and so it can refresh two RAM rows when $\overline{BUSRQ}$ goes away.

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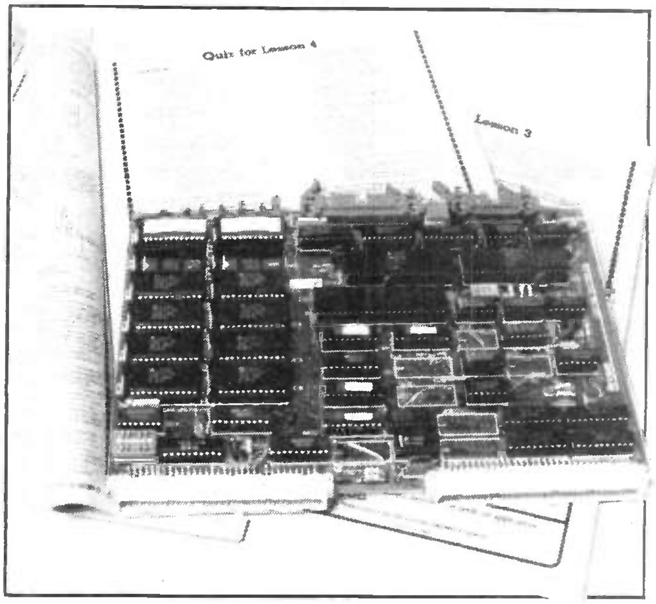

Over the last few months in **R&EW**, we have been offering – for your edification – the five lessons that make up the Zilog Z8000 tutorial series. These covered

- **Basic Architecture.**
- **Memory and Peripheral Interfacing.**
- **Interrupts, Traps and other Context Switches.**
- **Memory and Peripheral Management.**
- **Instruction-Set Details.**

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As we promised right at the beginning of the course, a leading Zilog distributor — Arcom Control Systems — has agreed to donate a complete Z8000 development system as the prize for the reader that answers most accurately the questions associated with each lesson in the series. This board incorporates not only a Z8000 micro but also Zilog's new SCC CIO support, CMOS RAM and PALs supported by a sophisticated monitor.

The questions are reproduced on the following three pages and the answer form for you to send in is on this page. Your answers should be sent to:

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Your entries will be assessed by our panel of judges during that week and the Zilog board presented to the winner on a mutually convenient date later that month. This event will be covered, along with details of the results, in our January 1984 issue (out in December).

We would also like you to suggest a project involving the Z8000 development system that you would like to undertake and a space has been provided for this on the entry form. In the event of a tie, the judges will select the ultimate winner according to which project appears to them to have the most potential.

The judges are:
Dr Brian Jasper; Applications Manager for Zilog, **Mike Quee**; Zilog's Sales and Marketing Manager, Industrial Products (Northern Europe) and our own **Jonathan Burchell**, Computing Editor of R&EW.

R&EW Zilog Competition

Indicate the answer for each question by ringing the appropriate letter.

Lesson 1:

Question 1	A	B	C	D
2	A	B	C	D
3	A	B	C	D
4	A	B	C	D
5	A	B	C	D
6	A	B	C	D
7	A	B	C	D
8	A	B	C	D
9	A	B	C	D
10	A	B	C	D

Lesson 2:

Question 1	A	B	C	D
2	A	B	C	D
3	A	B	C	D
4	A	B	C	D
5	A	B	C	D
6	A	B	C	D
7	A	B	C	D
8	A	B	C	D

Lesson 3:

Question 1	A	B	C	D
2	A	B	C	D
3	A	B	C	D
4	A	B	C	D
5	A	B	C	D
6	A	B	C	D
7	A	B	C	D
8	A	B	C	D
9	A	B	C	D
10	A	B	C	D

Lesson 4:

Question 1	A	B	C	D
2	A	B	C	D
3	A	B	C	D
4	A	B	C	D
5	A	B	C	D
6	A	B	C	D
7	A	B	C	D
8	A	B	C	D
9	A	B	C	D
10	A	B	C	D

Lesson 5:

Question 1	A	B	C	D
2	A	B	C	D
3	A	B	C	D
4	A	B	C	D
5	A	B	C	D
6	A	B	C	D
7	A	B	C	D
8	A	B	C	D
9	A	B	C	D
10	A	B	C	D

The project I have in mind for the Z8000 development system is: ....

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Name: ....

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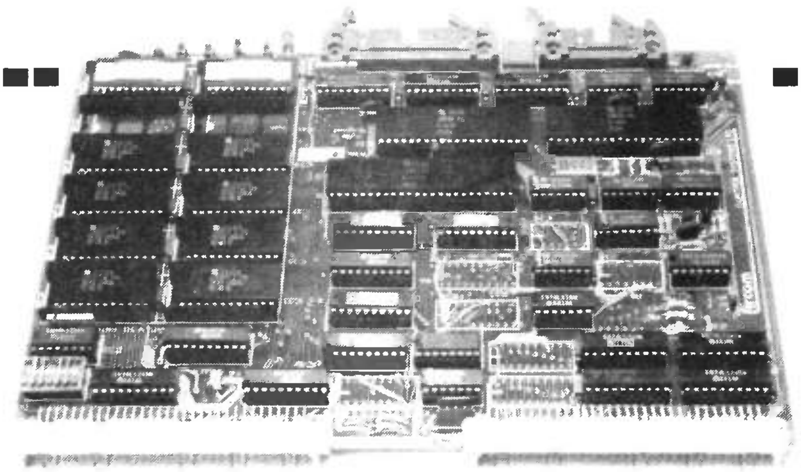


Lesson 1: Basic Architecture

1. While the Z8000 has many features which set it apart from older generation microprocessors, in a certain sense, it can be considered a very "regular" machine. The Z8000 is "regular" in its:
____ A. Register architecture
____ B. Address architecture
____ C. Internal memory segmentation
____ D. Microcoding

2. Which output from the processor can be used to create two separate memory spaces?
____ A. The $\overline{MREQ}$ output
____ B. The Normal/System (N/$\overline{S}$) output
____ C. The $\underline{SN6}$:O outputs
____ D. The $\overline{AS}$ output

3. The major difference between the Z8001 and the Z8002 is that the Z8001:
____ A. Contains more circuitry
____ B. Is faster
____ C. Addresses more memory
____ D. Can distinguish more types of memory and I/O spaces

4. The Z8000 allows the programmer to compute instruction operand addresses at runtime using:
____ A. Immediate Mode (IM)
____ B. Direct Access (DA) mode
____ C. Base Indexed (BX) mode
____ D. Register (R) mode

5. In addition to program loading and I/O device initialization, proper Z8000 initialization after RESET *always* requires:
____ A. Loading the FCW and PC
____ B. Loading system and normal stack pointers
____ C. Loading the PSAP and REFRESH
____ D. None of the above

6. Programs written for the Z8002 can always be run on a Z8001 in nonsegmented mode:
____ A. With no modification
____ B. If RR14 and PSAP are formulated to use segmented addresses
____ C. If all status areas and interrupt routines are formulated to use segmented addresses
____ D. If RR14, PSAP, all status areas and interrupt routines are formulated to use segmented addresses

7. The Status (ST) outputs can be used to:
____ A. Segregate program, data and stack memory areas
____ B. Prevent individual processes from disrupting the overall operating system
____ C. Allow the Z8000 to share the bus with other devices
____ D. None of the above

8. Of the three types of interrupt requests accepted by the Z8000 – Nonmaskable (NMI), Nonvectored (NVI) and Vectored (VI) – which, if any, would be considered the most flexible?
____ A. Nonmaskable
____ B. Nonvectored
____ C. Vectored
____ D. Since each serves a distinct function, none can be considered more flexible than another.

9. When the REFRESH register of the Z8000 is used to provide dynamic-memory-refreshing, row-address outputs on an estimated-demand basis, which of the following statements is *not* true?
____ A. The programmer must load the rate portion of REFRESH with a value which guarantees that the interval beteen refreshes will not be too long.
____ B. The Z8000 decrements the rate value every four clock cycles
____ C. When the rate value reaches zero, the original rate value is reloaded
____ D. Up to 128 rows may be refreshed.

10. All of the following forms of addressing in the Z8000 allow an address to be computed at runtime. However, only one allows both an index into a table as well as the table's base address to be calculated at runtime. Which is it?
____ A. Base Mode (BA)
____ B. Index Mode (X)
____ C. Base Index Mode (BX)
____ D. Relative Mode (RA)

Lesson 2: Memory and Peripheral Interfacing

1. The CPU clock is not one of the primary Z-Bus signals because:
____ A. Memory and I/O transfers are not synchronous to system clock.
____ B. Address strobe synchronizes address emission and latching during memory and I/O accesses.
____ C. Data strobe synchronizes data transfer and latching.
____ D. All of the above.

2. Proper memory access demands that a memory controller look at least at which of these signals?
____ A. $\overline{AS}$ and $\overline{DS}$
____ B. $\overline{AS}$, $\overline{DS}$ and R/$\overline{W}$
____ C. $\overline{AS}$, $\overline{DS}$, R/$\overline{W}$ and B/$\overline{W}$
____ D. $\overline{AS}$, $\overline{DS}$, R/$\overline{W}$, B/$\overline{W}$ and A0.

3. Bus direction in Z8000 systems should be determined with R/$\overline{W}$ and $\overline{DS}$ so that the bus normally points:
____ A. Toward the Z8000 except during read cycles.
____ B. Toward the Z8000 except during write cycles.
____ C. Away from the Z8000 except during write cycles.
____ D. Away from the Z8000 except during read cycles.

4. The ST lines by themselves can be used to create as many as:
____ A. Six memory spaces
____ B. Three memory spaces
____ C. Five memory spaces
____ D. Four memory spaces.

5. Which one of the following statements is *true*?
____ A. In order to work on a Z-Bus system, peripherals *must be* word organized.
____ B. Peripherals used on a Z-Bus system *must be* byte organized.
____ C. On a Z-Bus system peripherals *may be* byte organized if they read from and write to the appropriate half of the bus according to A0.
____ D. On a Z-Bus system peripherals *may be* byte organized if they read from and write to the appropriate half of the bus according to $\overline{AS}$.

6. Which of the following is *not* one of the basic cycles of which all Z8000 instructions are composed?
____ A. Memory
____ B. I/O
____ C. Execution
____ D. Internal

7. The time that memory and peripherals have to respond before data strobe goes away can be extended by pulling the:
____ A. $\overline{WAIT}$ line low
____ B. $\overline{STOP}$ line low
____ C. $\overline{BUSRQ}$ line low
____ D. ST3:0 lines low

8. By using the N/$\overline{S}$ and ST lines, as many as six memory spaces may sensibly be distinguished by a Z8000 system. How many I/O spaces can be distinguished?
____ A. Six
____ B. Four
____ C. Three
____ D. Two

Lesson 3: Interrupts, Traps and other Context Switches

1. In the Z8000, program status is defined as:
____ A. The PC and PSAP.
____ B. The stack pointers and the PC.
____ C. The status area and the PSAP.
____ D. The PC and FCW.

2. The PSAP and the status area it points to define:
____ A. Possible future FCW and PC values.
____ B. Responses to interrupts and traps.
____ C. Addresses of vectored-interrupt routines
____ D. All of the above

3. In the Z8002 each status subarea PC occupies:
____ A. One word.
____ B. Two words.
____ C. Three words.
____ D. One or two words depending on the SEG bit in FCW.

4. In the Z8001, with SEG = 0 (nonsegmented mode), an interrupt or trap causes:
____ A. Four words to be pushed on the system stack.
____ B. Four words to be pushed on the current (system or normal) stack.
____ C. Three words to be pushed on the system stack.
____ D. Three words to be pushed on the current stack.

5. Setting the extended processor bit on or off in a Z8000 affects:
____ A. The response to bus requests.
____ B. The number of unimplemented instructions.
____ C. The number of privileged instructions.
____ D. The number of peripherals that the Z8000 can handle.

6. System initialization after RESET requires that the system and normal stack pointers be loaded and the PSAP be pointed to a proper status area. The greatest danger to completion of these tasks is posed by:
____ A. A segmentation or other trap.
____ B. A vectored interrupt.
____ C. A nonmaskable interrupt.
____ D. A non-vectored interrupt.

7. Vectored interrupts in the Z8002 may access how many PC values, compared with the Z8001?
____ A. More.
____ B. Fewer.
____ C. Same.
____ D. None - because Z8002 addresses are always nonsegmented.

8. The Z8000 allows the PSAP to point to:
____ A. Exactly one status area.
____ B. Any status area.
____ C. Any status area that starts at an address multiple of 256.
____ D. Any status area that starts at an address multiple of 266.

9. Which FCW control bit(s) determine the number of executable instructions?
____ A. S/$\overline{N}$.
____ B. SEG.
____ C. S/$\overline{N}$ and SEG.
____ D. VI.

10. The control bits in the FCW are accessible:
____ A. In system mode only.
____ B. In normal mode only.
____ C. In both system and normal modes.
____ D. In system mode only in the Z8001 and in both system and normal modes in the Z8002.

Lesson 4: Memory and Peripheral Management

1. For a program to be reentrant and shared by multiple users, it must:
____ A. Contain only instructions.
____ B. Be copied in memory once per user accessing it.
____ C. Exist only in virtual memory.
____ D. Be accessed by only one user at a time.

2. Which of these Z8001 signals could be used to define memory segments?
____ A. SYSTEM/$\overline{\text{NORMAL}}$.
____ B. ST3:0.
____ C. SN6:0.
____ D. All of the above.

3. The Z8001 emits a segment number on the SN6:0 signals:
____ A. With the segment offset during a T1 cycle.
____ B. Once at the beginning of each program.
____ C. In T3 or T4 of a preceding memory cycle.
____ D. Asynchronously.

4. A segmentation trap routine could be used to:
____ A. Support virtual memory management.
____ B. Issue a warning concerning memory usage and allocation.
____ C. Signal illegal memory accesses.
____ D. All of the above.

5. Use of virtual memory involves:
____ A. Having to use a memory segmentation scheme.
____ B. Transferring files between physical memory and long-term or intermediate storage devices.
____ C. Addressing memory that does not exist.
____ D. The need for larger physical memory.

6. The number of possible I/O peripheral address spaces for the Z8000:
____ A. Depends on whether segmentation is implemented.
____ B. Is larger for the Z8001 than for the Z8002.
____ C. Is defined by the ST3:0 signals.
____ D. Is defined by the SN6:0 signals.

7. The Z-Bus structure allows:
____ A. Neither nested interrupts nor nested bus sharing.
____ B. Both nested interrupts and nested bus sharing.
____ C. Nested interrupts but not nested bus sharing.
____ D. Nested bus sharing but not nested interrupts.

8. In a system without resource-sharing, the MREQ instructions can be used:
____ A. To generate timing delays.
____ B. To request a memory cycle.
____ C. As a NOP instruction.
____ D. To generate an illegal instruction trap.

9. In a virtual memory system:
____ A. All users' segments are in physical memory at all times.
____ B. Some users' segments are in physical memory at all times.
____ C. Logical space sometimes appears smaller than physical address space.
____ D. Some users' segments may not be in memory when their programs are ready to run.

10. Which of the following is *not* one of the four basic types of Z-Bus transactions?
____ A. Memory.
____ B. I/O.
____ C. Peripheral.
____ D. Multiprocessor.

Lesson 5: Instruction-Set Details

1. Which addressing modes allow use of the short form for segmented addresses for the Z8001?
____ A. Register and Indirect Register.
____ B. Base Address.
____ C. Base Indexed.
____ D. Direct Access and Indexed.

2. A block of data located at memory addresses 4F00 (hexadecimal) through 5400 is to be moved to locations 5000 through 5500. Which load instruction is the most likely to be used to effect this transfer?
____ A. LDIR
____ B. LDDR
____ C. EX
____ D. LDM

3. The DAB instruction is normally used:
____ A. To add two bytes of BCD data.
____ B. After an arithmetic operation involving BCD numbers.
____ C. To convert from ASCII to BCD.
____ D. To alter the DA and H flags.

4. To return from an interrupt routine, the programmer should:
____ A. Use the IRET instruction.
____ B. Use the RET instruction.
____ C. POP the FCW off the stack and use the RET instruction.
____ D. Either A. or C. above, depending on the FCW.

5. The TSET instruction is typically used to:
____ A. Resolve bus contention between multiple Z8000's in a system.
____ B. Test and set any bit in a word.
____ C. Allow multiprocess sharing of an I/O device.
____ D. Map a series of flag combinations into a bit.

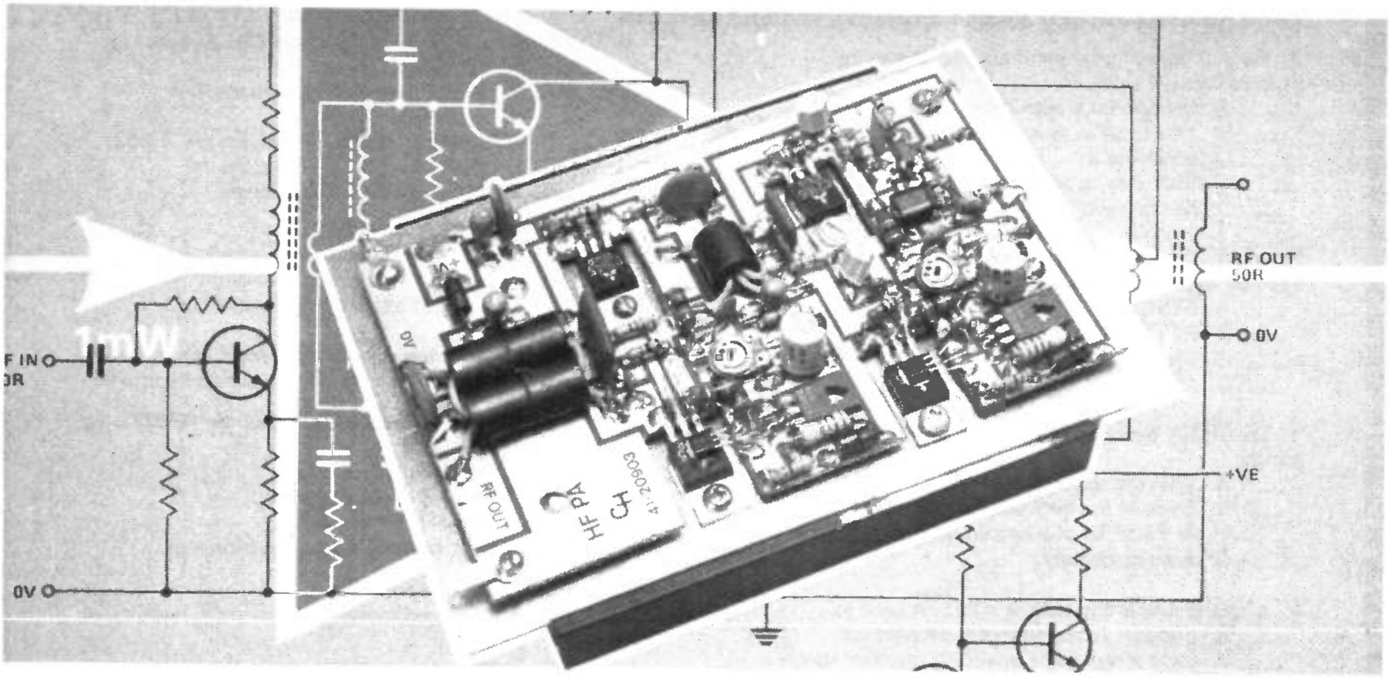
6. The System Call (SC) instruction:
____ A. Is used to switch from normal mode to system mode.
____ B. Uses the system stack.
____ C. Changes the FCW and PC.
____ D. All of the above.

7. The easiest way to do context switching from system to normal mode is:
____ A. Using the LDPS instruction.
____ B. Using the LDCTL instruction.
____ C. Using the SC instruction.
____ D. Using the MREQ instruction.

8. In normal mode, the programmer can directly alter the flags with:
____ A. An LDCTL instruction.
____ B. An LDCTLB instruction.
____ C. An LDPS instruction.
____ D. An COMFLG instruction.

9. Special I/O instructions differ from regular I/O in that:
____ A. Special I/O can be used only in system mode.
____ B. Special I/O can be used only for the Z8010 MMU.
____ C. Special I/O causes a different code on the ST3:0 lines.
____ D. Regular I/O can only be used with normal mode.

10. When switching from segmented to non-segmented mode on the Z8001, the SN6:0 lines:
____ A. Remain fixed at their current value.
____ B. Enter the high-impedence state.
____ C. Are cleared to logical zeroes.
____ D. Decrement to a pre-determined value, then remain fixed.



A Linear HF Power Amplifier

Chris Honey describes the design and performance of a wideband amplifier he has developed which should prove very good value for money.

The broadband 2–30MHz linear power amplifier described here has been designed primarily for amateur band use. In particular, the inclusion of a high gain pre-amplifier allows operation from double balanced mixers and similar low level sources. Another less obvious application is for boosting the output from RF signal generators: this could be used to advantage when testing the frequency response of medium power passive filters which inevitably seem to change their characteristics when subjected to a juicy amount of RF.

The somewhat unusual construction technique employed in this design permits the use of inexpensive components throughout and exploits some of the plastic RF power transistors that were originally aimed at the Citizens Band fraternity.

Design Considerations

An ideal linear amplifier would be one in which the output signal is simply the input signal amplified by a certain amount. In reality no transistor is perfectly linear and therefore the output signal of an amplifier is never an exact replica of the input signal. The non-linearity of the device generates harmonics which are added to the signal in the form of harmonic or intermodulation distortion. These harmonics may not appear in the amplifier output, owing to filtering and cancellation effects, but they are always generated in the amplifying transistors.

In this design, a push–pull configuration has been used in order to improve distortion products and to attain higher power levels than can generally be achieved with a single transistor. This has the effect of reducing the amplitude of even harmonics by an amount that is primarily dependent upon the matching of the two transistors, but even in the worst case the suppression provided in a push–pull design is superior to that of any single ended alternative.

Audio Hi-Fi buffs might tear their hair out at the distortion produced by this amplifier: but all RF designs rely heavily on filtering after the output, so this distortion is no real problem and the performance is as good as any middle of the road commercial alternative. However, the construction technique employed should NOT be undertaken by anyone simply because it's cheaper: a degree of experience both in soldering and in the general construction of RF circuits is essential if full advantage is to be taken of this Power Amplifier's potential.

The gain needed to provide the required ouput power is distributed among three amplifier stages – each handling a progressively higher amount of power. The last two stages have a push–pull configuration, while the first stage is a single ended class A amplifier to ensure low distortion.

A general discussion of all aspects of the amplifier follows.

Classes of Amplifiers

A **class A** amplifier is one in which the operating point of the transistor maintains a collector current at all times regardless of the input signal. It operates essentially over a linear portion of its characteristic, and reproduces the whole of the input signal.

A **class B** amplifier is one in which the operating point is at one extreme of its characteristic, so that the quiescent power is very low. If a sine wave is input into such a device, amplification takes place for just one half of the cycle.

A **class AB** amplifier is one operating between the two extremes of classes A and B. The output signal from a class AB device is active for more than half of a sinusoidal input cycle but not for the full cycle.

Biasing

The practical method of biasing low to medium power amplifiers – and the method that is usually applied – is the well known clamping diode circuit. This was indeed used in the **R&EW** 2m Power Amplifier (see June 1982 p67). This was tried here, but variations in transistor DC current gain (H_{FE}) produced differing collector currents which could only be optimised by changing the value of the series drop resistor – a highly impractical procedure unless a range of 1W resistors are at your disposal.

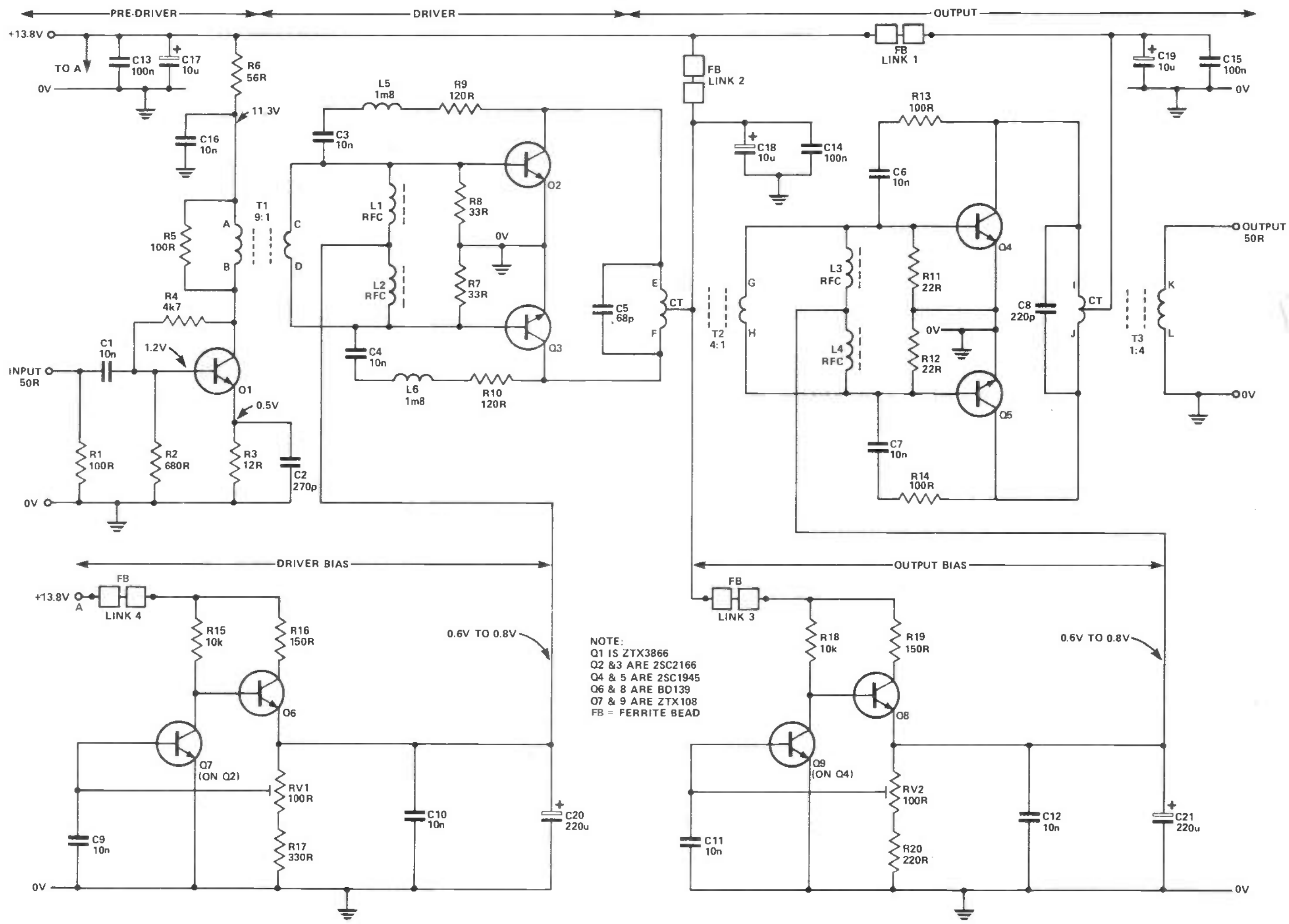


Figure 1: Main circuit diagram.

The circuit finally decided upon controls the bias adjustment in a way that compensates for variations in transistor current gain. The quiescent collector current for both the output and driver stages can thus be set at an optimum level, even if the supply voltage is not the design value of 13.8 volts.

Similar circuits produce each of the bias voltages as shown on the main circuit diagram (***Fig. 1***). The bias voltage for a particular stage can be set anywhere from 0.6–0.8V at room temperature, allowing that stage to operate anywhere between class B and class A. The bias voltage is impressed across the base–emitter junction of two transistors in parallel through RFCs that ensure that the RF signal is essentially isolated from the bias circuits. The decoupling components of the latter absorb any stray signal that might get through. As the biased transistor dissipates power and heats up, its actual base-emitter voltage falls by 2mV/°C: correspondingly, the quiescent collector current increases, altering the bias condition, and thermal runaway would ensue if Q7 or Q9 were not present. The latter transistors are mounted in thermal contact with the biased transistors Q2 and Q4, so that they both track the temperature and heat up in the same manner. But now an increase in the collector current of Q7 and Q9 reduces the base voltage of Q6 and Q8 (both acting as voltage followers) and the applied bias voltage is reduced. This stabilises the quiescent collector current against temperature variations, with the result that 50°C increase in temperature changes this current by approximately 1%.

RF is kept from upsetting the bias circuits by the decoupling capacitors C10 and C12. Capacitors C20 and C21 function as audio-frequency bypasses to keep the source impedance low at modulation frequencies.

With the aid of these bias circuits, the output stage operates in class AB and the driver in class B.

Impedance Matching

The output and interstage impedance matching is accomplished with the aid of conventional broadband transformers. These are not as efficient as transmission line transformers but they are better in practical terms because they are far easier to duplicate.

Two basic factors were considered in choosing magnetic cores for the transformers. The first was core losses and how these affected frequency response. The second was the power handling capability which is limited by magnetic saturation of the core and heat generation.

The primary concern in regard to the first transformer, T1, is core losses. Since it is operating at a relatively low power level, any losses will reduce the signal and degrade the amplifier's performance. A small ferrite balun core has therefore been used for T1 with the two sets of windings closely coupled together.

Conversely the core of the output transformer T3 should be as large as possible so that it can handle the required power levels and remain in the linear operating region of the material's B-H curve. The permeability of a magnetic core changes with applied signal level, and if too large an excitation is applied, saturation of the core results and distortion is produced — this is noticeable on the ▶

envelope of the output signal. Saturation usually occurs at low frequencies and this was a problem in the early stages of designing T3. The primary of T3 consists of one turn, centre tapped to the supply. This must have a minimum inductance of 4uH to provide suitable load impedance for the output transistors when these are operating at full power.

The ferrites available have a permeability of 850 and the inductance attainable with a single turn is limited to 2.5–3.0uH by the physical size of the core. This limits operation to around 4MHz, below which excessive harmonics are generated, causing self heating and loss of efficiency.

A possible solution would have been to increase the number of turns, but the design could not accommodate this. Instead four ferrite cores were used, two stacked on top of each other, alongside a similar pair: all the windings were then wound through them.

The interstage matching performed by transformer T2 was accomplished with a single core of the same type, helped by having two turns on the primary to provide the collector load for the driver stage.

Transformer Details

Transformer T1 provides a 9:1 impedance transformation to match the output of the pre-driver to the driver stage. The primary winding consists of six turns of 0.25mm enamelled copper wire and the secondary of two turns, both wound on a Fair-Rite type 43 ferrite balun core. The winding details are summarised in ***Fig.2***. The impedance seen at the transformer primary is 100 ohms.

A signal can be injected directly if the pre-driver stage is omitted: T1 is then replaced by a 4:1 impedance type with four turns on the primary and two on the secondary. This changes the impedance to 50 ohms, suitable for being driven from low level stages that have an output of around 10mW. Of course, an ideal alternative to the pre-driver stage would be the LF wideband amplifier that was featured in the August issue of **R&EW** (p50).

Transformer T2 has a ratio of 4:1, with a centre tapped primary to match the driver to the output stage. The base–base impedance in a push–pull circuit biased for class B operation would be four times the base–emitter impedance of one transistor. However in class AB, where the base–emitter junction is forward biased and the conduction angle is increased, the impedance is closer to twice that of one device.

In this design, an impedance of 20 ohms needs to be matched at the driver output. The minimum drive required is approximately 1 watt, which is equivalent to the driver output having a load of 200 ohms. The closest practical impedance ratio to this is 9:1. The transistor input impedance increases at lower frequencies and a better match was achieved with a 4:1 ratio. This presents a lower load to the driver stage which results in improved linearity.

Winding details for T2 are given in ***Fig.3***.

Transformer T3 matches the output stage to the antenna. The required impedance on the secondary is 50 ohms and the load for the output stage must be around 25 ohms to produce the required 10W output. This calls for a 2:1 impedance ratio, but for practical reasons a 4:1 transformer was used.

The winding details of T3 are given in ***Fig.4***.

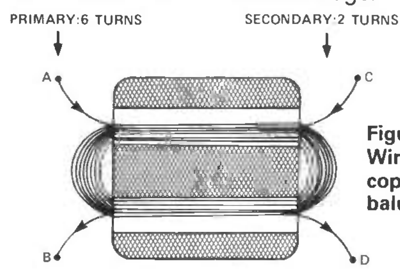


Figure 2: T1 winding details. Wire used — 0.25mm enamelled copper; core used — Fair-Rite balun core type 28-43002402.

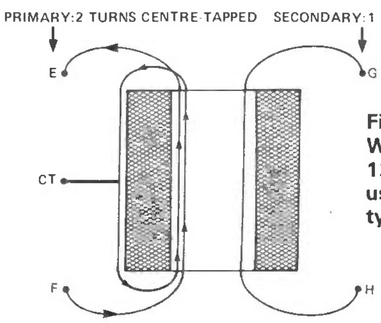


Figure 3: T2 winding details. Wire used — solid core PVC 1×0.6mm PVC insulated; core used — Fair-Rite ferrite sleeve type 26-43006301.

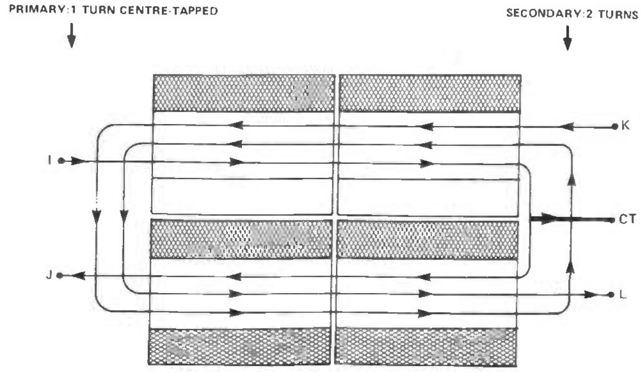


Figure 4. T3 winding details. Wire used – solid core PVC 1×0.6mm PVC insulated; cores used – 4 Fair-Rite ferrite sleeves type 26-43006301 arranged as shown. The cores can be cemented together or held in place with heatshrink sleeving.

The Pre-Driver

This is based around a ZTX3866 transistor biased for class A operation. This affords excellent rejection above the second harmonic, which is itself some 30dB below the fundamental. Such characteristics are quite adequate for this application.

The operation of the pre-driver is best understood with reference to the circuit diagram in ***Fig.1***. Resistors R6, R4 and R2 maintain a DC bias voltage of 1.2V on Q1 and C1 isolates this from the input source. The output signal is developed across the primary of T1 and the transformer is damped by R5 to keep the Q low. Resistor R4 – from collector to base – provides negative feedback to maintain a flat gain across the frequency range and to keep the input impedances of the stage low. Capacitor C16 decouples the top end of T1 at RF and C2 provides extra gain above 20MHz to assist further in keeping the frequency response flat.

The input impedance of the amplifier is maintained by R1 at 50 ohms. The actual AC load seen by Q1 is nine times the input impedance of the driver stage, i.e. around 100 ohms. The power gain is approximately 10dB and the frequency response extends to 50MHz before falling off, making the pre-driver suitable for higher frequency use – for example, at 6m.

Driver and Output Stages

The efficiency of the pre-driver under class A operation is only 40% and a simple calculation shows that, if class A were to produce 10 watts, then 25 watts would be consumed from the supply and 15 watts developed as heat in the output device. Fortunately class AB or class B operating conditions are more efficient. On the other hand, these result in considerable distortion in a single output device. Ideally one wishes to achieve operation with the efficiency of class B but the low distortion of class A. Such a goal is not realistic but, as I mentioned above, surprisingly low-distortion, high-efficiency operation can be obtained with the push–pull configuration.

The circuit of ***Fig.5a*** uses an input transformer to present signals of the opposite polarity to the two transistor inputs and an output transformer to drive the load in push–pull. The push–pull nature of the circuit can readily be seen in the partial circuit diagram shown schematically in ***Fig.5b***, by considering the effect of opposite-polarity inputs being supplied to the two transistors. The DC quiescent currents (I_{CQ}) for each transistor travel in opposite directions through the transformer winding, and so the magnetic fluxes set up by each of these currents in the core are similarly opposing. The net flux in the perfectly matched case is zero and thus the transformer – because it does not have to handle a large amount of flux generated by DC currents – can have a smaller core.

During a positive half-cycle, transistor Q1 is driven further into conduction whereas T2 is driven less. This is because the signal current I_s in Q1 is in the same direction as I_{CQ} (resulting in a larger total current) while that in Q2 is in the opposite direction (thus decreasing the current). The net result of this current flow through the transformer primary is a half-cycle of voltage across the secondary and thus across the load.

Similar argument reveals what happens in the negative half of the cycle. It turns out that the two input signals generate currents in the transformer that are in opposite directions on each half of the cycle and thus provide a complete cycle of signal at the transformer secondary.

How does push–pull reduce distortion? ***Fig.6a*** shows the signals for each collector in ***Fig.5b*** under class B operation; note that both waveforms are distorted on the negative half-cycle. ***Figure 6b*** shows their main components below each of the signals. The 3rd, 4th, 5th (and so on) harmonics are, naturally, also present. But while the fundamental and all the odd harmonics of each signal are of opposite polarity (and therefore add in the voltage output at the secondary), the second and the other even harmonic components are of the same polarity and therefore cancel. The resulting output is thus made up of the fundamental and all the odd harmonic components of the distorted signal. The total distortion should therefore not be much more than the small

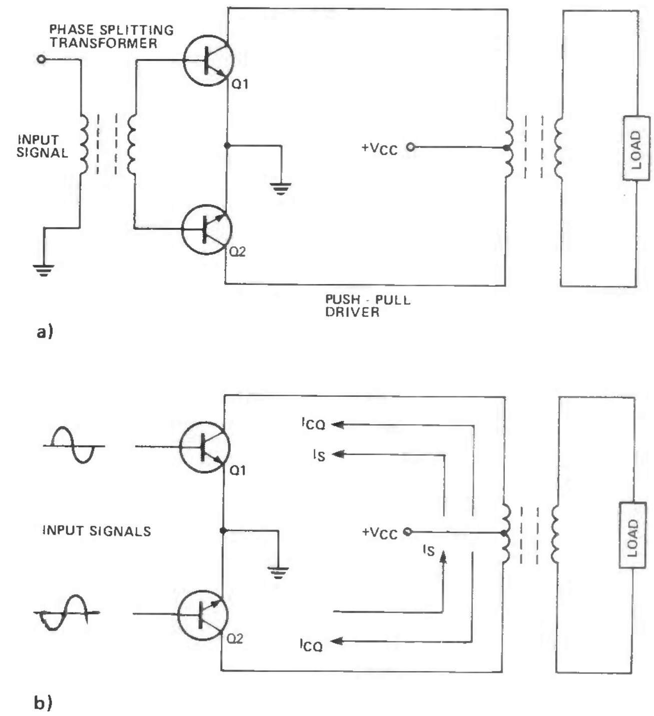


Figure 5: a) Push–pull circuit. b) Pull–pull operation.

amount of third harmonic distortion present. In reality the distortion will almost certainly be increased overall since the circuit will not be perfectly balanced due to transistors being mismatched, the transformer centre-tap being off-centre and the input signals not being exactly equal and opposite.

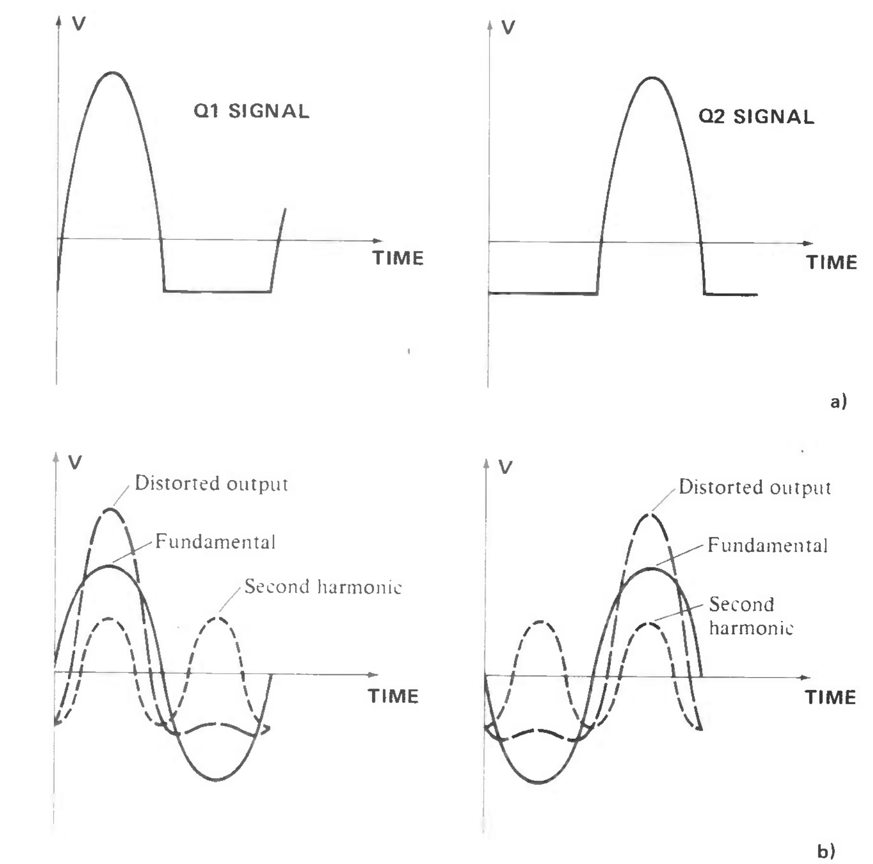


Figure 6: a) Collector signals in the push–pull configuration. b) Resulting distortion.

The push–pull stages can clearly be seen in the main circuit digram of ***Fig.1***. Gain compensation in both these stages is achieved through negative collector-to-base feedback. For the driver, the desired frequency selective feedback is provided by C3, L5 and R9/C4, L6 and R10, with C3, C4 acting as DC blocks. The reactance of L5, L6 means that the gain does increase slightly with frequency – to the tune of 0.8dB/octave.

The role of R8 and R7 is to stabilise the changes in the base–emitter impedance of the transistors, thereby keeping a constant input load and ensuring that the signal does not fluctuate with frequency. Capacitor C5 is a compensating capacitor which resonates with T2 at the top end of the frequency range to give a quicker roll-off.

The output stage operates in precisely the same way as the driver stage.

Construction and Testing

The printed circuit board employs those principles that are now regarded as standard in the construction of HF circuits.

The underside is a copper earth plane connected to the top component side in eleven places. All the components are soldered to the top, with their leads as short ▶

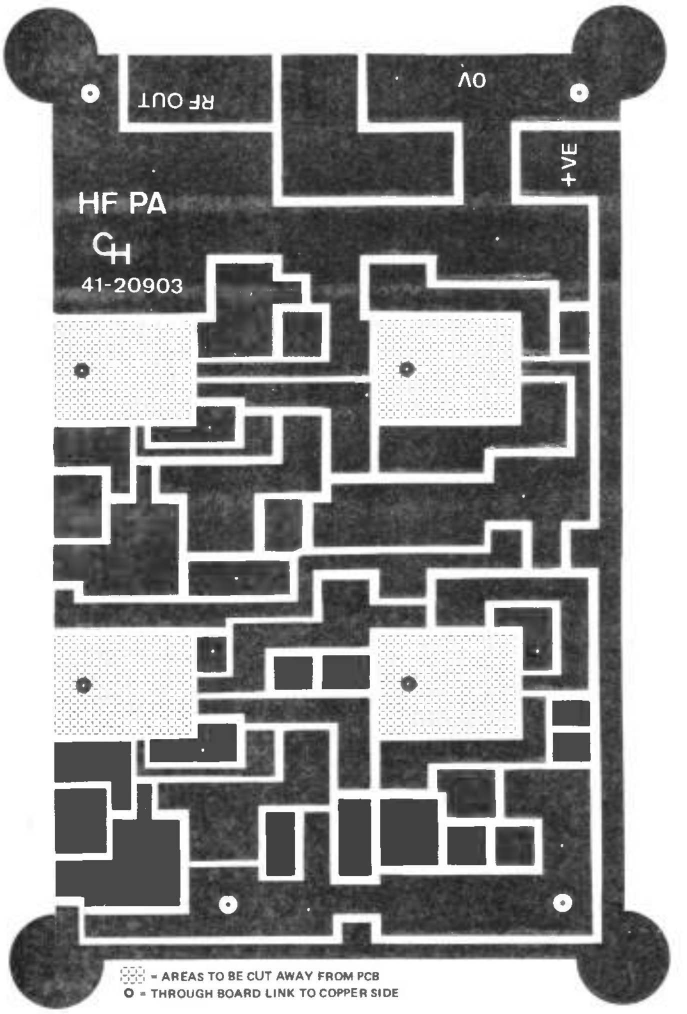


Figure 7: PCB foil pattern. Constructors that make their own PCB should cut out the shaded areas.

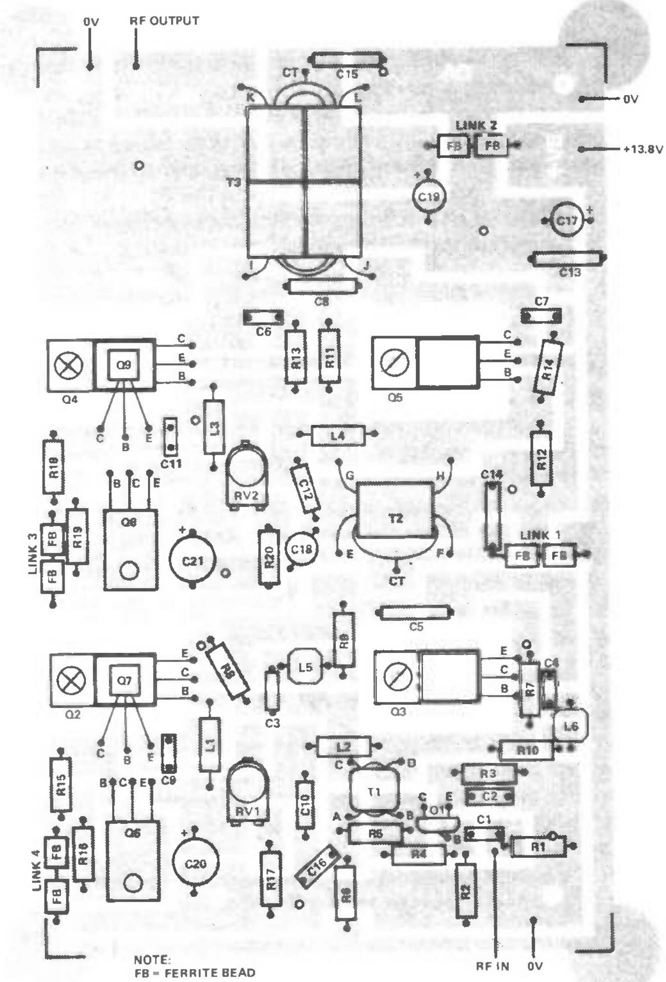


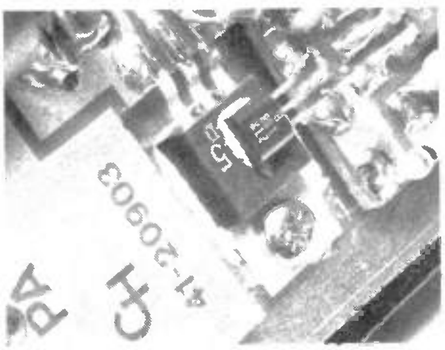
Figure 8: Component overlay.

as possible and bent to fit, as shown on the overlay in ***Fig.8***. Having the connections between components visible from the component side has the advantage that the circuit can easily be followed and checked during construction.

To avoid any mishaps, construction is best undertaken in the following step-by-step approach.

Before any components are soldered, the board has to be mounted, together with the four TO220 cased transistors, on the heatsink and the case. The four transistors are mounted on the heatsink through rectangular holes in the circuit board; so if you are etching your own board, remember to cut out these holes (as illustrated in ***Fig.7***). The PCB itself must not be mounted until the eleven through-board links have been soldered in place. These are just lengths of wire, typically cut from the ends of components or dedicated pins, inserted through the PCB and soldered on each side.

Once the links are in place, the next step is to drill the heatsink and case as shown in ***Fig.9***. (Alternatively the PCB foil can be used as a template.) Ensure that all the holes are deburred, otherwise a good thermal contact will not be achieved and overheating will result.



◀ **View of Q9 mounted on Q4. Note the use of silicone grease.**

Another cause of overheating is, of course, insufficient heatsinking. A 2.5°C/W heatsink is recommended for use with a 30% duty cycle signal at 10 watts, while for RTTY or FM use a larger heatsink will be necessary. Extra heat dissipation is readily provided if the lid of a metal case is sandwiched between the transistors and the heatsink. This technique was in fact employed in the prototype and the heatsink used was the same as that in the **R&EW** 2m power amplifier (see May 1983 p46) and fits in nicely between the PCB mounting holes.

After drilling has been completed, bend the leads of transistors Q2,3,4,5 upwards at 90° about 3mm from the plastic body,

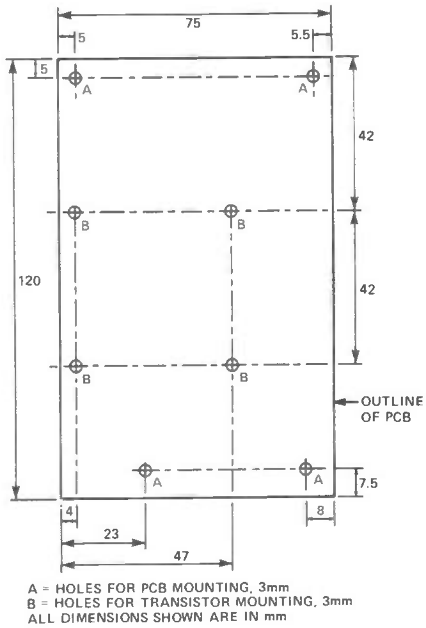


Figure 9: Drilling details.

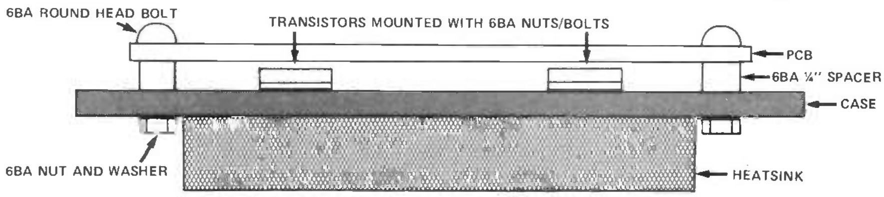


Figure 10: Side view showing sandwich construction.

and attach these transistors to the heatsink/case using 6BA nuts and bolts. Remember to use silicone grease heat transfer compound between the heatsink and the case and between the case and the transistor. Since their metal tabs are connected to their collectors, Q2 and Q3 (2SC2166) must be mounted along with insulating washers to prevent them shorting to the 'earthy' heatsink.

The PCB may now be bolted to the case with the transistor heads passing through the holes in the latter. The board may be mounted directly onto the surface carrying the transistors, but the prototype used ¼" spacers to allow a greater flow of air to circulate around the PCB.

Figure 10 gives a 'side-on' view showing how the heatsink, case and circuit board are arranged relative to each other.

It is advised that construction on the top side of the PCB be done in the following logical steps, because these will aid testing.

First solder the leads of Q2,3,4,5 to the PCB. Then bend the leads of Q7,9 so that the cases of the transistors will like flat when mounted on Q2,4 respectively, before soldering them in place with spot of silicone grease on the underside of their cases. Q6 and Q8 can then be added to the board.

The four links LK1 – 4 each consist of two ferrite beads threaded on a length of wire. These should now be soldered in place, at the same time ensuring that the beads will not touch the board subsequently. Follow this with the insertion of decoupling capacitors C13,14,15 and C17,18,19.

The next step is to solder in place VR1 and VR2, bending their leads so that they lie flat, followed by R15 – 20. R16 and R19 get quite hot and are best mounted 10mm above the board. Construction continues with the insertion of C9 – 12 and C20, C21; the radio frequency chokes L1 – 4; and finally R7, R8, R11 and R12.

This completes the construction of the bias circuits and they are now ready to be tested.

Turn both VR1 and VR2 fully anti-clockwise and apply power to the board. The current drawn should be around 100mA; if not, switch off and check for faults in construction. If all is well so far, check that the voltages at the bases of Q2, TR3 vary between 0.6 and 0.8V as VR1 is turned. Similarly test the bases of Q4, Q5 for the same voltage range by adjusting VR2. Achievement of these voltages proves the operation of the bias circuits.

Construction is continued by soldering in place all other components except for T2 and T3. Winding details for T1 were, I remind you, given in ***Fig.2***.

The constructor should now test the DC conditions of the pre-driver. Again turn VR1 and VR2 fully anti-clockwise and apply power. Current consumption should be less than 200mA; otherwise there must be a fault in the construction.

Next, measure the voltage at the collector of Q1: this should be around 11.3V with respect to ground, with a 13.8V supply.

The next stage is to build T2 as in ***Fig.3*** and to solder it in place, except for the centre tap (CT) which should be bent to point upwards. Apply power again and check that the current consumption has not risen since the previous measurement. Now connect a multimeter between the supply (positive lead) and T2's centre tap (negative lead). Put the multimeter on a 50mA current range, and adjust VR1 until the meter reads **20mA**. This represents twice the quiescent collector current of Q2 and Q3. Leave this for 10 minutes (readjusting if necessary) before removing the power. T3 should now be built (following ***Fig.4***) and soldered in place with the centre tap upwards as for T2. Once again a multimeter should be connected between the supply and the centre tap, precisely as for T2 except that the meter should be set to a 500mA range and the current reading should be adjusted to **100mA** with the aid of VR2. Once the quiescent currents have been adjusted in this manner, the centre taps may be soldered to the board.

The entire amplifier can now be tested. Connect the output to a 50 ohm dummy load and a power-meter (an **R&EW** Autobridge – July 1982 p48 – would be ideal), short the input connection to ground and then apply power. No spurious oscillations should occur and so no reading on the power meter should be observed.

It is advisable to leave the amplifier in this state for 10 minutes whilst observing the current consumption, which should not increase dramatically. A low level signal now input should produce an amplified signal. In other words, the HF linear amplifier is now ready for use.

Power Supplies

There has been no mention so far of how to provide power to the amplifier. Fortunately expensive supply units are not required: a battery or any supply capable of giving 4 amps at the operating voltage will suffice. However, since the amount of current drawn is about 350mA on standby

PARTS LIST

Resistors (All ¼W 5% carbon unless specified)

R1,5,13,14	100R
R2	680R
R3	12R
R4	4k7
R6	56R
R7,8	33R
R9,10	120R
R11,12	22R
R15,18	10k
R16,19	150R ½W
R17	330R
R20	220R
VR1,2	100R Horizontal miniature preset

Capacitors

C1,3,4,6,7,9,11	10n Monolithic
C2	270p Ceramic plate
C5	68p Silver Mica
C8	220p Silver Mica
C10,12,16	10n Low voltage disc ceramic
C13,14,15	100n Low voltage disc ceramic
C17,18,19	10uF 16V tantalum bead
C20,21	220uF 6.3V ultra min. electrolytic

Semiconductors

Q1	ZTX3866
Q2,3	2SC2166
Q4,5	2SC1945
Q6,8	BD139
Q7,9	ZTX108

Inductors

L1,2,3,4	100uH Axial RF choke
L5,6	1.8uH 7BS fixed inductor. Toko 283AS - 1R8

Ferrites

Fair-Rite 28-43002402 Balun Core (T1)
Fair-Rite 26-43006301 5off (T2,T3)
Fair-Rite 26-43000101 8off (Ferrite beads).

Miscellaneous

0.25mm enamelled copper wire: 1m. 0.6mm solid copper wire PVC insulated: 1m. PCB. TO220 insulating kits (2 off). 6BA nuts, bolts (length depending on mounting). Heatsink (Prototype used type 4M-229). Silicone grease.

Note: An **R&EW** Project Pack is available for this design. See p 21 for details.

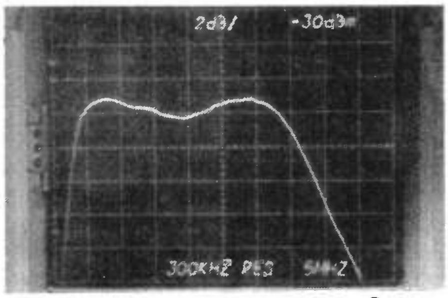


Photo 1: Frequency response. Output power 10W.
Vertical 2dB/div
Horizontal 0 – 50MHz. 5MHz/div.

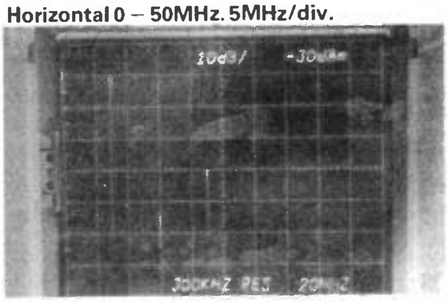


Photo 3: Output frequency spectrum showing 2nd and 3rd harmonics. Fundamental 30MHz. Power output 10W. Vertical 10dB/div. Horizontal 0 – 200MHz. 30MHz/div.

and this rises with signal level, the supply regulation must be good. For AM and SSB use, the AC impedance of the supply should not be greater than 0.05 ohms to ensure that the power output level is not modulated by the signal. Generally speaking, heavy duty wire should be used for connections to the power supply to keep voltage drops to a minimum.

Performance Data

Various measurements were taken on the amplifier to assertain its performance over all the operating range. At a power output of 10W CW, almost all the output harmonics were found to be about 26dB or more below the fundamental, the exception being the third harmonic which was only attenuated by 14dB below 10MHz. This figure is typical for a four and a half octave amplifier and it is obvious that some type of output filter will be required when this PA is used for communication purposes.

The driver transistors turned out to be very badly mismatched, but as they had been chosen from a random batch of transistors, the results obtained with this prototype must represent just about the worst you can expect from this amplifier.

POWER IN mW	POWER OUT W	POWER GAIN dB
1.00	15.0	42
0.32	5.9	42
0.10	1.5	42
0.03	0.4	42

Table showing power in, power out and gain at 30.0MHz.

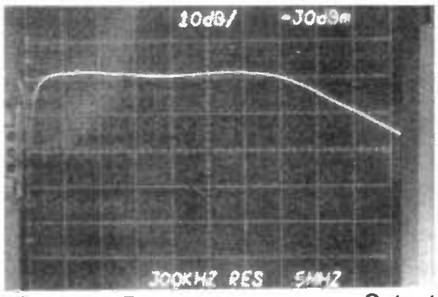


Photo 2: Frequency response. Output power 10W.
Vertical 10dB/div.
Horizontal 0 – 50MHz. 5MHz/div.

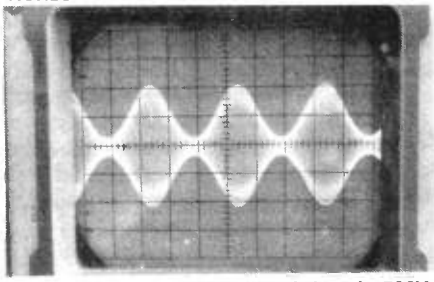


Photo 4: Amplitude modulated 5MHz carrier.
Single 1KHz tone.

SPECIFICATIONS of the prototype

Bandwidth	1.6–30MHz ± 1dB (max)
Power Gain	40dB (min)
Power Input for 10W output	0.8mW (min)
Supply Voltage	11–14V (nominal 13.8V)
Load Mismatch Susceptibility	10:1 at any phase angle

The higher order odd harmonic components can be substantially reduced by increasing the collector currents of the output and driver stages although, in the prototype, increasing the driver stage current produced no better results. Increasing the collector currents of the output stage reduced the 5th, 7th, 9th harmonics by around 10dB but increased the third harmonic by 2-3dB. Of course, increasing these currents will entail using a larger heatsink.

The various pictures displayed in photos 1–4 give a visual impression of how harmonics, frequency response and amplitude modulation are handled by the amplifier.

Load mismatch was simulated at 10:1 VSWR by using a reactive load containing 10m of URM95 coaxial cable. The latter has an attenuation of approximately 1dB at 30MHz, corresponding to a return loss of 2.0dB. The coax cable was terminated in an LC network consisting of two 30–140pF capacitors and two inductors (shown in *Fig. 11*).

FREQUENCY MHz	HARMONIC DATA (dB below fundamental) 2	3	4	5
2.0	–30	–14	–35	–26
4.0	–30	–15	–36	–32
7.5	–32	–15	–37	–38
15	–25	–20	–37	–34
20	–30	–18	–40	–44
30	–44	–28	–70	–70

Harmonic data taken at 10W power output into a 50 ohm load.

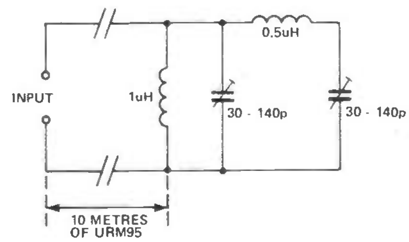


Figure 11: Load mismatch test circuit.

Under these conditions, the amplifier was found to be stable at all frequencies and at all phase angles. However the output transformer T3 became warm and the transistors became more heated. The extent of this overheating will obviously be the crucial factor in determining the maximum load mismatch that can be accommodated.

Equipment Used.

A Hewlett-Packard 8640B signal generator was used for all single tone measurements, while frequency spectrum measurements were carried out with a Tektronix 7603 combined oscilloscope and spectrum analyser in conjunction with a TR501 tracking generator. Other equipment included a BNOS 13.8V stabilised power supply, a Philips PM2521 automatic multimeter and an **R&EW** Autobridge. A Gould OS250B was used to display the AM modulation.

■ R&EW

References

1. Granberg.H. 'Low-distortion 1.6 to 30MHz SSB Driver Designs.' AN-779. Motorola Semiconductor Products Inc.
2. Granberg.H. 'Broadband Transformers and Power Combining Techniques for RF.' AN-749. Motorola Semiconductor Products Inc.
3. Boylestad and Nashelsky. 'Electronic Devices and Circuit Theory' Pages 399 to 403. Prentice–Hall.
4. Bowick.C. 'RF Circuit Design.' Howard.W. Sams & Co. Inc.

R&EW Data Brief

ZN419CE

Precision Servo Integrated Circuit

FEATURES

- ★ Low External Component Count
- ★ Low Quiescent Current (7mA typical at 4.8V)
- ★ Excellent Voltage and Temperature Stability
- ★ High Output Drive Capability
- ★ Consistent and Repeatable Performance
- ★ Precision Internal Voltage Stabilisation
- ★ Time Shared Error Pulse Expansion
- ★ Balanced Deadband Control
- ★ Schmitt Trigger Input Shaping
- ★ Reversing Relay Output (DC Motor Speed Control)

The ZN419CE is a precision monolithic integrated circuit designed particularly for pulse-width position servo mechanisms used in all types of control applications. The low number of components required with the ZN419CE, together with its reduced length and low power consumption, make this integrated circuit ideal for use in model aircraft, boats and cars where space, weight and battery life are at a premium. The amplifier will operate over a wide range of repetition rates and pulse widths and is therefore suitable for the majority of systems. The ZN419CE can also be used in motor speed control circuits.

Servo Application

Introduction

In the standard servo application the displacement of a control stick varies the pulse width of a timing circuit and many such pulses are time division multiplexed and typically modulate a 27MHz or 35MHz transmitter. A receiver then decodes the transmitted signal and reconstitutes an independent train of pulses for each servo channel. The servo shown in *Fig.2* consists of the ZN419CE integrated circuit, several external components, a power amplifier consisting of two external PNP transistors and two on-chip NPN transistors which form a bridge circuit to drive the DC motor. The motor drives a reduction gear box which has a potentiometer attached to the output shaft. This potentiometer in association with R_1 and the timing components C_T and R_T controls the pulse width of the timing monostable. The input pulse is compared with the monostable pulse in a comparison circuit and one output is used to enable the correct phase of an on-chip power amplifier. The other ouput from the pulse comparison circuit drives the pulse expansion circuit (C_E, R_E) via the deadband circuit (C_D). Thus any difference between the input and monostable pulses is expanded and used to drive the motor in such a direction as to reduce this difference so that the servo takes up a position which corresponds to the position of the control stick.

Input Circuit

The ZN419CE operates with positive going input pulses which can be coupled either directly or via a capacitor to pin 14. The advantage of AC coupling is that should a fault occur in the multiplex decoder which causes the input signal to become a continuous positive level, the servo will remain in its last quiescent position, whereas with direct coupling the servo output arm will rotate continuously. A nominal 27kohms resistor

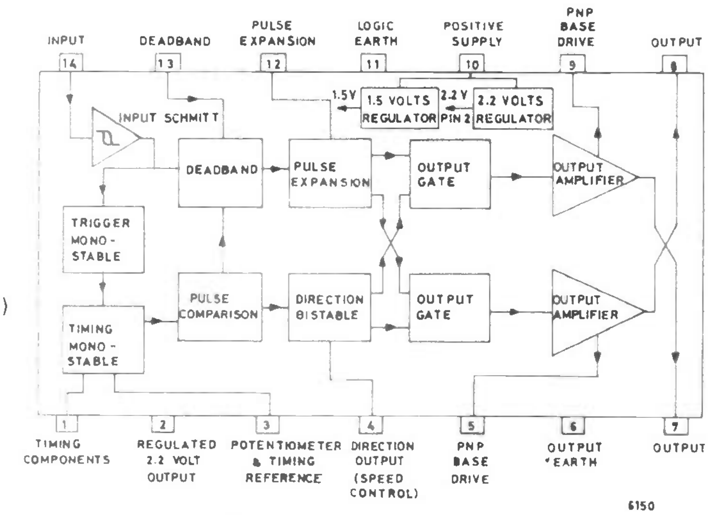


Fig. 1. SYSTEM DIAGRAM

ABSOLUTE MAXIMUM RATINGS

Supply Voltage	6.5 Volts
Package Dissipation	300 Milliwatts
Operating Temperature Range	−20°C to +65°C
Storage Temperature Range	−65°C to +150°C

CHARACTERISTICS (V_S = 5V. At 25°C ambient temperature unless otherwise stated).

Parameter	Min.	Typ.	Max.	Unit	Conditions
Input threshold (lower)	1.15	1.25	1.35	V	Pin 14
Input threshold (upper)	1.4	1.5	1.6	V	Pin 14
Ratio upper/lower threshold	1.1	1.2	1.3		−10 to +65°C
Input resistance	20	27	35	kΩ	$V_{in} \leqslant 2V$ (Pin 14)
Input current	350	500	650	μA	$V_{in} \geqslant 2V$ (Pin 14)
Regulator voltage	2.1	2.2	2.3	V	−10 to +65°C, 1.3 mA load current
Regulator supply rejection ratio	200	300	—		Vs = 3.5 to 6.5V $RSRR = \frac{dV_{in}}{dV_{out}}$
Monostable linearity	—	3.5	4.0	%	±45°, R_P = 1.5 kΩ R_1 = 12 kΩ
Monostable period temperature coefficient	—	+0.01	—	%/°C	Excluding R_T, C_T. R_P = 1.5 kΩ, R_1 = 12 kΩ (potentiometer slider set mid-way)
Output Schmitt deadband	±1	±1.5	±3	μs	C_E = 0.47 μF
Minimum output pulse	2.5	3.5	4.5	ms	C_E = 0.47 μF, R_E = 180 kΩ
Error pulse for full drive	70	100	130	μs	15 ms repetition rate C_E = 0.47 μF, R_E = 180 kΩ
Total deadband	±3.5	±5	±6.5	μs	C_D = 1000 pF
P.N.P. drive	40 35	55 50	70 65	mA mA	T = 25°C T = −10°C
Output saturation voltage	—	300	400	mV	I_L = 400 mA
Direction bistable output	2	2.8	3.6	mA	V_S = 2V max.
Supply voltage range	3.5	5	6.5	V	
Supply current	4.6	6.7	10	mA	Quiescent
Total external current from regulator	1.3	—	—	mA	V_S = 3.5V
Peak voltage $V_{C\ EXT}$ (with respect to 2V regulated voltage)	— —	0.7 0.5	— —	V V	T = 25°C T = −10°C

OPERATING AND DESIGN NOTES

1. SERVO APPLICATION

Component Function	Circuit Reference	Value	Comments
Monostable Timing Components	R_T	100 kΩ	
	C_T	0.1 μF	
Potentiometer and Timing Reference Components	R_p	1.5 kΩ	
		5 kΩ	
	R_1	4.7 kΩ	
Pulse Expansion	CE	0.47 μF	
	RE	180 kΩ	11Ω Motor
		150 kΩ	8Ω Motor
Deadband (Note 1(c))	C_D	1000 pF	11Ω Motor
		1500 pF	8Ω Motor
Dynamic Feedback	R_F	330 kΩ	
	R_B	330 kΩ	
	R_2	1.2 kΩ	
Input Coupling	C_C	2.2 μF	
Motor Decoupling	C_2	0.01 μF	
	C_3	0.01 μF	
R.F. Decoupling	C_1	0.1 μF	
Drive Transistors	T1, T2		

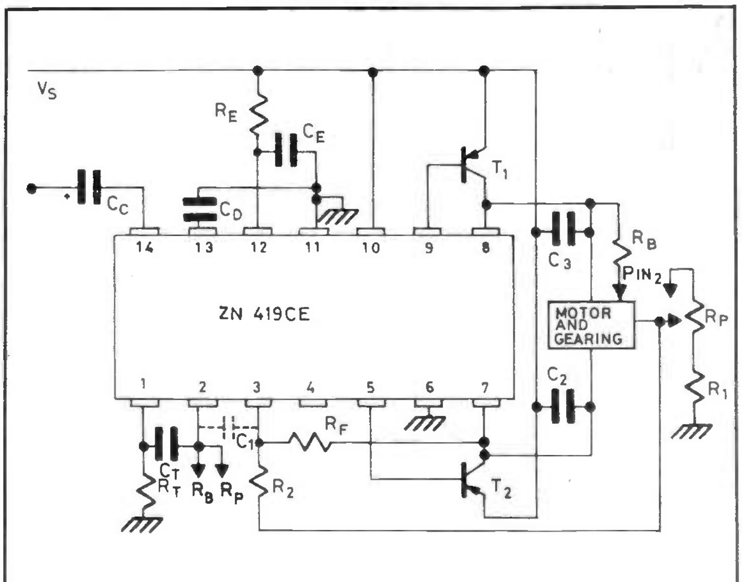


Fig. 2. SERVO SYSTEM USING THE ZN419CE

is shunted across the input on chip to provide DC restoration of the input signal when AC coupling is used. The active input circuit is a Schmitt trigger which allows the servo to operate consistently with slow input edges and supplies the fast edge required by the trigger monostable independent of input edge speed.

The input circuit and its V/I characteristic are shown in ***Fig.3.*** D_1 and D_2 are the parasitic substrate and isolation diodes associated with the input resistors. It is advisable that the pulse input amplitude should not fall below 0V nor exceed the supply voltage V_{CC} in order to prevent these diodes from conducting, although a small amount of conduction will not cause the circuit to malfunction. When AC coupling is used the value of C_C should be chosen to give a pulse droop not exceeding 0.3V.

Assuming that the input signal swings between 0V and V_s and taking the input chord resistance R_{in} of 13kohms, the droop for a pulse of duration t_p will be:

$$V_d = \frac{V_s\, t_p}{C_C \cdot R_{in}} \text{ volts}$$

with t_p in ms, C_C in uF and R_{in} in kohms. For a nominal pulse width of 1.5ms and V_d equal to 0.3V the required minimum value of C_c is found to be 1.85uF so the nominal value of 2.2uF is chosen (nearest preferred value).

$$C_C = \frac{4.8 \ . \ 1.5}{0.3 \ . \ 13} = 1.85\ \mu F$$

If the servo is to operate with reduced input pulse amplitude, the input pulse should exceed the upper Schmitt threshold voltage of 1.5V by a reasonable margin and a minimum input amplitude of 2.4V is recommended.

Deadband Circuit

The function of the deadband circuit is to provide a small range of output shaft position about the quiescent position where the difference pulse does not drive the motor. This is necessary to eliminate hunting around the quiescent position caused by servo inertia and overshoot. The minimum deadband required is also a function of the pulse expansion characteristics and dynamic feedback component values.

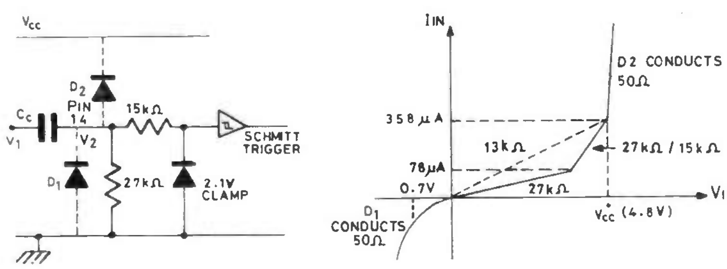


Fig. 3.

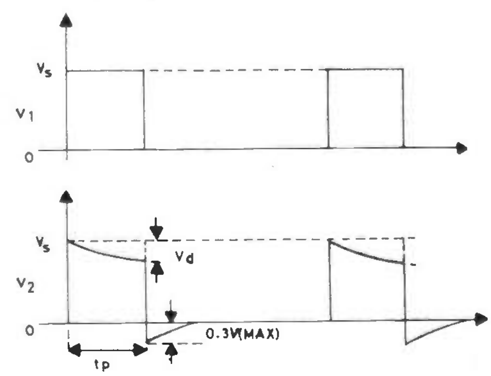


Fig. 4. INPUT WAVEFORMS

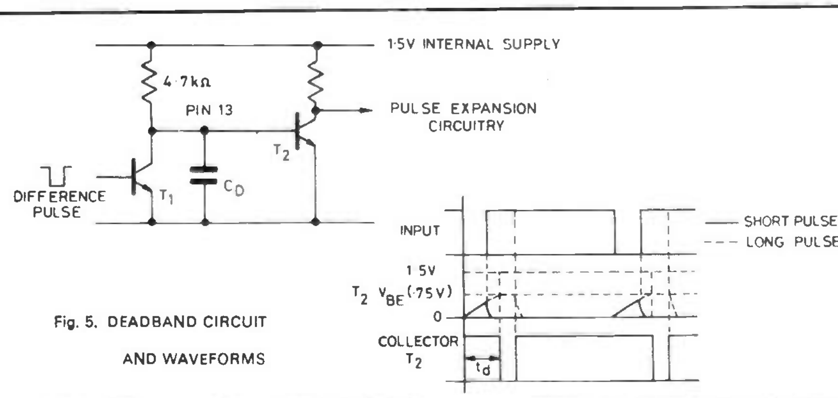


Fig. 5. DEADBAND CIRCUIT AND WAVEFORMS

When the difference pulse is applied, T_1 turns off and the base of T_2 rises on an exponential waveform with a time constant of 4.7kohms × C_D. If the difference pulse is small, the potential reached on the base of T_2 is insufficient to turn T_2 on and no output results.

The pulse expansion circuit has a built in deadband of 1.5us with C_E=0.47 uF and this must be added to the deadband caused by C_D to obtain the total T_d.

$$\therefore \quad T_d = 1.5 + t_d \ \mu sec$$

t_d is found from the exponential equation.

$$V_{be} = V_1 \left[1 - \exp\left(\frac{-t_d}{C_D \ . \ 4.7\,k\Omega}\right)\right]$$

$$\therefore \quad t_d = C_D . \ 4.7 \log e \left(\frac{V_1}{V_1 - V_{be}}\right)$$

$$\therefore \quad = 3.3 \ C_D \ \mu sec \ (C_D \text{ in nF})$$

(Taking V_1 = 1.5 volts and V_{be} = 0.75 volts)
Thus with C_D equal to 1000 pF (1 nF)
t_d = 3.3 µsec and T_d = 4.8 µsec.

The mechanical deadband Ød depends on the chosen sensitivity S_1 of the servo and in the usual radio control application a ±500 us input pulse variation causes ±50° rotation, i.e. S_1=10us per degree.

$$\text{Thus} \quad Ød = \frac{2.T_d}{S_1} \text{ degrees}$$

(T_d in µsec. S_1 in µsec per degree).

Thus a value for T_d of 5 µsec provides a mechanical deadband Ød of 1°.

And generally:

$$Ød = \frac{2. \ (1.5 + t_d)}{S_1}$$

$$Ød = \frac{3 + 6.6 \ C_D}{S_1} \text{ degrees}$$

$$\text{with} \begin{cases} C_D \text{ in nF.} \\ S_1 \text{ in } \mu sec \text{ per degree.} \end{cases}$$

Pulse Expansion

A schematic of the pulse expansion circuit is shown in ***Fig.6***. In the quiescent state with no drive, the Schmitt trigger input is biased via R_E and takes up a level just above the lower threshold V_L. A drive pulse causes a current I_E to be switched on for the duration of the pulse and this discharges C_E linearly with time. Thus, at the end of the pulse the voltage on C_E depends on the duration of the pulse. If the pulse is narrow and just causes the potential on C_E to fall to V_L, the Schmitt trigger will switch to the upper threshold V_H and at the end of the drive pulse C_E will start to charge to V_H with a time constant $C_E R_E$. When the potential on C_E reaches V_H the Schmitt will switch to V_L and C_E will discharge to the quiescent level. The output drive is taken from the Schmitt output.

DC motors need a certain amount of drive to overcome static friction and the minimum output pulse obtained from this form of pulse expansion characteristic is chosen to ensure that the motor will rotate when driven. A linear initial pulse expansion characteristic would result in the motor remaining stationary and drawing full stall current for small drive periods. If the motor needs 2ms of drive at a repetition rate of 20ms to cause rotation, this is equivalent to an average drain of 50mA for a 0.5A stall current. This is many times more than the quiescent current of the ZN419CE (7mA) and could

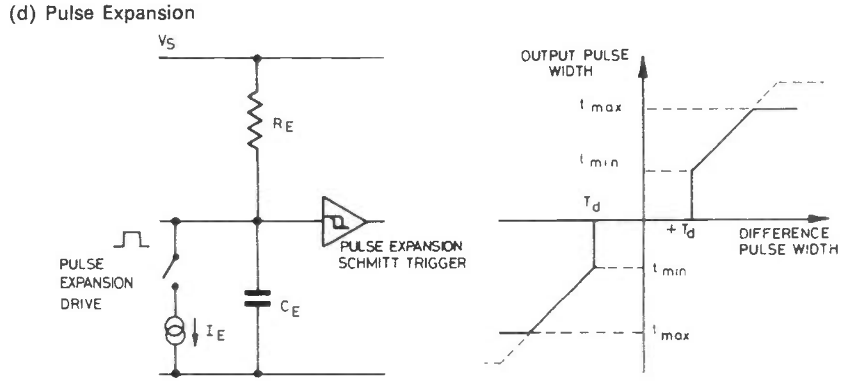


Fig. 6. PULSE EXPANSION CIRCUIT AND CHARACTERISTIC

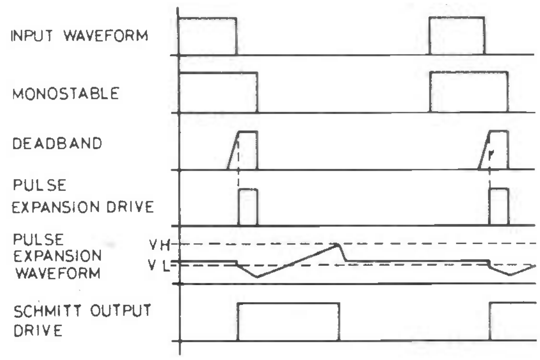


Fig. 7. PULSE EXPANSION TIMING DIAGRAM

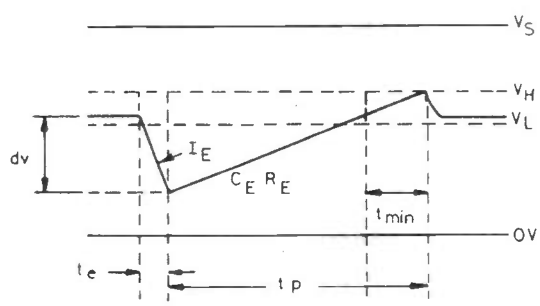


Fig. 8. PULSE EXPANSION WAVEFORM

considerably reduce flying time for the standard battery operated airborne multichannel radio control system. This effect also causes an annoying buzz from the motor and gearbox. The use of the Schmitt trigger removes these two deficiencies.

The value of t_{min} is determined by the Schmitt trigger hysteresis and the exponential waveform on C_E in the following equation.

$$V_H = (V_{CC} - V_L)\left(1 - \exp\left[\frac{-t_{min}}{C_E R_E}\right]\right)$$

Because V_H is small the following linear relationship is sufficiently accurate.

$$V_H = \frac{(V_{CC} - V_L)}{C_E R_E} . \ t_{min}$$

$$\therefore \quad t_{min} = \frac{V_H}{(V_{CC} - V_L)} . \ C_E R_E \text{ msec}$$

For nominal operation

V_{CC} = 4.8V; V_L = 1.5V; V_H = 0.12V and:

$$t_{min} \simeq \frac{C_E R_E}{30} \text{ msec} \quad \begin{cases} C_E \text{ in } \mu F \\ R_E \text{ in } k\Omega \end{cases}$$

and for C_E = 0.47 µF and R_E = 180 kΩ, t_{min} = 3.5 msec.

It can be seen from the simple equation that t_{min} is dependent on V_{CC}, and t_{min} will increase with reducing V_{CC}. This variation is put to good use to maintain the initial motor drive, V_{CC} × t_{min}, reasonably constant over the operating voltage range of 3.5 — 6.5V.

When the pulse expansion drive is increased above the minimum value, the output pulse increases from t_{min} almost linearly until full pulse expansion is reached, i.e. when the output pulse width equals the input pulse repetition rate. The

(e) Monostable Timing

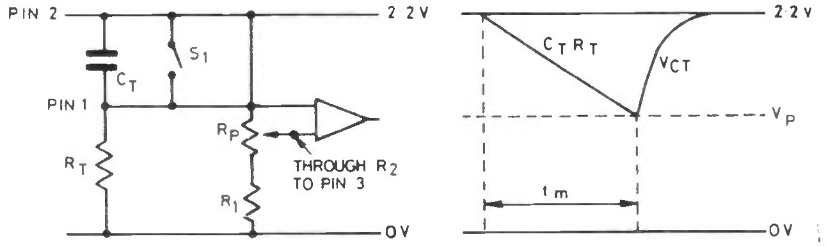
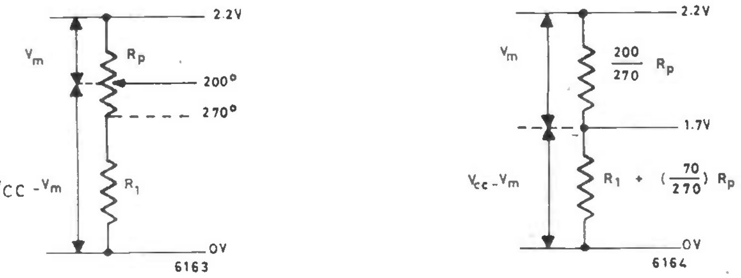


Fig. 9. MONOSTABLE TIMING CIRCUIT AND WAVEFORM



POTENTIOMETER SET AT 200°

EQUIVALENT CIRCUIT

Fig. 10

pulse expansion will be almost linear provided that the current source I_E does not saturate, i.e. provided that C_E is not discharged to almost zero volts. Ideally the current source should saturate when full motor drive is obtained but, due to component tolerances, it is usual to allow some margin to ensure that full motor drive can be obtained. If a margin is allowed, an extended pulse expansion characteristic results (shown dotted in ***Fig.6***) and if this is excessive it can lead to the servo exhibiting an underdamped characteristic causing jittering or hunting. Thus, for full pulse expansion, the voltage on C_E should discharge from its quiescent value of 1.5V — 0.75V. Thus with I_E=3mA for the current source:

$$\frac{1.5-0.75}{t_e} = \frac{I_E}{C_E}$$

$$\therefore \quad C_E = 4. \quad t_e\ \mu F \ (t_e \text{ in msec})$$

For t_e = 0.1 msec, a value of 0.47 μF was chosen for C_E.

If t_p is the maximum motor drive pulse length required, i.e. equal to the input pulse repetition period for full pulse expansion, and the mean value of the potential on C_E is taken as 1.2V then:

$$dv = \frac{(t_p - t_{min})}{C_E R_E}. \quad (V_{CC} - 1.2)$$

And for the discharge period t_e:

$$dv = \frac{I_E \cdot t_e}{C_E}$$

$$\therefore \quad R_E = \frac{(t_p - t_{min})}{I_E\, t_e}. \quad (V_{CC} - 1.2)$$

For nominal values of V_{CC} = 4.8V and I_E = 3 mA

$$R_E = 1.2\,\frac{(t_p - t_{min})}{t_e}\ k\Omega$$

and for t_p = 20 msec, t_{min} = 3.5 msec,

t_e = 0.1 msec, R_E = 180 kΩ

(Nearest preferred value).

Monostable Timing

The leading edge of the input waveform triggers the timing monostable by opening switch S_1. C_T then charges until the differential amplifier detects that the timing waveform potential has fallen to V_p the potential on the potentiometer wiper, and switch S_1 is closed to terminate the timing pulse. Thus the monostable period is determined by the setting of the potentiometer wiper. In the standard application the servo centre position pulse width is 1.5ms with a range of ±50° rotation at 10us/degree. Thus the 2.0ms maximum monostable period $t_{mono(max)}$ corresponds to a potentiometer setting of 200° (for a linear relationship) and since the potentiometer has a total rotation of approximately 270° and the maximum allowable swing on pin 3 is specified as 0.5V, the value of $C_T R_T$ can be calculated as follows:

$$\frac{0.5}{t_{mono(max)}} \simeq \frac{2}{C_T R_T}$$

$$\therefore \quad C_T R_T = 4. \quad t_{mono(max)}$$

Thus if $t_{mono(max)}$ = 2 msec,

$C_T R_T$ = 8 msec.

The optimum value of R_T is 100kohms, owing to the design of the on-chip monostable circuit, giving C_T=0.1uF (nearest preferred value). The value of R_1 can now be calculated from the actual voltage swing with a potentiometer setting of ∅p=200° and ∅max=270°. Thus from the equivalent circuit

$$\frac{V_m}{\frac{200}{270}\cdot R_p} = \frac{(V_{CC} - V_m)}{R_1 + \frac{70}{270} R_p}$$

where V_m is calculated from the actual value of C_T and R_T chosen using the relationship

$$V_m = \frac{2.0 \ . \ t_{mono(max)}}{C_T R_T}$$

With the chosen values of C_T and R_T, V_m=0.4V and hence R_1=3.2 R_p. If R_p=1.5kohms then R_1=4.7kohms

Dynamic Feedback

Without dynamic feedback, in the standard application the inertia of the motor and the gearbox causes the servo output shaft to overshoot the set position, which results in the servo 'hunting'. If the deadband was widened to stop this effect, an unacceptably large deadband would result and the servo would still be underdamped. The dynamic feedback circuit uses the motor back EMF (which is proportional to motor speed) and feeds back a proportion of this signal to the wiper of the potentiometer. The phase of the feedback signal is chosen to modify the potential on the wiper in such a way that the monostable period is dynamically varied to reduce the motor drive as the servo output shaft approaches the set position and the values of the feedback resistors are chosen to achieve optimum settling characteristics.

The value fo R_F and R_B of 330kohms will suit the normal type of servo mechanism; however if the servo is fairly fast, this can be decreased to 300kohms to minimise any tendency to overshoot. Where the servo is slow, R_F and R_B can be increased to 360kohms or 390kohms.

Alternative Value of R_p

Although a 1.5kohms feedback potentiometer is the most common source of R_p, 5kohm potentiometers are used in some servo mechanisms. In order to use this value with the ZN419CE a 2.2kohm resistor is usually connected across the potentiometer to maintain the values of the R_F and R_B at 330kohms and R_1 at 4.7kohms, R_2 is omitted; i.e. the wiper of the potentiometer is connected directly to pin 3 of the ZN419CE.

RF Decoupling

C_1 (typical value 0.1uF) is only necessary where strong RF fields may affect the operation of the circuit.

Traansistors T1 and T2

The external PNP transistors are usually selected for a low $V_{CE(sat)}$ to obtain maximum output drive and the recommended types are the ZTX550, ZTX750 or ZTX753.

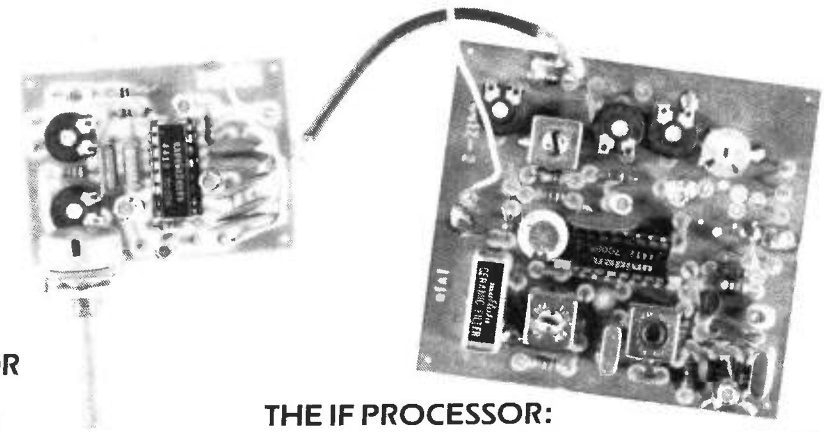
■ R&EW

Next Month

in the first issue of Volume 3

MODULAR COMMUNICATION SUBSYSTEMS — PART ONE

Practical Building Blocks : Cheap, Sophisticated and Informative



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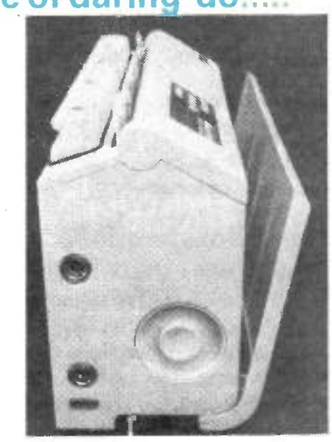

PLUS:

- ALL THE NEWS THAT IS FIT TO PRINT
- TWO APPROACHES TO TONEBURST
- SPECTRUM ANALYSIS MADE EASY
- THE YAESU FT77 HF TRANSCEIVER

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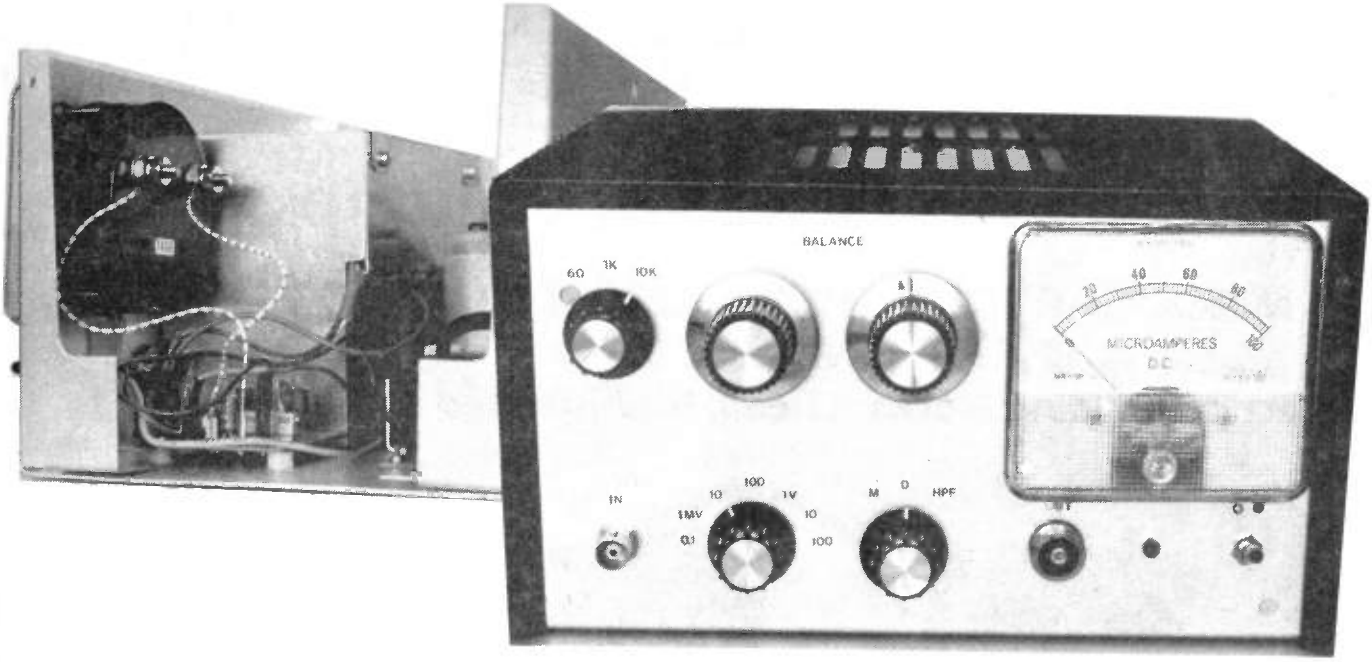


A SENSITIVE MEASURE OF DISTORTION

L. Boullart describes the philosophy that led to the development of a Sensitive Distortion Meter which is easy to build and makes a practical substitute for a spectrum analyser among the amateur constructor's test equipment.

Distortion measurement can readily be carried out by means of a spectrum analyser, but it may be assumed that few amateurs have access to this costly instrument. On the other hand, a traditional distortion meter is relatively easy to build and a good design will have a similar level of sensitivity.

Design Considerations

Such an instrument, shown schematically in ***Fig.1***, is based on the following principles. First the fundamental is filtered out by means of a notch filter; then the residual distortion is amplified and read off on a suitable instrument (an AC millivoltmeter); and finally the reading is converted to a percentage of the original signal level. The procedure is undoubtedly somewhat more complicated than using a spectrum analyser, but the results are of equal merit.

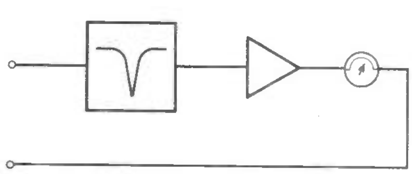


Figure 1: Principle of distortion measurement

In fact, the method described above is generally the more accurate one for very small distortion contents, and since the new generation of amplifiers – with MOSFET output stages – will often produce less than 0.003% harmonic distortion, there seems to be a good case for this kind of instrument, provided it will be sensitive enough to detect distortion down to at least 0.0001% of the output voltage of a power amplifier.

Consider, for example, a moderately rated amplifier (say 25 watts into 4 ohms). This will deliver 10V_{rms} into a 4 ohms load:

$V_O = R\,(P/R)^{1/2} = (P.R)$

The desired sensitivity of 0.0001% of this value amounts to 10uV. Assuming a reasonably accurate reading at 1/10th of FSD (full scale deflection), this ultimately entails a sensitivity of 100uV in practical terms.

At the same time, the instrument amplifier must have a noise figure somewhere around 2uV, referred to the input, with the result that needle deflection should be hardly noticeable in the absence of a signal.

The Notch Filter

We turn next to the notch filter. Other things being equal, the parallel T-filter offers the simplest means of obtaining a null at a chosen frequency and it has been in general use in several commercial distortion meters for quite some time.

As its name implies, the parallel T-filter consists of two symmetrical T-filters (***Figs.2a and b***) connected in parallel. For convenience, the impedances Z1, Z2, Z'1, Z'2 are made equal. This condition is fulfilled when:

$R_y + 2/j\omega C_y = 2R_x + 1/j\omega C_x$

which leads to:

$R_y = 2R_x$ and $C_y = 2C_x$

(***see Fig.2c***). The characteristic impedance will be:

$Z_{in} = Z_{out} = R_x + 1/2j\omega C_x$

At the notch frequency f_0, this becomes:

$Z_{in} = Z_{out} = \sqrt{2}.R_x$

The notch frequency in turn is determined by:

$f_0 = 1/(2\pi.2R_x.C_x)$

At lower frequencies, the impedance will gradually approach $4R_x$ (+ Z_{load}). Indeed, the impedance of C_x and $2C_x$ will approximate to infinity and may therefore be ignored. ***Figure 2c*** then becomes ***Figure 2d***.

At frequencies much higher than f_0, the impedance of C_x becomes so low that the set up reduces first to ***Fig.2e*** and then ***Fig.2f***. The impedance ultimately reaches $\frac{1}{2}R_x$.

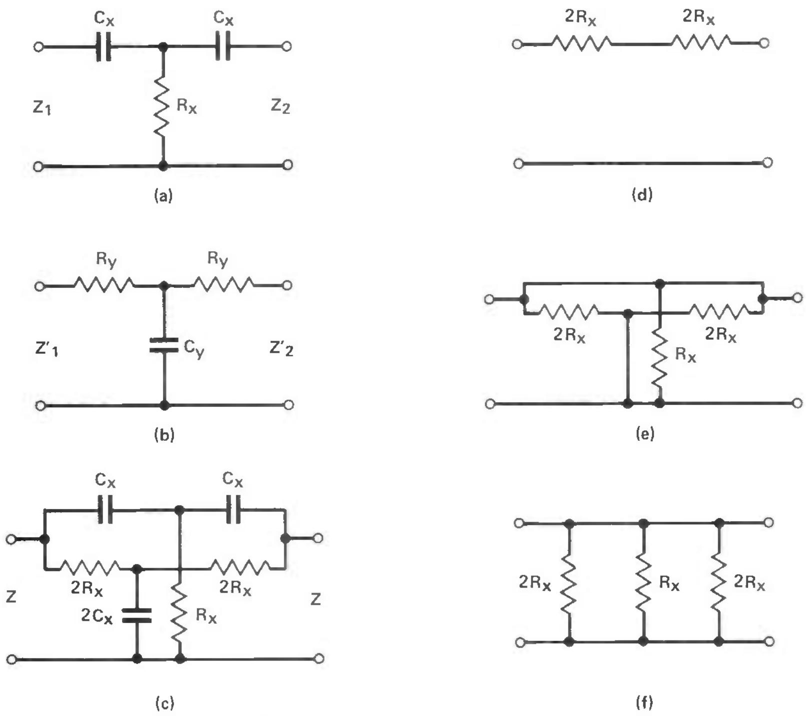


Figure 2: Analysis of the parallel T-filter

Starting from the low frequency end, the phase lag will reach $-90°$ at f_0; but from the higher end of the frequency scale, the phase difference will gradually increase up to $+90°$ at f_0. This means a sudden jump of 180° at f_0 – in other words : a polarity reversal.

These impedance and phase characteristics, together with the transmission curve, are represented in ***Fig.3***. A closer study of these parameters will reveal the conditions which have to be fulfilled to ensure satisfactory performance with a parallel T-filter.

i) **Phase relationship**: The polarity reversal at f_0 clearly indicates zero admittance, which means complete suppression of the fundamental.

ii) **Impedance**: It is obvious that the notch filter must look into an input impedance several times higher that $4R_x$; on the other hand, the filter must be fed from a source impedance considerably lower than $\frac{1}{2}R_x$.

iii) **Insertion Loss**: This is undoubtedly the weak point of this type of filter. The Q-factor is only 0.24, according to the formula $Q = f_0 / \Delta f$, Δf (the bandwidth) being the difference between the two -3dB points on the transmission curve. In this case, the response is 9dB down at $2f_0$ (the second harmonic) and the loss is 5dB at $3f_0$ (the third harmonic). As second and third harmonics normally account for the greater part of the total distortion, accurate distortion measurement is not possible.

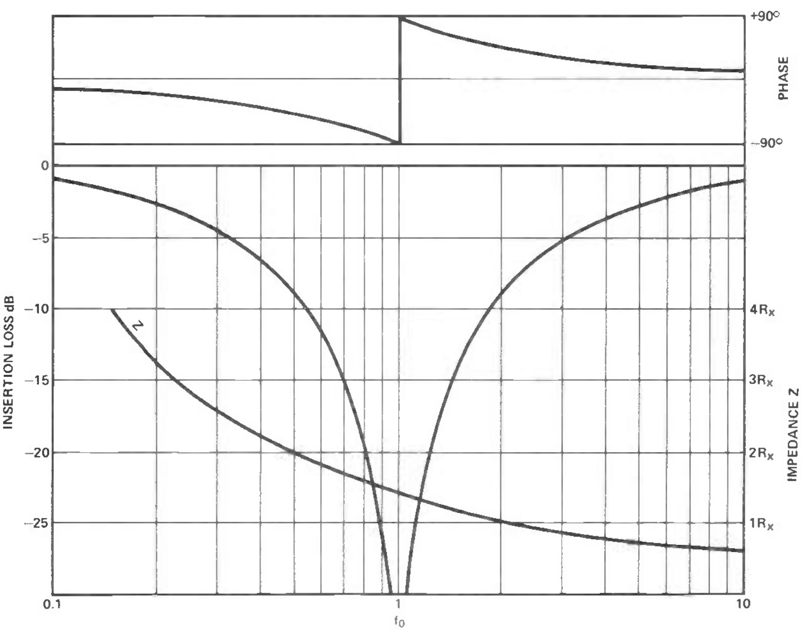


Figure 3: Transmission, impedance and phase characteristics of the parallel T-filter

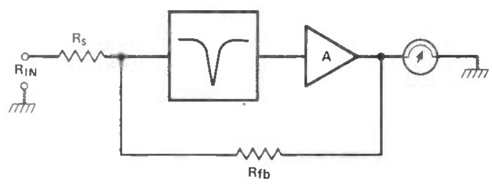


Figure 4: Parallel T-filter with shunt feedback

It will therefore be necessary to raise the Q-factor of the parallel T-filter; in other words the notch must be made much sharper to avoid excessive loss of harmonics. Fortunately this can be achieved by applying the right amount of feedback to the filter. Many distortion meters have appeared on the market which make use of shunt feedback to sharpen the response of the parallel T-filter (Radford, Sugden). Their general arrangement is shown schematically in ***Fig.4***.

For very large values of 'A' (open loop gain), the closed loop gain is determined by:

$$A' = \frac{(R_{IN} + R_x) + R_{fb}}{(R_{IN} + R_s)}$$

Clearly, R_{IN} will influence the amplification, so it must be kept constant. This could be achieved by preceding the filter by an emitter–follower, which will provide a constant low-impedance source for the parallel T (Sugden). Because the distortion and the noise generated by the emitter–follower also pass through the filter, the use of this circuit is limited in practice to a distortion reading of about 0.05%.

Further Developments in Filters

Since then, much work has been done on active filters, such as the Butterworth and the Tchebychev, which make use of positive feedback – in the form of bootstrapping. The possibility of applying the same principle to the parallel T-filter was pointed out by Riordan in 1963. In the case he considered, the bandwidth of the filter was reduced in proportion to the feedback factor.

If a normal gain amplifier is used, the same effect is achieved by inserting a potential divider across the output, provided that

$$\frac{R_2}{R_1 + R_2} < A$$

(*see **Fig.5a***). However, the response curve will assume an asymmetrical shape, as a ▶

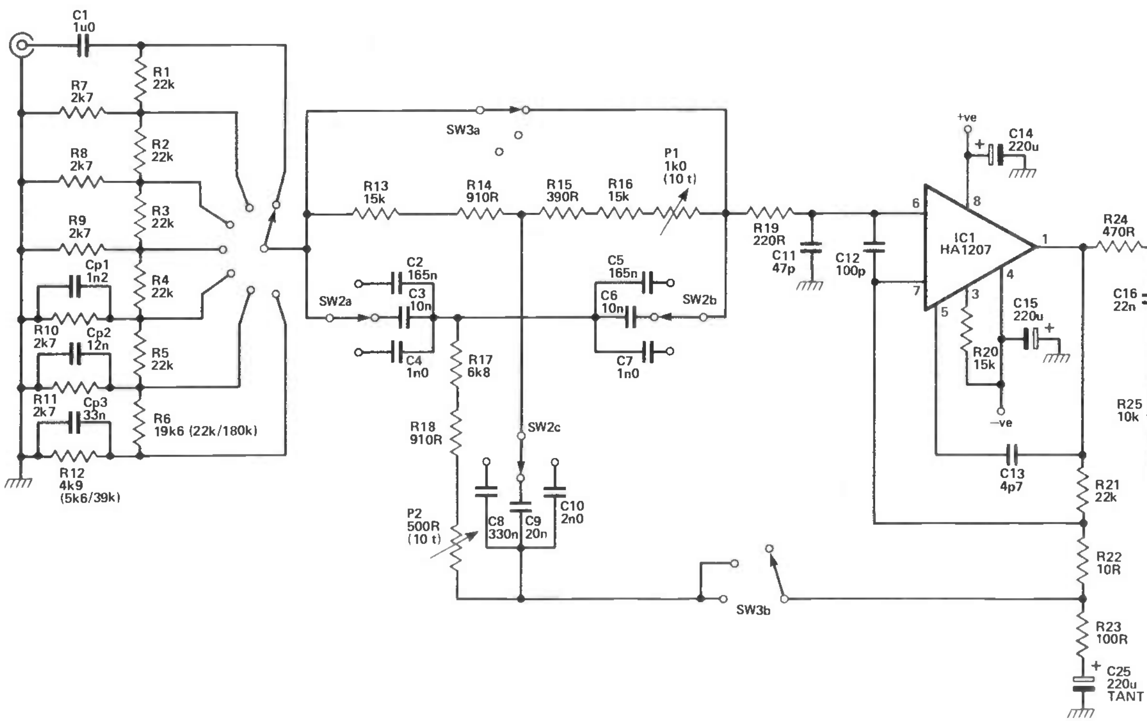


Figure 6: Circuit diagram of the HD meter

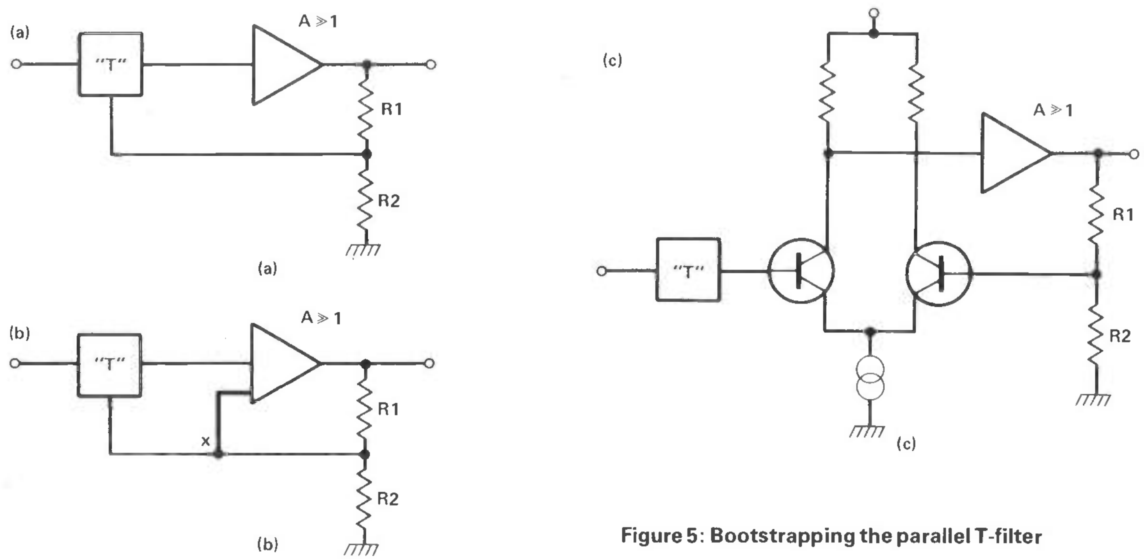


Figure 5: Bootstrapping the parallel T-filter

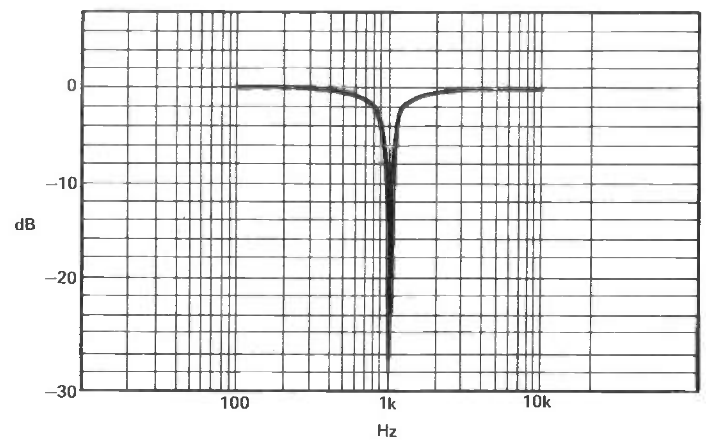


Figure 7: Actual transmission curve of the filter with Q=3

result of the additional phase-shift. This is of course undesirable; however this particular difficulty can be overcome by using the same voltage divider to inject feedback to the system (see ***Fig.5b***). Positive feedback is then introduced between point 'x' and the input. It is also possible to apply feedback to the filter by means of a differential amplifier, as shown in ***Fig.5c***.

The Hitachi HA12017 operational amplifier is one that can be adapted for this kind of application, and indeed it has been used in this particular design.

Design Characteristics

A practical design for a distortion meter will then present the following characteristics:

1) A constant impedance input attenuator.
2) A low impedance load at the output of the filter.
3) A high impedance load at the output of the filter.
4) Three or more fixed frequencies for distortion measurements.
5) Modified HA12017 circuitry to obtain a bandwidth of 100kHz ± 0.2dB.
6) A voltage follower op-amp driving meter with 0.1mA FSD.
7) An optional high-pass filter to attenuate 50 and 100Hz hum.
8) A power supply derived from batteries.

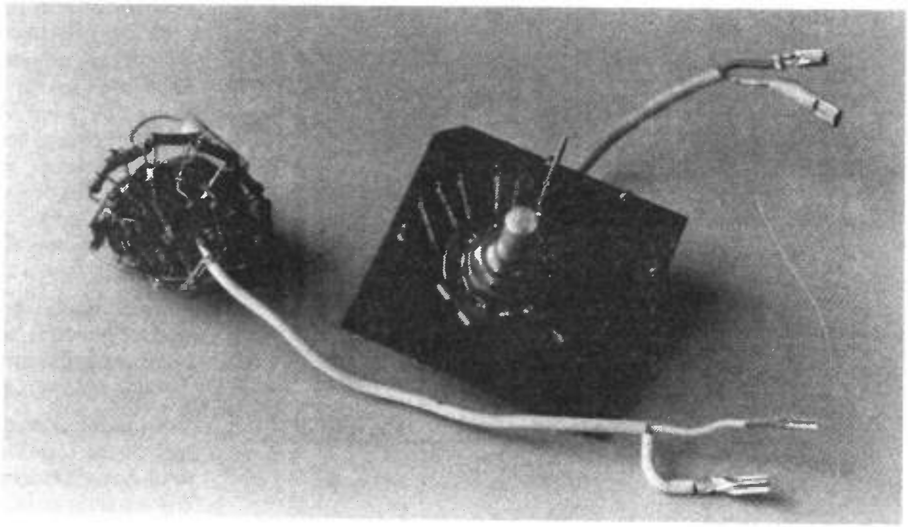
Circuit Details

Figure 6 shows the complete circuitry for the distortion meter. The description that follows brings out how the desired characteristics for the distortion meter have been implemented in this design.

1) Input sensitivity is selected by an L-type constant impedance attenuator. There are seven sensitivity ranges: 100uV, 1, 10, 100mV, 1, 10, 50V. The last value was chosen because amplifier output will generally lie between 10 and 30V, which can be read more accurately off a 50V scale.

For a constant attentuation ratio of 10:1, the resistors for the successive steps must be in the proportion of 8.1 to 1. This is readily achieved by choosing values of 22k and 2.7k from the E-12 series of resistors (1% metal film). The error is only 0.6%; even so, the total discrepancy after six steps is 3.6%. It is therefore advisable to measure the individual resistors with an accurate DMM and to choose combinations which will come as close as possible to a ratio of 8.1:1. The 50V-position will require a voltage divider with a 4:1 ratio and a total resistance of 24.444kohms. Parallel combinations of resistors have to be used here.

A final point to be raised in this connection is the frequency response of



Two types of attenuator (S1).

the attenuator. On the 1 volt position, the attenuation ratio is 10,000:1, and stray capacitance of just 0.1pF between the input and the mother-contact of the switch will cause a rise of +3dB at 70kHz (see ***Fig.7***). Obviously, some form of frequency compensation is necessary. The exact value of the capacitors Cp1, Cp2, Cp3 will depend partly upon the physical properties of the switch and the lay-out, but with the more usual type of switch (e.g. the CK1024 supplied by Ambit) values of 1.2nF, 12nF and 33nF respectively were suitable, regardless of the configuration (two possibilities are shown in).

2) The input resistance of the attenuator is 24.4kohms. This is a bit on the low side, but it should be borne in mind that amplifiers and pre-amplifiers have (or should have!) a low impedance output. On the other hand, the attenuator has an

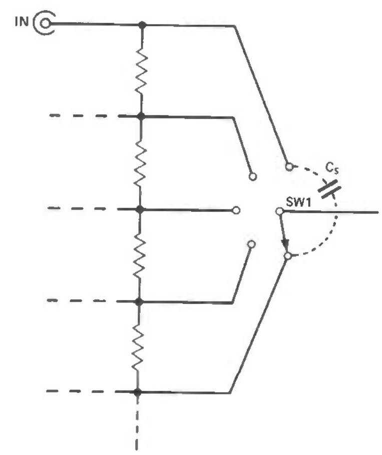
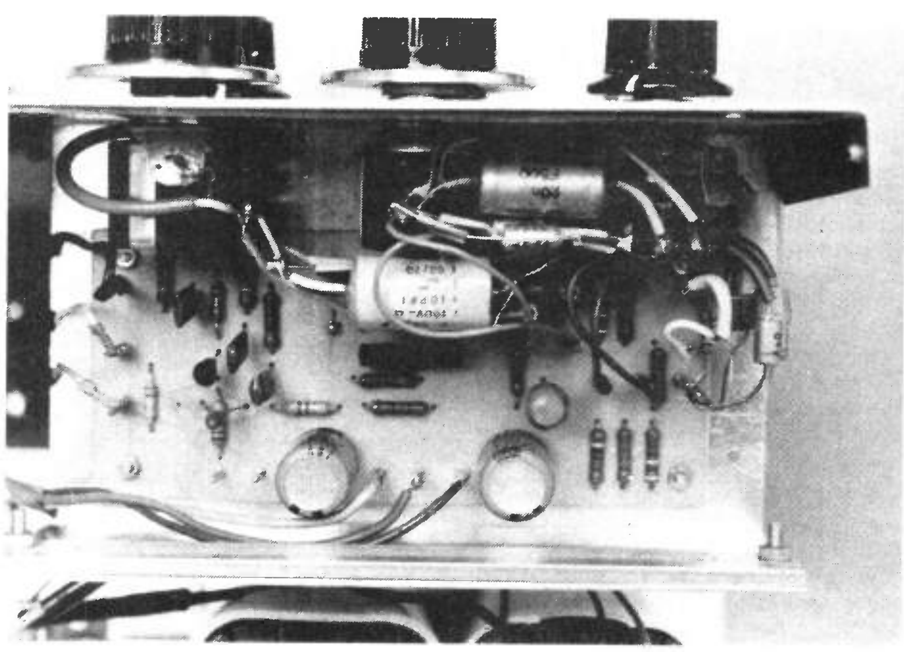


Figure 8: Stray capacitance within the attenuator



Inside the sub-chassis.

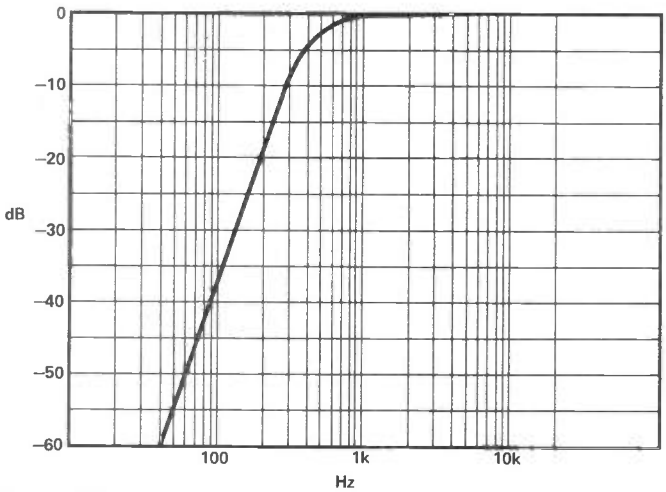


Figure 9: High pass filter

output resistance of 2.2kohms, which is just about right to feed the parallel T-filter (except on switch position No.1, where the total resistance is determined by the input resistance – 24.4kohms – in parallel with the output impedance of the apparatus under test).

3) The measured input impedance of the HA12017 in the circuit shown in ***Fig.6*** was greater than 600kohms at 1Hz. This will not cause any significant loading on the parallel T-filter.

4) By using two variable resistors (fine and coarse adjustment) in each arm of the filter and three sets of four capacitors, continuous coverage from 20 to 20,000Hz could be achieved. But this would require several adjustments of six knobs for each reading: a rather elaborate procedure!

For simplicity's sake, a few well-chosen spot frequencies are much to be preferred. In that case, S2 is used to select three sets of capacitors. Moreover, only two variable resistors (10-turn types) are needed to filter out the fundamental, provided the signal generator is adjusted to within a few percent of the nominal frequency. In the prototype, the choice was limited to three frequencies: 60Hz, 1kHz, 10kHz.

5) Some modifications to the original Hitachi applications circuit (**R&EW** July 1982 p17) are required in order to adapt the HA12017 to its present purpose:

i) All the elements concerned with RIAA correction have to be omitted.

ii) The stabilisation circuit with R107, C107 and C108 is unsuitable for this application: it causes a hump of approx. 10dB at 70kHz. Simple frequency compensation with a 4.7pF capacitor between pins 1 and 5 proved satisfactory at a gain of 200 and a bandwidth of 100kHz ± 0.2dB. This would have reduced the stability margin but no adverse effects were noticed.

iii) Negative feedback is applied between pins 1 and 7. With the specified values for R21 R22 and R23 the amplification factor becomes:

$$A' = \frac{R_{21} + R_{22,23}}{R_{22,23}} = 200.$$

R22 has been included to avoid excessive sharpness of tuning in the parallel T-filter. Indeed, with an open-loop gain of 105dB at 1kHz, the Q-factor with 100% bootstrapping would become very high. With R22 included, Q reaches a value of +3 and the harmonics will be well maintained (see ***Fig.7***).

Incidentally, harmonic distortion of the measuring amplifier is not a major consideration, because this parameter will be introduced into the system roughly as a fraction of the reading: e.g. a distortion factor of 1% will increase a reading of 10uV to 10.0005uV! – an error which may be safely ignored...

Input noise is an altogether different matter. The measuring amplifier has an input noise of 0.85uV with R_{IN} = 220ohms. The total input noise is mainly caused by Johnson noise in the input resistor(s). It is determined by:

$$V = (4kTR\triangle f)^{1/2}$$

in which k is Boltzmann's constant (1.38×10^{23} J/K), T is 300° Kelvin (at room temperature), R is the resistance and $\triangle$f is the bandwidth. The formula can be written in the more practical form:

$$N(uV) = (0.0166.R\,(kohms).\triangle f\,(kHz))$$

This means a noise level of about 2uV with a 2.4kohms input resistance. Together with the noise factor of the HA12017, the total noise amounts to approximately 2.4uV, which will barely cause perceptible needle movement*.

With the parallel T-filter switched into the circuit, the situation deteriorates: its impedance is added to the input resistance. For f_0 = 1kHz, the total noise level is raised to 3.5uV and the needle will move to a little more than 1 scale division. Although this is not a very serious drawback, it can be avoided by using 0.2mA meter. No other changes are necessary (except for multiplying the scale indications on S1 by 2, of course).

6) The output from the HA12017 measuring amplifier is fed to the drive amplifier for the milliameter. It consists of a CA3140 voltage follower. In its normal configuration, the circuit will produce a loss of some 3dB at 90kHz. A frequency-compensation network, consisting of a 220ohms resistor and a 3.3nF capacitor, is therefore shunted across P3. The latter allows precise adjustment of the meter scale.

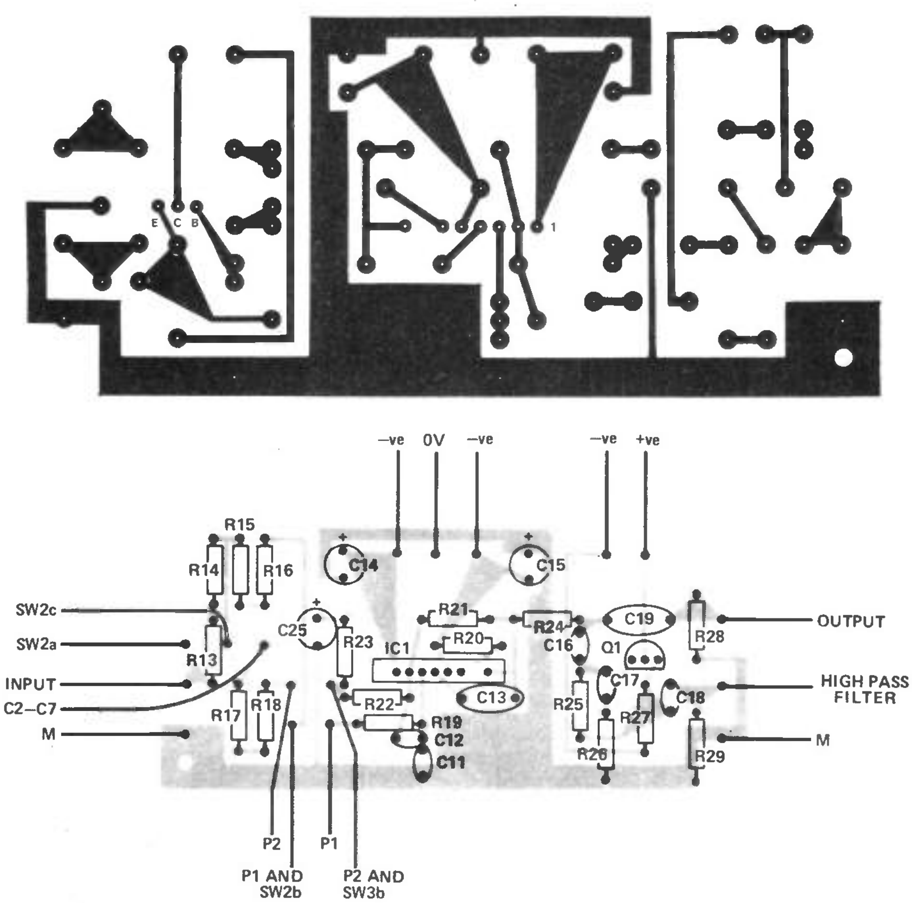


Figure 10: Measuring amplifier PCB: a) copper side b) component overlay

An oscilloscope may be connected to the output of the measuring amplifier. This not only allows exact examination of the distortion contents, but it will also assist during the adjustment of the notch filter.

7) Very small distortions may partly be masked by mains and rectifier hum at 50 and 100Hz. It is therefore a sensible precaution to include a switchable high-pass filter. The circuit around Q1 consists of an active Tchebychev 2nd-order filter with a 1dB ripple and a turn-over point at 440Hz, followed by a passive RC element.

As a result, there is a cut of 36dB at 100Hz and of 54dB at 50Hz, which are ample (see *Fig.9*).

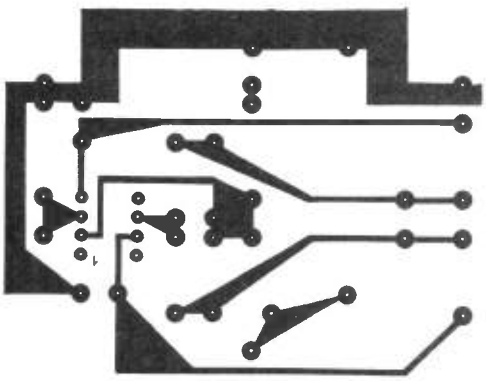
8) A mains power supply was tried out, but it proved impossible to avoid a certain amount of hum breakthrough. Current drain being a mere 9mA, battery supply is by far the simplest solution (2 × PP3).

Constructional Details

Little remains to be said about the input circuit, except to point out that the connector and the cable should be of the first quality (BNC and RG58U cable). A small extra screening cover over the connector and the coupling capacitor (C1) is advisable.

The measuring amplifier and the voltage follower are mounted on separate PCB's (see *Figs. 10 and 11*).

A ⊔ -shaped sub-chassis is used in order to keep S2, P1 and P2 as close together as possible. It is fixed to the front panel by means of these components' shaft nuts. A metal cover over this sub-chassis will ensure effective screening of these sensitive elements. On one side, the cover must extend to the bottom of the case in order to screen the CA3140 voltage follower from the rest of the circuitry. A few holes are drilled in the bottom of the sub-chassis, through which the connecting wires to S1, S3 are passed.



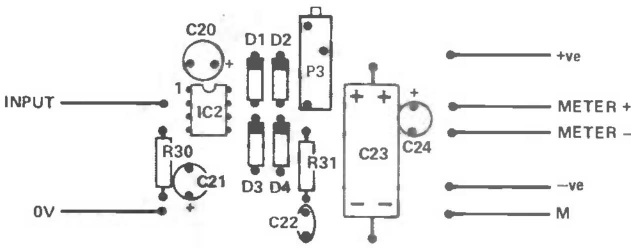


Figure 11: Driving amplifer PCB: a) copper side b) component overlay

Measurement Procedure

Let us assume that we want to ascertain the harmonic distortion produced by a power amplifier with an output of 16 watts into a 4ohms load (V_{out} = 8 V_{rms} at 1kHz)

1) With S1 on the 10V position and S3 on 'Direct', the output from the signal generator is adjusted to a reading of 8V on the scale of the distortion meter.

2) S3 is switched to 'Distortion' and S2 to 1kHz: P1 and P2 are adjusted for minimum reading.

3) S1 is switched down to the 1V position and P1, P2 are again adjusted for minimum reading.

4) S1 is switched down again and the whole procedure is repeated until no further reduction of the fundamental is possible.

5) Assuming a final reading of 4mV, this is converted to a distortion percentage:

$$D\% = \frac{V_D \times 100}{V_{out}} = \frac{4(mV) \times 100}{8(V)}$$

$$= 0.05\%$$

Versatility

Apart from its obvious use as a distortion meter, the instrument will also perform several other functions:

i) mV metering
ii) frequency characteristics measurement
iii) hum and noise measurement

PARTS LIST

Resistors (1% metal film)

R1,2,3,4,5,21	22k
R6	19k6 (22k 180k)
R7,8,9,10,11	2k7
R12	4k9 (5k6 39k)
R13,16,20	15k
R14,18	910R
R15	390R
R17	6k8
R19,31	220
R22	10R
R23	100R
R24	470R
R25	10k
R26	39k
R27	3k3
R28	180k
R29	18k
R30	1M

Capacitors

Cp1,2,3	see text
C1	1uF polyst.
C2,5	165nF 1%
C3,6	10nF 1%
C4,7	1nF 1%
C8	220nF 1%
C9	20nF 1%
C10	2nF 1%
C11	47p
C12	100p
C13	4p7
C14,15	220uF 16V
C16,17,18	22nF 1%
C19	0.47uF polyst.
C20,21	10uF 16V
C22	3n3 polyst.
C23	330uF 16V
C24	1uF tantal.
C25	220uF tantal.

Potentiometers

P1	1k – 10 turns
P2	500R – 10 turns
P3	220R – pre-set

Semiconductors

HA12017	
CA3140	
Q1	2SC2546 (BC550C or equivalent)
D1–4	AA119 (or equivalent)

Miscellaneous

S1	1 pole, 7 way rotary
S2,3	3 pole, 3 way rotary
0.1mA meter	

2 BNC connectors, PCBs, knobs, case (for example, Centurion DX3 from Ambit, or 270-270 from Tandy)

References

1. D.T.N. Williamson: "Design for a High-quality Amplifier"(Wireless World, May 1947, etc.)
2. L.Boullart: "Distorsiometre" (Toute L'Electronique, France, Nov. 1963).
3. Riordan: "Simulated inductance" (Electronics Letters, Jan 1963).
4. W. Van Bokhoven: "Filters zondre spoelen"(Radio Electronica, Oct. 1970).
5. J.Linsley-Hood: "Spot-frequency distortion meter" (Wireless World, July 1979).
6. L.Boullart: "Ultra-gevoelige distortiemeter" (Radio Bulletin, Holland, Nov. 1982).
7. Beatty & Sowerby: "Attenuation circuits" (Radio Data Charts, 1949).

*It should be remembered that, even with an op-amp voltage follower, the rectifier characteristic of the diodes does not remain completely linear at extremely low currents.

■ R&EW

ATV on the Air

PRESENTED BY
ANDY EMMERSON, G8PTH

Welcome again to your ATV column, which this month takes a look at what ATVers are getting up to on the air.

We start with 70 cm and a bit of mobile TV; I hear that G4BAV is 'at it' in the Ipswich area, but more details are missing. Amazing what you pick up from other people ... New station just north of Canterbury is G8KUC at the University of Kent. They have installed a MM transmitted in their club shack and are feeding it with video from an Acorn computer. Contacts to date include Tony G6EXU in Ashford and yours truly in Blean. G6EXU has had a number of other contacts lately, such as G8PPQ (Ide Hill, 700 ft ASL), G4NYO in Crowborough and G6VHL in Hawkhurst. The last mentioned, John G6VHL, is suffering from the classic TVI problem — a communal aerial system with the wrong group aerials, a 'DC to light' wideband preamp and incredibly weak off-air broadcast TV signals. John's ATV transmissions wipe out Channel 4, yet the authorities responsible for the aerial system refuse to renew it. In the meantime, the Buzbies have declared John's ATV transmissions 'clean' but he has to live with the neighbour problems. If you don't suffer in this way perhaps you should count your blessings ...

In Wallington, Surrey, Ted G6CTV announces he is now QRV with lovely high quality colour. Seems like he got a Hitachi 1020 camera at a 'silly' price and now he can justify that CTV call. The letters CTV came by accident, by the way. Some stations in the north-west have been getting extra QSL cards lately: Andy Webster, an SWL from Billinge near Wigan, tells me he has logged G3RLA (Heswall), GW6NUO, G8VHF (pirate?), G8VPH (Sutton Coldfield) and GW8XLL (Rhyl) during his DX-TV watches. A couple were also logged by TV-DXer Arthur Milliken (also Wigan) using his Panasonic 7000 VCR's tuner, which covers 70 cm.

Nick Foot G8MCQ wrote a fine letter from Wimborne detailing the stations active several nights of the week in his neck of the woods; they are:

G8MCQ/G6TEA Wimborne; G6MPA Northbourne; G6IAC Ringwood colour; G6MYU West Moors colour; G2HCG Barton on Sea; G8MCP Corfe Mullen; G4BGT/G6JGR Corfe Mullen colour; G6OAI Poole colour; G6JAT Parkstone colour; G8CMQ Southampton; G4JQU Southampton; G6CPE Romsey; G6COB Southampton; G4JXC Romsey; G4MHF Broadstone.

Many stations have built up converters (mainly PW design) and are thinking of building transmitters, Nick says. Of the transmitting stations most apparently run 5 to 10 watts though Nick runs 50 watts (2C39 homebrew PA) and G4MHF 100 watts (MM solid state PA). The 2C39 PA design came from a 1974 issue of 'VHF Comms' and has just been reprinted in the 'UHF Compendium', available from RSGB sales. (I too have bought this marvellous book: it's the size of a telephone directory, full of 70 cm and 23 cm info and knocks spots off the RSGB joke VHF manual of museum piece information. Have you seen the super 405 line circuits in the latest 1983 edition??? – G8PTH) Nick also had TVI problems, which could be cured only by installing filters ahead of people's masthead preamps.

One more 70 cm letter and that's from Ray Hill G6TSL in Ross on Wye, Herefordshire. With 3 watts from a Wood & Douglas ATV1 he has worked Grant G8CGK (4 miles), Neil G6TZA (7 miles), GW4RZE/GW6PMF/P (5 miles) and Chris G8TPS/P at Kington Golf Course (P2 pix over a 30 mile path — not bad...). On Friday 13th May he sent pictures to Grant who was giving a talk to the local Round Table on SSTV. The meeting opened and Grant announced over the air from Ray's QTH. On the 14th and 15th a demonstration station was set up at a scout camp at Walford, not far away. Pix were sent from Ray's shack by G6TSL, GW4RZE and his brother in law. A brief talk was given on ATV, with explanations of the difference between amateur radio and CB. Ray welcomes any skeds and would like to see a circuit for a linear using a QQVO6-40A.

On to higher things (or bands) and news is coming in fast. I said last time that I suspected there was some quarter-metre band TV in the London area and this has been confirmed by Chris G8CIU (Bexley) who says he and Dick G8CTT (Chislehurst) have been swapping signals on 1308MHz. They generate an AM signal on 427MHz and put it through a MM varactor tripler; reception is with 23cm to 2 metre converters feeding a VHF–UHF upverter and a normal TV. What's more it works — and passes colour...

In the Worthing repeater area Martin G8KOE (East Preston) is already transmitting 24cm to Roy G6AIW and Nick G4JEI. Roy acts as relay station and retransmits the signal on 70 to the

Thinking of upgrading the TV in the shack? Then this JVC CX-610 should do the job. It covers broadcast VHF and UHF channels (so it will work with all ATV converters) and changes automatically between PAL and SECAM colour (ideal for openings to France!) As well as being a receiver it's also a monitor, so you can use it for closed circuit demonstrations or use it to extract a video and audio signal from off-air reception (to make a recording or to retransmit). For battery or mains operation, with audio subcarrier offsets covering 5.5, 6.0 and 6.5 MHz, it's a very versatile set; compact too, with a 6" screen. Price around £240.

stations 'round the corner' in Chichester. Moving to Essex now, John G3OGX has 5mW on 24cm (good start) and hopes to swap signals with Nick G4IMO, who is also building when he isn't watching FM TV from the Russian satellite.

Some while ago I mentioned the 150 watt PA available from muTek. Domestic reasons have prevented me from getting it on the air, but Frazer G8FEZ is currently using it on 23cm with a MM SSB transverter. The verdict is excellent... Nick G8MCQ is also building for 24cm, as is G6IAC; Nick hopes to have 50 watts and a 4×23 el. quad loop array fed with 0.5" heliax. He has an optical takeoff for at least 15 miles to the north and will be looking for contacts. A TV repeater is another possibility under active consideration.

Several other stations are known to have transmitters nearly complete, so things should get busy soon.

Finally a bit of DX, like 2000km. This snippet was lifted from the February 1983 issue of 'Amateur Radio' (Australia). On the night of 19.11.1982 Reg VK5QR sent pictures 2000km to Wally VK6WG on 1290MHz. Reg was transmitting 100 watts and Wally received him with a MM two metre converter (144MHz is Australian TV channel 5A). Recognisable pictures were passed between Albany and Adelaide, and I guess this must be a world ATV record. No silly AM versus FM quips, please.

Yes, we even cover SSTV, with letters from three people. Top of the pile is John G3YCV in Cliffsend, near Ramsgate, who has been active in SSTV on 20 metres and elsewhere for 15 years or more. Starting with flying spot scanners and 5FP7 tube receivers, John is now fully up to date with a SC160 scan converter modified for colour (assistance from G3NOXY and DL2RZ gratefully acknowledged). TX tests, with a PyeLynx camera, are just awaiting receipt of the correct colour filters. John is QTHR and will be happy to answer anyone's SSTV queries for the cost of an SAE. He says Tony G3VID, also in the Thanet area, is finishing a new scan converter.

Nick G8MCQ has a working slow to fast scan converter based on the JA0BZC design – any two metre SSTVers in the New Forest area who can send him signals? Finally, a welcome note from Dick G3LUI (Hullbridge, Essex). He says the Wednesday night SSTV net is going great guns (2030 hrs, 144.50MHz). Current participants include G4BCH, G4KXN, G4IMO, G3NOX, G8UUL, G8BKE and G3LUI (Essex area). Also G3EDK, G3WCY, G4CZT, G4GZN, G3GRJ, G4PAL and G8ZWM (London area), G3WW (Cambs.), G8ASI (Hemel Hempstead) and G6IYD (Ashford, Kent). Successful 3D colour tests have been carried out between Jeremy G3NOX and several others, believed to be a UK 'first'. Peter G4BCH continues his battle to convert his all singing, all dancing version of the Robot 400 to colour, while Nick G4IMO, Roddy G3CDK and G3NOX are getting very good results interfacing computers with their Robot 400s. Dick's DL2RZ SC160 plus two homebrew memories is at last producing PAL colour via the BATC PAL coder and an ASTEC 1233 modulator. Finally a plea to all SSTV stations using 144.50: please call CQ rather than just listen. After all, this is World Communications Year, says Dick.

That's it, a bumper bundle of activity, and that's just mentioning a few districts. If your station or club didn't get a namecheck this time, why not drop me a line care of **R&EW**? And if there are any other TV topics you'd like to see covered just write ... See you next month.

■ **R&EW**

EVENTS: MOBILE RALLIES August/September/October

August 21st	RAIBC/FRARS Hamfest '83	Flight Refuelling Social Club, Wimborne	Robert A Burrows, Christchurch 474305
August 27th	Scottish ARC	Cardonald College, Glasgow	GM4JDU
August 28th	Torbay Mobile Rally	ITT Social Centre, Old Brixham	Mrs MG Rider, Kingskerswell 5130
August 28th	BARTG Rally	Sandown Park, Esher	Edward Batts, G8LWY
August 28th	Preston ARS 15th Annual Mobile Rally	Lancaster University	Mrs D Stevens, Houghton 3304
September 6—8th	6th West of England Electronics Show	Bristol Exhibition Centre	Oxted 4371
September 11th	Telford Mobile Rally	Town Centre Malls, Telford	G8DIR, G8UGL, G3UKV
September 11th	Vange Mobile Rally	St.Nicholas School, Basildon	Mrs D Thompson 10 Feering Row, Basildon
September 18th	Peterborough R&ES Mobile Rally	Wirrina Sports Stadium Peterborough	D T Wilson Peterborough 76238
September 25th	Harlow Mobile Rally	Harlow Sportscentre	G8FRG
September 25th	West ARC	Oakdale Community College, Blackwood	R B Davies, GW3KYA
October 2nd	Great Lumley ARES Rally	Community Centre, Great Lumley	Ian Blackman, G4OCQ
October 6—8th	Amateur Radio Retailers Exhibition	Doncaster	Fred Hopewell, G4PGC
October 15th	Midlands VHF Convention	BT Training School, Stone	J P H Burden, G3UBX
October 15—16th	EI—GI Convention	Ballymascanlon	

SHORT WAVE NEWS FOR DX LISTENERS

Frank A. Baldwin

All times in GMT, bold figures indicate the frequency in kHz

Continuing our review of the Latin American stations likely to be heard here in the UK during the 'season' for reception of this area of the world under the most favourable conditions, a progression is made to the more difficult to log transmitters.

The Bolivians have always been somewhat hard to receive, the first one to be mentioned being a typical example. Radio Nueva America in La Paz, the capital city, operates on **4797** from 1000 to 0400 (Sunday until 0200) with a power of 10kW but this frequency is shared with the Brazilian Radio Tabajara scheduled from 0730 to 0400 (Saturday until 0500) with a power of 2kW. As they both close at 0400 one must hope that the former predominates at some period during the latter part of the schedule - and by that I mean from around 2300 through 0400. The plot thickens however in that just 2kHz away is the 10kW transmitter of La Voz de los Caras in Ecuador working away on **4795** whilst 5kHz further up the band is Radio Lara in Venezuela on **4800** at 10kW.

Radio Nueva America on **4797** is therefore straddled by two 10kW transmitters, one on **4795** and the other on **4800**. Sharing the channel does not help either!

I have described this example in some detail in order to bring to readers' attention some facets of the 'difficult' label I have assigned to the stations mentioned in this part of the general review. Despite the above however R Neuva America is sometimes logged by DXers in this country and reported in the SWL press.

Sited in Yacuiba is Radio Frontera operating on **4805** from 1100 to 0400 with a power of 1kW. Another occupant of this channel is Radio Difusora do Amazonas in Brazil at 5kW but from 2230 to 0130. Obviously then one must tune to this frequency after the latter signs off.

Radio Nacional, La Paz is listed on **4815** from 1000 to 0400 at l.5kW and is very seldom reported. I'm not surprised at that - this frequency also being occupied by three Brazilions, a Peruvian and the powerful (by comparison) Colombian Radio Guatapuri at 10kW on a 24-hour schedule.

Probably one of the most reported Bolivians is Radio Grigota, Santa Cruz on **4833** at 1kW. This one wanders around from **4832** to **4834** and therefore one must hope it is on the latter channel so that the listener can largely avoid interference from the **4832** Emisora Radio Reloj in Costa Rica. The latter operates around the clock whilst the former is listed from 1000 to 0400.

Then we have the La Paz based Radio Fides on **4845** at 5kW from 2300 to 0300 (Saturday to 0200) it also operates from 0900 to 1800 but this time slot does not interest us here in the UK Despite the often dominant co-channel Radio Bucaramanga in Colombia, R. Fides is logged from time to time.

La Cruz del Sur, La Paz is on **4875** with a 10kW signal, that part of the schedule of interest to us being from 2300 to 0030. If you are listening for this one then you must do battle with the co-channel Radio Jornal do Brasil 10kW, the irregular La Voz del Norte in Colombia 5kW and the often reported Radio Super. This latter Colombian operates around-the-clock with a 2kW transmitter.

Radio Illimani, 'La Voz de Bolivia', uses a 10kW transmitter on **4945** from 1000 to 0400 but the snag here is that another occupant of this frequency is the very often reported Radio Caracol in Colombia on a 24-hour schedule. Radio Illimani is more often reported on the parallel **6025** channel.

Radio Battalon Topater in Oruro is scheduled from 1000 to 0400 at 5kW on **4980** but again a co-channel transmitter hogs the limelight in the form of Ecos del Torbes in Venezuela timed from 0900 to 0400 at 10kW.

In despair you could tune to **5025** for R. Quillabamba 5kW, it closes at 0300 weekdays or in desperation to **5045** for Radio Altiplano l.5kW, it closes at 0500. And this is where I close the review for this month - it's about Peru next time.

Around the Dial

In which are listed the frequencies, the times and the programmes which will prove of some interest both to the short wave listener and the DXer. Some target areas are also shown.

Pakistan

Islamabad on **17660** at 1040, YL (young lady) with songs in Urdu in a World Service presentation to the UK, scheduled from 0715 to 1100 daily.

Karachi on **17640** at 1034, local-style music then OM (old man — male announcer) with announcements during the Indonesian programme, timed from 1000 to 1045.

Radio Pakistan on **6080** at 0058, interval signal (an appealing composition which instantly brings to mind the locality from which it emanates), OM with announcements in vernacular then quotations from the Holy Quran. Both the location and the schedule are unknown, this channel not being listed.

India

AIR (All India Radio), Delhi on a measured **17387** at 0958, interval signal (a charming melody in local-style repeated many times and well worth recording if one is interested in Indian music), YL with station identification followed by OM with a newscast in the English transmission intended for Australasia and North East Asia in the General Overseas Service and timed from 1000 to 1100.

AIR Delhi on **9912** at 1735, OM and YL with a duet in Hindi during the Persian programme directed at Iran from 1615 to 1745. At the latter time, OM with station identification at the commencement of the Arabic programme which is timed from 1745 to 1945 on this channel.

Egypt

Cairo on **17745** at 1045, YL with station identification 'Huna Kohera' (Here is Cairo) during a 'Voice of the Arabs' transmission to Africa, Europe and the Middle East timed from 0600 to 1400 on this frequency.

Cairo on **17670** at 1355, OM with a song in the Arabic General Service for the Middle East, Europe, North Africa and North America and scheduled from 1300 to 1900.

Cairo on **9850** at 1740, OM's with a

DX-TV

Compiled by Keith Hamer & Garry Smith

The 1983 Sporadic-E season opened on cue with a flurry on May 2nd with Central and Eastern European countries predominating during the early afternoon. Unfortunately the good conditions turned out to be short-lived and were quickly followed by endless 'dead' days with only minor openings taking place, usually from the USSR. Conditions improved on the 15th and from then on several intense openings occurred.

Reports filtering through indicate that at least two signals classed as 'exotics' have been seen. A Romsey enthusiast noted a programme with French subtitling on channel E4. This was almost certainly the Lebanese Maasser El Chouf outlet operated by CLT with 60 kW ERP. To endorse this possibility, a West Midlands DXer positively identified an Arabic transmission at around the same time on channel E3 originating from the 104kW Suweilih outlet in Jordan.

Throughout the UK, signals from the Zimbabwe E2 transmitter at Gwelo appeared on several occasions during May with typical F2 multiple-image and video distortion. ZTV was seen using the PM5544 test card on the 24th.

African Television

Most signals encountered from a southerly direction originate in Portugal (RTP) or Spain (TVE) but from time to time double or even triple-hop Sporadic-E allows the reception of signals from an African country. The following African states use Band I and reception is possible in the UK given favourable conditions:-

Ghana (GBC) on channels E2, E3 and E4; Nigeria (NTA) on E2, E3 and E4; Sierra Leone (SLTV) E2; Equatorial Guinea (RTGE) on E2.

Kenya (VOK) and Zimbabwe (ZTV) also use channel E4 (48.25MHz vision) but these are more likely to be received via a combination of Trans-Equatorial skip and Sporadic-E. How does one identify such a transmission? Well, watch out for dark skinned announcers and newsreaders. If the sound channel is resolved it will usually be English. Test transmissions tend to be confusing since standard patterns such as sawtooths, greyscales, grids and multi-bursts are commonly used. Sierra Leone uses a chessboard pattern at times, not unlike the Spanish type, while Equatorial Guinea radiates a test card similar to the one used by TVE-Spain *(see Fig.1)*. This pattern was devised by Guardia Tecnical Espanol. The Equatorial Guinea version has the identification 'Radio Television Guinea Ecuatorial' at the top in lieu of 'rtve' and the location 'malibo' at the bottom. White blocks are substituted for the digital clock and transmitter inserts used by TVE. Identification captions show the initials 'TGE'. Nigeria uses a caption featuring a satellite dish with the letters 'NTA' to the right. Occasionally the transmitter location is shown together with the channel number.

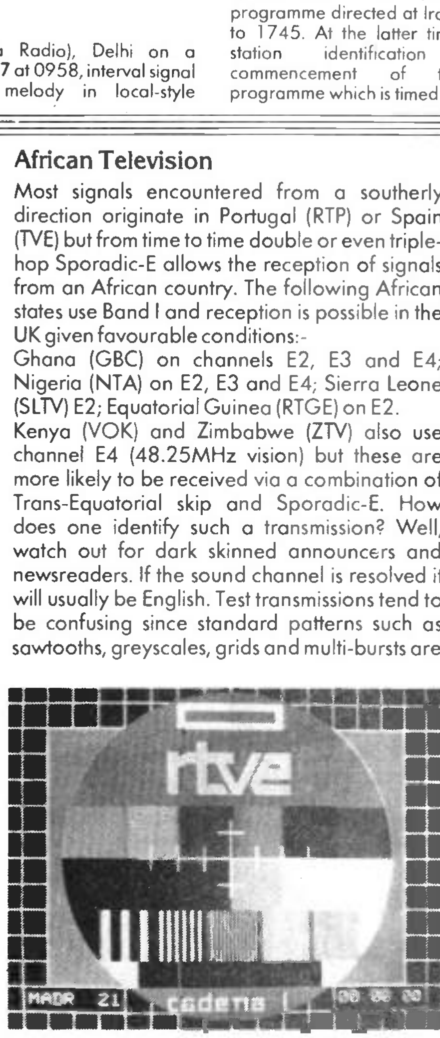


Figure 1. The GTE colour test card used by Spain and Equatorial Guinea.

Service Information

Luxembourg: There is speculation that RTL are to introduce a new television service next October in the German language. It is anticipated that there will be four hours of programmes each day. The new service appears to be part of RTL's preparations for their satellite TV network which is due to commence in 1986.

Albania: Television transmissions from an RTS outlet operating on the Eastern European OIRT channel R5 (93.25MHz vision, 99.75MHz sound) have been monitored at Titograd in neighbouring Yugoslavia. Signals were positively identified by the RTS test card. It was previously assumed that RTS radiated only on CCIR (Western European) channels such as IC (82.25MHz vision). Test transmissions noted during May featured the PM5544 test card with the identification 'RTS' at the top and 'TV Shqiptar' in the lower black rectangle.

discussion in the Arabic Domestic Service which may be heard on this channel from 1500 to 2345 - the service that is.

Turkey
Ankara on **17885** at 1016, OM and YL with announcements in a 'Voice of Turkey' presentation for Turks abroad, on this frequency from 0900 to 1430.

Qatar
Doha on **17910** at 1446, Arabic-style music, OM with announcements in Arabic in a Domestic Service programe, scheduled here from 1300 to 1730.

Israel
Jerusalem on **17865** at 2017, OM with an interesting talk all about internal affairs during an English programe directed to Africa, Europe and North America and timed on this channel from 2000 to 2030.

Jerusalem on **17630** at 1103, OM with a newscast mainly of local affairs in the English transmission intended for North America, Europe, the Middle East, Australasia and South and East Asia, on the air from 1100 to 1130. Also logged in parallel on **17685**.

Jerusalem on **17585** at 1028, OM with a local pop song and music in a relay of the Domestic Service Network 'B', on this channel from 0400 to 1400 and from 1830 to 2310. Also heard in parallel on **17630** where this service operates from 0610 to 1100 and from 1200 to 1400.

Greece
Athens on **11645** at 1845, YL with a newscast mainly composed of local affairs in an English language news report which may be heard here from 1840 to 1850 daily.

VOA ('Voice of America') Kavalla on **7170** at 0332, OM with news of world events in an English programme for North Africa, scheduled from 0500 to 0700. Also logged in parallel on **7200** but this is a Wooferton (UK) relay.

Ascension
BBC Relay at 0340 on **7105**, OM with identification at the end of the Italian transmission for East Africa, timed from 0300 to 0345. Off at 0345.

United Arab Emirates
Dubai on **21655** at 1056, OM with station identification at the end of the English programme for Europe and North Africa, scheduled on this channel from 1030 to 1100. A transmission in Arabic followed.

Afghanistan
Radio Afghanistan on **15530** at 1709, OM with a newscast in an Arobic programme for the Middle East, scheduled here from 1700 to 1730. This transmission probably originates in the USSR.

Austria
Vienna on **6155** at 0830, OM with station identification, a newscast and then news comment during an English transmission for Europe, timed from 0800 to 0830.

Vatican City
Vatican on **6252** at 1934, YL with a talk in the French programme for Europe, scheduled from 1930 to 1950.

Bulgaria
Sofia on **17825** at 1129, interval signal, YL with station identification as 'Huna Sofia' at the commencement of the Arabic transmission intended for the Middle East and North Africa, timed from 1130 to 1230.

Australia
Melbourne on **21720** at 0925, OM with identification and announcements in the English programme (External Service) to the Pacific, timed from 0800 to 1100 on this channel.

Now Log This
In which is presented each month a station for your special interest. Listen for it, log it and QSL it. A start is made by bringing to your attention a station that has been much in the news, particularly of course during the Falklands Campaign and I refer to -

Argentina
LRA31 Radio Nacional in Buenos Aires on **15345** at 2240, YL with a talk about some local musicians and orchestras during an English transmission directed to the Americas which may be heard on this channel from 2230 to 2300 but not on Sunday. For those interested, the English programme for Europe, Africa and the Middle East is scheduled from 1900 to 2000 on the same channel. The power is 50kW. The address is Casilla de Correo 555, 1000 Buenos Aires.

Brazil
Radio Nacional do Brasil, Brasilia on **15390** at 2050, OM with announcements about the frequencies and times of transmissions, target areas etc. All during the English presentation to Europe and scheduled from 2000 to 2100.

Radio Nacional da Amazonica, Brasilia on **11780** at 1950, OM with announcements in Portuguese, time pips every second until OM with station identification. ZYE365 is on the air from 0500 to 1200 and from 1500 to 2400, the power is 250kW.

Chile
Radio Nacional de Chile, Santiago on **6150** at 0055, OM with a talk in Spanish, some local music and then station identification at 0100. CE615 operates from 1100 to 0500 with a power of 5kW.

Ecuador
Radio Luz y Vido, Loja on a measured **4851.7** at 0420, OM with a local pop song, YL with announcements, identification and off at 0430 without the National Anthem.

Now Hear These
As is mostly the case with stings in the tail, the only antidote is to log them. I therefore leave you this month with the following targets.

In Olanchito, Honduras, Radio Lux operates on **4890** from 1200 to 0300. The closing time is variable, reportedly closing anytime between 0240 and 0400. I can report it closing at 0402 after listening to some piano music, OM with announcements and identification in Spanish and then a choral Nationol Anthem. The power is 5kW.

In La Paz, Bolivia, Radio Illimani has a 10kW signal working to the schedule 1000 to 0400 on **4945**, at which point on the dial it was heard at 0200 with a sports commentary. The signal was dominant over the co-channel Radio Caracol in Colombia at this time. Radio Illimani was also logged at a later date on the **6025** channel at 0106, OM with a talk in Spanish after station identification. CP5 La Paz has the same schedule as that shown for CP7.

A change in direction and location brings us to the Republic of China in the shape of Xinjiang PBS in Urumqui which can be logged on **4735** where it is scheduled from 2230 to 0200 and from 1045 to 1730 with the Home Service in Uigher and relays of Radio Beijing (Peking). It also operates in Russian from 1800 to 2100. Entered into the log here at 2350 when featuring a talk in the Uigher Home Service.

With these parting shots, I bid you all adieu until next month!

Iceland: The channel E7 transmitter at Hafell is reported to have an ERP of 1100kW. Its location on the south coast means that it may just be possible to receive RUV in Band III during exceptional tropospheric conditions.

West Germany: Programmes from the third network of Norddeutscher Rundfunk are now broadcast from the channel E54 outlet at Minden/Jacobsberg.

The French Forces network (FFB) operating in West Berlin is to commence broadcasting a selection of programmes made by the French services of TF-1, Antenne 2 and France Regions-3 rather than material purely from TF-1. Channel E31 is used for FFB programmes which are beamed from a 17.8kW site in the 'Quartier Napoleon'.

Bulgaria: Bolgharska Televizia is radiating a new colour electronic test card which has, presumably, replaced the old monoscopic test card 'G'. The new pattern *(see Fig.2)* includes the identification 'BT-SOFIA' in Cyrillic characters.

Figure 2. The new Bulgarian colour test card radiated from studios in Sofiya.

The above information was kindly supplied by Gosta van der Linden (Netherlands) and Alexander Wiese (Editor of the German DX magazine 'Tele-audiovision').

Reception Reports
Kevin Jackson (Leeds) has recently moved into a tower block giving his aerials an effective height of 100ft above ground level. He has a clear take off from the north-east through to the south-east and despite the use of indoor aerials his results are excellent. Using a 10-element group B aerial at UHF he is able to receive Crystal Palace, Lille (France) and several Belgian transmitters on an almost daily basis. On May 12th using a Band I dipole against the window he saw a Russian clock caption showing BST+4 hours on channel R1 from Yerevan Television situated in the area between the Black Sea and the Caspian Sea. Other successes include practically the whole of Europe with strong signals from the Bucuresti (TVR-Rumania) transmitter on R2 on the 25th. Closer to home, auroral activity on the 24th produced Scottish 405-line reception on channels B3 and B4.

Cyril Willis (Little Downham, Cambs) also noted the excellent conditions of the 25th. Using a Tandy Patrolman 50 to monitor audio in Band I he was surprised to hear Spanish cordless telephone conversations on 49.60MHz during an opening to the south.

Andrew Webster (Billinge, near Wigan) has again been active following the cessation of high-level interference from a CEGB insulator. Two short-range signals have aroused interest: Lopik E4 (NOS-Netherlands) was seen not as a trop signal but was in fact similar to one propagated by SpE, while the Eireann (RTE) transmitter at Gort is now received on a regular basis. 50MHz amateur radio activity has been noted at times during the late afternoon. There is speculation that it originates from a 6-metre ham in Gibraltar rather than a naughty UK operator!

Clive Athowe (Blofield, Norfolk) commented that there were many quiet days during May when only short-duration signals from the USSR on R1 and R2 were present. His log for the 16th and 25th makes impressive reading:—

16th: TSS (USSR) colour test pattern, R1; ORF (Austria) with programmes on E2a; JRT (Yugoslavia) with cartoons on E3; CST (Czechoslavakia) using the EZO test card on R1 and R2 plus the PM5544 on R2 with the identification 'BRATISLAVIA'; TVP (Poland) with the PM5544 on R1 and R2 received in SECAM colour.

25th: ORF E2a; TVP R1, R2; TSS R1, R2; JRT E4; RAI (Italy) IA, IB; TVE-2 (Spanish second network) E2; RTP (Portugal) E2, E3; TVR (Rumania) using the EBU Bar test pattern followed by the test card at 1745BST. Programmes then followed which were also noted on channel R3.

On the 13th, the MUF rose high enough to permit reception of TSS on channel R4 (85.25MHz). Clive also noted a mystery greyscale pattern from the south on E2 on May 20th which was apparently via F2-layer and SpE propagation modes. He wonders if this may have been of African origin. Another impressive catch was the Polish PM5544 test card on channel R6 (175.25MHz vision) via a meteor shower on the 5th.

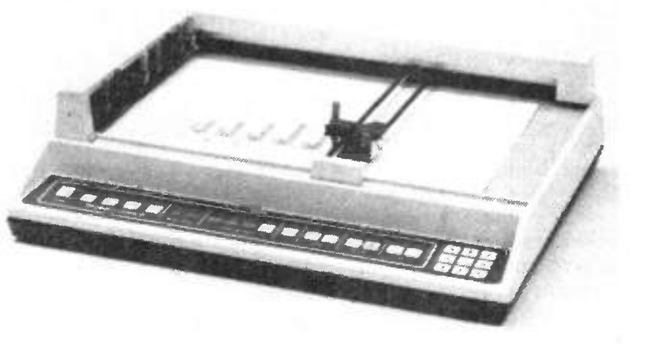
NEW PRODUCTS

Smart 8-pen flatbed plotter

The DMP-29 — a low cost multi-pen desktop plotter manufacturerd by Houston Instruments — is now available from House of Instruments. In many ways, this compact device seems too good to be true. Not only are the graphics multicoloured and said to be of the quality you might expect from a rather more expensive machine, but the firmware incorporated in the DMP-29 gives: five sets of characters; circles,arcs, ellipses and general curves; straight or slanted characters at any of 360 possible angles and in any of 255 sizes; line-type variation from smooth line to dashes and dots (including a print mode); automatic clipping for when drawing is larger than the page; selected area reproduction; and scaling — to name but a few, for then there are all the operator-friendly features that have been built-in. The latter include, for example, an adhesive (paper) hold-down to make loading 'amazingly quick and simple' — and a choice of two plotting formats, DIN A4 and DIN A3.

To give you some idea of the speed at which it works, smooth step-free strokes can be produced across the page at a rate of 16" per second or at 22.62" per second diagonally. The resolution is 0.001" and the reproducibility 0.004" (0.008" with a different pen). Other points to note are that the DMP-29 can deliver on paper, vellum or mylar (and so can be used to produce overhead transparancies) and that the plotter has an RS232C port. No wonder that the suppliers claim that it can handle 'NC tape verification, architectural drawings, business graphs and charts, engineering drawings, medical applications and more.'

House of Instruments,
Clifton Chambers,
62 High Street,
Saffron Walden,
Essex
CB10 IEE



Toroidal Transformers

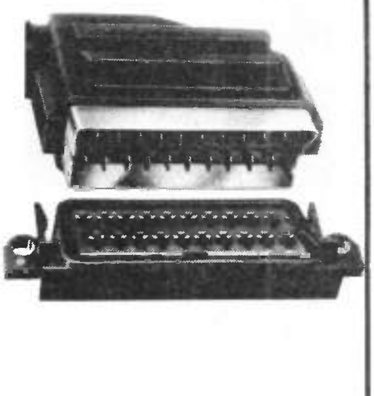
Twenty-one low noise toroidal transformers appear in the 'Budget Range' manufactured by Cotswold Electronics. They all are fixed by a single hole (using a dished washer) and they can be supplied in the following power ratings: 30,60,100,160 and 530VA. The toroids have two separate primary windings (to permit both 120V parallel operation and 240V series operation) and twin separate secondary windings to provide a range of output voltages including 2x6,9,12,15,18,22,25,30,35,45 and 50V (RMS) — though naturally not from each VA size! Winding termination is via 150mm long flexible leads.

Other aspects to note about these toroidal transformers are primary to secondary winding insulation to class E (120°C); winding wire to Class A (105°C) — and that their construction enables them to be operated for short periods at 120°C without deterioration. The transformers can also be operated in a 'derated' condition that results in lower temperature rise and improved regulation. The nominal frequency is 50—60Hz over an operating range of 47 — 400Hz, and the voltage tolerance is within 3% at nominal input and full load.

Cotswold Electronics Ltd.,
Unit T1,
Kingsville Road,
Kingsditch Trading Estate,
Cheltenham,
Glos.
GL51 9NX.

Peripheral TV Connectors

A new type of peripheral TV connectors — SCART plug and socket connectors — are now available from Hesto (Henkels—Stocko). These have been designed to enable TV receivers to be used as VDUs and they meet European Standard 50 1Q 049 and the German DIN-EN 50049. Design features include: leaf spring contact; reinforced contact blade; and cable assembly by multi-crimping. They also incorporate an interlinking device that prevents unintentional disengagement of connectors. The basic technical data are: normal voltage of 35V at 50 cycles; maximum current loading of 3A at 20°C or 1A at 70°C for single contact but 1.5A at 20°C or 0.1A at 70°C for all contacts; and the contact resistance is 25mohms.



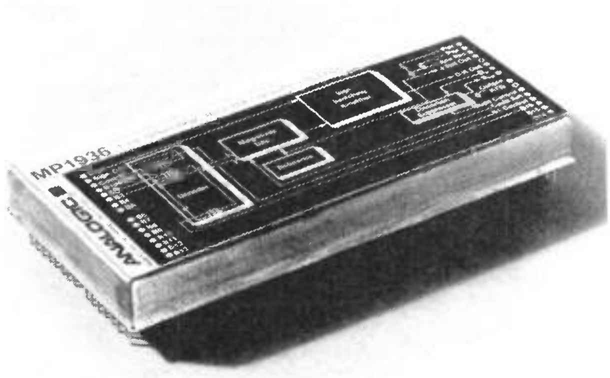
Hesto (Henkels—Stocko) Ltd,
21/23 Station Close,
Potters Bar,
Herts
EN6 1TT

Audio Communications Decoder

Analogic's new MP1936 (patent pending) combines a 16-bit DAC with a distortion suppressor in one compact unit that has been optimised to meet the criteria of such diverse digital audio communications systems as satellite downlinks and low-cost digital telephone equipment. It s ability to decode digital signals to analogue form with virtually no distortion — for example, giving a peak line distortion of less that —86dB on a full scale +5V sine wave measured over the 20Hz to 20KHz audio band — results from the propietary DAC architecture that has been incorporated in the decoder. This is claimed to offer ultrahigh differential linearity as the output passes through zero volts — which is where conventional DAC systems often exhibit their largest errors at audio frequencies but where the best performance is often demanded. The MP1936's nonlinearity near 0V is quoted as typically ⅛ LSB and it is said to drift by less than 1LSB even when the temperature changes by 60°C. Also quoted is a calculated maximum nonlinearity after 3 years without recalibration — +25ppm FSR.

Of course, Analogic has also taken the step of providing all the necessary analogue support components — such as a distortion suppressor, a precision reference supply and power supply by—pass capacitors. The result, one fully tested unit that can handle four voice grade (32kHz sampling rate) channels and can be used to decode a typical 60kHz to 108kHz PCM/FDM telephone baseband group.

Analogic Limited,
The Centre, 68 High Street,
Weybridge,
Surrey



NEW PRODUCTS

High Power Hybrid Op-Amps

Burr-Brown has introduced a new high power hybrid operational amplifier that is rated for continuous 80W dissipation and can withstand peaks of more than 200W without damage. The OPA501 can deliver ±10A peak into a 2 or 2.6ohm load and ±4A continuous into a 5 or 6.5ohm load. Output current limiting circuitry is included to protect both the amplifier and the load should the amplifier be overdriven or a fault condition occur. Other specifications include a unity gain bandwidth of 1MHz and a full power bandwidth of 16kHz, typically. The input offset voltage against temperature is around ±10uV/°C while the input bias current changes by ±0.05uA/°C. The input impedance is 10Mohm (differential configuration) or 260Mohms (common mode). Other important aspects of the OPA501 include an ability to operate from ±10 to ±36V (so it can readily be inserted in existing circuits) and being hermatically sealed in a 8-pin TO-3 package, the outer can of which is electrically isolated from the amplifier circuitry. These op-amps can therefore be mounted directly on a chassis or heatsink.

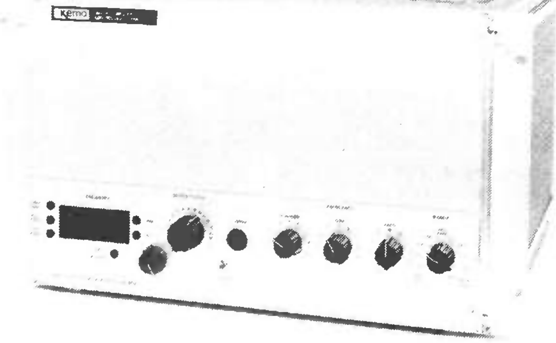
Burr-Brown International,
Cassiobury House,
11/19 Station Road,
Watford,
Herts
WD1 1EA

Variable Filter System

The VBF/29 from Kemo is a 16-channel variable filter system that can be tuned either manually or from a computer via either a parallel or a serial interface. It should thus be ideal for use in automated instrumentation or signal processing systems. Each channel of the filter can be set independently over the range 0.1Hz—100kHz (in fact 0.01Hz is available as an optional lower limit) and its fine-tune facility offers 1023:1 resolution with decade multipliers.

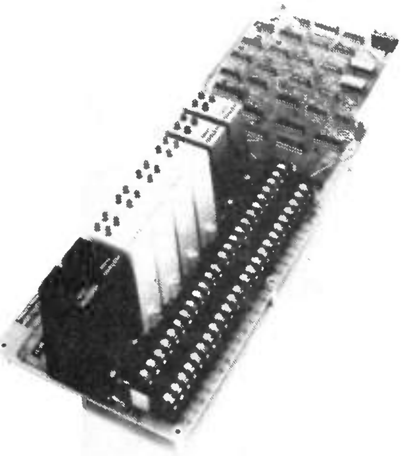
A full range of filter options is available. For example, there is an anti-aliasing filter offering an attenuation of 135dB/octave (factory set to either high-pass or low-pass characteristics) as well as a 90dB/octave filter with switchable high-pass/low-pass response. Filter characteristics include Butterworth, elliptic and linear-phase types.

Kemo Ltd,
9/12 Goodwood Parade,
Elmers End,
Beckenham,
Kent
BR3 3QZ



Parallel Addressable Multiplexer

Rapid Recall has announced the availability of a new parallel addressable multiplexer I/O system known as PAMUX II, which is manufacturerd by the American company of OPTO 22. The PAMUX II is a freestanding circuit board that can be used with 8 or 16-bit data bus structures, the board itself accommodating OPTO 22 high density Quad Pak power I/O modules. A watchdog timer is included as standard, while there is also potential for an anaolgue option with up to 48 A/D and 8 D/A channels, both with 12-bit resolution.



On-board mechanical switches allow the address of each PAMUX II board to be set individually and, as a result, up to 16 boards can be multiplexed to a single microcomputer parallel I/O port. (This is achieved with the aid of a 50-way connector daisy chain cable.) Thus, as there are a maximum of 8 Quad Pak modules on any board, up to 512 individual I/O functions may be acccommodated in one PAMUX II system.

Each Quad Pak device contains either four inputs or four outputs and some of them are AC while the others are (naturally) DC. Details are best obtained from Rapid Recall, but it is worth noting that all of them provide complete electrical isolation and can be used to control or monitor AC/DC motors, relays, solenoids etc directly.

Rapid Recall Ltd.,
Rapid House,
Denmark Street,
High Wycombe,
Bucks

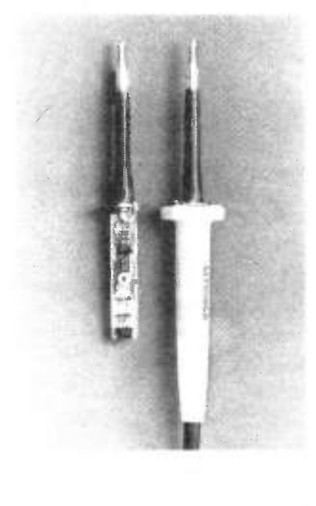
Electronic Soldering Iron

Light Soldering Development (Litesold) has announced the introduction of a soldering iron the temperature of which is controlled electronically. In other words, the EC50 has an electronic temperature control circuit mounted inside its handle that operates in response to a thermistor that is incorporated within the bit mount. Power to the 50W heating element is controlled by a triac that is operated by a zero-voltage switching IC to minimise spiking and attendant RF interference. The iron is fully earthed and so it can safely be used on electrically sensitive equipment and components. (The usual temperature restrictions on where the iron is applied still hold, of course.)

A special feature of the design is that the low voltage supply which runs the control circuit is obtained by a novel means on which a patent is pending. However it is admitted that it involves fitting a dropper resistor in or near the handle. The value of this invention is that the handle of the iron remains sufficiently cool for electronic control to be feasible.

The power to the heating element is fully on or fully off outside a particular temperature band, but within that band power is supplied in regular pulses, the interval between which remains the same but their length varies according to the difference between the 'actual' and the 'set' temperatures. This mechanism leads to very close termperature control with no swing or overshoot. The temperature is set via a control potentiometer and the available range is 280—400°C (standard setting is 370°C).

Light Soldering Developments Ltd,
Spencer Place,
97/99 Gloucester Road,
Croydon
CR0 2DN



NEW PRODUCTS

Low Cost Potentiometer

Variohm Components is the UK agent for KIF Parechoc of Le Sentier, Switzerland, which has just introduced its Series 7040 potentiometer into the UK market. This device uses the Rolling Ball Wiper system but the manufacturer has still been able to fabricate it at relatively low cost. The advantages of this type of construction (as far as this potentiometer is concerned) are a standard linearity of 0.8%, a life expectancy of around 100,000 cycles at 40rpm and a 'behind the panel' space requirement of only 6.6mm.

Like its predecessor, the 714, the new unit is available with three different terminal configurations, details of which are best obtained from the suppliers. The 7040 can, of course, be mounted directly onto printed circuit boards.

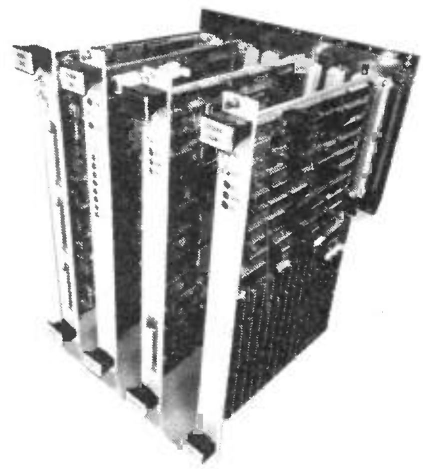
Variohm Components,
The Cattle Market,
Watling Street,
Towcester,
Northants,
NN12 7HN

Motherboards for VME Modules

Microsystem Services has announced the availability of two motherboards designed for use with the full range of VME bus compatible modules manufactured by Force Computers. These are known as the SYS 68K/MOTH-09 and the SYS 68K/MOTH-20 and they can accommodate up to 9 or 20 modules respectively. The data transfer rate between modules can be anything up to 20 MHz.

The range of VME modules includes 8MHz and 10MHz CPU boards; a 512 Kbyte dynamic RAM board; a 512Kbyte EPROM static RAM board; and a SASI interface board, floppy and Winchester disk controllers, a serial I/O board, and a network communications board. (While the former are already available from MSS, the latter group are being added to the firm's range.) A full screen orientated editor/assembler, together with an extended BASIC interpreter for the CPU board, is also available. The VME modules are plugged into the motherboards via 96 pin connectors (DIN 41612C), while goldplated 'fast-on' connectors are used to provide the required external power to the motherboards.

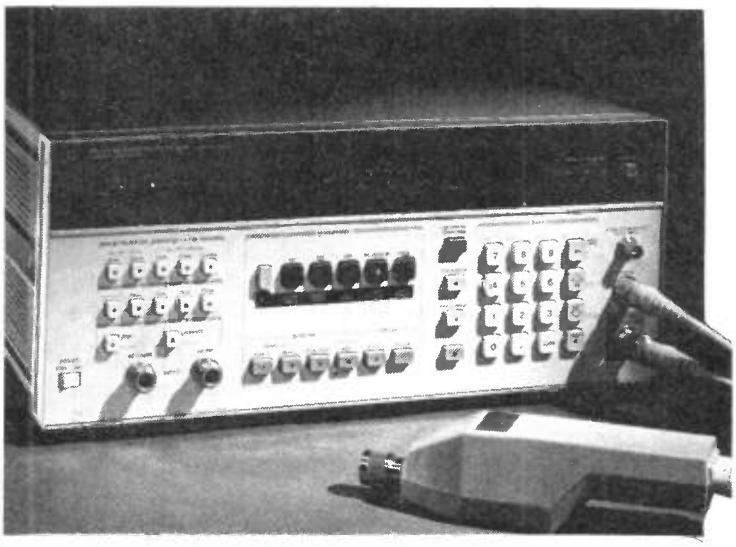
Microsystem Services,
P.O. Box 37,
Lincoln Road,
Cressex Industrial Estate,
High Wycombe,
Bucks
HP12 3XJ



Precision RF Measurement

The new HP8902A from Hewlett-Packard is a fully programmable measuring receiver with which to determine RF power, tuned RF level, modulation and RF frequency to a high degree of accuracy. For example, in combination with a HP11722A sensor module, it can measure power from —20 to +30dBm at frequencies from 100Hz—2.6GHz, while the HP8902A can also determine filter rejection of over 100dB in seconds when it is being used to test transmitter multiplexers in a cellular radio base station, for instance. At the same time, the instrument is also expected to make a very useful laboratory or production tool because it offers all the functions of power, level, frequency count, modulation and audio anaylsis. The combined dynamic range of the tuned RF level function and the built-in power meter is 157dB and it can thus be used to characterise a signal generator over its entire dynamic range (+30dBm to —127dBm) easily and with a great deal of precision.

Hewlett-Packard Ltd (Literature Section),
Eskdale Road,
Winnersh,
Wokingham,
Berks
RG11 5DZ



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U.S. Project Pack Agents, Box 411, Grenville, New Hampshire, NH030408. U.S.A.

An End of Term Report

This issue marks the end of the second volume of **R&EW** and, as hinted in the last issue, we've been taking a look at the way we're going.

One of the first things you will have noticed is that we have shifted publication date from the first Thursday of the month preceeding the cover date to the the third Thursday of the month preceeding the cover date. The reason is simple: **R&EW** was appearing as much as two months ahead of cover date, frequently being taken off sale before the date shown on the cover. This was leading to a degree of confusion in the minds of everyone from your friendly local newsagent to our beloved advertisers, not to mention the staff of the magazine itself.

If we had the nerve, we might have even published on the first Thursday of the cover date month, but even *we* aren't brave enough to flout such time honoured conventions.

We also hope to use this shifted date to emphasise the fact that **R&EW** operates to the tightest news schedule in the monthly market.

Philosophy

The only thing that we seem able to conclude from the surveys we have carried out into the nature and likes/dislikes of our readership is that the readership of the magazine is as broad as the content. Few readers actually undertake many of the projects in a 'personal' capacity, citing time and 'lack of test equipment as the major problems. Notwithstanding the agonies and efforts that go into the compilation of these types of feature, we're tailoring the approach to our practical features to accommodate the restrictions under which our readers find themselves working.

But perhaps one of the most significant but uncited problems for our readers is the fact that the modal age band is between 25 and 35. Those of us in this bracket are painfully aware of the costs of operating a home/wife/kids, let alone the luxury of running a costly hobby and the problem of finding the time without incurring our partner's wrath.

As usual, the surveys revealed that a prime mover in occasioning practical motivation is the possibility of achieving a performance that compares the cost of DIY favourably with the cost of the equivalent item courtesy of Messrs. Japanese. Educational interest wasn't perhaps as fully evaluated in the format of the questionnaire as might have been.

Volume 3 is just around the corner — and we shall be bearing in mind many of the points you've raised over the last two years as we continue in our aim to bring you the up-do-date magazine that looks at the forefront of electronics and communications technology.

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