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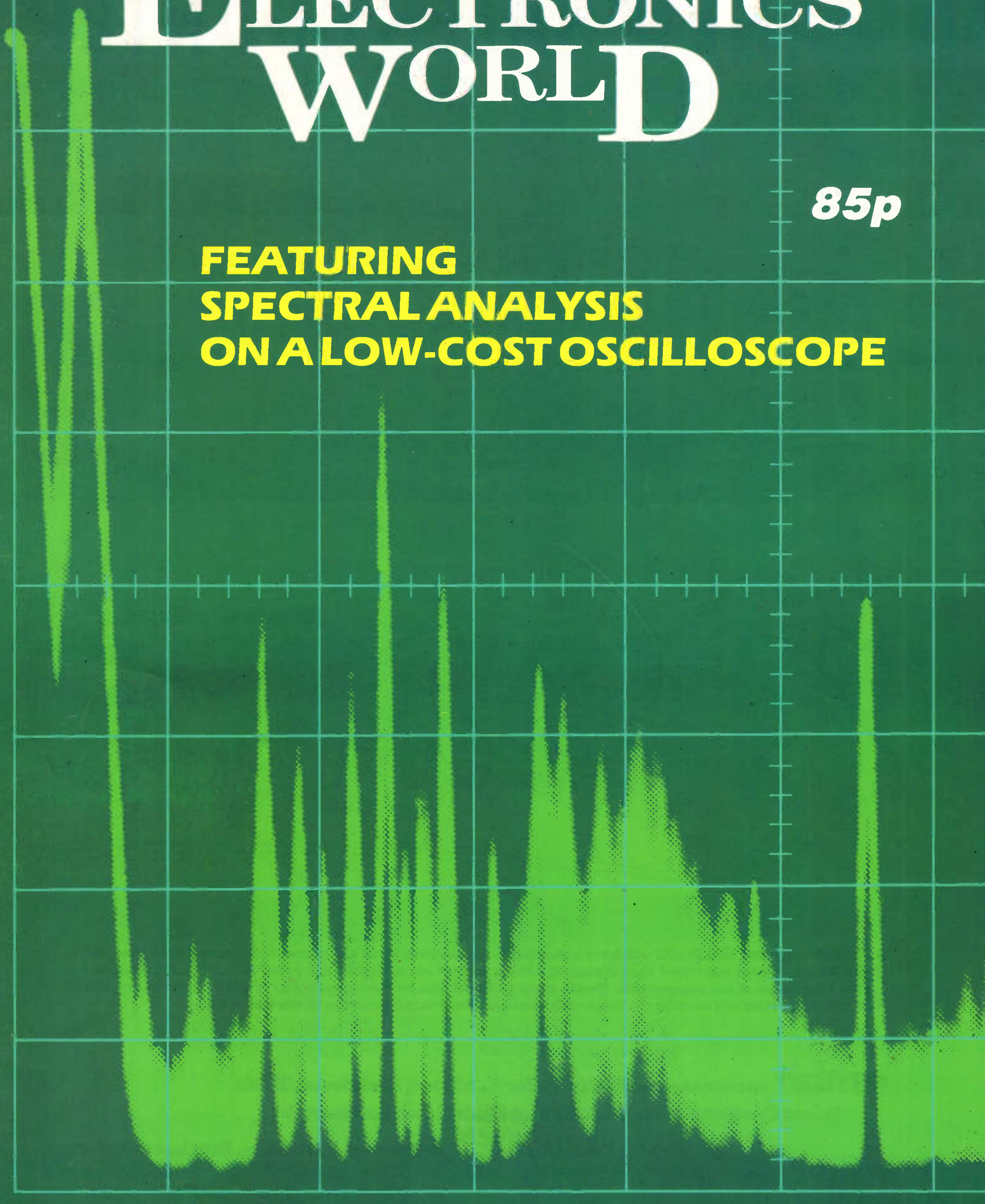

THE COMPLETE ELECTRONICS AND COMMUNICATIONS MAGAZINE

D71699

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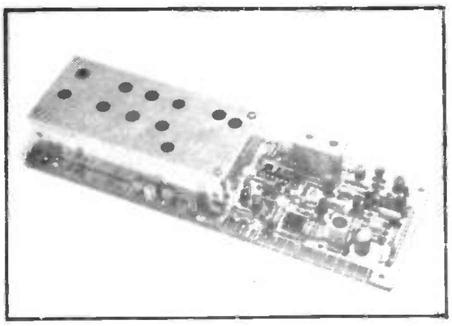
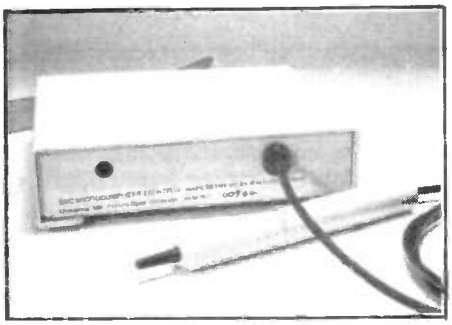
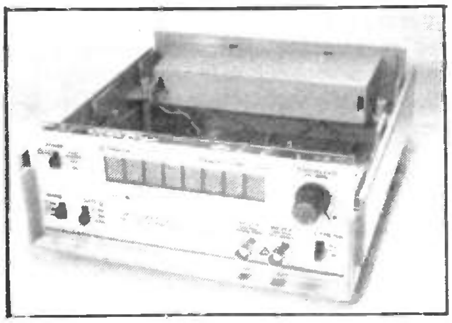
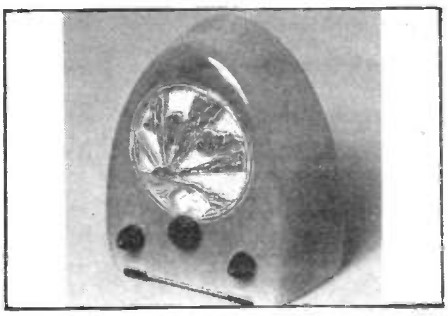
RADIO & ELECTRONICS WORLD

NOVEMBER 1983









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Note: The closing date for both the August caption competition and the Zilog competition (September issue) is *1st November*.

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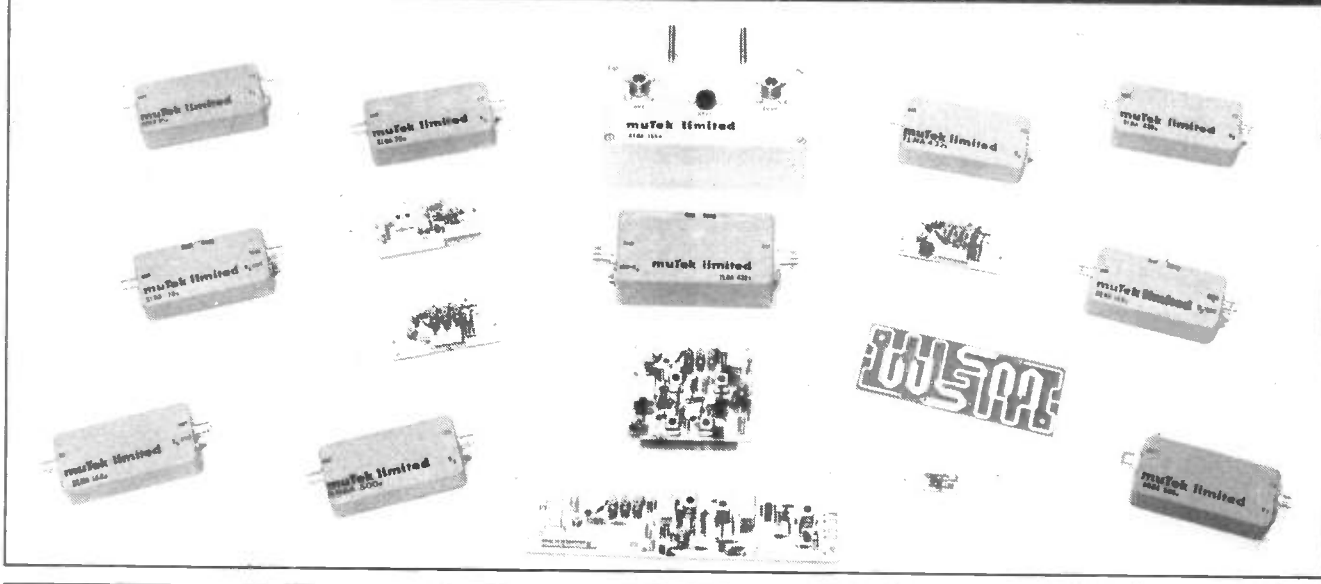
NOT ONLY, BUT ALSO...



Many of you probably won't realise just how large our range has become over the last year or so. With preamplifiers covering from about 20MHz right up to 1.3GHz, dedicated receiver front-ends (look out for the new RPCB 271ub for the IC 271 transceiver), and a lot more in the pipeline, need you look further? Feast your eyes over the selection, any further questions? — then ring 040924-543. We're here to help you.

Replacement Receiver Front-Ends

RPCB 144ub Replacement front-end for the Yaesu FT221/5 series of transceivers. Our pcb manufacturer calls this board 'the old faithful', and you've only to look at the results of vhf contests over the last few years to see why! It's now better than ever, and will inject new life into your rig for **£71.00** inc. VAT (+£1.20 p&p).

RPCB 251ub Not quite so easy to fit as our RPCB 144ub above, but still well within the capabilities of most. A complete receiver front-end with antenna changeover relay will really make your IC 211/251 sit up and listen! And it'll listen well in the presence of neighbouring strong signals too (providing they're clean!). Another contest winner this one, for **£76.90** inc. VAT (+£1.20 p&p).

RPCB 271ub Designed to fit in the position intended for the Icom optional 'preamp', this board for the new IC 271 transceiver is even better than the RPCB 251ub! We're not content to sit still here at muTek, and the improved dynamic properties of this new board are the result of a continuous research effort into low-noise amplifier design. Easy to fit? YES, give us a ring and we'll tell you how! We will let you know the price too, but it won't be that different from the RPCB 251ub. Complete with all necessary cables and hardware of course!

Preamplifiers

We manufacture preamplifiers specifically for use in the 6m, 4m, 2m, 70cm, and 23cm bands. These are available in various forms: plain boards without rf bypass switching, boxed preamplifiers without rf bypass switching, boxed preamplifiers with rf bypass switching, and environmentally housed units with rf bypass switching!

The whole range is shown below. One new addition is our SBLA 144e masthead mounting switched preamplifier using an advanced balanced Si mosfet circuit, to fit neatly into our range between the SLNA144s and the top-of-the-range GFBA 144e preamplifier. By the time you read this we should have a firm price, please give us a ring, and we'll let you know more about it.

The Range

		Price£
SLNA 50s	50MHz low noise switched preamplifier using BF981	37.10
SLNA 70s	70MHz low noise switched preamplifier using BF981	37.10
SLNA 70u	70MHz low noise unswitched preamplifier using BF981	22.40
SLNA70ub	Unboxed version of SLNA 70u	13.70
SLNA 144s	144MHz low noise switched preamplifier using BF981 (0.9dB noise figure)	37.10
SLNA 144u	144MHz low noise unswitched preamplifier using BF981	22.40
SLNA 144ub	Unboxed version of SLNA 144u	13.70
SLNA 145sb	Transceiver optimised preamplifier with antenna c/o switching using BF981. Intended for the FT290R, but has many other applications	27.40
GFBA 144s	Ultra-high performance environmentally housed switched gasfet preamplifier using advanced negative feedback circuitry for superb dynamic performance. Supplied with ATCS 144s controller.	129.90
TLNA 432s	Very high performance bipolar transistor switched preamplifier for 430-440MHz using BFQ69 for 1.4dBnf and 0dBm input intercept performance.	74.90
TLNA 432u	Unswitched boxed variant of TLNA 432s	29.00
TLNA 432ub	Unboxed TLNA 432u	20.40

GLNA 432u	432MHz gasfet preamp. 0.7dBnf/14dB gain	52.90
BLNA 432ub	Sub-miniature 1.3dBnf BFQ69 preamplifier	13.70
BLNA 1296ub	Noise matched NE64535 1.3GHz lna	26.90
RPCB 144ub	Complete replacement front-end for the FT221 and FT225	71.00
RPCB 251ub	Complete replacement front-end for the IC211 and IC251	76.90
HDRA 95u-1	1.5dBnf/8.5dB gain high dynamic range 88-108MHz preamplifier	32.90
HDRA 95u-2	11.5dB gain variant	32.90
BBBA 500u	20-500MHz broadband high dynamic range preamplifier	29.00
BBBA 860u	250-860MHz broadband low noise amplifier	22.60
XBPF 700ub	Microstripline band pass tvi filter	2.95
PPSU 012	12V (nominal) mains psu for HDRA95 & BBBA860	6.90
CISA 001	'UHF'(f) to BNC(m) coaxial adaptor	1.60
ATCS 144s	Transmit receive changeover sequence and controller	22.60
Carriage/Postage rates		
GFBA 144s		2.50
All other products above		1.20

All prices include 15% VAT

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COMMENT

A Dangerous Precedent

We continue last month's theme of concern for what 'we' are actually doing and achieving through the application of new technology. Whatever else may be said about the state of the 'consumer' high technology market, you can't say it doesn't provide a lot of scope for examination and thought.

Personal computer manufacturers who felt that they simply could not make enough machinery about this time last year discovered that people do not buy computers during the summer months. Or rather they are hoping and praying that the slump of '83 was a seasonal phenomenon and not a sudden discovery by the public that, if they wait a year, then they would get twice the computer power for half the money.

Just supposing this theory were true, then the PC will have gone the way of the calculator and watch market. And less visibly, the way of the cash register business, and the weighing machine business, and the hifi business, and the ....Help!

Cold Comfort

The foregoing markets have been systematically sized up, fattened up and reaped by those nifty chaps from the Far East; the Japanese taking the quality end, and Korea, Taiwan and Hong Kong picking up the remains.

I don't want to frighten you all, but Acorn has leapt with, to my mind, indecent haste at the opportunity to get the Electron made in Malaysia. If you didn't know, part of the deal over the BBC computer was that it should be 'made' in the UK. Nevertheless, a glance inside even a kosher Model B will reveal that most of it is constructed from components sourced abroad.

Sir Uncle tries harder than perhaps he ought to manufacture in England, against all the odds and against the 'system' – in the shape of everything from 16% customs duty on parts, as opposed to 7—12% on manufactured assemblies, to the efforts of the archetypal British working person. The British government makes an unseemly spectacle of itself trying to attract foreign manufacturing companies to invest in the UK as a manufacturing base. Anyone would think Datsun hadn't actually spent the last ten years trying its best to undermine part of what used to be the infrastructure of the British industrial economy.

Think Positive

Notwithstanding all this, positive thought still has a real part to play. Those of you who read/saw/heard the inimitable (and apparently unfollowable) *Hitchhiker's Guide to the Galaxy* may recall that part of the masterplan was to maroon all the hairdressers, insurance brokers, bankers, restaurateurs and other middlemen-cum-service industries in order to tidy up the order of 'things'. Ironically, it now seems that we are faced with the dubious pleasure of establishing a nation that is comprised almost entirely of these service industries. The Japanese have not (yet, anyway) devised a means of cutting our hair using Japanese labour, and it will be a while before they crack running hamburger chains based on porpoise and whale meat burgers.

Readers of *R&EW* are better placed than most to survive the New Order. New Technology needs a lot of explaining, servicing and operating – and thanks to prodigious investments in automation of assembly and test, it doesn't take a lot of manufacturing.

This month's career advice is to stay clear of manufacturing and creation of products, and explore the sales and service industries – if security is what you seek. The best way to get the practical experience you will need to make life perhaps more fulfilling is to read magazines like *R&EW* and apply your creativity to writing features and constructing projects. Working in manufacturing industry is unfortunately likely to be remote, long winded, unrewarding and, ultimately, a disenchanting experience.

It's a pretty disastrous prospect for a nation that once was synonymous with enterprise, manufacturing and domination of world markets. What are *you* doing about it?

BULLETIN BOARD

Improved Ion Implantation for Microcircuits

Arsenic, zinc, beryllium and caesium are ideal elements as far as selective ion implantation within the fabrication of submicron integrated circuits on silicon or gallium-arsenide (GaAs) wafers is concerned – except that they have high vapour pressures (i.e. they evaporate very readily) and they are poisonous.

However, Hitachi, working in conjunction with the Toyohashi University of Technology, has come up with a ion microbeam system whereby the source is confined within a reservoir through which passes a fine tungsten needle. The tip of the needle is pointed towards the target while the lower end may be heated by an electron beam to 3000°C – more than twice the temperatures involved in conventional systems. The heat conducted to the reservoir melts a little of the solid source and this flows up the capillary within the needle and wets the tip. There 30kV across a pair of electrodes produces the field which extracts an ion microbeam from the film of molten element. Double-stage octopole ion optics focus the beam on the target, this arrangement giving less distortion and aberration as well as the facility to scan a larger area. These optics were designed using a CAD system developed by Dr Hazime Oiwa of Toyohashi University.

The spot diameter is less than 0.5μm and the maximum area that can be scanned is 2mm x 2mm, itself ten times larger than that covered by conventional ion beam systems. Moreover there is no chance of poisonous fumes escaping, while at the same time the remote heating method stops the source from becoming contaminated via that route.

✱ ✱ ✱ Nota Bene ✱ ✱ ✱

The Independent Broadcasting Authority is currently gearing itself up for its launch into the field of direct broadcasting satellites (or DBS). The most recent driving force in these developments was the announcement by the Home Secretary, in a speech to the Royal Television Society on 18th September, that the Government intends introducing legislation during the next session of Parliament that will permit the IBA to issue one or more contracts for the establishment of a DBS system.

The contract invitations will indicate a range of options open to potential applicants, in particular specifying such things as the technical standards that will have to be met, the means of funding and the types of programme that would be acceptable. Though the DBS services are unlikely to have the range of public services in terms of the kind of programme that will be transmitted, the aim will still be to benefit the subscriber.

This is a new area for the IBA, whose terrestrial services will continue to be its principal activity. Thus the IBA is hoping to hear from those with outline plans to put forward before it completes the specification.

The bill concerned is expected to be introduced before Christmas and enacted in the Spring, and the IBA intend to seek DBS contracts as soon as it is legally entitled to do so. Under the arrangements that are envisaged, the IBA would control the 'uplink' to the satellite but the programme contractor would be entirely responsible for the provision of the satellite. The contracts thus create opportunities but it will be up to individual companies or consortia to judge whether those opportunities are worth taking. The financial risks will be considerable.

PCB prospects

The European market for multilayer PCB's is currently worth £150 million and growing at a rate of 16% a year. This is the picture presented by Circuit Techniques – a company that has recently invested over £1m on equipping its newest factory with some of the latest computer based design and production systems for multilayer PCB manufacture – in the first of its PCB industry briefing notes. The other information drawn from its researches implies that the total market represented by UK manufacturers is between £20m and £30m, of which something more than £10m is available to independent producers, and that the growth rate is likely to increase as advanced computer aided systems broaden the range and scope of the boards through reduced design and production costs overall.

That being the case, any company has also to invest to keep up with the 'state of the art'. At the same time, though, this does not spell the end for the independent PCB manufacturer because his services will remain in demand for prototypes and small-to-medium production runs that would be uneconomic for any electronic equipment manufacturer to carry out in-house.

New Breed of Transistors

Electronics Weekly (31st August) reported that engineers at the University of New South Wales had developed a way of making transistors that can amplify an incoming electronic signal by as much as 25,000 times. The new transistors are based on a heterogeneous metal-insulator-semiconductor (MIS) emitter junction, rather than the conventional silicon-silicon homojunction.

The original research was done in connection with the University's solar cell studies where it was shown that the open circuit voltage was 10–20% above that of conventional p-n cells. Indeed the resulting cells are said to be the most efficient in the world and NASA has awarded the group a contract aimed at developing the cells for use in space. The junction's performance in transistors means not only that more than twice the amplification can be achieved than ever before with one such device but that greater control is possible over the properties of the base region. The former reduces circuit complexity and so reduces noise generation within that circuit, while the latter represents an important step towards close optimisation in specific high voltage, high gain or high speed applications.

Digital Labels for Digital Recordings

The BBC, in close co-operation with Willi Studer AG, has recently proposed a format for digital 'labels' for digital audio recordings. The labels would be carried within the 48kbit/sec users' data channel built into the recently proposed AES/EBU Digital Audio Interface. They could carry such operational details as programme duration, date and time of origin, and editing cues; technical information such as audio wordlength, signal compression characteristics, and level and balance settings; and commercial data such as copyright details and keys that would protect against unauthorised copying. Such labels would, of course, be able to be re-recorded or transmitted as required as their use could be valuable away from the source, and a high degree of error protection is incorporated.

The proposed format is said to be simple and flexible, allowing it to be readily applied in response to a wide variety of operational requirements. Unfortunately, more details were not available at the time of going to press.

A Problem Harnessed

Producing electrical cable harnesses should in future be nothing like as time consuming and labour intensive as it has been using the current peg board method. The promising factor is the development of 'Marconiweave' at the company's Kidsgrove site where researchers have had many years of experience of producing cable harnesses for underwater weapons systems and have hit upon a novel adaptation of standard weaving machinery. As a result, Marconiweave can be flat, multilayer or tubular and can combine a wide range of different wire gauges and insulation factors. Other facilities include the incorporation of special wires and small tubes carrying liquids or gases, and automatic and controllable insertion of spacers. The result is that Marconi sees a wide range of applications in communications, computers and other installations that involve large numbers of electrical connections.

Vintage Stuff

The Vintage Wireless Company, which has been operating in Bristol for the last 12 years or so, specialises in antique wireless, obsolete electronics and radio, TV and industrial valves. This is a 'mail-order only' operation with a wide variety of old equipment, books and data sheets in stock. Recent promotions have included some 'delightful "mock" art deco radios in hand finished ceramic cases' (with British made transistor radios inside) – like the one shown here – and repro horn gramophones. Free data with every item and repairs are among the services offered.

The Vintage Wireless Company also produces a monthly newsletter which is admittedly to a great extent a catalogue of the present stock

and requests for particular items, but it also includes data from old manuals and subscribers' adverts which are free to non-commercial subscribers. These, of course, may only deal with vintage radio and TV.

405-line Transmitter Closures

The transmitters listed below are those that are expected to be shut down during the first half of 1984. There will be further closures over the rest of the year and the rest will go during the first week in 1985: we shall list these stations nearer the time.

BBC	IBA
Les Platons	Fremont Place
Tacolneston	Mendlesham
Peterborough	Sandy Heath
Sandale (Scotland)	
Oban	
Fort William	
	St Hilary (Wales)
Llanddona	Arfon
Holyhead	
Swingate	Dover
Eastbourne	
Hastings	
Rye	
Folkestone	
Brighton	
Sidmouth	

Viewers living in areas where it is not possible to receive BBC 2 can be fairly certain that they are dependent on the 405-line service. Additional 625-line UHF relay stations are being built at a rate of about sixty a year, but some people in scattered communities could still be without UHF TV at the end of 1986. Affected viewers are asked to send their names and addresses to: (for BBC): Engineering Information Department, BBC, Broadcasting House, London W1A 1AA; (for ITV) Engineering Information Service, IBA, Crawley Court, Winchester, Hants SO21 2QA.

★ ★ Company News ★ ★

Wayne Green Inc, the publisher of *73 Magazine* along with such computing titles as *Desktop Computing*, has merged with **CW Communications Inc**, which publishes such computer-related publications as *PC World*. The latter is a subsidiary of the **International Data Group**. Wayne Green remains as president and chief executive officer of the newly formed division, as well as of the Wayne Green Enterprises Division which is the post-merger manifestation of **Instant Software**, a division of Wayne Green Inc whose main business is the publication and mass production of software.

Mors Industries, the UK subsidiary of **Societe Mors** – the supplier of telecommunications equipment and computer products, among other electronic components – has announced the formation of **Mors Components**. The latter will initially specialise in the manufacture and marketing of professional quality miniature and industrial switches, in particular rocker switches, toggle switches, push-button switches and PCB-mounted switches.

Global Specialities Corporation has become a wholly owned subsidiary of **North American Specialities Corporation**, itself a part of **Interplex Industries Inc**. The chairman and chief executive officer of Interplex, Jack Seidler, has now taken on this role in relation to GSC as well. GSC is a multinational manufacturer of electronic test and protyping equipment, while Interplex manufactures and markets connectors, machinery and precision components.

Bell & Howell has formed a new Television Systems Division (**BHTV**) to enable its existing Professional Video Division to concentrate on 'non-broadcast' products (distributed through its network of Video Centres). The new division will handle Bell & Howell's range of broadcast-level production equipment which includes JVC high band recorders and broadcast-quality cameras. These will be distributed through just six of the Video Centres.

BeTA Marketing is a new company that has been set up by a former Marketing Manager of Gould as a specialist power supply sales organisation. One of its first contracts is as West Country sales representative for **Gould**, the agreement covering the latter's entire range of DC/AC power supplies and line conditioners.

Acorn Computers has added a number of new activities to its range over the last couple of months. In addition to launching the Electron in August, the company was floated on the Stock Market on 29th September and took the same occasion to open its London office and showroom in Covent Garden. Less well publicised is the company's recent venture into sports sponsorship – in the shape of supporting David Hunt (brother of James) in Formula 3, starting with the Marlboro F3 Championship meeting at Silverstone on August Bank Holiday Monday. This particular activity is seen as a bonus for the staff, as well as an opportunity to impress business associates – and the press!

Zilog has filed a complaint against the **Nippon Electric Company (NEC)** with the International Trade Commission. The complaint accuses NEC of patent, trademark and copyright infringement with regard to NEC's PD780 micro chip and systems based on that device. Moreover, the way these are imported into the US through NEC subsidiaries is seen as constituting unfair competition to the Z80.

British Aerospace Dynamics has been given the contract to develop and produce the Air-Launched Anti-Radar Missile (ALARM) defence suppression system. It in turn has given **Lucas Aerospace** the contract to design, develop and manufacture the attendant actuation system – said to be incorporating the latest technology in high performance electro-mechanical actuator design.

BUSINESS DIARY

The Flat Screen TV Lives!

7 years, 5 million pounds and the advent of the LCD later, Sinclair Research produces the goods for public display. Are they yet quite set for public consumption? Read on as William Poel takes a sideways look at the sideways TV.....

Walking on water

Sir Clive Sinclair took to the rostrum and bravely opened the batting at the press conference to introduce the £80 Sinclair flat TV. Doubtless you will have seen the pictures in the National Press and on the conventional TV by the time you read this piece, so I shall keep to the tradition of *R&EW* and colour in the background of the event. There was plenty of that.

Whilst not quite on a par with the lavish example of the genre recently set by the Russians when wheeling out brass hats to explain away zapping civilian airliners, the flat TV press launch was a weighty affair, with the entire national and technical press present in force. The Holiday Inn in Chelsea isn't the most substantial of venues (indeed, it was about 30% over capacity with the numbers that turned up).

This mass of humanity teetered precariously around the obligatory Holiday Inn swimming pool. As those of you familiar with the popular view of the gentlemen of the press may recall, persons connected with this profession are ever so slightly infamous for their predisposition to distillations of the grape (and anything else that evaporates). Since there was literally but a foot or so between the tables alongside and undying infamy in the annals of the apocryphal tales of the assembled technical correspondents, various photographers were seen to be waiting with cameras poised for 'something

unfortunate' to occur. Anonymous employees of Sinclair Research asked for contributions from eager sensation seekers towards a fund that would determine once and for all whether the noble knight was in fact capable of walking on water.

The fund failed to reach the reserve, whatever that was.

Forward defensive

The TV itself was delightfully typical of this type of event. There was a total of three to be seen together at any one time, and when Sir held up the set for the first time, that clatter of autowind Nikons and Canons coupled with the whining of fast recycle flash guns brought the proceedings to a temporary halt with a fit of the giggles. Sir Clive held his baby aloft proudly as the world's press set about wetting its head.

Much of the questioning bowled at Sir Clive was pointedly aimed at drawing him into an indiscretion concerning the likely availability. Sir Uncle was nevertheless not naive enough to have been unprepared on the subject, and he confirmed that no one's money would be taken until the goods were ready to be shipped.

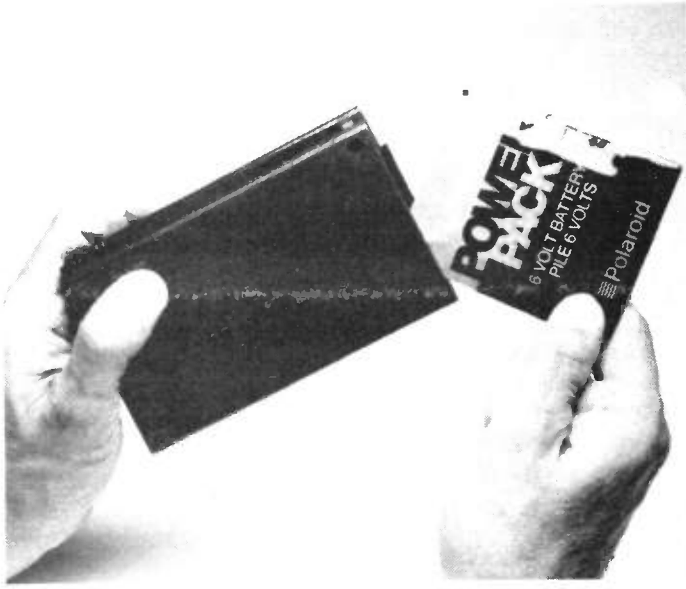
Whilst Sir Clive's bat was impeccably straight on the subject of mail order policy, a few faster deliveries escaped past the outside edge on the subject of exactly how many are being made now, and when the first shipments are to be made. Indeed, certain members of the press delighted in roughing up the wicket with distinctly vexatious enquiries trying to get through the gap between bat and pad.

The first boundary came when Sir Clive described the Britishness and leading edgeness of it all. The redoubtable Barry Fox (he who writes on the subject of consumer technology for just about everything that brings paper and ink together) quizzed the knight of the day on the subject of the 'numerous' patents applied to the tube and its IC technology. The sly Mr Fox had actually researched the patents registry only the week before to see what he could unearth in anticipation of this event, and had found precious little relating to the flat TV. Aha! We all thought.

Sir Clive glanced nervously at the umpire. The finger didn't go up, and confirmation was received from the pavilion that the patents had been filed only the day before the launch. The passion for secrecy surrounding Sinclair's new products is absolute, and Barry Fox's googly was struck firmly for six, whereupon he retired hurt.

Throughout a penetrating session, Sir Clive batted magnificently. The perception of the questioners was generally well above average, and it didn't take long for the questioning to find the rough outside the off stump in the shape of the paradox of a multistandard, multinational set that doesn't actually sport VHF coverage. But it turned out that a combined VHF/UHF version was under development for the US market, and the present intention was to whip out the FTV for the UK and Euro viewer – barring the French, who in their inimitable fashion have chosen to be unstandard.

Curiously, no-one present complained about its non-compatibility with the French standard. Vive la



difference, or whatever.

Another nasty lifter whizzed past Sir Clive when questions probed the efficacy of the choice of a 6V battery that costs – wait for it – £3 a refill for 15 hours viewing. Admittedly 15 hours equates to several passes of *'Gone with the Wind'*, but estimates show that the average household watches 15 hours of TV in 2–3 days. It makes the licence fee pale into insignificance, doesn't it?

Not wishing to be a spoilsport, I should mention that there is confidence that the lithium battery price will drop towards £1 a go. Estimates given at the event of the capacity of the US-made lithium marvel vary from 1500mAh to 500mAh, and since the battery itself is labelled 'P500' by Polariod who make it, I know which one I shall believe until proven otherwise. Sir Uncle tickled the question to fine leg with a passing dismissal of penlight batteries on the grounds of bulk. I'm not convinced, but I would concede that even my great aunt could change the battery pack in this thing without fusing the lights or calling for assistance from the RAC.

The set itself runs for 15 hours minimum on the battery provided which, if it really is only 500mAh capacity, means a prodigious feat in power efficiency has been achieved; that is probably the most technically impressive aspect of the set outside the tube technology. A mains adaptor (not multistandard) is available.

The lunch session

In precisely the same way as all good batsmen rush for the pavilion once they have decided that they have faced the last ball of the morning, without leaving time for the umpires to decide there's time for another over, Sir Clive whipped off the bails and strode for the pavilion after an hour was up. He carried his bat, and whilst offering generous praise for his fellow team members, he never once let them near the bowling.

The informal session around the aforementioned pool was supplemented by limitless food and drink as the assembled press persons tried to prise out some inside aspect to titillate their copy. Your scribe was fortunate enough to actually get to speak with one of the SR folk ▶

who claimed to 'make the tea' amongst other duties. As you will all understand, the person that makes the tea is frequently the best informed and most straightforward of the lot.

I promised to sit on any juicy bits of scandal, and am pleased to report that there appears to be good old-fashioned 'seat of the pants' enthusiasm for the project amongst those responsible – which is quite a refreshing change from the corporate blandness and sterility of many a consumer product launch these days. Working till 3am on the night before the event is/was the life blood of British ingenuity, and I am pleased to report that it's alive and well at Sinclair Research.

R&EW was duly acknowledged by a member of the RF design team (who didn't actually admit to having used all our ideas in the development), who coincidentally had more than a little to do with the coil-less FM receiver design aired by Rod Greenaway in the last issue.

A consumer viewpoint

A throng gathered around one of the working models on show, and someone whipped out a Sony Watchman, which is certainly much bigger, heavier and according to reports 'three times the price'. The display was (as the good Knight had claimed earlier) rather dull — something of a nonsense on the power comparison. Sir Clive also pointed out that at the rate an LCD is bashed for TV purposes, much of the power consumption advantage used by 'slow' watch displays is lost. LCD driving is all about charging and discharging capacitance, and at high frequencies this presents progressively less impedance to the scanning signals.

The absence of a brightness control may seem a problem at first, but it's never been a limiting factor with the earlier Microvision. The built-in loudspeaker is a disappointment. One Sinclair PR person excused this by citing battery life as a serious drawback to providing more volume. Phooey — I'm not asking for a sound to fill the Albert Hall; just one to overcome the ambient noise in the middle of a field in Cambridgeshire, for example. Two pheasants having a fight half a mile away could conceivably be the limiting factor in such circumstances.

RF sensitivity was good, with a surprising lack of ghosting. The tuning locked up very well, and the absence of AFC was not a problem. The designer's view was that AFC was necessary for colour (which is 'under development') but not monochrome. Definition is good and, despite the interposition of a Fresnel screen to amplify the picture signal at frequencies above the infrared, I'm prepared to believe that subtitles could be read with the aid of a magnifying glass.

Journalists were much intrigued by the possibility of seeing a computer with a built-in flat screen display, but Sir Clive 'no-balled' such questions as being more speculative than he was prepared to entertain. Nevertheless, this avenue of development was definitely under consideration. The feeling generally expressed in technical circles is that the flat screen tube is fine up to maybe 3–4 inches (diagonal), but after that a form of projection technique would be required.

The striking feature of the system is the quality of the image obtained through viewing the phosphor from the same side as the electron strike. If you get the chance to glance inside a TV or monitor and to get a glimpse through the back of the tube where some of the masking paint has been scraped away, you will readily see how much brighter the side you don't see really is. (If you blow yourself up in this experiment, please don't complain to me about it.)

Would I buy one? Yes. But then I'm a sucker for these things and have bought variously a Micromatic, various bits of Project 60, an Executive calculator, a Microvision plus the statutory ZX81 and Spectrum. Could I buy one? No. There was talk of some special order form system to ensure correct stacking of requests, but there were none available at the launch, so I telexed the MD, Nigel Searle, when I got back to base to be sure of leaving documentary evidence of my intentions. Watch this space.

Sir Clive went to considerable pains to explain that the delayed launch was due to the need to set up for mass production from day one. Comparison with the numbers involved in the earlier Microvision project was not valid on the grounds that the £200 tag four or five years ago bore little resemblance to £80 in this age of inflation, and that the constructional complexity of the two sets offered no comparison. At a rough guess, with the complexity of the new set, it seems possible that it could be sold for £50 if the competition ever threatened, and there's no doubt, as Sir Clive observed, that even the Japanese would draw the line at operating at a vast loss indefinitely.

The most memorable observation of the entire event was Sir's comment that he envisaged this product would do for TV what the transistor did for radio. In other words a 'personal' rather than a communal consumer experience. He may well have hit the nail on the head with that observation, and only time will tell if this is to be an example of an advance or a further decline in the standards of civilised behaviour. How long before the pocket-sized VCR, Sir Uncle??

■ R&EW

VIDEO NEWS

Peter Luke takes his regular monthly look at the world of video.

"WOW! YOU TRIPPING OVER THE WIRES'LL LOOK TERRIFIC IN SLOW MOTION!"

The drawback with most portable videos, or component systems as Sony likes to call its F1 ensemble, is that when used around the home they do not look as stylish as their mains only counterparts. The problem is that the units must be connected together by a series of cables that always conspire to look as unsightly as possible. While the manufacturers of video equipment have learnt some lessons from the audio industry and have in general managed to keep the connections confined to a couple of multi-cored cables and perhaps a co-axial cable for the RF signal, the result is still likely to offend the sensibilities of those with a sense of perfect order.

To The Rescue

A new recorder from Hitachi, the VT-7, solves the problem by having a 'lift out' recorder. With the recorder *in situ* the unit looks for all the world like a standard recorder, but when the need for portable work arises, the recorder can simply be slipped out of its mount leaving the tuner etc. behind.

The VT-7 features a 14-day, 5-event timer and – unusually – this is built into the recorder rather than the tuner. This makes timed recordings in the field possible. Uses for this facility do not spring immediately to mind but it may well find application in scientific/research fields.

The recorder boasts a range of video effects – reverse play, insert editing, slow motion and date coding. Hitachi has also borrowed a leaf from Panasonic and have a version of that company's OTR system.

The VT-7 at £900-odd is not cheap but its price does compare favourably with other portable systems and, with its generous range of features and Hitachi's acknowledged quality and technical performance, the machine is worth considering if you're in the market for a portable recorder.

Hitachi has a second new machine in the VT-19. This is a conventional mains machine and comes in at the top of the company's range. The machine, as well as having the usual range of video effects found on flagship recorders, features dual speed recording and a stereo sound capability. Again as may be expected, Dolby noise reduction is incorporated.

At about £700 the VT-19 looks good value for money for those wanting an all singing, all dancing mains machine.

Budget Toshiba

The VC-31 is a new machine from Toshiba that is selling for around £450. The recorder has a rather slimmer look than the model that it replaces – the V9600B – and has a trick video facility that is not usually found on budget recorders, namely slow motion at one fifth of normal speed. The timer on the recorder is however what one might expect from a budget machine – i.e. seven-day and only one event specification.

The price of this recorder is not as low as some beta recorders have been in the past; instead it is about what one would expect to pay for a basic VHS model. The choice between the formats is now down very much to the features offered by different recorders and to the availability of software.

New Ferguson

Another company to get on the OTR bandwagon is Ferguson. Its new 3V35 features a one-touch button that will start the machine recording instantly, with the off time selectable in half hour chunks up to the maximum VHS standard recording time of four hours. Another unusual aspect of the 3V35 is that it incorporates a full function remote control as standard – something usually found only on more expensive machines.

The timer is rather a disappointment, for although it can be set to record over a 14-day period it can only be set to record one programme in that time.

That said though, at under £500, the recorder with its various trick functions and an elapsed time indicator should be worth a look at least.

At Last

In my opinion, the British TV industry is only just beginning to get back on its feet after years of virtual hibernation. Ferguson has contributed to the recent increase in activity in this area but has to date concentrated on the upper end of the market. This has let Far Eastern sets dominate the lucrative £200 and under portable market.

The new TX90 chassis from Ferguson changes the situation – for with a price tag of only £170, a host of impressive features and a credible technical performance, the set looks to have a bright future. The cost of the set has been kept down both by careful design and by employing a streamlined production process.

The sets are available now and, in this case, buying British means not only being patriotic but buying one of the best sets of its type around.

■ R&EW

Designer's Update

The storage and manipulation of video signals is an interesting field for experiment. Michael Graham has discovered a new low-cost video-speed A/D, D/A chip set that is ideally suited to this type of application.

In recent years, improvements in semiconductor technology and reductions in the price of memory devices have meant that digital processing of video signals has become a commercial proposition. Indeed both the BBC and ITV television companies now make extensive use of digital vision mixers and caption generation equipment: just five minutes of *Breakfast Time* can show just what can be achieved with current facilities.

For the person with slightly less cash at their disposal than the average TV company, though, digital sampling of TV signals has to date been rather too expensive. Admittedly, systems have appeared in the hobbyist press but all such designs have only been capable of producing very low resolution results.

The new SP9000 series of devices from Plessey Semiconductors, however, brings video speed convertors within the reach of many constructors and offers a flexible 8-bit A/D, D/A convertor system that can be used with clock rates of up to 20MHz to provide a bandwidth from DC to 20MHz.

Operation

Figure 1 shows that a slightly unusual approach to the problem of fast A/D conversion is adopted in applying the SP9000 series of high speed ECL circuits to video processing. The technique is known as subranging and, while a similar approach has been used for many years in low speed systems, Plessey has managed to extend the technique to video frequencies.

Subranging has a major advantage over the most commonly used method of A/D conversion — the Flash system — in that it uses far fewer components to achieve similar accuracy. For example, a Flash Convertor required to produce 8-bit accuracy would incorporate 256 comparators: compare that with the 32 comparators in a subranging system of equivalent accuracy.

The subranging system shown here first buffers the input signal and then passes it to a sample-and-hold stage that holds the signal constant over the 25nsec conversion time. The output of the sample-and-hold circuit is then applied to the 4-bit A/D designated the SP9754. On the positive clock edge of the system clock, this device converts and latches the four most significant bits of the 8-bit code.

To produce the remaining four bits (the least significant), the latched output of the first A/D is fed to a D/A device to reconstitute the analogue signal and then via a differencing amplifier to a second A/D. The other input to the differencing amplifier is the original input signal and it can thus be deduced that the second A/D will form the lower four bits of the digital signal as required.

Both of the latched 4-bit outputs are in turn fed to an octal latch to form the 8-bit output of the system.

Figure 2 shows the block diagram of a complete system that also

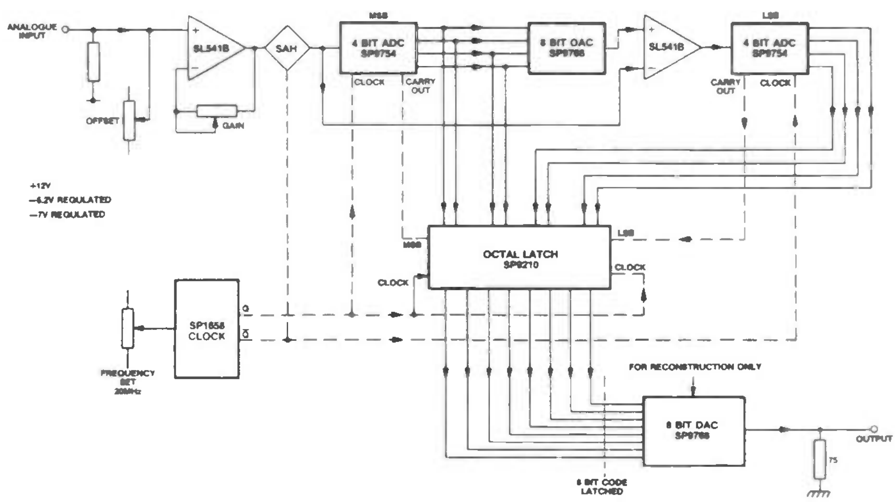


Figure 1: Block diagram for the SP9000 series-based A/D convertor.

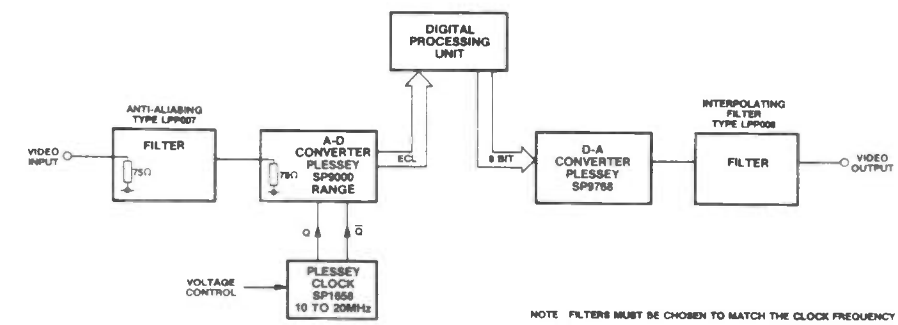


Figure 2: Block diagram for a full system board layout.

includes an anti-aliasing filter to obviate both aliasing and the effects of sin*x*/*x* distortion that can occur when sampling high frequency signals. The timing diagram of the circuit is shown in *Figure 3* while *Figure 4* shows the system's circuitry in full.

A corresponding D/A device is easily built up by using only the D/A section of *Figure 4*, although in this case all eight bits are converted. The circuit diagram for this D/A is shown in *Figure 5*.

The two pictures (*Photos 1 and 2*) show just what can be achieved with the Plessey system. The full 8-bit resolution is capable of reproducing colour TV pictures with very little in the way of distortion, while reducing the sampling to just three bits still produces a recognisable picture although much of the fine detail is lost.

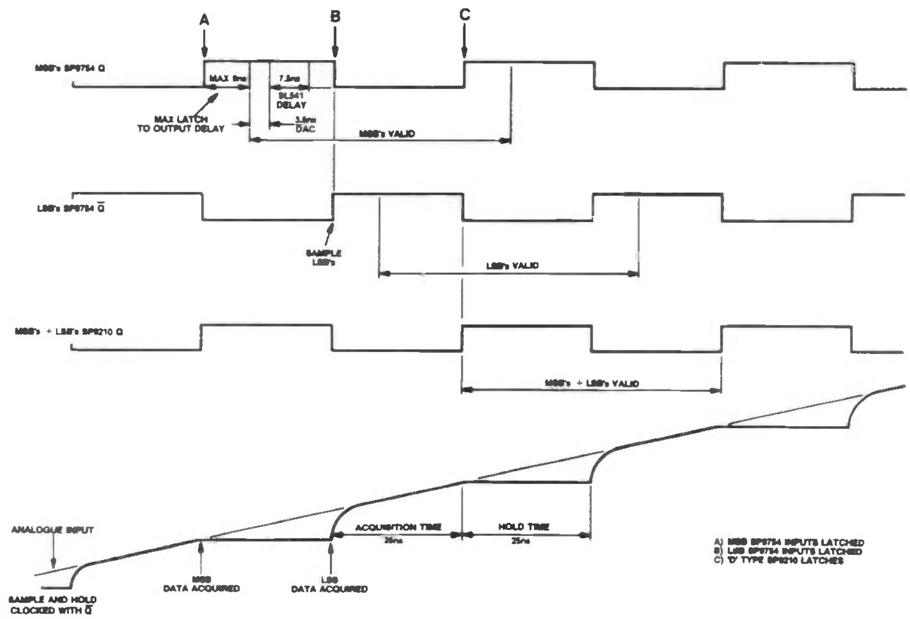


Figure 3: Timing diagram for the 20MHz clock.

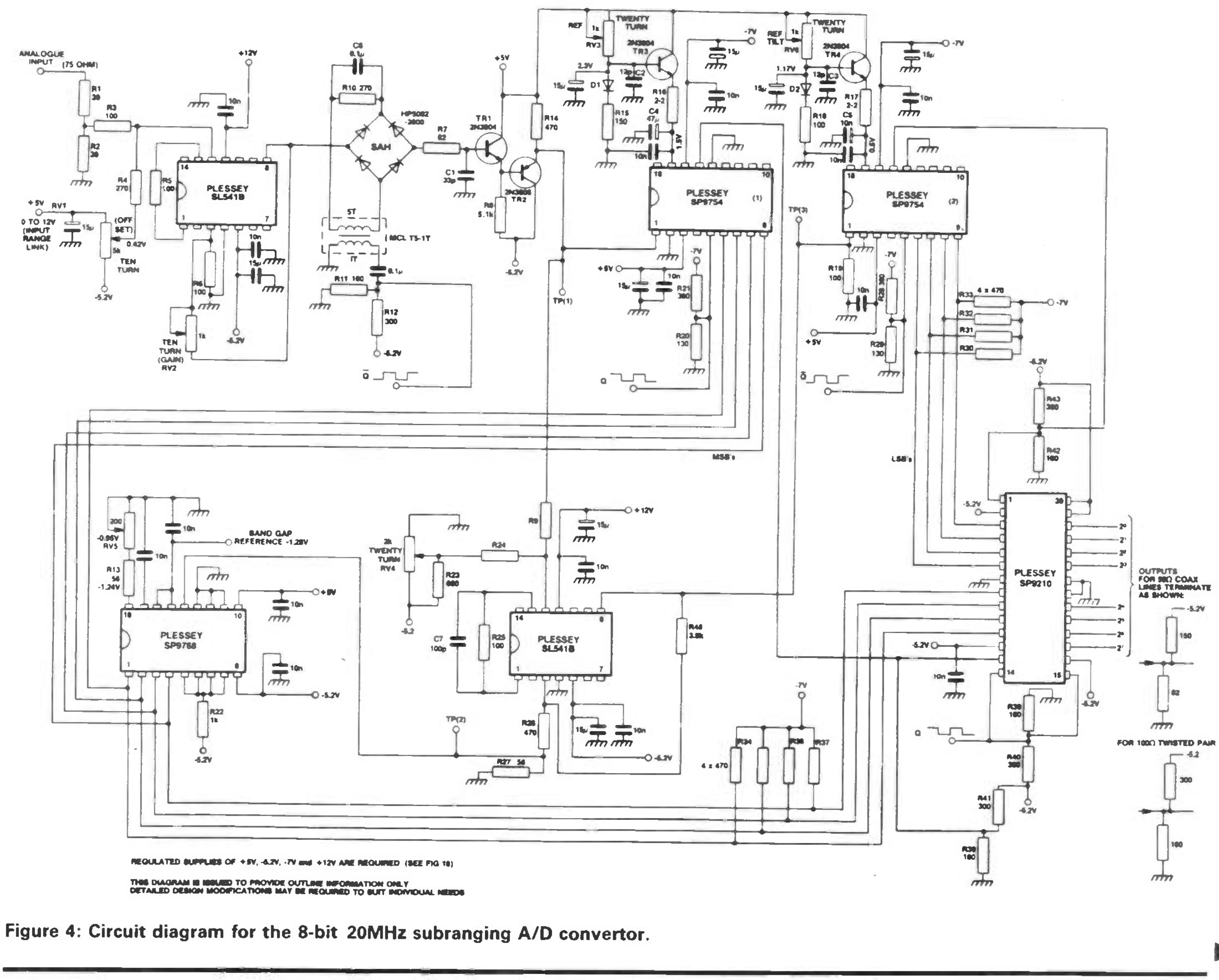


Figure 4: Circuit diagram for the 8-bit 20MHz subranging A/D convertor.

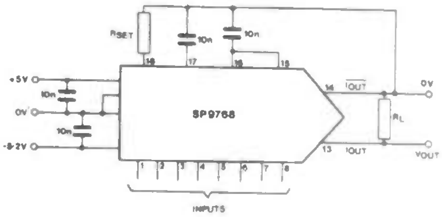


Figure 5: D/A set-up (negative output with respect to ground).

Photo 1: Off-air TV picture reconstructed to 8-bit resolution.

Photo 2: The same picture reconstructed to 3-bit resolution.

Potential

To open up the world of digital manipulation of TV signals fully to the amateur, some means will have to be provided for processing the digital signals, if possible with a home micro. Two potential problems arise here: the speed with which digital samples could be written to memory and the amount of memory required to store a complete frame. The second problem could be overcome by using lower than the full resolution (say, 4-bit) together with some form of data compaction. The first difficulty might entail processing only still pictures which were built up over a number of TV frames.

If these problems are overcome, it should be possible to produce some really spectacular video effects.

■ R&EW

COMMUNICATIONS BUILDING BLOCKS

Front ends for all — Part I

This month, we take a look at various approaches and solutions to front end design and active-receiving antenna systems, without getting too deeply embroiled in quantitative analysis of intermodular distortion.

In an ideal world ...

...signals received on the antenna would be detected and converted into audio at the earliest possible opportunity: preferably in the first active stage of the system. Direct conversion receivers set out to do precisely this (*Figure 1*) and it is a matter of great alarm among designers of sophisticated multi loop, multi IF, multi filter communications receivers that direct conversion systems appear to work as well as they do.

Things direct conversion receivers don't do too well include receiving modes other than DSB/SSB, handling AGC, coping with strong signal blocking and radiating the LO/VFO back up the antenna. But, on the other hand, there are plenty of conventional receivers that don't score too highly in those areas either.

The indifference of the AGC on direct conversion receivers is the most unforgivable point from the user's point of view: has anyone yet produced a DC receiver that can match the 90dB+ AGC range and performance of a modern receiver like the R2000 or R70?

So if we can comfort ourselves with the feeling that there is indeed at least some justification for setting out on the long and tiresome road of the superhet, we'll proceed with the basic definition of the two building blocks being described here.

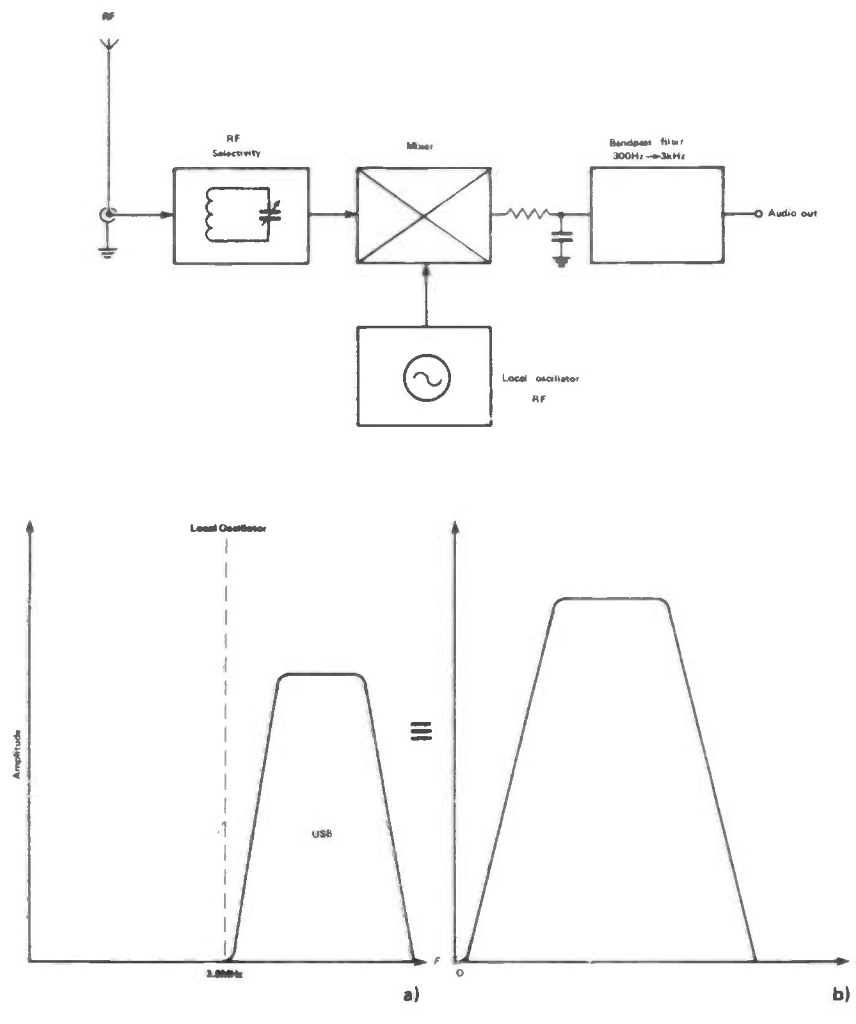


Figure 1: Direct conversion basics a) USB signal with RF injected locally to set the datum point for the resultant audio spectrum. b) The resultant audio spectrum.

A broadband HF front end

Perhaps the trendiest aspect of the superhet receiver for HF is its ability to handle strong signals with the minimum amount of effort. Tracked tuning of signal and oscillator stages is an artform that is shortly about to pass into the museum of radio science as virtually all new receivers exploit the concept of 'octave' bandpass filter tuning.

Tracked (ganged) stages require a constant offset to be maintained between the RF and oscillator frequencies (the Intermediate Frequency), when maintaining the offset as a constant over six bands and 30MHz is no fun at all. There is always an element of compromise, which means that the sensitivity across the band isn't constant (tracking error) or that strong adjacent signals may actually be amplified instead of attenuated.

The *Q* of a multiple RF tuned circuit array can be a positive menace, since the magnification of the incoming signal voltages can result in total saturation of the RF tuned circuit inductors, leading to detuning, cross modulation etc. The output of an RF stage with a gain of 20dB doesn't need much encouragement to limit where the supply rail is held to 12V or thereabouts. AGC will help, but only if the wanted signal (i.e. the signal that has passed through the main IF selectivity) is adequate to generate enough AGC to reduce the gain of an adjacent signal that is 60dB up on the one you're listening to (*Figure 2*).

Selectivity of that kind simply isn't available from the *Q*, especially in view of the inaccuracy of RF tank circuits. It *is* available from ceramic and crystal filters, but no-one is likely to want to produce a separate 8-pole crystal filter for each HF channel. By mixing the incoming frequency with an offset equivalent to the filter frequency, the superhet creates the effect whereby a single filter appears to have a continuously variable centre frequency.

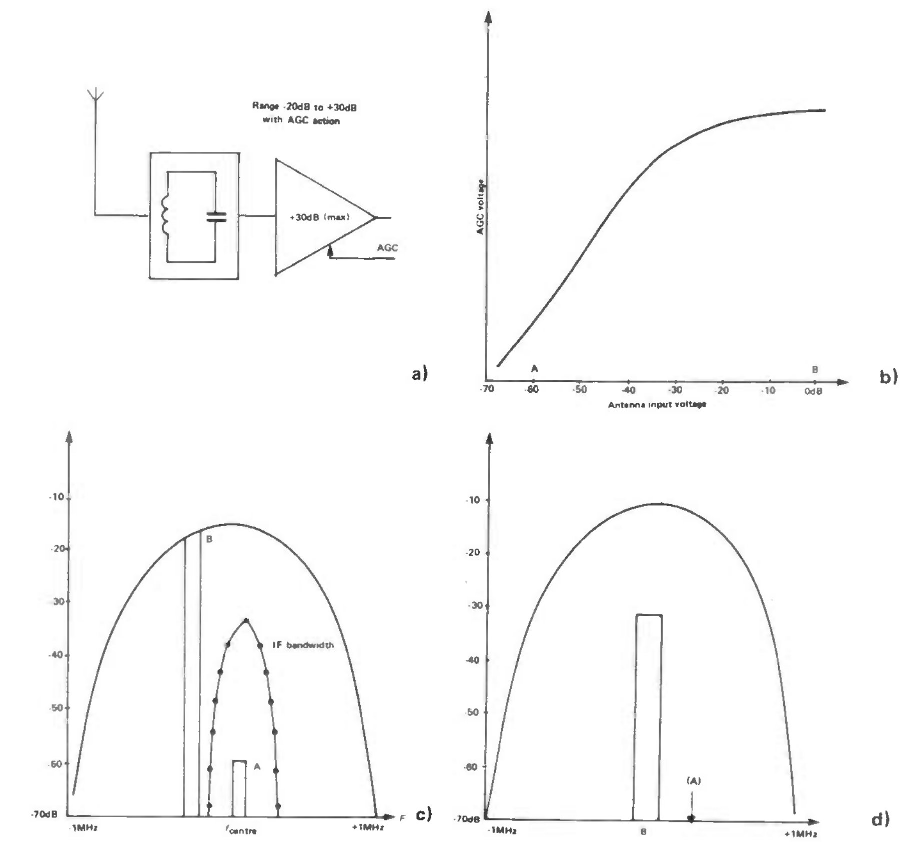


Figure 2: Explanation of why RF selectivity is not a complete solution to strong signal handling. a) Basic set-up: limiting occurs at 0dB with no AGC. b) Interdependence of AGC voltage and antenna input voltage. c) Illustration that RF selectivity is of little use with strong adjacent signals. The RF stage will attempt to amplify A and B by 30dB: B will limit and distort through harmonic generation. d) With signal B in the passband and AGC applied, the stage remains linear and so the performance appears satisfactory.

So if we can abandon fondly-held memories of multiply tracked and painstakingly tuned resonant elements at the incoming frequency, the first element in the front of the system is the antenna.

Up front

The front of a receiving system is an antenna – and at the risk of sounding boring, the antenna is certainly the single most crucial element in the receiving system, since if the ether cannot be persuaded to part with the best possible signal-to-noise ratio for the desired signal at this point, then no amount of high technology is going to improve this state of affairs. The noise figure at the antenna socket is the factor that determines the ultimate ability to dredge weak signals from the airwaves. If the wanted signal delivered to the receiver input is actually below the noise level generated by adjacent electrical interference, atmospheric conditions, etc, then you won't hear it.

Transmitting antenna requirements differ hugely across the HF spectrum since it is important to maintain an accurate low impedance match between transmitter output and antenna input. Receiver antennae can use much higher impedances without incurring the large RF voltages that raise their heads in transmitting systems, a fact exploited in a number of commercial broadband active antenna systems.

The basic point is that an antenna that is much shorter than a quarter wavelength displays a highly reactive (capacitive) impedance, and it is then relatively simple to translate from this high impedance to a low impedance using a source follower or similar stage. The 100% feedback of such a stage ensures good bandwidth – and the perceived performance of such an antenna will usually be equivalent to a dipole. The much smaller dimensions nevertheless allow such a system to be mounted remotely from sources of interference. At the same time, the active section helps to overcome the basic problem of remote locations in that the losses incurred in a feeder cable in a passive antenna system always supplement ▶

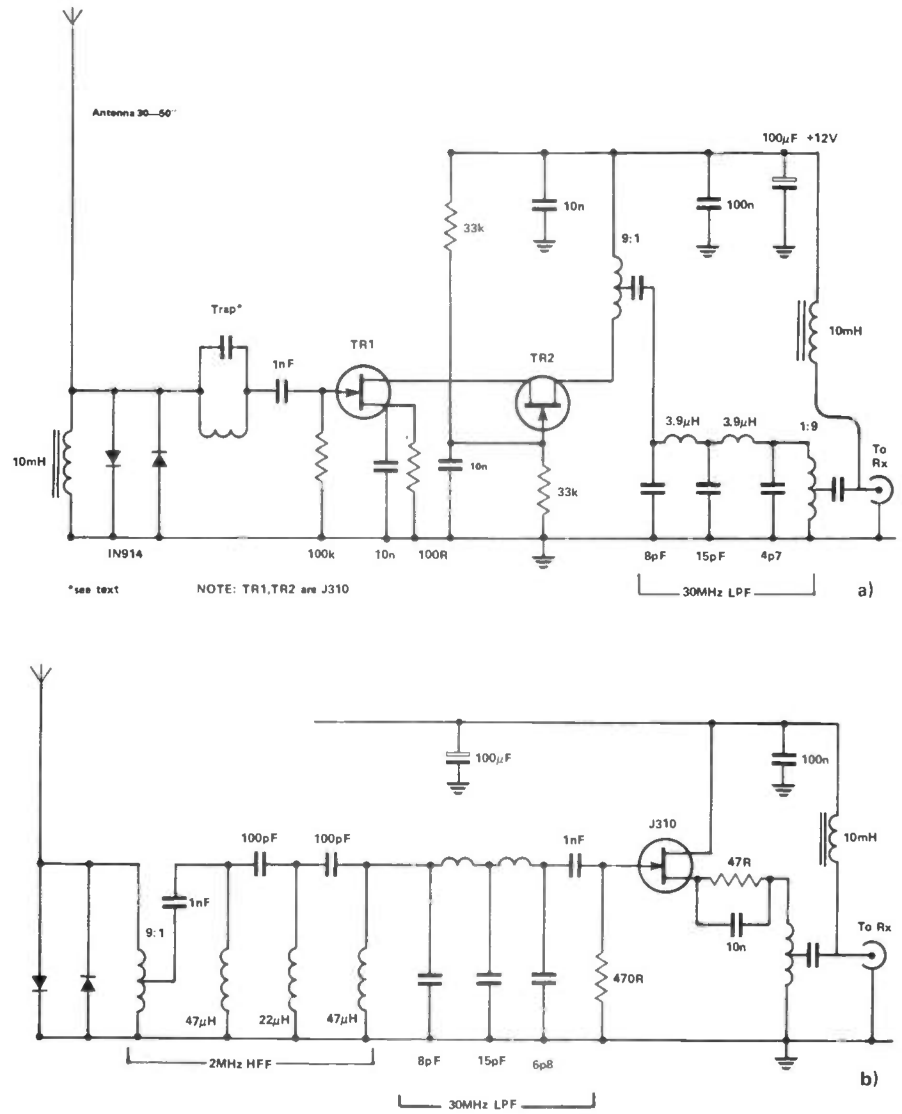


Figure 3: a) An active antenna head amplifier with low pass filtering. b) An active antenna stage with bandpass filtering.

the noise figure, and cannot be compensated by any amount of amplification at the far end.

The active antenna is itself the front end of the receiver – and equally applicable to direct conversion techniques. *Figure 3* illustrates a pair of suggested designs, which although not claimed as the last word, will provide a starting point for enthusiast developments. A couple of practical points will emerge; to wit that the length of the active section of the whip antenna should measured, and a parallel trap inserted corresponding to the frequency at which the whip is resonant. If, for example, the whip were 30 inches long and you happen to live near a Band 3 VHF TV transmitter, there's a fair possibility of creating some apparently inexplicable problems as the resonant antenna sets about doing its 'passive' job. The same applies if you want to use the antenna in a marine installation where the 156MHz radiotelephone could wipe out HF reception.

It is, of course, possible to cope with such problems by using low pass filters, and the second circuit illustrates such an approach – but, as purists will point out, tuned filters require their input and output impedances to be better defined than is possible with a length of wire. Applying the filter after the gain stage could be too late. Nevertheless, it is important to filter the output of the amplifier since it will inevitably contain frequencies outside the band of interest and these can cause problems. The second of the two circuits is perhaps better suited to situations where local out-of-band transmissions (both MW and VHF) are problems that transcend the niceties of optimised impedance matching!

Power to the antenna system is fed along the signal feeder. Although it is shown as 12V, the more volts that can be supplied within the limits of the active circuitry, the better will be the strong signal performance. And, by the same token, the lower the impedances involved in the signal paths, the more power can be transferred for a given 'headroom' voltage.

Before passing on, it's as well to mention that an optimal solution to an HF active antenna would be to select a complete octave filter section in the same way as the receiver front end does. Control of remote switching can be achieved using the antenna feeder and a signal 'carrier' medium (e.g. 60kHz FM), and maybe here's some real scope for the experimentally minded to cut loose.

Mix 'n' match

If you have reached this far, you should by now have gained the impression that what goes on before the first mixer should be kept to a bare minimum. Nevertheless, there are a few more points to bear in mind when deciding what to do after the receiver input socket, the first one being to work out the numbers involved in the first mixing process, and their implications for the sum and difference frequencies.

The prime objective of the circuitry preceding the first mixer is to avoid embarrassment in strong signal handling, and to counteract the potential for unwanted products in mixing. The input can provide the 'image' of the signal you want by 'reflecting' it in the oscillator frequency. There must, therefore, be a facility for rejecting the one you don't want before it reaches the mixer, and rather than undergoing sophisticated phase inversion processes resulting in imageless mixing techniques, front ends are required to limit the input to the mixer to one of the two possible images.

Remember that with an oscillator at 70MHz, the signal at 30MHz may be equally as valid as the one at 110MHz. Judicious application of this principle can lead to receivers using a single oscillator to provide HF and VHF coverage by simply switching the filter in front of the first mixer – and nothing else.

What IF?

The type of front end selectivity required will depend on the IF chosen. If the IF is a low frequency (455kHz), then the image will only be 910kHz away from the desired RF response. As a very rough rule of thumb, the image problem will become a nuisance (i.e. less than −30dB on the wanted response) if the IF is less than one quarter of the highest frequency to be tuned. Thus a medium wave receiver just about gets away with a 455kHz IF when operating at 1.6MHz – and is helped by the absence of much broadcast activity on (1600+910)kHz. An extra RF tuned circuit will tend to add another 30dB to the image rejection – but that's not an ideal solution for the reasons already discussed.

For an HF receiver, the choice of 9MHz as an IF arose, as far as I can see, by the accidental fact that a local oscillator tuning 5.0–5.5MHz works for both 80m and 20m in one go. But I cannot for the life of me imagine how 10.7MHz arose, apart from the fact that there doesn't appear to be a lot happening on that frequency. If any reader knows the secret of 10.7MHz, perhaps they would write and let me know.

The use of 21.4MHz seems equally arbitrary, and then above 30MHz, things have really gone haywire with 34.5MHz, 35.4MHz, 40MHz, 45MHz, 48.005MHz, 70MHz... 48.055MHz can be derived from the R1000 oscillator and mix-down process, and seems to make some sense, while 45MHz is a nice round number though it is potentially a problem in the lands of Band 1 VHF TV.

So the choice of IF is perhaps best made in terms of the most cost effective solution within range of your required application. Contrary to popular belief, it is not an anathema to chose an IF which occurs in the middle of the RF range you require to tune. Few listeners have much use for 10.7MHz – nor indeed the 20kHz either side that will be desensitised by such a choice. A good 8-pole filter is vastly cheaper than an equivalent performer at 45MHz, for example.

At 21.4MHz there are also some delightful performers in some very small packages, and since quite a number of HF listening applications only go beyond 21.4MHz on very rare occasions, the problems of tuning through the IF frequently don't arise.

■ R&EW

Space permitting, next month will see a look at low noise oscillator and mixer designs, including the two sides of the SL6440 argument, in part 2 of our consideration of front ends.

Squelch Systems

So you thought squelch was simple? Rod Greenaway pulls on his wellies and sets out to uncover the many guises of the circuitry that lurks behind this panel control.

The principle of squelch (or muting) is very simple. Listening to white noise on a communications circuit is both tiresome and unnecessary — so why not switch off the output when nothing of interest to the listener is being received? Thus a squelch system is a means of detecting whether or not a signal is present, and operating a switch on the audio output accordingly.

A more recent innovation is the introduction of tone squelch, which is a form of group selective calling where a number of stations on a single frequency may wish to speak with and listen to each other — but not anyone else. In such applications a continuous tone is transmitted at a low level during the transmission, and detection of this tone by the station that wants to hear causes the receiver squelch to be operated.

Tone squelch is something of a misnomer, since the tone detection usually occurs in addition to and after the usual form of squelch, since the selective filters used in the tone detection circuitry may tend to filter the white noise present on the input to produce enough signal to operate the tone squelch gate with no signal present.

Until recently, squelch was almost exclusively used on VHF FM radio and not on HF. There's no technical reason why this should be so, and several recent HF receivers for the amateur market now provide the facility. It seems likely that this is now included because the stability and repeatable tuning of synthesised local oscillators means that if a station plans to broadcast/call another on a specific frequency, a synthesised receiver will not have drifted past the edge of the passband and so will not remain deaf to the incoming call until retuned. The freedom from atmospheric crackles and various man-made electronic raspberry noises is very welcome indeed — and if you own a receiver of adequate stability without squelch, then you could think about a retrofit job.

Three approaches

Squelch operating signals are derived in three ways. The most common is in FM reception where the no-signal noise is always very substantial due to the effects of the limiting amplifiers operating randomly with no input. The random noise thus generated at the detector

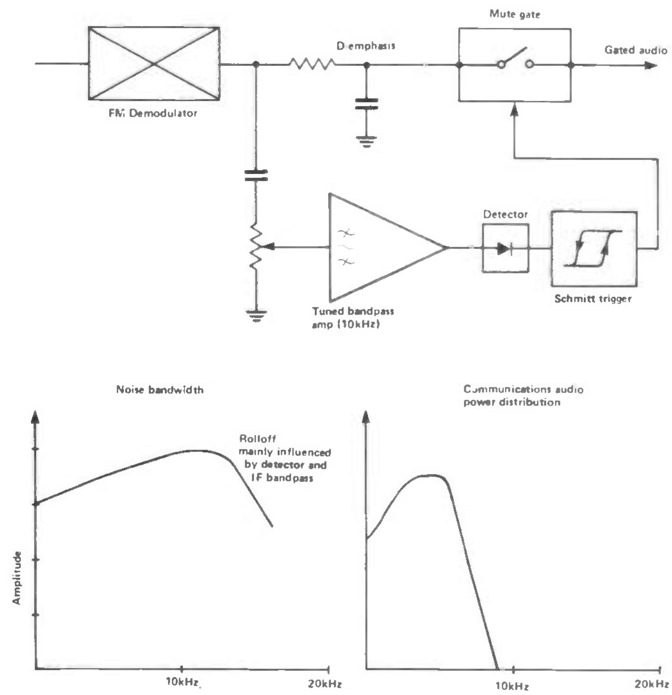


Figure 1: Block outline of FM noise squelch.

occupies a broad spectrum, with substantial energy at high audio frequencies. It will be tailored to a certain extent by IF filtering, but not so significantly as to prevent the use of a tuned audio filter above the audio bandwidth to amplify and detect the signal to be used for muting the audio output. The block outline of FM noise squelch is shown in *Figure 1*.

The second most frequently used system is carrier-derived squelch, where a DC signal representing the incoming signal strength is available to operate the audio switch. The system is most commonly used in AM systems, and is probably best known in AM CB applications and in AM sets. Such a control signal is usually readily derived from the AGC system — see *Figure 2* where this principle has been applied to the TDA1083 AM/FM complete receiver IC.

The third approach is to use the detected audio signal to operate the audio gating, in the same way as a voice operated switch works. A quick way to get started on this tack is to use an SL1621 (*Figure 3*), which provides the necessary facilities. These are basically the same as for audio derived AGC; namely fast attack and slow decay.

Basics

All the above systems require the following features:

Fast attack: The squelch system must be capable of operating quickly enough to prevent noise bursts from blasting through the loudspeaker when the incoming transmission ceases.

A fast operating mute is particularly necessary in battery equipment that incorporates a battery economiser system whereby the power to the entire receiver is switched on a duty cycle of, say, 200msec in

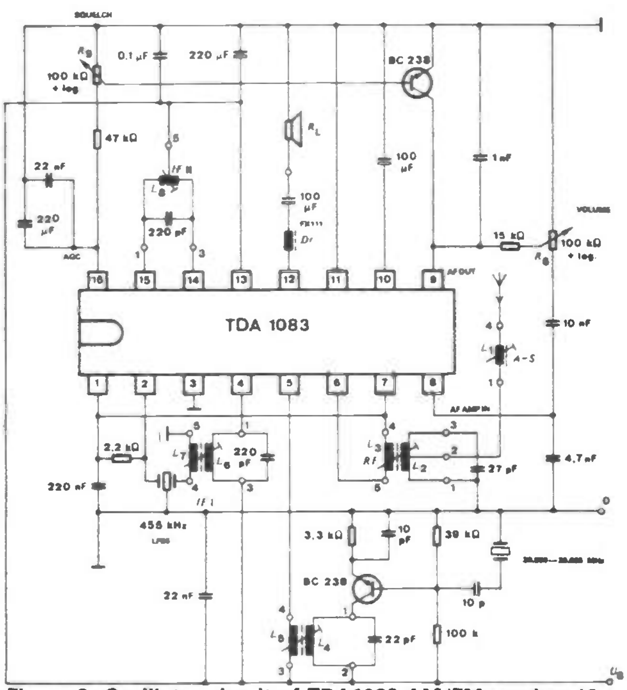


Figure 2: Oscillator circuit of TDA1083 AM/FM receiver IC.

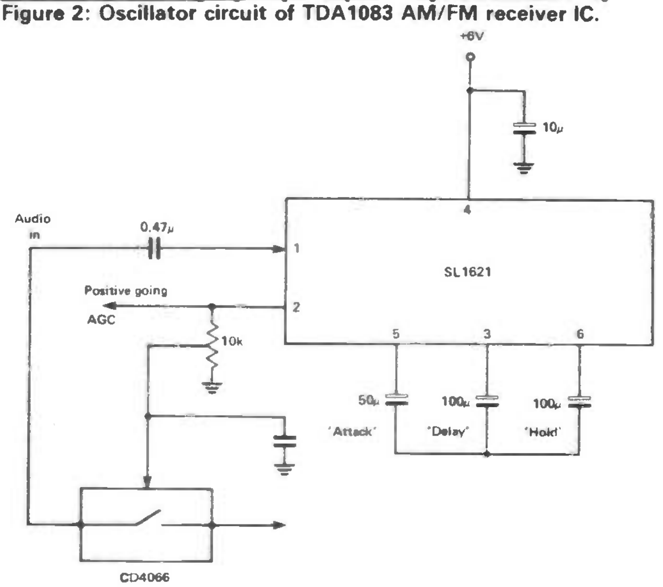


Figure 3: SL1621C AGC generator also controlling mute in an audio-derived application.

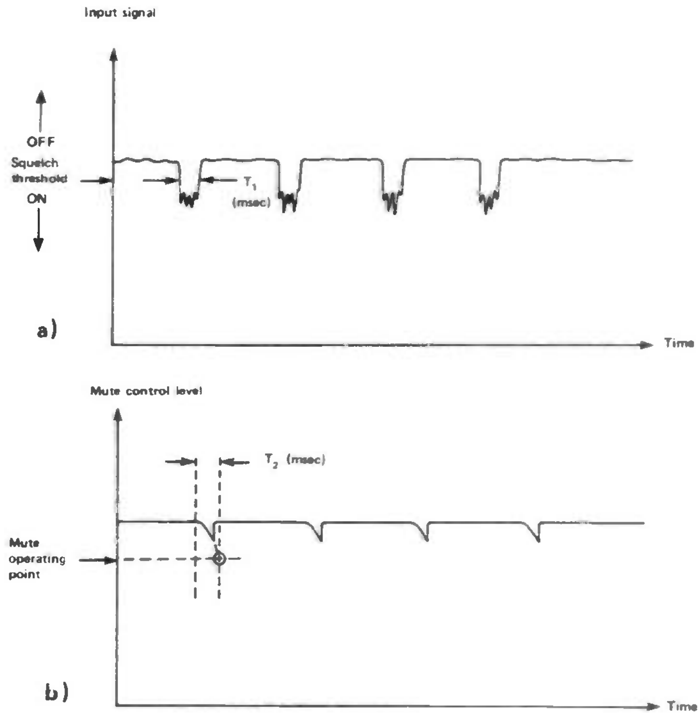


Figure 4: a) Signal flutter brought about by driving past a line of trees. b) Effect of mute. The flutter immunity will depend on the mute operating point with respect to the average incoming signal level. Mute is rarely 'absolute' — i.e. regardless of the incoming signal level.

3 sec. The receiver has to power up and be active and the mute has to decide if there's a signal being received in a very short space of time.

Freedom from 'chatter' on marginal input signals: Signals that waver around the threshold of operation of the circuit must not cause the mute gate to switch on and off in sympathy with the signal flutter — see *Figure 4*. In order to remain consistent with the requirements of fast attack, the trigger circuit requires hysteresis — which can be supplied in the form of 'true' hysteresis designed into a Schmidt trigger that covers the expected range of inputs likely to precipitate chattering, or more simply by providing a time constant in the shape of some slugging capacitance.

Stability of the operating point with regard to temperature and supply voltage: A Schmidt trigger circuit is basically an electronic hair trigger whose operating point is established by a preset voltage. In amateur radio squelch systems the threshold setting is usually achieved by a panel control; in commercial two-way radio, the control is frequently not user-accessible, and so it is doubly essential that the setting does not drift in operation.

Thermal drift is a particularly awkward problem in mobile equipment since, when the cold car warms up on the way to work, the unsuspecting operator may be rudely awoken when the receiver bursts into life after ten minutes or so. More pernicious is the case where the receiver in a car left parked in the sun suddenly blasts noise through the loudspeaker — and after ten minutes of this treatment, the loud speaker and/or audio stages expire.

Figure 5: Muting circuitry of ICOM's IC2/4 series.

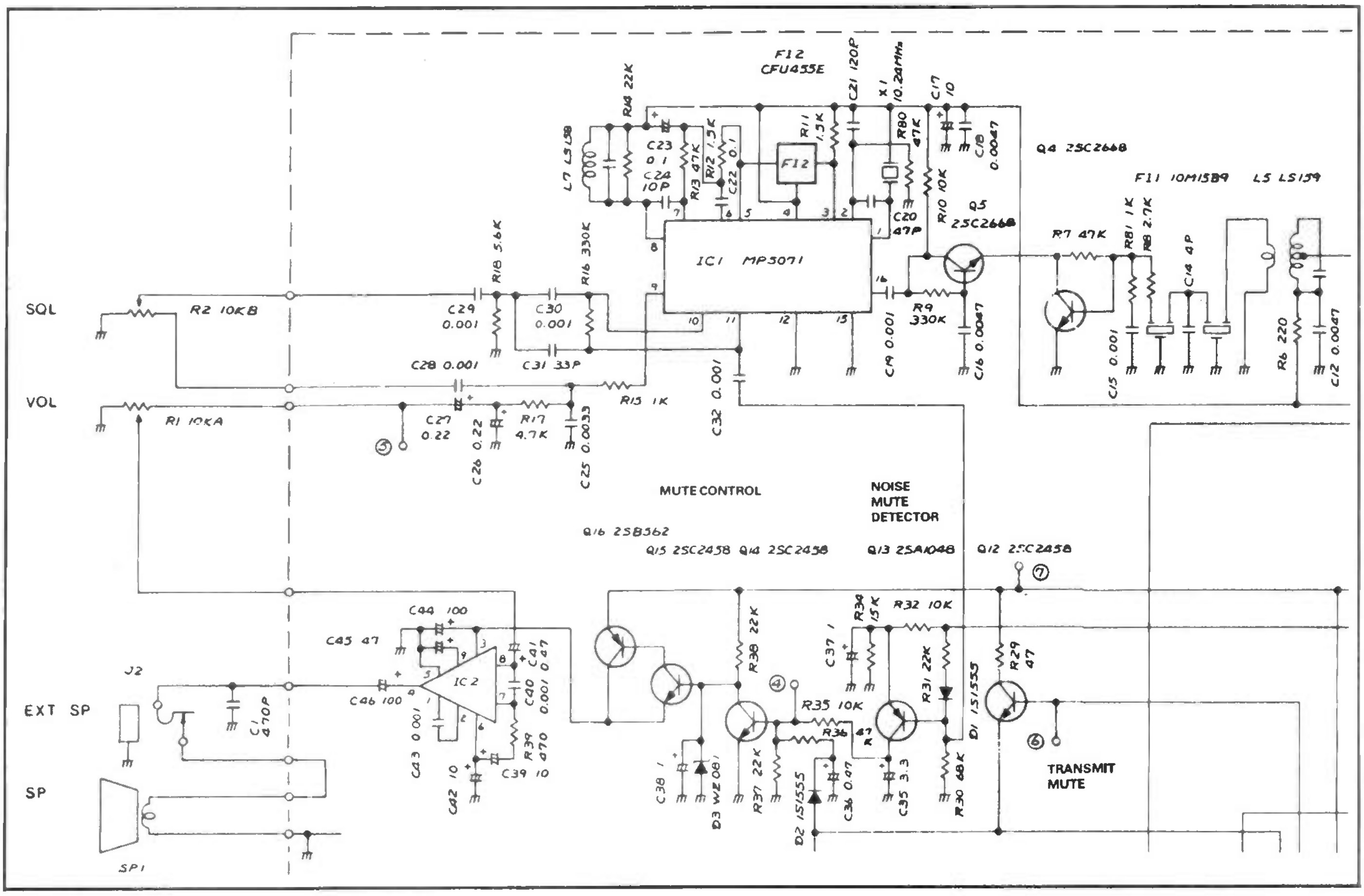
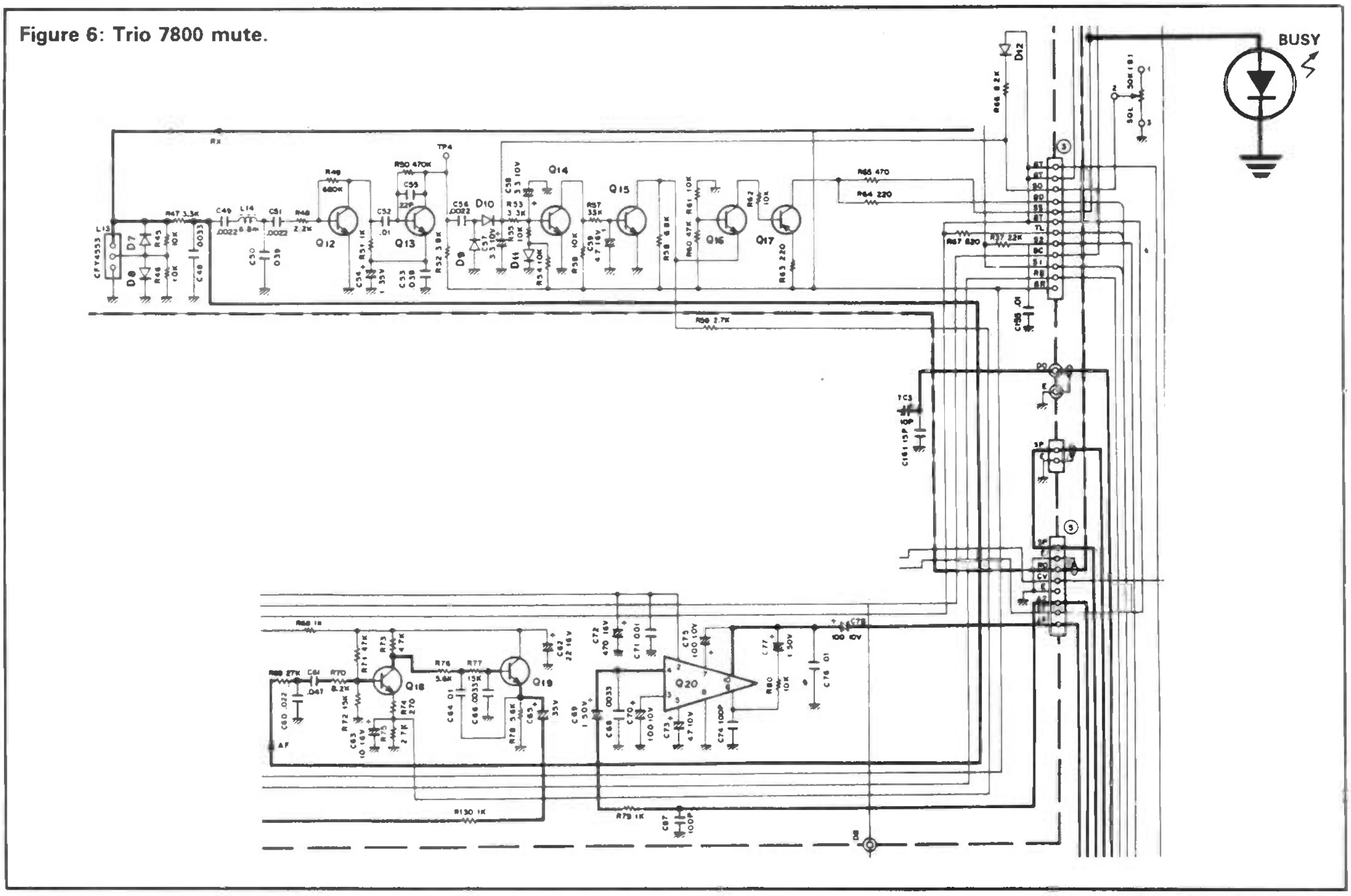


Figure 6: Trio 7800 mute.



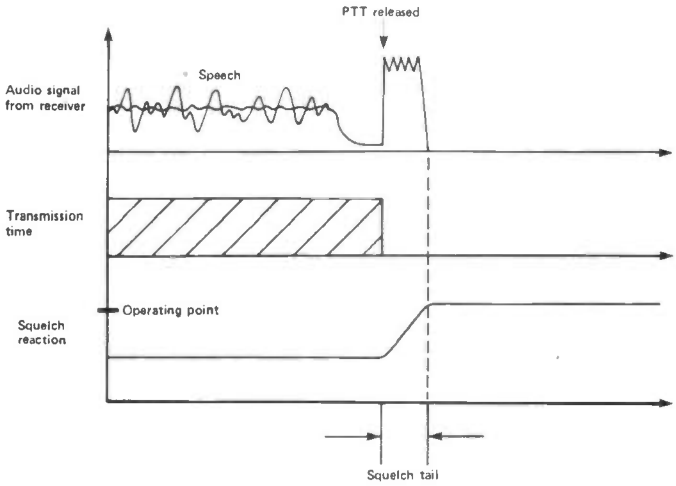


Figure 7: Squelch tail.

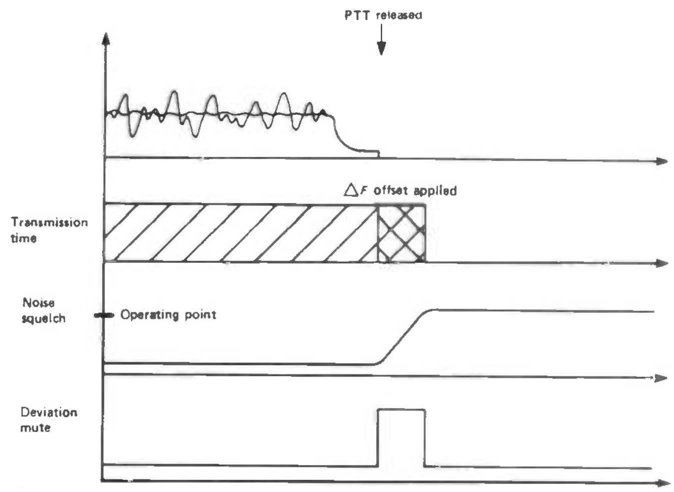


Figure 8: No squelch tail!

Silent operation: There have been one or two truly notable pieces of equipment through the hands of *R&EW* where the mute circuit actually contributes an enormous 'click' as it operates. This can result from systems where the DC input to the audio stage is preemptively clamped to ground, encouraging the output to do likewise. In cases where the audio stage is basically a power op-amp (LM380), one of the inputs is sometimes used as the switch point, thus immediately driving the DC output voltage hard up against the supply rail — 'click'.

The idea should be to return the input to the audio stage to its DC quiescent point as undramatically as possible. The mute gate circuit described with the KB4413 IC in the October issue's 'Communications Building Blocks' feature is a neat example of an integrated audio gate that operates silently.

The seal of good muting

The 'reference model' in good muting systems is exemplified by the circuit used in ICOM's IC2/4 series (see *Figure 5*). This circuit uses the MC3357/MPS5071's noise muting amplifier (a bandpass tuned on-chip operational amplifier stage), but avoids the on-chip Schmidt trigger circuit which is prone to thermal and supply drift. The squelch threshold is set by adjusting the input level to the noise amplifier — and this approach produces better results than fiddling about with DC operating points further down the chain.

The only minus point to the ICOM approach is the fact that the circuit switches the entire supply to the audio amplifier — so a degree of switching transient is inevitable. The small loudspeaker and relatively small coupling capacitor reduce the effect to tolerable proportions, and the saving in quiescent current (about 5mA for the BA516/546) is worthwhile in battery operated equipment.

The mute circuit from the Trio 7800 FM receiver (*Figure 6*) suffers rather more from problems of chatter — although this may be contributed to by the detector system being a ceramic derivative of the ratio detector, which produces a characteristically less harsh interstation than a quadrature detector anyway. The operating point is established by tweaking the DC bias on Q14, with Q15 operating the audio gate via the emitter of Q18. However, the fun doesn't stop at the collector of Q15, since Q16 and Q17 carry on to provide two additional signals — the Busy Detect (BD) and the Scan Stop (SS), operating an LED and stopping the scanning respectively — when the mute is open.

These last two features of the 7800 circuit are virtually obligatory on modern rigs where LEDs and scanning are as standard as loudspeakers.

Tail docking

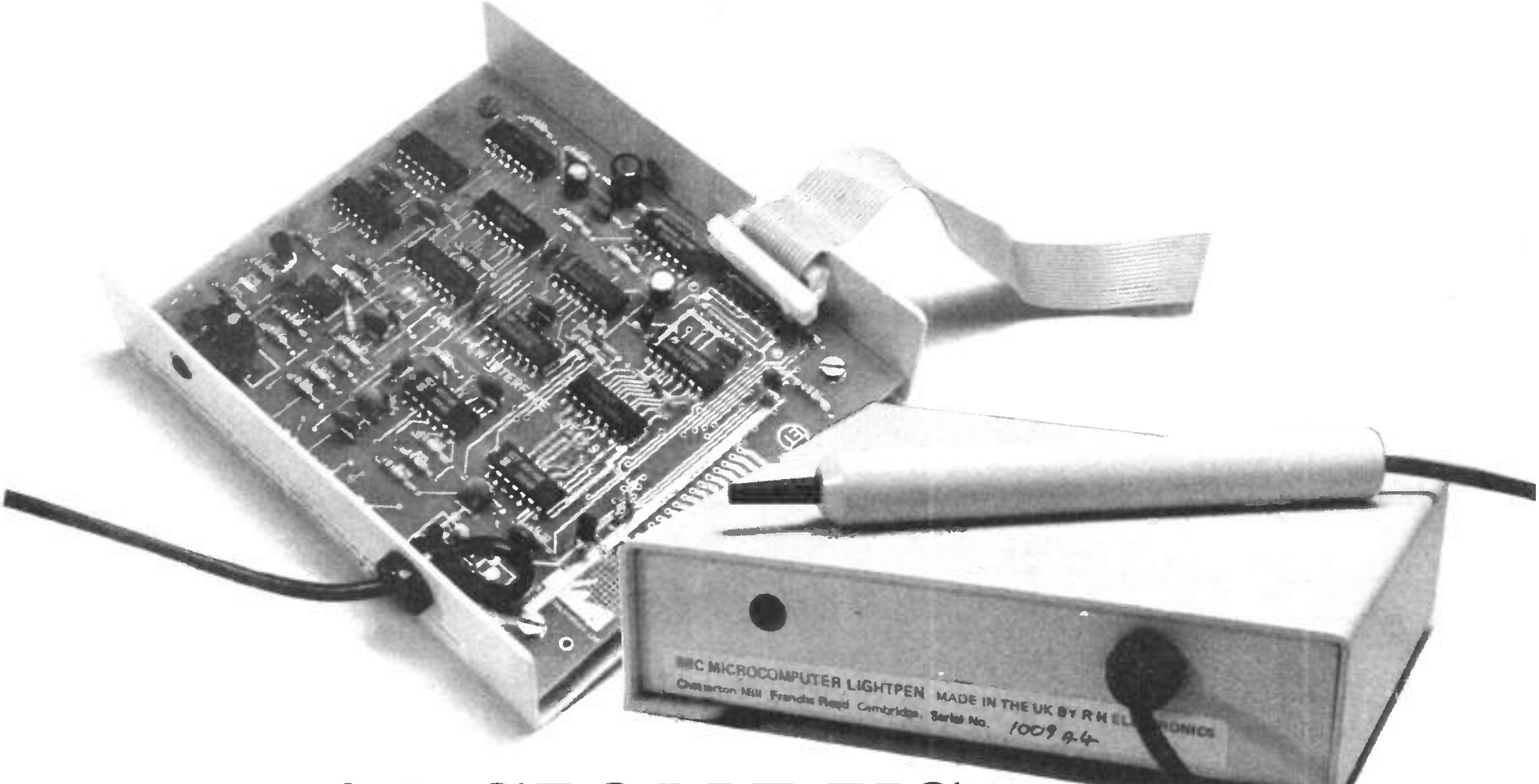
FM noise mutes have a particularly annoying feature that is not easily remedied. The time between the cessation of transmission and the shutting of the mute provides a period when the white noise can burst through. The effect is referred to as the 'squelch tail', and is an unavoidable symptom of the compromise of keeping the decay time from being so brief that chatter is encouraged to occur. *Figure 7* outlines the nature of the problem.

It is possible to get around this problem by including a bucket-brigade delay line to delay the audio before it reaches the mute gate — but that's a large sledgehammer to crack the nut. The tone squelch systems referred to earlier provide a means of avoiding the problem, since the transmitter can be arranged to cut the tone 100msec or so before dropping the carrier, thus giving the receiver time to shut the gate before the no-signal noise occurs.

One system that would seem to offer a good 'standard' for avoiding squelch tail problems is the deviation muting system, not hitherto discussed in this feature. Briefly, deviation mute operates by sensing the AFC DC error voltage present in all FM detectors, and when it exceeds preset upper and lower limits (the window), the circuit triggers the mute gate, regardless of the noise mute situation. In channellised FM receivers this is not as relevant as it is in continuously tuned broadcast receivers where tuning through the signal will result in reception of the distorted and very loud signals caused by the edges of the IF filters.

However.... if the transmitter is arranged to apply a brief offset to the transmitted signal frequency immediately the PTT is released, then a deviation mute detector circuit can operate at the receiver that shuts the mute gate when the signal drops out before the squelch tail leaks through. *Figure 8* explains this further.

■ R&EW



EXPANSION BUS

The Route to New Features

Philip Anthony kicks off our new series that examines the ever-increasing number of bolt-on goodies available for popular home microcomputers.

Most add-ons for microcomputers are produced by companies other than the original manufacturer of the computer. Why, you may ask, are these so-called PCMs (it stands for Plug Compatible Manufacturer; nothing to do with pulse-code modulation) hoping to succeed in competition with the original manufacturer?

Well, there are two main reasons. Firstly the 'David and Goliath' effect means that small companies can often make relatively small and uncomplicated add-ons more efficiently and therefore at lower prices than their larger cousins. Secondly, and more importantly, computer manufacturers often design-in and publicise the capability for expansion but the hurdle of actually shipping and supporting working units in quantities greater than that required to grace a press conference seems to sap their strength to such an extent that the add-ons are forgotten until well after their fresh and enthusiastic PCM pals have scooped the initial marketplace. This is not, of course, to say that they didn't intend to design and market the add-on, but 'not just now while we're trying to write the version 1.2 ROM and find out why we reject 20% of the gate array chips'!

Anyway, so much for the general theory: now down to a specific example:

Take a Light Pen

The very first *R&EW* (October 1981) contained a look ahead to the BBC micro compiled from the various sources available at that time. On the subject of light pens it said 'At the moment, it is not clear if a light pen input is provided'. A year later we had a model B and there was a light pen input — a pin on one of the rear connectors (LPSTB, pin 9 on SK6). But there was no mention of the feature anywhere in the text of the otherwise comprehensive manual. Indeed, where did the LPSTB connection go inside the machine? Pass the circuit diagram please.....

Whilst wandering around the Acorn User Show in August we saw a light pen add-on being demonstrated by RH Electronics Ltd of Cambridge. It comes in a tidy box 5" x 6" x 1" with a single lead to the SK6 socket on the BBC micro, from which it also draws its power. The pen itself is of a very sturdy construction, incorporating a switch in its tip that signals to the computer that you wish to mark a point and an LED in the base which glows when the pen is close enough to the screen. Another feature of interest is the gain control on the front of the box. This is a preset potentiometer and you really need a special tool to turn it, but once it has been set up for a particular TV or monitor, it should require no further adjustment. A narrow field of view is provided courtesy of the light guide optics within the pen.

We will now attempt to construct a very simple Light Pen program

First of all load in the driver program (CHAIN "END" etc.)
Type NEW and press RETURN.
Type the suggested program in (or load it in from disk or tape, if previously saved).
Add the following lines:

```
1000 MODE 4
1010 INPUT "TRIM"offset$ : ?P_trim=VALoffset$
1020 VDU23; 10,32,0;0;0; 19,1,4,0,0,0,19,128,134,0,0,0,5
```

Line 1000 sets screen = MODE 4

Line 1010 asks for users trim (1,0 or −1 is usually adequate) and then sends the value to the data table.

Line 1020 turns the cursor off, changes foreground to blue and background to cyan, tells the computer to print text at the graphics cursor and stops the screen from scrolling.

```
1040 CALL PEN_INIT
1050 ?P_command=0 : CALL PEN_PROG
```

Line 1040 PEN_INIT is always called before using the Pen and after each MODE change. It is the entry point for cold boot.

Line 1050 sets the command byte to 0 (default) and sends it to the Pen.

```
1070 REPEAT
1080        IF INKEY-2 THEN CLG
1090        CALL PEN_STAT2
1100        IF ?P_latch THEN X%=?P_xpoint*32+15 :
Y%=1007-?P_ypoint*32 : PROC_PRINT
1110        FOR N=0 TO 100 : NEXT N
1120 UNTIL 0
```

This is the main program loop

Line 1070 is the start of the REPEAT UNTIL loop

Line 1080 checks to see if the CTRL key has been pressed, if so, clears the screen.

Line 1090 updates P_latch. If a valid video data pulse was received, i.e. when the switch was pressed, P_latch is set to 1. Otherwise P_latch is reset to 0.

Line 1100 checks to see if P_latch has been set (video data pulse received?) if so, sets X% and Y% to equal the X and Y co-ordinates on the screen (this is done by reading P_xpoint and P_ypoint plus some calculation). The computer is then told to go to PROC_PRINT. Upon return command is transferred to line 1110. See also jump table offsets at the rear of the manual.

5

Line 1110 is a short delay or damper to ensure correct reading of the screen.

Line 1120 terminates the REPEAT UNTIL loop.

```
1140 DEFPROC_PRINT
1150 MOVE X%, Y%
1160 PRINT "RH Electronics (Sales) Ltd"
1170 ENDPROC
```

Line 1140 defines the procedure called – PRINT.

Line 1150 moves the graphics cursor to X%, Y%, i.e. to where the pen is pointing (previously calculated in line 1100).

Line 1160 prints the words "RH Electronics (Sales) Ltd" at the graphics cursor, i.e. to where the pen is pointing.

Line 1170 terminates the procedure called –PRINT and tells the computer to go back to the main program and continue where it left off.

You may like to add lines 1030 1060 and 1130, each followed by a space and return, to aid readability.

Check that the program has been entered correctly and type RUN.
Enter the trim (−1, 0 or 1) and press return.
The background should change to cyan. Point the pen to anywhere on the screen and press gently. The words "RH Electronics (Sales) Ltd" should appear, in blue at the tip of the pen. Repeat this as many times as you like. To clear the screen and start again press the CTRL key.

Try adding:

```
1155 @%=0
```

and change line 1160 to:

```
1160 PRINT X% "," Y%
```

It's a good idea to save all your hard work. To do this just save the program as you would any other BASIC program. Don't forget to chain the driver in before you load it back though.

6

Figure 1.

All the necessary software is provided on a cassette. This includes a set of routines which boot themselves into the machine and allow the user program to make fairly simple CALLs to operate the interface electronics. Utilities within the program invoke clear-screen, pen-up, pen-down, draw-line and erase-line functions. The most impressive application program on the cassette is a point-to-point drawing demonstration which enables the user to display a cartoon made up of straight lines.

The manual gives a comprehensive description of the internal protocols of the software and leads the reader through a simple application (reproduced in part here as *Figure 1*). Although the unit undoubtedly works and a well constructed user program will appear fairly painless to the operator, the 'Magic' to make it all go seems pretty incomprehensible/unreadable, judging from listings of the BASIC programs.

In Operation

How does it all work then? Fundamentally the contents of the box is a fast amplifier which takes a signal from a photo-transistor in the pen and sends a corresponding video strobe pulse to the computer when it sees the TV's raster-scan pass the end of the pen. (This means, of course, that it essentially responds only to illuminated areas of the screen.) Inside the machine one of the chips (the 6845 CRT controller) is busily counting the horizontal and vertical character positions and addressing the various memory locations required to form the complete screen display. When the light-pen pulse arrives, it merely latches the horizontal and vertical counts into two of its lavishly supplied registers. It is then up to the software to read these numbers out and interpret which character position the pen must have been over when the pulse occurred. The maximum definition of the unit is therefore limited to one character position.

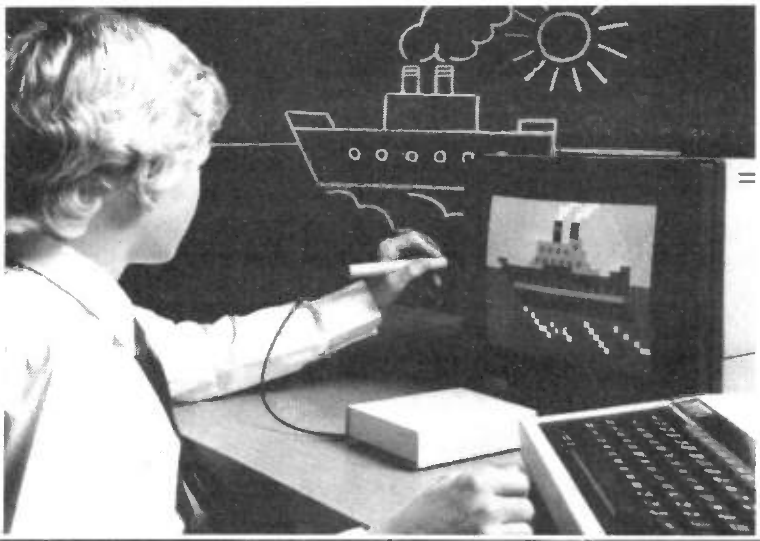
Problems within the hardware design mean that strange values will be latched if the pen pulse occurs at about the time the character count is incrementing. (The chip manufacturer would like you to synchronise the pen pulse with one of the system clocks but the Acorn design doesn't incorporate facilities to do this.) This, together with the inevitable jitter encountered within analogue design, means that the software has to perform an averaging process to decide finally on the pen position.

The unit costs about £50.00 and is dedicated for use on a BBC micro. The software works and it will be better when there is more of it. By the way, if you look inside the box, you will see that you are getting an awful lot of electronics for your money!

■ R&EW

R. H. ELECTRONICS (SALES) LTD. Chesterton Mill, French's Rd, Chesterton, Cambridge. Tel: (0223) 311290

GOODIES FOR THE BBC MICROCOMPUTER



RH Lightpen

The RH lightpen is compact, little bigger than a felt-tip. It is versatile, with a sophisticated microswitch at its point which responds to the slightest pressure, and an LED lamp at the user's end to indicate data transmission. Both microswitch and LED are fully programmable.

The RH lightpen is reliable, with a rugged metal case to provide physical and electronic protection. Its sensitivity can be adjusted to the thickness and type of your TV screen, giving the highest levels of accuracy.

With the lightpen connected to your BBC Micro you can draw lines on the screen, or give commands simply by pointing to a menu.

Colour-Graphic software

This additional software is available so that all the colours of the BBC Micro's palette are available at the tip of your pen. Complex graphics can be created in minutes.

Art-Fun software

This program is guaranteed to bring out the artist in you. It provides inspiration for users of the lightpen and provides full interaction between pen and screen.

Lightpen £45.95 — 40 track disc version of lightpen software £5.95 — Colour-graphic software (tape) £9.95 — Art-fun software (tape) £9.95

RH Software

RH Electronics has a whole series of excellent software for the BBC Microcomputer Model B. For games, business and education, they will be highly valued by any BBC Micro owner.

Plegaron People Eaters **£8.95**
Stop the Plegarons' path of destruction by walling them in. A game of skill (9 levels) and cunning.

Galactic Wipeout **£8.95**
Fight off alien attackers and meteor showers as you transport the survivors of the human race to a new planet.

Ski Slalom **£8.95**
Guide the skier through the 40 gate course avoiding deadly ice and landsliding snowballs.

Viper **£8.95**
Guide the snake around its electric cage devouring as much food as you can. Avoid touching the electrified walls, swallowing unsavoury food or causing the snake to eat its own tail.

3 in 1 (A) **£7.50**
This set of three games for the younger enthusiast includes: Task Force — a strategic battle of sea and air; Demolish — blast your way to freedom avoiding radioactive fall-out and falling masonry as you go; Cosmos — where you have to defend the earth from an invading battle fleet.

Ed-master **£12.95**
This program uses the quiz format combining the element of fun with educational teaching. 160 questions may be programmed by the teacher, divided into eight subject areas of 20 questions each. Questions and answers can be changed as often as you wish. The computer will tell the pupil whether he or she has the correct answer or not, but cheating is prevented as pupils cannot access the program to find out the correct answers. The scores of up to 40 pupils are stored in the quiz memory and easily recalled for comparison.

Snail Trail **£4.95**
Help the snail escape from the maze he's fallen into before he starves to death. There are two skill levels to this cassette.

Database **£12.95**
A cassette for the business or home. It enables you to file, sort and access a great number of items such as diary entries, addresses, telephone numbers, accounts or other information.

AT LAST!! A worthwhile peripheral

R.H. ELECTRONICS (SALES) LTD.
Exclusive Distributors of DCP Microdevelopment products

"These computers are all very well but they can't REALLY do anything can they?"

How many times have you heard that sentence and realised that you are inclined to agree? That's all in the past with these long awaited exciting new products from DCP.

For the BBC Microcomputer:

INTERBEEB

The self-powered INTERBEEB is a rugged new peripheral, housed in a neat thermo-plastic case the INTERBEEB contains the following hardware to allow your computer to control the outside world ... and get an answer WITHOUT having to re-invent the wheel!

1) an 8 bit, 8 channel Analogue to digital convertor (ADC). 2) 4 high current relay outputs. 3) an 8 bit input port and a SEPARATE 8 bit output port. 4) 4 switch inputs. 5) DCP bus connection allows communication with other units in the DCP range.

The unit comes complete with all the necessary cables, a mains power unit and a manual giving examples for beginners, all for **£59.95** + postage and packing.

For the ZX Spectrum or ZX81:

INTERSPEC

The INTERSPEC gives users of Sinclair computers the same facilities for control and interrogation of the outside world as the INTERBEEB and with the advantage of the DCP bus connector, which presents all the necessary bus connections and power lines to the user, upto 4 further packs may be added allowing (for instance) proportional control of analogue driven equipment.

The INTERSPEC comes complete with a comprehensive manual including examples of use and hints for ZX81 users. Control of your environment can be yours for only **£39.95** + post & packing.

DAC PACK

The DAC PACK (Digital to Analogue Convertor) will give your computer, for the first time, the capability to communicate with the outside world in its own language. The DAC PACK features a 2.55 volt internal reference voltage for rock-steady output and a step resolution of 10mV in 255 levels and high quality connectors for reliable operation. The DAC PACK connects to the DCP bus and therefore requires that either the INTERSPEC or INTERBEEB be present.

As with all other DCP products the DAC PACK comes complete with a comprehensive manual and costs **£19.95** + post & packing.

AD PACK

The AD PACK (Analogue to Digital Convertor) is easy to both use and understand and consists of a fast A to D convertor with an internal precision voltage reference source for accurate conversions. The input voltage swing is 0 to 2.55V with a tolerance allowable of ±5%, therefore giving a 10mV input resolution. The AD PACK is connected using the DCP bus and will therefore require either the INTERSPEC or INTERBEEB to be connected to the host computer.

The AD PACK comes with a manual which includes examples of operation and costs **£19.95** + postage & packing.

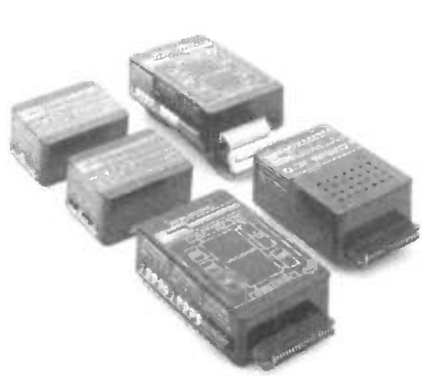
S-PACK

The Speech Pack is a completely self-contained add-on speech synthesiser for the ZX81 or Spectrum Computers which may be used in addition to a ZX RAM PACK, DCP PACK and/or ZX printer. The S-PACK is supplied complete with Word Pack ROM 1 which contains all the letters of the alphabet, numbers 0 to over a million and some other general words which can all be 'spoken' under computer control. Up to three more Word Pack ROM's can be fitted to expand the vocabulary, details of which are available on request. The 2 versions of the speech pack for the ZX81 and Spectrum operate in similar manners but are NOT interchangeable, therefore the type of host computer should be specified when ordering.

The S-PACK comes complete with an operating manual and is available for **£59.95** plus postage & packing.

Word Packs 2, 3 and 4 are **£14.95** + postage & packing.

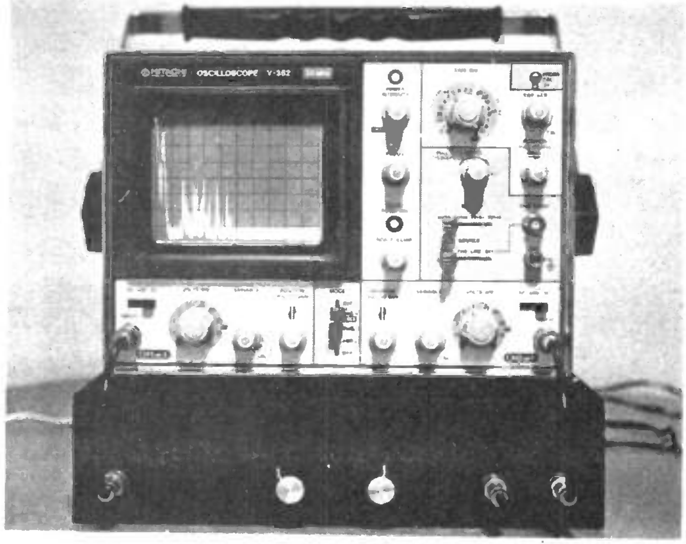
Dealer and Quantity enquiries welcome. For further information regarding the above range please contact **RH Electronics (Sales) Ltd.**



Make cheque or PO payable to **RH Electronics (Sales) Ltd.** allowing 28 days for delivery. All prices include VAT and p&p

Send or telephone your order to: **RH Electronics (Sales) Ltd., Chesterton Mill, French's Rd, Cambridge CB4 3NP. Tel: (0223) 311290**

Poor Man's Spectrum Analyser Part I



Our thanks to Wayne Green's '73' magazine for this gem of a feature, based on an article written in 1982 by Frank Perkins, WB5IPM.

Radio amateurs enjoy making all types of electrical measurements. In fact, it's one of their favourite pastimes and topics of conversation. Fortunately, good, low-cost oscilloscopes, DVMs, and other instruments are available for measuring voltage, current, power, SWR, frequency, and so on.

There is one instrument, however, that has been beyond the reach of most our budgets–the spectrum analyser. Commercial versions of this useful RF instrument (*see Photo 1*) start at £4000, which is a little steep for a hobby pursuit. It is possible for you to build a simple spectrum analyser for about £100 that works with a low-cost oscilloscope. Its use, theory of operation, and construction are discussed in this article.

Spectrum Analyser Operation

A spectrum analyser is a receiver that allows you to view the frequency components of its input signal on an oscilloscope CRT. It operates in the frequency domain, as opposed to the time domain of the oscilloscope. The spectrum analyser repeatedly tunes across the frequency band you have chosen with its centre-frequency and frequency-span controls. For example, if you set the centre-frequency control for 20MHz and adjust the frequency-span control for a tuning range from 10MHz below to 10MHz above the centre frequency, the analyser will repeatedly tune the 10MHz–30MHz band.

Photo 1: A commercial spectrum analyser — the Tektronix 492.

As the analyser tunes from the low end to the high end of the band, it moves the CRT trace from left to right. The *S*-meter output from the analyser moves the CRT trace up from the bottom of the CRT screen according to signal strength. There usually appears to be some 'grass' along the bottom of the CRT display. This is due to system noise.

To appreciate how useful a spectrum analyser can be, let's first look at *Photo 2*, an RF signal on a normal oscilloscope. It looks like a clean sine wave. What do you think?

Now look at *Photo 3* – the same RF signal on our spectrum analyser. The half-spike on the left is our zero-frequency reference: unless the mixer in the analyser is a perfectly balanced DBM, zero frequency will always appear as a 'signal' in the passband. The next signal to the right, which is the tallest, is the fundamental component of our RF signal. The three signals to the right of the fundamental are the 2nd, 3rd, and 4th harmonics.

To understand what's wrong,

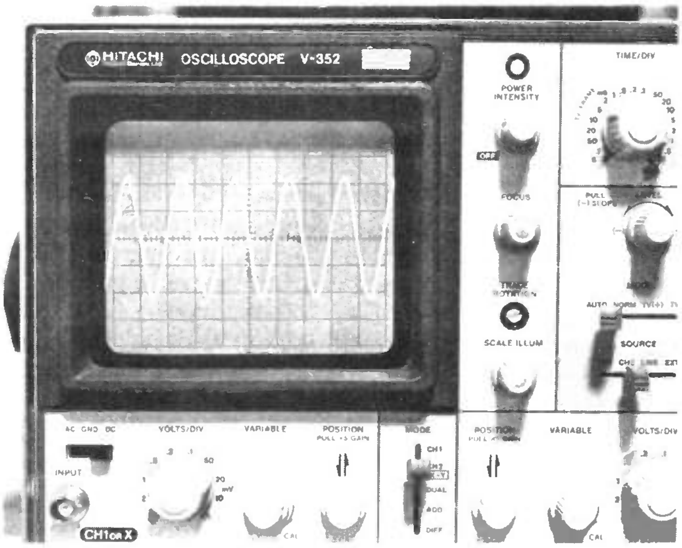


Photo 2: RF signal on an ordinary oscilloscope. Is this a clean signal?

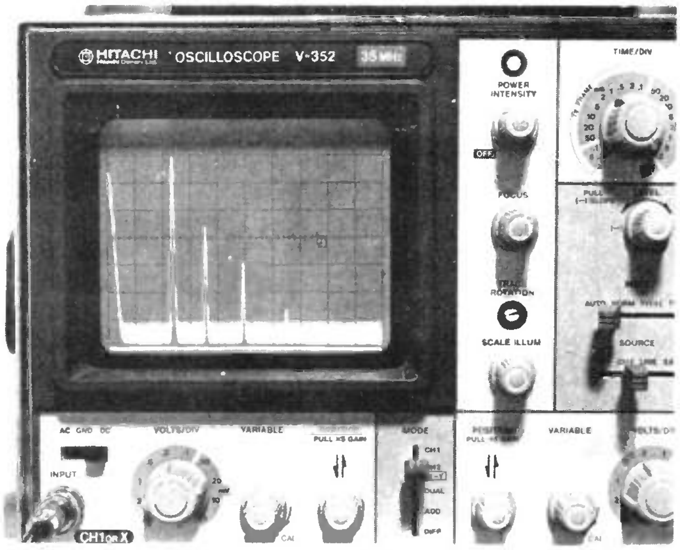


Photo 3: The same RF signal on our spectrum analyser.

compare the height of the 2nd harmonic signal to the fundamental. The second harmonic is about 2.6 CRT divisions shorter than the fundamental. With a 10dB-per-division vertical calibration, the second harmonic is 26dB below the fundamental.

We can correct the problem by adding a filter between our transceiver or linear and the antenna. However, unless we are able to check the output spectrum of our transmitting equipment, we may never know we have a problem – until our neighbours start complaining or we get a 'friendly advisor' from the local HO monitoring station.

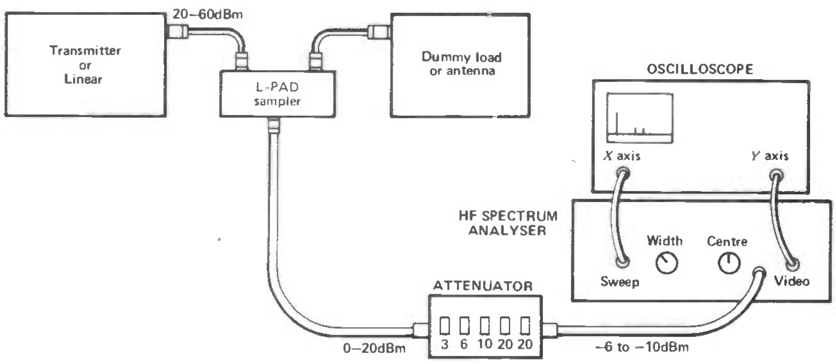


Figure 1: Typical HF spectrum analyser hookup. Always check that transmitter, linear, L-pad, attenuator, analyser and scope are grounded.

Spectrum Analyser Hookup

Figure 1 shows how to hook up a high frequency spectrum analyser for monitoring the output spectrum of a transmitter or linear amplifier. Remember, the analyser is a receiver. It requires a very small sample of power for operation and this is done with a L-pad sampler. The sampler will not interfere with normal transmitting or transceiving operation. The output from the L-pad is further reduced with a step attenuator to match the full-scale input power requirements of the analyser (1/4 to 1/10 of a milliwatt). The spectrum is displayed on the oscilloscope being used with the spectrum analyser.

Double-check your hookup before applying power. If the output of a transmitter were directly connected to the analyser by accident, it would instantly be damaged when the transmitter was powered up.

Overall Circuit Operation

Let's first discuss *Figure 2*, the spectrum analyser block diagram. We will then look at the circuits in each block in detail. Notice that the analyser block diagram looks similar to that of a single-conversion superheterodyne receiver (you can put an earpiece on the detector output of a spectrum analyser and listen to AM signals in zero span mode). The IF frequency of the spectrum analyser is 90MHz.

The sampled input signal from the L-pad is adjusted to the proper power level with the step attenuator, as we discussed before. The signal is then taken through a low-pass filter with a 60MHz cut-off frequency. The low-pass filter prevents 90MHz signals from leaking into the analyser and 'confusing' it. The input is next mixed with the 90–150MHz voltage controlled oscillator (VCO) in the double-balanced mixer. The difference output from the mixer, which is the desired IF signal, is then filtered by the 90MHz bandpass filter. The bandpass filter provides the necessary selectivity for the spectrum analyser. The 90MHz signal from the bandpass filter is pre-amplified and applied to the log amplifier. The output from the log amplifier is logarithmic signal strength video for the oscilloscope vertical (*Y*) axis.

The voltage controlled oscillator frequency is controlled by the sweep generator, which simultaneously ▶

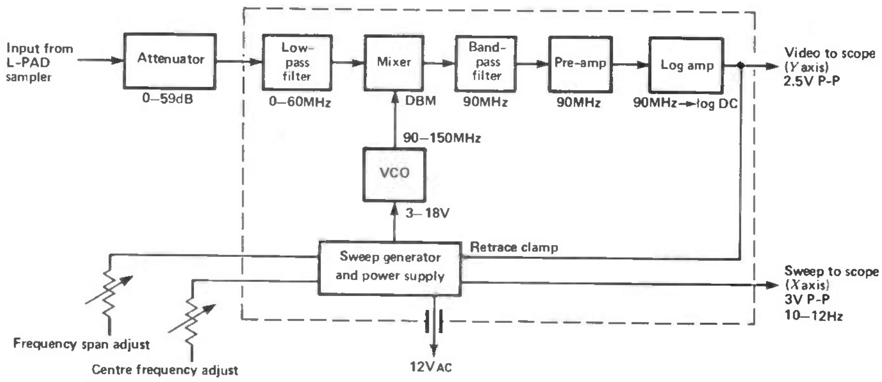


Figure 2: Block diagram.

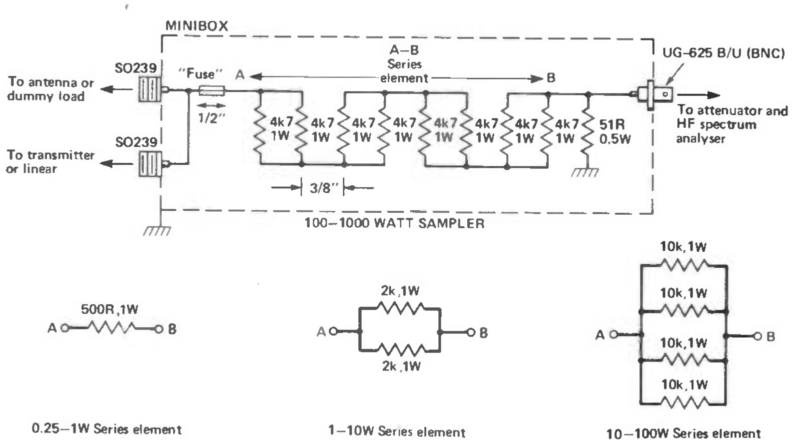


Figure 3: L-pad sampler. Always test run the sampler before connecting it to the attenuator.

controls the horizontal (or *X* axis) of the oscilloscope. Note that when the VCO is tuned to 90MHz, the analyser is tuned to zero (MHz). When the VCO is tuned to 120MHz, the analyser is tuned to 30MHz. And with the VCO at 150MHz, the analyser is tuned to 60MHz.

The tuning range of the analyser is adjusted with the centre-frequency and frequency-span control on the sweep generator. The sweep generator automatically tunes the analyser across its tuning range about 10 times each second. The sweep generator clamps or 'shorts out' the video during the retrace between each sweep to avoid a confusing oscilloscope display. This eliminates the need for an oscilloscope with a *Z*-axis (blanking) input. The power supply provides +24VDC, +12VDC, and −6VDC for the spectrum analyser circuitry. The power supply operates from 12VAC supplied by a wallplug transformer.

L-Pad

Figure 3 shows the circuit diagram of a 100−1000W L-pad sampler, with alternative circuitry for a 10−100W sampler, a 1−10W sampler, and a 0.25−1W sampler. Four pairs of 4.7k, 1W resistors form the series element of the 100−1000W sampler. A 50Ω, 0.5W resistor forms the shunt element. The L-pad resistors are rated for continuous operation.

0−59dB Step Attenuator

Figure 4 shows the step attenuator circuitry. Five pi-style resistive attenuators are switched in or out as necessary to achieve the proper attenuation. The switches are double-pole, double-throw. Resistors may be 0.5W or 0.25W, although 0.25W resistors are easier to work with. Note the shielding between sections. Resistors must have 5% tolerance.

Low-Pass Filter, Mixer and VCO

Figure 5 shows the details of these circuits. The low-pass filter consists of three pi-sections, separated by shielding. The cut-off frequency of the filter is about 60MHz. Three sections are used to give a high attenuation at the 90MHz IF frequency and above.

Each port of the double-balanced mixer is padded with 50Ω attenuators to encourage good mixer performance (low mixer spurs) at the expense of extra conversion loss. 'Mini-circuits' SRA-1 and SBL-1 are good commercial mixers. It is possible to build a suitable double-balanced mixer from small ferrite toroids and hot carrier diodes, if you seek an alternative.

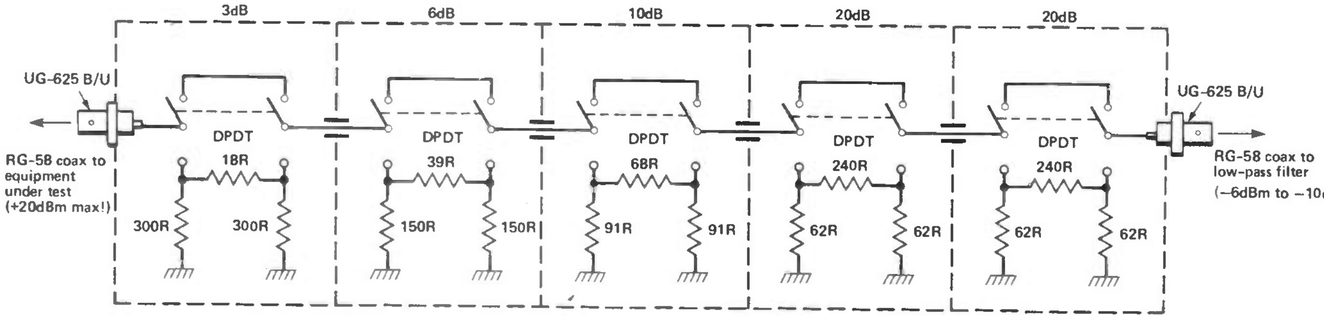


Figure 4: 0—59dB step attenuator.

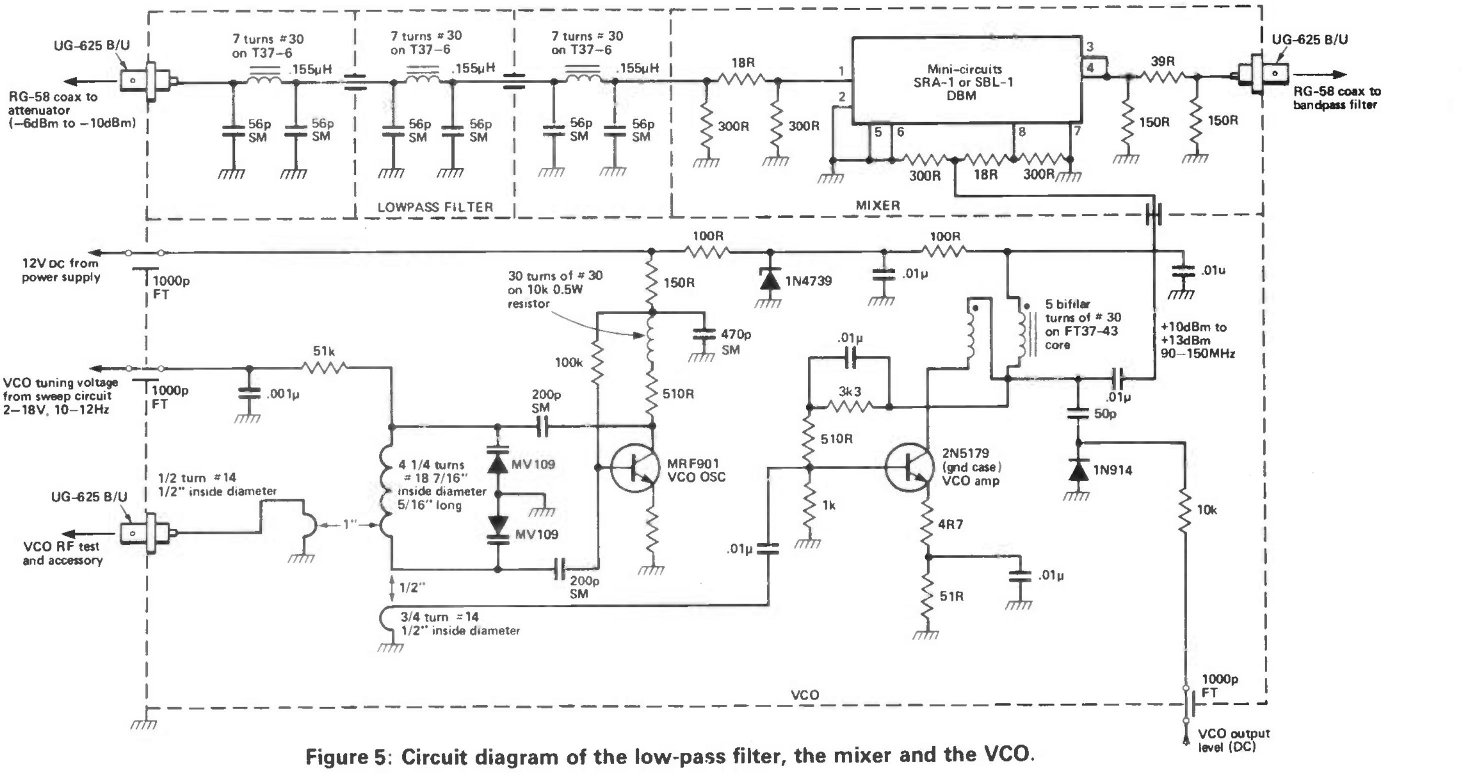


Figure 5: Circuit diagram of the low-pass filter, the mixer and the VCO.

The VCO consists of an MRF901 Colpitts oscillator (a *BF240* would be an adequate European substitute) coupled to a wideband 2N5179 (*BFR91*) amplifier. The MRF901 was ultimately chosen for the oscillator transistor because of its well-behaved phase-shift characteristics between 90MHz and 150MHz. The two MV109 (*TOKO KV1210*) hyper-abrupt Epicap diodes act as tuning capacitors and account for the oscillator's wide tuning range.

A small pick-up loop near the oscillator coil provides an output for checking frequency and doing other tests. The oscillator is also lightly coupled to the 2N5179 VCO amplifier. The output of this amplifier drives the local oscillator port of the mixer. A diode-capacitor RF detector provides a DC output for checking the amplifier output power. The wideband amplifier design is based on the data from Reference 1. The oscillator design is based on third-attempt desperation! Note the use of the feedthrough capacitors and shielding. These are as much a part of the circuit as the oscillator transistor!

Bandpass Filter

The bandpass filter is displayed in *Figure 6*. It consists of four relatively small helical resonators. The input and output resonators are tap-coupled to the input and output connectors. The four resonators are aperture-coupled to each other. The two centre resonators are slightly stagger-tuned to give the filter bandpass a sharp 'noise'. The 3dB bandwidth of the filter is about 220kHz. Insertion loss is somewhat high, but is acceptable for this application.

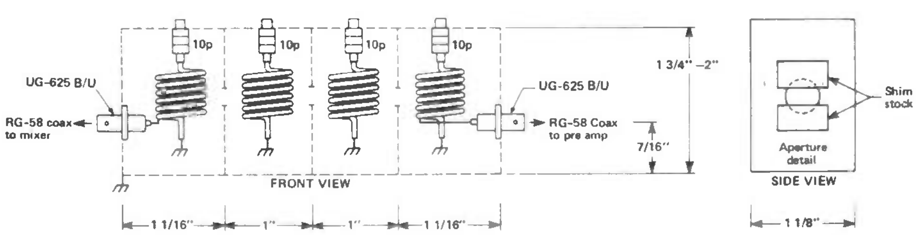


Figure 6: Bandpass filter. NB: Mount the BNC connectors near to the front.

Pre-amplifier and Log Amplifier

The circuit diagrams of the pre-amplifier and log amplifer are shown in *Figure 7*. The pre-amplifier consists of two wideband 2N5179 amplifiers. The log amplifier consists of six tuned 90MHz IF stages. Each stage uses the friendly 40673/*3SK51* dual-gate FET. The input stage acts as a buffer amplifier. The next five stages form the logarithmic signal-strength video detector. The log amplifier may remind you of an IF strip in a FM receiver. In fact, it uses the limiter principle in its operation.

Notice that each stage in the log amplifier has an RF detector across its output consisting of a 50pF capacitor, a 1N914/1N4148 diode, and a 10k resistor. The RF detector on the buffer stage is just a tuning aid. The outputs of the RF detectors on the 1st–5th log amp stages are tied to a common 1k resistor (in parallel with a 150pF capacitor). Because of its relatively low value, the detector outputs are more or less summed across the 1k resistor.

A small input signal is amplified by all five log amp stages. Only the 5th stage will develop enough signal to provide an output from its detector. As the input signal is made larger, ▶

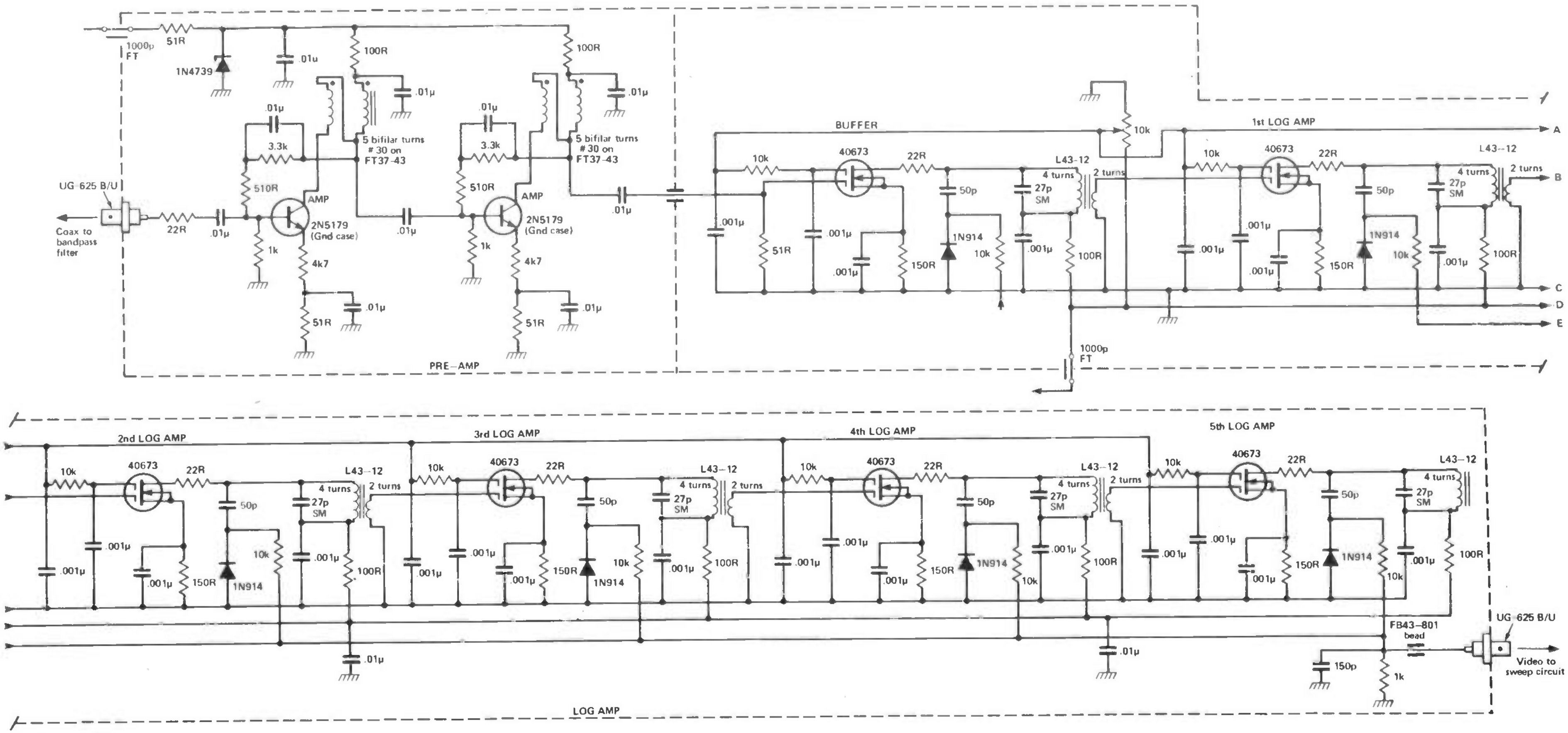


Figure 7: Circuitry of the pre-amp and the log amp.

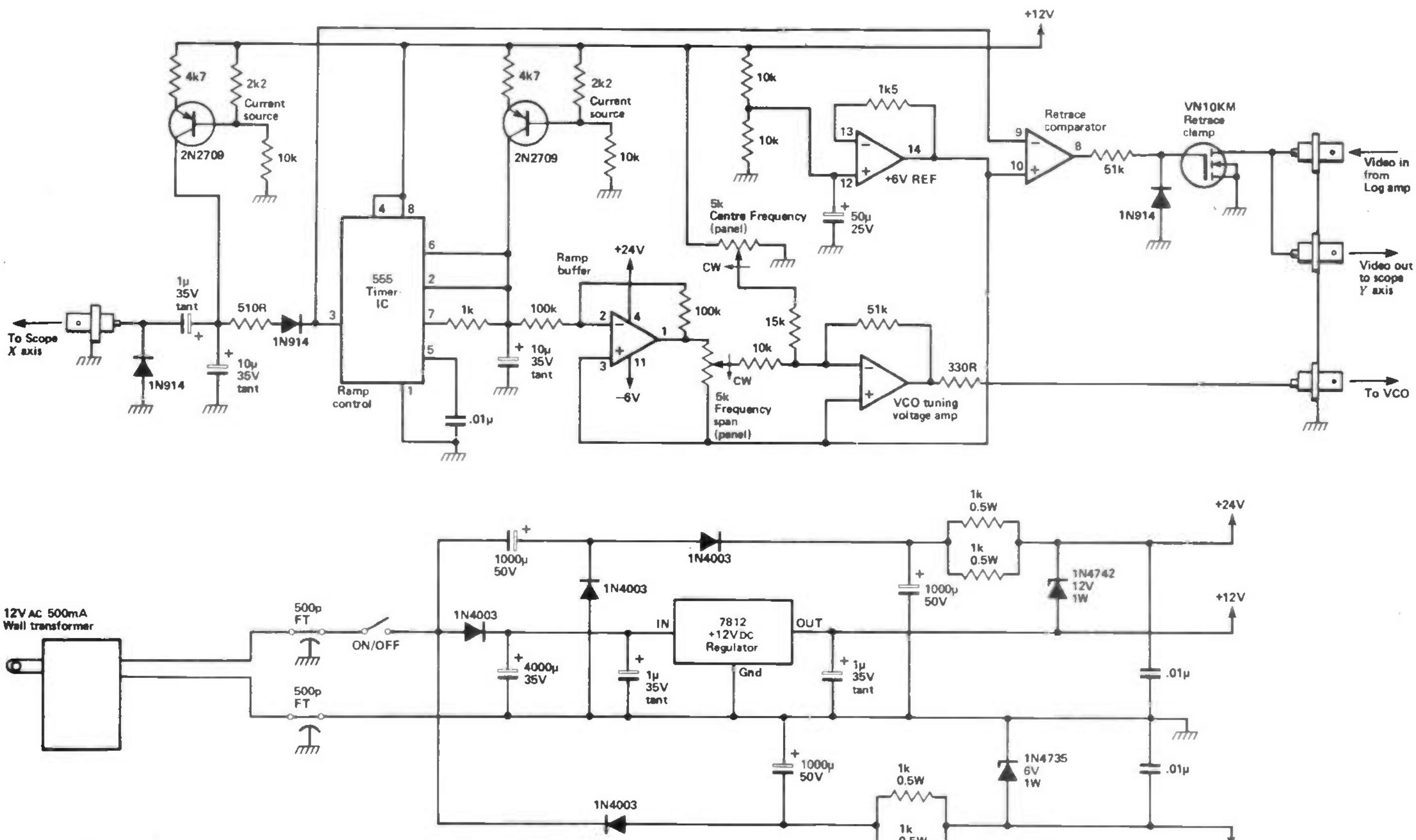


Figure 8: Power supply and sweep circuits.

the 4th stage detector also will begin contributing to the output. As the output is made still larger, the 5th stage will saturate or limit. From this point it will contribute no additional voltage across the 1k output resistor. At about this same signal level, the 3rd log amp stage will begin to contribute some output, and so on. Each log amp stage provides a gain of about 12dB until it saturates. The gain of the IF strip, from the 1k resistors point of view, then drops 12dB. It is this successive limiting and dropping off of IF stages that creates the logarithmic video output characteristic. Note that when the 1st log amp stage saturates, the log amplifier reaches its full scale output.

The author was surprised how accurately the logarithmic amplifier does track a logarithmic curve. Using my commercial step attenuator as a reference, the calibration of my logarithmic amplifier was within 1dB. The sensitive IF system must be shielded to prevent interference from commercial FM stations.

Power Supply and Sweep Generator Circuits

These circuits are shown in *Figure 8*. The power supply is straightforward, providing +12VDC, +24VDC, and −6VDC. Note the feedthrough capacitors used to filter out any RF picked up by the 12VAC power leads.

The heart of the sweep generator is the 555 IC timer. The two 2N2907s act as current sources. Each generates linear amp voltages across 10μF tantalum capacitors. The 555 synchronises the ramps. The ramps are set at a 10Hz−12Hz repetition rate. One ramp is fed through a DC-restoring capacitor−diode clamp to the output connector for the oscilloscope horizontal (*X*) axis. The second ramp is fed to the 5k frequency-span potentiometer through an inverting operational amplifier buffer. The output from the frequency-span pot is summed with the output of the 5k centre-frequency pot in the VCO-tuning voltage amplifier. The output of this amplifier is fed to the VCO-tuning voltage input.

When the ramps are reset by the 555, pin 3 of the 555 also trips the retrace VMOS clamp transistor through the retrace comparator amplifier. This shorts the logarithmic amplifier video output to ground during retrace. Otherwise, the video is fed to the output connector for the oscilloscope vertical (*Y*) axis. The 4th amplifier in the TL084C quad-operational-amplifier IC is used simply as a 6VDC reference by the other three amplifiers.

Shielded Enclosure Construction

All circuits in the high frequency spectrum analyser except the sweep generator and the power supply must be installed in shielded enclosures. The author built each enclosure for his analyser using 1/16-inch, G-10 epoxy circuit board stock. Enclosure base plates are made from single-sided or double-sided stock. Double-sided stock must be used for the enclosure sides, ends and partitions. (See *Figure 9* for construction details.)

Note the brass 'cap strips'. These provide a base for soldering on the thin copper (shim stock) enclosure tops. The author used this method for mounting the tops so that they can be peeled back easily when he needs to modify or repair circuitry. Use a 40W soldering iron to solder the enclosures together. Solder the tops on with a 25W iron. Be sure the solder seams have no gaps.

The original analyser used quite a ▶

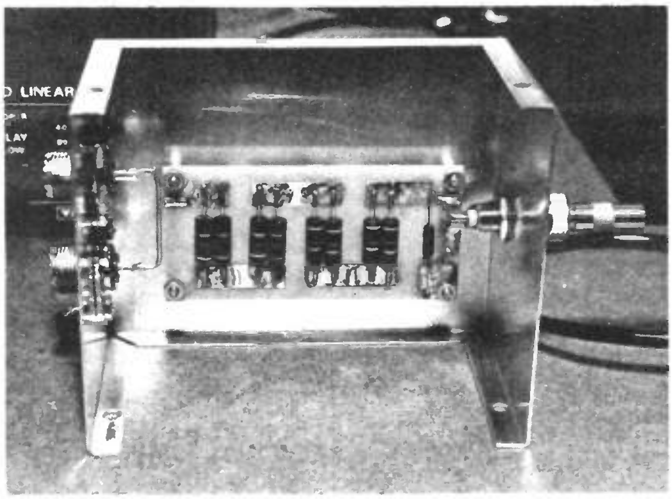


Photo 4: The L-pad sampler.

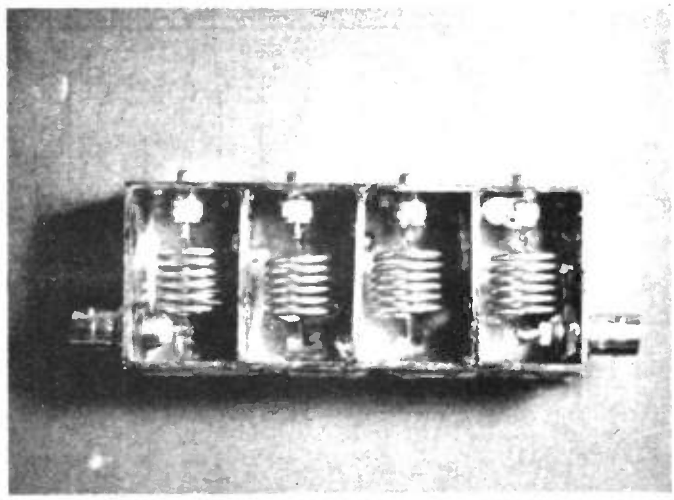


Photo 5: The bandpass filter.

few BNC connectors. The number of connectors can be reduced by building the low-pass filter, mixer, and VCO enclosures together on one base plate. Look at the circuit diagram (*Figure 5*) for shield partitioning details. Likewise, the pre-amplifier and log amplifier enclosures can be built together (*Figure 7*). The bandpass filter should be built by itself, as should the attenuator. This arrangement allows the analyser to be tuned up with very little test equipment.

Circuit Board Layout and Construction

There are a lot of possible component substitutions for the spectrum analyser which make having a standard circuit board impractical. It is easy to lay out your circuitry for construction on a single-sided circuit board. The top (copper) side acts as a ground plane and helps stabilise the circuitry. All analyser circuitry constructed in this manner was built on 1.8-inch-wide circuit board strips – lengths as needed. The lowpass filter, bandpass filter and attenuator are built 'in the air' inside their shielded enclosures.

The VCO circuit is built totally on top of the circuit board ground plane so that leads can be very short. Follow the layout in the photo carefully. The VCO amplifier is built in the normal way.

The author used brass tubes (bought at a hobby shop) for coil-winding mandrels. Where wiring goes through a partition, use a 1/8-inch hole drilled in the partition wall.

After you have double-checked your wiring; install the circuit boards in their shielded enclosures. Tack-solder the ground plane of the circuit to one side of the enclosure. Do not install the tops of the enclosures yet – we have testing to do!

Because of the power involved, build the L-pad sampler carefully. The circuit board used to mount the resistors has no copper on either side except at the corner on the far side of the SO-239 connectors. This small piece of ground plane is covered with masking tape before the copper is etched with ferric chloride. The 51Ω resistor is grounded here. A ground wire is then taken from here to a lug at the BNC connector (make the lug from copper shim stock).

Mount the board using 4-40×3/4-inch screws. Use 5/16-inch diameter×1/2-inch-long aluminium tubing slipped over each 4-40 screw to stand the circuit board off. Be sure the resistor pairs are separated from each other by 3/8 of an inch. The physical layout of the resistors should look like the diagram in *Figure 3*.

■ R&EW

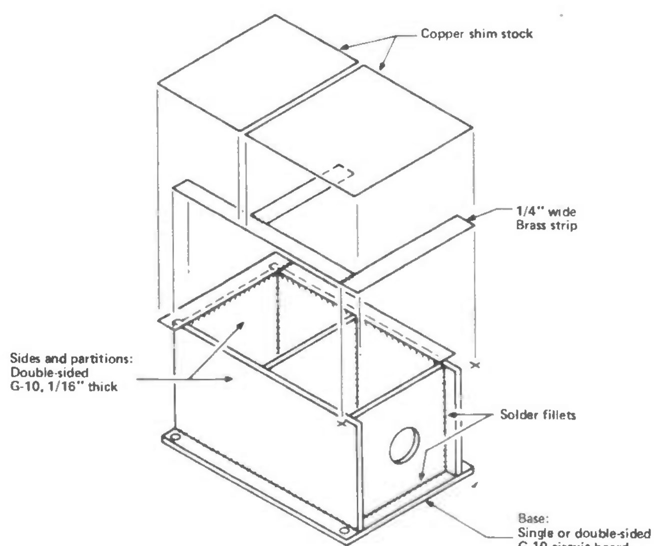


Figure 9: Details of shielded box construction.

References

1. West Hayward and Doug DeMaw *Solid State Design for the Radio Amateur* (ARRL Publications).
2. *Hewlett-Packard Electronic Instruments and Systems* (Hewlett-Packard, Palo Alto, California) 1981.
3. Wayne Ryder "High Performance Spectrum Analyser" *Ham Radio*, June 1977
4. Clyde F Coombs *Printed Circuits Handbook* 2nd Edition (McGraw-Hill).

NEXT MONTH: Details on how to test, tune and tweak this spectrum analyser.

The Wideband FM Stereo Tuner Module — Part II

The assembly of the 7256 tunerset, the principles of which were discussed by William Poel and Derek Frost in the September issue

Assembly is quite straightforward with the orientation of all components clearly indicated on the overlay diagram (*Figure 1*). The PCB patterns for the top and bottom screen are illustrated in *Figure 2*.

A close examination of the layout diagram will reveal that there are some components connected to both top and bottom planes. There are also a number of pins connecting the two planes together, including a number under the tunerhead unit. These links and top soldered components should be inserted and soldered first since the completed board is heavily populated, making late connections to the board top plane difficult without a fine soldering iron and a steady hand.

Keep all component leads as short as possible without risking damage or strain and remember to avoid unwanted earth connections that arise when components are pulled too tightly onto the top plane of a PCB when the earth runs underneath. The end caps of many types of resistor offer inadequate resistance to the heat of soldering if placed under strain in these circumstances.

Front End Considerations

The tuner front end is supplied as an ALPS standard FD618 with a 0–20V tuning bias, tested and aligned, and may be inserted and used as supplied. If, however, the unit is required for use with a synthesiser control unit, then it will not be satisfactory in its standard form since most synthesiser systems limit the maximum tuning voltage available to 8V which will only allow the varicaps to tune up to about 90MHz.

There are two possible solutions to this problem and the one chosen will depend mainly on available equipment and experience for the following reason. Solution 1 – and the one which is preferable – is to change the six varicap diodes in the front end for 8V tuning types i.e. TOKO KV1310's. This, unfortunately, is also the more difficult solution since it requires complete re-tuning and alignment of the front end, which entails at the very least the use of a high quality VHF generator with an accurate attenuator, and an oscilloscope (preferably) with a 30MHz bandwidth.

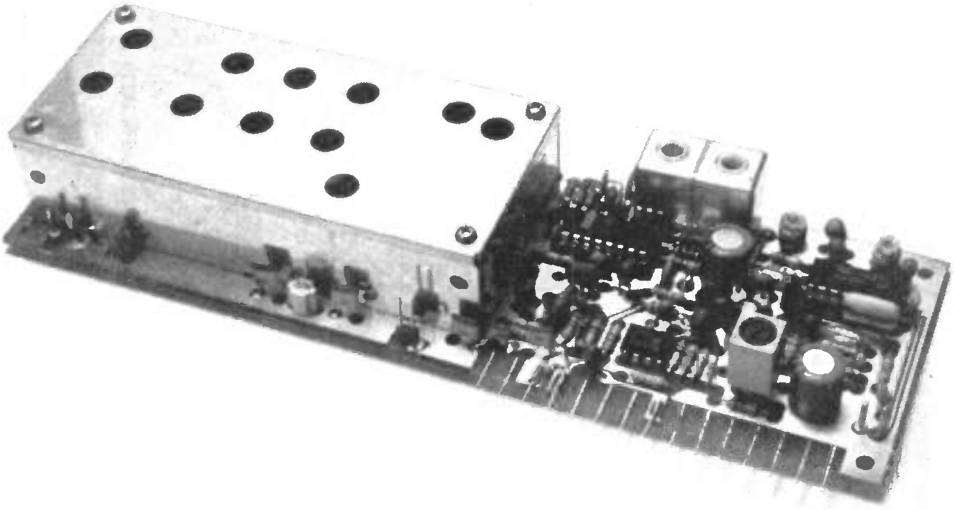
If this type of test equipment is not available, it would be better to use the standard front end with a low drift op amp in the tuning line (i.e. a CA3130) configured as an integrating filter (*Figure 3*). This converts the input from the phase detector into a tuning voltage of 1–18V.

If this tunerset is to be used with a Larsholt 6095 synthesised tuner, the integrator will have to be built on a small PCB mounted piggy-back fashion over pins 1&2 on the tunerset (i.e. V_T and V_S).

Constructional Notes

Constructors will notice that unlike the original 7255 tunerset (see *R&EW* October '82 p49, November '82 p35), we have not included de-emphasis components on the 7256 tunerset since the popular view is now that it is a better solution to include them in the feedback loops of the muting pre-amplifier IC. Owners of 7255 modules may replace the existing de-emphasis capacitors (100nF) with 100pF polystyrene and insert 4n7 mylar or similar types in the optional position on the Larsholt 8823 pre-amplifier module.

Alignment and testing of the tunerset can be approached in



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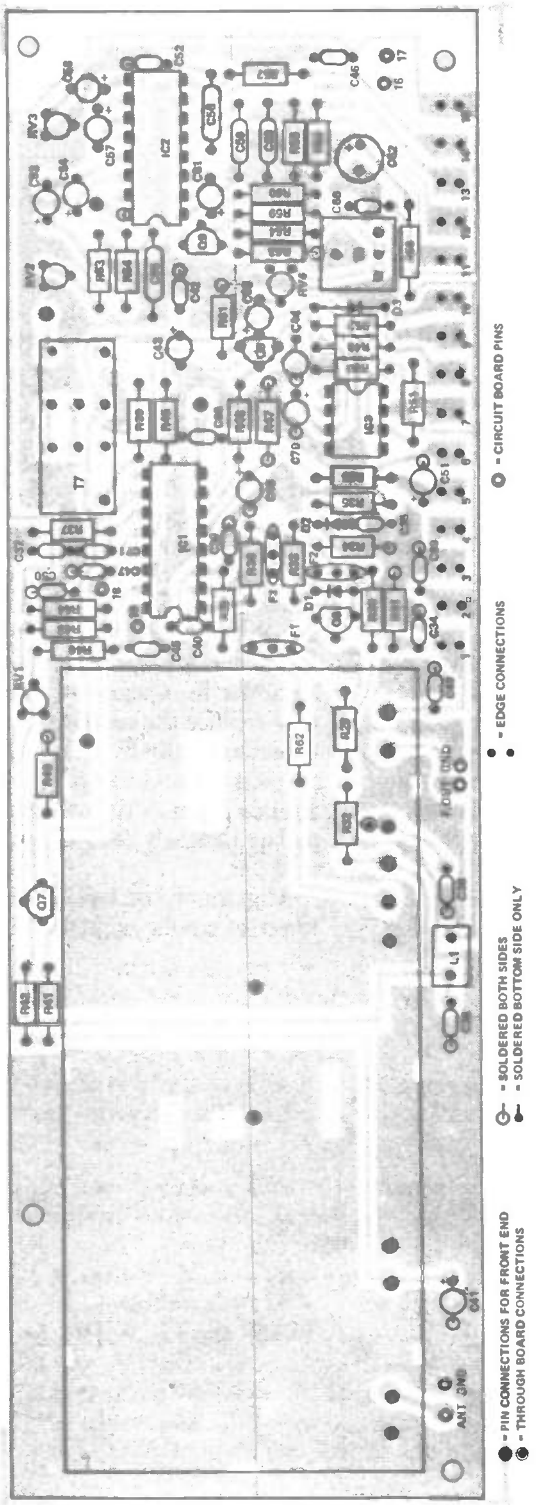


Figure 1: Component overlay for the 7256 tunerset.

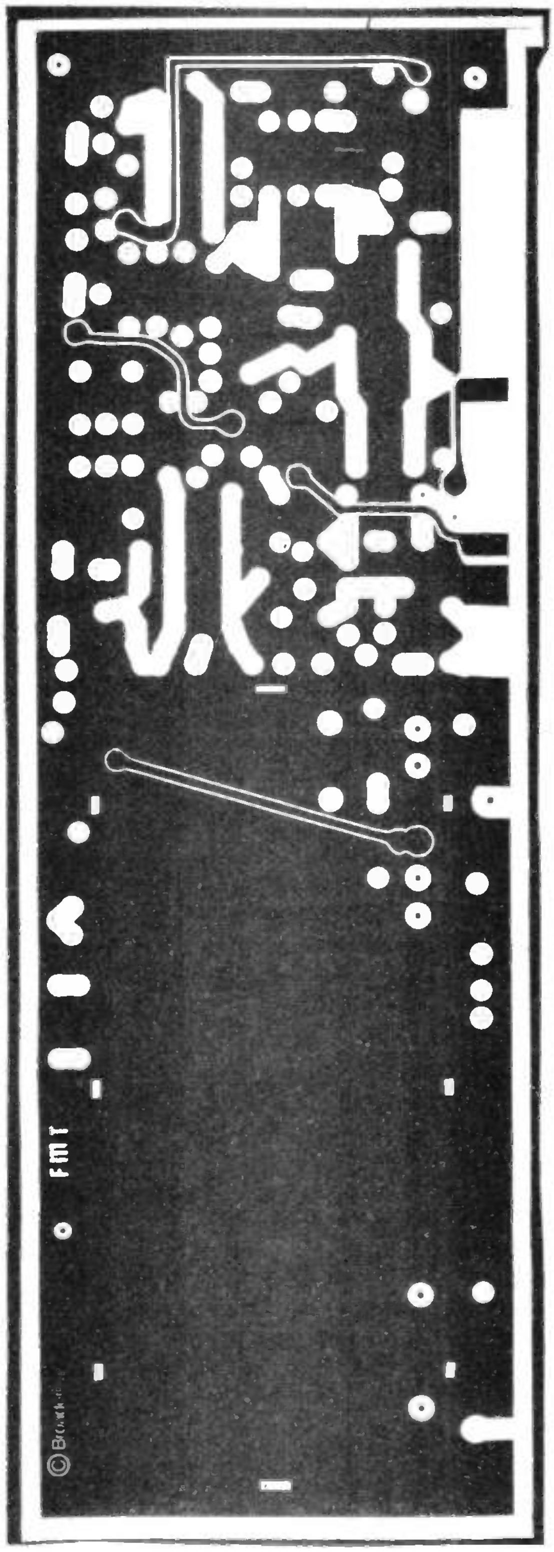


Figure 2a: PCB pattern for the top screen.

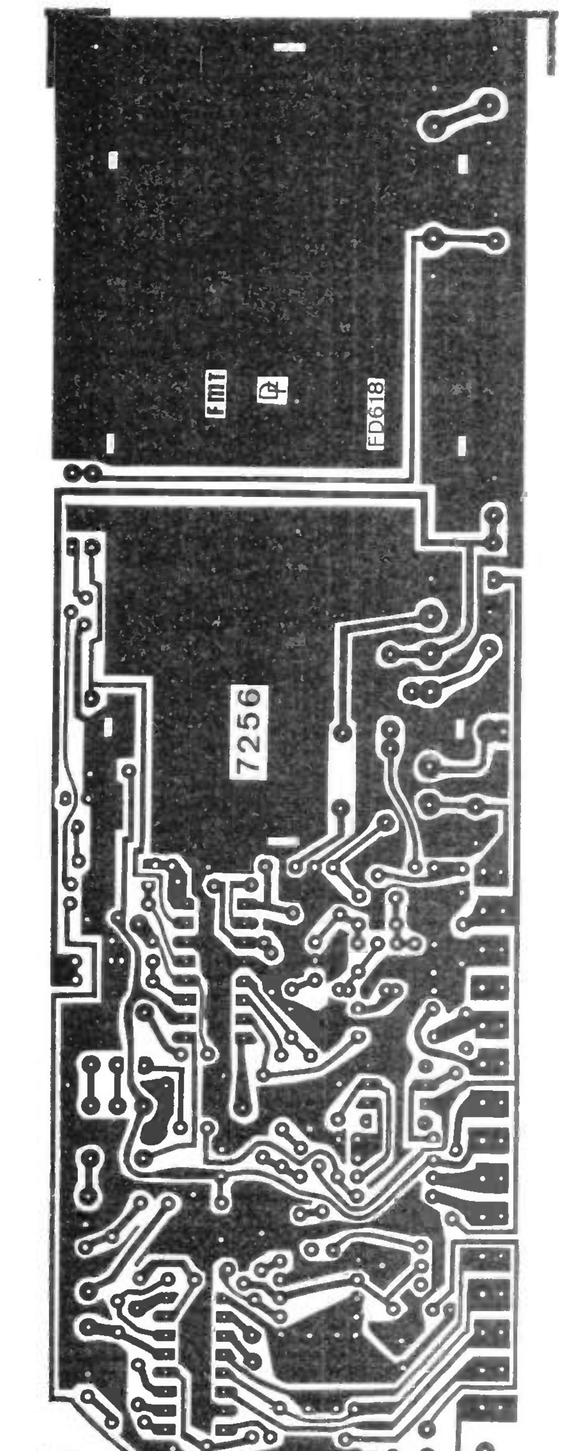


Figure 2b: PCB pattern for the underside.

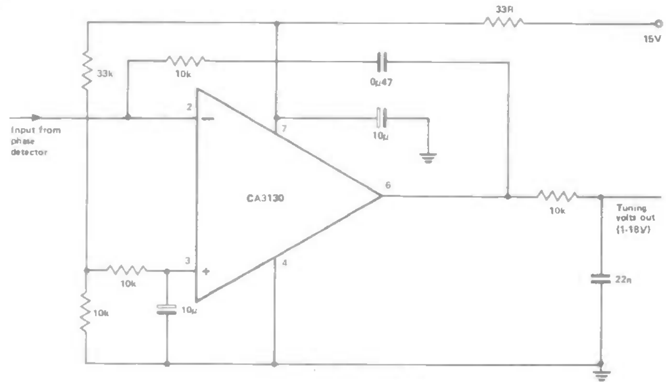


Figure 3: The CA3130 op-amp configured as an integrating filter.

two ways: the easy way and the hard way. The easy way is to nip along to the company's R&D facility and borrow some time on the spectrum analysers there – in which case you won't need instruction here on their use. The hard way is the one which many an FM tuner constructor has tried to apply: that one involves using basic instrumentation and luck!

With all the parts in position, and the module connected as shown in *Figure 4*, the first objective is to get some noise at the audio output. In initial setting-up, *any* noise is better than no noise.

With the AFC and mute 'off', and if you are moderately careful in your constructional projects, there's a 50/50 chance you will be able to hear the characteristic blank 'hiss' of FM interstation noise. If you are lucky, then tuning the tuning voltage between about 3 and 8V will actually bring in signals from FM broadcast stations.

Basic alignment is very simple once you have reached this stage, since the pre-aligned tuner and IF stages should mean that the only adjustments called for are those of the detector assembly. It is possible to achieve reasonable distortion performance with only a multimeter by following the process outlined below (using the wideband IF filters):

1. Tune to a known local FM station – say Radio 2 on 89.1MHz – and monitor the voltage on the signal strength output (pin 15 on the tunerset terminations). Also monitor the centre zero tuning output (across pins 5 and 8, with 4k7 in parallel).
2. Tune for maximum signal strength, then adjust the detector coil primary (the half without the damping resistor connected) for zero voltage on the centre zero monitor. (It doesn't have to be a true centre zero meter; an ordinary voltmeter will suffice.)
3. Check that the mute drive voltage at pin 10 drops to zero as the tuning approaches the centre zero point, thus verifying the operation of the de-tuning muting function.
4. With the mute circuitry enabled, the threshold of muting can be set by adjusting RV1 (on pin 16 of IC1). It should be set so that the mute operates on the weakest signal level you are interested in receiving. ▶

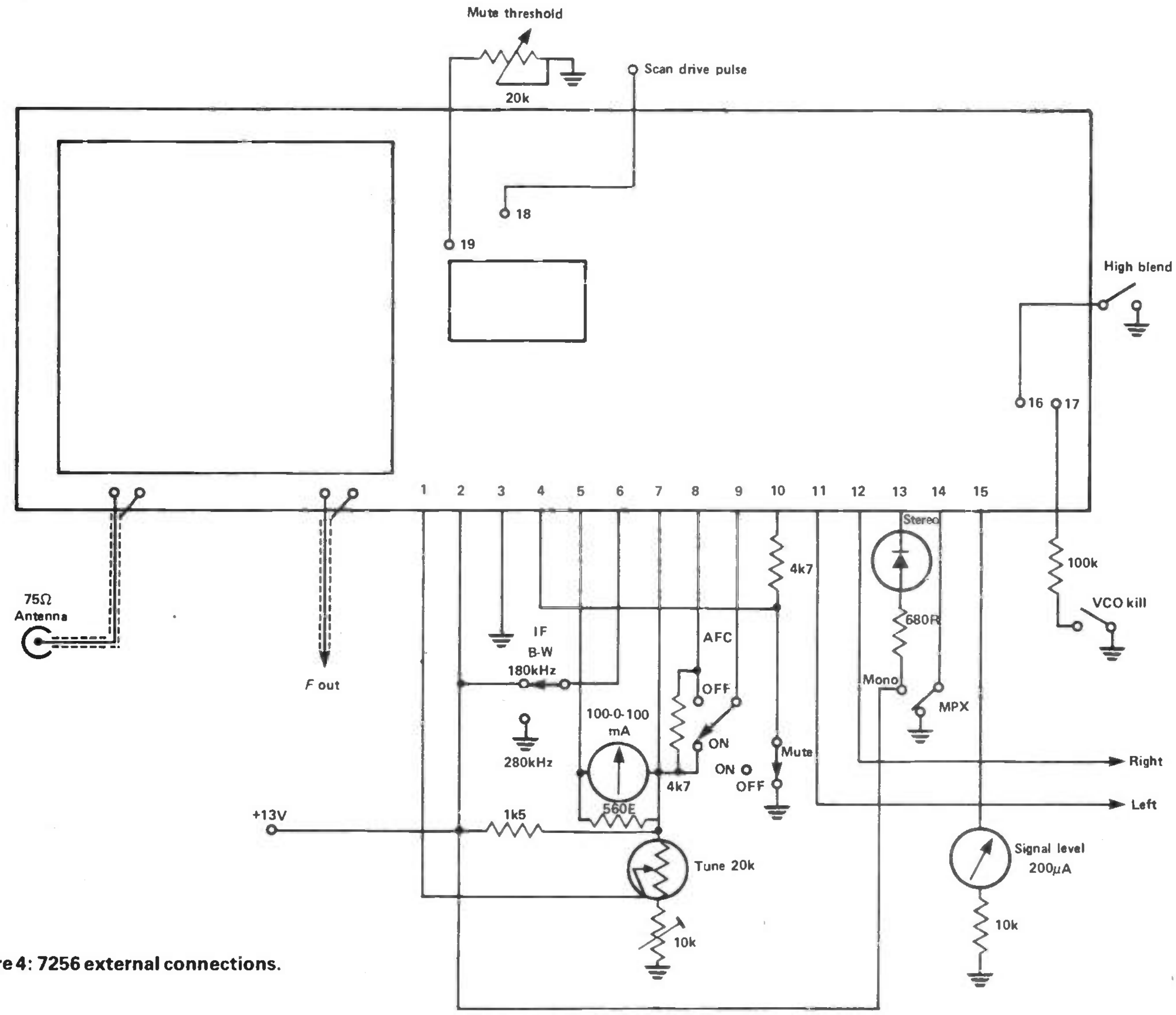


Figure 4: 7256 external connections.

Maximum resistance corresponds to most sensitive mute operation.

5. The VCO in the stereo decoder is set by simply tuning to a known stereo transmission, and adjusting RV2 until the LED lights. If it doesn't, then make sure you've connected the LED the right way round before looking for anything more subtle.

6. The 19kHz pilot cancel facility can easily be tuned with an oscilloscope. The 19kHz pilot tone appears very visibly on either output channel, and can be notched out by adjusting RV3. If you have got the de-emphasis capacitors C59/C60 in circuit, removing these will greatly increase the 19kHz signal for the purposes of fine tuning the notch. It's important to carry out this adjustment with a correctly tuned signal (AFC operational), since detuning affects the IF phase which can produce enough of an error to make the pilot cancel setting all but meaningless.

Additional Tweaking

Nothing has yet been said about the secondary of the detector coil. If you have neither a distortion meter, wobbulator or audio spectrum analyser, it's probably best that you never start to worry about what 'might have been'. The basic purpose of the adjustment is to linearise the phase response of the bandpass tuned pair. Moreover, whilst the coil is reasonably well aligned at the factory, an in-circuit tweak will certainly optimise the application.

Those of you who enjoy A-level physics practicals may choose to plot the AFC voltage versus IF frequency using a DVM, signal generator and DFM and iterate the adjustments of the detector secondary and primary until the detune voltage at +100kHz from the IF centre is exactly the same as that at −100kHz (opposite sign), and all points between. After all, that's what the wobbulator does rather more simply in 'real time' before your very eyes.

Similarly, to optimise the birdy filter (T8) requires an audio spectrum analyser and a tracking generator to 'sweep' a stereo encoder until the flattest possible separation has been achieved. Happily/regrettably, the state of the art of tuner performance has advanced a great deal since those halcyon days immediately after the introduction of stereo broadcasting to the UK when it seemed that just about every enthusiast constructor was having a go at the latest *WW* designs, and achieving a performance that was at least as good as the commercial offerings in the shops using only a multimeter and a wet finger. Times change.

■ R&EW

Those interested in constructing the 7256 tunerset are asked to send an SAE to the R&EW Editorial Office for a Parts List.

The Four-Channel Audio Mixer — Part III

Details of performance and possible modifications from its designer, David Strange.

Last month we looked at the final assembly of the mixer along with the metal work, PCBs and wiring: this month we shall look at the basic specification and at modifications to both up-grade and down-grade the design according to application needs.

Firstly though, two errors crept into last month's article, both of which do not affect the layout. For a start, C18 and C19 should read 100nF and not 10nF: no modifications are required as the new value has the same lead pitch and more or less the same body dimensions. The other component error concerns D18, which was shown in the wrong orientation on the component layout diagram — in other words its cathode should be pointing in the same direction as D21.

Having admitted those errors, let's move on to the specification.

SPECIFICATION

Distortion

THD	0.1% at 1kHz

S/N Ratio

Unweighted (CCIR 468.2)	108dB
Weighted (CCIR 468.2)	105dB

Headroom

>20dB (10VRMS) at output.

Supply

Voltage	± 9V
Current	47mA
Life	10 hours on specified batteries

Balanced Inputs

Impedance	~ 1k2
Sensitivity	continuously variable between —70dB (0.24mVRMS) and 0dB (0.775VRMS)
Common mode rejection ratio	>80dB
L—R Separation	45dB at 10kHz 50dB at 1kHz 48dB at 100Hz

Output Levels

Balanced	+2dB (1VRMS) into High *Z* 0dB (0.775VRMS) into 600R
Unbalanced	—3dB (0.55VRMS) into 600R
Phones	0dB (0.775VRMS) into 50R
Oscillator	1kHz — level variable

Limiter

Threshold	0dB (0.775VRMS)
Attack	10ms
Recovery	100ms

Frequency Response (see *Figure 1*)

Flat	—3dB at 50Hz and 20kHz (line A)
Medium pass	—3dB at 100Hz and 20kHz (line B)
High pass	—3dB at 150Hz and 20kHz (line C)

Up-grading

Since most tape recorders do not incorporate high quality meters, and some even lack a headphone monitoring socket, one useful addition to the *R&EW* mixer would be the ability to switch between mixer out and tape out. Sockets for inserting tape recorder outputs into the mixer would be required for this, along with a four-pole double-throw switch to de-select meter and phones from their usual monitoring points on the mixer-to-tape outputs. Some attenuating resistors may also be required to match levels. This is a particularly worthwhile modification where off-tape monitoring is available from a tape machine.

Another useful upgrade modification worth considering is that to give the mixer what is sometimes called a slating facility. With this in the system, the mixer operator could — without interfering with the normal microphones or their setting — put his own voice on tape for identification purposes. A small electret capsule along with a low quality pre-amplifier

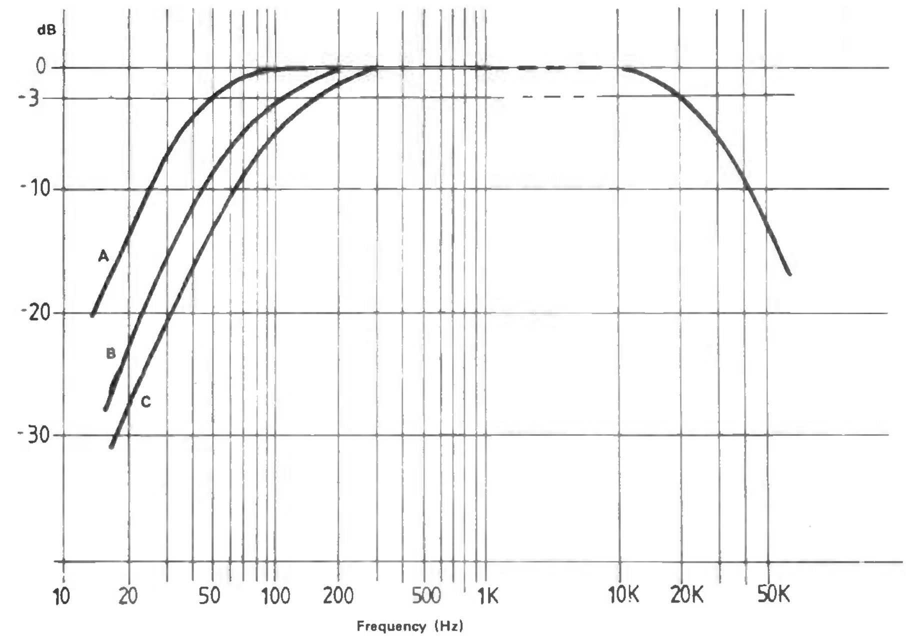


Figure 1: Frequency response.

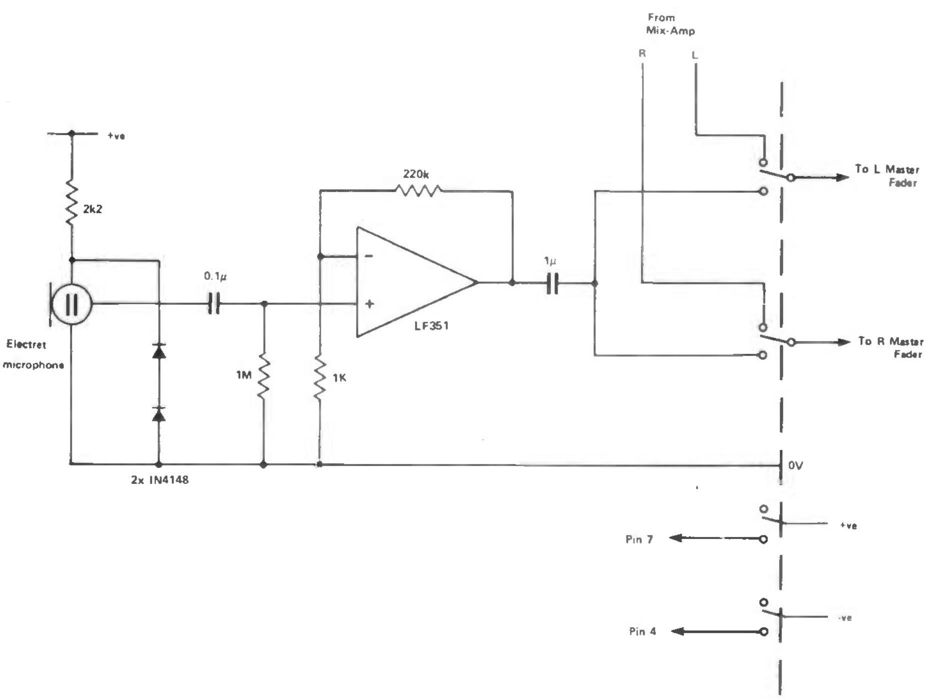


Figure 2: Slate microphone and amplifier.

inserting its signal via a switch to the channel faders is quite sufficient here and the circuit diagram for this is shown in *Figure 2*. Note: As there is always the possibility of breakthrough, the supply to the pre-amplifier should be broken by the switch when slating is not required.

Down-grading

There are a number of savings that could be made if the mixer as published exceeds actual requirements. I do not recommend that the RF filtering on the inputs be removed, but of course the input amplifiers can be used unbalanced and single-pole jack inputs used instead of balanced 'Cannons'. One leg of the input may simply be connected to ground and the input signal applied between ground and the ungrounded input.

The metering is another area that may be simplified and components from *Figures 6 and 7* of the first part of the article (September '83) may be left out. Two simple VU meters can then be used to monitor the outputs from the master faders.

Headphone monitoring is somewhat of a must, but where sufficient monitoring is available from the tape machine, components from *Figure 9* of the first article may be excluded.

The output amplifiers can also be left out when only unbalanced outputs are required. However, outputs taken directly from the limiter outputs need an additional series 100R protection resistor.

Lastly, if battery operation only is contemplated, the mains power supply and charging circuit may be omitted.

Overall

The mixer, having been in use for a number of weeks now, has come up to or exceeded all expectations. For example, the high pass filters have proved particularly useful in removing wind and microphone handling noise when the mixer is used outdoors.

The subjective assessment of sound quality made by several people is that a very crisp and 'accurate' sound is obtained from the mixer.

■ R&EW

A Guide to High Frequency Coils

Part II

Last month we looked at the general characteristics of HF coils and in particular, their role as filters. This month we take a detailed look at the construction of coils and one method of measuring coil constants

Magnetic core structure and stability

Table 1 displays the scheme for coil notation with respect to their structure, provision for mounting, presence or absence of shield case and built-in capacitor, and other information. The structure of the magnetic core (a range of which are shown in *Table 2* on p46) has a significant bearing on the coil characteristics, an effect best considered in terms of the apparent permeability of the core. The latter is defined by $\mu_{app} = L/L_0$, where L is the inductance with the core and L_0 is its value without the core. A high value of μ_{app} implies that it is possible to obtain a high inductance but, inevitably, a more critical element is the very small air gap within the core's magnetic circuit. Any variation in the dimensions of the air gap is likely to change the inductance: consequently, its stability is an important consideration. This and the stability of three coil constants are determined both by the winding and the magnetic core structure and by the methods of their maintenance, as described below.

Depending on the structure (see *Figure 1*), the bobbin will either just serve as the winding former or additionally serve as the magnetic core. In either case, it is important that the bobbin be firmly fixed to the coil base. It is similarly important that the winding should not fall out of shape. For example, in the case of a single spiral winding, care must be taken to ensure that the wire does not slip within the slot; further, the wire should not be exposed in such a way that it could be touched with the hand. The usual way of fixing the winding is to use a wax that has a low high-frequency loss factor but 'cement wire' (see later) is sometimes used to fix a multilayer winding. Of course, the use of a bobbin with flanges will also keep the winding in place.

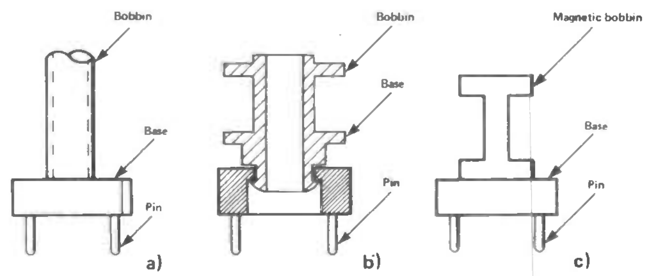


Figure 1: Bobbin — base structures. a) Bobbin and base in one unit; b) Separate bobbin and base — bobbin snapped into place; c) Bobbin bonded to the base.

The method of fixing the adjustable core is especially important, and particular attention must be paid to ensure that the ambient temperature, humidity, vibration and other such factors do not affect the relative position of this core and the winding and/or other cores (when two or more cores form the magnetic circuit). Examples of the structures adopted for the adjustable core are shown in *Figure 2*.

The other point to note is the fixing of the terminal pins. There are two types of pin — round and flat — with round pins used in the majority of coils. In general the

Table 1: Coil forms and structures

Notation	Winding	Provision for mounting	Use of case	Built-in capacitor	Base shape-pin layout
01	Single-tuned or Single Winding	Yes	Yes	Yes	Square — square
02					Round — round
03					Others
04				No	Square — square
05					Round — round
06					Others
07			No	Yes	Square — square
08					Round — round
09					Others
10				No	Square — square
11					Round — round
12					Others
13		No	Yes	Yes	Square — square
14					Round — round
15					Others
16				No	Square — square
17					Round — round
18					Others
19			No	Yes	Square — square
20					Round — round
21					Others
22				No	Square — square
23					Round — round
24					Others
31	Double-tuned	Yes	Yes	Yes	Square — square
32					Round — round
33					Others
34				No	Square — square
35					Round — round
36					Others
37			No	Yes	Square — square
38					Round — round
39					Others
40				No	Square — squar
41					Round — round
42					Others
43		No	Yes	Yes	Square — square
44					Round — round
45					Others
46				No	Square — square
47					Round — round
48					Others
49			No	Yes	Square — square
50					Round — round
51					Others
52				No	Square — square
53					Round — round
54					Others
61	'Multi-tuned'	Yes	Yes	Yes	Square — square
62					Round — round
63					Others
64				No	Square — square
65					Round — round
66					Others
67			No	Yes	Square — square
68					Round — round
69					Others
70				No	Square — square
71					Round — round
72					Others
73		No	Yes	Yes	Square — square
74					Round — round
75					Others
76				No	Square — square
77					Round — round
78					Others
79			No	Yes	Square — square
80					Round — round
81					Others
82				No	Square — square
83					Round — round
84					Others

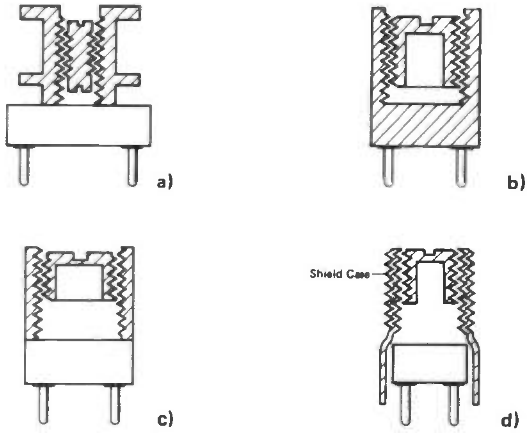


Figure 2. Adjustable core structures. a) Tapped bobbin for screw cores; b) Base with tapped section for cap core; c) Tapped section separate from base; d) Use of threaded shield case.

pins are fixed by the method shown in *Figure 3*. Initially when the pins are pushed in, they can be pulled out again by a force of about 500g. However, after they have been heated to approximately 450°C in solder for 1–2sec (i.e. during solder-dipping), they should withstand a pull of about 2kg. In general, the important points to note here are:

1) The pins should not be loose and there should be no play;
2) The pins should withstand a pulling force;
3) The pins should withstand a pushing force; and
4) The material holding the pins must be heat-resistant.

Unless strict attention is paid to these points, open-circuiting could result during use.

Material considerations

We look first at the materials used in the coil structure, which should meet the following requirements for high frequency applications:

1) Heat resistance — especially in that part of the coil into which the terminal pins are attached;
2) Low high-frequency losses — particularly where performing an insulating role;
3) Resistance to chemicals;
4) Suitable elasticity where securing the adjustable core;
5) Low moisture absorption; and

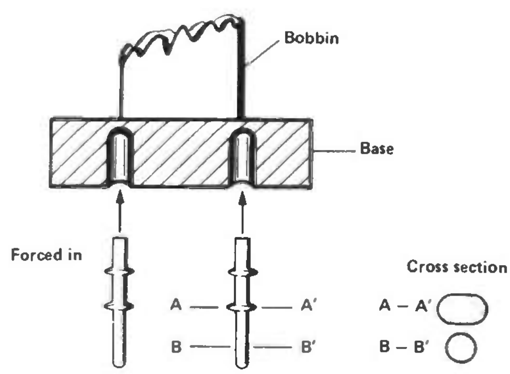
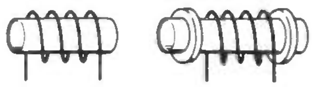
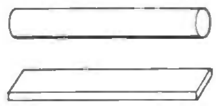
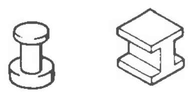
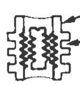
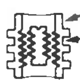
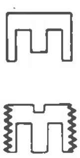
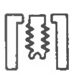
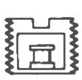
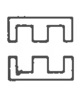


Figure 3: Pin insertion.

Table 2: Magnetic core structures

NOTATION	STRUCTURE	PHYSICAL
F	Air core (self supporting)	
G	Air core (winding on bobbin)	
A	'Rod and bar' type for antenna coil	
B	Cylindrical (slug type)	
D	'Drum' type	
M	Pierced core	
Q	Toriod type	
R	Cylindrical with screw	
H	Metallic (Cu,Al,brass,etc), threaded	
T	Screw type	
C	Cap type with centre core; with or without thread	
J	Cap type with screw core	
K	'Drum' type with cap core	
P	Pot type	
X	Other types	

Cross sections (rows H to X)

6) Resistance to deformation so that coupling conditions are not affected.

In general, these requirements are met by heat-hardened resins — in particular, the phenolis resins — though, naturally, different characteristics are displayed depending on the basic materials used in their composition. Disadvantages include little elasticity, the fact that they cannot be moulded into precision structures and a high level of moisture absorption, compared with, say, heat-moulded resins. The characteristics of some typical examples of the latter group are shown in *Table 3*.

Turning to the magnetic core, ferrites are mainly used here though some designs do incorporate non-magnetic materials such as aluminium or brass. The reasons for having ferrite cores in high frequency coils are their low high-frequency loss, their high reluctance and the comparative ease with which the desired shape can be achieved. It is best to refer to the various treatises for details of ferrite properties; however, the effect of temperature and magnetic field on these cores deserves further consideration here.

The temperature coefficient of inductance for the coil comes from two sources:

1) The coil structure, for which the coefficient may be either positive or negative; and

2) The effect of the temperature coefficient of permeability, which is normally positive.

The overall effect is in the positive direction but compensation can readily be applied. It is evidently desirable that the variation should be linear with respect to temperature.

The other effect of temperature is to modify *Q*, which generally rises with temperature. This, in turn, affects the sensitivity, selectivity, stability etc of the circuit in which the coil is being used and thus should always be taken into account.

The effect of an ambient magnetic field is to modify the permeability and attendant losses, increasing the inductance and lowering *Q*. Care must therefore be taken in selecting

Table 3: Heat-moulded resins and their properties

Material	Heat-resistant properties	Resistance to chemicals	Mechanical properties
Polyphenolene oxide, PPO	In general, heat resistance is	Not good	Fairly hard
Polyacetal (Delrin, Duracon)	inferior towards the lower part	Good	Fairly hard
Polycarbonate	of this column*.	Not good	Fairly hard
Polypropylene		Good	Has elasticity
Polyamide (Nylon)		Not good	Has elasticity
Polyethylene		Good	Very soft

* Note: Even polyphenolene oxide is not a satisfactory material when it comes to securing terminal pins therein.

Table 6: Temperature coefficients and capacitance for built-in capacitors used in 10mm square coils.

Conductor		Coating thickness	Finished wire	Resistance
Dia. (mm)	Tolerance	(min.,mm)	(max.,mm)	(max.,Ω/km)
0.10		0.009	0.140	2647
0.12		0.010	0.162	1786
0.14	±0.008mm	0.010	0.172	1505
0.16		0.011	0.204	969.5
0.18		0.012	0.226	757.2
0.20		0.012	0.246	607.6

the magnetic material. At the same time, any ferrite-cored coil should be located well away from those components that generate stray magnetic fields, such as loudspeakers.

Moving on to consideration of the wire material to be used in winding the coil, polyurethane copper wire and conglutinate polyurethane wire feature here. The former was developed by Siemens in West Germany and its polyurethane coating has many advantages. For example, the number of 'pinholes' is minimal, the coating can withstand banding and pulling (within limits) and solder can be applied directly without removing the coating. The conductor wire diameter of the material used in most HF coils is in the range 0.06–1.0mm. (Other data are given in *Tables 4 and 5*).

Conglutinate polyurethane wire is often known as 'cement wire' because it has a second coating — usually styrol or nylon — the purpose of which is to fix the winding so that it will not fall apart. This is done by melting the coating by passing an electric current through the winding or by immersing the coil in a special solution.

The other wires in the field are those in which fibres of cotton, silk or tetron are used to cover either insulated or bare copper wire. These wires are inherently thick and so are not suitable for small coils, but they do offer low distributed capacitance and high *Q* with no risk of shorted turns.

The final material consideration is that of the built-in capacitor where this is incorporated in a coil designed for use as part of a tuned circuit. Ceramic capacitors are widely used for the purpose, but other types — such as mica and styrol — are sometimes used. The reason ceramic capacitors are used is that they are available with different temperature coefficients and, in addition, in small sizes.

The temperature coefficient of a ceramic capacitor is generally negative; thus some temperature compensation is possible when used with a coil having a positive temperature coefficient. *Table 6* shows the range of temperature coefficients and capacitances for the built-in capacitors used in 10mm square coils. It should be noted that the dielectric constant is low when the temperature coefficient is low, and thus for any given size, the capacitance also becomes low.

Table 4: Polyurethane wire nomenclature

Notation	Temp. coefficient (ppm/°C)	Maximum capacitance (Limiting value, pF)
PH	150 ± 60	68
RH	220 ± 60	100
SH	330 ± 60	120
TH	470 ± 60	150
UJ	750 ± 120	180

Table 5: Characteristics of polyurethane wire

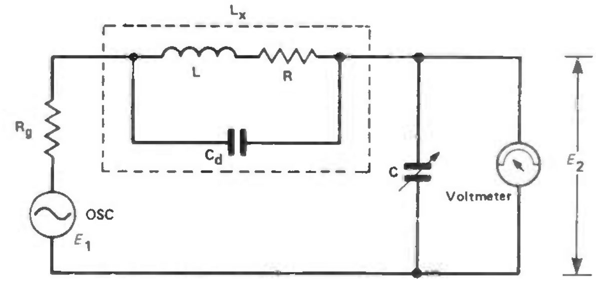
Type	Notation	Coating
1	1 UEW	Thick
2	2 UEW	Thin
3	3 UEW	Extra-thin

Measurement

There are essentially three techniques which are employed in measuring the characteristics of high frequency coils, namely:

1) The Q-meter method (which uses the resonance principle);
2) The RF-bridge method; and
3) The voltage—current method.

However we shall confine ourselves here to considering the *Q*-meter method, which uses the circuit shown in *Figure 4*. A known voltage E_1 is supplied at frequency *f* and a variable capacitor *C* is adjusted until the voltage across it, E_2, is maximum. From the values of E_1, E_2, *f* and *C*, it is possible to determine the inductance *L*, the resistance *R* and the distributed capacitance C_d of the coil under test.



G_L : load conductance
M : mutual inductance
OSC: oscillator
R_g : internal resistance of signal source
C : calibrated variable capacitor
V : voltmeter
L_x : coil under test
L : inductance of coil
C_d : distributed capacitance
R : resistance in L_x (representing a loss)

Figure 4: *Q*-meter test circuit.

HF COILS

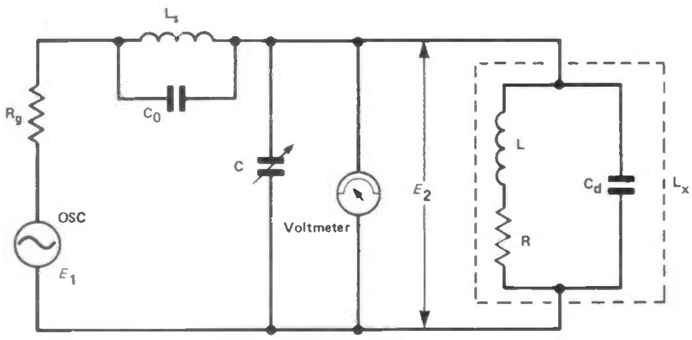


Figure 5: Single-frequency method of measuring C_d. L_S auxiliary coil; C_0 distributed capacitance of L_S.

The inductance may be calculated from the relation:

$$L = \frac{1}{(2\pi f)^2\ (1 + C_d/C)C} \qquad (1)$$

In theory, the value of C_d must be known before L can be deduced, but by suitable selection of the frequency f, the value of C will be very much greater the C_d and so C_d can be neglected. This very much simplifies the measurement but it should be noted that the error can be large when L is read off in this manner. Moreover, no such short cut can be taken when deducing Q from:

$$Q = \frac{E_2}{E_1}\left(1 + \frac{C_d}{C}\right) \qquad (2)$$

There are two ways of determining C_d – the two-frequency method and the single-frequency method. The former comprises setting the frequency to f_1 and f_2 successively and noting the capacitances C_1 and C_2 at the resonance points. C_d may then be calculated from:

$$C_d = \frac{C_2 - (f_1/f_2)^2\, C_1}{(f_1/f_2)^2 - 1} \qquad (3)$$

Note that if $f_1 = 2f_2$, then $C_d = ⅓(C_2 - 4C_1)$.

The single-frequency method is, however, preferred since it is both more efficient and it offers higher accuracy. The circuit used is shown in *Figure 5* and the procedure is as follows:

1) Connect the auxiliary coil L_S as shown: this should have a very much smaller inductance than the test coil L_x.
2) With the test coil out of the circuit, tune the circuit to resonance. Note the value of C and call it C_1.
3) Connect L_x into the circuit and set C for resonance. Call this C_2.

The distributed capacitance may then be calculated from:

$$C_d = C_1 - C_2 + \frac{L_2}{L}(C_1 + C_0) \qquad (4)$$

If L_S is 4% or less of L_x and the frequency selected is such that C_1 is as small as possible, then $C_d \simeq C_1 - C_2$.

■ R&EW

NEC564
A third generation monolithic phase locked loop

Before the Signetics Corporation was swallowed by Philips, it had established a reputation for innovation in monolithic linear technology with Phase Locked Loop (PLL) devices. The first generation of these devices included the NE560, 1 & 2 — 30MHz, 18V devices that incorporated an RC 'tuned' VCO, phase detector (PD) and loop filter stage. The NE561 also included an AM detector function, while the NE562 split the internal interconnects so that things like programmable *'N'* counters could be inserted into the loop. The diagrams that make up *Figure 1* illustrate the block functions of these three devices.

The two LF (operation to about 500kHz) members of the family — the NE565 and the NE567 — are still going strong, performing a variety of data reconstitution and tone decoding functions, the NE567 being the major success story for its part in the DTMF telephone signalling system.

Signetics passed on the second generation of monolithic PLLs when RCA (and others) produced the CD4046 CMOS PLL as part of its CMOS logic family system. However, its third generation device — the NE564 — has now totally superseded the NE560, 1 & 2 with a range of functions that ought to satisfy devotees of the earlier family, while attracting a new following by virtue of its speed at 5V. The internal layout shown in *Figure 2* is much as before, but reference to the internal circuit diagram (*Figure 3*) reveals evidence of Schottky that accounts for the improved speed/voltage performance. Operation to 50MHz (or, in selected examples, to 70MHz) has opened up applications in TV IFs, notably for satellite FM TV standards in the USA.

Functions

The input stage of the NE564 comprises a differential amplifier with Schottky diodes limiting the amplitude variations. Like most mixers (a phase detector is essentially a 'mixer'), the NE564 Phase Detector (PD) prefers to work with square wave inputs with a 50% duty cycle; otherwise DC offsets may arise which create a bias in the VCO phase when the loop is apparently locked.

Following a conventional 'transistor tree' type of mixer stage, the loop error signal is amplified to drive the output Schmitt trigger stage. A trigger circuit (the reference input to which is biased by the quaintly named 'DC retriever') is used here to recover FSK inputs — although the linear FM signal is still available at pin 14.

By the way, *R&EW* claims a proof-reading prize for spotting that the circuit diagram within the Signetics data sheets has the

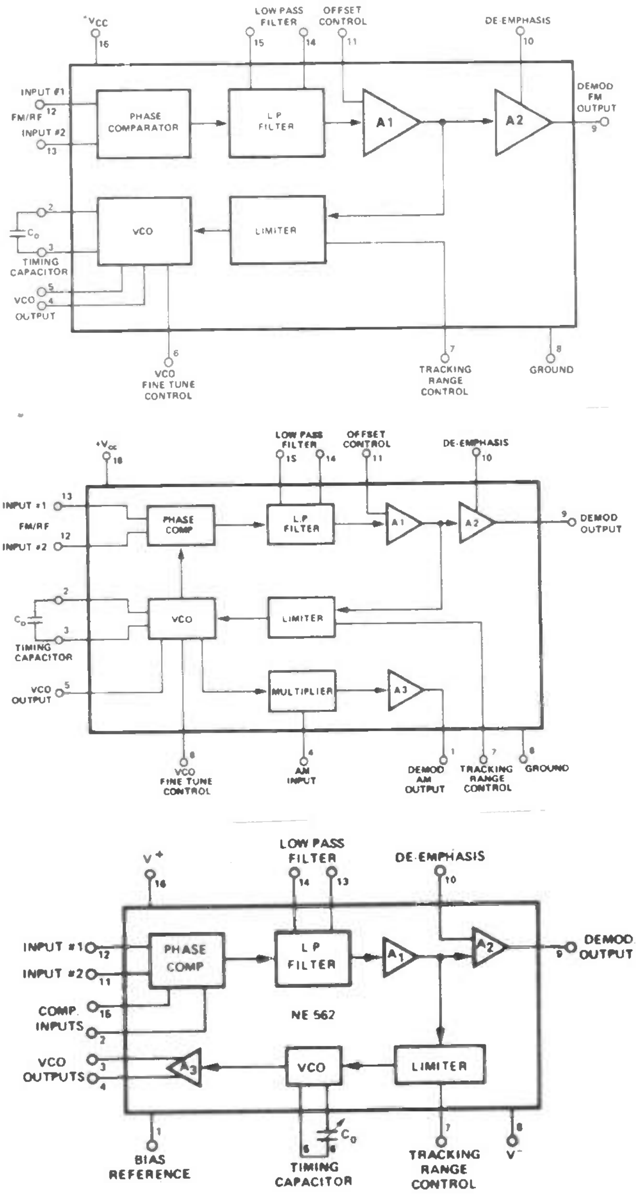


Figure 1: Block diagrams for a) the NE560; b) the NE561; and c) the NE562.

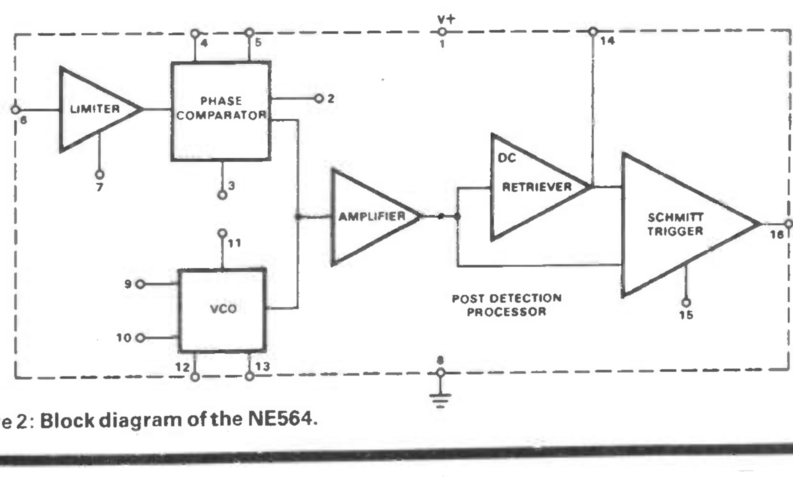


Figure 2: Block diagram of the NE564.

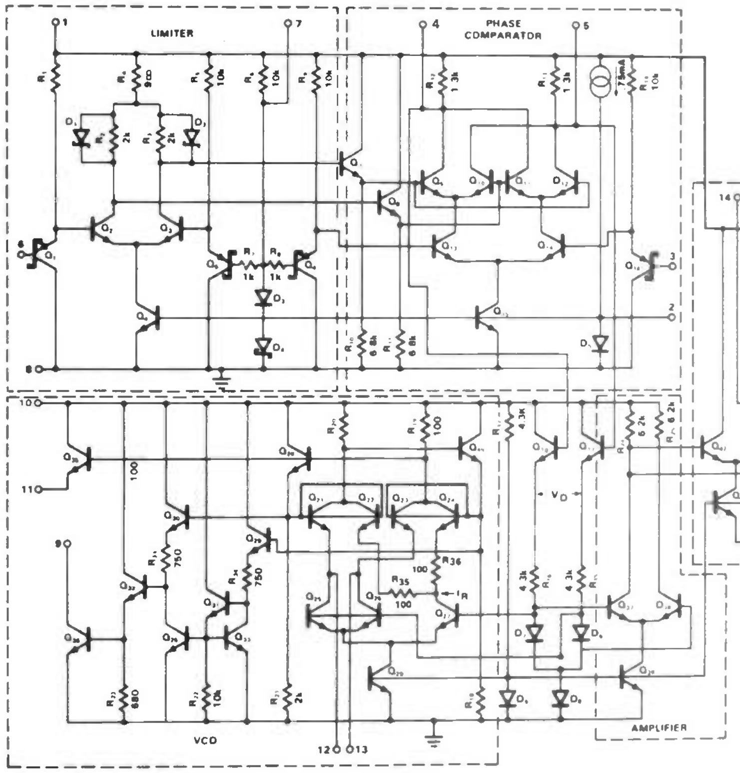


Figure 3: Circuit diagram for the NE564, with errors corrected (see text).

collector of Q47 connected to one of the 'limiter' pins rather than directly to the internal supply rail and no label to pin 4. We have corrected these oversights in reproducing the diagram as *Figure 3*.

The VCO output uses an open collector stage (Q36) at pin 9, which when connected to the internal phase detector derives its current path via the PD input transistor base (Q16). The oscillator itself is formed from Q25 and Q26, in a configuration familiar to those of you who have tripped around the insides of the various radio ICs that use single terminal oscillators — TDA1083, TDA1220 etc. In this case, control is by R-C as opposed to L-C, according to the equation:

$$f_0 = 1/1600.C_0$$

Designing with the NE564

The NE564 obeys the usual formulae associated with PLL design, the major one of which is still:

$$\omega_n = \sqrt{\frac{K_0 K_D}{\tau}}$$

where K_0 = VCO conversion gain (rad/sec/volt); K_D = PD conversion gain (volts/rad); τ = Loop filter time constant (sec); and ω_n = Natural loop frequency (rad). Unfortunately, the NE564 data sheet is rather sketchy on these values, and the accompanying applications notes imply that the user should derive his own data to get the necessary variables to insert in the equation. A frequency counter and a voltmeter should be adequate, but....

For example, to develop an FSK demodulator at 6MHz with 1% deviation, 500mVRMS input and a worse case S/N of 10dB, first set the value of C_0 (the timing capacitor): in this case it works out to 66pF. Then by checking the input against the lock range (using *Figure 4*), it can be seen that 500mV is plenty to operate the device in its optimum region. At 6MHz, the K_0 constant with 200µA into pin 2 (I_b) works out to 48 x 10^6 (rad/volt/sec), and K_D to 0.6 (volts/rad), and the loop gain K_V = 2.9x10^6.

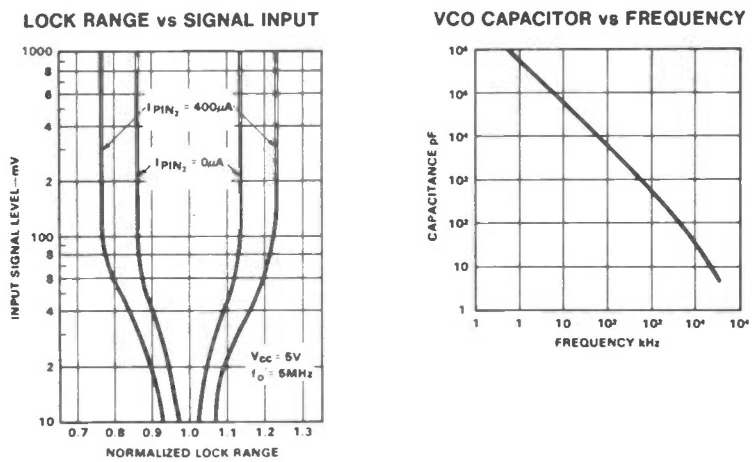


Figure 4: Typical NE564 performance characteristics.

With a loop damping factor ζ of 0.5 (a typical 'average' value), the expression for the loop time constant shakes down to:

$$\zeta^2 = \frac{1}{4K_V.\tau} = (0.5)^2$$

$$\tau = \frac{1}{4.2x9x10^7\ (0.5)^2} = 3.5x10^{-8}\ \text{sec.}$$

Back to the original formula to solve for ω_n:

$$\omega_n = \sqrt{\frac{2.9x10^7}{3.5x10^{-8}}}$$

$$\simeq 2.9x10^7\ \text{Hz}$$

$$\equiv 29\text{MHz}$$

Finally, the value of the loop filter capacitors at pins 4 and 5 are determined from:

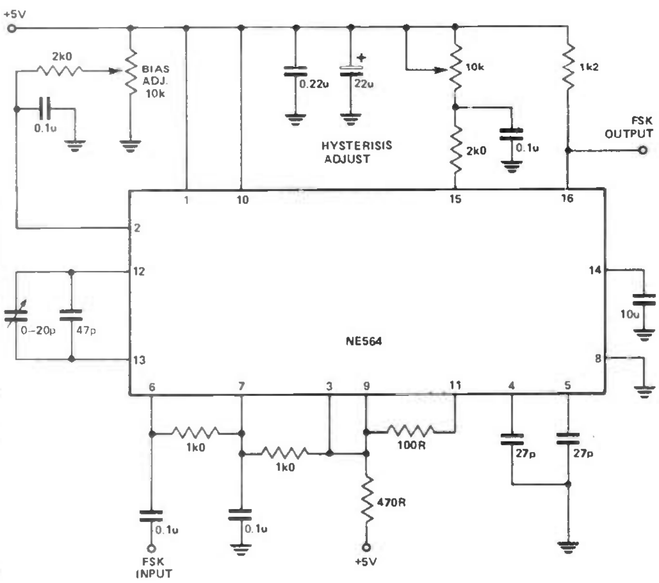
$$C_L = \frac{\tau}{1k3} = \frac{3.5x10^{-8}}{1.3x10^3}$$

$$= 27\text{pF}$$

(where 1k3 is the internal resistance).

ELECTRICAL CHARACTERISTICS $V+ = 5V$, $T_A = 25°C$, $fo = 5MHz$, $I_B = -200\mu A$ unless otherwise specified.

PARAMETER	TEST CONDITIONS	SE564			NE564			UNIT
		Min	Typ	Max	Min	Typ	Max	
Maximum VCO frequency		50	65		45	60		MHz
Lock range	Input ≥ 200mVrms, T_A = 25°C	60	90		60	90		% of fo
	= 125°C	30	50					
	= −55°C	120	150					
	= 0°C				100	120		
	= 70°C				50	70		
Capture range	Input ≥ 200mVrms, R2 = 27Ω	25	35		25	35		% of fo
	= 100Ω	35	50		35	50		
VCO frequency drift with temperature	fo = 5MHz, T_A = −55°C to 125°C		400	1000				PPM/°C
	= 0°C to 70°C					400	1250	
	fo = 500kHz, T_A = −55°C to 125°C		250	500				
	= 0°C to 70°C					400	850	
VCO frequency change with supply voltage	V+ = 4.5V to 5.5V		3	6		3	6	% of fo
Demodulated output voltage	Modulation frequency: 1kHz, fo = 5MHz							
	Input deviation: 10%, T = 25°C	120	140		120	140		mVrms
	: 1%, T = 25°C	12	14		12	14		mVrms
	T = 0°C				11	13		mVrms
	= −55°C	9	12					mVrms
	= 70°C				13	15		mVrms
	= 125°C	14	16					mVrms
Linearity	Deviation: 1% to 8%		1	3		1	3	%
Signal to noise ratio			40			40		dB
AM rejection			35			35		dB
Supply current	V+ = 5V		35	50		35	50	mA
Leakage current	Pin 9		1	10		1	10	μA
Output current	Pin 9			6			6	mA
Supply voltage	Pin 1	4.5		12	4.5		12	V
	Pin 10	4.5		5.5	4.5		5.5	V



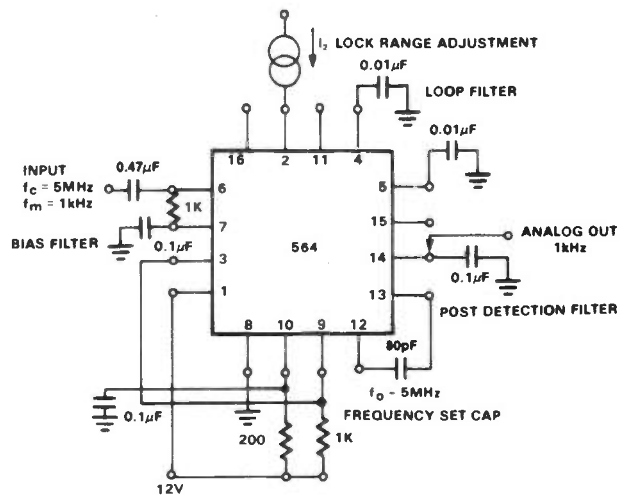


Figure 5: Circuit for an FSK decoder that incorporates an NE564.

Figure 6: Circuit for an FM demodulator at 12V based on an NE564.

So the resulting circuit looks like *Figure 5.* Don't forget to decouple the device properly. Schottky switching speeds will lead to sharp edges on the various power supplies, and the PLL will radiate hash along the line to anything willing to 'listen'.

A further application as an FM demodulator is shown in *Figure 6*, which is adaptable to a variety of applications previously covered by the defunct NE560/1/2. The absence of an AM detector facility (the 'multiplier' shown in the NE561 block diagram) could be overcome by using an external multiplier/DBM, such as that found in the KB4412/KB4413 or in the SL1600 series devices.

The main attraction of this aspect of the NE561 was the novelty of AM reception without coils (what is it designers have against those delightful things?). There's no reason why you cannot experiment with the NE564 to produce a wide ranging RC tuned receiver without coils: 'all' you need to do is feed the VCO into one port, the AM signal (unlimited) in at the other and remove the resulting 'difference' as demodulated AM. Do let us know how you get on.

■ R&EW

Morse by Micro

J C Barker describes his design whereby a ZX81 can be used either as a morse tutor or as an auto keyer.

The following scheme enables any group of morse characters keyed into a ZX81 home computer to be transmitted in sequence, with all the correct timing intervals. It could thus be used by a newcomer to CW as a morse tutor or, alternatively, as an autokeyer by those who have already gained their 'full ticket'.

The design given here is intended to be run on an unexpanded ZX81 and it offers the following facilities.

1) Transmitting morse characters as a series of tones and/or
2) Transmitting morse characters as a series of on/off key strokes.
3) Programmable speed in words per minute.
4) Printing to screen, in synchronism with the transmitted character, all but eight of the morse characters.

Table 1: Morse characters

0	–––––	A	•–	N	–•
1	•––––	B	–•••	O	–––
2	••–––	C	–•–•	P	•––•
3	•••––	D	–••	Q	––•–
4	••••–	E	•	R	•–•
5	•••••	F	••–•	S	•••
6	–••••	G	––•	T	–
7	––•••	H	••••	U	••–
8	–––••	I	••	V	•••–
9	––––•	J	•–––	W	•––
		K	–•–	X	–••–
		L	•–••	Y	–•––
		M	––	Z	––••

Special characters

Sinclair Chr.		Morse Chr.
£	Preliminary Call	–•–•–
$	Underline	••––•–
:	Apostrophe	•––––•
?	Question	••––••
(	Brackets	–•––•–
)	Brackets	–•––•–
>	Error	••••••••
<	End of message	•–•–•
=	End of work	•••–•–
+	Long break	–•••–
—	Hyphen	–••••–
*	Inverted commas	•–••–•
/	Oblique stroke	–••–•
;	Spare	
,	Comma	––••––
.	Full stop	•–•–•–

Spacing and length of signal

1) 1 dash equals 3 dots
2) The space between elements which form a character is equal to 1 dot
3) The space between two characters is equal to 3 dots
4) The space between two words is equal to 5-7 dots

Table 1 shows a list of morse characters; all but a few of the special characters use the direct Sinclair equivalent to input to the computer. The design involves two parts: the hardware which could hardly be simpler; and some software, part of which is in BASIC and part in machine code.

Loading the Software

The software consists of a BASIC program, with a call to a machine code subroutine located in a line 1 REM statement, and it must first be loaded and saved on tape. This is done by first of all filling a line 1 REM statement with 225 character 9's:

1 REM 9999999......etc (225 in all)

The BASIC program (*Program 1*) should then be typed in. This program allows the machine code program (listed in hexadecimal in *Program 2*) to be loaded into the REM statement. When *Program 1* has been input, press the RUN button and enter the machine code in response to the input prompt, one line at a time and pressing NEWLINE after each line. The machine code must be copied exactly as listed, otherwise the program will crash. When the machine code has all been loaded, input 'STOP'. This action returns the user to the BASIC operating system.

Program 1

```
10 LET X = 16515
20 INPUT A$
30 IF A$ = " " THEN GO TO 20
40 POKE X, 16 *CODE A$ + CODE A$ (2)
-476
50 LET X = X + 1
60 LET A$ = A$ (3TO )
70 GOTO 30
```

Program 2: HEX Machine Code Program

```
0A 00 05 A8 06 34 06 78 06 30
06 B4 06 B4 08 00 05 50 06 14
05 88 06 84 06 48 05 90 00 00
06 CC 06 54 05 F8 05 78 05 38
05 18 05 08 05 00 05 80 05 C0
05 E0 05 F0 02 40 04 80 04 A0
03 80 01 00 04 20 03 C0 04 00
02 00 04 70 03 A0 04 40 02 C0
02 80 03 E0 04 60 04 D0 03 40
03 00 01 80 03 20 04 10 03 60
04 90 04 B0 04 C0 00 00 00 00
3A 82 40 FE 00 28 45 FE 0C D8
FE 40 D0 D7 D6 0B CB 27 21 83
40 4F 06 00 09 4E 23 46 3E 00
B9 28 1E CB 20 38 04 3E 01 18
02 3E 03 32 00 20 CD 4B 41 3D
FE 00 20 F5 32 04 20 CD 4B 41
0D 18 DD 3E 02 CD 4B 41 00 00
00 00 3D C8 18 F5 D7 3E 07 CD
4B 41 00 00 00 00 3D C8 18 F5
21 83 40 56 1E FF 23 77 3E 00
1B BA 28 02 18 FA 7E C9
```

The line 1 REM statement should now look completely different.

Lines 10–70 should now be deleted and the BASIC program (*Program 3*) typed in. Lines 1–70 constitute the software necessary for the hardware and this should be saved on tape by entering the direct command SAVE "space". When required the program can be loaded via the direct command LOAD "space". The user is, by the way, advised to save the program on more than one tape, to guard against accidental loss or damage.

Program Description

Lines 2 and 3 set the speed of transmission in words per minute,

Program 3

```
2 INPUT A
3 POKE 16515, INT (120/A)
10 INPUT A$
15 CLS
20 FOR N = 1 TO LEN A$
30 POKE 16514, CODE A$ (N)
40 RAND USR 16621
50 NEXT N
70 GOTO 10
```

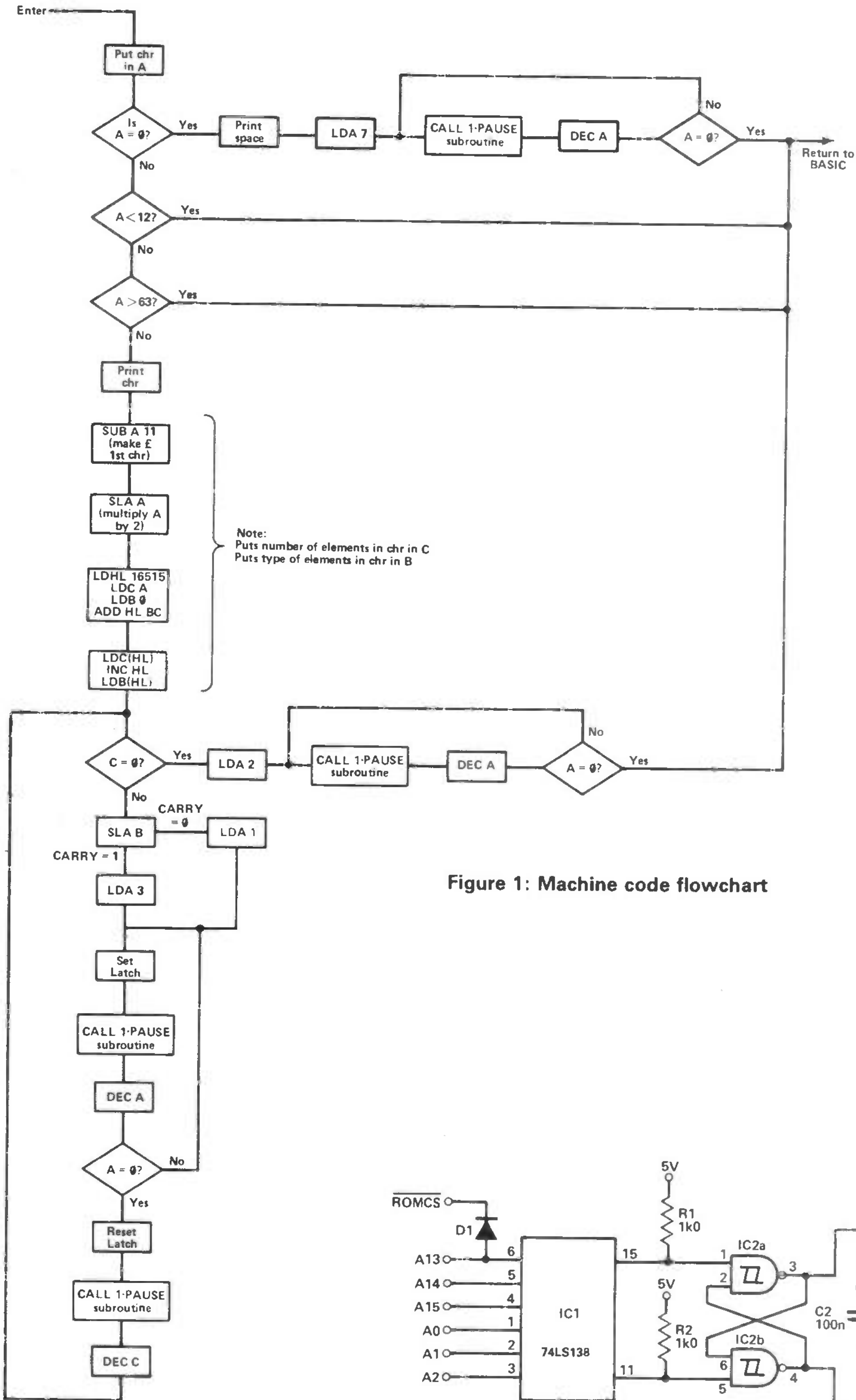


Figure 1: Machine code flowchart

while lines 10–70 are used to input a string of any length. Line 40 uses a call to the machine code routine to output each character in turn and to SET and RESET the latch.

The first part of the machine code, starting at address 16517, is simply a 'look up' table in which each morse character is stored as two bytes. The first byte gives the number of elements in the character while the second byte gives the type of elements (i.e. dot or dash) in the character, a '0' representing a dot and a '1' a dash. For example,

C = –• –•
= 04 A0 (A0 = 1010oooo)

The software algorithm displayed in *Figure 1* shows how the rest of the machine code, starting at address 16621, processes the characters.

The Hardware

The hardware is shown schematically in *Figure 2*. It is accessed as a memory location in the block 8192 to 16383 which is an image of the Sinclair ROM. It is the job of IC1 and D1 to decode this memory location, and at the same time to disable the Sinclair ROM by generating a high signal on $\overline{\text{ROMCS}}$. IC2a and IC2b are connected as a latch, which can be SET and RESET by outputting a memory command to 8192 and 8196 respectively. IC2c forms a gated oscillator to drive the buzzer, whilst IC2d is used to drive the reed relay.

The hardware, which plugs into the expansion port at the back of the ZX81, is made up using strip board (*Figure 3*). Cut the strips where

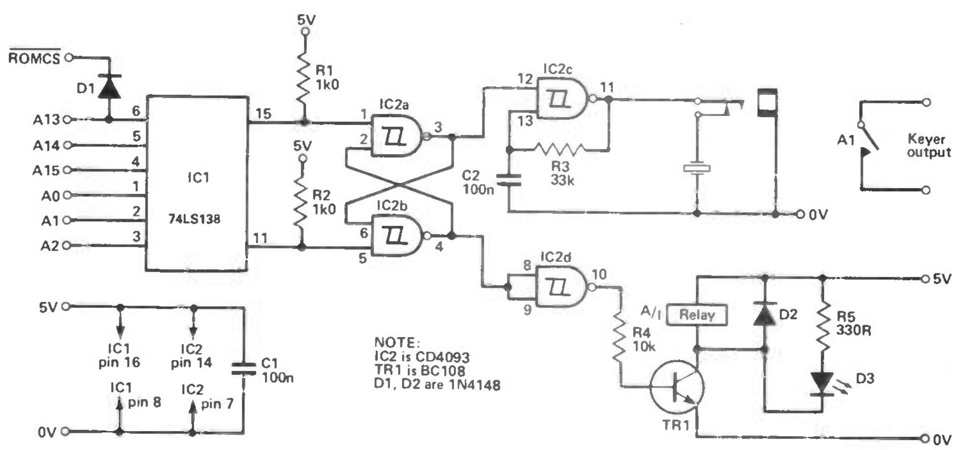


Figure 2: Circuit diagram

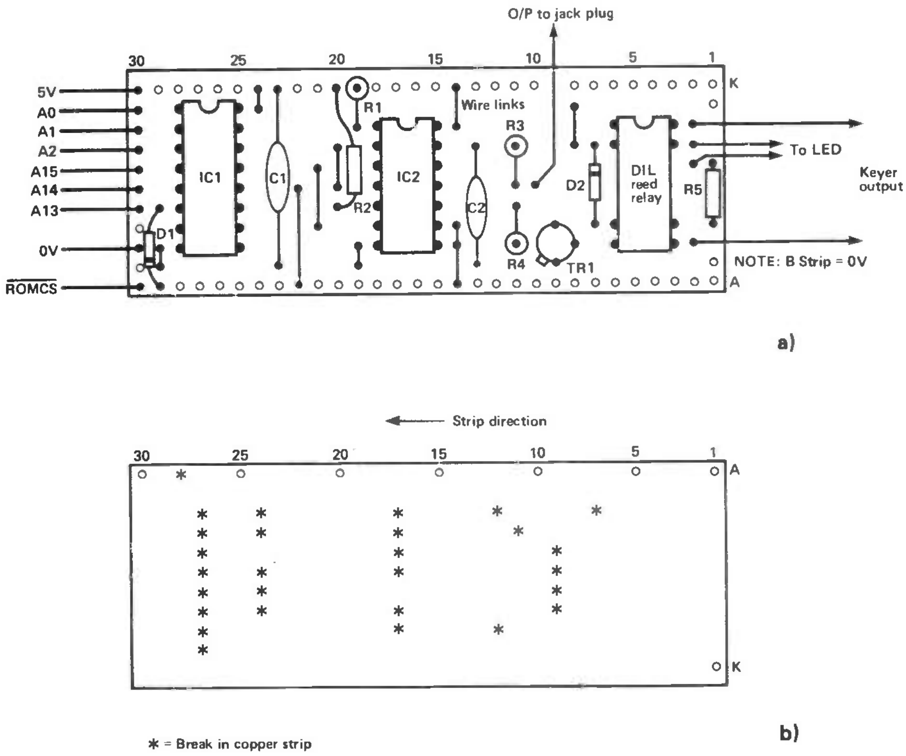


Figure 3: Strip board construction. a) Component side. b) Strip side.

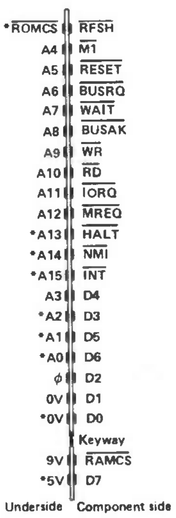


Figure 4: Edge connector wiring

shown, then fit the links, and then the rest of the components, using IC sockets for the two ICs and the DIL reed relay. The board is connected to the ZX81 edge connector socket at the appropriate points shown in *Figure 4.*

If the design is to be used solely for a morse tutor, R4, TR1, D2, D3, R5 and the reed relay need not be fitted. If when it is used as a keyer the buzzer is not required, C2, R3, the buzzer and the 3.5mm jack socket should be omitted and pin 13 of IC2 taken to pin 14.

In Use

The unit must never be plugged into the ZX81 or unplugged whilst power is applied: always plug the unit into the ZX81 and then apply power. The computer should return the usual K in the bottom left hand corner; if not — switch off, remove the unit and check the construction and all wiring. If the unit gives a continuous tone and/or D3 is lit, the latch can be reset with the direct command POKE 8196,0.

If all is well the software previously saved should now be loaded, with the command LOAD " ". Then when RUN (NEWLINE) is typed in, the computer waits for an input that sets the speed of transmission in words per minute (wpm). This can be 12, 13, 14, 16, 20, 24 or 30. The speed is initially set to 12wpm and if this speed is required, RUN 5 is entered.

In theory, the speed could be set to less than 12wpm but this is not recommended even for the newcomer to morse. The reason for this is that it is the sound of the whole morse character that should be learnt and not the individual dot/dash elements.

The ZX81 then waits for a string input, having first given an input prompt; the message to be transmitted should then be input. When NEWLINE is pressed the message is both serially transmitted and printed to screen.

When first learning on the unit, it is recommended that the line

45 PAUSE 100

is included in the program. This gives a pause between each individual morse character, and as the learner becomes more competent with morse, the PAUSE can be gradually reduced until it is no longer needed. If the line

60 GOTO 15

is included, the group of characters typed in are transmitted repeatedly, until the BREAK key is pressed. It is recommended that different groups of characters are learnt in this way.

For personal learning, a high impedance earpiece can be plugged into the output socket. If, on the other hand, the unit is to be used for group tuition, it can be used to drive an amplifier/loudspeaker combination.

Back to BASIC

When the user requires to get back to BASIC (and if line 60 is not used), delete the input prompt and input STOP.

■ R&EW

PARTS LIST

R1,R2	1kΩ
R3	33kΩ
R4	10kΩ
R5	330Ω
C1,C2	100nF
D1,D2	IN4148
D3	red LED
TR1	BC108
IC1	74LS138
IC2	CD4093
A/I	5V DIL SPST Reed relay

3.5mm jack socket; 23 way edge connector; PB2720 piezo buzzer

One Night's Work

Following on from last month's morse key oscillator, a three-digit timer from Stephen Ibbs that will enable you to measure your speed in sending or receiving morse.

It is often useful to time yourself, both when sending or receiving morse, not only to measure how your speed is progressing, but also to ensure that e.g. a practice three-minute passage of plain language has actually been sent in the time. The circuit below (*Figures 1,2*) may help; moreover, because the LEDs are mounted on their own PCB, it should be possible to house the tuner quite simply. It will run off batteries, in which case one can ignore the dotted section, but the current consumption will be quite high and, as the batteries become run down, the timing will become less dependable – so a mains supply has been included. Please take care that the mains connections to the transformer are shielded, preferably with heat shrinking, and a fuse incorporated into the 'live' line – *R&EW* does not want to lose any of its readers that way! The mains components have been deliberately omitted from the PCB to make sure that no part of the PCB is at mains potential.

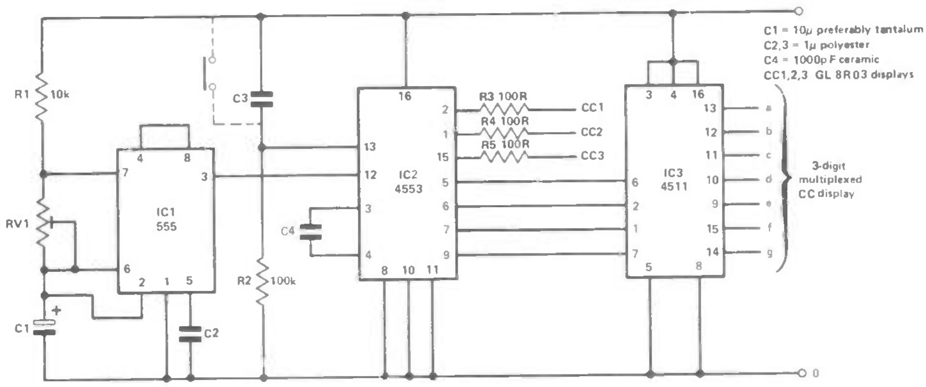


Figure 1: Circuit diagram of timer unit.

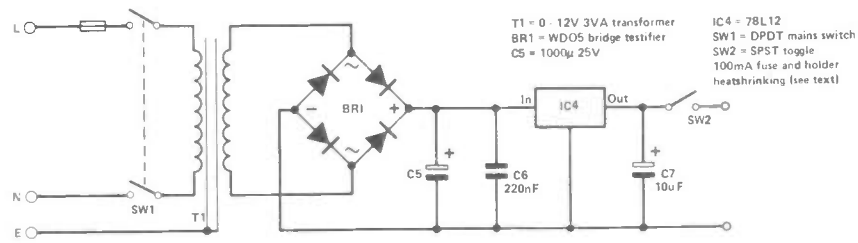
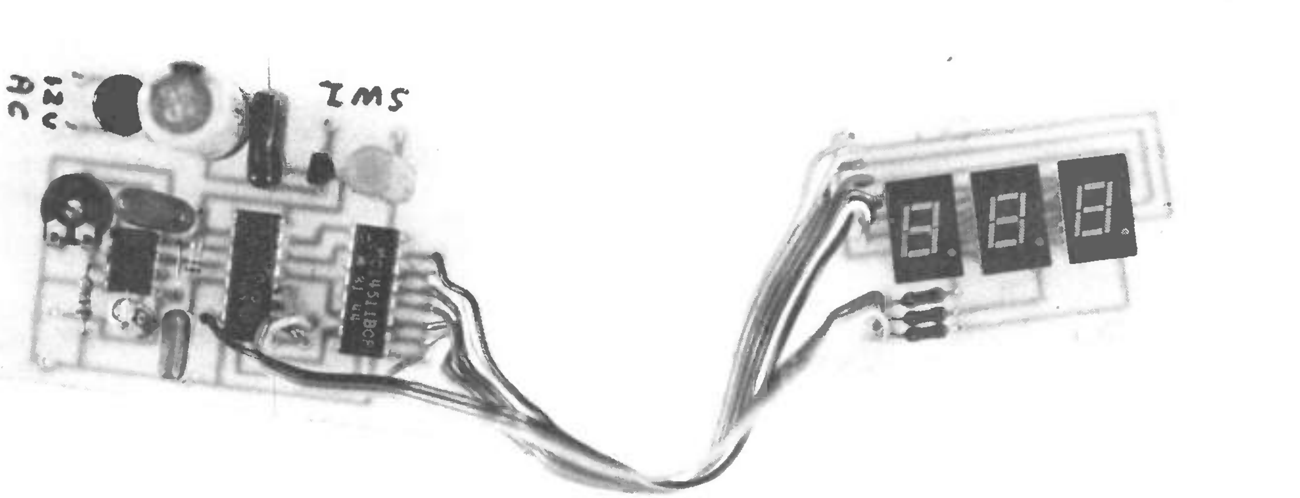


Figure 2: Circuit diagram of display unit.



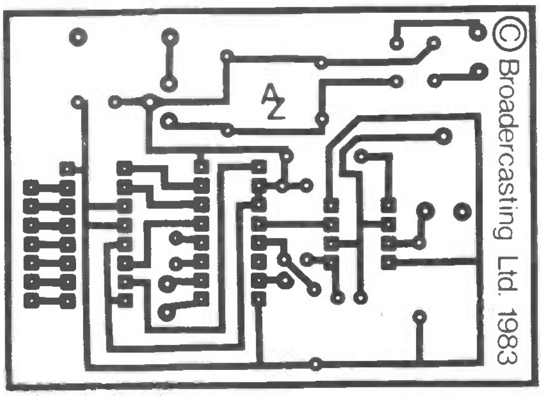


Figure 3: PCB for timer unit.

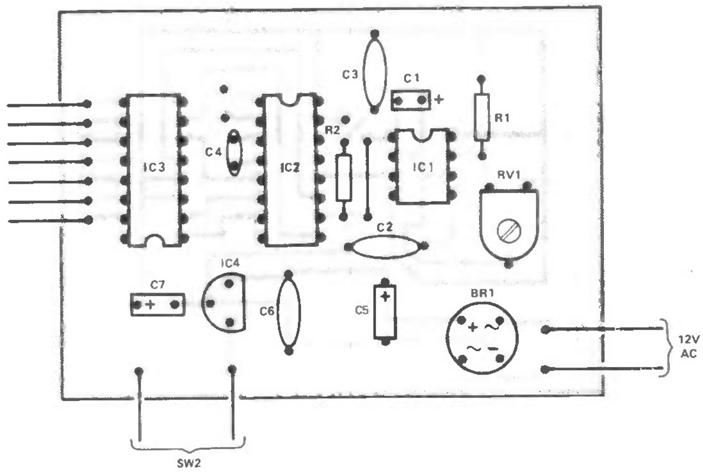


Figure 4: Component overlay for timer unit.

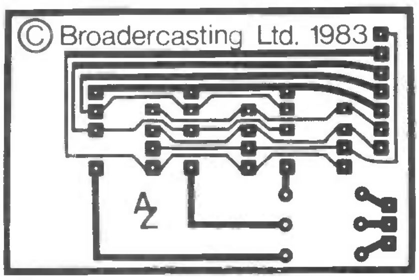


Figure 5: PCB for display unit.

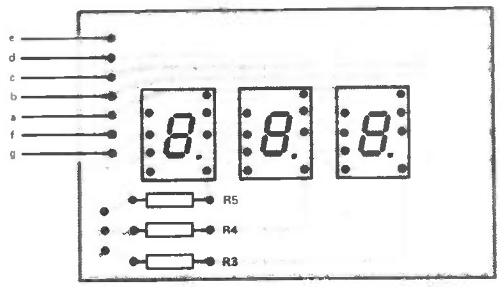


Figure 6: Component overlay for display unit.

Principle of operation

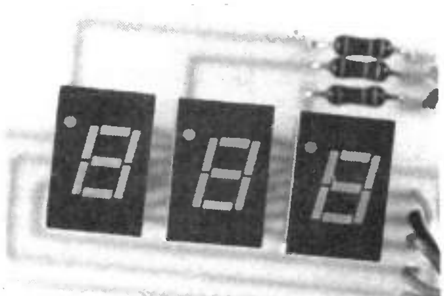
IC1 is a 1Hz generator, i.e. it produces a pulse once per second. This is counted by IC2 and sent out in binary coded decimal (BCD) form to IC3. The latter device decodes the data and sends it to the three digits. A reset pulse network comprising C3 and R2 is included to make sure that the counting always starts from zero. The power supply consists of approx 12VAC coming from the secondary winding of the transformer, which is rectified by BR1, smoothed by C5, and regulated by IC4, C6 and C7 to produce 12VDC. Note that both the 'live' and 'neutral' leads should be switched by SW1, and that the 'live' lead has a fuse (250mA) *before* the switch.

Construction

Though veroboard could be used with care, PCBs are recommended and the designs for these are given in *Figures 3–6*. Make sure that the appropriate devices are inserted the correct way round when mounting the components. The displays used were GL8R03's and these were trimmed as shown in *Figure 7* before mounting. Check everything before connecting the transformer secondary leads to the PCB, and then turn on the mains. Also ensure that the regulator is giving out 12V before closing SW2 and applying voltage to the circuit. If all is well the display should immediately register zero and start counting. Calibrate by adjusting RV1 to give a rate of 1 per sec.

A reset pushbutton may readily be included by connecting it between pin 13 of IC2 and +ve.

■ R&EW



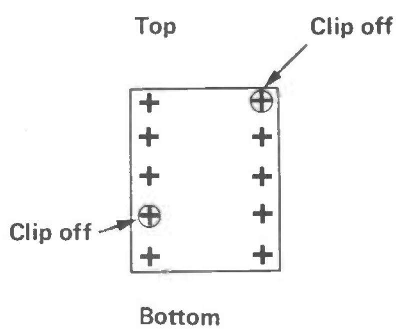


Figure 7: Trimming details for displays.

Note: Some components values were unfortunately omitted from the morse key oscillator in this series, published in our September issue. They are: R1 100k; R2 680k; C1 1000pF.

Data File

Pulse generators and monostable multivibrators are amongst the basic 'building blocks' of electronic circuit design. To start this new series of 'Data Files', Ray Marston presents a wide selection of CMOS versions of these devices.

Amateur and professional circuit designers often have to devise means of generating pulse waveforms in various parts of a circuit. Sometimes, they simply need to generate a pulse with a non-critical width on the arrival of the leading or trailing edge of a rectangular input waveform, as shown in *Figure 1*, and in such cases they may use a circuit element known as a 'half-monostable' or edge-detector. On other occasions the demand may be for a pulse of precise width on the arrival of a suitable trigger signal, and in such cases they usually use a full monostable multivibrator circuit.

In a standard monostable circuit, the arrival of the trigger signal initiates an internal timing cycle which causes the output of the mono to change state at the start of the timing cycle, and then revert back to the original state on completion of the cycle (see *Figure 2*). Note that once a timing cycle has been initiated, the standard monostable is immune to the effects of subsequent trigger signals until the timing period has been ended naturally. This type of circuit can sometimes be modified by adding a RESET control terminal, as shown in *Figure 3*, to enable the output pulse to be terminated or aborted at any time by a suitable signal.

A third type of monostable circuit is the 'retriggerable' mono. Here, the trigger signal actually resets the mono and then, after a very brief delay, initiates a new pulse-generating timing cycle (as shown in *Figure 4*), so that each new trigger signal initiates a new timing cycle even if the trigger signal arrives in the midst of an existing cycle. Thus the designer may use a half-mono, a standard mono, a resettable mono, or a retriggerable mono to generate pulses in a circuit, the 'type' decision depending on the specific design requirement.

The selection of the actual IC to implement a chosen pulse generator design is usually dictated by considerations of economics and convenience, rather than by the actual design requirement. Thus, if the designer needs a standard CMOS monostable of only modest precision, he can build it very inexpensively by using a logic IC such as 4001B or 4011B, or he can do so more expensively by using a 7555 timer chip or a dedicated monostable IC such as a 4047B, etc. It is with this in mind that we take a detailed look here at CMOS versions of the various types of monostable circuit, and at a variety of ways of implementing them.

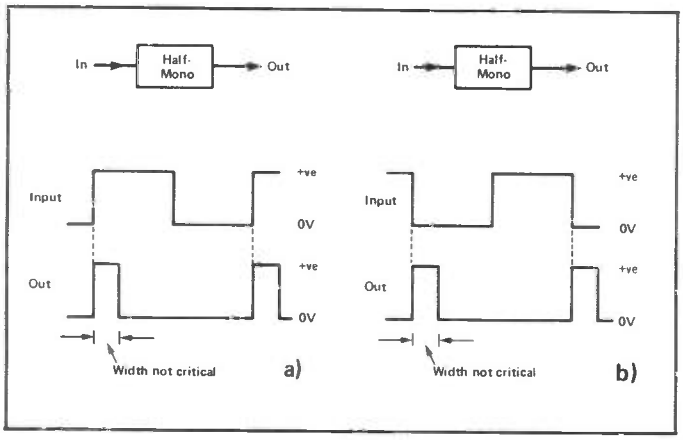


Figure 1: A 'half-mono' circuit may be used to detect a) the leading or b) the trailing edge of an input waveform.

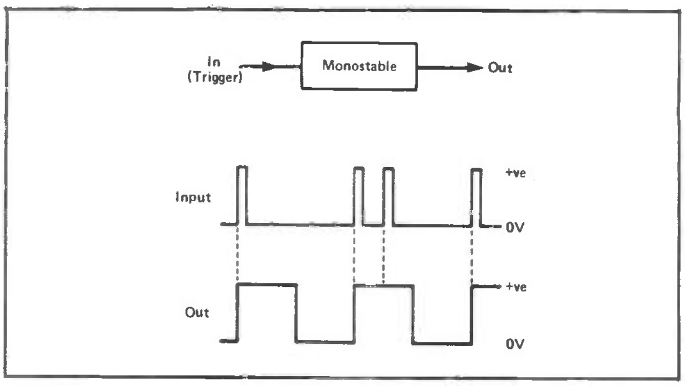


Figure 2: A standard monostable generates an accurate output pulse on the arrival of a suitable trigger signal.

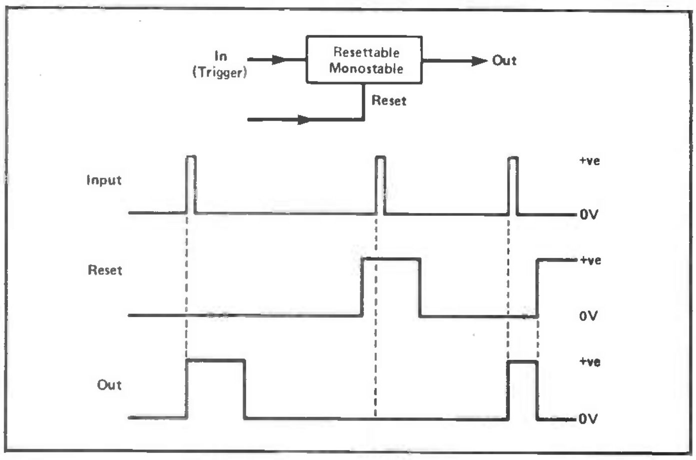


Figure 3: The output pulse of a resettable mono can be aborted by a suitable reset pulse.

Edge-detector Circuits

Edge-detector circuits are used to generate an output pulse on the arrival of either the leading or the trailing edge of a rectangular input waveform. In most practical applications, the precise width of the output pulse is not critical. The basic method of making an edge-detector is to feed the input waveform to a short-time-constant CR differentiation network, to produce an output waveform with a sharp leading edge and an exponential trailing edge on the arrival of each input edge, and then to eliminate the unwanted edge waveform with a discriminator diode. The remaining 'spike' or sawtooth waveform is then converted into a clean pulse by feeding it through a Schmitt trigger circuit. The Schmitt may be of either the inverting or the non-inverting type, depending on the required polarity of the output pulse waveform.

CMOS Schmitt ICs incorporate built-in protection diodes on all input terminals, and these can be used to perform the discriminator diode action described above. It is useful to note that each gate of the popular 4093B quad 2-input NOR Schmitt can be used as a normal Schmitt invertor by wiring one input terminal to the positive supply rail and using the other terminal as the input point, as shown in *Figure 5*. It is also useful to note that a non-inverting Schmitt can be made by wiring two inverting Schmitts in series (*Figure 6*).

Figure 7 shows two ways of making a leading-edge detector circuit. Here, the input of the Schmitt is tied to ground via resistor R, and C and R together have a time constant that is short relative to the period of the input waveform. The leading edge of the input signal is thus converted to the 'spike' waveform shown, and this spike is then converted into a good pulse waveform via the Schmitt. The circuit generates a positive-going output pulse if a non-inverting Schmitt is used (*Figure 7a*) or a negative-going output pulse if an inverting Schmitt is used (*Figure 7b*). In each case, the output pulse has a period (p) of roughly $0.7CR$.

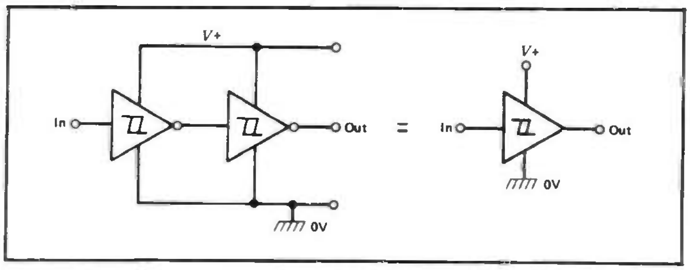


Figure 6: A non-inverting Schmitt can be made by wiring two inverting Schmitt elements in series.

Figure 8 shows how to make a trailing-edge detector. In this case the input of the Schmitt is tied to the positive supply rail via R, and RC again has a short time constant. This time, the circuit generates a positive-going output pulse if an inverting Schmitt is used (*Figure 8a*), or a negative-going pulse if a non-inverting Schmitt is used. The output pulse has a period of roughly $0.7CR$.

Two useful variants of the edge-detector circuit are the 'noiseless' push-button switch of *Figure 9*, which effectively eliminates the effects of switch contact bounce and noise, and the power-on reset-pulse generator circuit of *Figure 10*, which generates a reset pulse when power is first applied to the circuit.

In the former circuit, the input of the non-inverting Schmitt is tied to ground via the high-value timing resistor R1 and by the input-protection resistor R2, so the output of the circuit is normally low. When the push-button switch PB1 is closed, C1 charges almost immediately to the full positive supply rail value and the

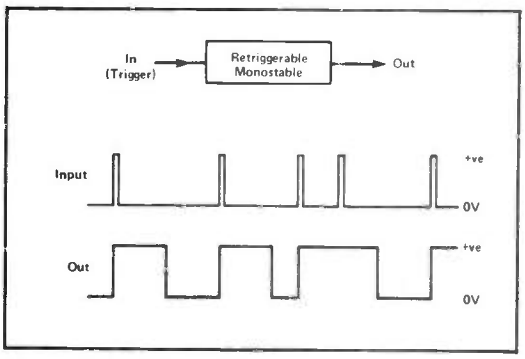


Figure 4: A retriggerable monostarts a new timing cycle on the arrival of each new trigger signal.

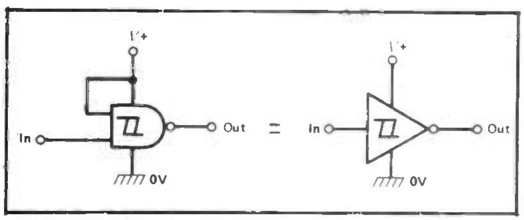


Figure 5: A 4093B 2-input NOR Schmitt can be used as a normal Schmitt invertor by wiring one input high.

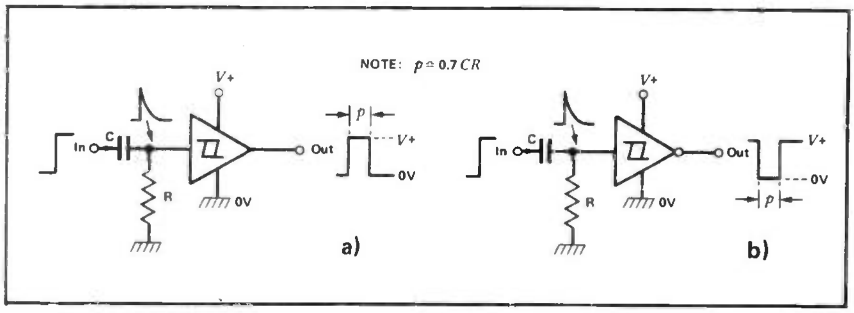


Figure 7: Leading-edge detector circuits giving a) positive and b) negative output pulses.

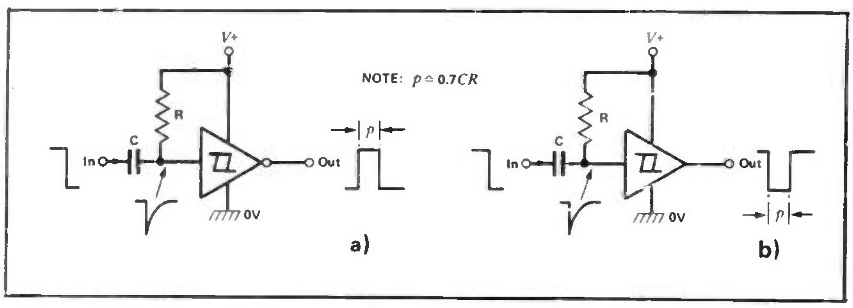


Figure 8: Trailing-edge detector circuits giving a) positive and b) negative output pulses.

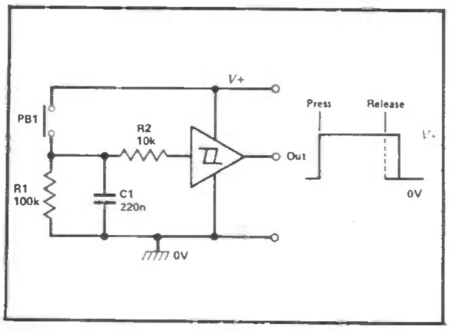


Figure 9: 'Noiseless' push-button switch.

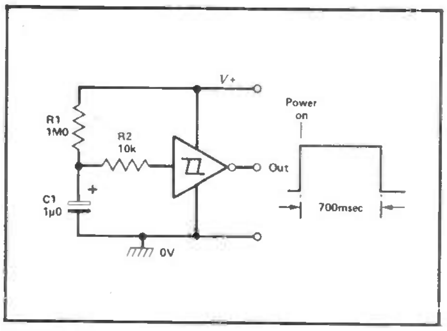


Figure 10: Power-on reset-pulse generator.

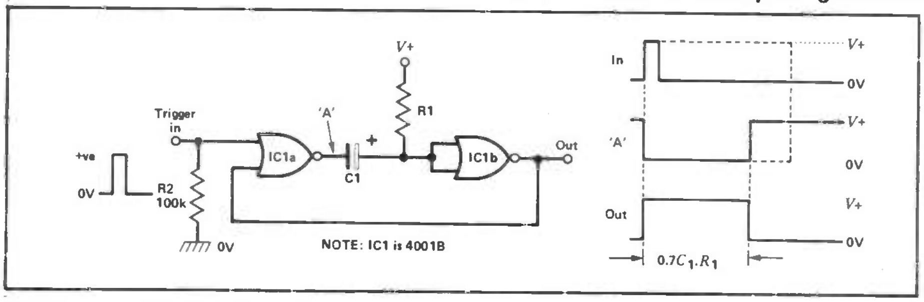


Figure 11: 2-gate NOR monostable is triggered by a positive-going signal and generates a positive-going output pulse.

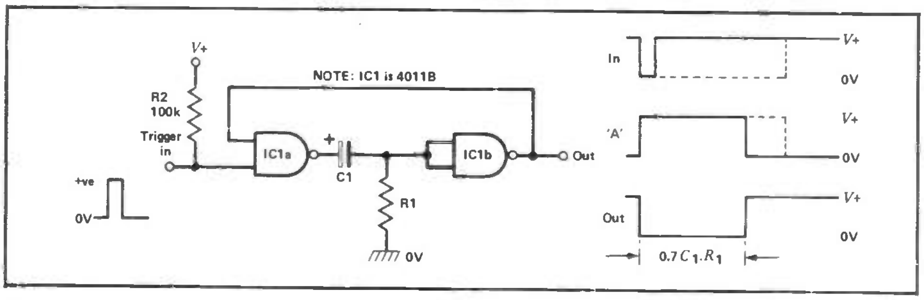


Figure 12: 2-gate NAND monostable is triggered by a negative-going signal and generates a negative-going output pulse.

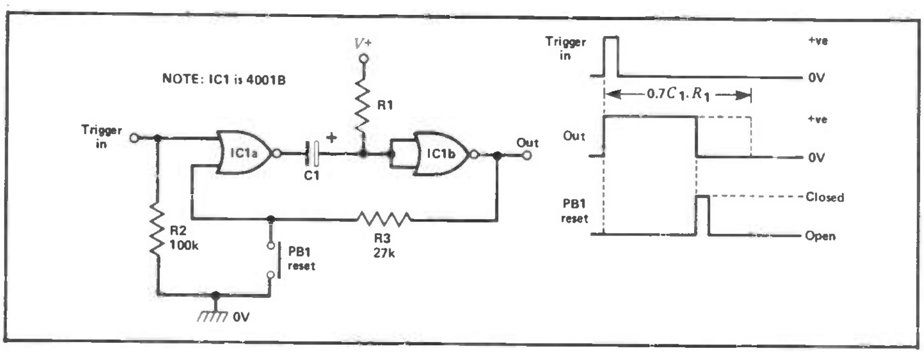


Figure 13: Resettable NOR-type monostable.

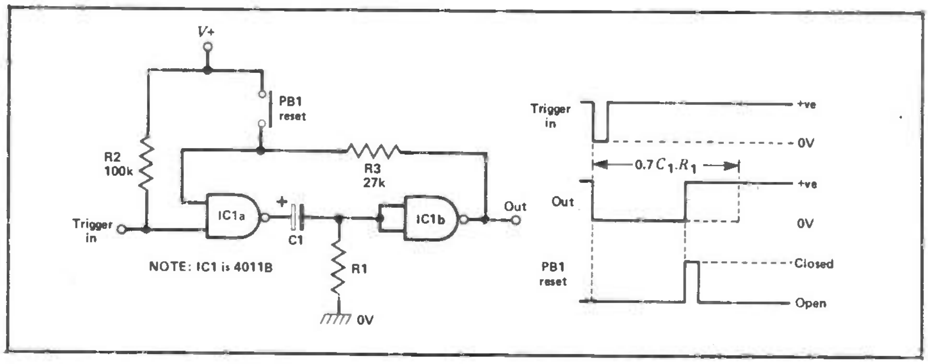


Figure 14: Resettable NAND-type monostable.

Schmitt output goes high, but when PB1 is released again, C1 discharges relatively slowly via R1 and the Schmitt output does not return low until roughly 20msec later. The circuit thus effecively ignores the transient switching effects of PB1 noise and contact bounce, etc and gives a clean output waveform.

The circuit shown in *Figure 10* produces a 700msec output pulse (suitable for resetting external circuitry, etc) when power is first connected. The circuit uses an inverting Schmitt. When power is first connected, C1 is discharged, thus pulling the Schmitt input low and driving the output high. C1 then charges via R1 until, after about 700msec, the C1 voltage rises to such a level that the Schmitt output switches low.

4001B and 4011B Monostables

The cheapest possible way of building a standard or resettable monstable circuit is to use a 4001B quad 2-input NOR gate or a 4011B quad 2-input NAND gate in one of the configurations shown in *Figures 11–14*. Note, however, that the output pulse widths of these circuits are subject to fairly large variations between individual ICs and to variations in supply rail voltage, and these circuits are thus not suitable for use in high-precision applications.

Figures 11 and 12 show the two alternative versions of the standard monostable circuit, each of which uses only two of the four gates that are available in the specified CMOS package. In these circuits, the duration of the output pulse is determined by the values of R1 and C1, and it approximates to $0.7C_1.R_1$. Thus when R1 has a value of IM5, the pulse period approximates one second per μF of C1. In practice, C1 can have any value from about 100pF to a few thousand μF, and R1 can have any value from 4k7 to 10M.

An outstanding feature of these circuits is that the input trigger pulse or signal can be direct coupled and its duration has little effect on the length of the generated output pulse. The NOR version of the circuit (*Figure 11*) has a normally-low output, and is triggered by the edge of a positive-going input signal, while the NAND version (*Figure 12*) has a normally-high output and is triggered by the edge of a negative-going input signal.

Another feature of these circuits is that the pulse signal appearing at point 'A' has a period equal to that of either the output pulse or the input trigger pulse, whichever is the greater of the two. This feature is of value when making pulse-length comparators, over-speed alarms, etc.

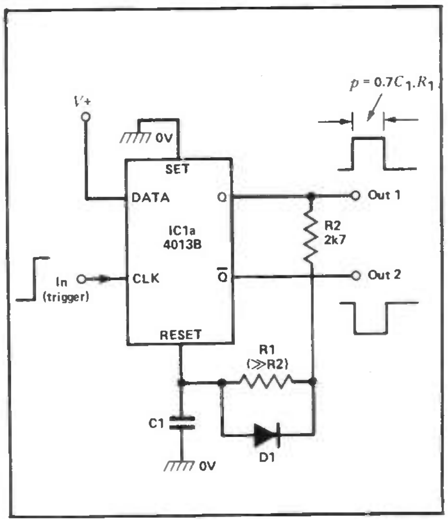


Figure 15: 'D'-type flip-flop used as a monostable.

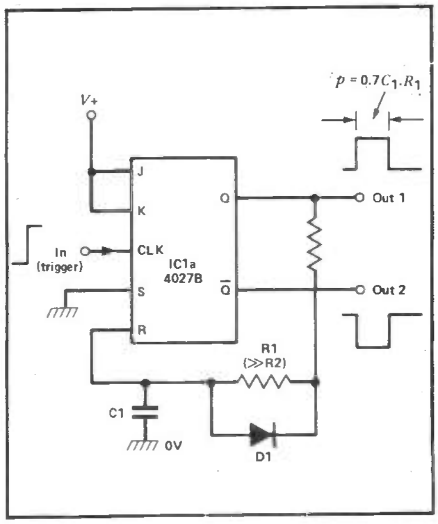


Figure 16: JK-type flip-flop used as a monostable.

The operating principle of these two circuits is fairly simple. Let us look first at the case of the circuit in *Figure 11*, in which IC1a is wired as a NOR gate and IC1b is wired as an invertor. When the circuit is in the quiescent state, the trigger input terminal is held low by R2 and the output of IC1b is also low. Thus both inputs of IC1a are low; so the IC1a output is forced high and C1 is discharged. When a positive trigger signal is applied to the circuit, the output of IC1a is immediately forced low and, since C1 is discharged at this moment, this pulls the input of IC1b low which thus drives the IC1b output high. IC1b's output is coupled back to the IC1a input, however, and this forces the IC1a output to remain low irrespective of the prevailing state of the input trigger signal. As soon as IC1a's output switches low, C1 starts to charge up via R1 and, after a delay determined by the values of these components, the voltage across C1 rises to such a level that the output of IC1b starts to swing low, terminating the output pulse. If the trigger signal is still high at this moment, the pulse terminates non-regeneratively but if the trigger signal is low (absent) at this moment the pulse terminates regeneratively.

The circuit shown in *Figure 12* operates in a manner similar to that described above, except that IC1a is wired as a NAND gate, with its trigger input terminal tied to the positive supply rail via R2, and the R1 timing resistor is taken to ground.

In both these circuits, the output is direct-coupled back to one input of IC1a to maintain, in effect, a 'trigger' input once the true trigger signal is removed, thereby giving semi-latching circuit operation. The circuits can be modified so that they act as resettable monostables by simply providing the circuits with a means of breaking this feedback path, as shown in *Figures 13 and 14*. Here, the feedback connection from the IC1b output to the IC1a input is made via R3. Consequently, once the circuit has been triggered *and the original trigger signal has been removed*, each circuit can be reset by forcing the feedback input of IC1a back to its normal quiescent state via push-button switch PB1. In practice, PB1 can easily be replaced by a transistor or CMOS switch, etc, enabling the RESET function to be accomplished via a suitable reset pulse.

'Flip-flop' Monostables

Medium-accuracy monostable circuits can easily be built by using standard edge-triggered CMOS flip-flop ICs,

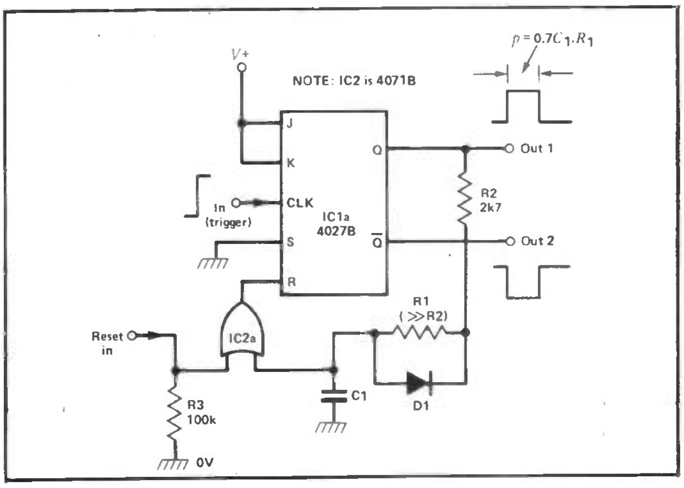


Figure 17: Resettable JK-type monostable.

such as the 4013B dual 'D'-type or the 4027B dual JK-type, in the configurations shown in *Figures 15 and 16*. Both of these circuits operate in the same basic way, with the IC wired in the 'divider' mode by suitable connection of its 'control' terminals (DATA and SET in the 4013B; J, K and SET in the 4027B), but with the Q terminal connected back to RESET via a RC time-delay network. The operating sequence of each circuit is as follows.

When the circuit is in its quiescent state, the Q output terminal is low and discharges the timing capacitor C1 via R2 and the parallel combination R1-D1. On the arrival of a sharply rising leading edge on the CLK terminal, the Q output flips high, and C1 starts to charge up via the series combination R1-R2 until eventually, after a delay that is determined mainly by the $C_1.R_1$ value (R_1 is large relative to R_2), the voltage across C1 rises to such a value that the flip-flop is forced to reset, driving the Q terminal low again. C1 then discharges rapidly via R2 and D1-R1, and the circuit is then ready to generate another output pulse on the arrival of the next trigger signal.

The timing period of the *Figure 15 and 16* circuits is roughly equal to $0.7C_1.R_1$, and the 'reset' period (the time taken for C1 to discharge at the end of each pulse) is roughly equal to $C_1.R_2$. In practice, R2 is used mainly to ▶

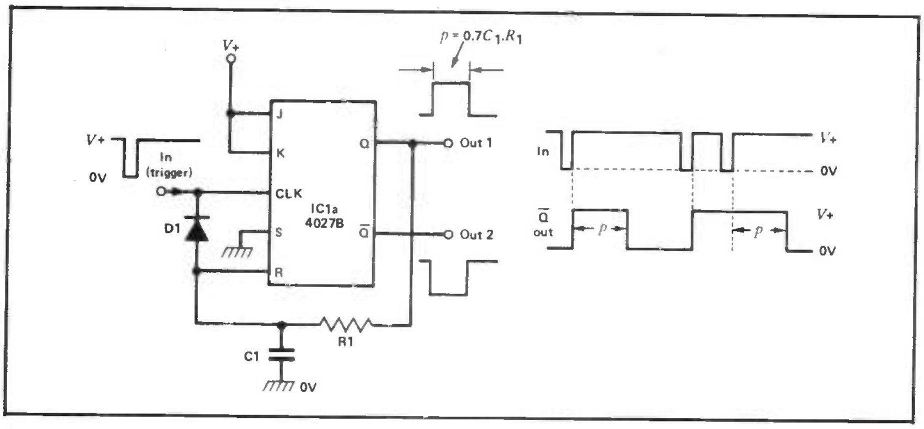


Figure 18: Retriggerable JK-type monostable.

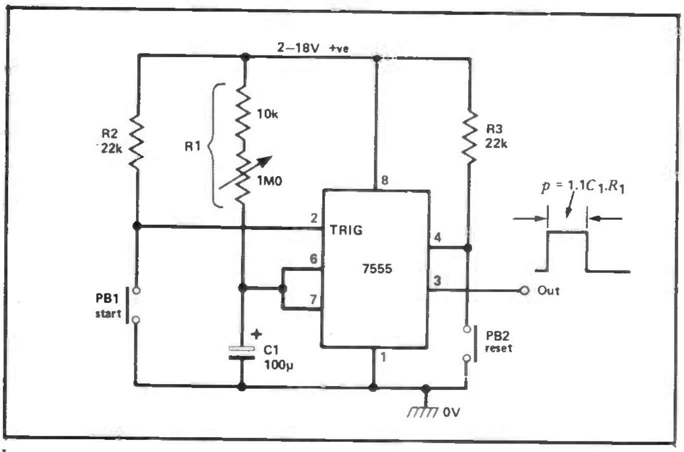


Figure 19: Manually-triggered 1.1–100sec monostable with reset facility.

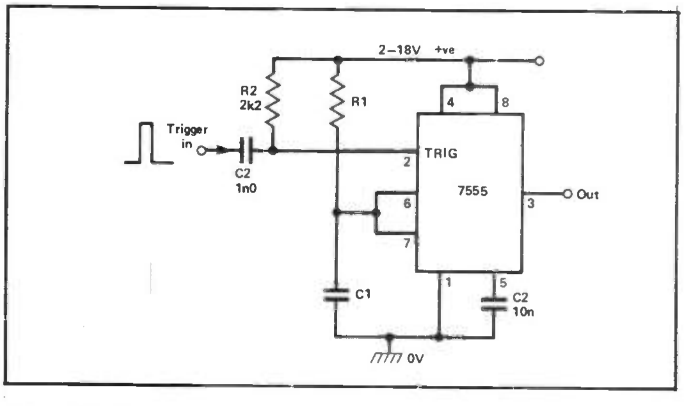


Figure 20: Simple electronically-triggered 7555 monostable.

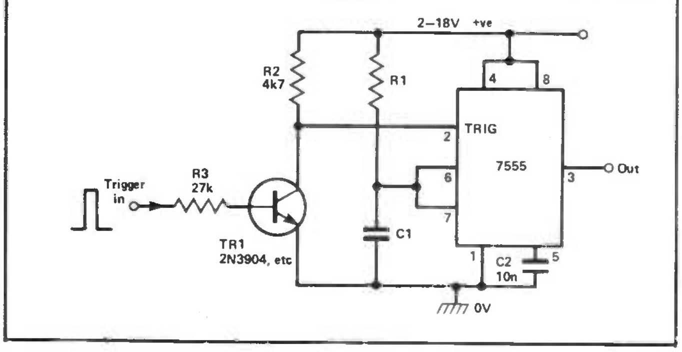


Figure 21: Pulse-triggered 7555 monostable.

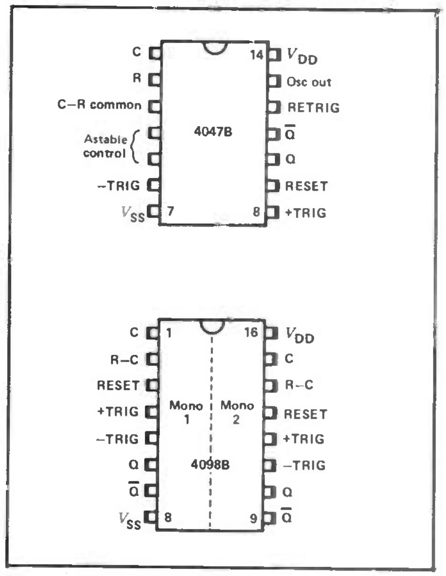


Figure 22: Outlines and pin notations of the 4047B monostable/astable IC and the 4098B dual monostable.

prevent degradation of the trailing edge of the pulse waveform as C1 discharges; R2 can be reduced to zero if this degradation is acceptable. Note that the circuit generates a positive-going output pulse at Q, and a negative-going pulse at Q̄, and the Q̄ waveform is not influenced by the value of R2.

Both these circuits can be made resettable by simply connecting C1 to the RESET terminal via one input of an OR gate, while using the input of the OR gate to accept the external 'reset' signal. *Figure 17* shows how the 4027B circuit can be so modified.

One last flip-flop circuit is given in *Figure 18* which shows how the 4027B can be used to make a retriggerable monostable, in which the pulse period restarts each time a new trigger pulse arrives. Note that the input of this circuit is normally high, and that the circuit is actually triggered on the trailing (rising) edge of a negative-going input pulse. The circuit operates as follows.

At the start of each timing cycle the input trigger pulse switches low and rapidly discharges capacitor C1 via D1 and then, a short time later, the trigger pulse switches high again, releasing C1 and simultaneously flipping the Q output high. The timing cycle then starts in the normal way, with C1 charging via R1 until the C1 voltage rises to such a level that the flip-flop resets, driving the Q output low again and slowly discharging C1 via R1. If a new trigger pulse arrives in the midst of a timing period (when Q is high and charging C1 via R1), C1 discharges rapidly via D1 on the low part of the trigger, and commences a new timing cycle as the input waveform switches high again. In practice, the input trigger pulse must be wide enough to fully discharge C1, but it should also be narrow relative to the width of the output pulse. The timing period of the output pulse equals $0.7C_1.R_1$. For best results, R1 should have as large a value as possible.

7555 Monostables

In all the monostable circuits that we've looked at so far, the width of the output pulse depends on the threshold

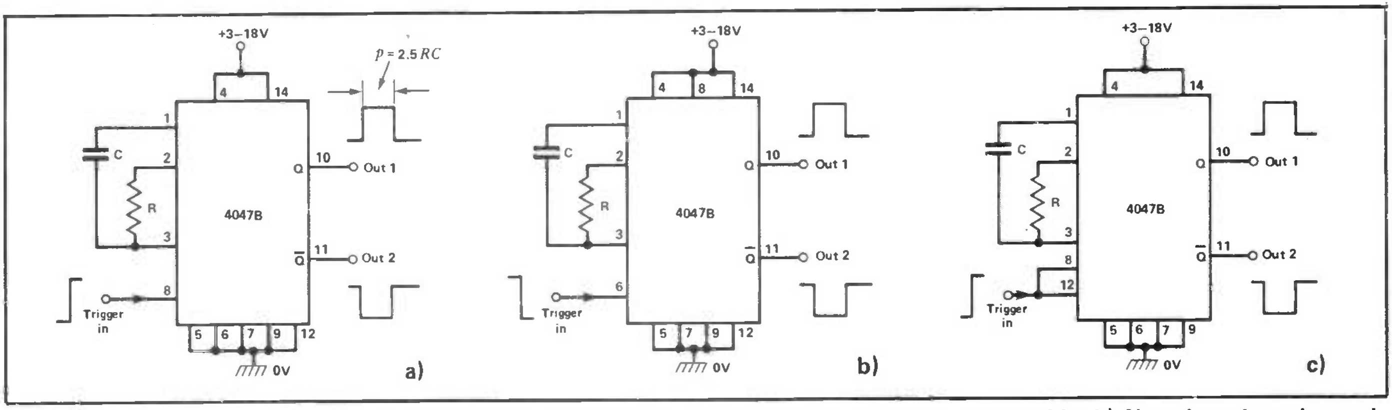


Figure 23: Various ways of using the 4047B as a monostable. a) Positive-edge triggered monostable. b) Negative-edge triggered monostable. c) Retriggerable monostable, positive-edge triggered.

switching value of the IC that is used, and this value is subject to considerable variation between individual ICs and to variations in supply voltage and temperature. These circuits thus have only moderate accuracy. If very high pulse-width accuracy is needed, the best way of getting it is to use a 7555 IC. This device is a CMOS version of the ubiquitous 555 timer chip and uses a built-in precision voltage comparator (referenced to the supply line) to activate internal flip-flops and thus control precisely the output pulse width irrespective of wide variations in supply rail value and temperature, etc. The 7555 can operate from supplies in the range 2—18V.

Figure 19 shows the basic way of using the 7555 as a manually triggered variable long-period pulse generator. Here, timing components R1 and C1 are wired between the supply rails and have their junction taken to pins 6 and 7 of the IC. The IC is triggered by briefly pulling pin 2 low (to less than $\frac{1}{3}V_{supply}$) via PB1, at which moment the output (pin 3) switches high and the IC enters its timing cycle, with C1 charging up via R1. Eventually, after a delay of $1.1C_1.R_1$, the voltage across C1 rises to the upper threshold switching vaue ($\frac{2}{3}V_{supply}$) of the 7555, and the output switches low abruptly, ending the timing cycle. The timing cycle can be terminated prematurely, if required, by briefly pulling RESET pin 4 low via PB2.

In most practical applications of the 7555 the designer will want to trigger the IC electronically, rather than mechanically, and in this case the trigger signal reaching pin 2 must be a carefully shaped negative-going pulse. Its amplitude must switch from an OFF value greater than $\frac{2}{3}V_{supply}$ to an ON value less than $\frac{1}{3}V_{supply}$ (triggering actually occurs as pin 2 drops through the $\frac{1}{3}V_{supply}$ value). The pulse width must be greater than 100nsec but less than that of the desired output pulse, so that the trigger pulse is removed by the time the monostable period ends.

One way of generating a suitable trigger signal from a rectangular input that switches fully between the supply rails is to connect the signal to pin 2 via a short-time-constant CR differentiating network, which converts the leading or trailing edge of the waveform into suitable trigger pulses, as shown in *Figure 20*.

The best possible way of triggering the 7555, however, is to use one of the previously described 'medium accuracy' monostables to generate a narrow (100nsec or greater) positive-going trigger pulse and then to couple this pulse to pin 2 of the 7555 via a direct-coupled transistor stage. *Figure 21* shows the connections. Note that C2 is used to decouple the trigger circuitry from the effects of supply line transients in both this and the previous circuit.

4047B and 4098B Monostables

A number of dedicated CMOS monostable ICs are available and are worth considering in some circuit applications. The best known of these devices are the 4047B monostable/astable IC, and the 4098B dual monostable (a greatly improved version of the 4528B); *Figure 22* shows the outlines and pin notations of these two devices.

It should be noted that the 4047B and 4098B monostables, like most of the CMOS circuits that we have already looked at, have rather poor pulse-width accuracy and stability. These devices are, however, quite versatile, and can be triggered by either the positive or the negative edge of an input signal, and can be used in either the standard (non-retriggerable) or the retriggerable mode.

The 4047B actually houses an astable multi and a divider stage, plus logic networks. When used in the monostable mode, the trigger signal actually starts the astable and resets the counter, driving its Q output high. After a number of RC controlled astable cycles, the counter flips over and simultaneously kills the astable and switches the Q output low. Consequently, the RC timing components produce relatively long ouput pulse periods, this period approximating to $2.5RC$.

In practice, R can have any value from 10k to 10M; C must be a non-polarised capacitor with a value greater than 1000pF. *Figures 23a and 23b* show how to connect the IC as a standard monostable triggered by either (a) positive or (b) negative input edges, while *Figure 23c* shows how to connect the monostable in the retriggerable mode. Note that these circuits can be reset at any time by pulling RESET pin 9 high.

The 4098B is a fairly simple dual monostable, in which the two mono sections share common supply connections but can otherwise be used independently. Mono 1 is housed on the left side (pins 1 to 7) of the IC, and mono 2 on the right side (pins 9 to 15) of the IC. The timing period of each mono is controlled by a single resistor (R) and capacitor (C), and it approximates to $0.5RC$. R can have any value from 5k0 to 10M, and C can have any value from 20pF to 100μF. ▶

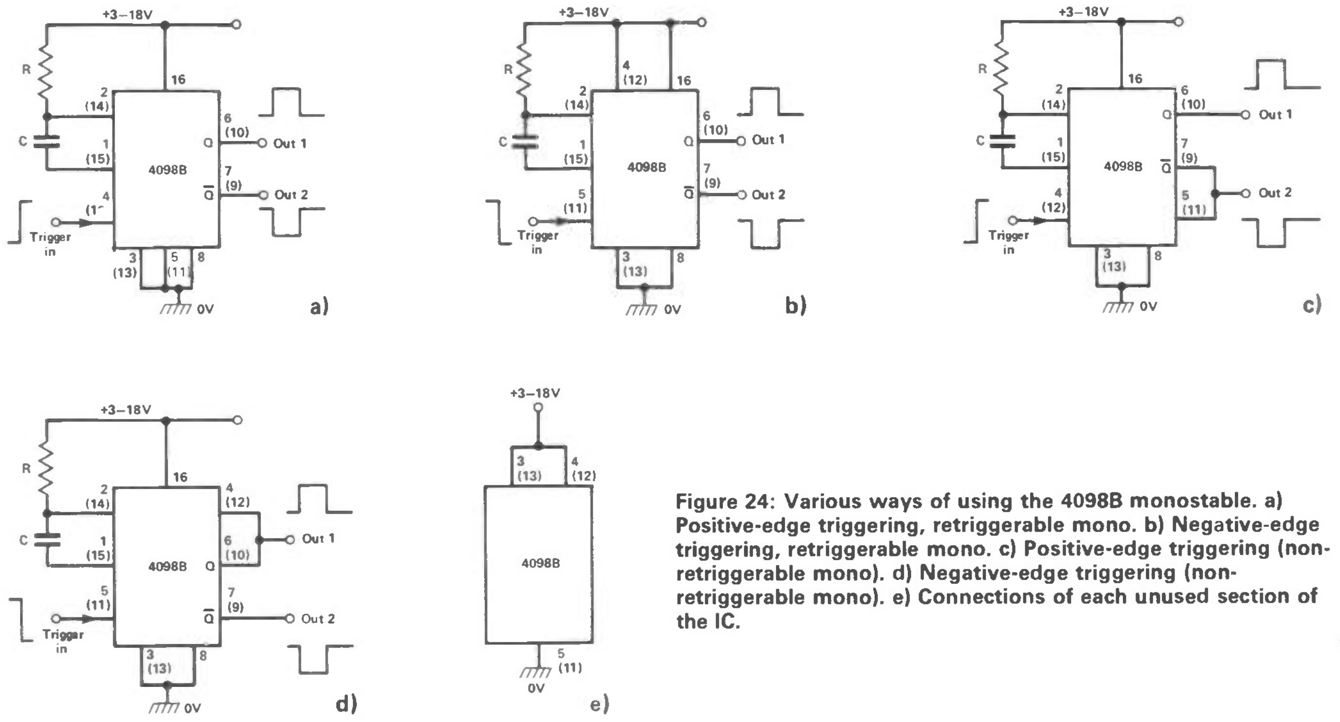


Figure 24: Various ways of using the 4098B monostable. a) Positive-edge triggering, retriggerable mono. b) Negative-edge triggering, retriggerable mono. c) Positive-edge triggering (non-retriggerable mono). d) Negative-edge triggering (non-retriggerable mono). e) Connections of each unused section of the IC.

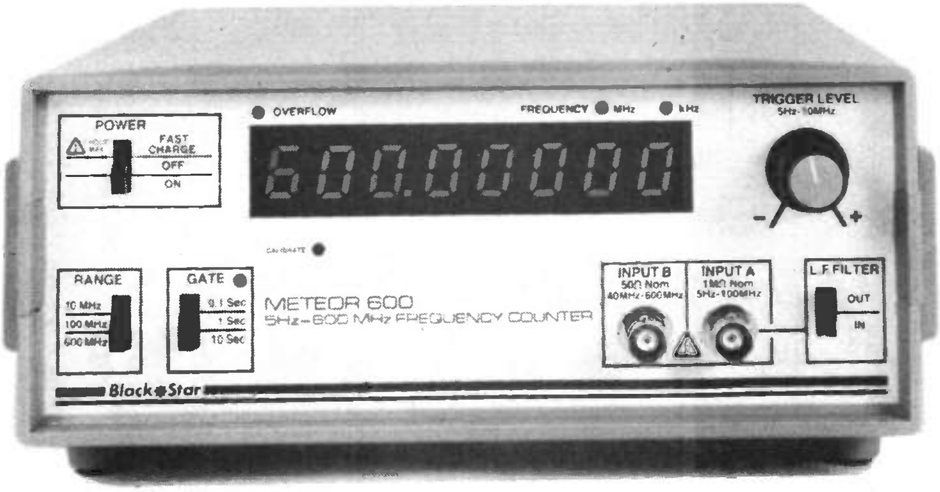
Figure 24 shows a variety of ways of using the 4098B. Note that in these diagrams the bracketed numbers relate to the pin connections of mono 2, and the plain numbers to mono 1, and that the RESET terminal is shown disabled (pin 3 or 13).

Figures 24a and 24b show how to use the IC to make retriggerable monostables that are triggered by positive or negative input edges respectively. In *Figure 24a*, the trigger signal is fed to the '+ TRIG' pin and the'−TRIG' pin is tied low; in *Figure 24b* the trigger signal is applied to the '−TRIG' pin and the '+TRIG' pin is tied high.

Figures 24c and 24d show how to use the IC to make standard (non-retriggerable) monostables that are triggered by positive or negative edges respectively. These circuits are similar to those mentioned above except that the unused trigger pin is coupled to either the Q or $\overline{Q}$ output, so that trigger pulses are blocked once a timing cycle has been initiated.

Finally, *Figure 24e* shows how the unused half of the IC must be connected when only a single monostable is wanted from the package: the '−TRIG' pin is tied low, and the '+TRIG' and RESET pins are tied high.

■ R&EW



Meteor 100, 600, 1000

John Mills reviews the Meteor range of low cost digital frequency counters, designed and built in the UK by Black Star.

The popularity of frequency counters has risen very sharply over the last five years, possibly as a result of the way the frequency response has been increasing while the price has been steadily decreasing. Following on, therefore, from its highly successful sales of imported counters, Black Star of St Ives, Cambridgeshire has recently announced a range of three counters, entirely designed and manufactured in the UK. Housed in a custom-designed grey plastic ABS case with integral tilt stand and battery compartment, the three models are designated Meteor 100 (100MHz), Meteor 600 (600MHz) and Meteor 1000 (1GHz).

The general finish of the counters is very good, particularly with regard to the case, and the front panel layout of all the inputs and controls is very tidy. The front panel has, in fact, been reverse printed to stop the control markings becoming erased through use.

The counter circuitry is provided on a single double-sided, plated-thru-hole PCB of extremely high quality. When this is mounted behind the metal/perspex front panel, it provides an extremely rigid unit to fit into the case.

The Controls

Four function switches are provided. One of these is a three position power switch that selects 'fast' charging for the NiCad batteries (if fitted); centre 'off' but trickle charge for NiCads if the external charger/eliminator is connected; and 'on' to feed power to the instrument either from the batteries or (preferentially) via the external eliminator. This position again provides trickle charging if NiCads are fitted. The charger/eliminator is supplied with the counters and not as an optional extra as is so often the case.

METEOR SERIES 8-DIGIT FREQUENCY COUNTERS
SPECIFICATIONS

	METEOR 100	METEOR 600	METEOR 1000
FREQUENCY RANGE	5Hz - 100MHz (Typically 2Hz to 120MHz) Switch selectable in 2 ranges with third range for ÷10 prescaler option	5Hz - 600MHz (Typically 2Hz - 700MHz) Switch selectable in 3 ranges	5Hz - 1000MHz (Typically 2Hz - 1.2GHz) Switch selectable in 3 ranges
MEASUREMENT ACCURACY	± (1 count + timebase accuracy)		
TIMEBASE Crystal Oscillator Frequency	10MHz		
Setability	<± 0.5 ppm Fully calibrated before leaving factory. Front panel access for any future adjustment.		
Temperature Stability	Typically <± 2.5ppm from + 10°C to + 40°C		
Aging	<± 10ppm/year		
Time between Measurements	200 mS		
GATE TIMES	0.1 sec., 1 sec., 10 sec., switch selectable with L.E.D. Gate status indication		
LOW FREQUENCY (Input A) Ranges	5Hz - 10MHz, 10MHz - 100MHz		
Input Impedance	1MΩ//30pf nom. (Low Frequency Filter - 'Out')		
Maximum Input Voltage	50VDC or 250V rms @ 50Hz decreasing to 5V rms @ 70kHz and above		
Sensitivity	10MHz range < 5mV 5Hz - 10MHz; 100MHz range < 10mV 10MHz - 50MHz; < 25mV 50MHz - 100MHz		
Resolution	10MHz Range 10Hz - 0.1 sec. Gate Time; 1Hz - 1 sec. Gate Time; 0.1Hz - 10 sec Gate Time. 100MHz Range 100Hz - 0.1 sec Gate Time; 10Hz – 1 sec Gate Time; 1Hz - 10 sec Gate Time		
Low Frequency Filter	Cut-off frequency 50kHz nom. from source impedance of <50Ω Switch selectable 'In' or 'Out'		
Trigger Level	Front panel adjustment of Trigger Level on signals 5Hz – 10MHz		
HIGH FREQUENCY (Input B) Range		40MHz - 600MHz	40MHz - 1GHz
Input Impedance		50Ω nom.	
Maximum Input Voltage		50VDC or 250V rms @ 50Hz decreasing to 2V rms @ 50MHz and above	
Sensitivity		<25mV 40MHz to 600MHz	<25mV 40MHz - 600MHz; <50mV up to 1GHz
Resolution		1kHz - 0.1 sec. Gate Time; 100Hz - 1 sec. Gate Time; 10Hz - 10 sec. Gate Time	
GENERAL Display	8 - Digit 0.5" 7 - segment L.E.D. Display with automatic decimal point and leading zero suppression. Frequency unit (kHz or MHz) indication by L.E.D. and Overflow warning by L.E.D.		
Power Requirements	9V DC @ (max) 600mA. Operation by Mains Adaptor/Charger (supplied) or 6 x NI-CAD 'C' Cells (optional)		
Battery Life	Typically 6 hours (100MHz range using 1.2Ah cells)		
Charging Rate	'On' or 'Off' 50mA nom., 'Fast Charge' 340mA nom.		
Environmental operating range	0°C to + 40°C (10% - 80% RH non-condensing)		
Case	Custom-moulded, sturdy, lightweight A.B.S. with tilt-stand and internal battery compartment with rear panel access.		
Size	219mm x 240mm x 98mm (Product only) 321mm x 352mm x 174mm (Packed)		
Weight	980g (Product only) 1.9Kg (Packed)		
Supplied Accessories	Mains Adaptor/Charger and Instruction Manual		
Optional Accessories	Set NI-CAD Rechargeable Cells; Passive Probes; External Reference Input Facility (10MHz); Prescalers; Telescopic R.F. Pick-up Antenna; B.N.C. - B.N.C. Coax Leads; Service Manual		

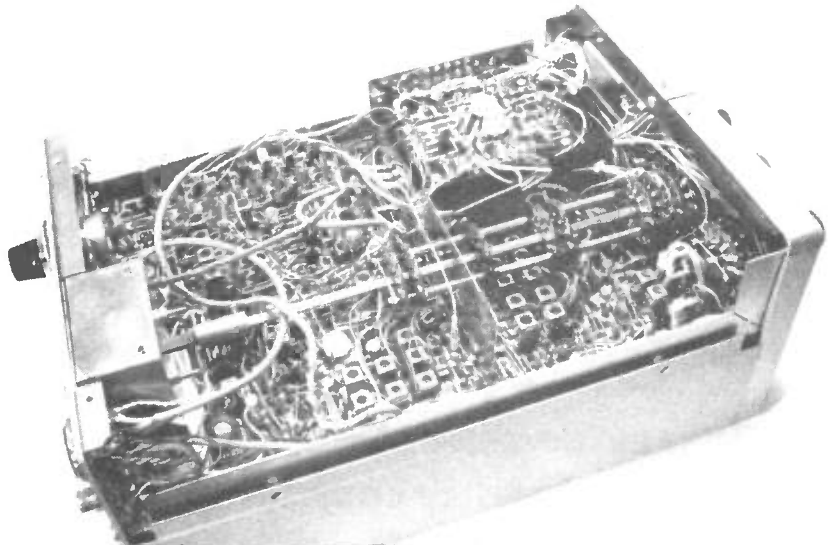
A word of warning regarding the 'fast' charge setting: no facility is provided to sense when the NiCads are fully charged and the manual provided therefore recommends that this position is never used for more than 1hr and then only for fully discharged NiCads.

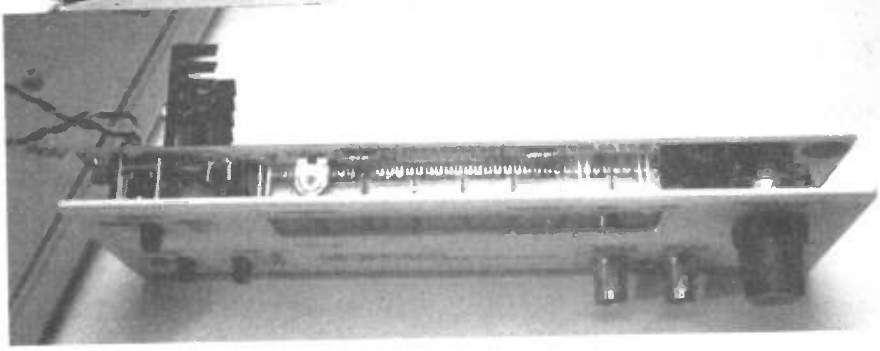
A second control is a 'range' switch that selects through its three positions 10MHz, 100MHz and external prescaler/600MHz/1GHz respectively, the latter selection depending on the model concerned. A further three-position 'gate' switch selects either 0.1sec, 1sec or 10sec gate times. The maximum resolution obtainable with these gate times is evidently 0.1Hz, 1Hz and 10Hz respectively.

A single BNC input on the Meteor 100 provides a nominal 1MΩ impedance over the range 5Hz to 100MHz. On the Meteor 600, a second BNC input ensures 40MHz to 600MHz input at 50Ω impedance, whilst the same input is employed on the Meteor 1000 model for operation at up to 1GHz.

Two extra facilities are available on all three versions for use with low frequency input (5Hz to 100MHz). One is a switched LF filter — provided to filter out any RF signals entering the counter. The filter is of the low pass single pole variety with a response typically of −3dB at 50kHz when fed from a low impedance source. This facility is particularly helpful when attempting to measure audio frequencies.

The other facility is the trigger level fitted for use on this range which operates in a similar way to those found on oscilloscopes. Its role is to enable the threshold of the squaring circuit to be moved to either the positive or negative part of the signal, thus allowing the user to overcome miscounts caused by poor or distorted input waveforms, ringing, overshoot or noise etc.





The Ins and Outs

A large 0.5″ LED display is provided. The only concern here is that the brightness may not be quite sufficient for use in direct sunlight. Normal ambient lighting conditions, however, should not cause any problems.

3mm LED indicators are also provided to give 'overflow', 'kHz', 'MHz' and 'gate open' indications.

To the rear of each counter is a battery compartment which can house six 'C' size NiCads or equivalent dry cells. A small DC socket facilitates power input from the external charger, while a further optional extra provides input and switching for use with an external frequency reference oscillator.

Accessories

A range of optional accessories are offered for use with the counters as detailed in the specification. In addition, a very well written and illustrated 12-page instruction manual is automatically supplied, together with a one year warranty. The latter covers defects in the material and the workmanship, provided the unit has been used in accordance with the instructions and has not been modified or otherwise abused.

Prices (at the time of publication) start at £104.07 inc for the Meteor 100, and rise to £133.97 inc for the 600 and £184.57 inc for the 1000: it is advisable to contact Black Star, 9a Crown Street, St Ives, Cambridgeshire to check whether these prices are still current or to obtain further information.

In Operation

The Meteor 1000 supplied for review was found to be very easy to use, possessing excellent sensitivity in all applications. The mains eliminator being supplied with the unit saved all the usual problems with batteries, etc that are experienced before using some units with 'optional extras'. The tilt stand supplied is not the usual flimsy affair and provides solid positioning for the unit when used on the bench.

Using a small telescopic antenna, the counter measured readily and accurately the output from 144MHz and 432MHz handheld transmitters. Measurements on audio frequencies were certainly helped by the LF filter provided and when used in conjunction with the trigger control it appeared impossible to find any signal sources that the unit would not accept.

For the asking price/specification it seems to the reviewer that the Meteor range will be hard to beat.

■ R&EW

Personal Pearl: Computing for all?

A relational database management program for CP/M80, CP/M86 and MSDOS that claims omnipotence when it comes to solving database management problems. Can it all be true?

Casting Pearls.....

We received a press release from the UK purveyors of the 'Personal Pearl' the other day. It made a few claims about its capabilities that prompted us to take a user's-eye view of its worth. Surveys show that our readers are more specifically computer users than aficionados, and a program that claims to permit the 'user of a microcomputer to actually do something more useful than word processing and canned programming' is playing our tune to begin with.

You may also recall the burst of publicity surrounding the launch of a computer program called the 'Last One'. The 'Last One' claimed to be the ultimate in microcomputer applications programming, suggesting that it was capable of generating programs using 'user friendly' menu techniques. 'Personal Pearl' is cast in a similar mould, operating via a barrage of menus to produce customised information management.

Basically, Personal Pearl allows the user to define and enter data records (files), and then to manipulate this information to produce abstractions, collations and summaries (reports). The classic application is a mailing list manager, where the files may contain all sorts of additional information (nature of business, credit rating, inside leg, etc), but where the report can be customised to select only the name and address details.

Personal Pearl is not (yet) for the likes of the ZX81 or Spectrum. It consumes a prodigious amount of disk memory – 400Kbyte spread over two disks. But it seems fair to assume that it will become available to even 'simple' systems within a very short space of time. Personal Pearl is a good example of the difference between a program that has to be all things to all users and one that is very specific – and the chances are that any one 'customised' application could be compressed into 16K. You don't have to thumb through all the menus to get to the bits you want to use: a quick entry technique is available from the system prompt to most of the actual user functions, and regular users will rapidly catch on to the value of this approach.

What you see is what you get

One of the most frustrating things about 'cheap' micro applications programs is the way in which the screen display and the 'printed' result are frequently two different things. Anyone that has ever used a computer word processing program that displays on the screen as it prints on the paper, versus one that prints on the paper according to format commands buried in the text – i.e. not necessarily as shown on-screen – will immediately grasp the relevance of this principle. It's usually the difference between a letter that fits tidily onto a single sheet, and one where the last line is printed on the platten. The Pearl system allows for several pages (memory dependent) of screen per record, permitting relaxed screen designs, without overcrowding.

Personal Pearl is also a transactional system. Each data file that is defined may access up to five other files (depending on the user memory available after loading CP/M). Exactly how these files are arranged ▶

```
FORM LAYOUT (PAGE 1) FOR ARNADD1
-----------------------------------------------------------
Company name    ________________________________1
Contact name    ________________________________2
Address 1       ________________________________3
Address 2       ________________________________4
Post town       _____________________5 PC _______6
County          ___________7 Country __________9
Tel no          ___________9 Telex  __________10
Fax or other    ________________________________11

-----------------------------------------------------------
INPUT AREA ATTRIBUTES:

1  DATA AREA NAME: CONAME
   DATA AREA TYPE: CHARACTER

   ___________________________________
   12345678901234567890123456789012345
            1         2         3
   REQUIRED DATA
   DATA AREA IS NON UNIQUE INDEX

2  DATA AREA NAME: CONTACT
   DATA AREA TYPE: CHARACTER

   ___________________________________
   12345678901234567890123456789012345
            1         2         3

3  DATA AREA NAME: ADRS1
   DATA AREA TYPE: CHARACTER

   ___________________________________
   12345678901234567890123456789012345
            1         2         3
   REQUIRED DATA

4  DATA AREA NAME: ADRS2
   DATA AREA TYPE: CHARACTER

   ___________________________________
   12345678901234567890123456789012345
            1         2         3

5  DATA AREA NAME: TOWN
   DATA AREA TYPE: CHARACTER

   ______________________
   1234567890123456789012
            1         2
   REQUIRED DATA

6  DATA AREA NAME: PCODE
   DATA AREA TYPE: CHARACTER

   _________
   123456789

7  DATA AREA NAME: COUNTY
   DATA AREA TYPE: CHARACTER

   ______________
   12345678901234
            1

8  DATA AREA NAME: COUNTRY
   DATA AREA TYPE: CHARACTER

   ____________
   123456789012
            1

9  DATA AREA NAME: TELNO
   DATA AREA TYPE: CHARACTER

   ______________
   12345678901234
            1

10 DATA AREA NAME: TELEX
   DATA AREA TYPE: CHARACTER

   ____________
   123456789012
            1

11 DATA AREA NAME: FAX
   DATA AREA TYPE: CHARACTER

   ___________________________________
   12345678901234567890123456789012345
            1         2         3
```

Figure 1: A typical Pearl form.

depends only on the whim and ingenuity of the user, and as the same file can reference up to five different files at report time, there is sufficient complexity to keep the most devious system designer happy!

The program handles all normal business calculations either on entry, or as part of report production, with no restriction on the placing of the fields contributing to the calculations. They can even 'live' on other files that are part of the system.

So what?

So, to take an example that all amateur radio enthusiasts can relate to, suppose you want to maintain a record of all the stations you have contacted, their locations, and the last time you worked them.

Start by designing the layout of the record entry, using the text editor provided. The screen is split into an upper working area, and a lower command and prompt area. Features on the Z19/H89 terminal are put to good use.

Next define which entries on the form are to be used for data, and which are simply for text: then set the entries on the record that are to be selected when the records are sorted. Data can be provided from other forms (a master file of names and addresses, for example).

Then finally you install the form, via a process which verifies that you haven't asked for the impossible. If you have, then the system does not simply crash, but prompts with suggestions on what needs to be done to fix the problem before installation can be completed.

This successfully done, you can print a 'proof copy' using the CP/M control-P command, the result of which is shown in *Figure 1*. As you can see, this is a simple mailing list management program. The printed information seems to be a great deal more than can be obtained by merely peering at the VDU, and should be produced and filed away as reference for each form created. (The layout entries indicated by underscores represent protected fields within the input form.)

First enter your data

Either before or after the database is duly nourished by the input of information, you may set about designing the 'report' layout. This entails basically the same process as the input form, but in this case the result will determine the nature of the summary output. This can be printed as a 'fixed' report (one per page), a 'list' report (as many entries per page as will fit), or a SuperCalc format file that provides data directly entered into the format of a SuperCalc spreadsheet program. The list report, for example, covers headers and footers, subtotals, widths up to 132 characters, data from up to five files and sorting using multiple keys.

In comparison to a really sophisticated database management program, one of the drawbacks of Pearl is the problem of 'random access' to a file member. It would be helpful if when entering names, for example, the system responded if that name already existed so that duplication could readily be avoided. Under the input editing facility of Pearl it's possible to access a record by entering a key – but this is an area that begins to disappear into a seemingly endless list of advanced features that are carefully kept hidden from beginners by virtue of the way the instruction manuals are presented.

There is a beginners' manual, which your reviewer 'cracked' inside about an hour of interrupted effort; then there's the advanced tutorial, which is not so straightforward; and then there's the reference manual, which is primarily for those familiar with the programming of their system at least at the CP/M level.

The story so far

Users are advised to take things in stages. Like 'Wordstar', Pearl is a program that can readily be put to use, but whose full potential only begins to emerge after a lot of practice and many browsings of the main manual. Indeed, to attempt to present the definitive review of a product so vast and full of potential as Pearl with less than 200 hours user experience is very dangerous. It's akin to passing judgement on a Ferrari after driving it round the block once.

In terms of database management, Pearl does not set out to put Prestel out of business. It isn't the last word in data manipulation (particularly in terms of on-line retrieval), but it is enormously good value for money if you are trying to operate a small business, or manage a sub-section of a larger business where central services are either inaccessible or inadequate.

Pearl runs happily under TurboDos (our multi-user version of CP/M), indicating that the people who wrote it stuck more religiously to the spec of CP/M than some programs we have tried.

Pearl gobbles up disk space. To make the most use with the least hassle, you will need a hard disk or floppies with 500K+ capacity. At least, this reviewer would take a good deal of convincing to the contrary.

The program should certainly help users to form a far better appreciation of what they actually want/need from their applications software – and it's quite possible that familiarity with this program will lead on to a desire for a solution relating more specifically to the format of the application.

The manuals available for Pearl are about the size of the latest BBC Computer user manual, and although there's always room for improvement, they are adequate for the market the product is supplying. Support is enthusiastic and helpful (when it can be reached), and the product is generally sufficiently well refined, tried and tested that anything the user thinks he's identified as being a bug is more likely to be a misinterpretation of the instructions.

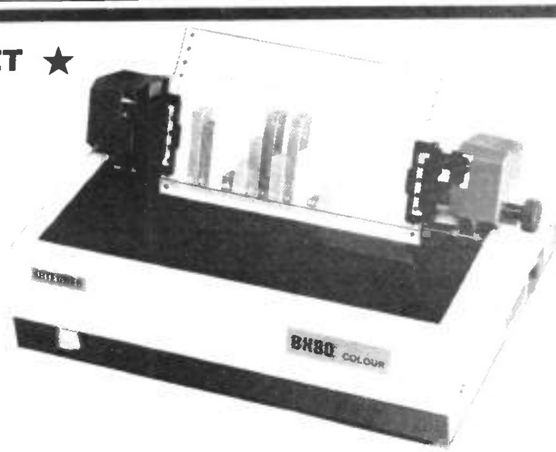
Each copy of Pearl comes with a built-in set of demonstrations, giving a combined tutorial and demonstration of Pearl's power. If that is not enough, Pearl Software offers comprehensive training sessions, from its premises in Bournemouth, for both computer users and total beginners.

On reflection

Personal Pearl is not a new product. It has been in use for over 18 months and has a worldwide user base of well over 20,000. However it is only a starter product, and will be joined this winter by some much more advanced database products, all upwardly compatible with Personal Pearl produced files. The first of these, which may be out by the time you read this, is a complete System Developer's Toolkit, allowing Pearl systems to be converted to fully menu driven systems, with pre-defined grouping of data entry and reporting into defined procedures – Month End, Year End etc. It will also contain a File Load facility (also available separately now in a Beta test version) that will allow Pearl to read pre-existing files produced by other software, or to read its own report output files back into its own database, thus allowing batch updating of data files and the creation of balance forward accounting systems and the like.

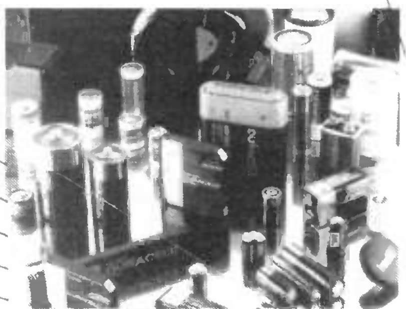
Personal Pearl costs £190 from Pearl Software, Teacher's House, Christchurch Road, Bournemouth (Tel: 0202 20692/3) and our thanks for the opportunity to review the product. If anyone has invented a program that adds an extra day onto the working week so that we can have enough time to review such products in depth, then please let us know.

■ R&EW



Next Month

The Secrets of Duracell Batteries
within a discussion of batteries of all types



A more considered look at
Sinclair's Flat TV

RADIO & ELECTRONICS WORLD

Metal Detectors in Warfare
— by no means just mine locators

Tantalum Capacitors
— structure and fabrication

PLUS:

More about front ends
Testing the Poor Man's Spectrum Analyser
A 4001/4011 tester — to be built in an evening

in the

December Edition
On Sale
11th November

Please note that the Articles mentioned here are scheduled for the December issue but circumstances may dictate alterations to the final content of the magazine.

THE COMPLETE MAGAZINE FOR ELECTRONICS, COMMUNICATIONS & COMPUTING

Western

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the discerning DX-operator ... or ... DX-SWL

... the TS-930s, £1199 *... and ...* *R-1000 £279*

Since, at 'WESTERN', we sell both Yaesu and Kenwood, we do not try to push a prospective purchaser into a particular brand of equipment ... we have no 'axe to grind' one way or the other. Our M.D. (He's spoilt! He just takes home what he fancies for a trial evaluation!) thought he'd try the top of ranges FT-1 and TS-930S. He promptly brought the FT-1 back to the stock-room (Mr. Hasegawa, please note!). Then he took the FT-102. He hitched the FT-102 and TS-930S up together but brought the FT-102 back. Said he'd got too old and lazy to bother with controls like PA Tune, PA Load, Pre-selection tuning, when the TS-930S does the same job with less knobs. He's grown to like the 930S so much he hasn't tried it against the Yaesu FT-980 — although no doubt it's only a matter of time (The FT-102 is back in the demonstration room!). The 'Noise Blanker' really cuts old 'Woody Woodpecker' down to size! UA's will have to find something new to annoy a TS-930S owner.

How often have you found a rare DX-station only to discover he has a good pile-up too! With the '930' you just press 'M In' and store his frequency in the memory and carry on tuning round on QSO elsewhere. Then to come back smack onto the rare DX you just select 'Memory' instead of the VFO, and up pops your DX station. Since there are 8 Memory channels there are more than enough for anyone!

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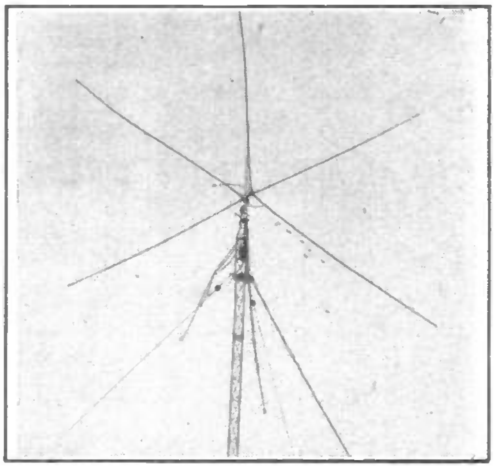

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The above are a few of the reports and comments received over the course of a few hours operating. They (or the antenna!) speak for themselves. When you up-grade your antenna system to a quad, you'll only have one regret... and that's not having done it sooner! Send SAE for specification.

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DX-103 3-element, 10m
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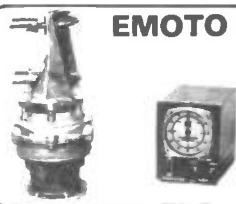

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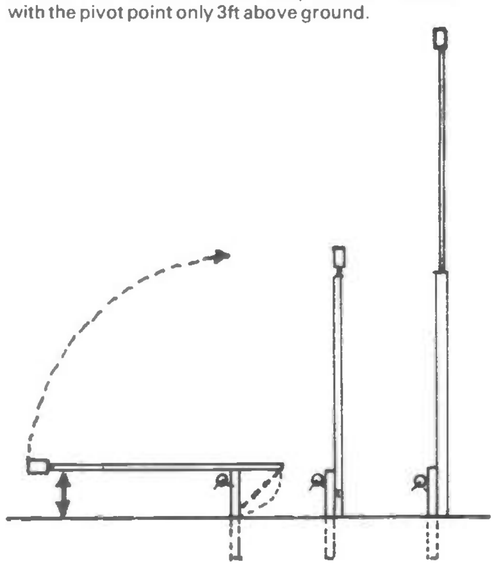

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ATV on the Air

PRESENTED BY

ANDY EMMERSON, G8PTH

It's back to basics this month, but before I launch into them, a couple of points need picking up from last month's column. One is that the Videomatte VM-1 video mixer and special effects generator is now available, and the price is £280 plus VAT. I have had a play with one and it's excellent; you will see a review in *What Video* shortly. As I said last month, it is clearly too expensive for merely amateur use but if you are involved in video as a paying hobby as well (e.g. filming weddings and the like) the VM-1 would give you a chance to smarten up your productions and have a bit of fun too. The other is to remind you about the BATC's amateur TV day-out in Leicester on 20th November (details were given last month).

Now down to business. Amateur television combines two technologies — wireless and video. Some people come into ATV after years of amateur radio and, while the RF side of things is no problem, the video side is not so familiar. Video has a vocabulary of its own and it is as well to get to know this. The finer points of video circuitry and connecting up baseband video devices come as second nature to people who have beeen on BBC training courses, but to mere mortals, well ... we all have to learn some time.

Video

Video is one of those signals which has been standardised around the world. It is a positive going signal (i.e. positive with respect to ground) and measures around 1V peak to peak. If the signal is spoken of as 'composite', it means that the complete signal contains blanking and synchronising signals as well as 'raw video'. The blanking signal tells the display monitor or TV receiver when it should turn off the picture ready for the 'sync' or synchronising signal (which tells it to fly back to start the next line or frame). Composite video is sometimes abbreviated to VBS, while the 'non-composite' signal (without sync) is VB. Raw video on its own is V.

Normally the sync to video ratio is 30:70, so that 0.3V of the signal is sync and 0.7V is blanked video. Non-composite video, i.e. with the sync stripped off, is often used where switching or mixing of the picture is to take place. Sync is then added at the last stage, prior to transmission, because this ensures that no picture break-up occurs due to unequal sync levels. Within digital circuits, video may be at the 5V level because it has been generated by TTL or CMOS ICs, but before being used 'in the real world', it is processed to return it to the regular 1V level.

In any professional video system there is just one source of uniform synchronising and other pulses, so that all picture sources are in step. Many amateur circuits use the same pulses and it is worth knowing their names. They may be derived from a central sync pulse generator (SPG) or by stripping them off a source of video which is acknowledged to be the master signal (genlocking). The main pulses are:

Line or horizontal drive (abbreviated to LD or HD) which signifies the start of the left-to-right element of the picture, and in the standard 625-line TV system it has a frequency of 15.625kHz.

Field or vertical drive (FD, VD) which times the vertical element of the image and occurs at the 'top lefthand' of the picture. It is normally the same as the mains frequency (but not locked to it except in the case of low-cost surveillance cameras). In Europe it is 50Hz.

Mixed blanking pulses (MB) which set the blanking period of the TV picture (when the picture should be dark), ready for flyback of the scanning beam.

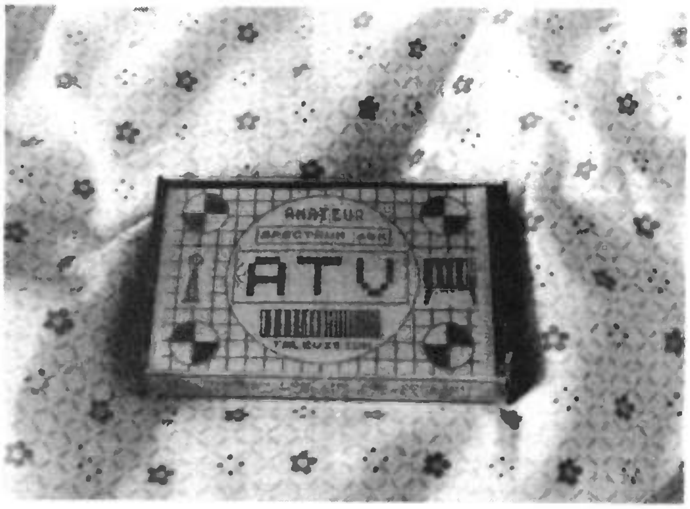
Mixed or combined sync (MS, CS) which is the total synchronising signal that actually triggers the synchronising circuitry in a receiver or monitor.

Burst gate or flag (BG, BF) which is the colour burst signal that synchronises the colour circuitry, and is omitted in monochrome set-ups.

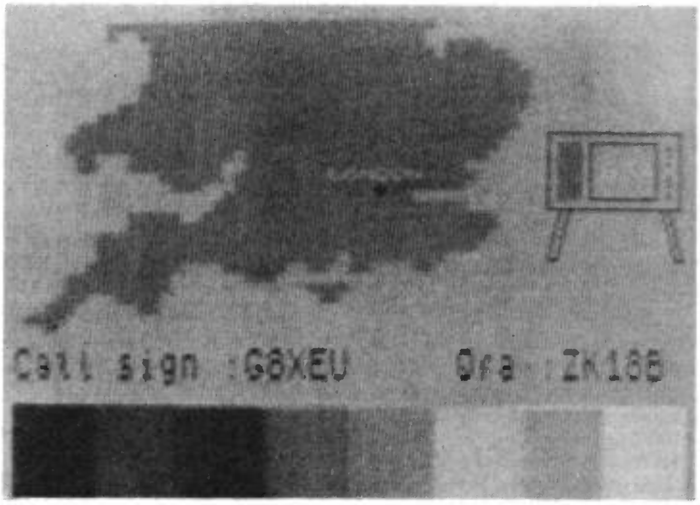
Whereas video is distributed at a level of 1V, pulses are pumped round at 2V (British practice) or 4V (American and Japanese practice; also on much Pye equipment, which was designed with export in mind). In amateur shacks, pulses are often left at TTL level.

Peripheral Hardware

Video contains frequencies up to 4.5MHz and therefore needs treating like RF. To avoid radiation and attenuation problems, connectors and cables for distributing video and pulses should be coaxial and of 75Ω impedance. The 'bootlace' variety of TV feeder,



To go on your Spectrum....



To appear on your screen

useless for aerials, is ideal and cheap, while UHF-type connectors are adequate. Professional video equipment used to employ UHF connectors as well (though nowadays the connectors are BNC), and you may well choose to use UHF connectors because they are cheap and the chances are that any surplus video equipment you buy will also have them. Belling Lee-type plugs and sockets are not recommended for this purpose as they wear loose in time and are not sufficiently robust for frequent use.

If digital signals are being pumped down coax, a 74128 line driver IC should be used between the source and the cable to avoid strange loading effects. All video and pulse signals must be 'terminated' in a 75Ω resistance to avoid instability and reflection problems. To avoid having to provide large numbers of pulse and video feeds it is normal to 'loop through' signals and terminate them only once. In plain English, this means that devices needing a signal have two sockets in parallel and a switch which can connect a 75Ω resistor. If you are looping through, the terminating resistor is not connected: the signal sees only a high impedance and passes on to the next device connected. The monitor or whatever in the meantime has 'sniffed off' sufficient signal, without loading up the feed. So the line is only terminated (in 75Ω) at the end of the chain, and in this way the proper level of signal is maintained.

Racks and cabinets are not standardised in ATV. Professional equipment is likely to come in 19" racks and if you intend to mix these with homebrew apparatus, surplus cabinets can be found to house these. They are of course a bit bulky and many amateurs prefer to build self-contained projects in plastic veroboxes or aluminium cases. Printed circuit boards produced by the BATC have up to now been 122 × 177mm to match professional equipment, but since the latter seems to come in Eurocard format these days the BATC will probably change as well.

Those wishing to learn more about how television works should find the two volumes of the 'Amateur Television Handbook' (published by the BATC) helpful, along with the 'Video Handbook' by Ruw van Wesel (Newnes) which has been written with the home constructor in mind. There are also plenty of textbooks on TV in public libraries, but these may be too technical for the beginner or casual enthusiast.

A Computer Program

Changing the subject, I must mention a computer program for ATVers. It has been written for the Sinclair Spectrum computer and it's amazing ... I have a BBC micro myself and I never knew that Spectrums could produce such good pictures. The program, which is for the 16K and 48K versions of the computer comes complete with instructions. It provides a colour testcard, callsign and QRA information, a Union Jack and two maps of the southern half of the UK. Also included are a number of test patterns, colour bars, pretty pictures and more — 25 features in all. Moreover, you can do large letter or full screen single characters.

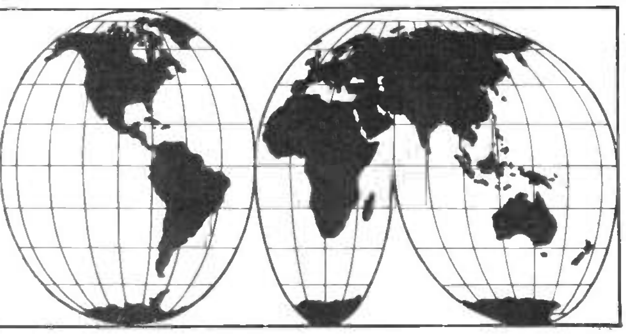
You get all this for £5.50, which includes postage and packing. Once Microdrives are widely available, the program will also appear in this format for £10. The author is Robin Stephens G8XEU and he has produced an excellent program to my eyes. Fortunately he is planning BBC and Dragon versions as well. All funds go to the Worthing 24cm ATV repeater project. Robin has also written some other programs and these are also available in aid of club funds. A QRA calculator program for the ZX81, Spectrum, Dragon and BBC is going for £2.50 including P&P and a tape with a radio-orientated database on one side and a morse tutor on the other.

The pictures this month show the tape and a typical screen shot. Orders to Robin at Toftwood, Mill Lane, High Salvington, Worthing, Sussex. If there is any delay it will be because he is swamped with orders!

That's all for this month. Letters care of the Editor are of course very welcome: let me know if there's a topic you'd like to see explained.

■ R&EW

SHORT WAVE NEWS FOR DX LISTENERS



by Frank A Baldwin
All times in GMT, bold figures indicate the frequency in kHz

The last few issues of this magazine have seen a brief survey of some of the Latin American stations operating on the 60-metre band (**4750** to **5060**) as the opening gambit of this feature. This series is now concluded with a review of some of the more difficult to receive Brazilian and Ecuadorean transmitters on this band.

First, Radio Tabajara, which in fact operates on **4797** although it is listed on **4795**. Sited in Joao Pessoa, it has a power of 1kW and is on the air from 0730 to 0400. It is difficult to log in that it is co-channel with Radio Nueva America in La Paz, Bolivia with a power of 10kW which also closes at 0400, except on Sunday (0200) and on Monday (0230). Listen for Radio Tabajara then on **4797** around 0245 on either a Sunday or a Monday – and even then the conditions for LA reception must be good for the exercise to be successful.

There are three Brazilians on **4815** – Radio Nacional de Tabatinga at 10kW, Radio Iracema, Fortaleza at 1kW and Radio Difusora, Londrina at 0.5kW. They all close at 0300 and all are overshadowed on this channel by the 10kW Colombian Radio Guatapuri. However, the plot thickens in that Radio Tabatinga can vary in frequency from that shown down to **4812**, whilst Radio Iracema wanders as far upwards as **4819**.

An elusive Brazilian is Radio Educadora, Braganca on **4825** where it operates from 0830 to 0200 with a power of 5kW. Co-channel is another Brazilian – Radio Mundial in Rio de Janeiro at 10kW, closing at 0400. Another snag – and there is always a snag! – is La Voz de la Selva in Iquitos, Peru on the same frequency from 1000 to 0500 at 10kW.

Radio Difusora de Macapa on **4915** is less often reported than the co-channel Brazilian Radio Anhanguera, although both are listed at 10kW, the former closing at 0300 and the latter at 0400.

But perhaps the toughest of all the Brazilians to unearth is Emissora Rural, 'A Voz de Sao Francisco', Petrolina on **4945**where where it is scheduled from 0755 to 0300 with a power of 2kW. I have never managed to log this one: every time an attempt is made, I end up by logging the ever-present – or so it seems – Radio Caracol in Neiva, Colombia. Oh well, perhaps some day....!

Turning our attention to some of the rarely reported stations located in Ecuador, La Voz de Galapagos, Isla San Cristobal can sometimes be heard here in the UK around 0300. Operating on **4810**, it is scheduled from 1215 to 1430 and from 2300 to 0400 with a power of 5kW. The channel is a difficult one, being shared by a Venezuelan, a Brazilian, a Peruvian and a Russian transmitter.

Another Ecuadorean station may be found on the nearby channel of **4820**: listen for signals emanating from Radio Difusora Paz y Bien in Ambato. The schedule is from 0900 to 0200 weekdays and on Sunday from 1100 to 0300 with programmes in Spanish and Quechua. The catch here, however, is La Voz Evangelica in Tegucigalpa, Honduras, which is usually dominant on this frequency. The latter closes at 0600 which doesn't held matters as far as the reception of the former station is concerned. Nevertheless, hope springs eternal and early one morning we may finally manage to log R Difusora Paz y Bien.

Then there is Radio Costa Azul in Porto Viejo on **4950** with a listed schedule from 1100 through to 0500 and a power of 1kW. Seldom reported in the short wave listener press, it is co-channel with the interesting DX catch of Radio Madre de Dios in Puerto Maldonado, Peru. The information which will aid in sorting these two out is that the Peruvian closes at 0230, leaving a clear field for two and a half hours in which to log Radio Costa Azul – you hope!

This concludes our survey of some of the South American transmitters that may be logged on the 60-metre band. In the next issue I will direct your attention to the much more difficult 90-metre band (**3200** to **3400**) and the DX-catches that abound on these channels, commencing as usual with the relatively easy to log stations – though none of them are *that* easy.

Around the Dial

In which are listed some of the stations and frequencies that may interest readers – both SWLs and DXers alike.

EUROPE

Albania
Tirana on **7300** at 0351, YL with station identification during an English programme directed to North America and timed from 0330 to 0400.

East Germany
Radio Berlin International on **9730** at 2040, OM with a news commentary in the English programme for Europe, scheduled from 2115 to 2200.

West Germany
Cologne on **9700** at 0615, YL with a talk about the Nigerian and Tanzanian economies during an English transmission to West Africa, timed from 0600 to 0630.

Hungary
Budapest on **12000** at 1519, YL presenting the Italian transmission for Europe, timed from 1500 to 1530 (not Sunday).

Italy
Rome on **9710** at 2050, OM and YL with the station identification and announcements at the commencement of the Italian programme intended for Australasia, scheduled from 2050 to 2130. To locate this one, listen for the bird-song interval signal just prior to 2050.

Monaco
TWR (Trans-World Radio) Monte Carlo on a measured **9492** at 0715, OM with station identification and announced English programme for Europe on **9500**! This station exclusively broadcasts programmes of a religious nature and is supported by voluntary contributions.

The Netherlands
Hilversum on **9895** at 1410, OM with an English programme for SWLs and DXers which is broadcast every Thursday 18 minutes after the start of transmission. Produced by Jonathan Marks, himself an SWL, this programme is well worth hearing. For Europe on this channel from 1330 to 1420.

Romania
Bucharest on **9690** at 1930, OM with station identification and a newscast in the English presentation for Europe, scheduled from 1930 to 2030.

Spain
Madrid on **9650** at 0745, OM and YL with the Spanish programme for Australasia, and the Near and Middle East (not Sunday) from 0600 to 0930 – a Glen Miller recording followed by a talk about the current situation in both Nicaragua and El Salvador.

Sweden
Stockholm on **9630** at 1110, OM with a talk about the Vikings, their travels and trade, all very

interesting. This was in the English presentation for Europe and the Pacific, timed from 1100 to 1130.

AFRICA

Angola
Radio Nacional de Angola, Luanda on **9535** at 2004, OM's with songs in Portuguese, guitar music – just like listening to Latin America!

Bonaire
Radio Netherlands Relay on **9590** at 0420, OM with a talk about Dutch affairs in a Spanish transmission to Central America and Mexico, scheduled from 0330 to 0425. Also logged in parallel on **6165**.

Cameroon
Radio Bertoua on **4750** at 2302, OM with a newscast of local events in English followed by a similar programme in the French language at 2303. Sign-off was at 2308 after announcements and a choral/orchestral National Anthem -- revealing the underlying Xizang PBS in Tibet on the same channel.

Radio Douala on **4795** at 2044, OM with announcements in French between pop music. Station identification and a newscast of African events at 2100, all in English. The published future plan for this station was a 20kW transmitter but from my S-meter readings it would appear to be much nearer 200kW!

Egypt
Cairo, 'Holy Quran Station' on **9755** at 0540, quotations from the Holy Quran in a transmission directed at Europe and the Middle East. All broadcasts from this station are entirely religious in nature and are radiated from 0200 to 0900 and from 1200 to 2100.

Cairo on **9850** at 1917, OM and YL's with songs in Arabic in the Domestic Service which occupies this part of the dial from 1800 to 2345.

Madagascar
Radio Netherlands Relay on **9715** at 2030, YL with station identification and a newscast during an English transmission for Central and West Africa, timed from 2030 to 2120.

Morocco
Rabat on **15335** at 1017, Arabic music complete with some songs in typical style during the Arabic Service which is on this channel from 1000 through to 0100.

Nigeria
FRCN Kaduna on **4770** at 0417, OM presenting pop records featuring UK artistes, all in a Channel 2 presentation which is on this frequency from 0400 through to 2400 in English and Hausa. The power is 50kW.

South Africa
Johannesburg on **9585** at 2110, OM with a news commentary in an English transmission for Europe and West Africa and timed from 2100 to 2200.

SABC Johannesburg on **4880** at 1835, OM with a talk in Afrikaans during the Home Service which is on this channel from 0348 (Saturday from 0427, Sunday from 0457) to 0550 and from 1520 to 2120 (Saturday until 2200). The power is 100kW.

Zaire
Radio Candip, Bunia on **5066** at 1827, OM and YL with announcements in French; then a programme of songs in the vernacular.

AMERICAS

Brazil
Radio Aparecida on **9635** at 0022, OM's with a discussion in Portuguese. ZYE954 is on the air from 0900 to 0300 at 10kW.

Radio Nacional Brasil on **17720** at 2140, OM and YL with the German programme for Europe (news comment) scheduled from 2100 to 2200.

Cuba
Havana on **4765** at 0233, OM with a talk in Russian in a 'Mayak' (Lighthouse) programme. This domestic service is a relay of Radio Moscow presumably for the merchant marine in the Latin American area, shipping Argentinian grain to Nicaragua and arms to Cuba, etc etc.

Another USSR relay is Havana on **9720** at 2040, OM with a talk in the Portuguese transmission for the Mediterranean Area and Africa and scheduled from 2000 to 2100.

Dominican Republic
Radio Clarin, Santo Domingo on **11700** at 0028, OM and YL with alternate items about Nicaragua in a La Voz del CID (Cuba Independients Democratica) programme. This one has a 50kW signal and is scheduled from 1100 to 0500. The frequency is likely to vary slightly.

Ecuador
HCJB Quito on **9745** at 0712, OM with a religious talk, station identification at 0715 during an English programme for North America, timed from 0600 to 0800. Also on **11835** at 0655, OM with announcements, YL with a hymn during an English transmission for Europe, listed from 0600 to 0700 on this frequency.

MIDDLE EAST

Afghanistan
Kabul on **9665** at 1917, OM with a talk about foreign affairs in the English programme for Europe, timed from 1900 to 1930. This is a USSR relay.

Israel
Jerusalem on **7410** at 0018, OM interviewing various tourists in an English programme for America and Europe and scheduled from 0000 to 0030 on this frequency.

Kuwait
Radio Kuwait on **9840** at 1853, local-style music, OM with songs during the Arabic Domestic/External Service which is scheduled on this channel from 0225 to 0600 and from 1600 to 2105.

Turkey
Ankara on **9660** at 2202, YL with local news and a review of the Turkish press in the English transmission for Europe, the Middle East, North America and South East Asia, scheduled from 2200 to 2300.

ASIA

China
Beijing on **17680** at 0432, YL with a talk about Chinese agriculture during an English transmission intended for the North American West Coast and scheduled from 0300 to 0500. Also on **7505** at 2040, YL with a song in Chinese in the Domestic Service 1st programme, listed on this channel from 2000 to 1730, and on **9900** at 2052, classical music in the European style in the Chinese programme intended for Europe, North and West Africa from 2000 to 2100.

Japan
Tokyo on **17755** at 0415, OM and YL with a talk during the Japanese General Service to the Americas, the Far East and Europe, timed from 0400 to 0430.

North Korea
Pyongyang on **9360** at 2045, YL with a newscast mainly about local affairs and events in an English programme directed at Europe and timed from 2000 to 2150 on this frequency.

AUSTRALASIA

Australia
Melbourne on **9760** at 0730, OM with the station identification and a newscast in English during a transmission for Papua New Guinea and the Pacific, on this channel from 0700 to 1000. Also on **9570** at 0601, OM with a newscast of world events in the English programme for Europe, scheduled from 0600 to 0800.

Indonesia
Jakarta on **9680** at 1458, when transmitting a programme of light orchestral music in the European style, OM with station identification and a newscast in Indonesian at 1500 – all in the National Programme which is on this channel from 2200 to 0100, from 0500 to 0800 (Sunday from 2200 to 0800) and from 1000 to 1715.

CLANDESTINE

'Radio Venceremos' on **6667** at 0006, OM and YL with alternate strident tirades in Spanish against the El Salvador authorities and complete with pro-Nicaraguan asides. This one supports the Farabundo Marti National Liberation Front and claims to be located within the borders of El Salvador. This transmission is scheduled from 0000 to 0100 (not Monday). There are other periods listed but that probably the best for UK listners — i.e. if this transmission is missed — is the one from 0230 to 0330. Provided they have not changed frequency once again.

'Radio Salvation of Iran' on **11660** at 1850, YL with a long harangue in Persian. Pro-monarchist and anti-Iranian Government, this one operates from 1830 to 1925 although the closing ceremony was difficult to log owing to the presence of a jamming signal on channel.

Now Hear This

Radio America, Lima, Peru on **6010** at 0308, OM with a pop song followed by announcements in Spanish, some local-style music with identification at 0316.

Now Log This

A rather more difficult one this month. Try logging the Peruvian Radio Eco which operates on **5112** from 1000 to 0600. The power is 1kW and the address is Casila 174, Iquitos. OAX8V has been heard by many UK based DXers but one must of course burn the midnight oil for quite a few occasions until that one night – or early morning – when conditions are just right for the reception of the Peruvians here in the UK. It was recently heard at 0225 – a weak signal adjacent to some utility QRM, OM with a talk in Spanish until 0230 and then some Andean pipe music.

DX-TV

Reception Reports

Compiled by Keith Hamer and Garry Smith

In retrospect, July 1983 was an excellent month for long-distance television via Sporadic-E. Record-breaking reception took place on the 6th when the trans-Atlantic MUF attained 72MHz and television signals from the West Indies reached the UK. DX from the Middle East was also witnessed on at least two occasions but the shorter range Sporadic-E (SpE) signals (up to 2000km) kept most enthusiasts happy with south-eastern Europe predominating yet again. Tropospheric reception from Norway down to Switzerland occurred mid-month due to settled weather conditions. However SpE has been the main attraction with a wealth of interesting reception.

Highlights of the month at our base in the Midlands included JTV-Jordan on channel E3 with the PM5544 test card on the 2nd, 3rd, 15th and 21st. During an opening to Iceland on the Ist from 1900 BST onwards, various USA/Canadian public service communication channels were received loud and clear between 41 and 64MHz while on 50MHz SSB amateur activity was heard. On the 22nd a mystery signal from the south was noted on E3 at 1840. It consisted of a coloured person with a white head-dress; the signal was slow fading and of medium strength. Portugal and Spain were present at the time on E2 and E4. The E3 signal was eventually swamped by sport from TVE-Spain. Similar E3 reception was seen again on the 29th at 1830. Could this have been Nigeria?

Reception Reports

Fred van Schuppen has sent a very impressive reception report covering July. At his location in Driebergen (The Netherlands) he has noted no less that ten countries via SpE propagation. Enhanced tropospheric conditions resulted in reception from Denmark, West Germany, Norway, East Germany and Luxembourg in Band III while on UHF Fred saw signals from Sweden (SR), East Germany (DDR: F2) and Switzerland (SRG) plus a host of British stations. Incidentally he has advised us that RTL-Luxembourg are using the PM5540 test card although, from his description of it with the inclusion of a digital clock, it could in fact be the PM5544. It is apparently radiated only from the VHF channel E7 outlet.

Despite hilly terrain to the south, Brian Renforth (Torquay) has managed to resolve Spanish and Portuguese signals. Using a 3-element wideband array for Band I, SpE has been an almost daily event with RAI-Italy being a frequent visitor. On the 20th at 0820 BST, Brian saw the EBU bar pattern on channels A and B. A little later he noted a caption consisting of a medieval ship with an inscription resembling 'CELBROUGH'. He comments that the picture looked 'very low budget' and thinks it could be an Italian pirate network since the national service of RAI was present as a co-channel signal on IB at the time. Brian noted most other European countries during July including RUV-Iceland, CST-Czechoslovakia and SWF-West Germany (Sudwestfunk) on E4 radiating the FuBK test card with the transmitter identification 'OCHSENKOPF'.

We understand that the new French TV service which will open in Band I using system L will be scrambled requiring the use of a decoder and pay card. However, Andrew Webster and Arthur Milliken of Wigan have seen test transmissions and programmes on the new channels without any form of encoding.

Simon Hamer (New Radnor, Powys) confirms this as he saw motor racing on the 20th at 1905 close to channel E3 but 'in the negative'. This is how a system L signal (positive video modulation) appears on a European/UK set. Most of Simon's DXing takes place during the evening; consequently much of the reception consists of programme material rather than test cards. Signals tend to originate from Italy, TVP-Poland and TSS-Russia. On the 6th at 1930 Italy's distinctive 'TG 1' news caption appeared but with a digital clock insert in the bottom right of the screen.

Mike Allmark of Leeds reports that TVE-Spain has been seen using the Philips PM5534 test card on E3 with 'RTVE 1' at the top and the transmitter name 'LA MUELA' at the bottom. So far this has been an isolated sighting. On the 19th during the morning the Russian electronic test pattern was seen carrying an unusual studio identification which, when translated, read 'Sebastopol'. The nearest Band I transmitter to this studio is Simferopol on channel R1 located to the north of the Black Sea. Mike hopes to obtain a SECAM decoder to resolve Russian and other Eastern European transmissions in colour. Also on the 19th (at 1519 BST), Mike received the Moroccan E4 outlet at Laayoune with an announcer and Arabic writing. Another Arabic station on E4 was noted on the 1st but was unidentified.

Another DX-TV enthusiast in Leeds, Kevin Jackson, noted enhanced tropospheric conditions with snow-free reception (excuse the pun) from Switzerland on E34 originating from the Saentis transmitter situated to the north-east. Many transmissions from West Germany were noted via outlets located along the borders with Switzerland and Austria including Wendelstein and Wuerzburg (both channel E10) using the FuBK test card with appropriate transmitter identification. It is interesting to note that all the signals were received on indoor aerials, the Band III array consisting of a dipole near the window!

Trans-Atlantic signals definitely arrived at the home of Hugh Cocks (Robertsbridge, East Sussex). Reception on the 6th between 1800 and 2000 BST gave spectacular signals on channels A2, A3 and A4 with A4 best in terms of video quality. They peaked westwards and all were Spanish speaking but there were no other clues as to their origin despite many commercials. Hugh suspects

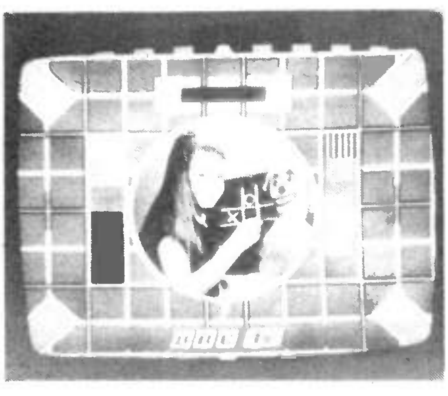


Figure 1: The famous, but discontinued, BBC Colour Test Card 'F'.

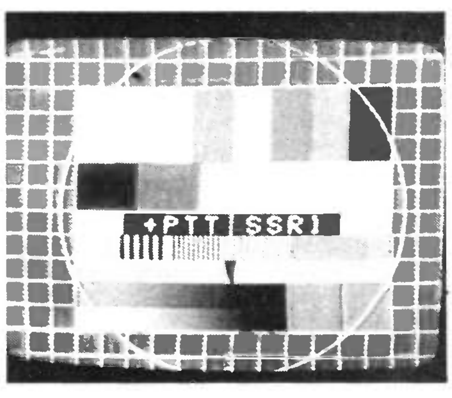
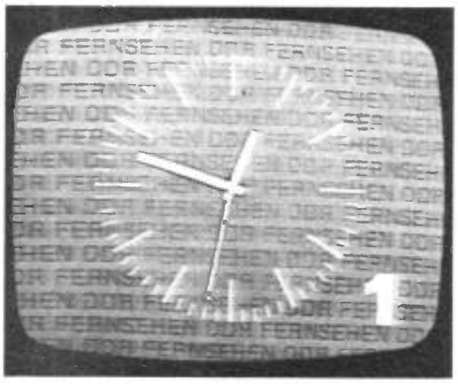


Figure 2: The Swiss FuBK test card radiated by the French-language service.

Figure 3: Clock caption used by DDR:F1 in East Germany and received on UHF.



Puerto Rico and the Dominican Republic since there were at least two signals noted on A2. He didn't do so bad from the Middle East either! On the 2nd and the 19th he saw the 'square' PM5544 test card of RCTV-Dubai going on to a clock caption (BST + 3 hours) which was followed by the Koran.

An Italian pirate television station was one of the main features of the month for Robert Panknen in southern Spain. It was received on UHF from Sicily during a lift in tropospheric conditions. The state-owned service of RAI was also noted on UHF with signals strong enough to obliterate the local Spanish network. Apart from reception of the usual European services, a number of countries which would be classed as 'exotics' in more northerly climes were noted by Robert including Algeria (RTA), Morocco (RTM), Zimbabwe (ZTV) and the Canary Islands (TVE).

Test Card 'F'

As we reported in last month's *R&EW* (and, incidentally, before any other journal) the very familiar BBC Colour Test Card 'F' has been discontinued.

Since mid-May, Trade Test Transmission periods have been replaced by sample pages of Ceefax together with ex-test card music. This decision has brought a broadcasting era to an end as there will no longer be a regular, useful, test card with which to adjust receivers. The first test card to be radiated by the BBC appeared back in 1947 and was designated Test Card 'C'.

Service Information

France: The following TF-1 819-line VHF outlets have been closed down: Carcassone, channel F4; Toulouse, F5; Paris, F8a; Bayonne, F9; Bordeaux, F10.

Çzechoslovakia: Ceskoslovenska Televize (CST) have recently tested their teletext information service which is to be called 'Teleinformacie'. It isn't certain whether sample pages will be radiated during normal test transmission periods.

East Germany; A new high-power outlet (possibly 1000kW ERP) is to be opened at Cottbus with DDR: F2 on channel E23. The DDR: F1 transmitter (presently on E4) will operate on E53. It is envisaged that DDR:F will cease Band I transmissions by 1985.

Norway: NRK has made a bid to use the ECS-2 satellite for a second national television network. Apparently dish aerials will not be a feature atop Norwegian dwellings as existing NRK transmitters will relay the satellite signal on UHF. NRK-2 is expected to be a 'Pay-TV' channel with subscribers requiring a specially coded card to activate the receiving equipment.

Teletext transmissions were recently introduced by NRK with a service called 'Tekst-TV'.

Turkey: TRT commenced a regular colour TV service last July using the PAL system.

Our thanks go to Goesta van der Linden (The Netherlands) and Tele-audiovision (West Germany) for supplying the above information.

■ R&EW

EVENTS : MOBILE RALLIES

October 22nd	Chiltern Computer Fair	Challney Community College, Stoneygate Road, Luton	John Pinney, Luton 56400
November 1st–3rd	Electronic Displays '83	Kensington Exhibition Centre	Network Exhibitions 0280 815226
November 8th–10th	Software/expo	Wembley Conference Centre	Online Conferences Ltd 01-868 4466
November 9th	Talk on Aerials	Lincoln	G4STO
November 11th	Broadcasting: Marconi to to Channel 4	Theobalds Park College, Waltham Cross	Ralph Barrett 01-845 6807
November 11th–13th	Hometech '83	Bristol Exhibition Centre	Stephen Hybs, Bristol 292156
December 7th	World Communications — Tomorrow's Trade Routes	Royal Lancaster Hotel, London	British Computer Society 01-637 0471
December 10th	RSGB AGM	IEE, Savoy Place, London	RSGB, Potters Bar 59015
December 11th	Leeds & DARS 3rd Annual Christmas Rally	Civic Centre, Pudsey	G6CJI
February 5th	Bury Radio Society Hamfeast	The Mosses Centre Cecil Street, Bury	MHF Bridge, G3VC
April 1st	White Rose ARS Rally	University of Leeds	A N Bramley, G4NDU
April 28–29th	RSGB National Amateur Radio Exhibition	National Exhibition Centre Birmingham	RSGB, Potters Bar 59015

Also:
Microfair — Electronic aids for the Handicapped.
Cardiff 31st October – 4th November; Edinburgh 28th November – 2nd December.
Info: Handicapped Persons Research Unit, Newcastle upon Tyne (0632) 664061

UPDATES

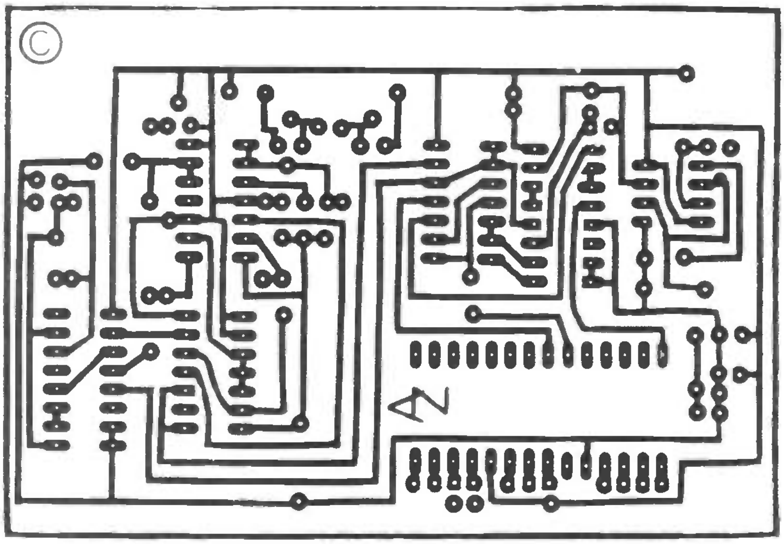


Figure 1: PCB foil pattern for main board of the Digital Capacitance Meter (July '83).

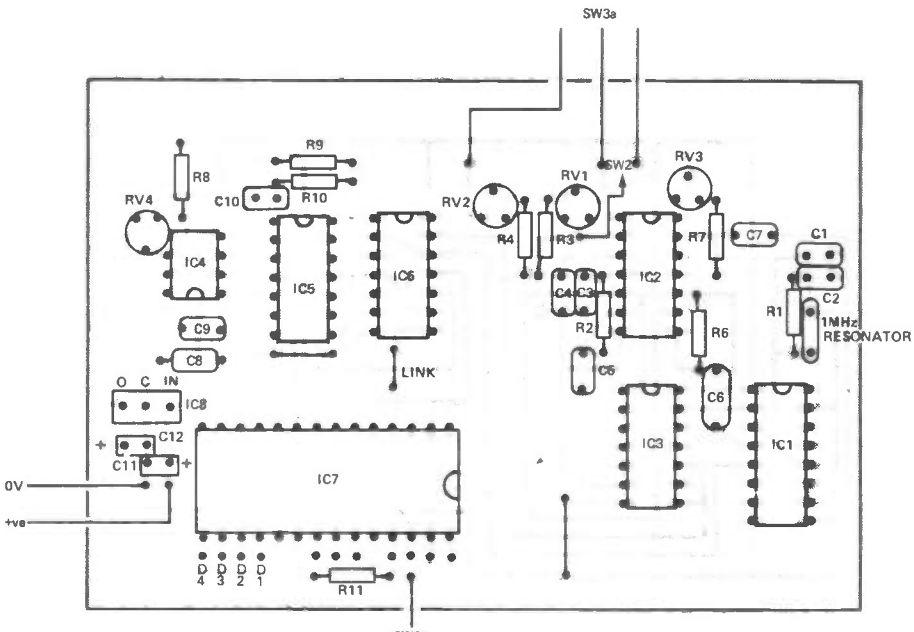


Figure 2: Note the change to the overlay in the region of IC5 of the DCM (July '83).

Digital Capacitance Meter: published in the July '83 issue.

Constructors should note:
1) IC7 is ICM7127A — not C.
2) The correct PCB foil pattern for the main board is shown here in *Figure 1*. Moreover, the overlay in the region of IC5 was incorrectly presented: the correct version is shown in *Figure 2*.
3) The PCB foil pattern and overlay for the GL8R04 four-digit multiplexed CC display are shown here in *Figure 3*.

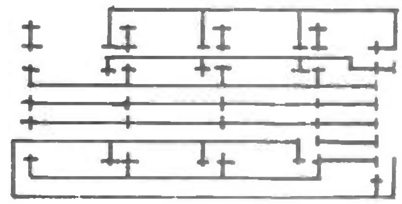
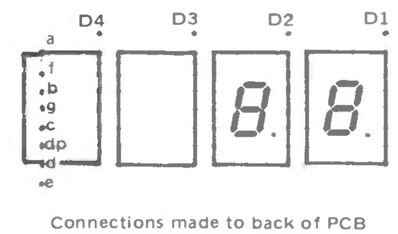


Figure 3: a) PCB foil pattern and



b) overlay for the GL8R04 displays used in the DCM.

Rotary Encoder Interface: published in the September '83 issue.

There was a minor error in the published PCB foil pattern: the component overlay remains the same. The correct version is shown here as *Figure 4*.

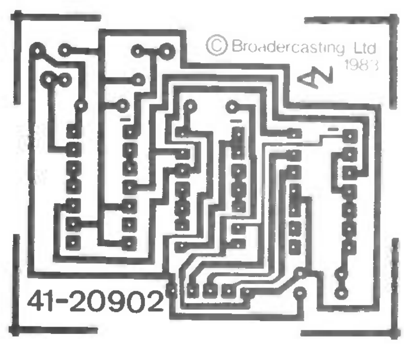


Figure 4: PCB foil pattern for Rotary Encoder Interface (Sept '83).

ZX81 RS232 Interface: published in the February '83 issue.

There were a number of minor errors in the diagrams associated with this design.
1) Figure 1: The labels R2 and C2 were omitted from the circuit diagram. They are, of course, the two unlabelled components shown adjacent to IC3.
2) Figure 2: The component overlay showed two C1's. The device adjacent to Q1 should have been labelled C7 (+ve towards the top of the page).
3) Table 3: This table in fact tabulated the UART clock (in hertz), the CTC clock number (being the clock frequency of 1.625MHz divided by the UART clock) and the corresponding A and B values for use in the program for some common transmission speeds.
4) Constructors should note that ZD1 is a 5V1 Zener; Q1, 2 are BC239's; and Q3 is a BC307.

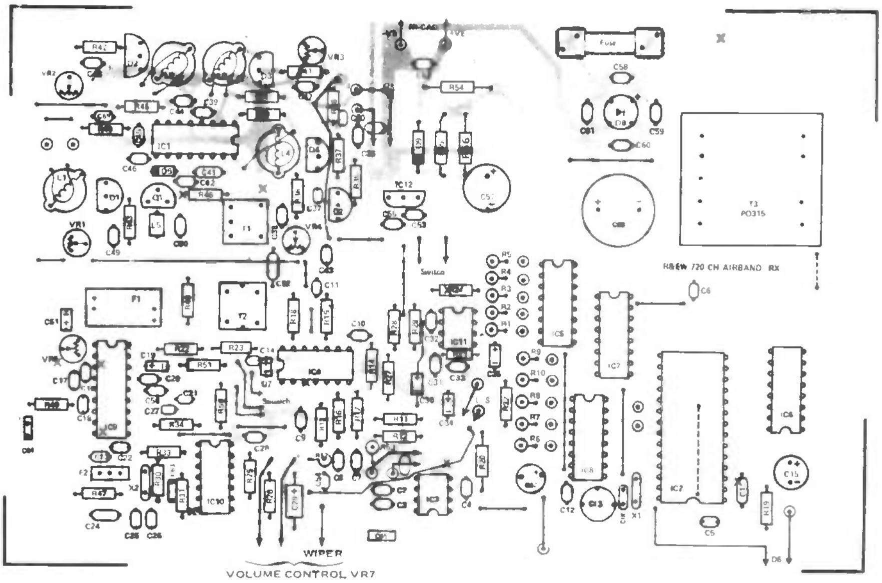


Figure 5: Component overlay for the 720 Channel Airband Receiver showing positions through board links in blue (Sept '82, Oct '82).

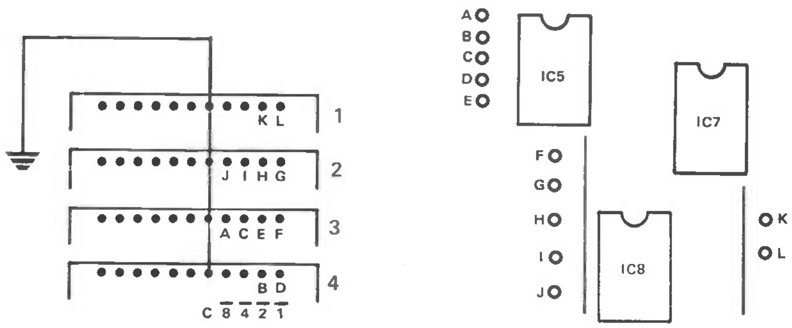


Figure 6: Connections to thumbwheel switches for the 720 Channel Airband Receiver.

720 Channel Airband Receiver: published in the September and October '82 issues.

Those constructing the kit supplied by Ambit should note the following:

1) All components that are soldered to the ground foil should also be soldered to the top foil (shield plane).
2) Add through board links as shown in *Figure 5* (locations brought in blue).
3) Coil L4 should use a 2½-turn link instead of the 1½ turns detailed in the parts list.
4) The correct position for R21 is that shown near IC11 (i.e. that in the published overlay). The other position indicated (near R55) corresponds to R56 on the circuit diagram enclosed with the kit and is not used: it should be omitted.
5) IMPORTANT: Check IC8 pin 9 for shorting against the top foil. Clear away the foil around the pin 9 hole with an X-acto knife.
6) The correct mounting for IC12 is with the metal block facing C55.
7) C33 should be a 10nF disc capacitor.
8) Insert a 100nF capacitor (e.g. that previously detailed as C33) in the LED O/P to ground (pin 28 of IC2).
9) The connections to the thumbwheel switches are shown here in *Figure 6.*

Rewbichron II: published in the April and May '83 issues.

Due to poor component availability, a second version of the Rewbichron II display has been constructed using dual digit displays. These displays, which have integral filters, are now part of the Rewbichron II project pack. The circuit diagram remains unaltered but the foil pattern and overlay have been modified. They are shown here as *Figure 7.*

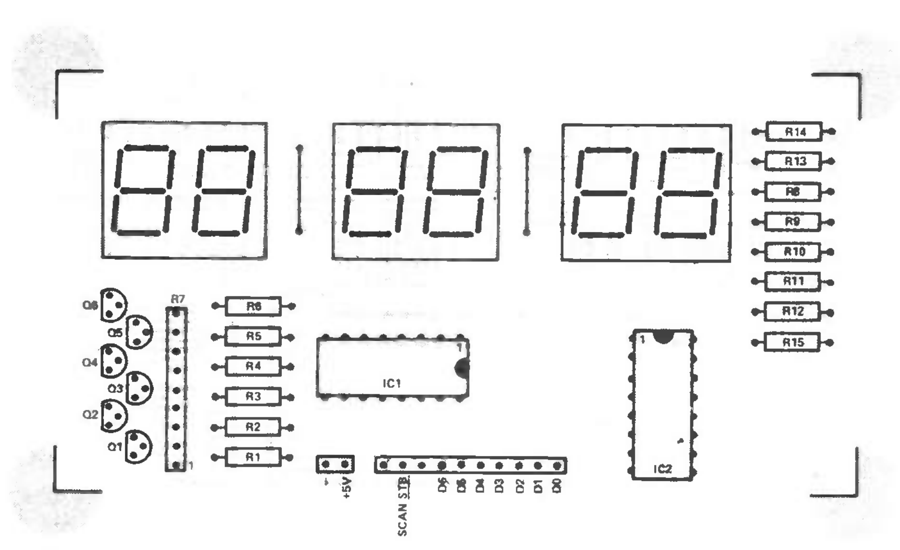


Figure 7: Overlay for updated version of the Rewbichron II display (April '83, May '83).

Analogic Probe: published in the August '83 issue.

As there were errors in some sections of this article, we reprint here the circuit diagram (*Figure 8*), the circuit description, the constructional details and the advice on testing.

Circuit Description

A linear bargraph driver, IC1 (set to dot drive mode) is the heart of the level indicator, directly driving 10 LEDs. An internal divider network, between pins 6 (RHI) and 4 (RLO), sets the thresholds for switching these on. The divider is fed from the supply rail, such that the switching thesholds are spaced at 5% of the supply – the first LED (4) is triggered by an input signal on pin 5 (SIG) of 5% +V and the last LED (13) at 50% +V. D4 is used to compensate for the forward voltage drop of the reverse polarity protection diode, D1, and R1 must be a slightly smaller value than R11, which is shunted with the internal divider resistance of 10k. These four components are fairly critical and the specified types must ▶

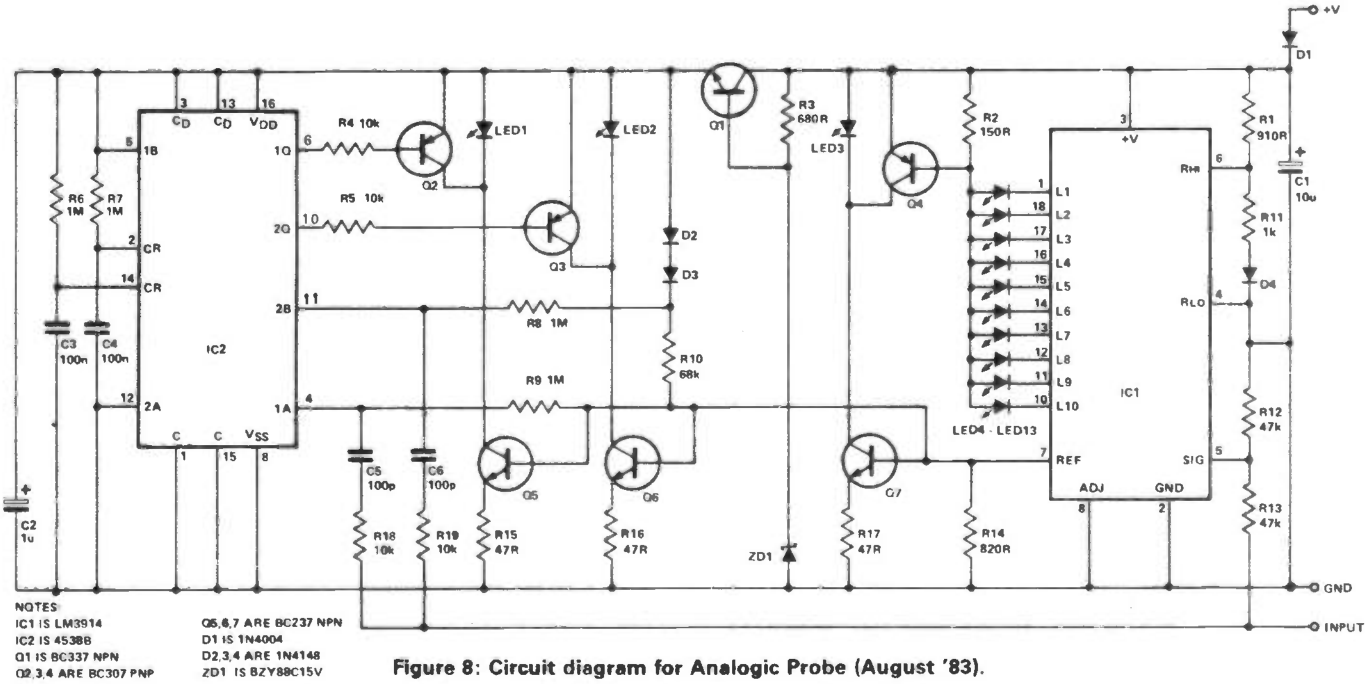


Figure 8: Circuit diagram for Analogic Probe (August '83).

be used to ensure exactly half of +V is present on pin 6. The input signal to pin 5 is also divided by two, via R12 and R13. This results in the sensitivity at the probe tip being one LED per 10% of +V. Pin 7, the reference of IC1, has 2 functions: it generates a stable voltage of 1V2 and the current drawn from it determines the current fed to the LEDs. R14 thus sets the LED current to approximately 12mA. Q7 and R17 form a current source, also of 12mA, to feed another LED (3), which is used to indicate an input at or near ground. As soon as the input rises to the threshold of one of the LEDs, Q4 is switched on and LED3 goes off, giving the desired 11-step level indication. The input to IC1, in conjunction with R12 and R13, can withstand inputs of ±100V without damage.

A standard CMOS dual monostable, IC2, forms the edge detector part of the probe circuitry. The specified device, a 4538B, is an improved and faster version of the more common 4528. Unfortunately the maximum supply voltage of this IC is less than the 24V required in this design, so a simple series regulator consisting of Q1, R3 and ZD1 is included. R6, R7, C3 and C4 are used to set the monostable pulse widths to 100ms and the outputs drive two LEDs via Q2, R4, Q3 and R5. These are once again driven by current sources Q5, R15, Q6, R16 derived from the 1V2 reference of IC1. The trigger inputs of IC2, pins 4 and 11, are connected to the network R8, R9, R10, D2, D3, C5, R18, C6 and R19, which is optimised to ensure adequate speed and sensitivity to cope with TTL type signals. The simplest circuit needed to trigger the monostables is a CR differentiating circuit (C5, R9 and C6, R8). However, on a +5V supply, CMOS needs a 3V5 swing to guarantee switching – TTL does not normally supply this, so the +ve going, edge sensitive input (1A, pin 4) is biased to +1V2 (that handy reference again!) and the −ve going, edge sensitive input is biased to 1V2 less than +V (D2, D3 and R10). This results in reliable triggering on edges of 2V or less, which is readily available from TTL. R18 and R19 are included to enable IC2 to withstand the same input overloads as IC1 – the internal protection diodes clipping excessive voltages so long as the current is limited.

C1 and C2 complete the circuit by decoupling the IC power rails.

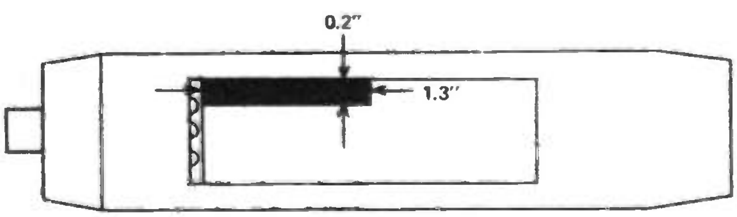


Figure 9: Cut-out details for case of Analogic Probe.

Construction

The specified probe case and a PCB are almost mandatory for this design. Even then, it is a tight squeeze to fit everything in. Particular points to note are:

1. Take great care with the LEDs to ensure they are all correctly orientated, and at the correct height above the board to fit in the case. The specified types have a slightly longer anode lead, and this side should face the edge of the board. A space of approximately 5mm should be allowed between the board and the base of the LEDs.
2. The four pillars inside the upper half of the case need to be shortened by 1 or 2mm to allow for the thickness of the PCB.
3. A rectangular cut-out is needed in the case (as shown). With a few guide holes drilled, a sharp knife will do the job.

Testing

After thoroughly checking the PCB, attach the probe tip and the supply cable (supplied with the case). Connect to a 5 or 6 volt supply/battery and the yellow LED *only* should light. Touch the probe tip onto the +ve supply and the yellow LED should go out, the top orange LED should light and the red and green LEDs may flash. If all is not well, disconnect and re-check the PCB and all components.

Please Note: LED's 1, 2, 3 and 5-14 were types CQX10, CQX11, CQX12 and CQX40 respectively; and the LEDs were shown *the wrong way round* on the component overlay.

■ **R&EW**

NOTES FROM THE PAST

Today, colour TV's are commonplace – dominating both rentals and sales despite the relatively high cost of the colour TV licence. Yet twenty-five years ago, 'Centre Tap' was caused to wonder whether viewers really wanted colour TV.

Almost concurrently with the appearance of my comments last month on the drawbacks of present-day TV, letters of similar purport appeared in the correspondence columns of *The Times*. A letter of defence from someone connected with an interested party (RCA) made out an excellent case to show that the progress of colour TV in the United States (and incidentally the reliability and stability of colour TV receivers) was far more rapid and successful than is generally believed over here. His figures, showing that American black-and-white TV receivers require an average of two service calls in the first three months, are rather alarming. I should have expected better from the sleek looking receivers and glowing phrases in the advertisement pages of US magazines! Colour TV's required two and a half.

When I touched upon the subject, I was raising the query: 'Do viewers *really* want colour TV' – that is, do they want it so badly that they are prepared to pay the extra cost and suffer the 'disadvantages' I outlined. The answer to that question is obscured by wishful thinking from two opposite points of view – those holding an interest in the colour systems likely to be used, who obviously see the rosy side, and those concerned with the manufacture of ordinary sets for whom (if colour TV were only a matter of weeks or months away) current-model production would come to a standstill. Obviously, when colour TV is imminent, or even believed to be 'just around the corner', the public are not going to buy models which are likely to be outmoded before the third instalment is due!

It is patently true, as I pointed out, that the demand for colour TV is largely by people who, when the time comes, will wait to see how it turns out before they dream of buying one. While history is hardly likely to repeat itself in this matter, appreciation of the course of development of black-and-white TV is at least illuminating. Full daily broadcasts started in 1936 (present system), and for a while viewers could be counted in hundreds. Even by the outbreak of war in 1939 they could still be comfortably counted in thousands. For several years following its post-war resumption, receiver possession was still comparatively limited to the few.

I am not suggesting that the growth of colour TV will be quite as modest as that, but are people with a serviceable and satisfactory receiver going to rush to buy colour sets at such a rate as to make possible drastic price cuts in production costs? Cinemagoers can judge for themselves how much greater is the appeal of technicolor over monochrome films. Not being a filmgoer I dare not give a judgment, but as a colour photographer I do know how the average viewer loves my projected colour transparencies. They watch with real pleasure, delightedly commenting on the colours (which incidentally reproduce beautifully, often better than natural!), when black-and-white projection would leave them cold. Obviously colour for its own sake has a tremendous appeal, and successful demonstrations, especially of subjects to which the colour adds pleasing interest, are likely to win over hosts of waverers into buying colour receivers. Yet much of this is based on novelty appeal. I am quite sure the popularity of my colour projections will decline to disappearing point when colour TV becomes commonplace. Judging by the reactions of discriminating filmgoers, I imagine they would rather see a good monochrome film than an indifferent colour one.

The question is, therefore, a very open one, and extensive sales are more likely to be decided on how cheap it is, rather than how good it is. A de-luxe car is very much more satisfying than a 'popular' one, but the vast majority of us have to be satisfied with the latter sort – that is providing we can afford even that.

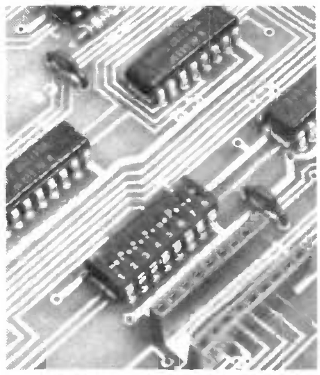
A few really keen types may have seen the BBC's successful experimental transmissions after ordinary programme hours, which may well give rise to a hope of early daily programme transmissions. Unfortunately, the success of these experiments has no real significance. They cannot go ahead with any definite plans until they are given the signal by the Government's TV Advisory Committee. It is unlikely that their report will be ready until late next year, and there are a tremendous number of factors, technical, financial, public interest and even export trade, to be taken into consideration. My guess, 1962, still holds. *(In fact it was late 1969 before colour was introduced on the three public channels. Ed.)*

■ R&EW

NEW PRODUCTS

Ultra low profile DIP switch

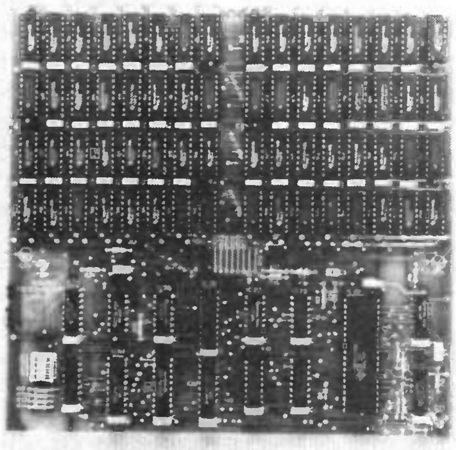
The recently announced K40 series of DIP switches from BICC-Vero Connectors is believed to be the first to match the dimensions of a standard IC. As such they can be packed in standard tubes and so can be incorporated in designs for automated assembly.



Other user benefits include that the actuators are flush with the top of the body, thus minimising the risk of accidental operation and that the DIP solder terminations are moulded into the switch body. The latter design rules out one of the most common causes of failure with other DIP switches — wicking of solder or flux into the switch area through the leads. Two independent contacts are provided at each point by bifurcated beryllium-copper switch slides which ensure contact integrity. The contact points all have at least a 0.7μm thick layer of gold over nickel.

A further 'plus' comes through the use of the latest design and production methods, together with 100% testing, to eliminate 'dead on arrival' instances.

BICC-Vero Connectors Ltd
Parr
St Helens
Merseyside
WA9 1PR

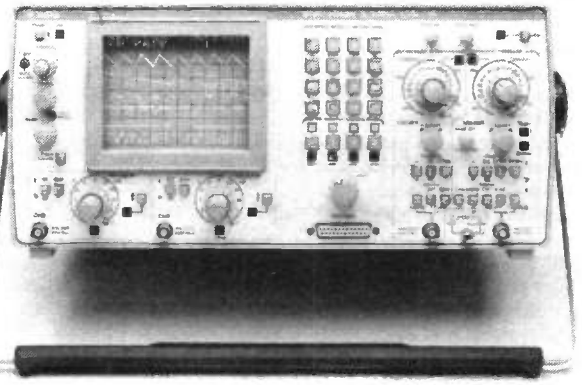


New 80-bus boards

Gemini Microcomputers has announced two additions to its range of 80-bus and Nasbus compatible 'Multiboards' — the GM839 prototyping board and the GM833 512K RAM-disk board. The former allows 80-bus users an inexpensive and very convenient means of adding specialised 'one-off' boards to their systems. It is a high-quality single-sided fibre glass PCB, on which the layout has been optimised towards high density packing of ICs. All the 80-bus signals are identified on the board, which comes with extensive power supply tracking and an 80-bus specification booklet.

The GM833 (pictured here) is an unconventional RAM board that has been designed around three Z80 I/O ports — to be regarded as 'track', 'sector' and 'data'. This construction means that it can act as an extremely high-speed disk drive — the developer claims that it is over 30 times faster than a conventional floppy disk drive in certain applications. In addition to its inherent 512Kbyte capacity, a DIL switch will allow multiple boards to be fitted to a simple system — pushing the available storage up to 8Mbytes.

Gemini Microcomputers Ltd
18 Woodside Road
Amersham
Bucks
HP7 0BH

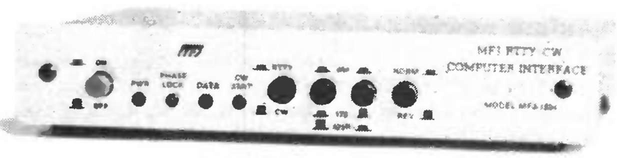


100MHz intelligent oscilloscope

Gould has announced a new 100MHz oscilloscope that adds ease of interfacing to the sophisticated microprocessor-based measurement facilities of its predecessor, the 5100. The 5110 also has a new circuit board layout that simplifies the interconnections and allows a greater degree of automation in manufacture: this should lead to reduced manufacturing costs and easier maintenance.

Features of the 5110 include automatic measurement of many parameters with the aid of a menu control system, full alphanumeric display of control settings and readings, and comprehensive trigger facilities that include delay by events and delay by time up to 344sec (10ns resolution). The built-in digital storage system provides waveform storage to the full 100MHz bandwidth of the oscilloscope and transient storage at a sample rate of up to 1MHz, together with storage for 2K words. The vertical resolution is eight bits.

Gould Instruments Ltd
Roebuck Road
Hainault
Ilford
Essex



RTTY/ASCII/CW computer interface

The new MFJ-1224 from MFJ Enterprises enables the user to employ his personal computer as a full feature RTTY/ASCII/CW station. For example, during reception it converts the CW or AFSK tones into TTL level signals and then displays them on the screen.

The unit contains an automatic noise limiter and a demodulator that maintains copy even on a slowly drifting signal, as well as a sharp 8-pole active filter which provides 170Hz shifts and permits good copy under crowded, fading and weak signal conditions. Once tuned, the interface allows the user to copy any shift and any speed up to 100 wpm or 300 baud, as appropriate. All DC voltages are IC regulated and, the phase continuous AFSK transmitter tones are generated by a 'clean, stable' EXAR 2206 function generator, along with standard space tones. A set of microphone lines are provided for both AFSK and PTT (both ground and out), as is a 280VDC loop output from which to drive your RTTY machine.

The MFJ-1224 uses Kantronics software with features such as split-screen display, a 1024-character type ahead buffer, 10 message ports and Centronics compatibility as well as send and receive facilities.

MFJ Enterprises Inc
PO Box 494
Mississippi State
Mississippi 39762
USA

NEW PRODUCTS

Universal test lead system

The Deluxe Test Lead System has been designed by Simpson Electric in the States to expand the measuring capabilities of all VOMs and DMMs with standard or reverse type banana jacks, whether they are Simpson or another brand. The 23-piece system contains colour-coded (red and black) pairs of 48" long test leads, 48" test lead extenders, probe-type test 'prods' for general purpose testing and 6" spring-tip hook-on probes. Colour-coded pairs of alligator clips, large and small spade lug adaptors, high-density probe tips, phone-tip plugs and two insulated adaptors (reverse banana to standard banana jack) are also included. The test leads end in special banana plugs in which the insulated sleeve automatically retracts when the plug is connected.

The system was recently safety tested and passed by Underwriters Laboratories under the UL-1244 standard on safety with regard to electrical and electronic measuring and testing equipment.

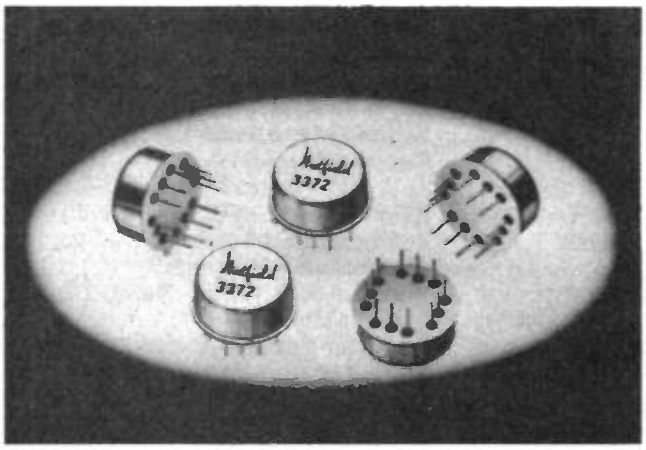
Simpson Electric Company
853 Dundee Avenue
Elgin
Illinois 60120
USA

Triple-output power sources

The American firm of LuTechnology has announced a new series of triple-output laboratory power sources known as Series 4200. Members of the range are dual tracking and they combine 0–±20V tracking outputs rated at 0.5A with a single output that is rated at 0–+6V at up to 2.5A in the case of the Model 4206A and at 0–+18V at 1A in the case of the Model 4218A. Current limiting has been built in to protect all the outputs against overload and damage arising from short circuiting: in particular the ±20V outputs are limited to 0.55A while the +18V output of the 4218A is limited to 1.1A. Further overload protection for the +6V output is provided in the 4206A through a current foldback characteristic, which also reduces the maximum available current and minimises semiconductor dissipation during overloads.

Both models offer a tracking accuracy of 1% and no more than 0.1% drift as well as a choice of line voltages (between 100 and 240VAC) and frequencies. They are expected to be an asset to any laboratory developing prototypes employing integrated circuit technology.

LuTechnology Inc
3516 Breakwater Court
Hayward
CA 94545
USA



Four-way power divider

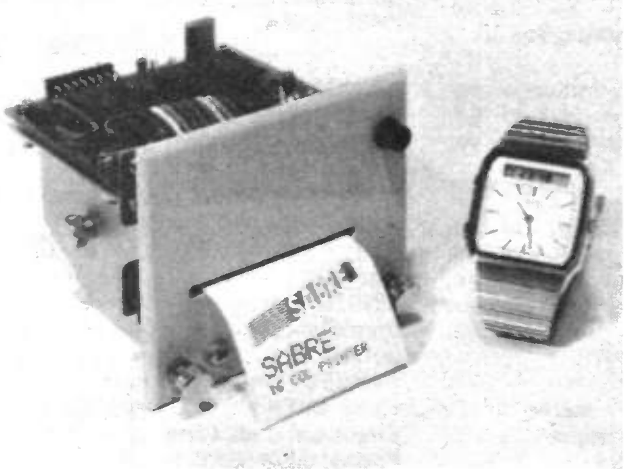
Hatfield components' Model 3372 is a reactive power divider that either splits an input signal into four equal (isolated) outputs or sums four inputs vectorially to give a single output. The device is hermetically sealed in a TO8 package and so typical insertion loss and isolation figures are 1.0dB and 25dB, respectively. Other characteristics include amplitude and phase imbalance at 0.4dB and 5° maximum over the full band of 30–500MHz. The operating temperature range is −55 to +125°C. The device is available from W&G Instruments.

W&G Instruments Ltd
Burrington Way
Plymouth
Devon PL5 3LZ

Ultra Compact Printer

Sabre has introduced a new member to its range of ultra compact printers that are designed 'to provide the OEM with a reliable, plain-paper, dot-matrix printer suitable for front panel or rack-mounting applications'. The UCP-16 being a 16-column printer is even more compact than the earlier 24-column UCP-24, and it measures only 68mm (H) x 75mm (D) x 80mm (W). However it still retains all the other facilities of the UCP-24 – parallel (Centronics-type) and serial data input formats; an ASCII 64 alphanumeric character set (upper case only, but inversion is an option); multiple character sizes; dot graphics; and self-testing. The rest of the specification includes a print speed of approximately 17 characters/sec for full lines, and a power input of +5±0.3V giving rise to a quiescent current of 120mA and an average current of 1A when printing. The serial interface handles 110–2400 baud (TTL asynchronous protocol), while the parallel interface handles 7-bit data.

Sabre Computers International Ltd
Process House
43 Selsdon Road
South Croydon
Surrey
CR2 6PY



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¾" E3 Series
50Ω to 500K 89p

CAPS

CERAMIC 100V DISC (PLATE)
E12 MICRO MINI
typically -5%
1pF to 10nF 7p

POLYCARB 5%
SIEMENS 7.5mm
MINI-BLOC E12
250V
1nF to 6n8 7p
8n2 to 47nF 8p
56nF to 150nF 10p
100V
100nF to 150nF 11p
180nF to 270nF 14p
330nF to 390nF 20p
470nF to 560nF 26p
680nF 30p
1µF (10mm) 35p

POLYESTER, 250V RADIAL (C280)
10nF 15nF 22nF 33nF 47nF 68nF 100nF 7p
150nF 220nF 10p
330nF 470nF 13p
680nF 18p
1µF 22p
1µ5 2µ2 39p

FEEDTHROUGH
1nF 500V 7p

HIGH VOLTAGE
Capacitors please enquire many types in stock

TANT BEADS
.1 35V 14p
.22 35V 14p
.33 35V 14p
.47 35V 14p
.68 35V 14p
1.0 35V 14p
2.2 35V 14p
3.3 35V 18p
4.7 16V 18p
4.7 35V 20p
6.8 25V 20p
6.8 35V 21p
10 16V 18p
10 35V 27p
15 10V 22p
15 16V 30p
15 25V 32p
22 6.3V 26p
22 16V 29p
33 10V 30p
47 3V 14p
47 6.3V 34p
47 16V 39p
100 13V 32p
100 10V 55p

ELECTROLYTICS
Mainly Matsushita (Panasonic) & Siemens
AXIALS (Wires each end)
µFd V
47 63 8p
47 100 9p
47 350 30p
1 63 8p
1 100 9p
1 500 40p
2.2 25 8p
2.2 63 9p
2.2 100 11p
2.2 350 30p
3.3 25 10p
3.3 40 11p
3.3 63 12p
4.7 16 8p
4.7 25 9p
4.7 40 11p
4.7 63 12p
4.7 100 14p
10 25 8p
10 40 12p
10 63 14p
10 100 16p

µFd V
22 25 11p
22 40 14p
22 63 16p
22 100 21p
47 25 14p
47 40 17p
47 63 26p
47 100 28p
100 16 14p
100 25 16p
100 40 22p
100 63 25p
100 100 30p
220 10 16p
220 16 17p
220 25 22p
220 40 25p
220 63 30p
220 100 40p
470 16 22p
470 25 28p
470 40 33p
470 63 43p
470 100 60p
1000 16 30p
1000 25 38p
1000 40 46p
1000 63 65p
2200 16 40p
2200 25 63p
2200 63 134p
4700 16 75p
4700 25 89p

RADIALS (PCB wires one end) Matsushita only
µFd V
10 16 6p
22 10 6p
22 16 7p
47 10 7p
47 16 8p
100 10 9p
100 16 10p
220 10 11p
220 16 12p
470 10 17p
470 16 18p
1000 10 20p
1000 16 24p
2200 10 34p
2200 16 44p

TRANSFORMERS

All 240V Primary
6 0 6V 9 0 9V
12 0 12V
15 0 15V
100mA 95p
1A 2.65
20 0 20V
1.25A £2.65
12 0 12 0
50VA 4.35
12 0 12 0
100VA 8.95
0 - 6 - 6 - 9 - 9
1.25A 4.25
These goods are heavy send extra p&p We will credit any difference

VERO

0.1" COPPER TRACKS
2.5 × 3.75 89p
2.5 × 5 99p
3.75 × 3.75 99p
3.75 × 5 1.14
2.5 × 17 2.99
3.75 × 17 3.85
4.79 × 17 4.93
VQ Board 1.92
Dip Board 3.90
Track Cutter 1.48
100 Pins 55p
Veroblock 5.95
Vero Wiring
Pen + Spool 3.35
Spare Spool 75p
Combs 6p

PCB MATS

FERRIC CHLORIDE
Quick dissolving pellets (mix with 1 litre water) 1.69

ETCH RESIST TRANSFERS
1 Thin lines
2 Thick lines
3 Thin bends
4 Thick bends
5 DIL pads
6 Transistor pads
7 Dots + holes
8 0.1" edge cons
9 Mixture
Any sheet of above 35p

GRADE ONE GLASS PCB
Single Sided
178 × 240mm 1.50
420 × 195mm 1.95
420 × 245mm 2.95

DALO ETCH RESIST PEN
+ spare nib 90p

PHOTO SENSITIVE PCB
1st Class Epoxy Glass For better results than spraying Expose to UV
Single sided
100 × 160 1.55
100 × 220 1.90
203 × 114 1.85
233 × 220 3.99
Double sided
100 × 160 1.65
100 × 220 2.15
203 × 114 2.21
233 × 220 4.55
Developer for above (do not use Sodium Hydroxide) 500ml 2.50

WIRE

Prices per Metre
Solid connecting wire 5p
Mains/Speaker Cable
Twin 1 amp 14p
Twin 2½ amp 16p
3 Core 2½ amp 18p
3 Core 6 amp 31p
3 Core 13 amp 56p
Screened Cable
Single 14p
Stereo 27p
Mini Single 12p
Mini Stereo 15p
4 Core 4 Screens 44p
4 Core 1 Screen 54p
8 Core 61p
12 Core 80p
Aerial Cable
50Ω RG58A 36p
75Ω UHF 25p
75Ω VHF 28p
300Ω Flat 14p
Rainbow Ribbon Cable
Prices per foot
8 Way 25p
10 Way 25p
16 Way 39p
20 Way 48p
24 Way 62p
30 Way 75p
32 Way 82p
40 Way 88p
64 Way 1.49

RECHARGE BATTERIES

Top quality Don't throw these batteries way they charge up to 1000 times!
HP2 (1.2AH) 2.10
HP2 (4AH) 4.75
HP7 (.5AH) 99p
HP11 (1.2AH) 2.29
PP3 4.95
Chargers
TYPE H Adjustable to 6 of any HP type above £15.59
TYPE M As above but charges 4AH batteries faster £25.95
TYPE P PP3 £5.50
TYPE A HP7 (Up to 4 at a time) £5.85

SOLDER

ANTEX SOLDERING IRONS
C240 (15W) 4.95
XS240 (25W) 5.25
Iron stand 1.75
C240 Element 2.25
XS240 Element
Bits C240
No 2 (Small) 85p
No 3 (Med) 85p
No 6 (Micro) 85p
Bits XS240
No 50 (Small) 85p
No 51 (Med) 85p
No 52 (Lge) 85p
SOLDER 125gms
18 swg 2.95
22 swg 3.10

PLUGS & SOCKETS

'D' Connectors
25 Way
Solder
Male 1.60
Female 2.09
PCB Wire Wrap
Male 1.60
Female 2.09
Covers £1.00
Phono Plugs
Blk Red Grn Wht or Yellow 15p
Line Skts 15p
Chas Skt 1 20p
Dual 30p
Quad 40p

TRANSISTORS

A small sample of our vast stocks
2N930 20p
2N930A 30p
2N1893 49p
2N2102 39p
2N2217 39p
2N2218 33p
2N2218A 25p
2N2219 27p
2N2219A 28p
2N2220 22p
2N2221 22p
2N2221A 23p
2N2222 24p
2N2222A 25p
2N2223 2.60
2N2223A 4.15
2N2368 25p
2N2369 19p
2N2369A 20p
2N2904A 27p
2N2905 28p
2N2905A 29p
2N2906 25p
2N2906A 30p
2N2907 25p
2N2907A 26p
2N2920 8.50
2N2923 25p
2N2924 15p
2N2925 15p
2N2926 10p
2N3053 27p
2N3054 56p
2N3055 60p
2N3055H 120p
2N3250 36p
2N3251 36p
2N3439 98p
2N3440 80p
2N3441 1.25
2N3442 1.35
2N3445 4.80
2N3446 6.09
2N3447 5.72
2N3448 6.56
2N3468 1.00
2N3512 1.06
2N3553 2.65
2N3638 55p
2N3638A 70p
2N3702 10p
2N3703 10p
2N3704 10p
2N3705 10p
2N3706 10p
2N3707 10p
2N3708 10p
2N3709 10p
2N3710 10p
2N3711 10p
2N3712 2.00
2N3713 1.38
2N3714 2.98
2N3715 3.31
2N3716 3.60
2N3773 1.99
2N3819 36p
2N3820 38p
2N3821 1.84
2N3822 90p
2N3823 45p
2N3824 1.70
2N3866 90p
2N3903 13p
2N3904 13p
2N3905 13p
2N3906 13p
2N4030 75p
2N4031 65p
2N4032 69p
2N4036 63p
2N4037 49p
2N4123 3.00
2N4347 2.26
2N4400 15p
2N4401 27p
2N4402 30p
2N4403 30p
2N4409 36p
2N4410 42p
2N4427 79p
2N4870 80p
2N4871 55p
2N4888 99p
2N4901 1.69
2N4902 1.85
2N4903 1.98
2N4904 2.15
2N4905 2.75
2N4906 2.99
2N4907 3.20
2N4908 3.15
2N4909 2.90
2N4918 65p
2N4919 75p
2N4920 85p
2N4921 55p
2N4922 69p
2N4923 99p
2N5086 36p
2N5087 39p
2N5088 37p
2N5089 37p
2N5190 68p
2N5191 70p
2N5193 90p
2N5194 75p
2N5245 37p
2N5246 40p
2N5247 45p
2N5248 40p
2N5249 48p
2N5266 28p
2N5293 98p
2N5294 1.28
2N5295 1.27
2N5401 37p
2N5415 1.10
2N5416 1.54
2N5447 16p
2N5448 19p
2N5449 21p
2N5450 23p
2N5451 29p
2N5457 25p
2N5458 29p
2N5459 29p
2N5460 72p
2N5551 29p
2N5884 5.95
2N5886 5.95
2N6083 17.95
2N6121 57p
2N6122 59p
2N6123 65p
2N6124 59p
2N6125 65p
2N6126 75p
2N6129 79p
2N6130 93p
2N6131 98p
2N6132 83p
2N6133 1.14
2N6134 1.36
2N6253 1.45
2N6254 1.55
2SC1306 95p
2SC2078 1.70
2SJ49 3.50
2SJ50 3.75
2SJ82 4.29
2SK134 3.50
2SK135 3.75
2SK226 4.29
3N128 1.22
3N140 1.07
3N200 6.93
3N201 2.98
40360 60p
40361 67p
40362 67p
40363 2.95
40406 1.39
40407 75p
40408 1.58
40410 1.80
40411 2.85
40412 90p
40673 83p
40822 1.80
40871 79p
40872 79p
AC125 49p
AC126 32p
AC127 32p
AC128 35p
AC132 68p
AC141K 28p
AC142K 28p
AC151 51p
AC152 45p
AC153 55p
AC153K 64p
AC176 27p
AC176K 37p
AC187 25p
AC187K 28p
AC188 25p
AC188K 40p
AF239 55p
AF240 1.00
BC107 12p
BC107A 12p
BC107B 12p
BC108 10p
BC108A 12p
BC108B 12p
BC108C 14p
BC109 10p
BC109B 12p
BC109C 12p
BC140 29p
BC141 37p
BC142 29p
BC143 30p
BC147 10p
BC147A 10p
BC147B 10p
BC147C 20p
BC148 10p
BC148A 12p
BC148B 13p
BC148C 13p
BC149 10p
BC149B 12p
BC149C 13p
BC152 35p
BC153 23p
BC154 27p
BC157 11p
BC157A 12p
BC157B 13p
BC158 10p
BC158A 12p
BC158B 13p
BC158C 13p
BC159 11p
BC159A 13p
BC159B 13p
BC159C 18p
BC160 42p
BC161 48p
BC167 10p
BC167A 10p
BC167B 13p
BC168 10p
BC168B 10p
BC168C 10p
BC169 10p
BC169B 10p
BC169C 10p
BC177 16p
BC177A 25p
BC177B 26p
BC178 16p
BC178A 24p
BC178B 25p
BC179 20p
BC179A 25p
BC179C 27p
BC182 10p
BC182A 12p
BC182B 13p
BC182L 10p
BC182LA 13p
BC182LB 14p
BC183 10p
BC183A 11p
BC183B 12p
BC183C 13p
BC183L 10p
BC183LA 13p
BC183LB 13p
BC183LC 14p
BC184 10p
BC184B 12p
BC184C 13p
BC184L 10p
BC184LB 13p
BC184LC 14p
BC186 24p
BC187 24p
BC212 10p
BC212A 12p
BC212B 13p
BC212L 10p
BC212LA 13p
BC212LB 14p
BC213 10p
BC213A 12p
BC213B 12p
BC213C 13p
BC213L 10p
BC213LA 13p
BC213LB 13p
BC213LC 14p
BC214 10p
BC214B 12p
BC214C 13p
BC214L 10p
BC214LB 12p
BC214LC 14p
BC237 16p
BC237A 16p
BC237B 17p
BC237C 18p
BC238 14p
BC238A 15p
BC238B 16p
BC238C 17p
BC239 16p
BC239A 16p
BC239B 17p
BC239C 18p
BC300 45p
BC301 44p
BC302 43p
BC303 47p
BC327 14p
BC328 14p
BC337 15p
BC338 15p
BC440 32p
BC441 33p
BC460 32p
BC461 33p
BC516 40p
BC517 40p
BC547 14p
BC546B 15p
BC556B 15p
BC547A 14p
BC547B 14p
BC548 12p
BC548A 13p
BC548B 14p
BC548C 15p
BC549 13p
BC549B 14p
BC549C 15p
BC550 15p
BC550C 25p
BC557 15p
BC557A 16p
BC557B 16p
BC558 14p
BC558A 15p
BC558B 16p
BC558C 17p
BC559 16p
BC559B 16p
BC559C 17p
BC560 15p
BC560C 25p
BC650 45p
BC651 46p
BCY70 16p
BCY71 16p
BCY72 19p
BD131 44p
BD132 44p
BD135 40p
BD136 40p
BD137 42p
BD138 39p
BD139 39p
BD140 39p
BD237 98p
BD238 98p
BD239A 57p
BD239C 64p
BD240A 59p
BD240C 73p
BD241A 61p
BD241C 67p
BD242A 65p
BD242C 70p
BD243A 72p
BD243C 85p
BD244A 82p
BD244C 1.00
BD245A 1.14
BD245C 1.30
BD246A 1.20
BD246C 1.50
BD249A 2.00
BD249C 2.31
BD250A 2.11
BD250C 2.46
BD419 1.29
BD420 1.37
BD437 88p
BD438 88p
BD439 90p
BD440 91p
BD441 91p
BD442 93p
BD529 1.20
BD530 1.30
BD535 75p
BD536 75p
BD537 80p
BD538 80p
BD539 80p
BD539C 1.10
BD540 85p
BD540C 1.20
BD675 72p
BD676 77p
BD677 78p
BD678 83p
BD711 1.32
BD712 1.32
BDX32 3.47
BDX66B 5.95
BDX67B 5.95
BDY54 1.70
BDY55 1.75
BDY56 1.80
BDY57 5.25
BDY58 6.15
BF194 12p
BF195 12p
BF196 12p
BF197 12p
BF198 15p
BF199 15p
BF200 1.49
BF224J 32p
BF225J 35p
BF244A 35p
BF244B 39p
BF245A 30p
BF245B 51p
BF246 52p
BF246A 39p
BF246B 53p
BF247A 54p
BF247B 55p
BF254 39p
BF255 42p
BF256A 35p
BF256B 48p
BF256C 62p
BF257 30p
BF258 32p
BF259 35p
BF457 46p
BF458 58p
BF459 62p
BF469 86p
BF470 86p
BFR39 22p
BFR40 22p
BFR41 22p
BFR79 22p
BFR80 22p
BFR81 22p
BFR90 2.11
BFS28 2.95
BFS61 1.00
BFS98 1.10
BFX29 26p
BFX30 27p
BFY50 23p
BFY51 23p
BFY52 23p
BFY53 31p
BSX19 24p
BSX20 24p
BSX21 40p
BU104 2.22
BU105 1.70
BU108 3.95
BU109 3.29
BU126 1.47
BU204 2.25
BU205 1.75
BU206 1.89
BU208 1.98
BU226 3.95
BU326S 2.35
BU406 1.45
BU407 1.45
BU408 1.35
BU500 2.95
BUY18S 3.95
E430 5.95
J300 48p
J310 53p
MJ802 3.99
MJ900 2.90
MJ901 3.10
MJ1000 2.50
MJ1001 3.00
MJ1800 3.60
MJ2500 2.19
MJ2501 2.25
MJ2955 1.00
MJ3000 2.19
MJ3001 2.25
MJ4502 3.99
MJ15003 4.85
MJ15004 5.55
MJ15015 2.45
MJ15016 3.34
MJE340 53p
MJE350 1.50
MJE2955 99p
MJE3055 69p
MPSA05 23p
MPSA06 25p
MPSA10 28p
MPSA12 29p
MPSA13 48p
MPSA14 46p
MPSA16 30p
MPSA18 65p
MPSA20 48p
MPSA42 49p
MPSA43 49p
MPSA55 28p
MPSA56 30p
MPSA65 40p
MPSA66 47p
MPSA70 45p
MPSA92 39p
MPSA93 39p
MPSL01 42p
MPSL51 48p
MPSU01 84p
MPSU04 1.32
MPSU05 55p
MPSU06 56p
MPSU07 75p
MPSU51 88p
MPSU55 58p
MPSU56 59p
MPSU57 1.20

JUST RELEASED
NEW ILLUSTRATED CATALOGUE
£1.00 inc.VAT, p&p

TIP29A 29p
TIP29C 38p
TIP30A 35p
TIP30C 36p
TIP31A 33p
TIP31C 34p
TIP32A 38p
TIP32C 42p
TIP33A 65p
TIP33C 78p
TIP34A 74p
TIP34C 88p
TIP35A 1.09
TIP35C 1.28
TIP36A 1.29
TIP36C 1.39
TIP41A 49p
TIP41C 55p
TIP42A 55p
TIP42C 65p
TIP49 1.20
TIP50 1.40
TIP53 1.57
TIP54 1.58
TIP110 74p
TIP112 90p
TIP115 81p
TIP117 96p
TIP120 69p
TIP122 73p
TIP125 84p
TIP127 84p
TIP130 93p
TIP132 93p
TIP135 99p
TIP137 99p
TIP140 1.04
TIP142 1.04
TIP145 1.15
TIP147 1.15
TIP162 4.95
TIP2955 77p
TIP3055 70p
TIS43 40p
TIS88A 62p
VN10KM 60p
VN46AF 84p
VN66AF 85p
ZTX107 10p
ZTX108 10p
ZTX109 10p
ZTX300 13p
ZTX301 15p
ZTX302 15p
ZTX303 23p
ZTX304 15p
ZTX310 25p
ZTX311 32p
ZTX312 35p
ZTX313 36p
ZTX314 24p
ZTX320 35p
ZTX330 35p
ZTX341 28p
ZTX450 39p
ZTX500 14p
ZTX501 14p
ZTX502 14p
ZTX503 17p
ZTX504 24p
ZTX510 34p
ZTX530 24p
ZTX531 25p
ZTX650 45p

DIODES

1N34A 30p
1N821 70p
1N823 92p
1N914 4p
1N916 6p
1N4001 4p
1N4002 4½p
1N4003 5p
1N4004 5½p
1N4005 6p
1N4006 6½p
1N4007 7p
1N4009 20p
1N4148 3p
1N4150 18p
1N4448 22p
1N5400 12p
1N5401 13p
1N5402 14p
1N5403 15p
1N5404 18p
1N5406 18p
1N5407 19p
1N5408 20p
1N5024 52p
1S44 10p
BA102 25p
BA115 25p
BA133 40p
BA138 30p
BA142 20p
BA155 15p
BA156 38p
BA157 25p
BA158 30p
BA159 32p
BA182 40p
BA201 18p
BA202 26p
BA316 25p
BA317 25p
BA318 30p
BAV10 16p
BAV19 15p
BAV20 15p
BAX13 10p
BB109G 65p
BY126 20p
BY127 22p
BY134 52p

SCR's, TRIACS DIACS

THYRISTORS
4, 8 & 12 Amps
Texas TO220
Suffix A 100V
B 200V
C 300V
D 400V
M 600V
TIC106A 46p
TIC106B 47p
TIC106C 48p
4A TIC106D 49p
TIC106M 68p
TIC116A 66p
TIC116B 68p
8A TIC116C 71p
TIC116D 73p
TIC116M 80p
TIC126A 72p
TIC126B 72p
12A TIC126C 73p
TIC126D 78p
TIC126M 96p

TRIACS
Texas 400V
TO220 Case
TIC206D(4A) 66p
TIC225D(6A) 74p
TIC226D(8A) 88p
TIC236D(12A) 1.16
TIC246D(16A) 1.22
TIC253D(20A) 1.90
TIC263D(25A) 2.11

DIACS
BR100 25p
ST2 25p

ZENER'S

400 500mW
E24 Series
2.4 47V 7p
1.3 Watt
E24 Series
3.3 82V 14p

BRIDGE

(PIV shown in brackets)
1½ amp type
W01 (100) 20p
W02 (200) 26p
W04 (400) 28p
W08 (800) 40p
2 amp type
Square with hole
S01 (100) 37p
S02 (200) 40p
S04 (400) 40p
S08 (800) 55p
6 amp type
Square with hole
PW01 (100) 50p
PW02 (200) 78p
PW04 (400) 85p
PW06 (600) 90p
25 amp type
Metal clad with hole
K01 (100) 2.20
K02 (200) 2.30
K04 (400) 2.80
K06 (600) 3.40
BYW64 3.95
35A 400V 3.95

OPTO

LEDs
R Red
G Green
Y Yellow
Large diffused
1 - 50 -
R5D 9p 7p
G5D 15p 12p
Y5D 15p 12p
Small diffused
R2D 8p 6p
G2D 12p 10p
Y2D 12p 10p
Micro 0.1"
R1D 25p 22p
G1D 27p 25p
Y1D 27p 25p
Large clear
R5C 12p 10p
G5C 17p 13p
Y5C 17p 13p
Super bright high efficiency
Large (100 times brighter)
R5U 38p 29p
G5U 42p 34p
Y5U 42p 34p
Rectangular Stackables LEDs
R6L 17p
G6L 18p
Y6L 19p

LINICS

AY1-5050 95p
AY3 8910 3.66
AY3 8912 4.40
CA3048 2.15
CA3059 2.80
CA3090AQ 3.70
CA3130E 87p
CA3130T 1.80
CA3140E 39p
CA3140T 95p
HA1366W 2.40
HA1388 2.54
ICL7106 6.85
ICL7107 9.50
ICL7611 97p
ICL8038 2.95
ICL7555 80p
ICL7556 1.50
LC7120 3.20
LC7130 3.20
LC7137 3.95
LF347 1.50
LF351 47p
LF353 92p
LF355 83p
LF356 92p
LF357 1.09
LF398 4.59
LM335Z 1.19
LM348N 62p
LM349N 1.09
LM350K 4.60
LM379S 4.50
LM380N14 75p
LM380N8 1.50
LM381AN 2.26
LM381N 1.40
LM382N 1.12
LM383T 3.40
LM384N 1.40
LM386 88p
LM388N 2.43
LM391N60 1.70
LM391N80 1.93
LM723CH 95p
LM723CN 35p
LM725CH 3.40
LM725CN 3.19
LM741CH 96p
LM741CN 15p
LM747CN 69p
LM748CH 1.00
LM748CN 35p
LM1871 3.25
LM1872 4.38
LM1886 7.44
LM1889 3.77
LM2907N 2.75
LM2907N8 2.60
LM2917N 1.89
LM2917N 1.89
LM387N8 1.65
LM3900 49p
LM3911 1.20
LM3914 2.50
LM3915 2.50
LM3916 2.50
LM13600 95p
MF10 3.50
DM335 7.20
NE531N 1.36
NE543N 2.50
NE544N 1.95
NE555 16p
NE556 45p
NE558 1.89
NE560 3.25
NE565 1.18
NE566 1.49
NE567 1.37
NE570 4.07
NE571 3.99
NE5534A 95p
RC4136 59p
TBA500 2.97
TBA500Q 3.11
TBA510 2.95
TBA510Q 3.05
TBA520 2.57
TBA520Q 2.75
TBA530 2.55
TBA530Q 2.76
TBA540 2.72
TBA540Q 2.74
TBA550 3.25
TBA550Q 3.27
TBA560C 2.87
TBA570 2.37
TBA570Q 2.48
TDA1002 3.39
TDA1003 3.94
TDA1004 2.87
TDA1005 3.94
TDA1010A 2.25
TDA1022 4.95
TDA2611A 2.50
TL061 40p
TL062 60p
TL064 99p
TL071 25p
TL072 50p
TL074 99p
TL081 25p
TL082 50p
TL084 89p
UAA170 1.69
UAA180 1.69
ULN2003 85p
UPC575C2 2.50
UPC1156 2.75
XR2206 2.92
ZN414 1.00
ZN419 2.25
ZN1034 1.99

74TTL

7400 16p
7401 16p
7402 16p
7403 16p
7404 16p
7405 16p
7408 14p
7409 14p
7410 15p
7411 16p
7412 18p
7413 18p
7414 25p
7416 19p
7417 19p
7420 15p
7421 19p
7422 19p
7423 19p
7425 19p
7426 19p
7427 19p
7428 26p
7430 14p
7432 22p
7433 22p
7437 25p
7438 21p
7440 15p
7441 55p
7442 32p
7443 89p
7444 89p
7445 49p
7446 59p
7447 39p
7448 49p
7450 15p
7451 15p
7453 15p
7454 14p
7460 15p
7470 34p
7472 25p
7473 25p
7474 19p
7475 25p
7476 25p
7480 39p
7481 1.19
7482 63p
7483 38p
7484 69p
7485 60p
7486 19p
7489 1.68
7490 20p
7491 35p
7492 25p
7493 25p
7494 36p
7495 36p
7496 35p
7497 89p
74100 80p
74104 50p
74105 55p
74107 19p
74109 25p
74110 35p
74116 50p
74118 55p
74119 59p
74120 59p
74121 25p
74122 35p
74123 35p
74125 30p
74126 29p
74128 35p
74132 29p
74136 27p
74141 55p
74142 1.75
74143 1.95
74144 1.95
74145 38p
74147 89p
74148 55p
74150 49p
74151 35p
74153 35p
74154 49p
74155 40p
74156 39p
74157 29p
74159 75p
74160 59p
74161 48p
74162 39p
74163 39p
74164 39p
74165 39p
74166 48p
74170 1.25
74172 2.50
74173 59p
74174 54p
74175 49p
74176 39p
74177 45p
74178 79p
74180 40p
74181 1.15
74182 80p
74184 89p
74185 89p
74186 4.69
74188 2.50
74190 48p
74191 48p
74192 45p
74193 45p
74194 40p
74195 40p
74196 45p
74197 39p
74198 79p
74199 83p
74221 53p

74LS TTL

74LS00 15p
74LS01 15p
74LS02 15p
74LS03 15p
74LS04 15p
74LS05 15p
74LS08 15p
74LS10 15p
74LS11 15p
74LS12 15p
74LS13 15p
74LS14 24p
74LS15 15p
74LS20 15p
74LS21 15p
74LS22 15p
74LS27 15p
74LS28 15p
74LS30 15p
74LS32 15p
74LS33 15p
74LS37 15p
74LS38 15p
74LS40 15p
74LS42 28p
74LS47 35p
74LS51 14p
74LS54 14p
74LS55 14p
74LS73 18p
74LS74 18p
74LS75 18p
74LS76 19p
74LS78 19p
74LS83 36p
74LS85 41p
74LS86 16p
74LS90 24p
74LS92 29p
74LS93 24p
74LS95 39p
74LS96 93p
74LS107 35p
74LS109 23p
74LS112 22p
74LS113 19p
74LS114 22p
74LS122 32p
74LS123 36p
74LS124 89p
74LS125 24p
74LS126 25p
73LS132 29p
74LS136 24p
74LS138 24p
74LS139 28p
74LS145 69p
74LS147 99p
74LS148 75p
74LS151 37p
74LS153 39p
74LS154 79p
74LS155 29p
74LS156 36p
74LS157 24p
74LS158 29p
74LS160 50p
74LS161 35p
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74LS164 40p
74LS165 49p
74LS168 84p
74LS169 85p
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74LS173 49p
74LS174 34p
74LS175 34p
74LS181 88p
74LS183 1.05
74LS190 36p
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74LS193 37p
74LS194 32p
74LS195 32p
74LS196 45p
74LS197 48p
74LS221 95p
74LS240 95p
74LS241 95p
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74LS243 95p
74LS244 95p
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74LS247 95p
74LS248 95p
74LS249 95p
74LS251 29p
74LS253 32p
74LS257 29p
74LS258 35p
74LS259 55p
74LS261 99p
74LS266 18p
74LS273 54p
74LS275 1.25
74LS279 29p
74LS280 89p
74LS283 39p
74LS289 4.70
74LS290 39p
74LS293 39p
74LS295 74p
74LS298 79p
74LS299 1.49
74LS323 1.59
74LS324 1.45
74LS325 2.96
74LS326 2.39
74LS327 2.39
74LS347 95p
74LS348 88p
74LS352 61p
74LS353 61p
74LS362 7.25
74LS365 29p
74LS366 29p
74LS367 29p
74LS368 29p
74LS373 55p
74LS378 68p
74LS386 1.14
74LS390 46p
74LS393 42p
74LS395 89p
74LS396 1.90
74LS398 2.70
74LS399 1.59
74LS445 99p
74LS490 2.20
74LS540 89p
74LS541 1.20
74LS640 99p
74LS641 99p

CMOS

4000 16p
4001 16p
4002 16p
4006 49p
4007 19p
4008 32p
4009 24p
4010 24p
4011 16p
4012 19p
4013 19p
4014 46p
4015 39p
4016 19p
4017 32p
4018 45p
4019 25p
4020 42p
4021 39p
4022 39p
4023 19p
4024 32p
4025 19p
4026 79p
4027 19p
4028 39p
4029 43p
4030 19p
4031 1.19
4032 79p
4033 1.20
4034 1.29
4035 44p
4036 2.49
4037 1.13
4038 99p
4040 40p
4041 40p
4042 39p
4043 39p
4044 39p
4045 99p
4046 44p
4047 39p
4048 39p
4049 22p
4050 23p
4051 44p
4052 58p
4053 49p
4054 79p
4055 83p
4056 79p
4059 4.35
4060 42p
4063 79p
4066 22p
4067 2.39
4068 19p
4069 19p
4070 19p
4071 19p
4072 19p
4073 19p
4075 19p
4076 45p
4077 19p
4078 19p
4081 19p
4082 19p
4085 49p
4086 60p
4089 1.23
4093 19p
4094 69p
4095 71p
4096 69p
4097 2.88
4098 74p
4099 89p
4502 55p
4503 39p
4507 33p
4508 1.26
4510 45p
4511 48p
4512 48p
4514 1.13
4515 1.13
4516 55p
4518 39p
4519 29p
4520 48p
4521 88p
4526 68p
4527 62p
4528 74p
4532 69p
4534 3.96
4536 2.59
4538 78p
4539 89p
4543 68p
4553 2.25
4555 35p
4556 35p
4560 1.49
4566 1.49
4569 1.65
4584 39p
4585 59p

LOGIC

CPU's
1802 6.50
2650A 11.99
6502 3.24
6800 2.10
6802 2.40
6809 6.20
8035 3.49
8080A 2.50
8085A 3.49
SCMP1 20.00
Z80A 2.98
Z80B 8.60

MEMORIES
2114 (200ns) 99p
2532 2.98
2564 6.25
2764 4.25
2708 2.95
2716(5V) 2.10
4116 (200ns) 99p
4118 3 3.25
4164 4.25
5101 (450ns) 1.89
5204 7.50
6116 3.85
6514 3.30
6810 1.15
7489 1.65
74189 4.00
74LS289 3.25
74LS188 2.25
74LS287 3.05
74LS288 2.25

MISC LOGIC ICs
ADC0804 3.95
ADC0816 14.90
ADC0817 10.06
INS1671 20.80
INS1771 20.00
RO2513LC 6.50
RD2513UC 6.50
SAA5000 3.00
SAA5010 7.10
SAA5012 7.10
SAA5020 5.50
SAA5030 9.00
SAA5040 15.00
SAA5041 15.00
SAA5050 8.50
SAA5052 8.50
SAA5070 16.95
TMS6011 3.65
8T26 95p
8T28 1.20
8T95 85p
8T97 85p
81LS95 80p
81LS96 85p
81LS97 90p
81LS98 85p
6522 3.19
6532 5.70
8154 9.00
8155 3.50
8212 1.10
8216 99p
8224 1.10
8226 2.50
8228 2.19
Z80ACTC 2.60
Z80ADART 5.50
Z80ADMA 6.70
Z80APID 2.70
ZN425E8 3.39

V.REGS

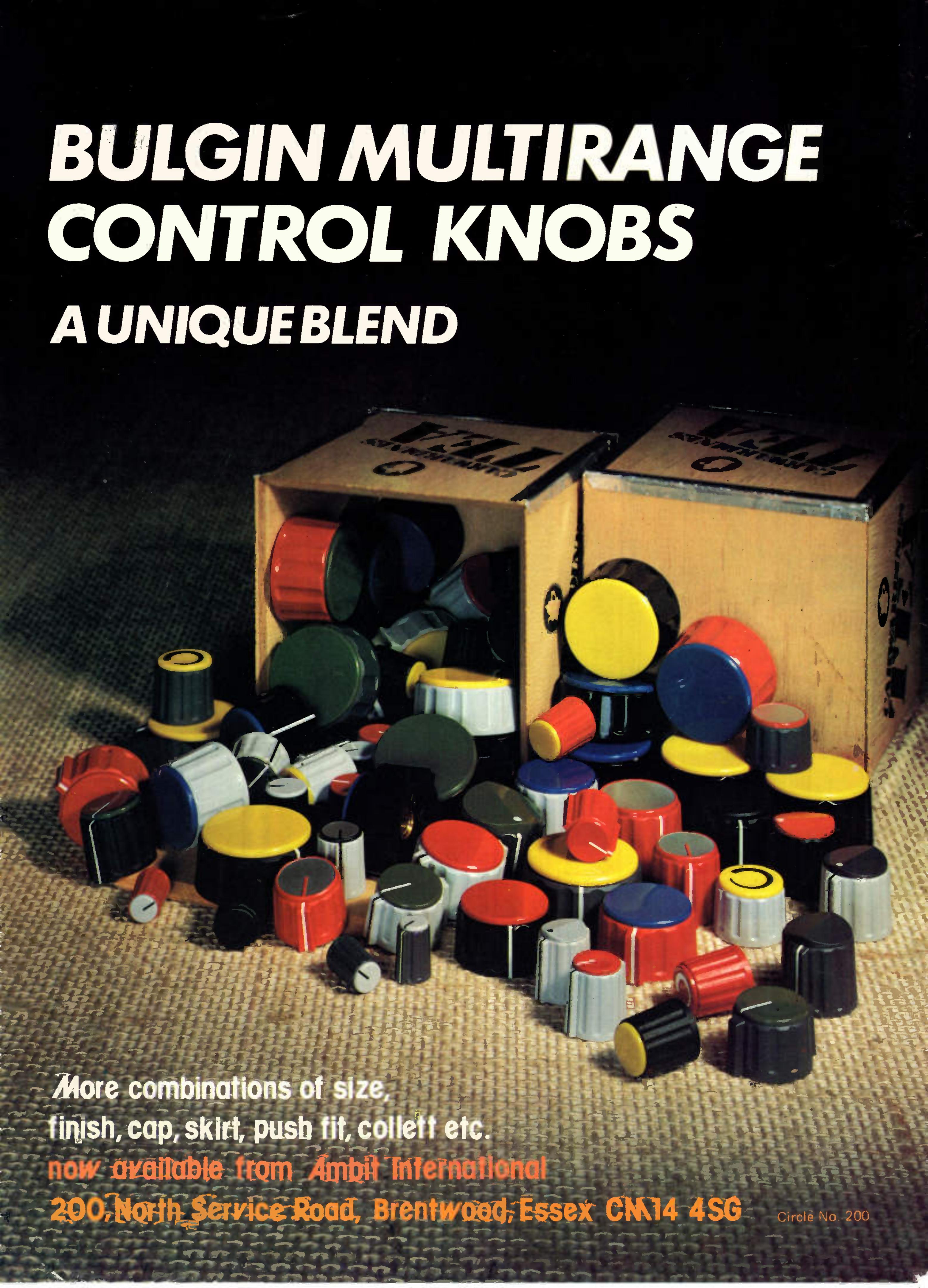
– Positive –
100mA
78L05A 29p
78L12A 29p
78L15A 29p
78L24A 29p
1 Amp T0220
7805T 39p
7812T 39p
7815T 39p
7824T 39p
– Negative –
100mA T092
79L05 49p
79L12 49p
79L15 49p
1 Amp T0220
7905T 44p
7912T 44p
7915T 44p
7924T 44p

ZIF SOCKET

24 Pin 4.35

SWITCHES

Toggles (Mini)
SPST 49p
SPDT 55p
DPDT 69p
DPDT C off 85p
4PDT 2.75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