DECEMBER 1981

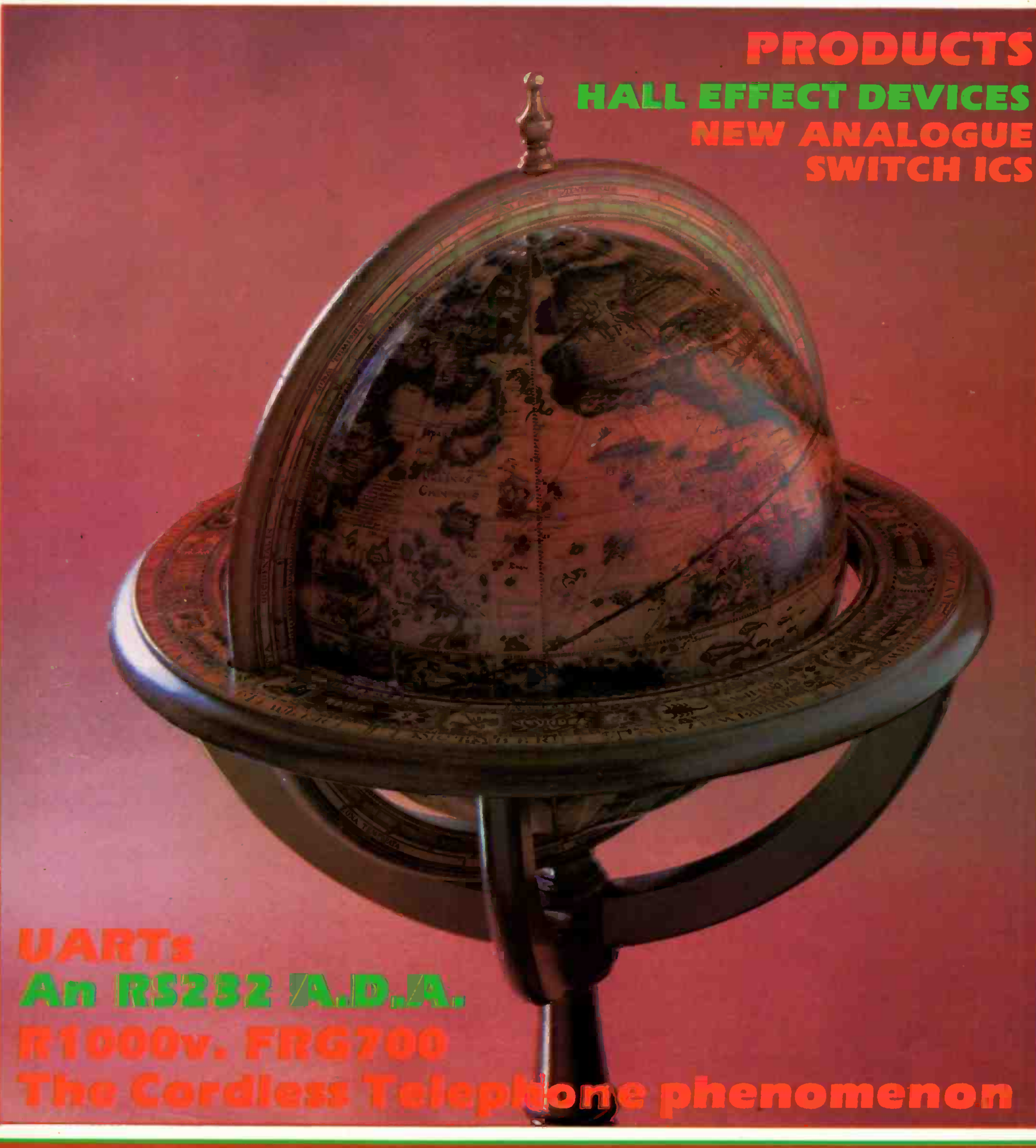
RADIO & ELECTRONICS WORLD

70p

PRODUCTS

HALL EFFECT DEVICES

NEW ANALOGUE SWITCH ICS



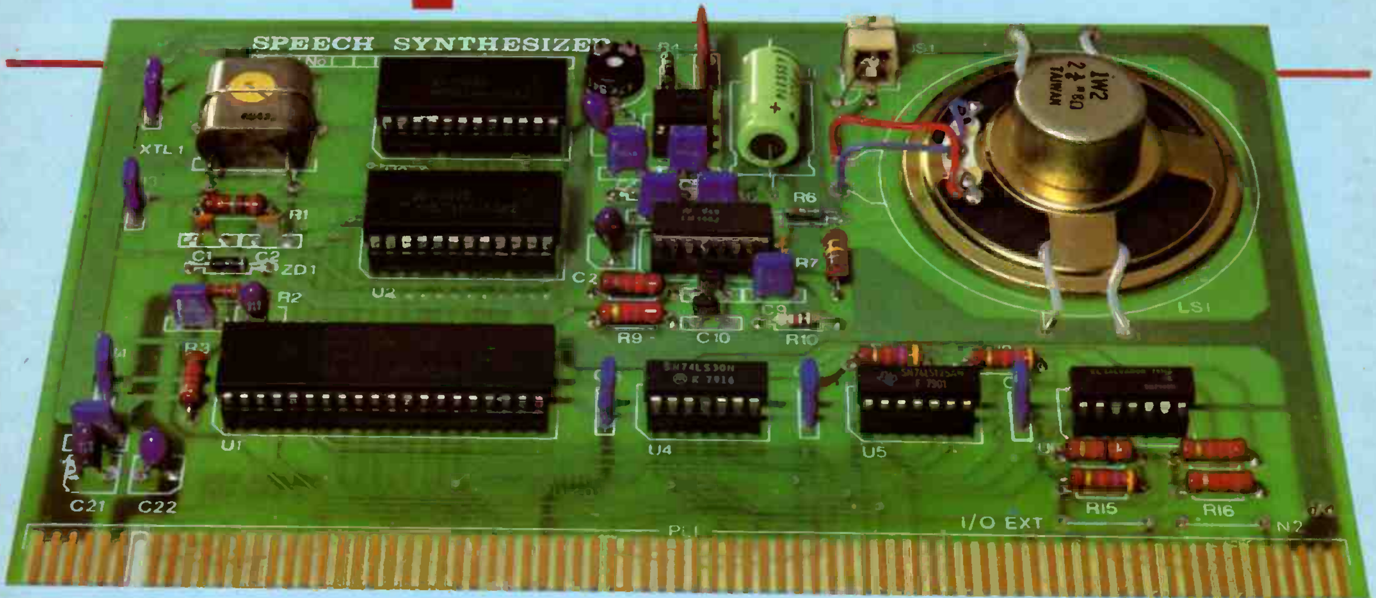
UARTs

An RS232 A.D.A.

R1000v. FRG700

The Cordless Telephone phenomenon

does your computer talk?



For use with Nascom, Pet, Apple, Tandy, UK 101.

The first in our new range of peripheral boards for the popular microcomputers is a speech synthesizer.

As with all our products it is fully built and tested.

The main board is 8" x 5", through plated, double sided and fully buffered. We are using the National Semiconductor 'Digitalker' chip. There is an on-board 2" speaker and audio amplifier.

The speech-board itself is "Nasbus" compatible.

There is a piggy-back board which generates an RS232 interface to any computer with an RS232 serial port.

The board is supplied with the necessary user software to make insertion into your programs simple. The depth to which you expand your use of the board is your decision.

The "Digitalker" chip has 256 expressions which include words and sub-sounds. These sub-sounds will enable you to expand your vocabulary rapidly and allow you to write your expressions/responses etc. into your programs using the appropriate code.

N.B.
Nascom Apple products available immediately. Commodore, PET, Tandy,UK101, Video Genie available very shortly.

Arfon Microelectronics is a new company based around the knowledge and proven design success of people who have been at the forefront of the expansion of micros in the UK.

The design group have an interest in many areas involved with microprocessors and future products will not always be specifically computing.

Based in Caernarfon, in a modern 25,000 sq.ft. factory, the company will sell its products throughout Europe. The custom built factory will produce built and tested products to a very high standard.

Not only will the factory produce 'house products' but will also manufacture products that the design team have generated for outside companies.

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For contact with the design team etc. please write to K. Borland at 153 High Street, Potters Bar, Hertfordshire.

Available Now: a Light Pen in use with the same series of microcomputers. The pen is properly encased and the whole manufactured for commercial use. The flexibility of input with a light pen and the instantanious screen addressing makes this product a must for a regular computer user.

AM AM AM

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Existing Computer System ....

Type of user: ☐ Hobbiest ☐ Commercial ☐ Industrial ☐ Educational

Mags Read: ☐ Practical ☐ PCW ☐ Comp Today ☐ Comp Weekly ☐ Computing

Others ....

RADIO & ELECTRONICS WORLD

Published by Broadercasting Ltd., 117a High Street, Brentwood, Essex. R&EW is published monthly, on the first Thursday of each month.

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Published by
Broadercasting Limited
Distributed by
SM Distribution Ltd
16/18 Trinity Gardens
London SW9 8DX
telephone 01-274-8611
Printed by
LSG Printers Lincoln
Photosetting by
Delafield Reprographic Service
481 Ongar Road
Brentwood Essex
Cartoons
Mike Turner
Framed original 'Turners' are available from R&EW for £25.00 each. First come, first served.

Subscriptions
Rates for 12 months
UK **£9.50**
Overseas £10.50

Projects

Reviews

News

Features

Information

Special Offers

Ideal Christmas presents for electronics enthusiasts

NB Due to pressure on space, this month's instalment of the frequency synthesis feature has been held over - along with the Helical Filter feature. We hope to squeeze them in next month.

BACK ISSUES: Don't forget, back issues of **R&EW** can be obtained from our subscription department at 75p each, inc postage. Use the reply paid card/order form or send a cheque/PO.

EDITORIAL

Keeping it up

When our various associates heard that a monthly electronics magazine was being planned, the most commonly asked question was:
"How on earth are you going to find enough material every month ?"

Well, fear not, we are perpetually faced with the problem of finding room for both the planned contents, and the last minute arrivals. The fact is that there is no shortage of material, and with this issue, you will see that we have squeezed some of the type sizes down a little to try and *get it in.* We have debated the concept of increasing the number of pages for editorial, but due to various production problems, this isn't going to be possible just yet.

We would also like to improve the paper type and quality, but you will notice that other 'bookstall' electronics magazines are printed on similar paper for a very good reason -not many of you would be willing to pay 85p for a 'glossy' version, although we are open to your suggestions.

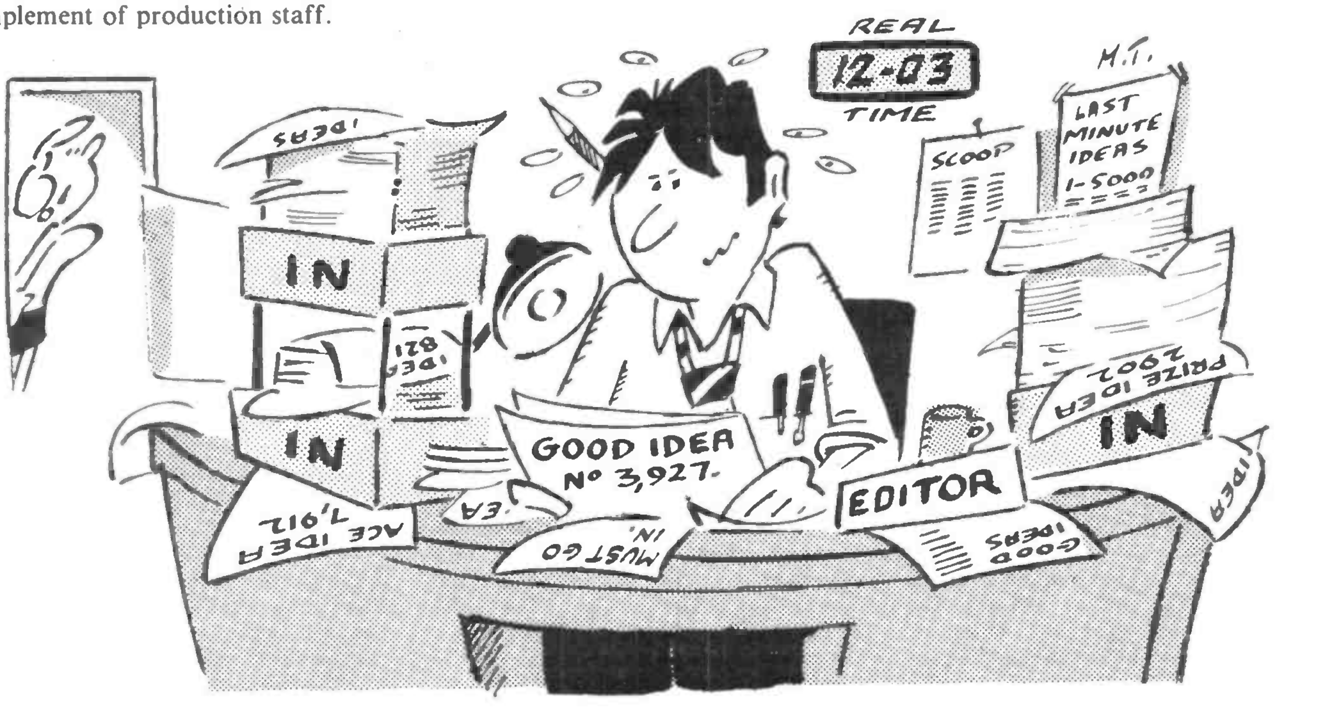
A brief survey amongst those who comment on the paper quality reveals that when put like that, 70p for 100 pages with around 70 pages of 'non-advertising' looks like rather good value.

The next most common comment assumed that the first few issues would be easy (i.e. assuming we would have six months to plan them) and that things would begin to fall apart once we began operating in *real time.* Well, such was the schedule of events with the introduction of the concise parts catalogue into the overall scheme, that we have been producing **R&EW** in real time from the first issue. This dash between issues isn't too good for the ulcers, but we are pleased to say that we have now settled into more of a routine - and have acquired a full complement of production staff.

This relative breather allows us to introduce a couple of new features this month; *Data Brief and Data File.* Data Brief is a two page concise review of the specifications of an IC that is not perhaps as well known as something like a 741. An ultra low cost evaluation 'kit' comprising the IC and a printed and etched - but undrilled - PCB, is also supplied to encourage our readers to get 'hands on' experience by overcoming the biggest two drawbacks - time and money. Use the response page to let us know what you think of the idea, and suggest other IC's that deserve an airing.

The second new feature of this issue is Data File -written by Ray Marston - who also takes over as Editor of **R&EW** with effect from the next issue. I wouldn't want to load him with the responsibility of this issue, which was only completed just after he made his official start.

I have enjoyed the challenge as acting editor of **R&EW** for the first three issues, but now that Ray is free to assume the role, I can get back to my job of investigating potential features, and reading some of the 30 magazines that arrive here every month. You are in good hands.



"GENTLEMAN HERE WANTS TO KNOW IF YOU'RE SHORT OF IDEAS..."

NEWS

"GERONIMO 'ERE, SARGE,.. BETTER GIT THE BUBBLE GUM MACHINE ON THE SCENE, OLD BUDDY, WE GOT US A LITTLE BITTY GLASS BREAKER..."

An electronic Telex, at last

With their usual flair for speedily accepting advances in technology, Telecom is making the first electronic telex terminals available to subscribers in the central and west London areas. The Z-80 based units are made by Trend Communications at around £1500 a piece, which has to be cheaper than the clattering converted 'typewriter' in the shape of the ITT teleprinters that most people have associated with the service since its inception.

The device uses the micro to perform various dialling and indexing functions, with 8k or 16k of CMOS message store. Error correction and editing modes are also available.

Will they be cheaper to hire than the ITT Creed 15B?? We are waiting to find out, but since the mechanical device must be costing at least as much to produce by now, it will be interesting to see if BT use the opportunity to hike the rates on long suffering BT business customers.

In view of the fact that any experienced PET or small micro user could turn a fairly basic machine into something approaching a telex terminal with built in word processing, it seems strange that the ITT 3000 Perfector (electronic telex with word processing plus a bit more) is being aimed 'firmly at the top end of the telex market'. Sounds ominous on the price front.

A prize of £50 to the first reader to submit a program to turn any popular micro system into an electronic telex, and show BT how it can be done for less than £500. Even better if you can produce a circuit for a suitable communications interface from something like the universal RS232, together with a universal BASIC program.

It's a shame BT did not concentrate on tidying up this archaic communication medium before rushing into the Prestel system with such a splash.

CB Started on November 2nd

At the time of writing, the news of the CB start date has just about been leaked through the 'usual' channels, and the race is definitely on to get equipment on sale by the time this issue appears. You will find mention herein of the first UK specification CB set that we have been allowed to test to our satisfaction, and if they're all as good, then there won't be a lot of trouble to other users of the spectrum.

Regardless of personal opinions, CB will doubtless bring about a sudden and massive increase in awareness of general communication technology. **R&EW**'s coverage will continue to concentrate on the technical and engineering aspects - there's enough of the 'good Buddy' style waffle available already.

64K plastic RAMs from Hitachi

Hitachi has now produced its 64K static RAM in plastic. The chip is derived from the earlier and far more costly ceramic package version to allow for different internal dimensions of the molded encapsulation.

Electrical improvements include improved alpha particle resistance, and an increase in cell capacity from 60 to 90 femtofarads. Production is expected to reach 700,000 devices a month by 1982.

BNOS to market built R&EW projects

We are pleased to announce the appointment of BNOS electronics as the first official manufacturers of **R&EW** project hardware, for sale as built and tested items. It is anticipated that most effort will be concentrated on the items of communications interest for the time being.

★ ★ ★ ★ ★ ★ ★ ★

The Writing on wall for Video disc systems already??

Without actually managing to get off the ground, it seems possible that the video cassette recorder has overwhelmed the much vaunted video disk. Philips are still not happy with the produceability of the disc at their Blackburn plant, and hardware to play the software is equally elusive.

What this means for the huge investment made in the system by the various consumer giants who must have tipped the best part ot £1000m into the various programmes is almost too awful to contemplate. However, the spin off's (sorry) in the shape of the development of laser disc memory systems and the huge data storage these represent, could almost be considered worth the trouble. Watch this space.

Ricoh in the Semi business

Following the path of vertical integration, Ricoh are now making their own MOS products in a $37.5 million facility for the design, development and production of LSI. Capacity is 1.5 million devices per month.

Stanley to make colour LCDs

Famous for high brightness LEDs, Stanley Electric are spending **$10 million** on a plant to produce colour LCDs. The products are destined for industrial and automotive applications - production capacity is around 1 million units a month.

Hitachi produce HF power FET

The 2SK317 is the first of Hitachi's RF power transistors. It can put out a whopping 180W at 100MHz and over 100W for 5W input at 175MHz. It readily parallels to provide multi KW FM broadcast transmitter power levels.

The drain-source voltage is 180v, and the overall concept is rather more akin to the use of valve stages, overcoming many of the problems associated with low voltage, huge current bi-polar systems.

REW's data sheet service can provide a data sheet of this and the 'half power' version, the 2SK318 (35p and an SAE, or 50p inc. postage, circle 50 on the response card, and pay by credit card).

We hope to be featuring this device shortly, which promises great things for all aspects of HF and VHF communication.

NEWS

Multichannel TV sound

In one of those moves, designed to prod along the need for consumer updates, several countries (notably Japan) have been starting to get to grips with stereo TV sound. Not only stereo sound, but bilingual sound - which is a great benefit to those many cosmopolitan areas where the local lingo is heavily influenced by ethnic concentrations. West Germany has just started with its system of stereo sound on the ZDF channel. Britain has no plans at present.

Fuji Electric to Second Source Siemens

Fuji is planning to make Siemens devices in Japan, after first establishing the market through a joint Fuji/Siemens venture (Fuji Electronic Components) which simply imported the Siemens product, production in Japan is starting about now. Mainly heavy duty devices are involved.

Analogue Devices & bit A/D with RAM

The AD7581 combines an 8-bit A/D with 8 channel multiplexer, dual port RAM and housekeeping logic in a single CMOS IC. The device continually performs sequential conversions on each input, and connects to virtually any 8-bit MPU, looking just like a RAM eliminating the need for interface logic and software development.

US resigned to Japanese computer influx

Much as a medieval peasant who has just been forced to watch his wife being ravaged by a horde of marauding Norsemen, only to find that they follow up by pressing their attentions upon his daughters, the US microcomputer business is shutting its eyes, and thinking of Uncle Sam as the Japanese move from consumer goods to the Micros.

A report by an American consultancy group - Strategic Inc., of San Jose -describes the situation as inevitable, in that the superior quality, more than just the lower price, will mean that Japanese products will take a big slice of the market. Only FCC RFI standards are preventing a huge influx at the present time, but these are rapidly being sorted out.

★ ★ ★ ★ ★ ★ ★ ★ ★ ★

Breadboard 81

Once again the major annual 'enthusiasts' gathering is looming on the calendar. As usual, the venue is the Horticultural Halls in Westminster - the dates are the 11th to the 15th of November.

R&EW will be there, along with a selection of items from issues past present and future. Come along and tell us what you like and dislike about **R&EW**.

Liquid cooled car stereo

Toyota's 1981 Cressida models are being supplied to the US market with a liquid cooled audio system. The heat pump system cools the 40W per channel amplifier which resides in a very compact combination tape/radio unit, with sythesised radio etc.

"DON'T LOOK AT ME, HONEY, I'M HOPING REAGAN WILL ARRIVE WITH THE FIFTH CAVALRY..."

Cartridge Winchesters

No, not the sort of thing to keep the 'Injuns' at bay, but a device the same size as an 8 inch floppy disc, with 10MBytes of formatted storage - which is removable. (Up to now, hard discs have stayed put).

These devices are made by Data Peripherals of Sunnyvale, and together with a conventional technology 40MByte drive of the same size, provide the ideal means of backing up a mass storage requirement quickly and efficiently. Data can be dumped at the rate of 4MBytes per minute. Unlike magnetic tape the backup system is itself a self contained and useful 'working' storage medium.

The 10MByte drive (known as the Lynx) uses a servo technique whereby 10% of the disc surface is precoded with a control signal, which is detected and read by the read/write head. The servo feedback signal is processed by an MPU to drive the head positioning control.

Having just installed the **R&EW** North Star Horizon networked system base on the S100 bus with hard disc, we are wondering if this is now obsolete.

RCA brighten up 1802 developments

Combining their talents as colour TV makers with the versatile 1802 CMOS MPU, RCA are introducing a 1,500 dollar development system comprising a 10" colour monitor, two cassette drives, CPU card, memory/tape controller card. Video display controller, and PROM programmer.

NEWS

Sony show 1125 line TV

Satellite broadcasting has encouraged development of high definition TV systems, and market leader Sony has been showing off its 30MHz bandwidth system. The definition is claimed to rival a 35mm film, with three separate channels for the primary colours.

The recording system uses a wideband RGB 1 inch videotape, using a wideband digital timebase corrector, and a new A/D system.

Not surprisingly, this system expected to revolutionize the motion picture industry, offering the advantages of instant replay, repetitive recording electronic editing etc.

CBS promote 'CX' noise reduction system - for discs

Possibly as a result of viewing the pricing problems with the digital video disc, CBS are marketing a noise reduction system for discs instead. The system is compatible with standard reproduction techniques, but players equipped with the appropriate decoder can achieve 85dB S/N (par for the digital disc).

A/B tests in front of the pundits revealed (as usual) that most of the gurus of audio could not tell the difference, although doubtless many will be able to write a few lucrative pages of excuses.

CBS and Warner have so far decided to adopt this recording format, and we hope to report further in due course.

5.25" pluggable hard disks

Following the introduction of the 8in. Winchester cartridge disc, Seagate Technology, DMA Systems, and Dysan Corp. have joined forces to do the same for 5.25in. disc systems. The project is now at 'design specification stage', which is a non-committal way of reminding everyone that the project is still under way.

17 for further details

Automatic Modulation Meter Part 2

by Roger Ray

In this concluding part of the article we cover the contruction and calibration of the instrument, and include some ideas for its further development

Assembly

Assembly of the modulation meter is straightforward, especially if the PCB layout (Figure 4) is used. The shape of the PCB allows a 6VA mains transformer to be fitted in the box used. The IC sockets should be soldered in first followed by resistors, capacitors, inductors, diodes and transistors in that order. If IC sockets are not used, then the integrated circuits should be soldered in last. Care must be taken to ensure that transistors are correctly orientated in their relevant positions. Q3 is soldered to the track side of the board. A 5mm hole should first be drilled in the PCB, to accommodate the body of the transistor. Pin 2 of the mixer is underneath the *'M'* of 'MCL' stamped on the top, it should be positioned as shown on the layout drawing.

The varactor diode D6 is actually comprised of two diodes in one 'snap apart' package. In this application, the two are mounted separately, being snapped apart by applying slight pressure with the fingers.

When viewing the diode from the legended side with pins facing downward, the cathode (+) is on the right hand side.

Be careful to fit the rectifier bridge D11, the 1000uF capacitor C31 and the regulator IC5 the correct way round, or severe damage will occur at 'switch on'.

After all components in the VCO section have been assembled, the tap on L3 can be made. A piece of tinned copper wire (approx 22swg) is very carefully soldered onto the coil 2 3/4 turns from the earthed end. This operation must be done with great care, or the result will be a molten coil former and the acrid fumes from the plastic dripping from the end of your soldering iron.

Next the screening box surrounding the VCO can be soldered in position. When all of the components have been soldered into the PCB, the IC's can be fitted into their sockets, again being careful to get them the correct way round.

The box together with front panel is assembled next. The mains transformer is fitted in the extreme rear right-hand side of the box. It is fitted to the base cover with 6BA screws through 3mm holes drilled in the base cover.

The primary windings are wired in series (2 x 115v), and the two secondary windings (2 x 6v) are also wired in series. This gives a primary of 240 volts and a secondary of 12 volts.

The assembled PCB is now fitted from the underside of the box. Note that only the screw nearest to the mixer makes contact with the earth track on the board, this is to prevent a 'hum' loop being formed in the earth track. The same considerations apply to this type of circuit construction as apply to any AC amplifier. All interconnecting links on the board should be made with insulated wire.

The connection between R4 and R33/R34, together with the connection between R4 and C22, should be made with screened cable to prevent hum pick-up.

With the PCB fitted, the front panel can now be removed to allow the hole for the meter to be cut. The switches LED's and BNC socket all fit in pre-drilled holes, so they can now be assembled. Fit the meter with the scale shown in *Figure 5* or alternatively make your own, and fit the meter into the front panel.

Cut 6 inch lengths of insulated wire and solder them into all flying lead positions on the PCB. Now refit the front panel and wire up the meter and other components. Wire the mains transformer secondary to the rectifier bridge D11.

Three core flex should be used for the mains wiring. Connect the earth lead to a good earth position in the box. Wire the 'live' through the fuse F1, and use a maximum fuse rating of 1 amp. Carefully insulate all mains connections with PVC tape and sleeving. Assembly should now be complete.

Errata

A few gremlins crept into the part 1 circuit diagram. R35 should be 4K7 as shown in the parts list. Values of C7 and C8 should be 100n and 10n respectively (reversed on the circuit and in the parts list). Also a 4.7uf (CX) capacitor was missed out entirely. It should go between R21 and pin 2 of IC2, positive end to IC2, the CA3140. IC4 earth should go to pin 11, not pin 8 as shown.

R35 (Next to 'RESET' should be R36 – the value of 100R is correct.
D10 is shown reversed.

A corrected version of the diagram will be supplied with any kits - or you can get a corrected copy by sending the reader's services department an SAE.

Testing and Alignment

It is preferable not to use the internal mains PSU during initial testing. Temporarily disconnect the wires to the secondary of the mains transformer, and connect them instead to a 16-18 volt DC power supply (with current limiting if possible). Switch on the external power supply, and check that ²12 volts is present on the output of the regulator. Temporarily short out the reset button to make sure the sweep oscillator is not sweeping. Apply a 10.7MHz carrier signal of about 50mV between pins 3/4 of the mixer and earth. Adjust the core of T2 to give a DC voltage of 5.5 volts on the junction of R33/R34.

Set VR2 fully clockwise, and measure the AGC voltage on pin 5 of IC1. Adjust T1 and T3 for maximum AGC voltage. Reduce the output level of the signal generator as necessary to keep the voltage in the range 1 - 4 volts. Now re-adjust T2 for 5.5v on the junction of R33/R34. AM modulate the signal generator with 1KHz 50% and adjust VR1 for maximum brilliance of D5.

With the reset button still shorted, adjust L3 to give a VCO output of 27MHz, measured on C19 with a frequency counter or monitored on a nearby receiver. This adjusts the low frequency end of the VCO range. Disconnect the signal generator and make sure it is turned off.

Remove the short from the reset button, and measure the voltage on the Q8 end of R28, using a moving coil meter (AVO etc) or an oscilloscope. Adjust VR5 so that the voltage rises to a maximum of 10.5 volts and repeatedly sweeps up from a lower voltage (level dependent on

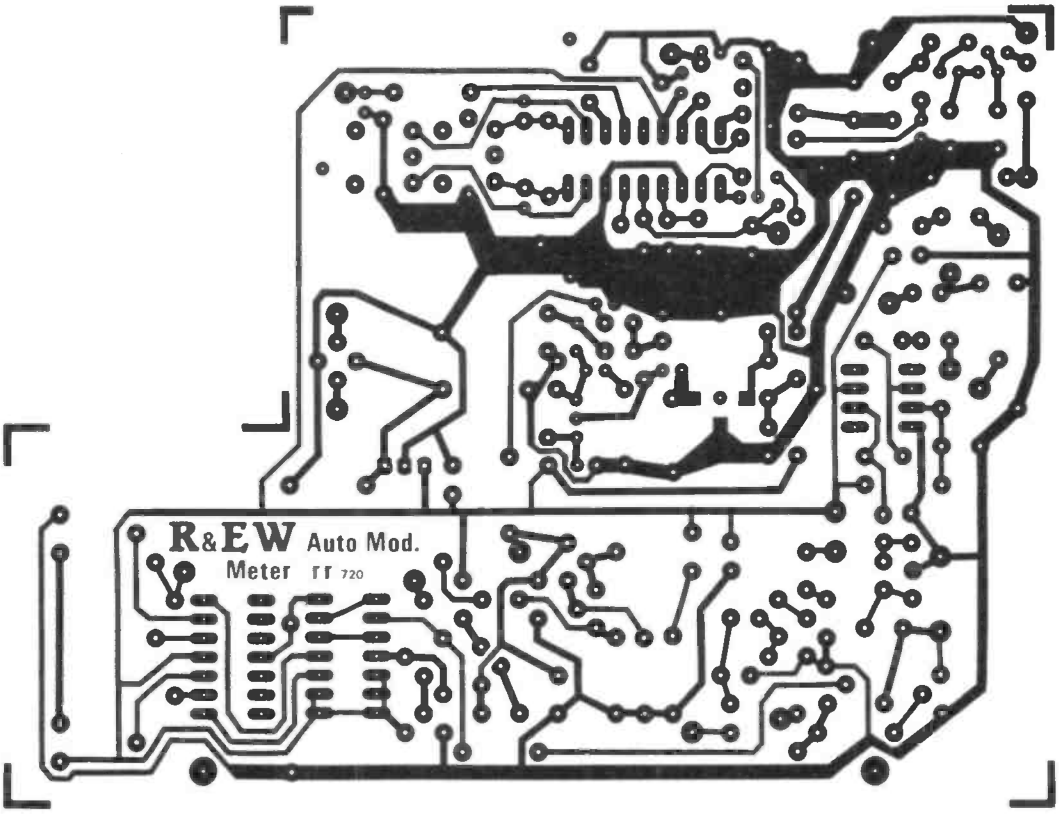
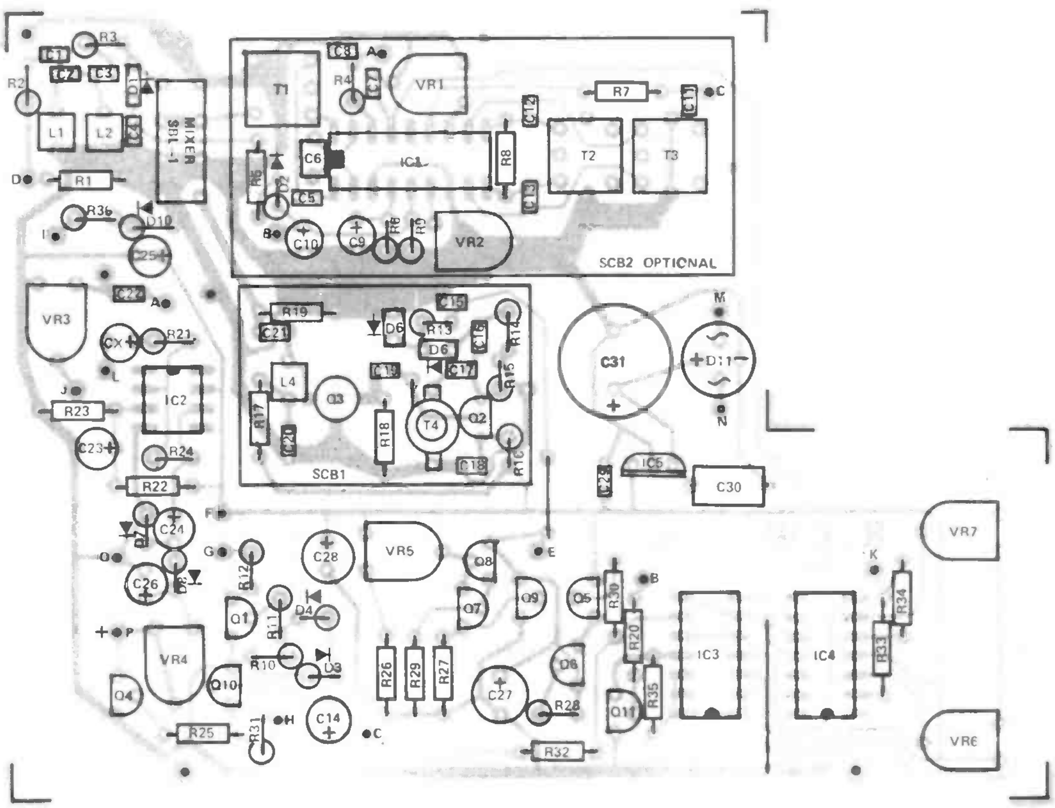


Figure 4

PCB layout. Track layout - top view and component positions - bottom view,



measuring instrument, oscilloscope approx 2.5v, AVO approx. 5v). If VR5 is set too high the voltage will only sweep up once after the reset button is pressed, if it is set too low the voltage will not reach 10 volts.

With the sweep oscillator running the VCO should be sweeping over the range 30-55MHz. Re-check the AGC voltage, and if necessary back off VR2 until the meter reads less than 0.5 volts.

Apply a DC voltage of 3.0 volts to the junction of R33/R34. Measure the voltage on pin 7 of IC4 and adjust VR7 until the voltage just jumps 'high' (10 - 12v). Increase the applied DC voltage to 8.0 volts and measure the voltage on pin 1 of IC4. Adjust VR6 until the voltage on this is just goes 'high'.

Connect a signal source of 100mV in the range 30-100MHz to the input of the instrument. D9 - the lock LED - should now illuminate. The LED will occasionally flicker as lock is lost and then re-established. With the instrument in the 'locked' state, the two FM deviation ranges can be calibrated. Set the 2.5/10kHz switch to the 2.5kHz setting, FM modulate the signal source to 2.5kHz and adjust VR4 for near maximum reading on the meter (set to 2.5 if the meter scale of *Figure 5* is used). Switch to the 10kHz position apply 10kHz deviation, and adjust VR3 for near maximum reading on the meter (10v on the lower meter scale).

The modulation meter should now be fully operative and the mains transformer can be reconnected, and mains power used. Check the output of the transformer to be absolutely certain all is well.

Using the Modulation Meter

The instrument is very easy to use. Simply connect the signal to be measured to the input socket, check the lock LED is illuminated, and read the peak frequency deviation from the meter. If the lock LED does not light, the input level must be too low, or the frequency is below 20MHz. When using input frequencies below 30MHz it may be necessary to use the reset button to establish lock.

Care should be taken not to overdrive the modulation meter, maximum input is 1 volt Direct connection to a transmitter will cause expensive damage. An aerial should not be connected to the input socket, because the sweeping oscillator may cause interference to nearby receivers.

The normal input frequency range is 20-175MHz. As higher order VCO harmonics are present at the mixer input, the meter can be used up to 500MHz. At frequencies above 175MHz, the modulation meter stays in lock for shorter periods of time. The resulting meter flicker makes accurate readings more difficult to obtain, but nevertheless possible.

AM modulation and AF output

In the basic form of the modulation meter, AM modulation varies the brilliance of the AM LED. The AM output can be switched to the meter, and the meter calibrated in % AM modulation. As long as the circuit is operating within the AGC range of IC1.

The reading will be reasonably accurate (+/−5% for input levels over 50mV). Greater accuracy could be obtained by comparing the AGC voltage to a reference voltage with a comparator (one of the spare Op-amps in IC4 could be utilised), and driving D1 until the AGC equals the reference. The more ambitious designer/experimenter may like to pursue this approach.

Audio output can be taken from a number of points. Low level FM audio is available with 6db/octave de-emphasis on the junction of R4/C8. A higher level flat response audio output is available on pin 6 of IC2. AM audio output can be taken from the juction of D4/R10.

The complete circuit could form the basis of a scanning monitor receiver. An RF amplifier would be required on the input, to increase sensitivity and reduce oscillator leakage. The circuit would lock onto the first signal encountered on the sweep. The length of time the circuit would remain locked being dependent on the leakage from C27 and the stability of the VCO. With a suitable input attenuator this would make a good 'bug' detector.

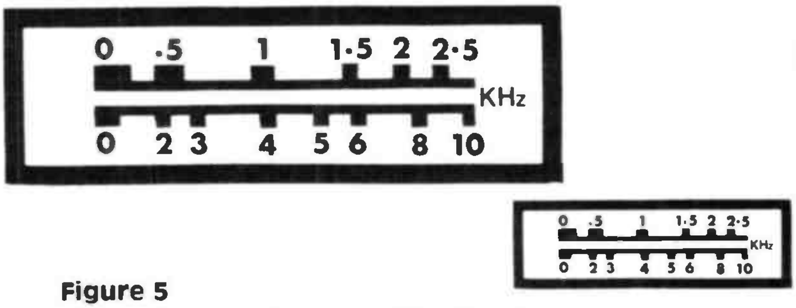
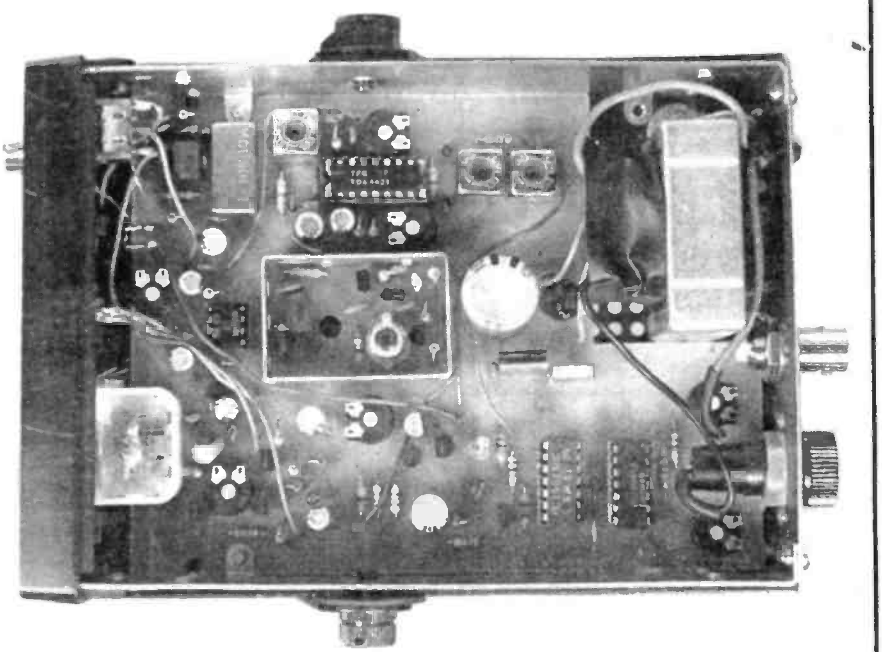


Figure 5
Calibrated meter scale for use with 900 series meter (200µA non linear - Ambit).

Your Reactions.........	Circle No.
Immediately Applicable	151
Useful & Informative	152
Not Applicable	153
Comments	154



Sinclair ZX81 Personal Comp
the heart of a system that grows with you.

1980 saw a genuine breakthrough – the Sinclair ZX80, world's first complete personal computer for under £100. Not surprisingly, over 50,000 were sold.

In March 1981, the Sinclair lead increased dramatically. For just £69.95 the Sinclair ZX81 offers even more advanced facilities at an even lower price. Initially, even we were surprised by the demand – over 50,000 in the first 3 months!

Today, the Sinclair ZX81 is the heart of a computer system. You can add 16-times more memory with the ZX RAM pack. The ZX Printer offers an unbeatable combination of performance and price. And the ZX Software library is growing every day.

Lower price: higher capability
With the ZX81, it's still very simple to teach yourself computing, but the ZX81 packs even greater working capability than the ZX80.

It uses the same micro-processor, but incorporates a new, more powerful 8K BASIC ROM – the 'trained intelligence' of the computer. This chip works in decimals, handles logs and trig, allows you to plot graphs, and builds up animated displays.

And the ZX81 incorporates other operation refinements – the facility to load and save named programs on cassette, for example, *and* to drive the new ZX Printer.

New BASIC manual

Every ZX81 comes with a comprehensive specially written manual – a complete course in BASIC programming from first principles to complex programs.

Kit: £49.95

Higher specification, lower price – how's it done?
Quite simply, by design. The ZX80 reduced the chips in a working computer from 40 or so, to 21. The ZX81 reduces the 21 to 4!

The secret lies in a totally new master chip. Designed by Sinclair and custom-built in Britain, this unique chip replaces 18 chips from the ZX80!

New, improved specification

- Z80A micro-processor – new faster version of the famous Z80 chip, widely recognised as the best ever made.
- Unique 'one-touch' key word entry: the ZX81 eliminates a great deal of tiresome typing. Key words (RUN, LIST, PRINT, etc.) have their own single-key entry.
- Unique syntax-check and report codes identify programming errors immediately.
- Full range of mathematical and scientific functions accurate to eight decimal places.
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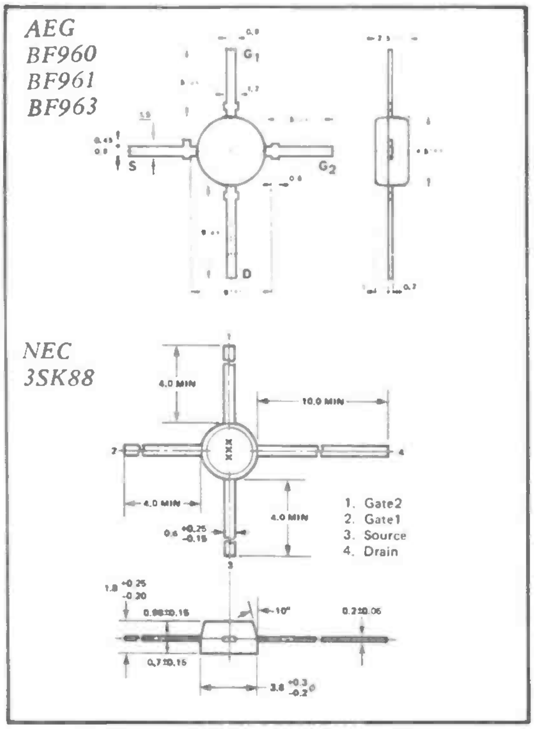
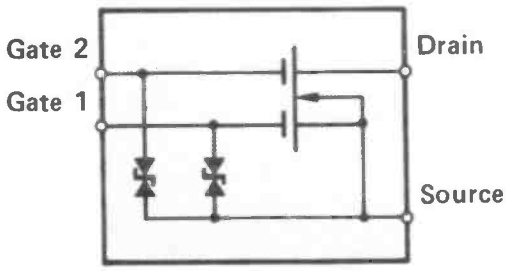
BF960: Low noise, low cost, high gain VHF/UHF
BF961: Low noise, low cost, VHF
BF963: Ultra low noise, high gain VHF
3SK88: Low noise, low IDSS, high rel. VHF/UHF

The above plastic package MOSFETs are the **R&EW** standards, and encompass virtually all functions required in high performance RF MOSFETs with operation from DC to 1GHz. All types are gate protected, and have been tried and tested by **R&EW** staff and contributors in a number of applications.

These devices can substitute metalcan devices (from the 40673, 3N200, 3SK... series), the only proviso being that the BF devices may require more board space, with larger lead holes. The 3SK88 should drop straight into the holes left by a metalcan device.



General Configuration



ELECTRICAL CHARACTERISTICS

VDS 3SK88 = 10v, VDS BF960/1/3 = 15v, VG2S = 4v — unless otherwise stated

		3SK88			BF960			BF961			BF963		
Symbol	**Parameter**	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max
BV_{DSX} .V	D-S breakdown VG VG1S = VG2S = −2v −4v	20			20			20			20		
IDSS mA	Drain current VG2S = 4v VG1S = 0v	0.01		6	2		25	4		20	6		40
VG1S off	G1-S cutoff VG2S = 4v			−2			−4			−4			−3.5
VG2S off	G2-S cutoff VG1S = 4v			−0.7			−4			−4			−3
IG1SS nA	G1 rev.I VDS = 0v VG1S = +/−10v +/−5v			20			100			100			100
IG2SS	G2 rev.I VDS = 0v VG2S = +/−10v +/−5v			20			100			100			100
Mfs/mS	VG2S = 4v, ID = 10mA, f=1kHz ID = 7mA, f=1MHz	14	17		11.5			14			16	25	
CiSS pF	Input Cap. ID=10mA, f=1MHz ID=7mA f=1MHz	1.5	2.0	2.5		1.7			3.7			6	
CoSS pF CDG1 fF	Output Cap. 61-D Cap. ID=7mA, f=1MHz	0.5	1.0	1.5		25			25			35	
GPS dB	Power gain at 900MHz 800MHz 200MHz	14	16	18		18 21			20			25	
Nf .dB	Noise figure 900MHz 500MHz 200MHz		3.8	5.5		2.8 1.6	4.0		2.0			1.8	

Choosing and using MOSFETs for RF applications

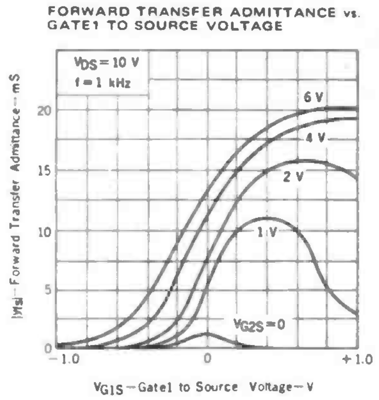
The great joy of the dual gate MOSFET is the interchangeability of different types. From the earliest 40600 to the latest 3SK88 pinout configurations have remained standard, and the high impedance nature of the devices means that a 3SK88 can be dropped straight into the circuit surrounding a 40600. There will possibly need to be some small trimming of the input/output capacitance, but that's about all. Optimization of the various parameters to achieve best noise figure will require a little more individual attention, but this exercise is beyond the resources of all but the very best equipped labs anyway.

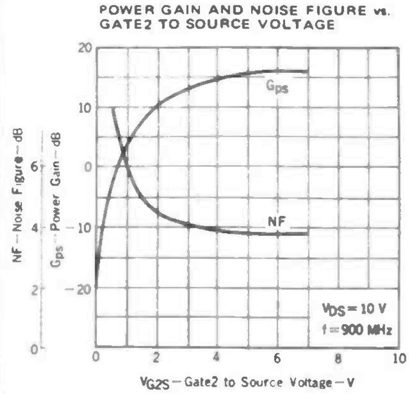
The dual gate MOSFET takes advantage of the cascode configuration on a single substrate; but whilst the cascode is a very much more stable configuration than a single gate grounded source FET, it is still possible to induce instability through positive feedback. Upgrading early MOSFET designs with the higher gain parts available can sometimes lead to this instability as both the input and output circuits are tuned to resonance - and since it is usually a question of a marginally stable physical layout, the cure can be effected by the damping effect of a ferrite bead on the drain lead, or a resistor in series with the drain or gate.

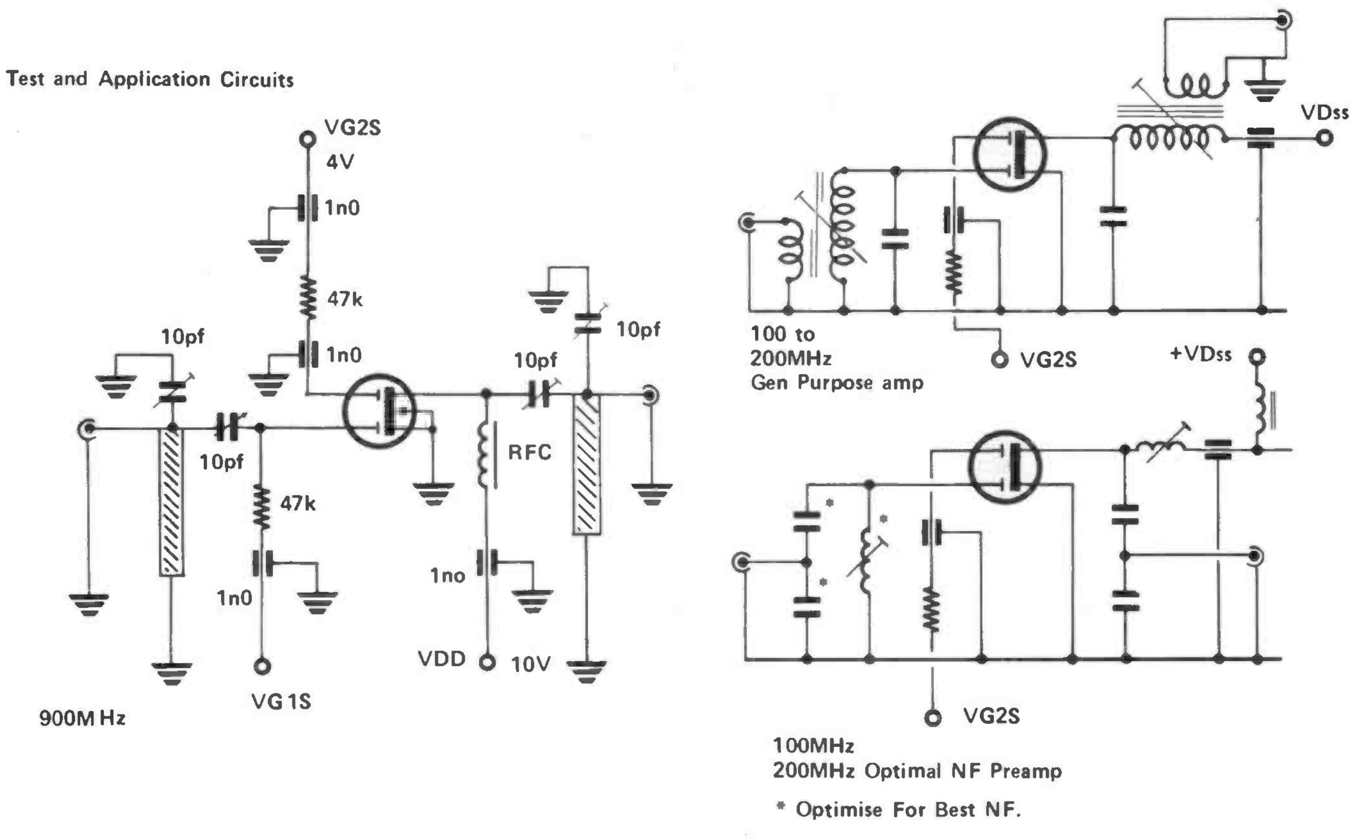
Also remember that best noise figure is not generally coincidal with maximum power gain. If anything, the input circuit appears to tune slightly HF at the point of optimum NF, although each individual situation requires its own careful optimization.

The test circuits show the widespread use of feedthrough decoupling capacitors, which although ideal for RF, are not usually very practical to implement in PC layouts. The alternative is a small ceramic capacitor, placed very close to the point to be decoupled, and soldered to an RF earth plane on the PC top to provide a low impedance AC bypass. You may 'get away' with single sided techniques, but you will inevitably find these more hit and miss, and subject to the obtuse manner in which RF tends to find it's own paths for positive feedback. ■

3SK88

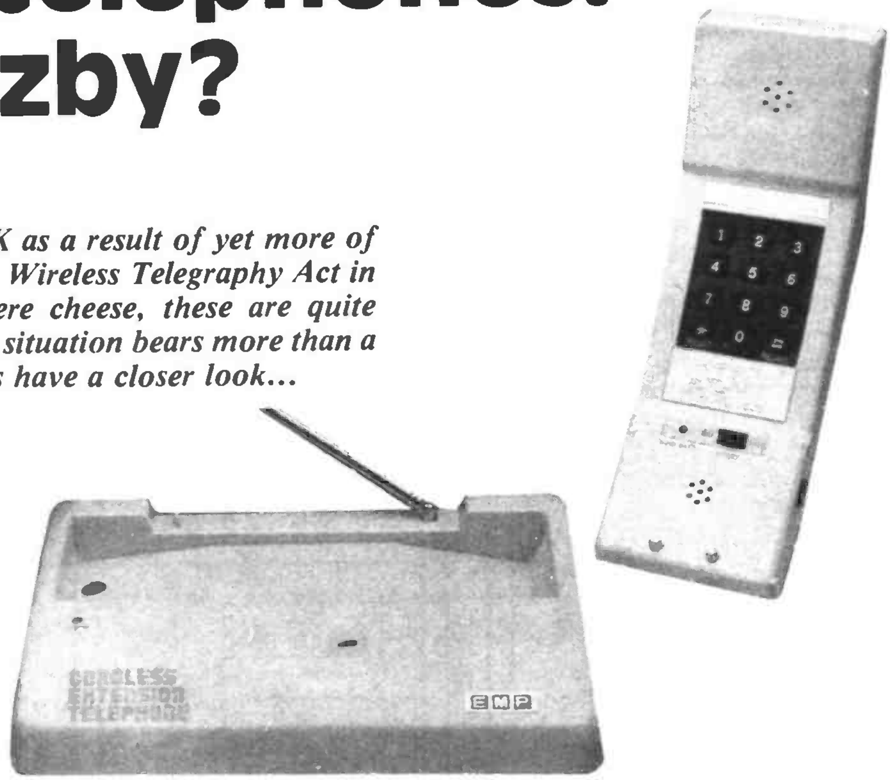






Cordless telephones: CB for Buzby?

Although widely available in the UK as a result of yet more of those loopholes that seem to put the Wireless Telegraphy Act in competition with a piece of Gruyere cheese, these are quite illegal if used in the UK. The overall situation bears more than a passing resemblance to CB - so let's have a closer look...



The cordless telephone is just that. Instead of being attached to the telephone network by a pair of wires, the user is free to wander around over a range of about 200-300 feet from the 'base station' and receive or make calls as the need/whim arises.

So, it must be pointed out, is anyone else with a similar cordless telephone within range of the same base station. Some units are 'answer only' systems, but many offer full duplex and 'dial out' facilities (simultaneous transmit and receive with the ability to dial any number normally accessible via the 'hard wired' version), based on the US FCC rules for 'low-power' transmitting apparatus with 49MHz from user to base, and around 1.7MHz from base to user.

Table 1: Frequencies in MHz for the Uniden system

User	Base
49.830	1.665
49.845	1.695
49.875	1.725
49.890	1.755

(Uniden are usually branded under the Cobra, President or Dynascan labels)

The Elektra 'Freedom Phone' and the Mura 'Muraphone' are simplex links on 49MHz -since the general RF noise and 'clutter' around the 1.7MHz band can be quite unacceptable at night. The relatively clear 49MHz band (people used to say that about 27MHz once upon a time) is sufficiently into VHF to be immune to the tribulations of the multiple propagation modes of lower frequencies.

The penalty is that the duplex nature of the conversation is compromised - you can't simultaneously transmit and receive on the same frequency, and the frequency 'split' available in a given band is not adequate to provide for low cost duplex filtering. e.g.

Transmit 49.830MHz
Receive 49.890MHz

implies a Q of over 800 for only 3dB isolation, never mind the 80-100dB that would be required for a usable system.

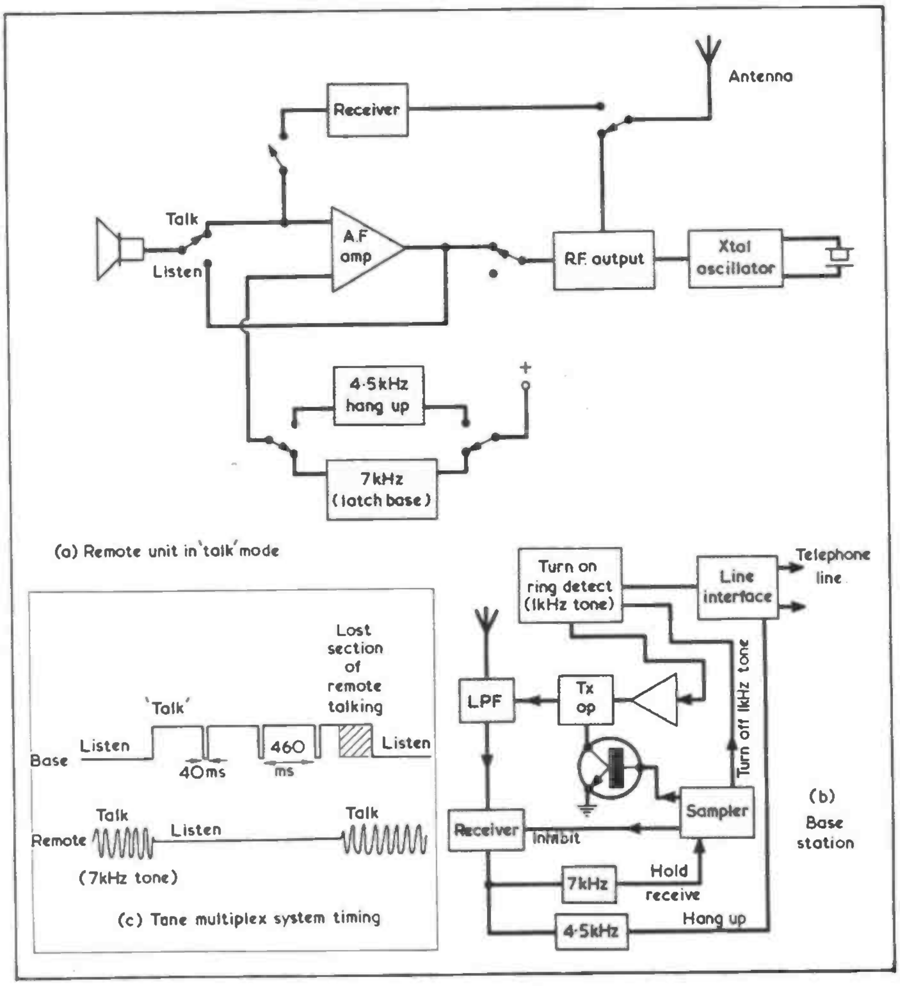


Figure 1: Muraphone Hand and Base block schematics.

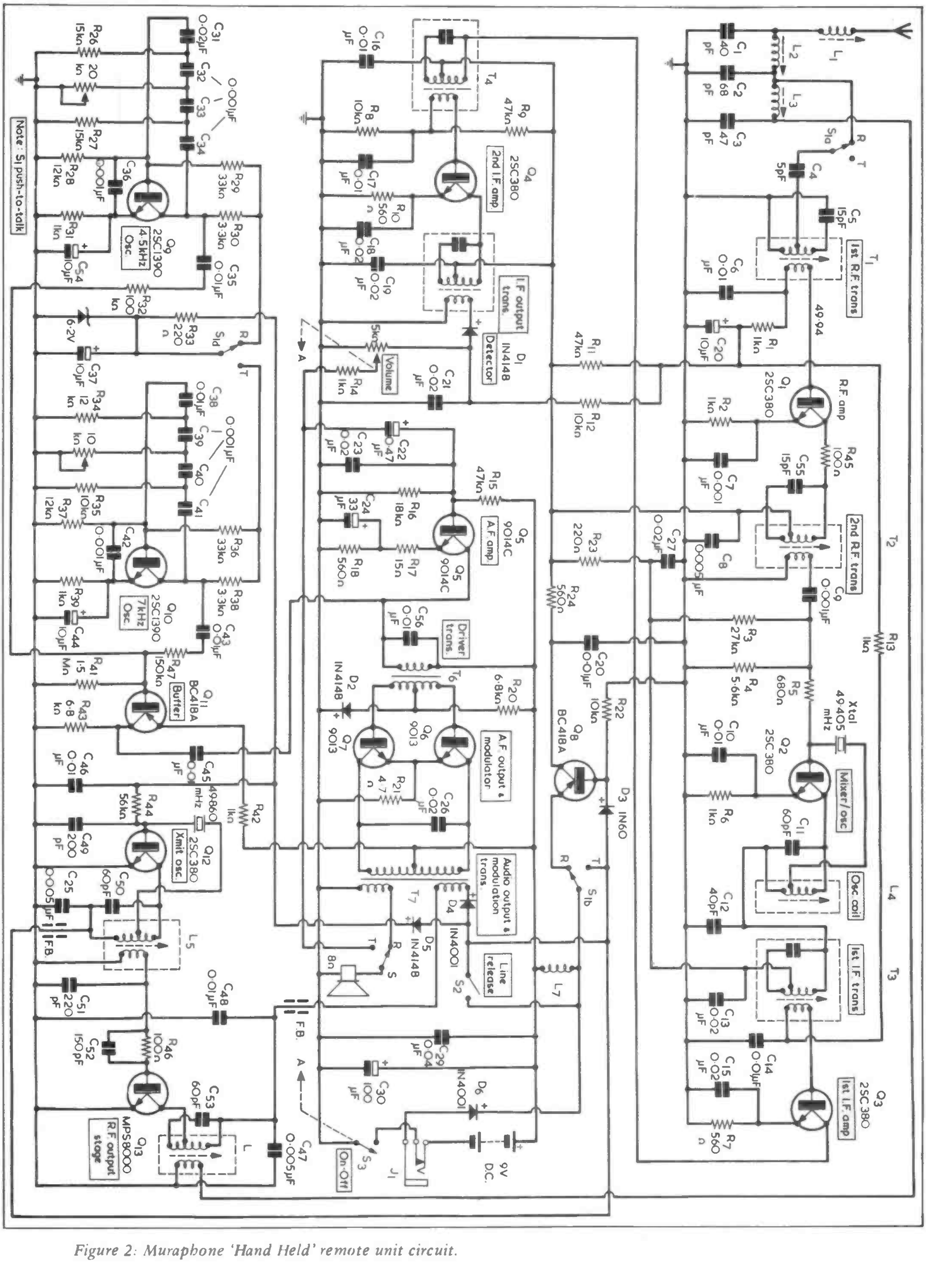


Figure 2: Muraphone 'Hand Held' remote unit circuit.

The Muraphone MP100 uses a time multiplex system to provide priority to the portable unit based on the timing of *Figure 1*. The base activates the remote unit by transmitting 1kHz AM tone on 49MHz, which alerts the user to pull up the antenna and reply. The fact that it is AM may seem surprising, but this would appear to be a compromise to avoid the need for muting - and keep the whole system low cost.

The remote phone *(Figure 2)* transmits a 7kHz tone which activates a tone decoder at the base station to latch on the line. The 7kHz tone is outside the bandwidth of the telephone line, so only a very basic form of filtering is applied.

The speech is then fed along to the telephone line transformer until the remote user releases the button to enable the receiver section. The 40mSec transmission gaps are hardly noticeable - and perhaps another reason for using AM for the system, since such gaps in an FM transmission would lead to noise 'blips' unless a carefully synchronized blanking process was used.

The remote user releases the line by pressing the 'line release' button, which simply operates a 4.5kHz oscillator in the remote unit, this is then decoded at the base to activate the hang up procedure and release the line hold relay.

The MP100 also permits intercom facilities by simply putting some volts in series with the carbon insert in the main telephone instrument, thereby modulating the line transformer.

The actual mechanism through which the Muraphone achieves its operation is a quite ingenious logic arrangement that provides a good example for those of you interested in the basic concept of talk-back paging systems. *Figure 3* abstracts the salient features of the design.

Duplex links

It seems very unlikely that the Home Office would sanction a Duplex system that uses 1.7MHz or thereabouts. Apart from the fact that it simply isn't very useful from a users point of view, the spectrum is simply not available around the crowded European airwaves. The USA's FCC rules permit its use in the USA, where the mains connections to the base station are loosely coupled in to the system as the 1.7MHz antenna *Figure 4*.

Carrier-current systems

The general concept of the mains carrier-current communications link is to employ existing mains wiring for relaying speech/data around the house - the signal cannot jump the line phase, so communication is restricted to its own 240V side of the mains circuit. The house next door may be on the same circuit - so confidentiality is not assured unless steps are taken to confirm the isolation of the mains circuit.

This tempting shortcut to providing communication has been brought to the attention of many through National Semiconductor's AN146 linear application note *(Figure 6)* - but it must be borne in mind that the circuit proposed by National is for 115V AC mains systems -**NOT** 240V AC. In fact, if the National circuit is copied verbatim, there is every chance you will either 'blow up' on switch on - or that there will be a dangerous leakage current since the medium employed for mains coupling is only rated at around 100V DC!

The **utmost** care must be observed when connecting anything like this to the mains - and it is regrettable that the National circuit could easily lead to serious trouble for unwary users. The basic concept is quite sound if approached with a healthy respect for 240V AC - and **R&EW** will be using this system a good deal in future issues.

FM is the preferred mode - AM can be used, but all the clicks, bangs and buzzes that are inherent in modern electrical environments are likely to escape through and cause severe problems.

The mains appears as a very low impedance load to the carrier current transmitter - and attachments across the mains present a sufficient impedance to the RF to cause only minimal losses to the RF carrier. The output of the 'transmitter' might take into account the nominal RF impedance of an average mains lead (around 50-100 ohms), and a loading coil can be placed in series with the output coupling to present a better match, and maintain isolation from variations on the mains circuit.

The UK specification for such forms of communication is enshrined in MPT381 - which sets a basis for broad approval of equipment in the range 16-150kHz. Although this basically relates to a closed induction loop system, it seems to be the nearest thing available to cover this form of communication. Various provisos are included with regard to the granting of approval and the allocation of a frequency, although the 'blind eye' situation that exists around the unregulated use of wireless intercoms would seem to indicate that the HO probably has bigger fish to fry. (*Who said 10-4 ??*).

The clincher is probably the requirement that the maximum field strength at 100 yards outside the loop in any horizontal direction is 100uV. This is generous enough for the purposes of wireless intercoms, and we have not seen any system approach this sort of level. Although quite a lot of 'power' mains wiring is encased in copper sheathing -there is still plenty of scope for radiation from wall sockets to appliances, lighting etc., so a 'receive-only' unit need not be fixed to the mains, but can simply use a local ferrite rod antenna.

On the phone...

A simple ferrite rod in the remote handset, provides a potentially more efficient antenna for paging than via a collapsed telescopic antenna in the case of simplex 49MHz operations. There is a problem of directionality with a ferrite antenna, but it isn't too severe at the higher frequency end of the MW.

The frequencies used around 1.7MHz are outside the permitted UK range, so unless the rules are going to be changed, existing cordless phones are not going to be licensable. The 16-150kHz range is arguably less effective due to the greater inefficiency of matching the transmitter at VLF/LF, and the fact that attachments to the line are likely to have more effect due to the generally lower impedance all round.

Nevertheless, the system has considerable potential and is not 'unworkable'.

A proposal for the UK

The illegal use of cordless telephones is due for some sort of response from the Home Office. Since CB could never be contained, it seems a good idea if a standard can be established for cordless telephones, before we end up with another set of enforced compromises.

The scope offered to the UK communications industry is quite vast, and it is arguable that it is more realistic to expect to be able to enforce the rules rather more positively than seems to be the case with CB. After all, the prospect of detection is rather more realistic, since the base station is not quite as untrackable as a CB rig installed in a moving vehicle. The prospect of losing one's telephone line is a severe deterrent for miscreants -quite apart from the provisions of the Wireless Telegraphy act with £400 fines, imprisonment etc.

The trouble is that cordless phones have found a market in the respectable end of society - solicitors, estate agents -all sorts of community stalwarts who probably really don't know that the whole thing is technically just as illegal as setting up a medium wave pirate radio station. Albeit as a matter of degree, the cordless phone does seem a shade less outrageous.

It is quite reasonable that a British citizen should be entitled to use a cordless telephone if he so wishes. Despite the progress of technology, there aren't many ways in which it can be seen to directly enhance the quality of life for the general public, and provided it complies with rules that ensure its operation does not cause undue interference to other users, the cordless phone is a considerable convenience.

The sparsely used MHz of Band 1 and Band 3 VHF TV could easily spare a few slots for the system - and it would probably be better to use the upper reaches of Band 3 in view of the improved antenna size and efficiency - and the fact that the transmissions are then well past most of the mobile radio frequencies. Output filters are also smaller and cheaper around 200MHz. But one problem may be the inevitable use of 'boosters' and excessive antennas to extend the range of

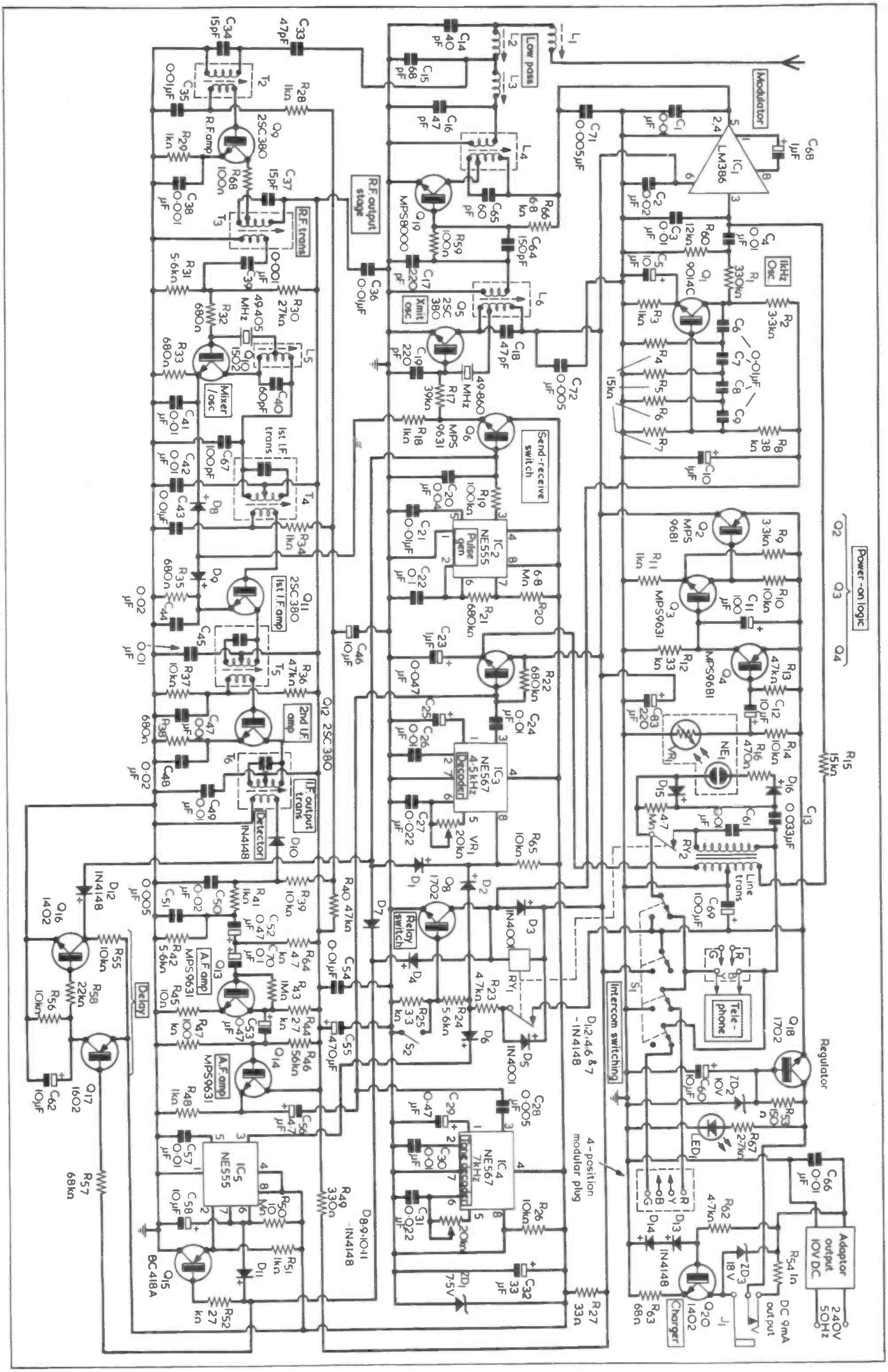


Figure 3: Base Station circuit.

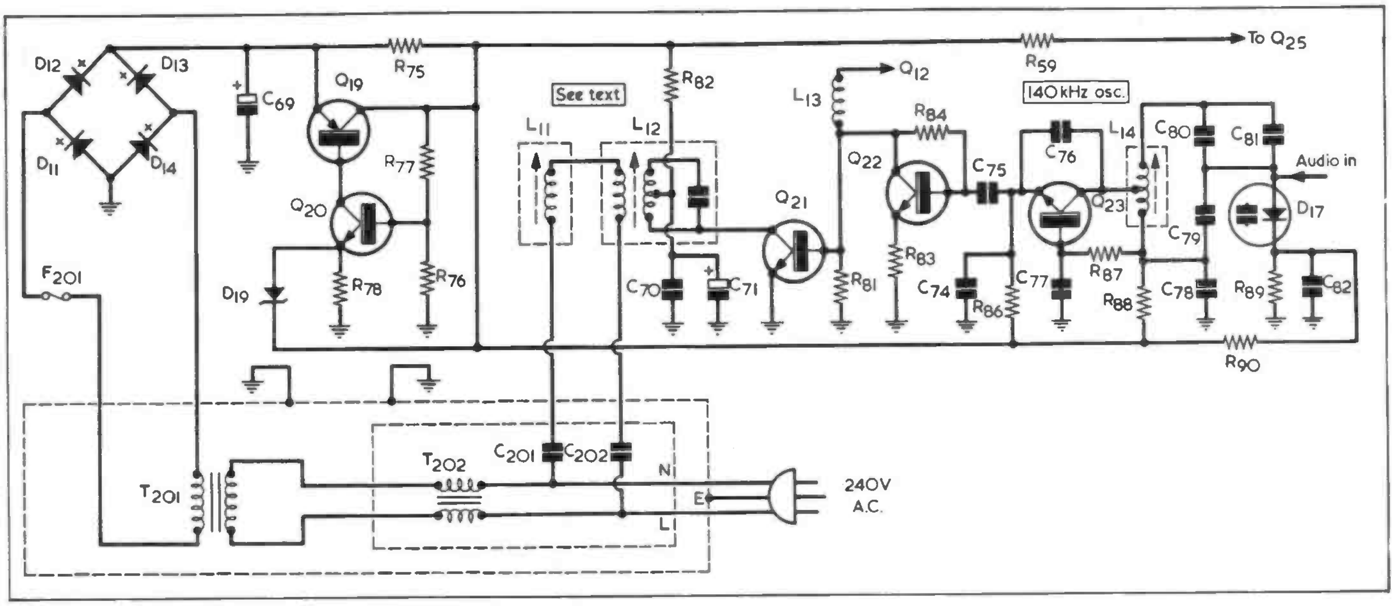


Figure 4: Circuit of a mains coupler used in a 1.7MHz cordless phone base station.

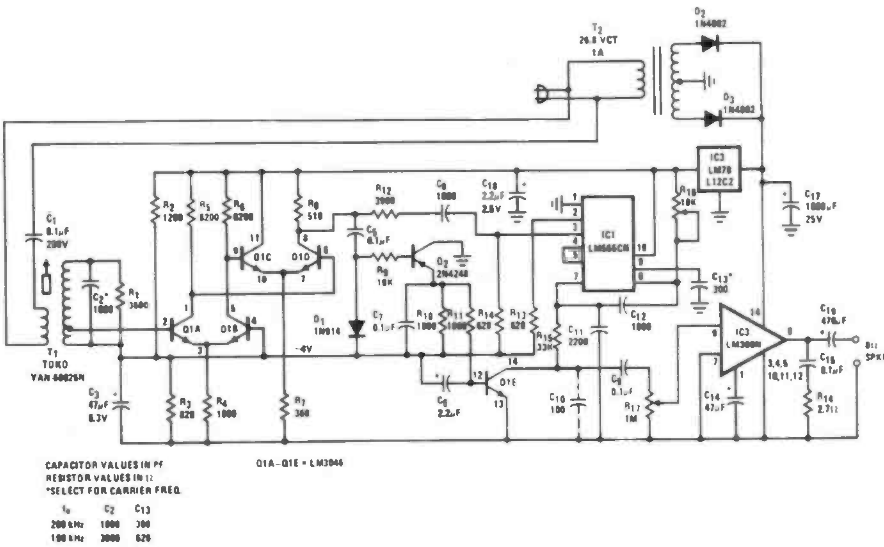
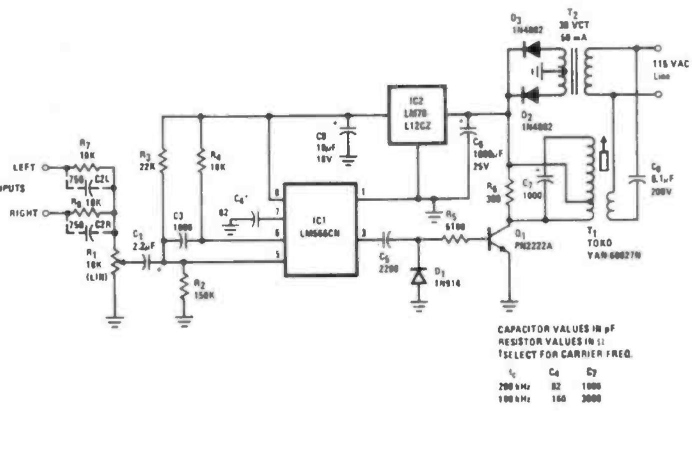


Figure 5: National Semiconductor's mains carrier link.
Above: Receiver.
Below: Transmitter.



the system, and thereby spoil the idea for others. Perhaps the knowledge that the conversation is not confidential may tend to curtail this aspect - but human nature being what it is, there is little doubt that someone will spring up to offer 'bigger and better' systems at the expense of legality. Playing fast and loose with the air waves has regrettably become one of those socially acceptable misdemeanours.

The use of a 7kHz tone seems wasteful of bandwidth. A sub audio (30-300Hz) tone ought to do just as effective a job, without spreading the spectrum. It could be a shade more costly to provide effective filtering - but not much - as long as FM is used, there would be no problems with modulation transformer bandwidth.

Various devices exist to cater for selective calling apart from sub-audio tones, and such a vast potential market ought to spur some UK manufacturer into responding. In view of the response to CB, this may seem a bit unlikely, but with any luck, we would end up with a sufficiently parochial approach that the numbers involved would not create an instant inrush of imports. And dare we suggest it, why not simply hold an 18 months moratorium on imports ?

After all is said and done, many far eastern manufacturers of cordless phones have no qualms about fuelling the bootleg trade in this country, so perhaps British manufacturers could be allowed to bask in the satisfaction of knowing that they have received their come-uppance at last?

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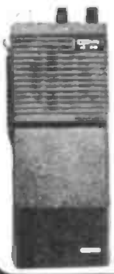

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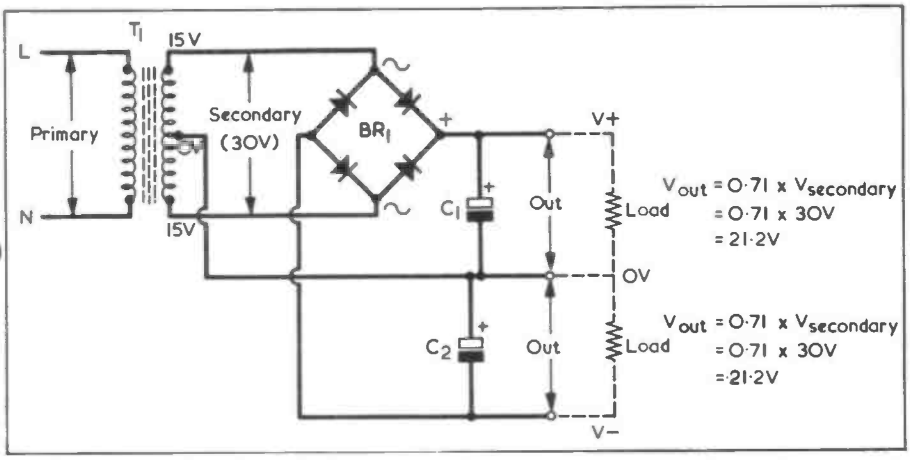
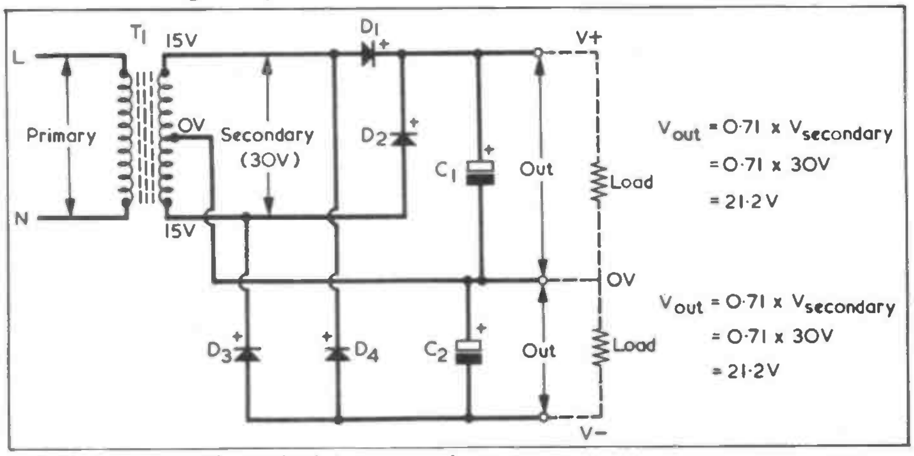
Two of the most common tasks facing the electronics engineer are those of designing basic power supply circuits to enable pieces of equipment to operate from AC power lines, and designing voltage regulator circuits to enable specific circuits to operate from well-defined DC supply voltages over wide ranges of load current variations.

Both of these design tasks are reasonably simple. Basic power supply circuits consist of little more than a transformer-rectifier-filter combination, so all the designer has to do is select the circuit values using a few very simple rules, to suit his own particular design requirements.

Voltage regulator circuits may vary from simple Zener networks, designed to provide load currents up to only a few mA, to fixed-voltage high-current units for powering logic boards, etc., or to variable-voltage high-current units designed to act as general-purpose pieces of test gear. We'll look at practical versions of all these examples in the next few pages.

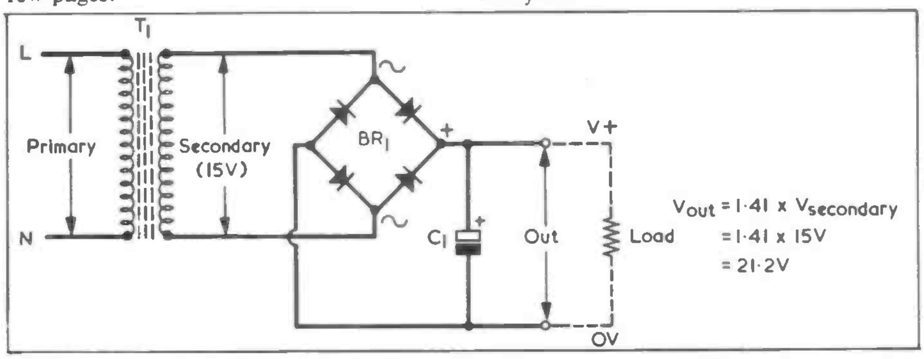


▲ *Figure 3: Basic split or dual power supply using a centre-tapped transformer and bridge rectifier.*

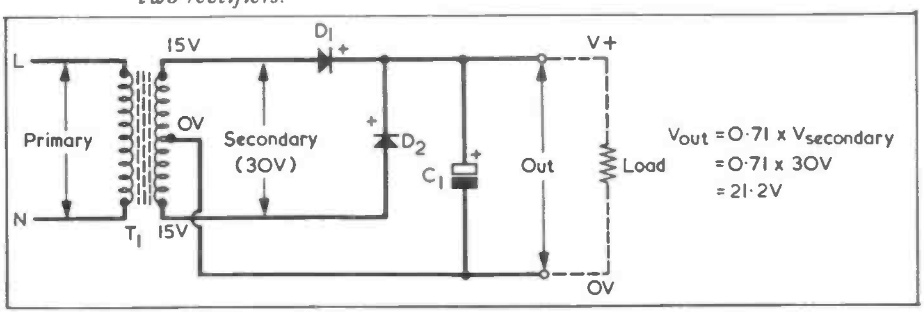


▲ *Figure 4: Basic split or dual power supply using a centre-tapped transformer and individual rectifiers.*

▼ *Figure 1: Basic single-ended power-supply using a single-ended transformer and bridge rectifier.*



▼ *Figure 2: Basic single-ended power supply using a centre-tapped transformer and two rectifiers.*



Power Supply Circuits

Basic power supply circuits are used to enable pieces of equipment to safely operate from the AC power lines (rather than from batteries) and are simply designed to convert the AC power line voltage into an electrically isolated DC voltage with the value required by the actual circuitry of the equipment.

The basic power supply circuitry consists of a little more than a transformer-rectifier-filter combination. The transformer is used to convert the AC line voltage into an electrically isolated and more useful AC value, and the rectifier/filter combination is used to convert the new AC voltage into a smooth DC value.

Figure 1 to *4* show the four most useful transformer-rectifier-filter combinations that you will ever need. The *Figure 1* circuit provides a single-ended DC supply from a single-ended transformer and bridge rectifier combination, and gives a virtually identical performance to the centre-tapped transformer circuit of *Figure 2*. The *Figure 3* and *4* circuits both provide 'split' or 'dual' DC supplies and again give virtually identical performances. The rules for designing these circuits are very simple, as you'll see in a moment.

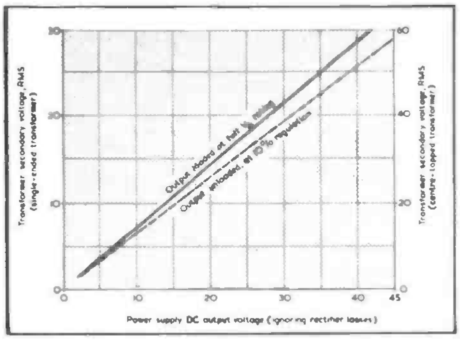


Figure 5: Transformer Selection Chart.

To use the Transformer Selection Chart decide on the required loaded DC output voltage (say 22 volts) then read across to find the corresponding transformer secondary voltage (15V single-ended or 30V centre-tapped).

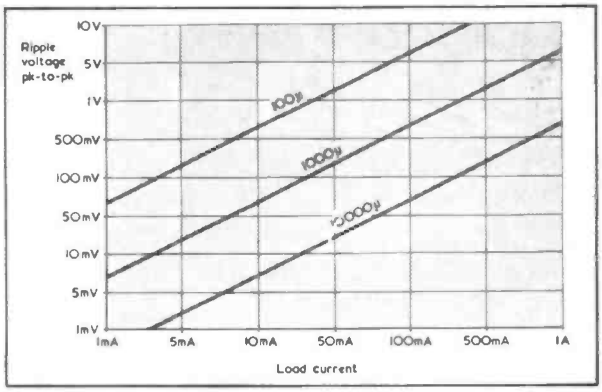


Figure 6: Filter Capacitor Selection Chart, relating capacitor size to ripple voltage and load current in a full-wave rectified 50-60Hz powered circuit.

Transformer-rectifier selection

The three most important parameters of a transformer are its secondary voltage, its power rating, and its regulation factor. The secondary voltage is always quoted in RMS terms at full rated power load, and the power load is quoted in terms of VA or watts. Thus, a 15V 20VA transformer will provide a secondary voltage of 15V RMS when its output is loaded by 20 watts. When the load is removed (reduced to zero) the secondary voltage will rise by an amount specified by the **Regulation Factor.** Thus, the output of a 15 volts transformer with a 10% regulation factor (a typical value) will rise to 16.5 volts when the output is unloaded.

Now, the most important point to notice here is that the RMS output voltage of the transformer secondary is **not** the same as the DC output voltage of the complete power supply. In fact, the DC output voltage of a full-wave rectified circuit is 1.41 times the RMS transformer voltage (ignoring rectifier losses) that is feeding the rectifier, as shown in the graph of *Figure 5.* Note here that this voltage is equal to 1.41 times the voltage of a single-ended transformer, or 0.71 times that of a centre-tapped transformer. Thus, our single-ended 15V RMS transformer with 10% regulation will in fact provide an output of about 21 volts at full rated load (just under 1 amp at 20VA rating) and 23.1 volts at zero load.

When rectifier losses are taken into account, the output voltages will be slightly lower than shown in the graph. In the 'two rectifier' circuits of *Figures 2* and *4,* the losses amount to about 600mV, while in the 'bridge' circuits of *Figures 1* and *3* the losses amount to about 1.2 volts. The rectifiers should, for maximum safety, have current ratings at least equal to the DC output currents.

Thus, the procedure for selecting a transformer for a particular problem is very simple. First, decide on the DC output voltage and current that is required:

The product of these two values (allowing for slight rectifier losses) determines the minumum VA rating of the transformer. Next, consult the graph of *Figure 5* to find the transformer secondary RMS voltage that corresponds to the required DC voltage. Simple?

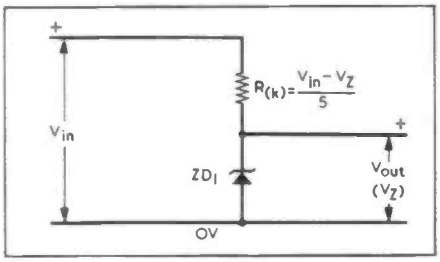


Figure 7: This basic Zener 'reference' circuit is biased at about 5mA.

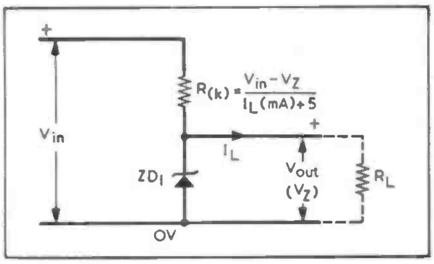


Figure 8:
This basic Zener 'regulator' circuit can supply load currents of a few tens of mA.

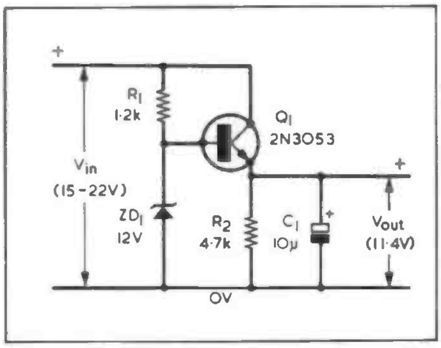


Figure 9: This series-pass Zener-based regulator circuit gives an output of 11.4 volts and can supply load currents up to about 100mA.

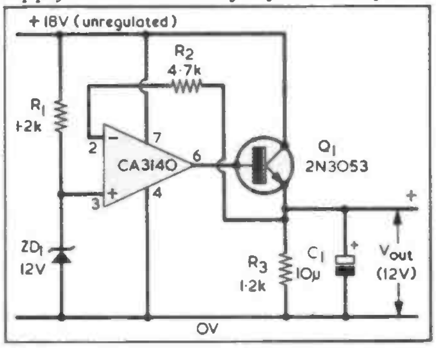


Figure 10:
This op-amp based regulator gives an output of 12 volts at load currents up to 100mA and gives excellent regulation.

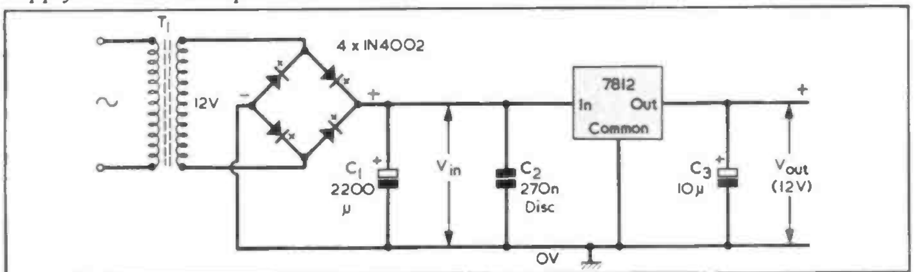


Figure 11: Connections for using a 3-terminal positive regulator, in this case a 12 volt 1 amp '78' type.

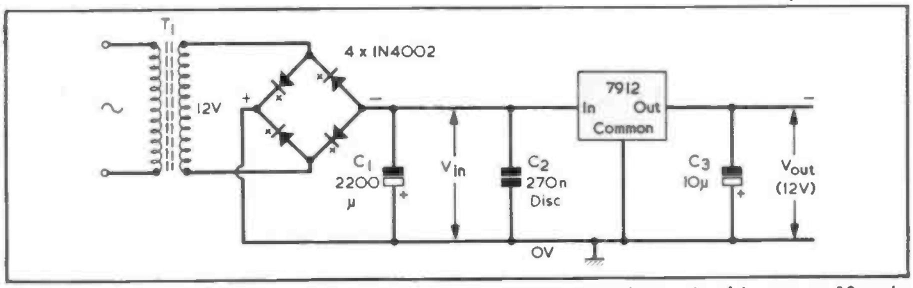


Figure 12: Connections for using a 3-terminal negative regulator, in this case a 12 volts 1 amp '79' type.

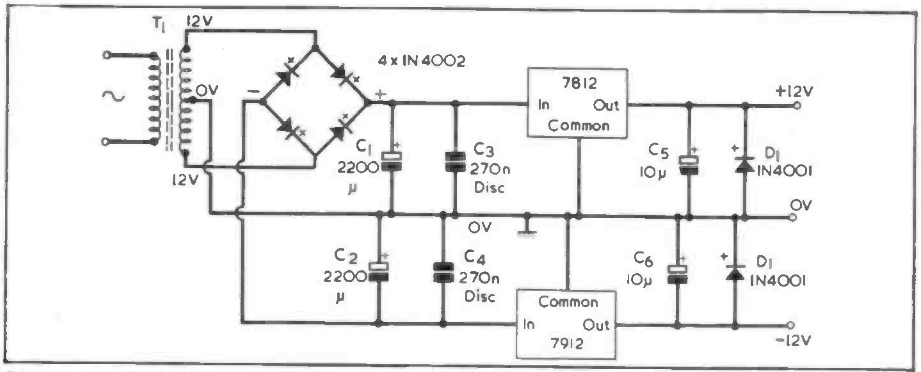


Figure 13: Complete circuit of a 12 volt 1 amp dual power supply using 3-terminal regulator IC's.

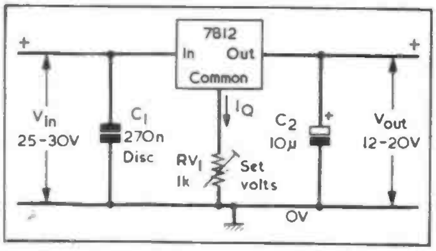


Figure 14: Very simple method of varying the output voltage of a 3-terminal regulator.

The Filter Capacitor

The purpose of the filter capacitor is to convert the full-wave rectified signal of the rectifier into a smooth DC output voltage. The two most important parameters of the capacitor are its working voltage and its capacitance value. The working voltage must be greater than the off-load output voltage of the power supply circuit. The capacitance value determines the amount of ripple that will appear on the DC voltage when current is being drawn from the circuit.

As a rule of thumb, in a full-wave rectified power supply operating from a 50-60Hz power line, an output load current of 100mA will cause a ripple waveform of about 700mV pk-to-pk to be developed from a 1000u filter capacitor, the amount of ripple being directly proportional to the load current and inversely proportional to the capacitance value, as shown in the **design guide** of *Figure 6*. In most practical applications, the ripple should be kept below 1-1.5 volts pk-to-pk under full load conditions. If very low ripple is required, the basic power supply can be used to feed a 3-terminal voltage regulator, which can easily reduce the ripple by a factor of 60dB or so at very low cost.

Voltage Regulator circuits

Voltage regulators may vary from simple Zener-based circuits designed to provide load currents up to only a few mA, to fixed-voltage high-current circuits designed around 'fixed' 3-terminal regulator IC's, or to variable-voltage high-current circuits designed around 'variable' 3-terminal regulator IC's. We'll look at practical versions of all three types of circuit in the next couple of pages.

Zener-based circuits

A Zener diode can be used to simply produce a fixed reference voltage by using the connections shown in *Figure 7*. Here, a current of roughly 5mA is passed through the Zener diode from the supply line via limiting resistor R. Often, the supply voltage (V_{in}) may be subject to fairly wide variations, causing the Zener current to vary over a similarly large range. So long as V_{in} is always more than a few volts greater than the Zener voltage and provided that the Zener power rating is not exceeded, this variation has only a moderate influence on the output voltage of the Zener, which typically has an effective output impedance of only a few tens of ohms.

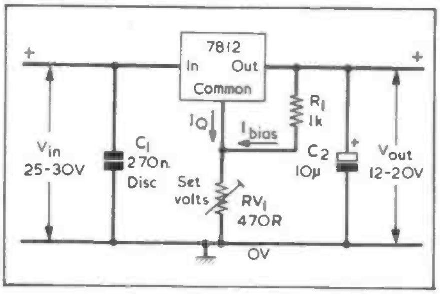


Figure 15: An improved method of varying the output voltage of a 3-terminal regulator.

A Zener can be used as a very simple voltage regulator, providing maximum load currents up to a few tens of mA, by merely selecting the value of 'R' as shown in *Figure 8*. Here, when the designed maximum load current is being drawn only 5mA flows through the Zener: When zero load current is being drawn the Zener passes 5mA plus the full maximum designed load current and thus dissipates maximum power: It is important to ensure that the power rating of the Zener is not exceeded under this 'no load' condition.

In most practical voltage regulator applications the Zener is simply used to apply a 'reference' voltage to a high-gain non-inverting buffer amplifier, which then supplies the required output power. The simplest example of this type of circuit is shown in the series-pass regulator circuit of *Figure 9*. Here, Q1 is wired as a voltage follower, its emitter remaining at about 600mV below its Zener-defined base voltage under all load conditions. The Zener network provides the base drive current to Q1, this current being equal to the output load current divided by the current gain of the Q1 'buffer' stage. Clearly, the higher the gain of Q1, the better will be the output regulation of the circuit.

One way of improving the regulation of the *Figure 9* circuit would be to use a Darlington or Super-Alpha pair of transistors in place of Q1. An even better solution is to use the op-amp plus transistor buffer stage shown in *Figure 10*. Here, the op-amp and Q1 are wired as a unity-gain non-inverting DC amplifier with a near-infinite input impedance and

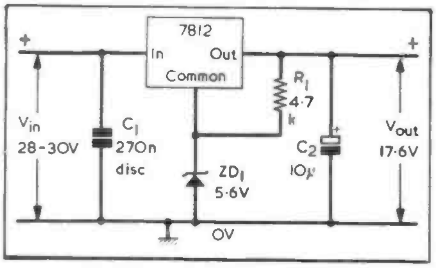


Figure 16: The output voltage of a 3-terminal regulator can be increased by wiring a suitable Zener diode in series with the common terminal.

near-zero output impedance. The output voltage tracks within a few mV of the Zener reference value. The safe output current is limited to about 100mA by the power rating of Q1: Higher currents can be obtained if Q1 is replaced with a power Darlington transistor.

The *Figure 10* circuit is very versatile. It can be made to generate any desired fixed voltage up to about 30V maximum by simply using a suitable Zener value and ensuring that the unregulated supply voltage is at least 5 volts greater than the Zener value (up to 36 volts maximum). The circuit can be used as a variable-voltage supply by simply wiring a pot

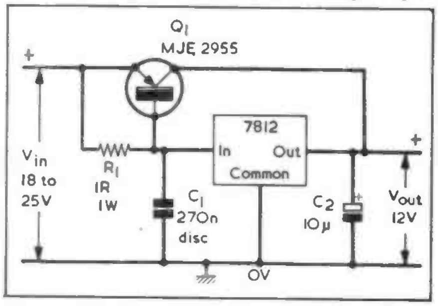


Figure 17: The output current capacity of a 3-terminal regulator can be boosted via an external transistor. This circuit can supply 5 amps at a regulated 12 volts.

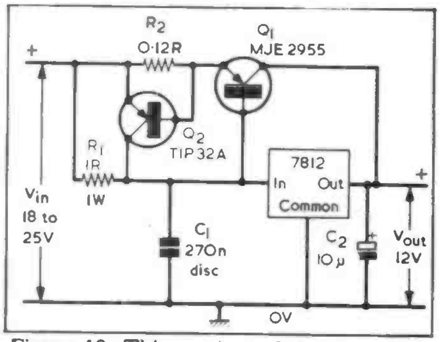
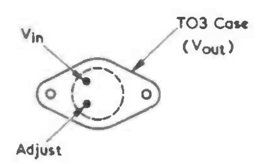


Figure 18: This version of the 5 amp 12 volt regulator has overload protection provided via Q2.



Parameter	317K	338K
Input voltage range	4-40V	4-40V
Output voltage range	1·25-37V	1·25-32V
Output current rating	1·5A	5A
Line regulation	0·02%	0·02%
Load regulation	0·1%	0·1%
Ripple rejection	65dB	60dB

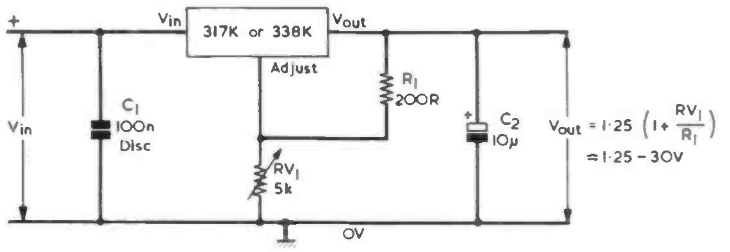


Figure 19: Outline basic data and basic application circuit of the 317k and 338k variable-voltage 3-terminal regulators.

across the Zener, with its slider taken to the non-inverting input of the 3140 op-amp: This op-amp can accept inputs all the way down to zero volts, enabling (for example) a 0.25V supply to be easily implemented.

'Fixed' 3-terminal regulator circuits

Fixed-voltage regulator design has been greatly simplified in recent years by the introduction of 3-terminal regulator IC's such as the '78xx' series of positive regulators and the '79xx' series of negative regulators. These IC's incorporate features such as built-in fold-back current limiting and thermal protection. A wide range of 3-terminal fixed-voltage regulator IC's are available: Standard current ratings are 100mA, 500mA, 1A and 3A and standard output voltage ranges are 5V, 6V, 8V, 12V, 15V, 18V and 24V.

Three-terminal regulators are remarkably easy to use, as shown in the basic circuits of *Figures 11* to *13*, which show the connections for making positive, negative and dual regulator circuits respectively: The IC's shown in these examples are 12V units with current ratings of 1A, but the basic circuits are valid for all other voltage ratings, provided that the unregulated input voltage is at least 3 volts greater than the desired output voltage. Note that a 270n or greater disc (ceramic) capacitor should be connected close to the input terminal of the IC and 10u or greater electrolytic to the output. Also note that these regulator IC's typically provide about 60dB of ripple rejection, so 1 volt of input ripple will appear as a mere 1mV of ripple on the regulated output.

The output voltage of a 3-terminal regulator is referenced to the 'common' terminal of the IC, which is normally (but not necessarily) grounded: Most regulator IC's draw quiescent currents of only a few mA, which flow to ground via this 'common' terminal. The regulator output voltage can thus easily be raised above the designed value by simply biasing the 'common' terminal with a suitable

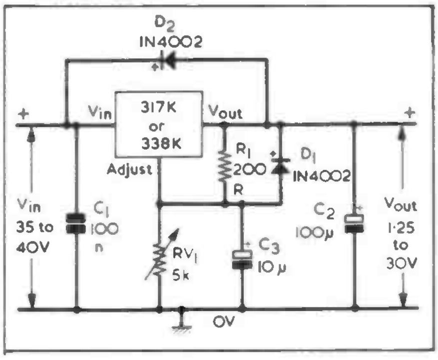


Figure 20: This version of the variable voltage regulator has 80dB of ripple rejection.

voltage, making it easy to obtain 'odd-ball' output voltages from the regulator. *Figures 14* to *16* show three ways of achieving this.

In *Figure 14* the bias voltage is obtained by passing the IC's quiescent current (typically about 8mA) through RV1. This design is adequate in most applications, although the output voltage obviously shifts slightly with changes in quiescent current. The effects of such changes can be minimised by using the circuit of *Figure 15*, in which the RV1 bias voltage is determined by the sum of the quiescent current and the bias current set by R1 (12mA in this example). If a fixed output voltage is required other than the designed value, it can be obtained by wiring a Zener diode in series with the common terminal as shown in *Figure 16*, the output voltage then being equal to the sum of the Zener and regulator voltages.

The output current capability of a 3-terminal regulator can be increased by using the circuit of *Figure 17*. R1 is wired in series with the regulator IC. At low currents insufficient voltage is developed across R1 to turn Q1 on, so all the load current is provided by the IC. At currents of 600mA, or greater, sufficient voltage (600mV) is developed across R1 to turn Q1 on, so Q1 provides all currents in excess of 600mA.

Finally, *Figure 18* shows how the by-pass transistor of the above circuit can be provided with overload current limiting via 0.12 ohm current-sensing resistor R2 and turn-off transistor Q2.

'Variable' 3-terminal regulator circuits

We've already seen that the outputs of '78xx' regulators can be varied over limited ranges by simply applying suitable variable voltages to their 'common' terminals, even though these IC's are designed as 'fixed' regulators. If, however, you need to vary the output voltages over fairly wide ranges, a far better solution is to use one of the special 'variable' 3-terminal regulator IC's, such as the 317k or the 338k.

Figure 19 shows the outline, basic data and the basic variable-regulator circuit that is applicable to these two devices. Both devices have built-in fold-back current limiting and thermal protection and are housed in TO3 steel packages, the major difference between the devices being that the 317k has a 1.5 amp current rating compared to the 5 amp rating of the 338k. The major feature of both devices is that their 'output' terminals are always 1.25 volts above their 'adjust' terminals, and their quiescent or adjust-terminal currents are a mere 50uA or so.

Thus, in the *Figure 19* circuit, the 1.25 volt difference between the 'adjust' and 'output' terminals causes several mA to flow to ground via RV1, thereby causing a variable 'adjust' voltage to be developed across RV1 and applied to the 'adjust' terminal. In practice, the output of the *Figure 19* circuit can be varied over the approximate range 1.25 to 33 volts via RV1, provided that the unregulated input voltage is at least 3V greater than the required maximum output voltage. Naturally, alternative voltage ranges can be obtained by giving R1 and/or RV1 alternative values, but it should be noted that for best stability the R1 current must be at least 3.5mA.

The basic *Figure 19* circuit can be usefully modified in a number of ways. The basic ripple rejection factor of this circuit, for example is about 65dB, but this can be increased to 80dB by wiring a 10u by-pass capacitor across RV1, as shown in *Figure 20*, together with a protection diode connected as indicated, to prevent the capacitor discharging into the IC if the regulator output is short-circuited.

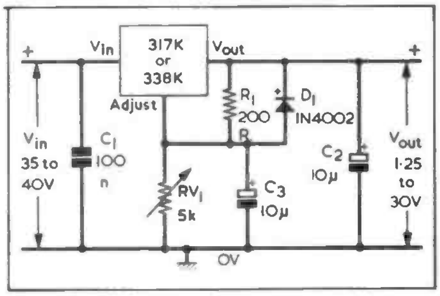


Figure 21: This version of the regulator has 80dB ripple rejection, a low impedance transient response, and full input and output short-circuit protection.

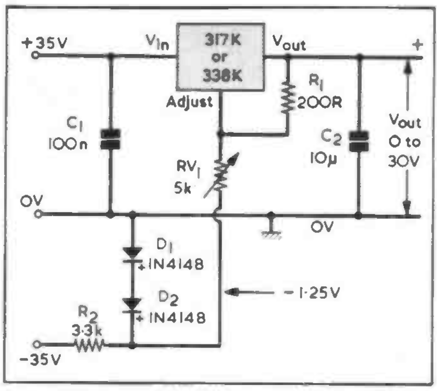


Figure 22: The output of this version of the regulator is fully variable from zero to 30volts.

A further modification of the *Figure 20* circuit is shown in *Figure 21.* Here, the transient output impedance of the regulator is reduced by increasing the C2 value to 100u; diode D2 is used to protect the IC against damage from the stored energy of this capacitor if an input short occurs.

The minimum output voltage of the *Figure 19* to *21* circuits is 1.25 volts. If you want the voltage to vary all the way down to zero, the circuits must be configured so that the 'adjust' terminal goes to —1.25V when RV1 is reduced to zero ohms. *Figure 22* shows how this can be achieved, using a 35V negative rail and a pair of series-connected diodes to clamp the low end of RV1 to —1.25V.

If you want to get the maximum possible voltage out of one of these regulators, you'll need to make sure that the input voltage does not exceed the 40V rating of the IC. The best way to do this is to use a simple Darlington-plus-zener pre-regulator circuit, as shown in *Figure 23,* which enables you to use any unregulated input in the range 35-55 volts. Note that as well as giving input over-voltage protection, this pre-regulator also gives a further improvement in ripple rejection. If you want to use this circuit with a 5 amp 338k regulator, you may need to reduce the value of R1 and beef up the power rating of the Zener diode.

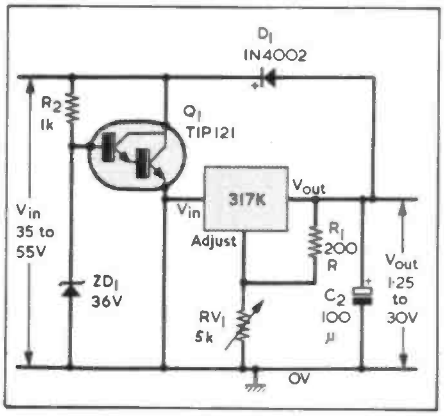


Figure 23: This variable-voltage unit uses a pre-regulator (Q1) to give input over-voltage protection and improved ripple rejection.

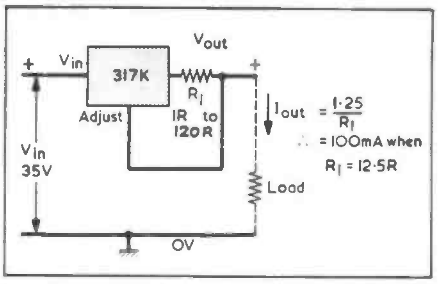


Figure 24: Method of using the 317k as a precision current limiter or constant-current generator.

Finally, to complete this look at regulator circuits, *Figure 24* shows how you can use the 317k as a precision current limiter or constant current generator in which the output current is determined by R1 and is virtually independent of the external load values. By suitable choice of R1, the constant-current magnitude can be set at any value between approximately 10mA (R1 equals 120R) and 1.25A (R1 equals 1R0). Not bad for a two-component circuit. ■

Your Reactions.........	Circle No.
Immediately Applicable	254
Useful & Informative	255
Not Applicable	256
Comments	257

ZX81 Histograms

-by Neil Patey

ZX81 program that works!

The program accepts up to 12 pieces of data in the range 1-41 and reproduces that data as a bar graph. Drawing commences on entering the twelfth number or by entering a zero in the data.

The following 1K program sets up a dimension and then draws a bar graph from information within that dimension.

```
 10 DIM D (12)
 20 FOR E = 1 TO 12
 30 PRINT E; "—";
 40 INPUT X
 50 PRINT X
 60 IF X < 1 THEN GOTO 100
 70 LET D (E) = X
 80 NEXT E
 90 LET E = 13
100 CLS
110 FOR C = 0 TO 21
120 PRINT AT C, 0; "."
130 IF C > 13 THEN GOTO 150
140 PRINT AT 21, C; "."
150 NEXT C
160 FOR C = 1 TO E — 1
170 LET B = C * 2 + 1
180 LET X = D (C)
190 IF X > 41 THEN LET X = 41
200 FOR A = 2 TO X + 1
210 PLOT B, A
220 NEXT A
230 NEXT C
```

Lines 10 to 80 set the dimension and allow the user to enter his own data, lines 110 to 150 draw the vertical and horizontal boarders. Lines 160 to 230 plot the graph, line 190 is necessary to prevent data in excess of 41 from stopping the program.

Although the program can be altered to handle a larger amount of data, it is not recommended for the unexpanded 81 as the remaining memory would not be sufficient to execute the program properly. However, if you are fortunate enough to possess the add on RAM, then the following lines would need to be altered.

Example to handle 20 data inputs

```
10 DIM D (20)
20 FOR E = 1 TO 20
```

Also

```
160 FOR C = 1 TO E + 7
```

If it is required to extend the base line then transpose lines 120 and 140 and alter line 130 accordingly. I.e.

```
120 PRINT AT 21, C; "."
130 IF C > 21 THEN GOTO 150
140 PRINT AT C, O; "."
```

RS232 ADA

by Jonathan C Burchell

The RS232 ADA consists of an 8-bit analog to digital converter, plus an 8-bit digital to analog converter, may be operated by any computer equipped with an RS232 serial communications interface.

The *RS232 ADA* consists of an 8 bit analog to digital converter, plus an 8 bit digital to analog converter, which may be operated by *any* computer equipped with an RS232 serial communications interface.

Although simple to construct and set up, the ADA converter relies on the use of LSI building blocks to 'simplify' what is in fact an extremely complex function. It is built from only a handful of components

Applications for the ADA board include: programmable power supplies with current feedback, signal sampling, component identification, and also the monitoring of any *real world* variable which can be represented as varying voltage. This last classification encompasses a virtually infinite number of applications.

The ADA board includes a UART (Universal Asynchronous Receiver Transmitter), which allows the reception of serial characters from the computer's RS232 output port. Once a complete 8 bit character has been received, it is transferred from the UART to an 8-bit digital to analog converter (D-to-A).

The converter produces a voltage which is proportional to the binary value of the character received by the UART. The converter output ranges from 0 volts for an input word of 00000000_2 to 2.5 volts for an input word of 11111111_2. Once a character has been received, it will remain at the output of the UART until the data source transmits another character. The rate at which characters can be transmitted is limited only by the selected baud rate. The converter itself has a worst case settling time of 2 microseconds, although the op-amp buffer provided, increases this to approximately 25 microseconds.

An analog to digital conversion is initiated by the RTS (Request To Send) or similar line from the computer going 'high'. This state is detected and the voltage being monitored is sampled.

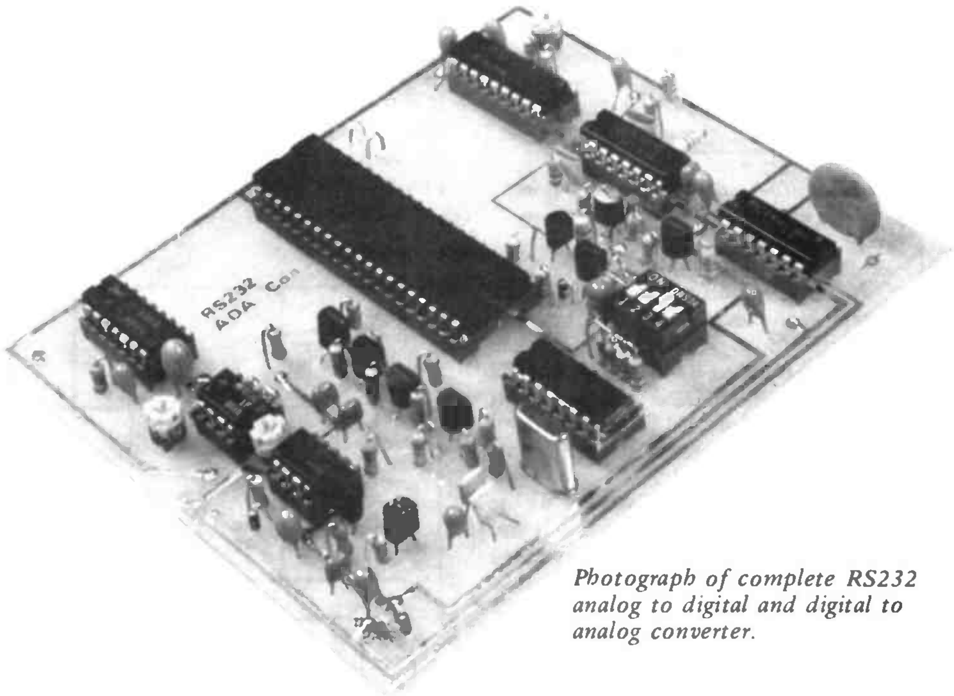
Once the sample and hold amplifier has stabilised, an 8 bit analog to digital converter is instructed to convert the voltage present at its input (from the sample and hold) into a binary value representation of the signal's magnitude.

When the analog to digital conversion is complete, the converter initiates the transfer of the data to UART. The UART appends to this data the appropriate parity and start/stop bits before transmitting it to the computer's RS232 input port.

Detailed circuit operation

The timing of the data transmission and reception is controlled by a CMOS baud rate generator type CD4702. The reference crystal is divided down to produce 14 standard baud rate frequencies, and the required frequency is selected by the combination of 1's and 0's set on SWB-1. The output from the 4702 (a square wave at 16x the selected baud rate) is fed directly to the UART's transmitter and receiver clock circuits. A signal at 153KHz (ϕ1) is taken from the 4702 and used for clocking the analog to digital converter.

The UART (TR1863) (IC5) is set up to transmit one start bit, 8 data bits, and one stop bit. Even or odd parity may be selected by taking pin 39 (IC5) high or low repectively. If it is not desired to generate and check parity, then pin 35 of IC5 must be taken high, otherwise it must be grounded. C4&R24 provide a power on reset circuit for the UART



Photograph of complete RS232 analog to digital and digital to analog converter.

The Digital to Analog Converter

The RS232 output from the data source cannot be connected directly to the UART, due to its large signal levels (possibly plus and minus 12 volts) and must be connected to an inverter and voltage translator consisting of R13, R14, R15, Q3 and D4. D4 prevents the base of Q3 from being damaged by the negative excursions of the RS232 signal.

The received data which is now in a TTL compatable signal range is connected to pin 20 of IC5 - the receiver data input. Any errors detected by the UART in the received signal are indicated by LED's 1-3. These LED's are driven from simple transistor buffers. Valid characters appear on IC5 pins 5-12 and are then connected to IC2, a ZN426 8 bit digital to analog converter.

The ZN426 has it's own built-in voltage reference which is supplied with power via R3, and decoupled via C1. The output on the ZN426 is buffered via an LF351 op-amp which increases the current available to 25 mA and prevents the output voltage from being influenced by loading considerations.

Preset VR1 allows the output buffer to be 'zeroed' whilst the gain of the op-amp is set by R1,R2 and VR2. This allows adjustment of the full scale output voltage to suit the user's needs. An option is provided on the PCB to allow the omission of R1, R2 and VR2 and the direct connection of IC1 pin 2 to 6 thus enabling unity gain to be selected.

Analog to Digital conversion

This process is more complicated than the D/A operation described above, and it may be useful to refer to the block diagram of the A-to-D logic as well as the full circuit diagram.

A command to the circuit to perform an analog to digital conversion is required, which in the author's circuit was the RTS line of the computer. Other signals can be used - see later. The command - which must consist of a low to high transistion - is received and buffered via transistors Q8 and Q9. The design of this buffer allows either RS232 level, or TTL signals to be used without any circuit modifications being required.

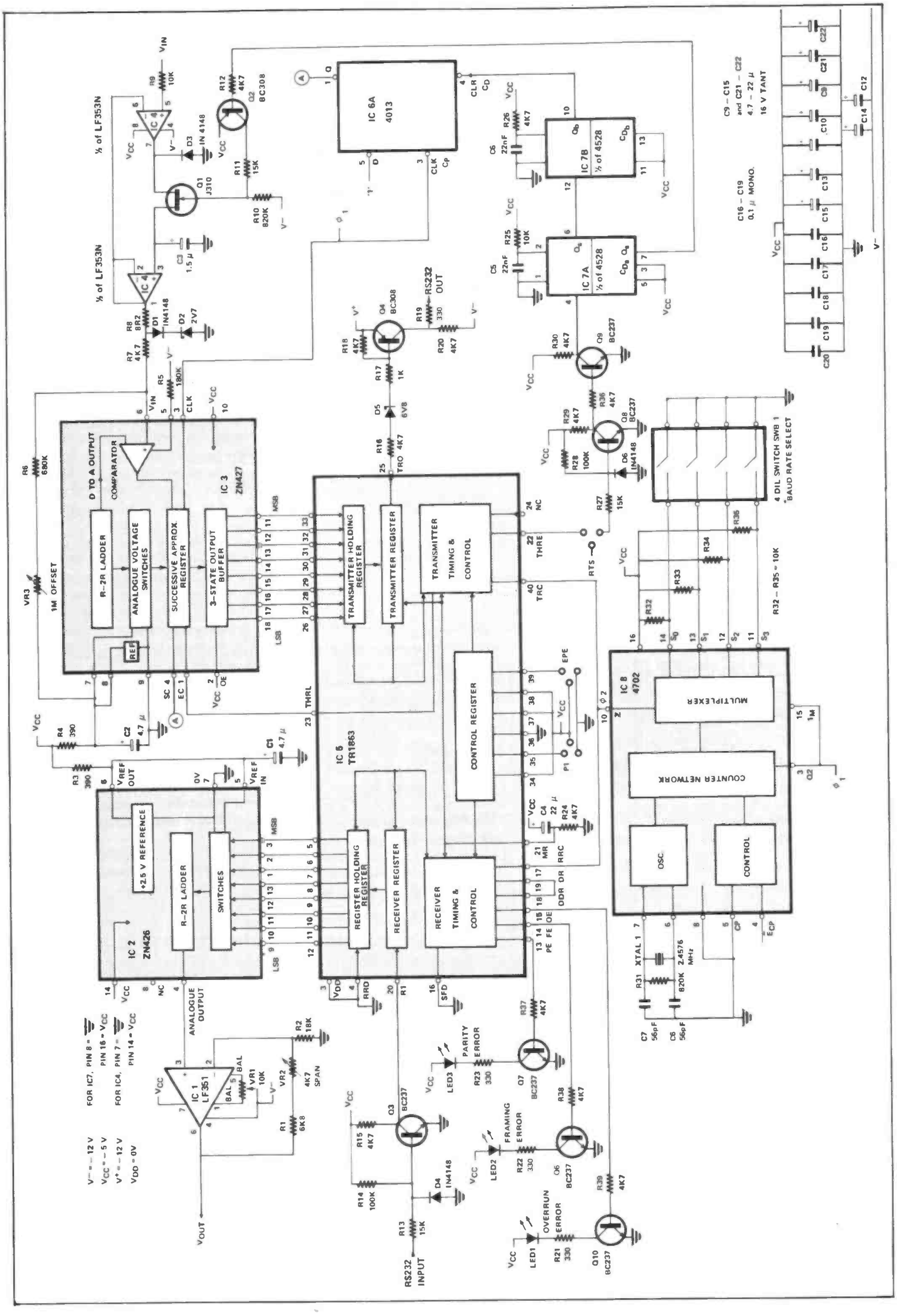


Figure 1: Complete Circuit Diagram of the RS232 ADA Board.

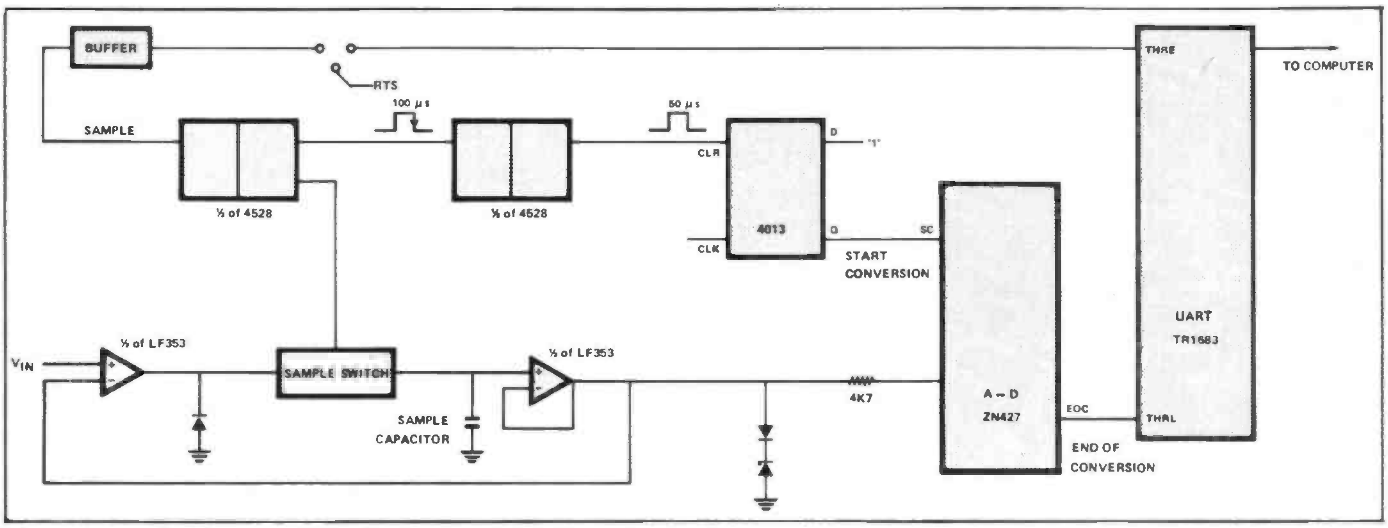


Figure 2: Block Diagram of the Analog to Digital Converter Logic.

The buffered 'convert' signal is fed to the first half of IC7 (a dual monostable). A pulse from the monostable causes the sample and hold amplifier to sample and track the input signal for the next 100 microseconds. At the end of this period, the second monostable is triggered. This second monostable introduces a delay of 50 microseconds into the circuit, which ensures that the sample and hold amplifier has completely settled to its new value before a conversion is initiated. The end of the 50 microseconds settling period allows a '1' to be clocked through the 4013 flip/flop, which is used to ensure proper synchronisation of the *convert* command to the ZN427 and the clock signal to the same device.

The ZN427 detects the *low to high* transition on pin 4, and begins a conversion cycle. The ZN427 employs a succesive approximation conversion technique and always takes 8 clock cycles. VR3 and R6 allow the nulling of any offset present, ensuring that the ZN427 gives an output of 00000000_2 for an input of 0 volts. The ZN427 has a full scale input of 2.55 volts to give an output of 11111111_2.

When the ZN427 has finished a conversion cycle, it brings pin 1 low. This signal is connected directly to the transmitter load input of the UART pin 23 IC5. When the UART detects a low in this pin, it transfers the data present on pins 26-33 into the transmitter register.

Data is clocked from the UART at the selected baud rate onto IC5 pin 25. D5 and Q4 provide an RS232 voltage level translator and driver.

The 'sample and hold' is built from a dual fet operational amplifier type LF353, an N channel fet forms the sample switch, Q2 provides buffering from the 0 to 5v convert signal, and the -12v gate bias of Q1. The sampled signal is held on capacitor C3.

The input signal is applied to the non-inverting input of the sample and hold amplifier via R9. D3 ensures that the sample switch cannot be made conducting during the 'hold-time' by becoming reversed biased. It also ensures that a negative signal cannot be applied to the ZN427. Diodes D1 and D2 provide a measure of overvoltage protection for the ZN427, as the signals on the input pin should be limited to less than 3.5 volts.

Like the D to A converter, the speed of operation is limited only by the baud rate - the prototype has worked successfully at 19200 baud. As was mentioned earlier any low to high transition at the base of Q6 will provide a convert command signal, and a very simple way to provide this is to connect a push button across D6. Be careful, however, as contact bounce will probably mean that not just one but several conversions are performed.

Another alternative is to use IC5 pin 22. This signal is generated by the UART whenever it has finished transmitting a character. It is issued once data transmission is initiated - e.g. by pressing a button across D6. The transmission of each character will cause a new sample to be taken and data will flow continually from the unit. Alternatively, a timer such as a 555 may be connected to cause a sample to be taken every 5 minutes or whatever period is required.

Since the output is 'RS232', it may be connected directly to a terminal without the need for a control computer - providing that the terminal can be programmed to transmit and display a full 255 character set. The prototype has also been used with a digital recorder in a remote monitoring application.

Constructional Details

It is recommended that the circuit is constructed on a PCB. *Figures 3 and 4* give the copper layout for a suitable double sided board. The PCB method is recommended, not only because of the relative complexity of the circuit and large number of interconnections, but also because the ADA board involves a mix of analog and digital circuits providing quite a few layout problems to the unwary constructor.

An 8 bit conversion means that a converted signal has a signal to possible error ratio of 50dB and in order to preserve this, the digital noise floor must be kept to a minimum. It is for this reason that the circuit is decoupled so generously.

As IC's 2,3,5,8 are not in the '2 a penny class', it is recommended that all IC's are socketed. The best order of contruction is to first fit the small thro' link under IC5, then place and solder all of the IC sockets checking their orientation with the overlay diagram *(figure 5)*. Next fit all the resistors and capacitors, being careful to orientate them in the correct manner.

Whenever there is a pad on both the top and bottom side of the PCB, the leads which pass through them must be soldered on both sides. Finally place the diodes and transistors.

When fitting the crystal, be careful not to over stress the leads by bending or prolonged heating. Finally fit the dil switch and any remaining top to bottom links.

Flying leads must be fitted for power supply connections, the analog input and output, the RS232 data i/o, the convert command and the three LED's.

Testing and Setting Up

The RS232 ADA board requires a well regulated power supply, the +5v and -12v need only supply 250mA whilst the +12v which is only used in the RS232 driver need only supply 20mA. Before fitting the IC's, connect the board to the power source and turn on. Once the power supply decoupling capacitors have charged, the current being drawn should drop to a few mA. If if doesn't, check carefully for solder splashes, bridges etc. Also check the correct orientation and type of all the electrolytics, diodes and transistors. Assuming all is well, double check the presence and value of the power supply voltages at the IC sockets.

Power down (*he means 'switch off' -ed*) and fit IC8, IC6, IC1, IC2, you have now installed the D-A half of the circuit. Connect a voltmeter to pin 3 of IC1. (You will also need to connect your RS232 data output to the end of R13.) Select the required baud rate on switch S0-S3 (See *table 1*), and install jumper connections for parity or no parity. Power up, and (via the computer terminal) send the board the 8 bit character 00000000_2, the voltmeter should read approximately 0 volts, and the various LED's should remain unlit. If they light, then there is a difference between the baud and parity settings of your computer and those programmed on the ADA card. Next transmit 11111111_2, the voltmeter should read 2.55 volts, and if nothing appears to work, then double check all connections, and try decreasing the value of R24 to 2K7. Whilst continually transmitting data, look for it with a scope, logic probe or voltmeter at the base and collecter of Q3. Check also that the baud rate clock is present on pin 10 of IC 8. If not, check the crystal connections and pin connections of IC 8.

Also check for UART function by transmitting single characters and seeing if they appear on IC5 pins 12-5. If the circuit functions but does not always increase in output voltage when sent a sequence of characters from 00_{16} to 255_{16}, then suspect 'stuck' or 'jammed' data bits between IC's 5 and 2.

When proper operation has been obtained, transmit a 0_{16} and connect the meter to IC1 pin 6. Adjust VR1 to obtain an output reading of 0 volts. If you can't get to 0 volts, then increase the value of VR1 to 50k.

Next transmit 11111111_2, and adjust the span pot to give the desired full scale output.

Power down and fit the rest of the ICs. Connect the RS232 ADA output to your computer's RS232 input. Connect up a 'convert' command generator, such as the RTS signal, and ground the input end of R9.

Power up. Send the board a convert command pulse - you should receive an 8 bit character back from the board, which is approximately 00000000_2. If not, send continuous command pulses and look from them at the bases of Q8, Q9, IC7A pin 4, IC7b pin 12, IC 6a pin 1. Check also for the presence of the 153Khz clock signal on IC6A pin 3, and IC3 pin 3. (This signal comes from IC8 pin 3).

If the convert signal is getting all the way to IC3, check for transitions from high to low after every convert pulse on IC5 pin 23. If they are not present, then suspect IC3. Next check for the presence of data at pin 25 IC6 the base of Q4 and R14/R20 junction.

When data is being received successfully, rotate VR3 to adjust the transmitted character to exactly 0. If characters are being received, but they are nowhere near zero, check that pin 1 of IC4 is near ground potential.

When all is working, remove the ground connecton to R9 and connect up a variable 0 - 2.5 volts source, a 5k pot in series with 4k7 across VCC will do fine. Arrange to transmit convert commands, and receive and display the transmitted data. Increasing the input voltage should cause an increase in the transmitted character value.

If this does not work, remove IC4 and connect the input voltage source directly to R8. If all now works, the fault must lie within the sample and hold. Replace IC4 and double check everything.

Software Requirements

To be able to converse with the ADA card your computer must be able to transmit and receive 8 bit characters via an RS232 interface. The author's computer uses an 8251, and the connect command was derived from pin 23 of the 8251 known as *RTS*. As mentioned, the convert signal can be either RS232 level, or TTL. *Table 2* shows the instruction sequences to be fed to the 8251 in order to initialise, transmit and receive characters from and to the ADA card.

Constructional and component details pages 32/33.

NEXT MONTH -*Practical applications of the ADA board including software.*

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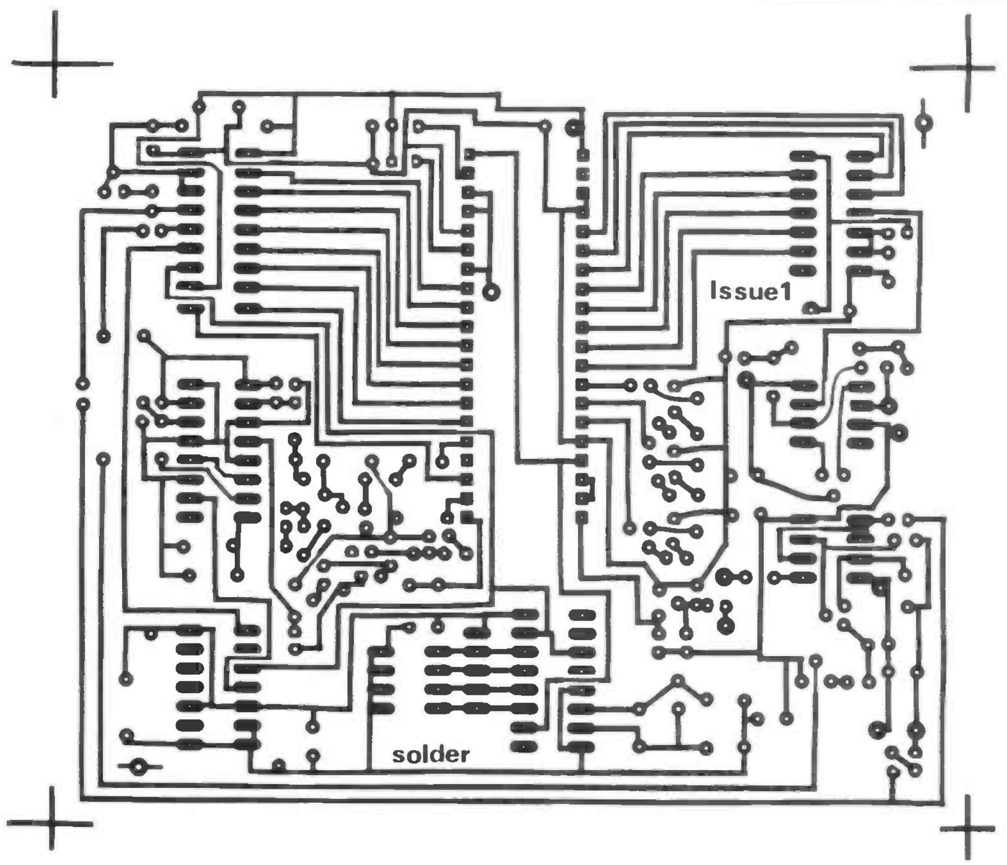


Figure 3: Full size PCB foil pattern. Non-component side

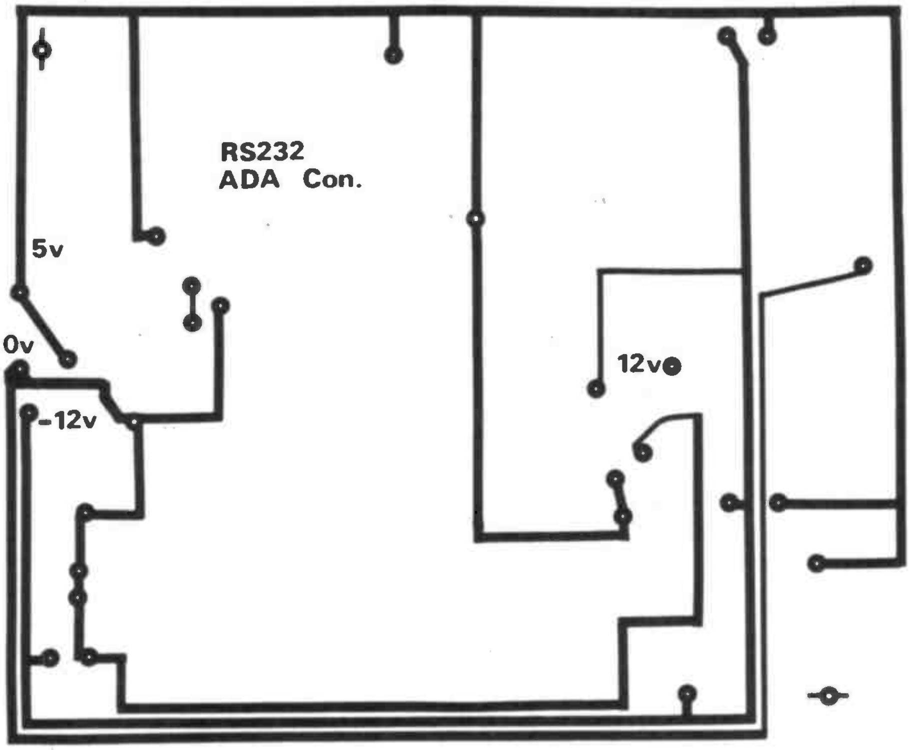


Figure 4: Top foil pattern for PCB (same size)

Figure 5: Component overlay of RS232 ADA board

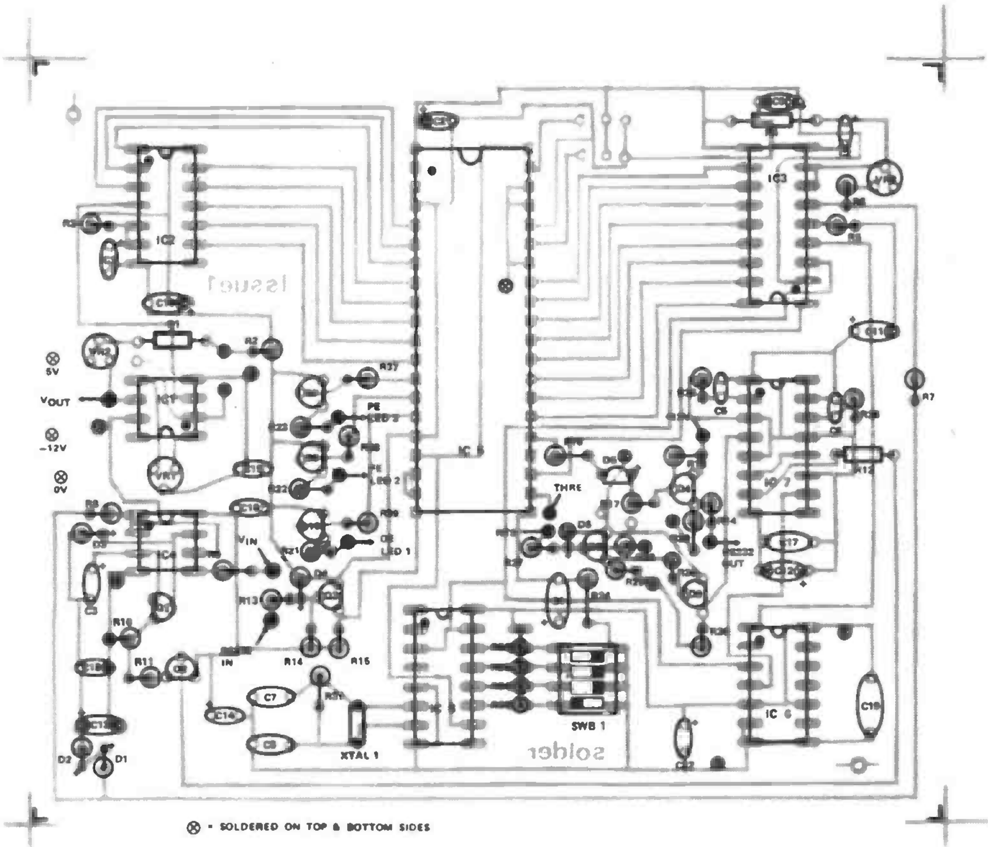
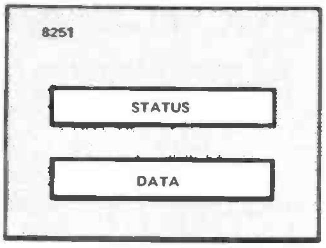


Table 1:

Baud Rate Settings

S3	S2	S1	S0	Baud rate
ON	ON	ON	OFF	50
ON	ON	OFF	OFF	75
OFF	OFF	OFF	OFF	110
ON	OFF	ON	ON	134-5
OFF	OFF	OFF	ON	150
ON	OFF	ON	OFF	200
OFF	OFF	ON	OFF	300
ON	OFF	OFF	ON	600
OFF	ON	OFF	OFF	1200
OFF	ON	OFF	ON	1800
OFF	OFF	ON	ON	2400
OFF	ON	ON	OFF	4800
OFF	ON	ON	ON	9600
ON	ON	ON	OFF	19200

TABLE 2 – 8251 PROGRAMMING



INITIALISE

TO BE USED ONLY AFTER
A RESET

LOAD STATUS , CE_{16}

LOAD STATUS , 07_{16}

SET UP MODE , NO. DATA BITS ETC.

SAMPLE – (READS A TO D CONVERTER)

LOAD STATUS , 27_{16}

LOAD STATUS , 07_{16} : GENERATE CONVERT COMMAND

LP1 LOAD REG., STATUS

AND REG., 2

JZ LP1 : WAIT FOR CONVERTED SAMPLE

LOAD REG., DATA : GET ANALOG VALUE

DATA OUT – (SENDS VALUE TO D TO A CONVERTER)

LP2 LOAD REG., STATUS

AND REG., 1

JZ LP2 : WAIT FOR TX READY

LOAD DATA , VALUE : TRANSMIT SAMPLE

Components List - RS232 ADA Project.

Resistors all .25W 5%

R 1 6k8
R 2 18k
R 3 390E
R 4 390E
R 5 180k
R 6 680k
R 7 4k7
R 8 8k2
R 9 10k
R10 820k
R11 15k
R12 4k7
R13 15k
R14 100k
R15 4k7
R17 1k0
R18 4k7
R19 330E
R10 330E
R21 330E
R22 330E
R23 330E
R24 4k7
R25 10k
R26 4k7
R27 15k
R28 100k
R29 4k7
R30 4k7
R31 820k
R32 10k
R33 10k
R34 10k
R35 10k
R36 4k7
R37 4k7
R38 4k7
R39 4k7

Preset resistors:
All min 6mm dia horiz. presets
VR1 10k
VR2 4k7
VR3 500k-1M0

Capacitors
(Tant. types may also be miniature low leakage electrolytics)

C 1 4.7uF 16v Tant
C 2 4.7uF 16v Tant
C 3 1.5uF 16v Tant
C 4 22uF 16v Tant
C 5 22nF
C 6 22nF
C 7 56pF
C 8 56pF
C 9 4.7-22uF 16v Tant
C10 4.7-22uF 16v Tant
C11 4.7-22uF 16v Tant
C12 4.7-22uF 16v Tant
C13 4.7-22uF 16v Tant
C14 4.7-22uF 16v Tant
C15 4.7-22uF 16v Tant
C16 0.1uF monolithic
C17 0.1uF monolithic
C18 0.1uF monolithic
C19 0.1uF monolithic
C20 0.1uF monolithic
C21 4.7-22uF 16v
C22 4.7-22uF 16v

Diodes

D 1 IN4148
D 2 2v7 zener
D 3 IN4148
D 4 IN4148
D 5 6v8 zener
D 6 IN4148

Transistors

Q 1 J310/2SK55
Q 2 BC308
Q 3 BC239
Q 4 BC308
Q 5 BC239
Q 6 BC239
Q 7 BC239
Q 8 BC239
Q 9 BC239
Q10 BC239

Integrated Circuits

IC1 LF351
IC2 ZN426-8
IC3 ZN427-8
IC4 LF353
IC5 TR1863
IC6 CD4013
IC7 CD4528
IC8 CD4702

Miscellaneous

LED1-3 any general purpose light emitting diode.
XTAL1, 2.4576MHz crystal (30pF parallel).
SWB1, 4 way DIL switch.

NEWS BACKGROUND

The Mushroom Principle

Many of you will doubtless have heard of the *Mushroom Principle* - a term applied to the situation where a person, or more usually persons, are kept uninformed (i.e. *in the dark*), and fed on a carefully arranged diet comprising only what 'is good for them' (i.e. organic fertilizers of one sort or another).

Mushroom farming is practised on a wide scale in government and big business, indeed, it is central to the workings of many large scale operations where the principle of 'means to and end' is used. Those of us who do not like to feel we are having the 'wool pulled over our eyes' take exception to some of the many ways in which this practice is applied, so let's take a close look at fungi growing on the electronics business.

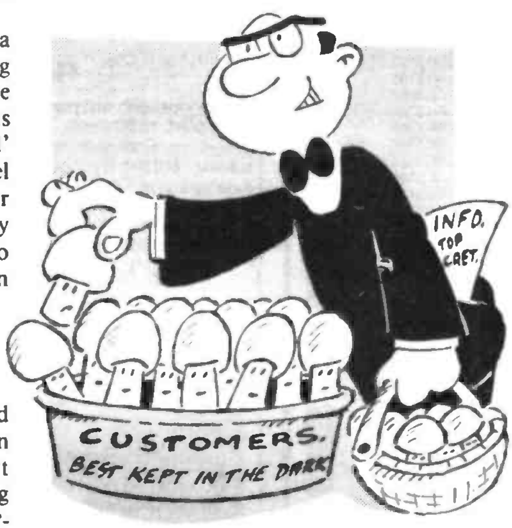
Please don't keep your lights under a bushel

R&EW tries to voice the ideas and opinions of the smaller scale enterprises in the EE business - (we are getting too short of editorial space to keep repeating *electronics, communications and computing*, so EE will have to suffice) -and one of the things to concern us is the marketing strategies of some of the bigger corporations. If your enquiry arrives on a piece of notepaper headed by some instantly recognizable *household* name, the wheels grind into motion.

If your enquiry is supplied in conjunction with a less than recognizable company name, then you must hope that the company enquired from adopts one of the more enlightened policies in the dissemination of its information. Hard bitten businessmen will argue that they cannot afford the time to deal with 'all' enquiries - cost of processing, shortage of staff etc., - but then again, several well known large corporations make a very specific point of dealing with any enquiry as part of their customer relations program.

The question of the 'bingo card' enquirer is somewhat vexed, since all of us have been guilty of the occasional marginal/data gathering enquiry from time to time. The response from a 'public' publication like **R&EW** must essentially contain many names from the distant reaches of mainstream electronics; but we maintain that these are still valid and should be dealt with or the whole business gets very incestuous without the infusion of the large numbers of new enthusiasts/students that are required to meet the growing demands of EE into the 80s.

Big corporations may not be set up to deal with this type of request at the head office, but the enquiry will be passed down the chain to an *outlet* specifically established to interface with that section of the market. The Semiconductor manufacturer/distributor relationship is a case in point, and seems to work tolerably well for many people.



But there are those who practise mushroom farming on a large scale, and a good number of these are of Japanese origin. You can certainly buy a Panasonic HiFi system in most High Street shops -but have you ever tried to get specific information on the components used therein? We have, and it's not easy.

Catch 22

The same can be said for most Japanese consumer goods manufacturers who also make their own semiconductors. These semiconductors are ostensibly supplied to the 'open' market, but the UK end of these sales operations have made the decision that now the UK industry has been so utterly decimated by imported goods, that it isn't worth the bother of servicing enquiries for components classified for use therein. But then again, how do you possibly rectify the situation when you cannot get details of *state-of-the-art* devices? We suppose we could all learn Japanese, but this hardly seems like a solution that will be accepted willingly. Especially by the English speaking Nations who are singularly unwilling/unable to learn another language. language.

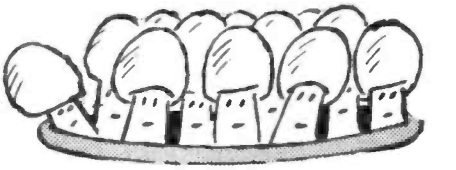
Even if you do speak the language, unless you want to buy 10,000 of an item, then you are a *small* customer in the scale of Far Eastern enterprise. Such is the scale of the domestic Japanese business, that very few *official* means of selling quantities of less than 5,000 seem to exist. In a country like the UK where large-scale business has crumbled away (indeed, as a nation we seem singularly unsuited to the demands of such operations), with many disenchanted erstwhile big company employees attempting to set up their own smaller scale operations - we need to enquire into these practices to see if they represent 'fair trade'. After all, if these corporations are allowed to dominate our high streets, then they might be considered to be *obliged* to extend some form of cooperation to our manufacturers in the shape of making both information and parts available in a similarly well organised fashion.

The question of encouraging the growth of a multiplicity of small-scale companies is all the more pertinent in view of the government's latest tax incentive scheme for those investing money in *start-up* companies.

A lot of the success story in Japan is due to the enlightened cooperation between state and private industry. The benefits of nationalisation in terms of political and financial *understanding,* together with the aims of the 'private' business. It may well be our own fault that we have allowed the constant bickering between the three corners of the UK industry to provide the opportunity for the takeover of many of our markets, but perhaps we should examine the alternatives if we are to establish a way out of the present decline. About the only positive aspect of the last twenty years of UK industrial decline has been the re-emergence of an appreciation of the benefits of smaller scale industrial units in terms of efficiency, job satisfaction, and improved employment-to-capital ratios.

The Information Explosion: Big Bang or Little 'Phut'?

By way of contrast to the preceding topic, have you noticed the surfeit of 'seminars', 'symposia' and general 'gatherings' to discuss matters of electronic and/or commercial interest? That anyone should wish to dissipate a commercial advantage by telling his competitors all about it seems strange, but at £300 plus VAT for a three day binge, the attractions for organizers are obvious. There are doubtless many good and worthy gatherings, but these are in grave danger of being swamped in a morass of trivia.



Reports reaching **R&EW** reveal that these events are frequently less than worth the trouble and expense - and we would like to invite readers to contribute their opinions and thoughts whilst we compile the material for the **R&EW** Seminar about seminars in the electronics business. (£150 + VAT per delegate, hotel extra, chair extra, conference registration £25 each, Conference Banquet £25 + VAT).

Those of you who read last month's editorial may recall we are proposing to hold specialised evening events at the London World Trade Centre. These are intended as an opportunity for a commercial organization to introduce and/or promote worthy aspects of their product ranges and technology to engineers, rather than those who have become remote from the practicalities of the subject. Not to be confused with a 'seminar'.

We invite recipients of circulars touting for the seminar, exhibition, symposium and trade to send us copies of any they find particularly irrelevant and tiresome, together with their reasons. 6 bottles of champagne (well, fizzy white plonk if the truth be known) for the most appropriate and scathing correspondent.

And 12 bottles of champagne to the first person who can actually provide details of an itinerary for 1982, with an exhibition, symposium or seminar taking place on every single working day in the life of an engineer or executive - allowing 4 weeks holiday. You may take your quest overseas if necessary. ■

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The Hall Effect

By E.F.D. Baker

New applications for the little used electro-magnetic Hall Effect are made possible by devices which combine a Hall cell with a differential input amplifier in one transistor — sized package.

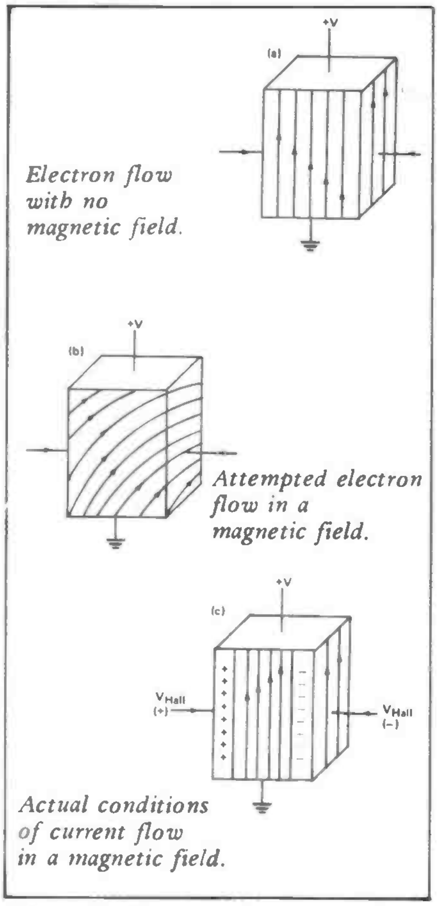


Figure 1: For a conductor carrying a current in a magnetic field - a potential exists perpendicular to the field.

Background

In 1879, an Ohio State University researcher of the name E.H. Hall, discovered an effect that bears his name to this day. Whilst investigating the nature of the forces acting on a conductor carrying a current in a magnetic field, he observed that a potential existed perpendicular to the direction of current flow. *Figure 1.*

The reasons behind this phenomenon were not understood until H.A. Lorentz and Paul Drude produced new theories of conduction - which explain the reason for the effect observed by Hall. However, it was found that material now recognised as semiconductors, gave contradictory results. In 1926, the advent of Quantum Mechanics uncovered the reasons for these contradictions.

With the arrival of Integrated Circuit technology, the application of the Hall Effect was removed from the environs of the laboratory, where it was a useful but impractical phenomenon, and elevated the Hall Effect into an everyday component of electronic technology.

Many of today's devices are integrated with amplifiers and/or Schmidtt Triggers, to produce simple to use devices on a size scale comparable with that of a transistor. Sprague Types UNG3013T and UNG3501T *(Figure 2)* are typical examples. Thankfully modern Hall Effect devices do not exhibit the same temperature instability as their predecessors.

Theory

The basic theory of the Hall Effect is an application of Lorentz forces. A charge travelling through a magnetic field follows a curved path - and the amount of curvature is proportional to the current and magnetic field strength with the direction of curvature determined by the vector directions. *Figure 3.*

The amount of Lorentz force is given by the expression: F equals q(V.B.)
Where q is electron charge
V is vector sum of average electron drift velocity (cm/sec)
B is vector sum of magnetic flux density (Gauss)

Graphically the Hall Effect is shown in *Figure 3,* where diagram (A) shows electron flow in the absence of any external forces. Application of a magnetic field causes Lorentz forces to curve the path of the electron flow as shown in (B). This attempt at curvature causes a build up of charges at a position perpendicular to the original direction of electron flow with a corresponding build up of 'holes' on the opposite side.

Eventually the force applied by the Hall Voltage equals the Lorentz force and the electron flow reaches a state of equilibrium as shown in (C).

Since the force generated by the Hall Voltage is equal to qE, where E is the electric field strength in volts/cm then:

$$qE = q\,(V.B.)$$

As V and B are vector quantities, we can simplify them to a single vector - and by taking electrostatic consideration into account, we can now generate a basic equation for the Hall Voltage (VH):

$$VH = \frac{IB}{nqt}$$

For a given material, 1/nq is a constant, so the equation can be further simplified i.e.

$$K = \frac{IB}{VT}$$

Where I is the Hall Cell Current
B is the Flux Density
T is the Thickness
V is the Hall Voltage

From this it can be seen that the Hall Voltage is directly proportional to the product of the Flux Density and the Hall Cell current. If we now drive the Hall Cell from a constant current source, we have a device that gives an output voltage that is linearly dependent on the applied Flux Density.

The original Semiconductor Hall Cells used exotic materials such as Gallium Arsenide and Indium-Antimonide - but they suffered from several drawbacks, the most severe being their poor thermal characteristics. Silicon is very much more thermally stable, but has a lower output voltage. However, since it is a material that is commonly used in integrated circuit fabrication, the lack of sensitivity can be offset by integrating the Hall Cell with an amplifier. An example of this is shown in the photograph of *Figure 4.*

Application of Hall Effect Switches

As previously mentioned, many of the devices available today are integrated with Schmidtt Triggers (such as the Sprague UGN3000 Series). This enables them to be used as self-contained solid state magnetic switches, resulting in a device that does not suffer from the drawbacks of mechanical or electro-mechanical units (e.g. reed switches). The most common failing of a mechanical contacting system is contact bounce *(Figure 5)* with wearing of contacts often due to pitting, making a close second. The Hall Effect gives entirely positive switching with no bounce.

Since it is solid state, the Hall Effect switch has almost indefinite life - with a switching speed of 15000 times a second. This adds up in terms of economics as well as theoretical elegance, which is always the final hurdle before science becomes translated into everyday technology.

Typical uses for Hall Effect Switches are:

1) Security Systems.

By using a Hall Effect device and associated magnet, opening (or closing) a door will cause the Hall Effect output to change state and trigger a warning or alarm. By the addition of a line monitor, protection against cutting of sensor lines can be provided. A typical example of such a system is shown in *Figure 6.*

The ULN2401 from Sprague was originally designed for automotive lamp monitoring. The circuit utilises the fact that the wiring between generator and lamps on an automobile have a finite voltage drop, (usually of the order of 70mV). If a filament goes 'open circuit', this voltage drop disappears, and the ULN2401 circuit output goes 'low'. In this application, the voltage drop is provided by the resistors in the power supply leads to the Hall Effect devices.

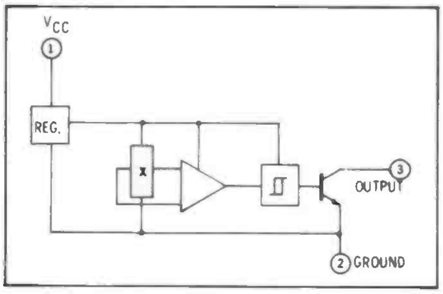
2) Solid State Ignition

The standard system of ignition coil and contactor (distributor) in a petrol engine has many drawbacks - ranging from sensitivity to climate, to wear and tear leading to the need for constant realignment. By fitting an electronic ignition system, most of these problems are overcome - and the use of a Hall Effect device and a magnet in place of the usual contact breaker system can enhance such a system.

The 'positive' switching and readily interfaced output will improve and simplify the electronics required. By feeding the Hall Effect output to a pulse counting circuit, an electronic tachometer is immediately available.

3) Keyboards.

By 'matrixing', it is possible to make a positive action keyboard unit for computers, telex, typewriters etc. Although the initial outlay is high, this type of keyboard will be cheaper in the long term since the Hall Effect has no contacts to pit or wear, and will considerably reduce maintenance costs and 'hardware' errors during data entry.



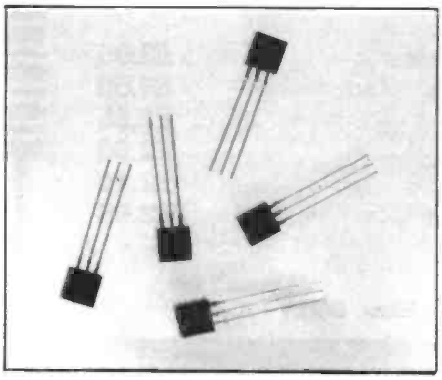


Figure 2: Sprague types UGN013T and UGN3501T.

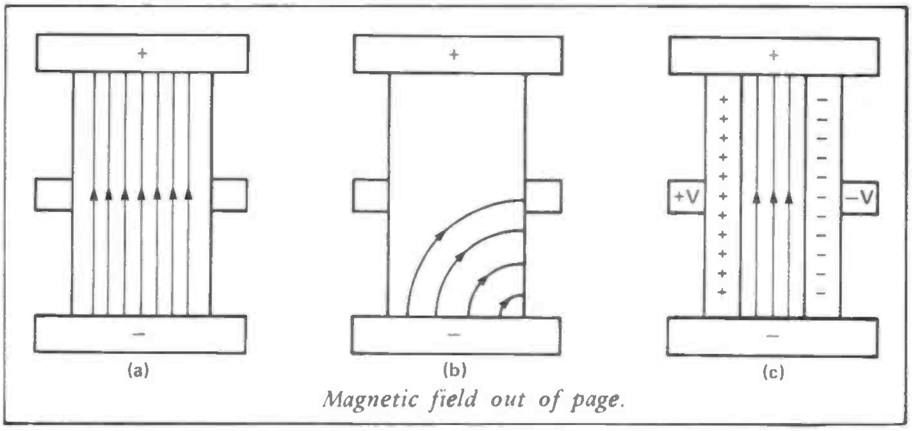


Figure 3:

The basic theory of the Hall Effect is an application of Lorentz forces. A charge travelling through a magnetic field follows a curved path - and the amount of curvature is proportional to the current and magnetic field strength with the direction of curvature determined by the vector directions.

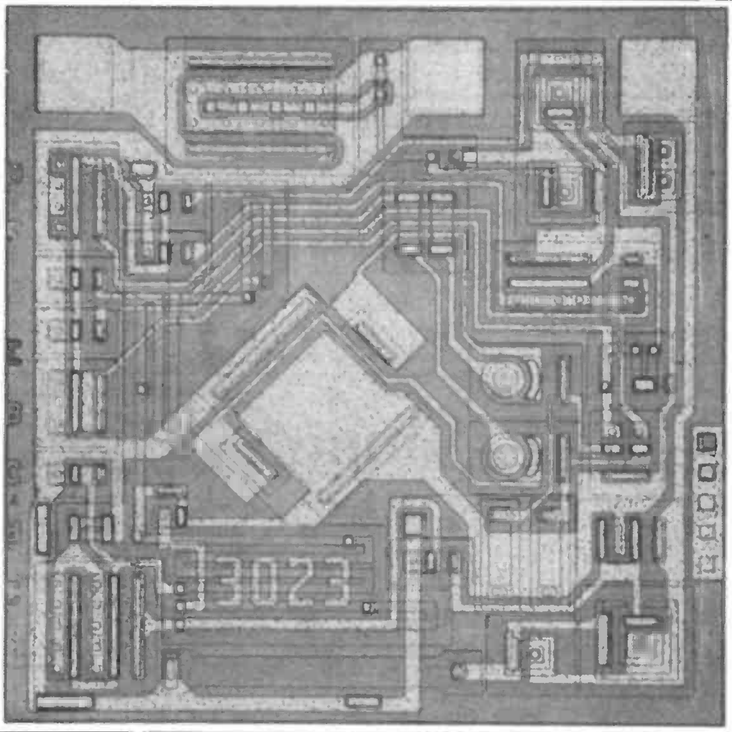


Figure 4:

However, since it is a material that is commonly used in integrated circuit fabrication, the lack of sensitivity can be offset by integrating the Hall Cell with an amplifier. An example of this is shown in the photograph of Figure 4.

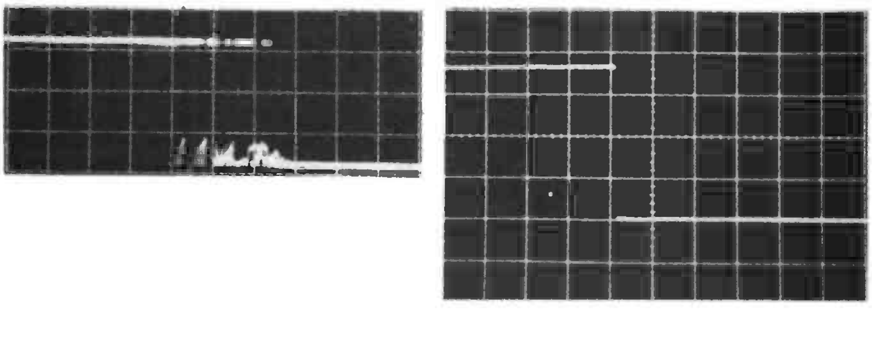


Figure 5:

The most common failing of a mechanical contacting system is contact bounce (Figure 5) with wearing of contacts often due to pitting, making a close second.

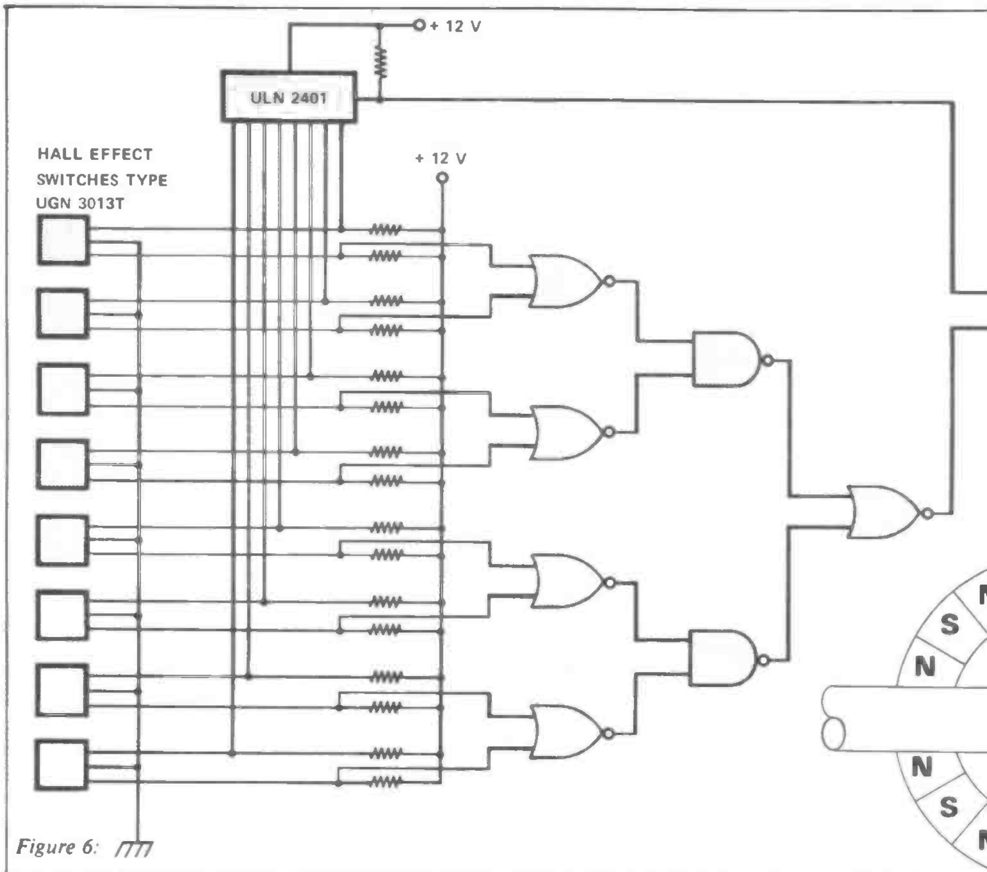


Figure 6:
By using a Hall Effect device and associated magnet - opening (or closing) a door will cause the Hall Effect output to change state and trigger a warning or alarm. By the addition of a line monitor, protection against cutting of sensor lines can be provided.

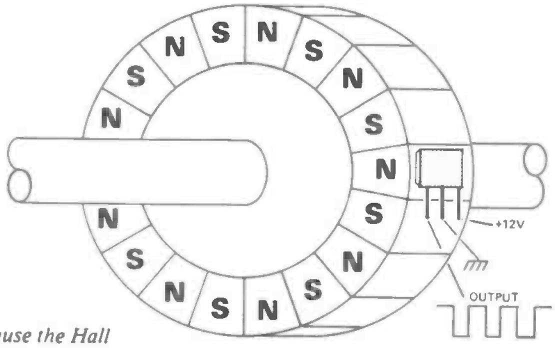


Figure 7 : Shaft encoding

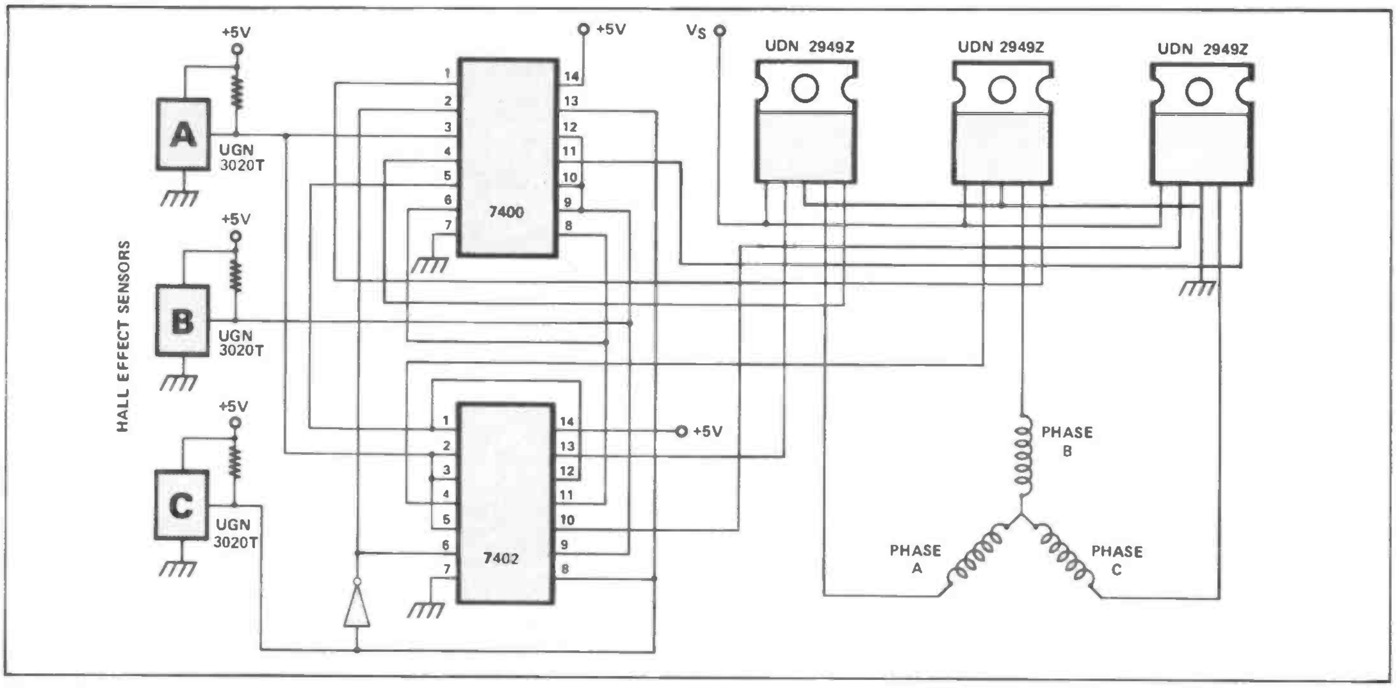


Figure 8:

An extension of the above concept would enable the construction of a brushless DC motor which has the obvious advantage of never requiring replacement of the carbon brushes usually fitted to DC motors. A suitable circuit for this is shown in Figure 8.

4) Speed Control.

If a ring of magnets is placed on the shaft of a motor or gear box with a Hall Effect switch placed in close proximity *Figure 7,* the result will be a string of pulses with pulse repetition rate (PRF) dependent on shaft speed. If these pulses are fed to a comparator, via a frequency to voltage converter, the resultant output can be used to control the motor speed. Such a system would be employed on high grade record and tape decks - and other applications where constant speed is essential.

An extension of the above concept would enable the construction of a brushless DC motor which has the obvious advantage of never requiring replacement of the carbon brushes usually fitted to DC motors. A suitable circuit for this is shown in *Figure 8.*

Applications of the Linear Hall Effects

So far, these applications have been for Hall Effect 'switches' - but the Hall Effect is essentially a linear phenomenon (proportional to some aspect of the external agency producing the effect) and thus it is available as such, both with and without integrated amplifiers.

1) Gaussmeter.

A very simple and effective gaussmeter circuit is shown in *Figure 9.* The device used gives an output that is linear over the range of 2.3v to 4.9v for a flux density of —2000 Gauss to +2000 Gauss. Reference to the manufacturer's data sheet shows that the mean output of 3.6v can vary anywhere between 2.5v and 5v. However, the preset 'zero' will provide sufficient adjustment to compensate for this. Similarly the sensitivity preset will have to be set using a calibration source to allow for production tolerances in the Hall device manufacture.

Without calibration, the circuit gives a very convincing demonstration model for the Hall Effect - and if you happen to be studying or teaching electronics and physics, a demonstration of the theory using this circuit is far more enlightening and interesting than setting out to prove Ohm's Law for the ninth time!!

2) Position Indicator.

By using the previous circuit with a moveable magnet, the meter can be calibrated for deviation from a mean position.

3) Ferrous Metal Sensor.

Using the circuit of item 1 again, but with a bias magnet fixed to the reverse face of the Hall Effect device, will provide an indication if the material placed on its front face has any ferrous content. The amount of the indication will be dependent on the percentage of ferrous material present. This unit could be very useful if you suspect a second hand car of having holes in its bodywork filled by glass fibre. A quick run over the outside will provide a noticeable drop in reading wherever this has been done, despite the presence of paint, dirt etc. (Who dares suggest **R&EW** isn't anything but informative and useful??)

4) Telephone Monitoring.

If a Hall Effect device is placed in close proximity (or even fixed to) the transformer inside a telephone and AC coupled to an amplifier or tape recorder, it is possible to monitor any conversation made on that telephone. It has the advantage that no actual connection is required, and so will not disturb the operation of the unit. (Shades of Watergate.)

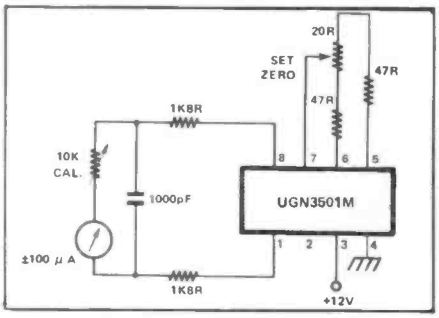


Figure 9: A simple Gaussmeter

Conclusions

This article can do no more than show a few examples of the multitudinous applications of Hall Effect - both for industrial, commercial and 'experimental' usage. **R&EW's** usual offer of feature sponsorship stands for any readers inspired with an idea or application that would be worth investigating in print.

Acknowledgements

Thanks to Sprague Electric (UK) Ltd for copies of application notes TP71-11 (magnetically activated monolithic integrated circuits for analogue and digital applications - by R.A. Anselmo and M.H. Oppenheimer) and TP71-12 (An IC form Hall Effect device can take on many new applications - by M.U. Oppenheimer), also the assistance given by Lance Fowler in the Geneva headquarters of Sprague, who have the singular presence of mind to employ the author, and the patience to answer many of the queries he raised.

(The Author is with Sprague Electric) ■

Your Reactions.........	Circle No.
Immediately Applicable	294
Useful & Informative	295
Not Applicable	296
Comments	297

The DFCM500

— A Combined 8 Digit Frequency and Capacitance Meter for Mains or Ni-Cad Battery Operation

— by A.L. Bailey

Part 2

Power Supply *(Figure 5)*

The +5v supply required to power the instrument is derived from a standard 3 terminal regulator, IC13 (7805), which stabilises the smoothed DC voltage from transformer T1 and its associated rectifiers, D9-D12, smoothed by C34. The two capacitors at the input and output of the IC prevent high frequency oscillations.

The unregulated DC voltage also powers the charger, IC14, another 3 terminal regulator type 78L05 this time configured in constant current mode. R58 sets the output current and in this case to 45mA, suitable for continuous charging of AA size ni-cad batteries, eight of which are used to give +10v, which is fed back to the output side of the recifiers when selected by the switch bank (the charger is of course disconnected under these conditions to prevent the battery charging itself!).

There are two modes under which the battery pack may be charged. Depression of both the AC power button and the battery select button allows full charge mode, disconnecting all other loads from the power supply. This allows the unregulated supply to rise to its full voltage, at which point there is sufficient excess voltage at the input of IC14 to ensure that it acts as a constant current source at 45mA. At this charge rate, the battery pack will be fully charged from a discharged state in 14 hours, but may be left for much longer periods without sustaining any damage or producing gas. During the full charge rate, both the AC and DC status LED's are illuminated to show this charge mode has been selected, with the display blank.

The battery pack is also charged at all times when the mains supply is switched on and the instrument in use. However, as the unregulated supply is then on load and at a lower voltage, IC14 no longer acts as a constant current source and the charge rate drops to between 1 and 10mA depending on the mains +5v current loading at any time. This allows the battery pack to be continually 'topped up'. Diode D13 prevents the battery pack discharging into the charging circuit under certain conditions, and FS2 is provided in case of circuit malfunction to prevent the battery being overcharged.

If the battery pack is installed, it is worthwhile occasionally removing the cells from their holders and discharging each cell **separately** down to 0.5v through a 0.5 ohm 5-10 watt resistor. This ensures that the cells do not slowly retain a 'memory' which will prevent efficient discharge and recharge cycles. **Never** discharge cells at this high rate connected in series, as permanent damage may occur, the cells becoming reverse charged, or even worse, reverse polarised. The normal maximum discharge rate for AA size cells is 500mA.

IC13 is provided with a heatsink which must not be omitted.

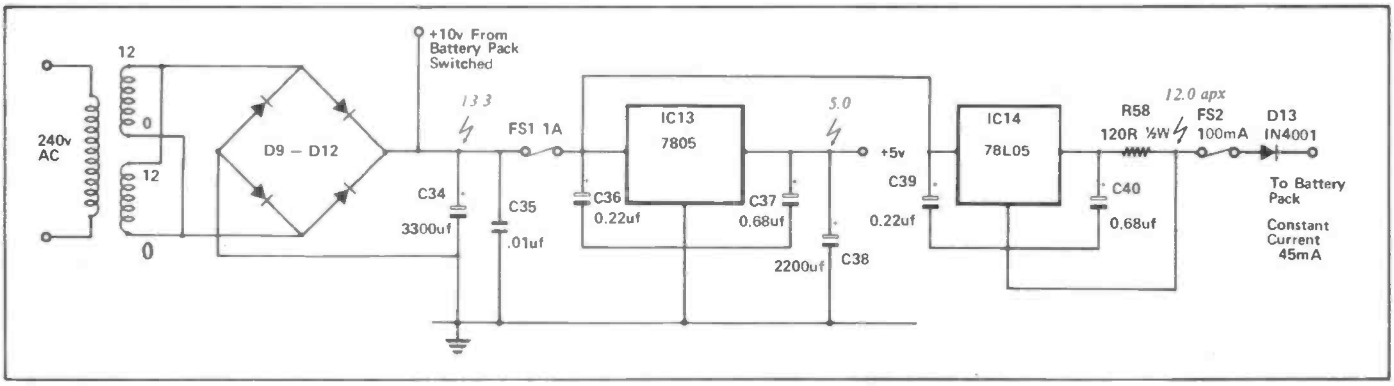


Figure 5: Power supply circuit diagram.

Construction

This section is reasonably detailed for the benefit of the less experienced constructor. Those with more experience can skip over many of the points raised, only following the rough order of assembly.

Essential tools are a modern, small bit soldering iron (1/8 inch diameter tip) 60/40 multicore solder (on no account use anything else for this type of work) and a pair of small sidecutters.

Constructors are advised to purchase the set of pcb's from the kit suppliers since they come ready drilled, tinned and with all the component positions screened on, unless they have access to facilities for photographic reproduction. They can be copied **with care** using a fine tipped etch resist marking pen (the one sold by Tandy is recommended) onto copper clad fibreglass board, and then etched in ferric chloride.

General points to note:

1. Virtually all resistors which are horizontally mounted have 10mm lead spacing. Gentle bending of the leads at right angles to the body will achieve this. (¼w-⅓w types).
2. Keep lead lengths as short as possible, but without damaging the components. This applies especially to circuits carrying RF signals.
3. Good solder joints are essential. **Never** carry the solder to the joint on the iron. Always hold the iron to the joint, then apply the solder to both, and never move the joint until the solder has solidified (1-2 seconds). A good joint is always bright and shiny.
4. Watch that semiconductors and polarised capacitors are inserted the correct way round as shown in the layout diagrams. IC's have either (or both) a notch at the Pin 1 end, or a small circular depression adjacent to Pin 1.

Display pcb *(Figures 6, 7 & 8)*

This holds the 8 LED displays in individual sockets, and the status LED's, and 32 pins to mate with the socket on the driver pcb.

1) Insert and solder the 4 resistors on the side of the pcb with the least tracks.

2) Using the excess wire clipped from the resistors, insert a short piece of wire into each of the holes marked **O**, soldering each

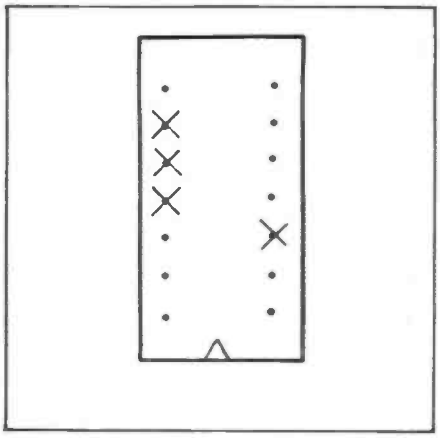


Figure 9: Modifications to LED Sockets, viewed from underside.

side of the pcb. Clip off the leads close to the pcb on each side.

3) Prepare the eight 14 pin IC sockets by clipping off the pins close to the underside of each socket as shown in *Figure 9.* Insert and solder each socket into place taking great care not to short the lower pads to the tracks running between them.

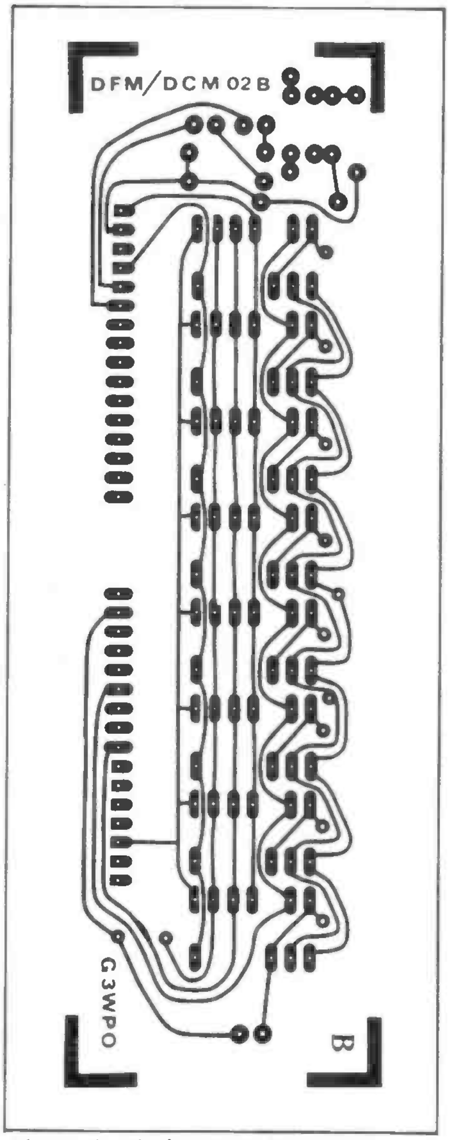


Figure 6: Display PCB Foil Pattern-Underside.

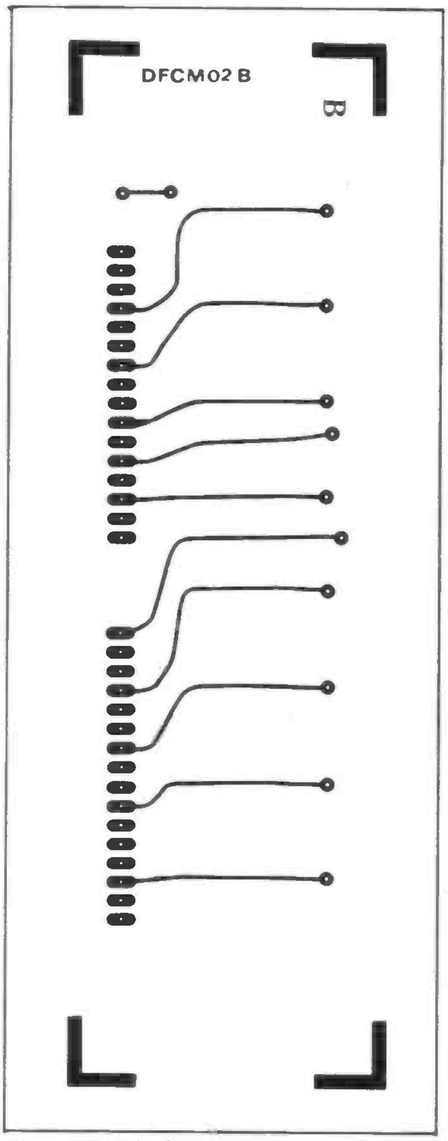


Figure 7: Display PCB Foil Pattern-Upperside.

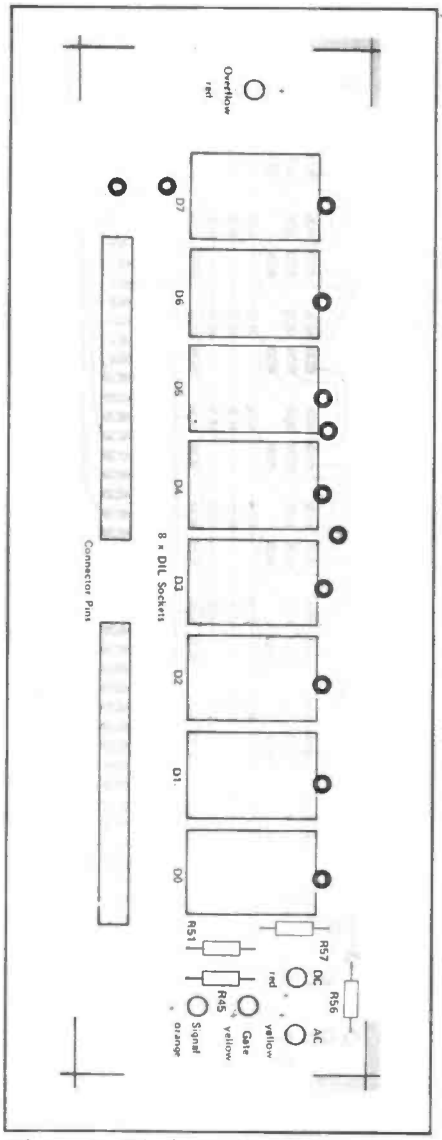


Figure 8: Display PCB Component Overlay.

4) Insert the shorter leads of the straight part of the Molex connectors into the row of pads along the bottom edge of the board, from the rear (non-socket) side of the pcb. Solder each pin to the pads on the front of the pcb. Now carefully prise off the plastic spacing strips from the connectors and solder each pin to the pads on the other side of the board.

5) Insert the LED's into their correct holes (the longer lead on each LED is marked as +ve on the layout). Leave 13mm of lead between the rear face of the LED and the front face of the PCB. Then solder the leads to the pads. Do not cut off the excess leads until the PCB is finally mounted in the case as they may need to be moved to be flush with the front panel.

This completes this PCB for the present.

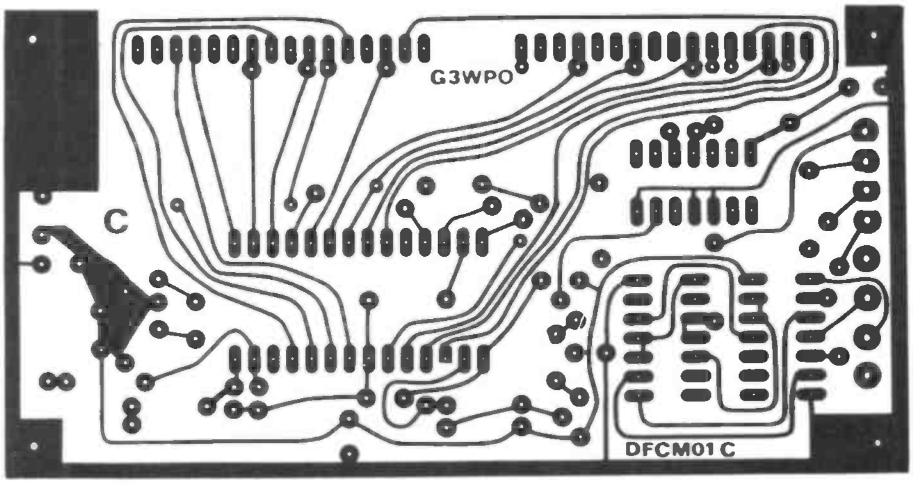


Figure 10: Driver PCB Foil Pattern - Underside.

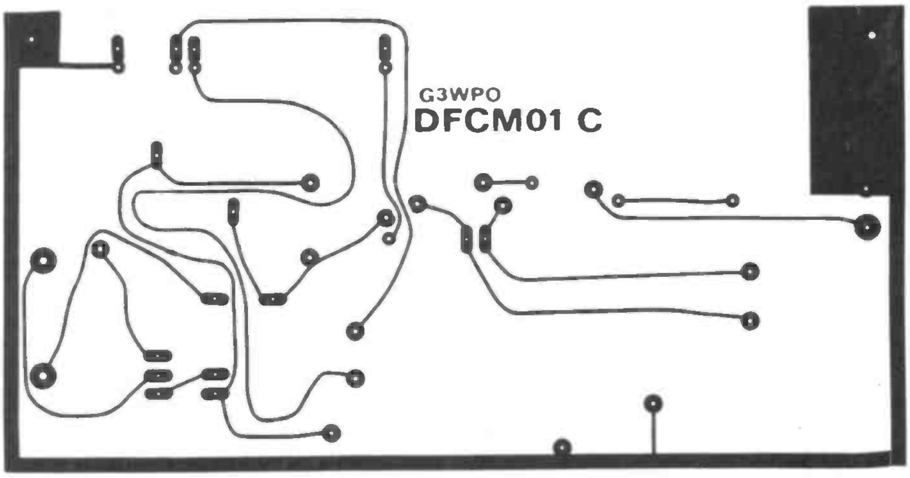


Figure 11: Driver PCB Foil Pattern - Upperside.

Driver PCB (Figures 10, 11, 12)

This accommodates the 7216C, and the switching and pulse stretching circuits. The underside of the PCB is the side with the post tracks on. Components sometimes have pads on both sides of the lead and must be soldered.

1) Insert and solder all resistors. If the socket for IC11 (28 pin) has an open centre, R55 should be mounted on top of the PCB, otherwise underneath.

2) As for (2) in the display PCB section, solder wires into all the holes marked **O**.

3) Push a connection pin into each of the holes marked **O**, from the underside of the PCB, using a hard object to get each one home. Solder.

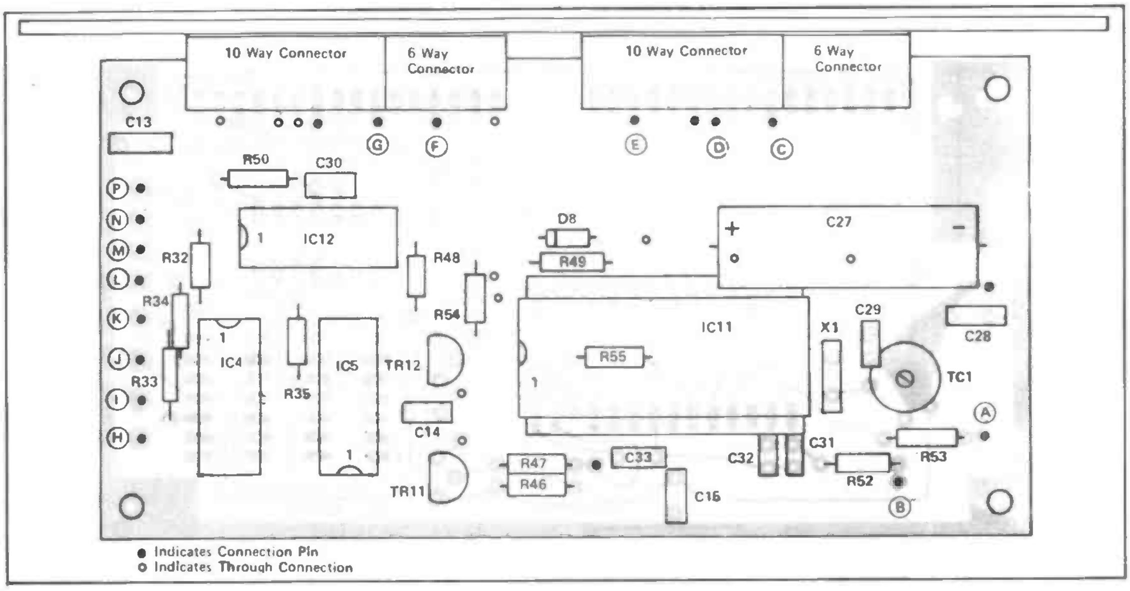


Figure 12: Driver PCB Component Overlay.

4) Insert and solder all fixed capacitors except electrolytic C27.

5) Insert and solder D8, ensuring correct orientation.

6) Insert and solder the 28 pin IC for IC11, with the notch agreeing with the notch position on the layout.

7) Insert and solder C27, ensuring correct polarity.

8) Insert TC1 so that the leads just protrude from the underside of the pcb by 1mm. Carefully solder the top centre lead to the pad on the top of the pcb taking care not to melt the plastic surround, then solder the underside.

9) Insert the 10MHz crystal with the base of the can 2mm above the pcb surface so as not to short out the tracks running underneath. Solder.

10) Snap the angled Molex connectors into place along the front edge of the pcb making sure that the retaining lugs are firmly under the pcb. Pins should be soldered on the underside of the pcb only.

11) Insert IC's 4, 5 and 12 ensuring correct orientation of each. Solder all pins on the underside, then those pins on the top which have pads visible.

12) Insert Tr11 and 12, and solder into place.

13) Carefully place IC11 in its socket, with the notch agreeing with that on the socket, check that all the pins are aligned inside the holder and then press down firmly at the centre until the IC snaps into place.

This completes this pcb.

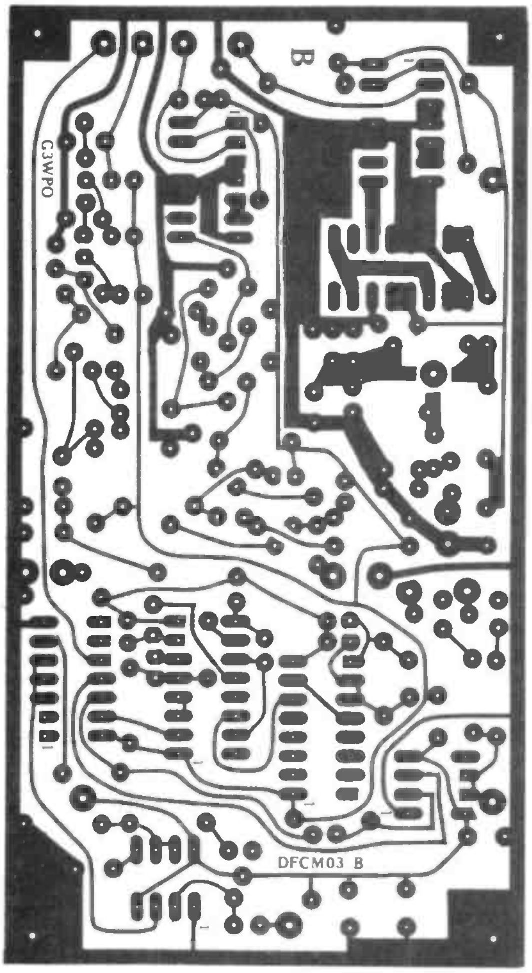


Figure 13: Preamplifier/Capacitance measure PCB Foil Pattern - Underside.

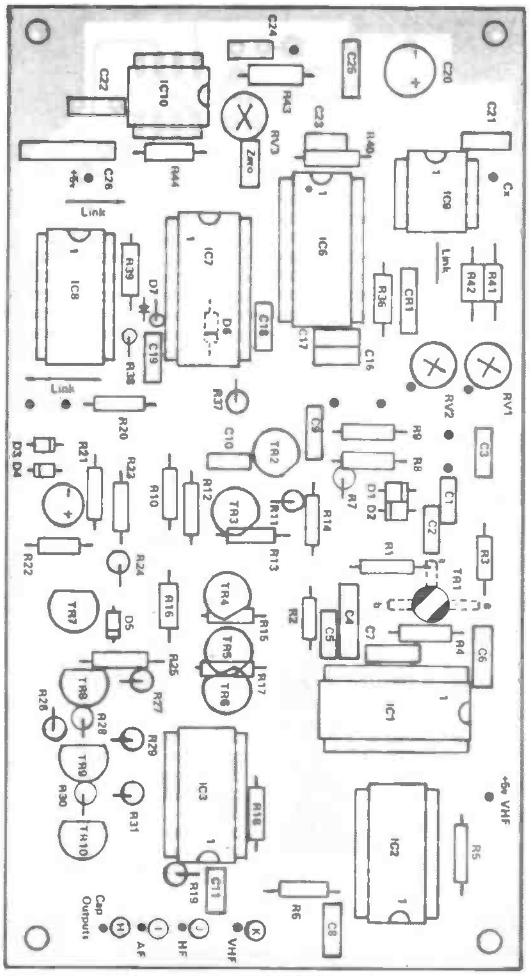


Figure 14: Preamplifier/Capacitance measure Component Overlay.

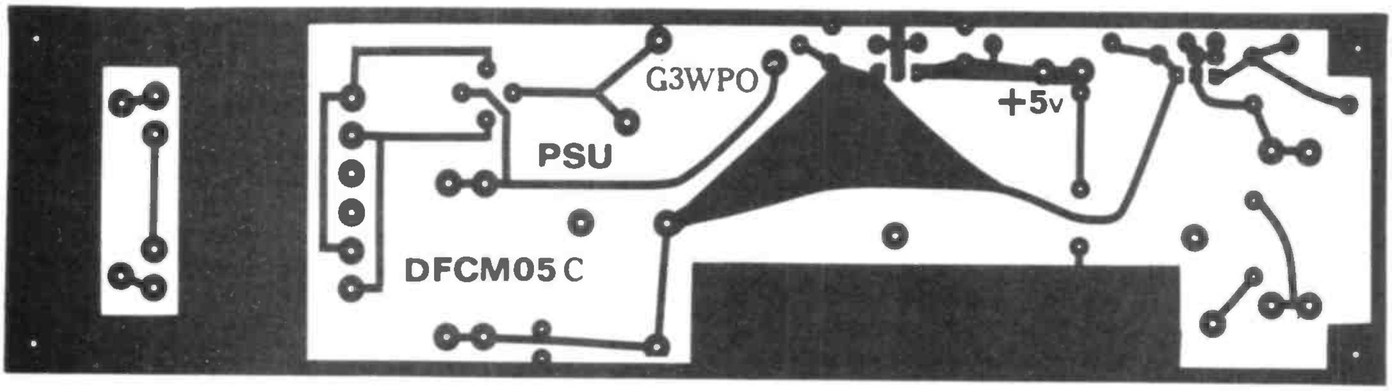
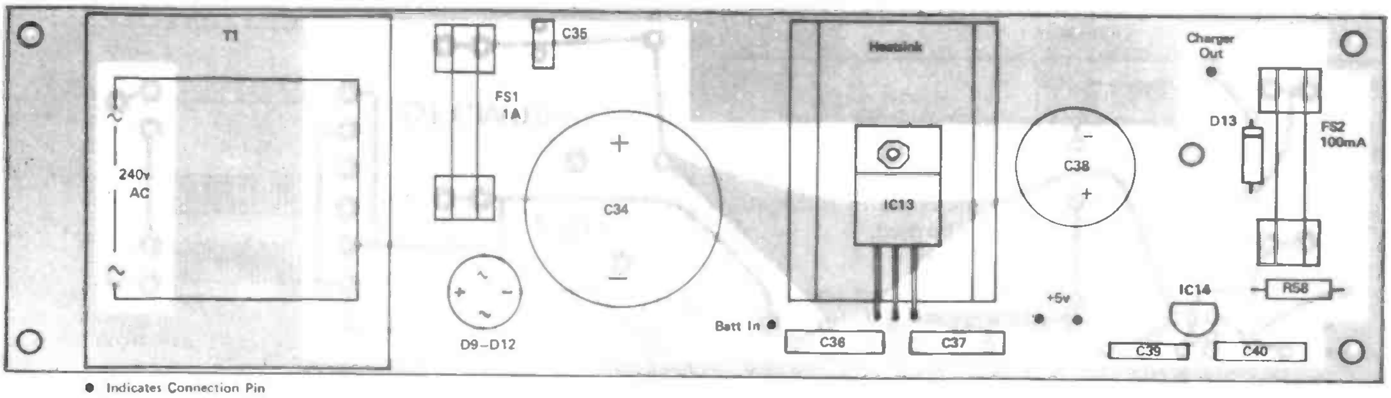


Figure 15: Power Supply PCB Foil Pattern.



● Indicates Connection Pin

Figure 16: Power Supply PCB Component Overlay.

Component Listing

R1	100R
R2,8,9,45,51,56	470R
R3,25	150R
R4,12	680R
R5,18,48	3k9
R6,19,28,30,31,32, 33,34,35,50	1k
R7,37,38	2k2
R10	27R
R11,26	4k7
R13	1k2
R14	10R
R15	1k5
R16	270R
R17	33R
R20	330R
R21,46,55	100k
R22	18k
R23,39	5k6
R24	12k
R27,29,52,53,54	10k
R36	1M0
R40,43	27k
R41	830k Metox
R42	470R Metox
R44	220k Metox
R47	22k
R49	10M
R57	220R
R58	120R 0.5W
RV1,3	100k ALPS cermet preset H0621
RV2	2k2 ALPS cermet preset H0621
C1,2,3,7,8,11,13,14, 15,21,22,25,28,30,35	.01uF disc ceramic
C4	47pF disc ceramic
C5	0.1uF disc ceramic
C6,9,10	1000pF disc ceramic
C12	4.7uF 10v electrolytic
C16,C17	82pF
C18,19,23,24	330pF disc ceramic
C20	100uF 10v radial electrolytic
C26	100pF polystyrene 50v
C27	1000uF 10v axial electrolytic
C29	39pF disc ceramic
C31,32,33	68pF disc ceramic
C34	3300uF 16v radial electrolytic
C36,39	0.22uF polyester
C37,40	0.68uF polyester or tantalum
C38	220uF 10v radial electrolytic
TC1	5-60pF film dielectric trimmer
CR1	TOKO 500kHz ceramic resonator CRM500A
X1	10.000MHz HC18-U 3rd ovt. crystal
D1,2,3,4,5,6,7,8	1N4148, 1N914
D9-D12	Bridge rectifier type WO-005 50v 1A
D13,14	1N4001
TR1	BFW92
TR2,3,4,5,6	BF274
TR7,8,9,10,12	BC239, BC109
TR11	BC307
IC1	11C90
IC2,3	74196 (or 74S196 - see text)
IC4	74LS00
IC5	74LS10
IC6,7	4049UB
IC8	4023B
IC9,10	555
IC11	ICM7216C
IC12	74LS121
IC13	7805
IC14	78L05
T1	0-12, 0-12v 6vA type PO612
FS1	1A
FS2	100mA
SW1-5	ALPS SUE 4 pole c/o latching
SW6,7	ALPS SUE 4 pole c/o push-push
SW8	ALPS SUE mains switch with 2 pole c/o + 5 way latch bar and spring, 7 way bracket, eight 7.5mm round knobs.

Also required

2	BNC chassis mounting sockets and tags
1	Heat sink REW type 401-964
1	Centurion case type DX4
4	pcb mounting fuse clips
2	push connectors
1	chassis mounting mains plug and socket
2	4 x AA battery clips
2	PP9 battery clips
8	AA size ni-cad batteries
1	28 pin DIL sockets
2	8 pin DIL sockets
3	16 pin DIL sockets
11	14 pin DIL sockets
2	10 way Molex connectors
2	6 way Molex connectors
5	AEG flat face LED's 3mm dia 2 red, 2 yellow, 1 orange.
4	rubber feet
40	0.1 inch pcb connection pins
1	polarised filter size 113 x 30mm
8	7 segment LED's RH decimal point HP type 5082-7651

All of the above components are available together with the printed circuit boards, and all hardware from **R&EW**'s readers services department, or retailers stocking **R&EW** project kits.

DFCM500 Errata - Part 1

We apologise for these errors and any inconvenience caused as a result.

A) Although pin compatible, the alternative chips for the prescaler are not compatible with the actual PCB layout. The 11C90 is the only chip that can be used.

B) Figure 2b output to Pin 4 IC4 (not IC6).

C) *Figure 3* - Circuit Diagram - IC4 and IC5 part numbers should be transposed as should IC4a pins 9 & 10. C16 should read C13. Crystal X1 is 10MHz.

D) *Figure 4* C16 & C17 now read 82pF. Delete connection between Pin 1 IC10 and pins 3,4 & 5 IC8b. Waveforms shown at D6 & D7 should be inverted.

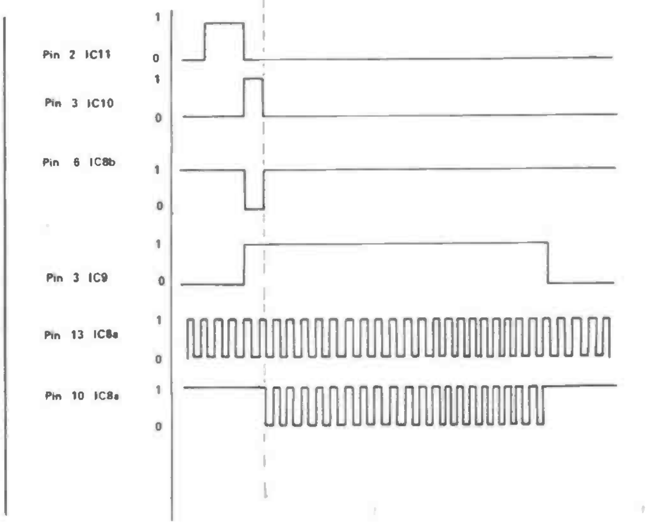


Figure 4b- Omitted from Part 1- Waveforms in the Capacitance Measuring Circuit.

Preamplifiers and Capacitance Measuring pcb *(Figures 13 & 14)*

Note that some resistors and diodes are mounted vertically on this pcb, and that all IC's have sockets.

1. Insert and solder the 14 connection pins in the same manner as for the driver pcb.
2. Insert and solder all fixed resistors. Note that R41/42/44 are close tolerance metal oxide types, coding as follows:

R41 = 830k (grey, orange, black, orange)
R42 = 470R (yellow, violet, black, black)
R44 = 220k (red, red, black, orange)

3. Insert and solder the 3 wire links, using surplus wire from the resistors, on the top of the pcb.
4. Insert all 7 IC sockets with the notches agreeing with the layout plan. Note that it is necessary to remove pin 12 on the sockets for IC2 and IC3 by clipping off the pin against the underside of each socket before inserting. Solder.
5. Insert and solder all capacitors. C12 and C20 are electrolytic and must be the correct way round.
6. Insert and solder D1-D7. D6 mounts on the track side of the pcb and D7 is vertically mounted. Ensure that the black line identifier on each diode is in the correct position.
7. Solder CR1 into place.
8. Solder VR1, 2 and 3 into position
9. Shorten the leads on TR1 (BFW92) to 5mm each. This transistor mounts on the track side of the pcb, with its body resting in the hole provided. The legend should face towards you looking at the track side. Solder each lead to the tracks.
10. Insert and solder the remaining transistors, keeping no more than 3-4mm of the lead above the pcb upper surface. All transistors have flats on the cases which should match the positions shown in *Figure 14*.
11. Carefully insert each of the IC's, making sure the pins are correctly located into their respective holders, with the notches agreeing with those on the holders, and press each firmly into place.

This completes this pcb.

Power Supply *(Figures 15 & 16)*

1. Insert and solder the 4 connection pins.
2. Insert and solder R58 and all capacitors. C36, 37, 39 and 40 have several hole options depending on the spacing of the capacitor pins. C34 is normally vertically mounting but holes are provided for horizontal mounting versions, make sure the polarity is correct.
3. Insert D13, and the bridge rectifier package (D9-12) with the +*ve* and -ve markings agreeing with the layout plan, and solder.
4. Insert the 4 fuse clips (open ends facing each other) and solder.
5. Insert IC14 and solder.
6. Insert IC13 into its holes, with the flat back of the package facing the 3mm fixing holes behind it. Carefully bend over the package so that the mounting hole is aligned with the pcb hole. Then remove the IC and if at all possible, smear some thermally conducting grease onto the back of the IC. Put the heatsink in place and insert a 0.5in. 6BA bolt through from the underside of the pcb. Reinsert IC13, and bolt down using a lockwasher and 6BA nut. Make sure that the IC leads are not touching the heatsink at the front, then solder into place.
7. Insert T1 into position against the pcb and solder all the pins.
8. Insert the 2 fuses into their respective holders.

All pcb's are now assembled and ready for initial testing.

Concluded next month with interconnecting wiring, testing and assembly. Details of the complete kit can be found on page 80.

Your Reactions.........	Circle No.
Immediately Applicable	275
Useful & Informative	276
Not Applicable	277
Comments	278

The Big Match; FRG7700 versus R1000

R&EW takes the lid off two popular HF receivers and finds out which one is best

The end of an era.

The beginning of the end of the classic *tracking* superhet receiver was apparent with the emergence of the Yaesu FRG7 and similar Wadley loop system receivers - the proof that the era is now completely past is offered by such receivers as the Yaesu FRG7700 and the Trio R1000. The concept of converting the incoming radio frequency up to an intermediate frequency well above the highest frequency likely to be received is not new - as with so many aspects of electronic technology, it just happens that recent advances in the price/performance ratio of the parts involved has changed the thinking of RF designers.

The similarity in the circuitry of the FRG7700 and the R1000 often leads a prospective purchaser to ask which one is best. Besides the handle on the R1000,

R1000 HF Receiver.

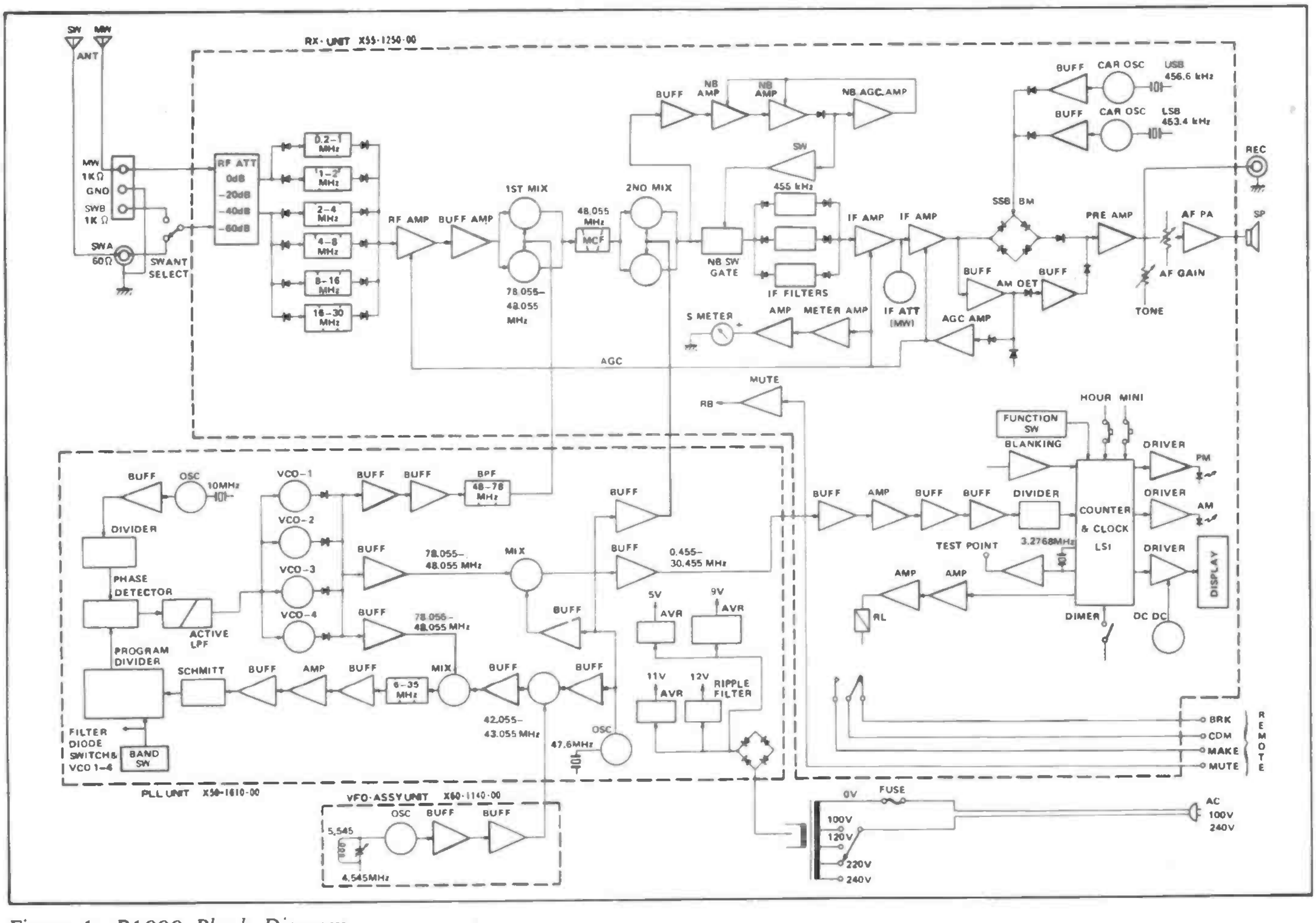
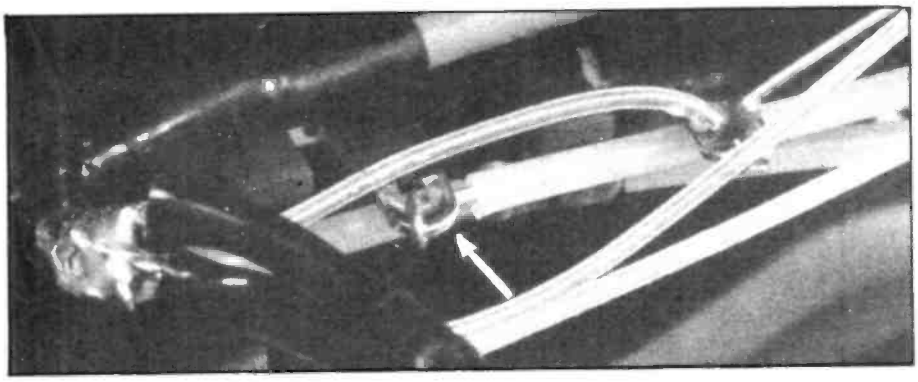


Figure 1: R1000 Block Diagram.



FRG7700: Detail of dry joint.

FRG7700 HF Receiver.

and the availability of the digital memory for the FRG7700, there isn't much to choose on the face of it. The usual clincher for the FRG7700 is the built-in NBFM modulator - but it is easy enough to fit one to the R1000, as will be seen in next month's round of the battle.

Both sets represent an extremely high level of achievement, although both sets contain approaches to design that have been superseded in many respects - such is the pace of this business. The analysis of these receivers gives us an opportunity of examining the state of the HF receiver art in some detail, so the reader is invited to retain an open mind as the philosophy behind the **R&EW** HF receiver begins to evolve.

First impressions

The R1000 is rather more tidily presented - the thoughtful layout of the rear panel and the general 'feel' of the receiver is slightly more confident than the FRG7700. The FRG7700 also had a dry joint *(see photo)* on one of the antenna connections. Tut, tut. There are those who find the carrying handle an unnecessary nuisance (in fact, we have yet to find anyone with a good word to say for it), but that's about all.

Both receivers are equally easy to operate. Simply switch on, select mode and bandwidth, dial up the requisite number of MHz, and wind in the 1MHz interpolation. Both receivers use a digital frequency display, supplemented by a

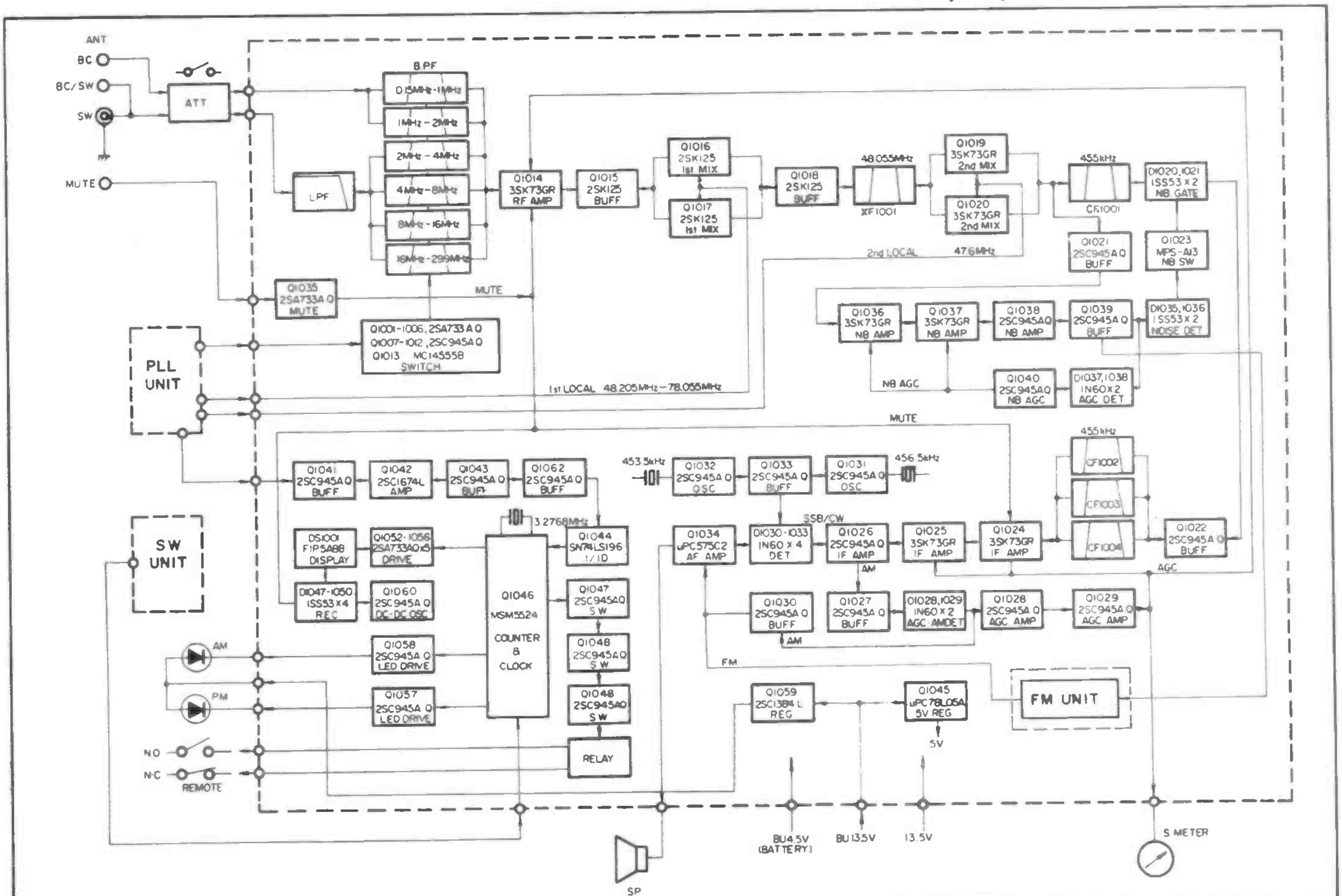


Figure 2a: FRG7700 Block Diagram.

Figure 2b: FRG7700 PLL Unit Block Diagram.

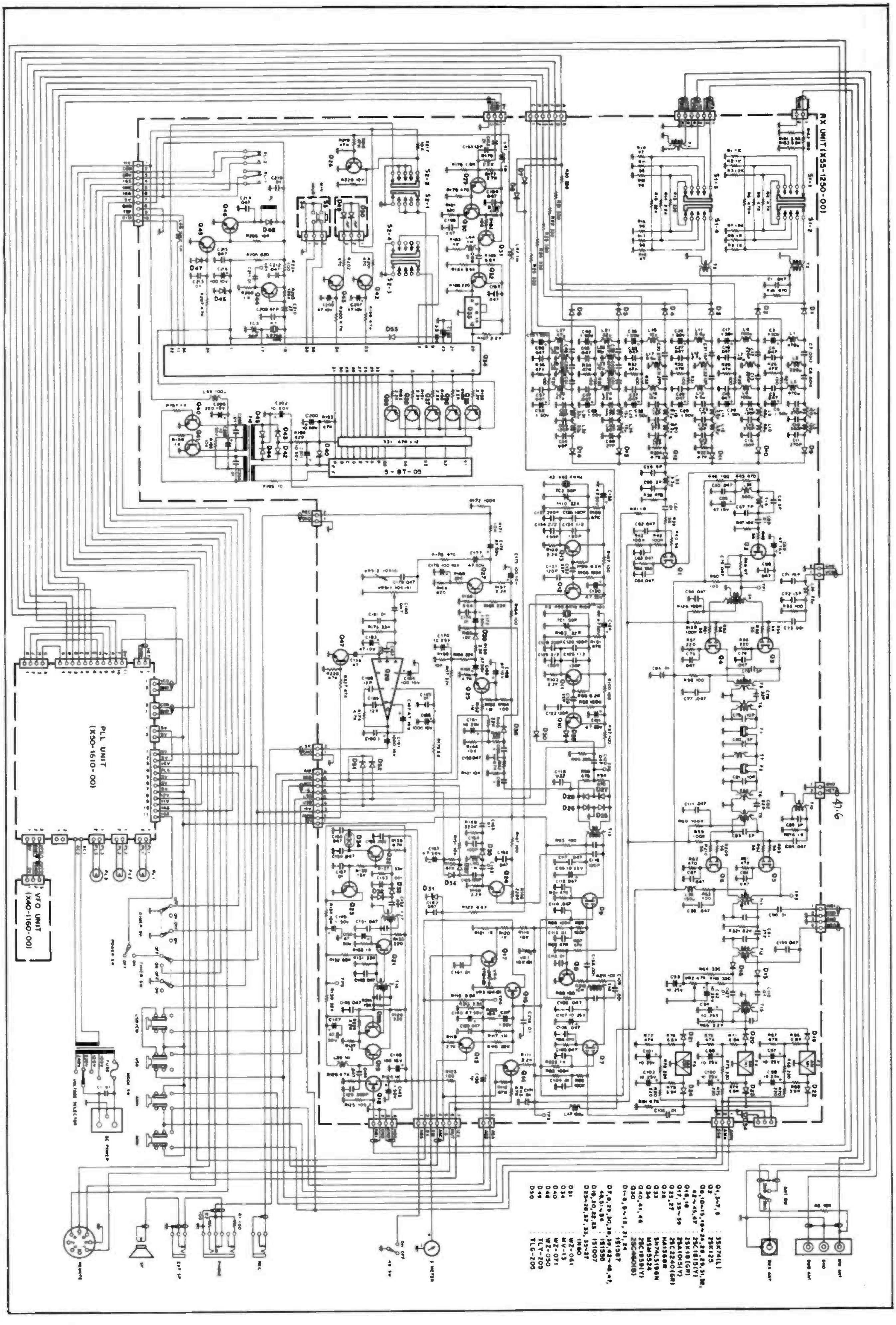


Figure 3: Circuit Diagram of the R1000.

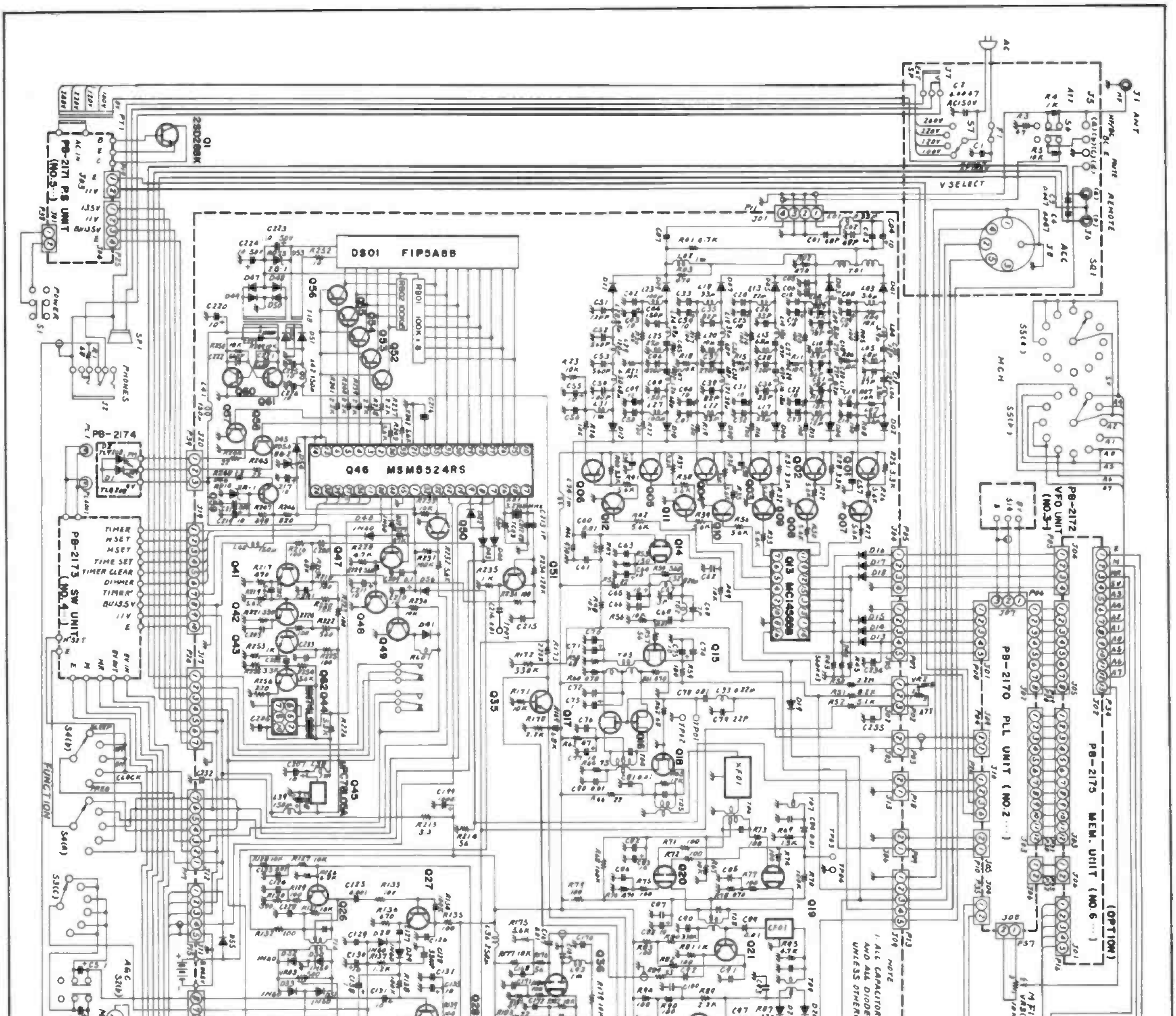
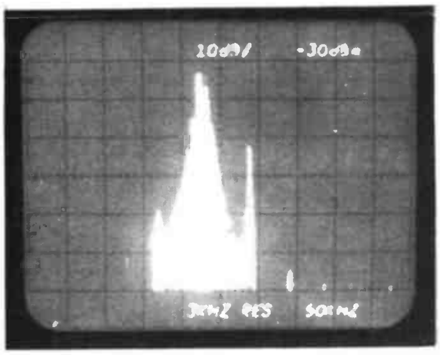
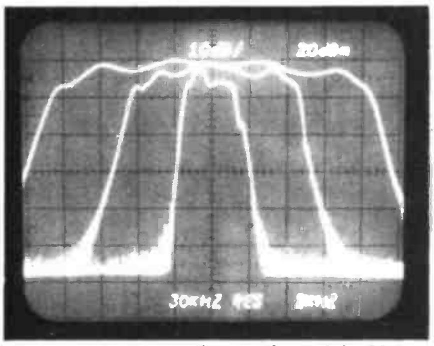


Figure 4: Circuit Diagram of the FRG7700.



R1000: 1st Filter Response (48.005MHz)



R1000: 2nd IF Filters 2kHz/Div Hor. 10dB Vertical/Div

10kHz calibrated dial. The adjustment clutch FRG7700 dial tended to slip a bit, but the function is really superfluous anyway. Maybe this was a 'Friday' night model we had bought.

The R1000 just *seemed* that little bi. nicer - possibly a function of the IF filter shapes available, but there really wasn't any discernible difference until the various IF sections were viewed more carefully.

The Block Diagrams

Comparisons of *Figures 1 and 2* will show that the signal path is identical in terms of frequency conversions and much else. The coils used in the FRG7700 bandpass filter were fixed 'chokes' as opposed to the adjustable shield coils of the R1000. Reference to the bandpass filter curves shows the R1000 has a marginal edge here - but nothing to worry about. The crosstalk between filter ranges was minimal, and the stray pickup from a hand brought alongside the input filter array, was only slight in the case of the FRG's unshielded array.

The space available in this issue does not permit a close analysis of the circuits of these two sets, although the next round will dive into the intricacies of the specific details of the circuits involved. Both sets use a dual gate MOSFET immediately after the octave filter, the FRG7700 uses the control gate for manual RF gain control (somewhat optimistically and grandiosely described as an attenuator), whereas the R1000 uses an accurate array of resistive attenuators switched by such a positive and chunky system that even erstwhile owners of classics like an AR88 would feel at home.

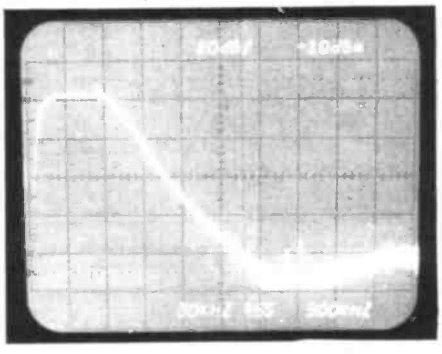
The FRG has a further switch on the rear panel marked 'DX' and 'LOCAL'. Without wishing to sound too rude, this switch seems like an afterthought for the benefit of owners who live alongside things like MW transmitters. To all intents and purposes, use of this function renders the set more than a trifle deaf - although it may be handy if you are setting up a transmitter in the vicinity, and need to listen to the audio quality.

At about this point in the circuit, both sets remember to include low pass filtering (i.e. to keep out everything above 30MHz) - which if bypassed, turns either set into an excellent 96-126MHz receiver. A FET buffer leads onto the first mixer: which is a balanced JFET array in the FRG, and a balanced MOSFET array in the R1000. Both seem more than just a bit good, and make early attempts at mixing with bipolar devices look decidedly primitive. Another FET buffer in the FRG feeds the first filter at 48.055MHz, and the R1000 begins to slip here since the filter is fed directly from the mixer output.

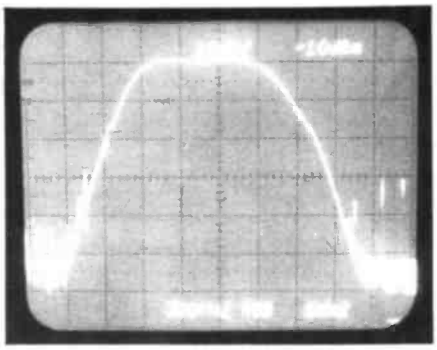
In fact, the FRG7700 throws quite a few more devices into the works overall, some are there to take into account the functions required by the memory option - and some are there - like this FET....

This is an opportune moment to pause and consider the views on the analyser around the first filter. The FRG filter has a delightful passband and none of the spurs that usually characterise high frequency monolithics. We weren't able to dissect the filter at length, but judging by the response, we suspect that it must be non-monolithic in nature. The stopband wasn't so hot, however.

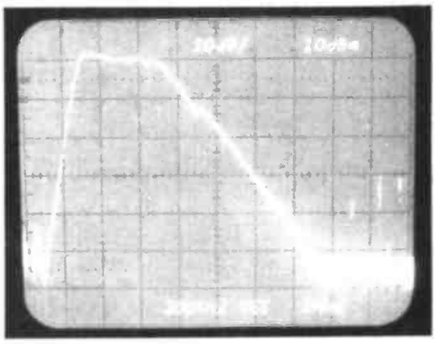
The R1000 displayed a superbly typical spur on the HF section of the bandpass, with an excellent stopband. This was probably due to the elongated nature of the layout of the filter, which was basically strung across the board in a line from first mixer to second mixer, taking into account the improved in/out isolation. The presence of the HF spur is not necessarily a problem at this stage of a receiver of this type. It would have been nice to have the FRG's response with the R1000's stopband - but the R1000's spur was well removed from the image point of the first IF, and so went unnoticed after the 455kHz filters had done their bit. The only potential danger being the presence of a large signal in the peak of the spur that would compromise the second mixer. The chances are, however, that such a signal would have already overloaded the first mixer anyway.



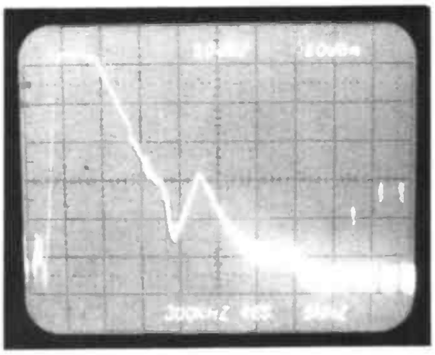
R1000: Modified 1st Octave Filter Response. 0Hz left screen.



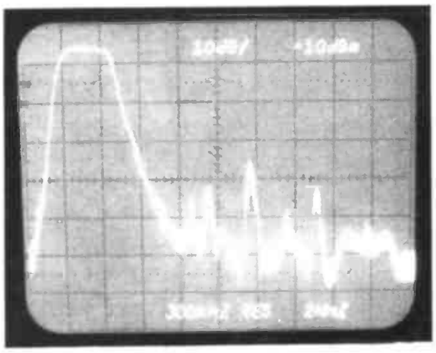
R1000: 15 - 30MHz BPF



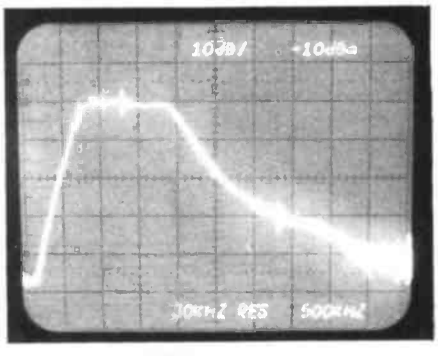
R1000: 8 - 15MHz BPF



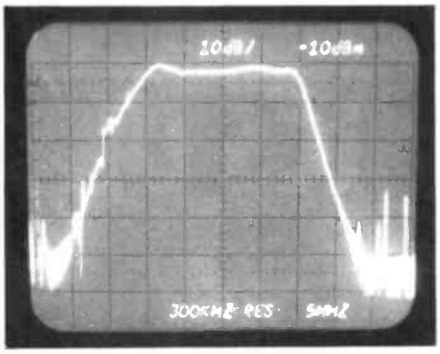
R1000: 4 - 8MHz.



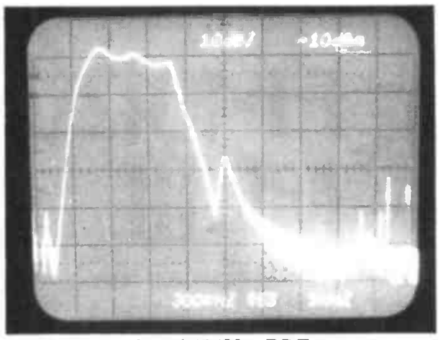
R1000: 2 - 4MHz



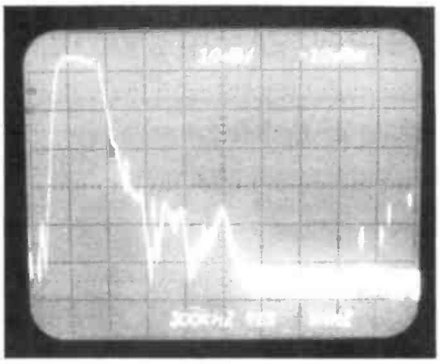
R1000: 1 - 2MHz



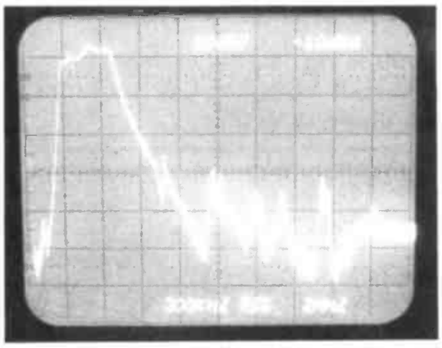
FRG7700: 15 - 30MHz BPF



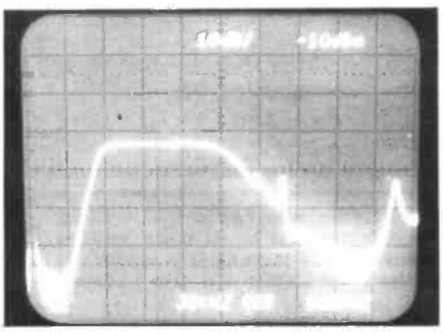
FRG7700: 8 - 15MHz BPF



FRG7700: 4 - 8MHz



FRG7700: 2 - 4MHz



FRG7700: 1 - 2MHz

The 2nd IF

Moving on past the second mixer (dual gate FETs for both) the FRG lobs in a broad ceramic 'roofing' filter before the noise gate. The filter is insufficiently broad to avoid stretching impulsive noise spikes (watch further instalments for the mechanics of the noise blanker), and possibly provides a modicum of signal delay in order that the blanking gate can catch the noise pulse before it's too late. The noise blanking receiver sections in both the R1000 and the FRG are works of art in their own right, although this is arguably an ideal place to fit an IC such as the HA1197 or similar AM receiver subsystem, and thereby save a lot of extra space and time.

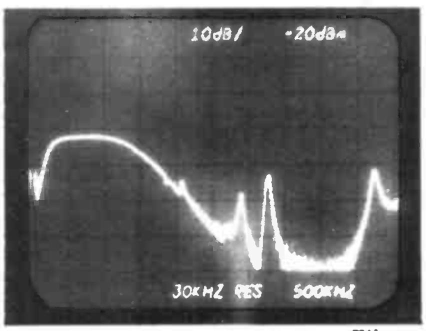
Despite not having the delay path of a ceramic filter, the R1000 noise blanker is marginally more effective. Yaesu find room for yet another transistor before the 455kHz filter block.

The displayed responses show that despite differences 'upstream', both sets show a remarkable similarity at the point immediately after the filter. The generator input level and analyser display levels are the same for both, although the FRG allows the narrowest filter to be used on AM, as well as SSB. The R1000 doesn't quite get its act fully together here, but since the SSB filter on the R1000 is basically just a bit narrower, listening to AM is rather fatiguing. The R1000 SSB filter is just that little bit better.

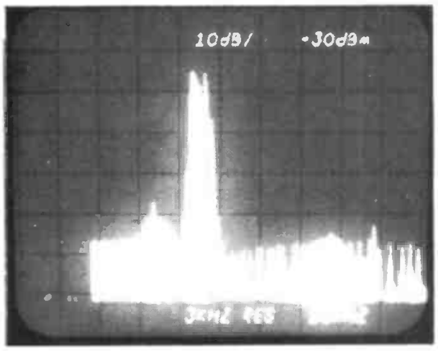
Up to the audio stage

Two more MOSFETs, and then they both pile into the various AM, AGC and SSB detectors. The FRG (you've guessed) finds room for one more transistor!

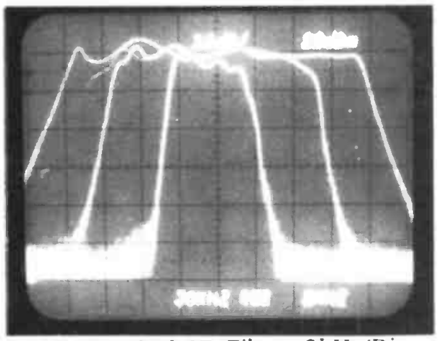
HF design purists may pale at the prospect of so much gain ahead of the various stages of selectivity in both receivers - but unless the operating conditions are *extreme* then neither receiver is bothered by it. In fact, this tends to highlight a fact which frequently gets overlooked in HF receiver thinking - namely that you hear just as much on a small *active* antenna as you can on a large external array primarily intended for transmitted efficiency. A steerable beam antenna has merit in that interfering signals can be *nulled* or lessened, but there is precious little apparent difference for the listener with 200 feet of antenna, or 20 feet of antenna.



FRG7700: 1st Octave Filter



FRG7700: 1st Filter Response (48.005MHz)



FRG7700: 2nd IF Filters 2kHz/Div 10dB Vertical/Div

Although nominally 50 ohm antennas, both sets work perfectly well on any old wire poked in the back, since the input circuitry is virtually that of an active antenna anyway - the main thing to try and achieve is freedom from electrical interference.

The AGC systems on both sets are comprehensive and effective - we measured well over 80dB input range for 3dB output change. It seems strange that both sets omit this from the spec in the front of the handbook. Both specs are rather nonchalant, and tend to be conservative when compared to actual results.

The R1000 does not give the user the option of the time constant from the front panel, and it does seem rather reluctant to *let go* on SSB. The choice of slow or fast AGC is left up to the user with the FRG7700. Again, a little more integration at this stage could have saved a number of discrete components in both designs.

Round one Summary

Points scored about even. The FRG7700 is just ahead on features and sheer weight of number of transistors, whilst the elegance of the R1000 and the better results from its signal analysis redress the balance. No sign of any knockout punch from either contender yet.

....Next month.... Into the local oscillators, PLLs and frequency display.

Your Reactions.........	Circle No.
Immediately Applicable	282
Useful & Informative	283
Not Applicable	284
Comments	285

Using UARTS Part 1

by Jonathan C Burchell

Line interfacing and clock driving

The Universal Asynchronous Receiver/Transmitter *(UART)* provides an extremely effective interface between a computer's serial in/out port and a parallel real world.

Nearly all home/personal computers are equipped with a serial RS232 port. By using a UART to communicate with this port it becomes possible to use it for an extensive variety of interface tasks. (See last month's Compulink for an in-depth look at parallel and serial data streams.)

To use a UART successfully three criteria must be satisfied. Firstly, the device must be electrically interfaced to the RS232 signal levels in the computer's interface port. Secondly, the UART must be supplied with a precise clock frequency to synchronise and time the transmission and reception of all data. Thirdly, the parameters of the data stream i.e. number of data bits, parity bit selection, number of stop bits, must be established at *both* ends of the communications link. See *Figure 1.*

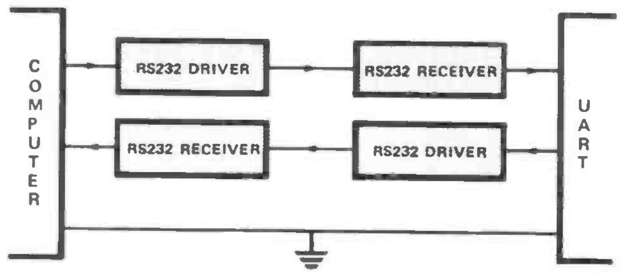


Figure 1: Complete RS232 communications link.

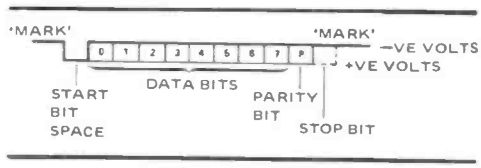


Figure 2: Serial data stream example.

Line interface: Receiving

The serial data stream from the transmitting RS232 device (See *Figure 2*) will consist of a signal ranging from +/—3v to +/—12v, since UART's are primarily TTL compatible this signal must be converted to a 0-5v range signal.

The circuit of *Figure 3* achieves this when the input signal is 'spacing' (+ve volts) - the transistor conducts and the output is at nearly 0v. When the signal is 'marking' (-ve volts) the transistor is held off, and the output is therefore high (+5v).

The diode is most important as it protects the transistor base from becoming reverse biased. This interface turns the marking condition of the RS232 signal into a TTL logic one. This is 'logically' correct and the level translated signal may be connected directly to the UART input.

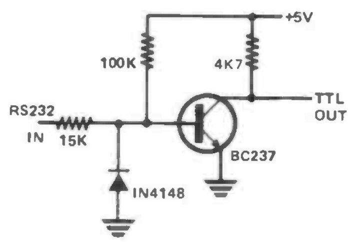


Figure 3: Simple RS232 receiver.

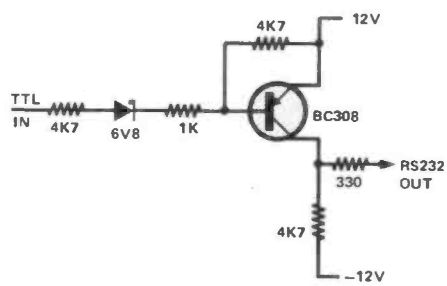


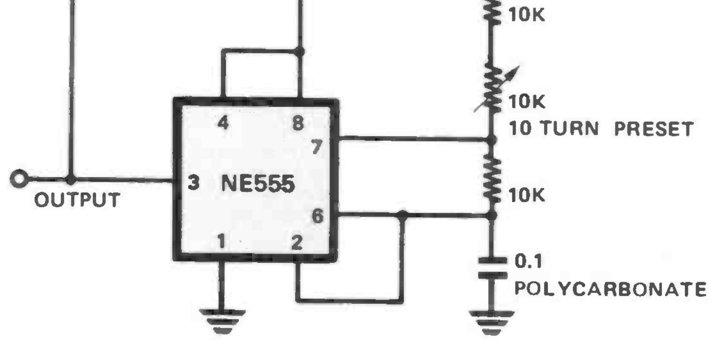
Figure 4: Simple RS232 Driver

Line driving

Here the TTL output of the UART must be converted into RS232. The simple circuit of *Figure 4* provides just such an interface.

When the UART output is high (+5v) the zener diode does not conduct, keeping the transistor turned off and the output in a 'marking' condition. When the UART output goes low, the zener diode conducts, and the transistor is then turned on, pulling the output into a spacing condition.

Figure 6: 110 baud clock



Neither of the circuits shown fully comply with the stringent specificiations of RS232, in practice they work without problems. However, if you wish to transmit your data over 50ft in an electrically noisy environment, the integrated circuits MC1488/89 provide four full RS232 receiver/drivers in one package, they are not cheap though. The MC1488 driver is designed to actively sink and source current, thus making it less sensitive to receiver loading effects. It also includes short circuit protection.

The MC1489 receiverhas greater noise immunity than the simple transistor receiver describe earlier. This is acheived by employing a dead band in the receiver characteristics around the 0 volt level, and by the use of considerable hysteresis around the amplifier. See *Figure 5*

Clock generation

The transmission and reception of all data from the UART is controlled by a clock frequency supplied to the UART's receiver and transmitter clock inputs. It is possible to transmit data at a different rate to that at which it is being received.

The clock can be any rate from DC to 1MHz, data will then be transmitted or received at 1/16th of this frequency. Normally one of fourteen standard clock or baud rates are used.

Due to the high stability required, the clock frequencies should always be crystal derived; although for baud rates of 110 or less (1760Hz) an NE555 timer and temperature stable components may suffice, providing a frequency meter is used to set up and check the operating frequency. See *Figure 6*

The CD4702 is a Fairchild Macro-Logic programmable bit-rate generator, see *Figure 7.* Simply by connecting a crystal to it, and applying the appropriate inputs to the multiplexer, any one of 14 standard baud rates may be generated.

The multiplexer inputs Im may be driven from an external clock to generate a non-standard baud rate, alternatively it may be connected to the Q2 output to provide 19,200 baud operation. If it is necessary to generate a number of different baud rates simultaneously - then the circuit of *Figure 8* may be used. ■

Next instalment: **Inside the UART Itself.**

Your Reactions.........	Circle No.
Immediately Applicable	124
Useful & Informative	125
Not Applicable	126
Comments	127

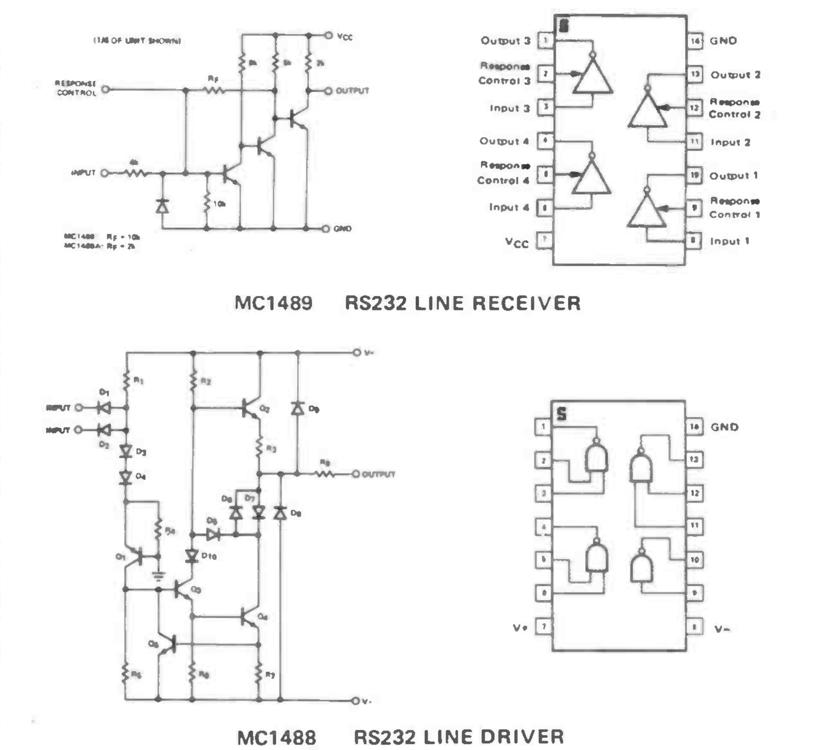
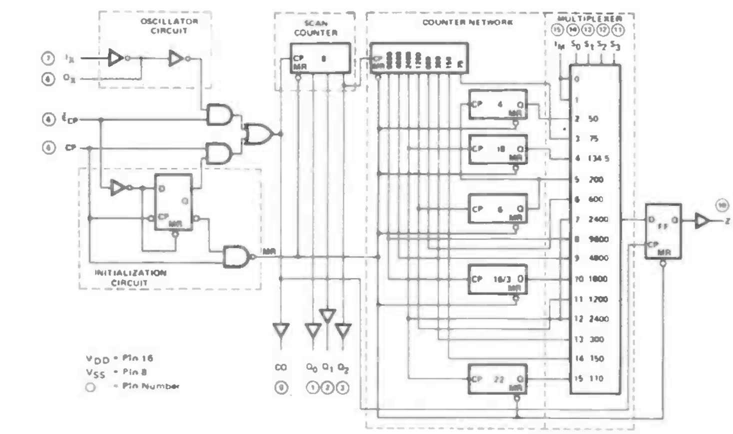


Figure 5.



TRUTH TABLE FOR RATE SELECT INPUTS

S_3	S_2	S_1	S_0	Output Rate (Z) Note 1
L	L	L	L	Multiplexed Input (I_M)
L	L	L	H	Multiplexed Input (I_M)
L	L	H	L	50 Baud
L	L	H	H	75 Baud
L	H	L	L	134.5 Baud
L	H	L	H	200 Baud
L	H	H	L	600 Baud
L	H	H	H	2400 Baud
H	L	L	L	9600 Baud
H	L	L	H	4800 Baud
H	L	H	L	1800 Baud
H	L	H	H	1200 Baud
H	H	L	L	2400 Baud
H	H	L	H	300 Baud
H	H	H	L	150 Baud
H	H	H	H	110 Baud

L = LOW Level
H = HIGH Level

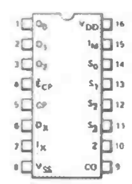
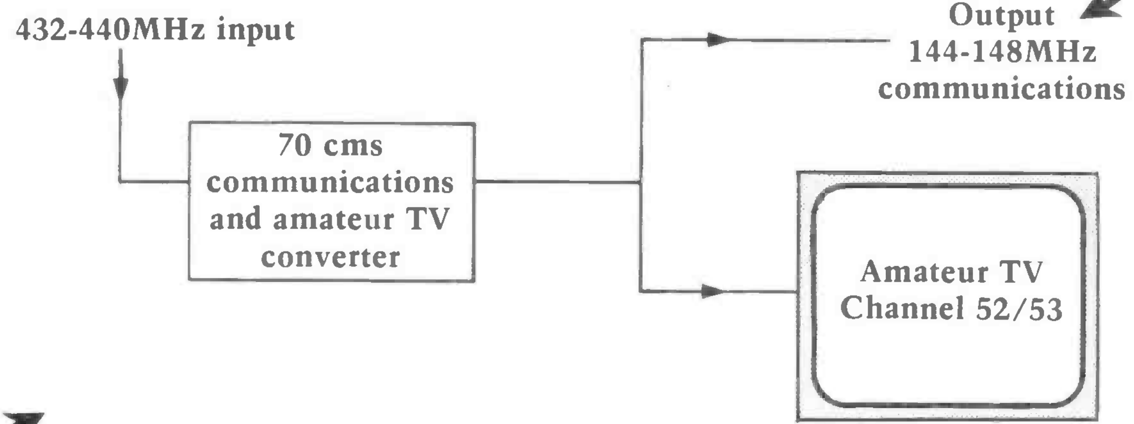


Figure 7: CD4702 Baud rate generator.

NEXT MONTH in RADIO & ELECTRONICS WORLD

R&EW's RF experts bring you...



......a dual purpose Amateur TV and 70 cm communications converter using easily aligned helical filters.

A bench/portable DMM with display 'freeze' feature

R&EW's professionally designed projects deserve professional packaging and presentation, so we are delighted to announce that we are presenting a series of joint features with a major supplier of test gear that will enable R&EW projects to be presented in the manner to which they - and you -deserve to become accustomed.

Watch for details of the complete test equipment range being planned.....

1981 ...good riddance ??

A light hearted glance at what 1981 had to offer, ranging from Timothy Edwards' report on the gastronomic disaster of the year - to some of the milestones in technology.

DATAFILE
DATABRIEF
COMPULINK
NEWS....

A digest of the month's events in, on and around the electronics, communications and computing scene.

Remember the mention of Takeda Riken's new combined spectrum and network analyser in our first (October) issue ??

Well, the UK Takeda Riken representatives have been good enough to contact us and send us all the details of this superb instrument, and the rest of the range. Those of you familiar with HP and Tek equipment will be in for a surprise when we review some of the excellent value for money equipment from this progressive Japanese manufacturer.

Plus plenty more besides. Order your copy of our January issue now!!

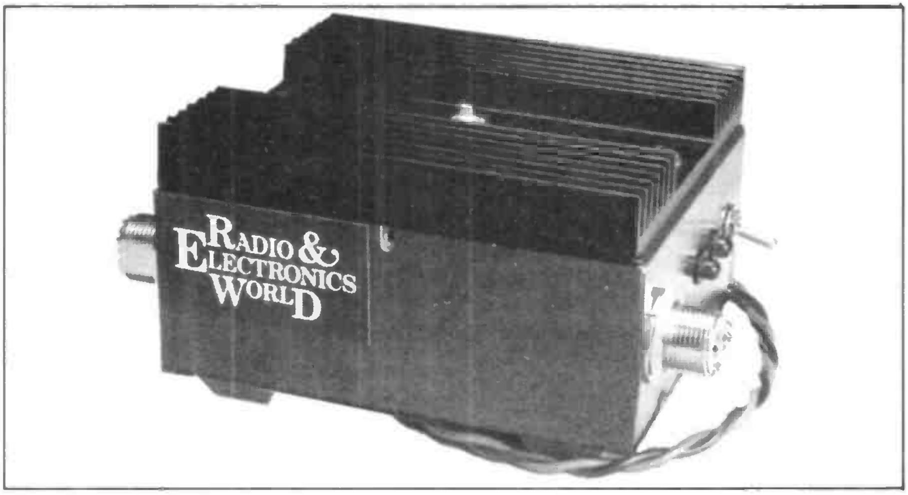
The Timothy Edwards 2m Power Amplifier

Tired of getting 'noisy' signal reports? Do pirates overpower you into the local repeater? Timothy Edwards provides a boost for IC2/FT290 users....

This article describes a high gain add-on FM amplifier (easily modified to linear use - see appendix), for use in the 2 metre amateur band (144MHz to 146MHz). Most hand–held and transportable transceivers such as the Trio Q2400, IC2E, FT207, FT290 etc. only produce RF outputs of 1-2 watts - which is inadequate for 'comfortable' mobile or fixed station use. The author, wishing to use his Q2400 in the car, discovered that there was no suitable low cost amplifier available on the market - and so this project was instigated. Only a single thin coax lead runs from the PA to the hand-held in use, enabling the maximum versatility to be obtained from your hand-held.

Being of small size and completely automatically switched (although certain dodges may be necessary in the case of SSB operation), the amplifier is ideally situated in the glove compartment, screwed under the dashboard - or housed along with a stack of 'D' sized nicads for use as a 'transportable' booster for serious portable work - field days, 'hill topping' etc.

The circuit was designed using easily obtainable components and can be built in a couple of evenings by anybody with limited experience of RF. The fact that this device is for use in conjunction with transmitting equipment pre-supposes the constructor will have at least the basic skills required to pass the Radio Amateurs Exam. The performance, as can be seen in the specification chart, is significantly better than most of the more costly amplifiers available on the market.



Circuit Description *(Figure 1)*

Relays RL1 and RL2 in their 'off' state bypass the amplifier stage for use either in the receive mode, or when the booster is switched out of circuit if low power will suffice. These relays, although not ideally suited for RF switching, offer a good compromise in cost/performance.

When approximately 1/4 of a watt or more is presented to the input socket, the signal is rectified by D1 and D2, in turn switching on Q2 which pulls over both relays, and also switches on the LED D4. For chatter free operation on SSB with rigs that possess good carried suppression, it is necessary to provide a DC switching voltage on the coax inner (see appendix). The input matching for the transistor is accomplished by the combination of C1, C2, L1, L4, C3A and C3B. L1 is an easily wound inductor, and L4 is designed as part of the stripline etched on the printed circuit board.

C3 is split into two values for two reasons, firstly to minimise the lead inductance that would be present if only one capacitor was used - and secondly to distribute the RF currents evenly through the printed circuit board. L2, L3 and R1 hold the base of Q1 at zero volts to ensure that the device operates in class C, but also to ensure that impedance is very low at the low frequencies where the gain of Q1 is very high, and thus deter any possible tendency to instability.

L5, L8, C6 and C7 form the output matching network, which matches the very low output impedance on Q1 into 50 ohms. The inductor L5, like L4, is a stripline inductor on the printed circuit board. C4, C5, R2 and L7 very effectively decouple the RF present at the junction of L5 and L8 thereby stopping any RF energy going back down the supply lines. The RF power transistor Q1, is a TP2320, manufactured by QW.

This particular device was selected because of its very high gain at an input of about one watt, since it is characterised by QW for this very application (Note 1). The printed circuit board has been very carefully designed, not only to incorporate the stripline inductors L4 and L5 but also to carry the tracks for the RF switching network on the opposite side of the board. It is strongly recommended

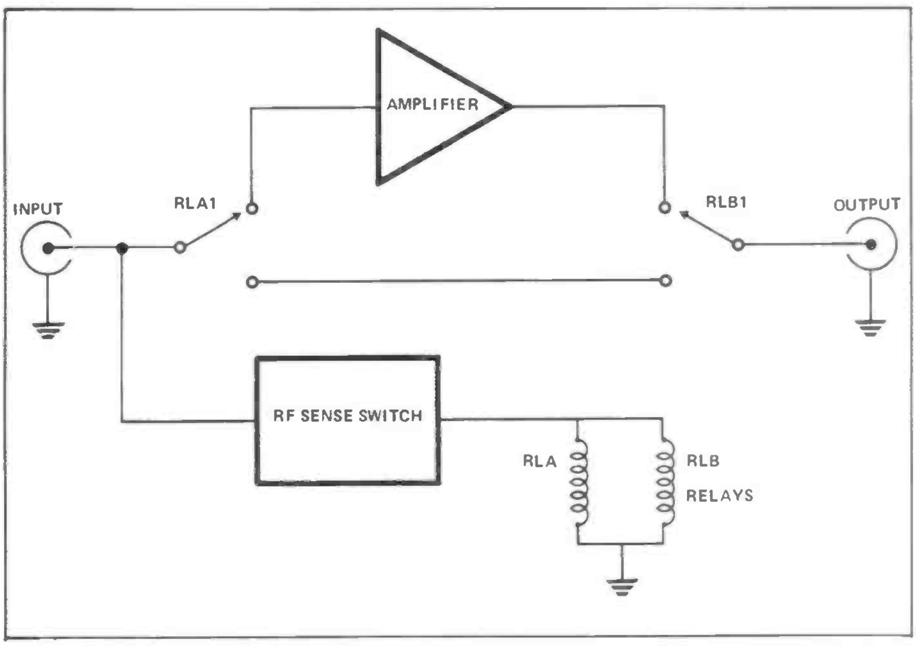


Figure 1: Block Diagram.

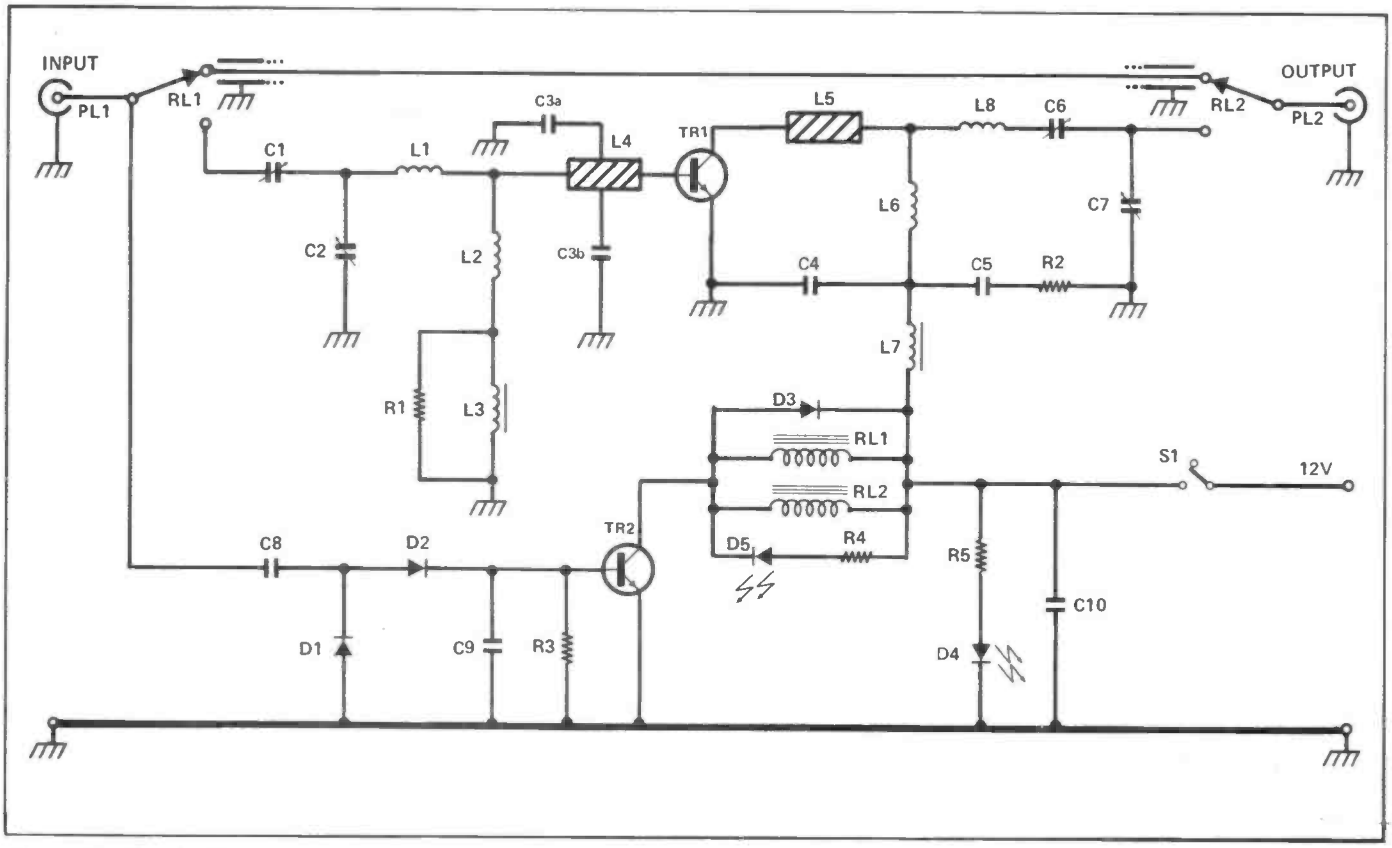


Figure 2: Circuit Diagram.

RF TRANSISTOR DATA

Characteristic	Conditions	TO2320	MPX085
BV EBO E-B breakdown	Ie = 5mA Ic = 0	4v	4v
BV CEO C-E breakdown	Ic = 50mA Ib = 0	18v	18v
Ic (max) collect current	— — —	6A	8A
PD Power dissipation	25	50W	70W
HFE (min) DC gain	Ic = 0.5A Vce = 5v Ic = 1A Vce = 5v	20	10
COB (max) C-B Capacitance	Vce = 20v 1MHz	70pF	90pF
RF Power Gain (min)	12.5v 175MHz 3W input 12.5v 175MHz 10W input	17W	40W

Specification

Power gain	10dB minimum
Output power	1 watt input 10watts output 2 watts input 20 watts output
Saturated power output	25 watts
Supply voltage	10-16V nominally 12V
Input and Output impedance	50 ohms
Supply current	Less than 2 amps at 10 watts output
Size	**110mm x 60mm x 90mm** not including sockets

that this layout be followed exactly, as the physical structure of the circuit is an integral part of the theoretical analysis.

The coaxial cable link near the two sockets is provided to enable insertion of a pre-amplifier if desired. It is recommended that the *state of the art* 2 metre pre-amp to be described in the next edition of **Radio and Electronics World** be used.

Construction and Alignment

Assemble the printed circuit board with all the components, except the power transistor Q1, using the components placement guide *(Figure 2)*. After construction, remove any solder splashes and check for dry joints. It is important to note at this stage that all the component legs on the underside of the board should be kept as short as possible.

Secure a 6BA nut and bolt through the mounting holes, and then place a piece of plastic sheet over these screws, so that when the board is tightened down it acts as a large insulating washer. Assemble the board to the chassis and heatsink as shown in the photographs - and secure the assembly with 6BA nuts.

Wire the unit with the power leads, LED and SO239 sockets also as shown in the photograph and diagrams, being very careful to ensure that the SO239's used have the earth contact rings soldered to the pins on the printed circuit board.

Only when you are sure that the unit is complete and mechanically stable should you fit transistor Q1. It is absolutely essential that it is secured mechanically before it is soldered. This is because the stud of the transistor is bonded to the transistor itself with a Beryllium bond. This is very easily broken if any pressure is exerted on the transistor. The big danger is that the device contains a **very** toxic Beryllium compound, and you **must** avoid any danger of contact with it.

If you are unfortunate enough to break the device, put the bits very carefully into a thick polythene bag and seal it. Wash your hands and send the package back to the supplier for disposal.

The legs of the transistor should be tinned before insertion, and also tin the board area where the legs will sit. Check that the heatsink is free from burrs and apply a little heatsink compound to the heatsink. Pass the stud of the transistor through the heatsink, and be careful to only tighten the nut to 'finger tight', if you have a torque wrench available, then the setting should be 6 foot pounds. The collector leg of the transistor is marked 'C' on the top of the transistor, (and there also has a portion of its leg cut away at approximately 45 degrees).

Solder the transistor carefully to the board. It should be noted that if at any time the board is removed, then the transistor should be removed from the board before refitting, using the technique described above. All this may seem rather tedious, but it is intended to avoid problems of fracture through distortion when the device is running and getting hot.

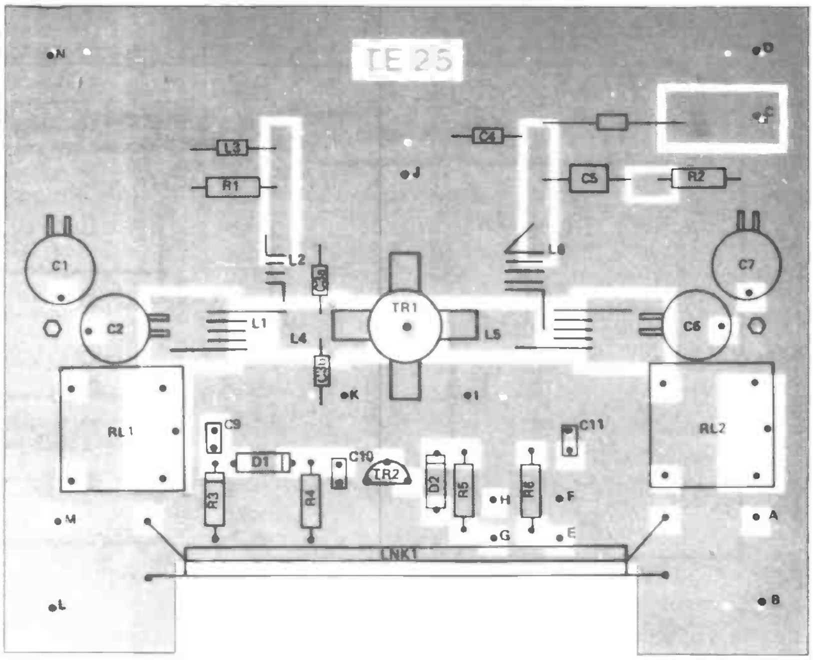


Figure 2: Component Overlay.

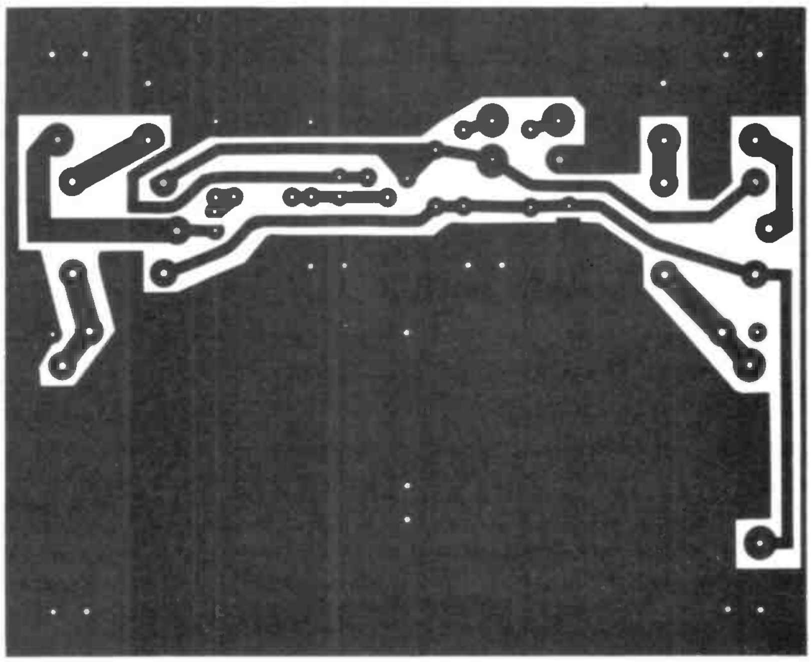
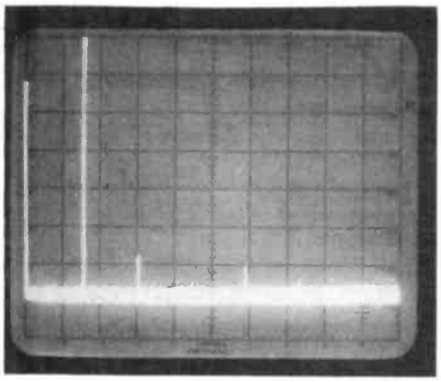


Figure 3: PCB Foil Pattern.

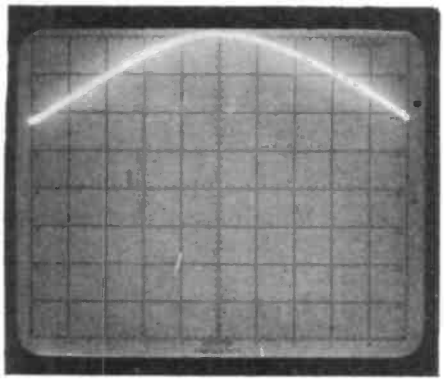
Pre-set the trimmer C1 to approximately 1/4 capacitance, and C2 to approximately 3/4 capacitance. Pre-set C6 to approximately 1/4 capacitance and C7 to 3/4 capacitance. After you are sure that you have carried out the previous instructions to the letter, gingerly apply power to the unit. When S1 is switched on D4 should light up. Connect your transceiver to the input socket, and preferably a dummy load and power meter on the output.

Key the transmitter, and check that no more than 2.5 watts is presented to the amplifier. Carefully adjust C6 and C7 to obtain maximum power output. It is important that these trimmers are adjusted first, then tune C1 and C2 also for maximum power output.

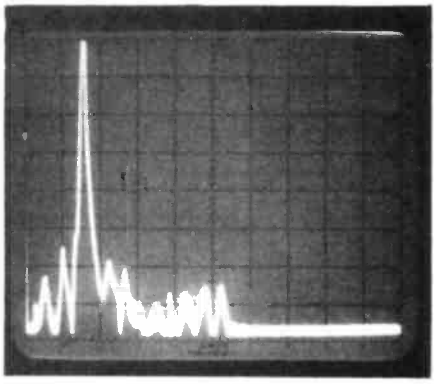
If all is well, (i.e. no smoke, sparks buzzes, flashes or bangs) an output of approximately 80% of the expected **RF** will be obtained. To squeeze the last ounce out of the unit, you must repeatedly tune C1, C2, C6 and C7 for maximum output. It should be noted that a screwdriver is definitely **not** the right tool to use for tuning these trimmers a specialized RF trimming tool must be used.



Harmonic Spectrum Output. Vertical scale 10dB/division. Horizontal scale 100MHz/division.0.0-1000MHz centred on 500MHz. This shows the second harmonic at -58dB, the third harmonic —65dB, the fourth harmonic -60dB.



Bandwidth. Vertical scale 2dB/division. 140.0-150.0MHz centred on 145MHz. This shows a 3dB bandwidth of 7MHz.



Response of Trio BPF2 Filter. Vertical scale 10dB/division. Horizontal scale 100MHz/division. 0.0-1000MHz centred on 500MHz.

Conclusion

The spectrum analyser photographs were taken from a HP spectrum analyser and also from a Tektronix 7L12 with matching tracking generators fed into a broad band power amplifier. During the power response tests, the relays were held in manually. The spectrum photographs were taken by inserting a bandpass filter centred on 145MHz at the output of the driving source. This was to ensure that the harmonics as seen on the analyser were those produced by the amplifier and not those produced by the driving source.

Notes List

TRW RF Semconductor's Handbook 1981, European Edition. Page B113 (4 pages).

Components List

Capacitors	
C1, C2, C6, C7	60p foil trimmer
C4	120p ceramic plate
C5	100n monolithic plate
C3A, C3b	47p ceramic plate
C8	2p2 ceramic plate
C9, C10	1n ceramic plate
Resistors 0.25w carbon film	
R1, R2	10R
R3	10k
R4, R5	330R
Semiconductors	
D1, D2	1N4148
D3	1N4001
D4, D5	LED
Q1	TP2320, MPX085 (TRW)
Q2	BC239 or similar
Coils and Inductors	
L1, L6, L8	3 1/2 turns 1.25mm enamelled copper wire, 6mm int. dia close wound.
L2	7 turns 0.5mm enamelled copper wire, 3mm int. dia close wound.
L3, L7	6 turns 0.5mm enamelled copper wire wound in ferrite bead.
L4, L5	Copper strip 12mm x 6mm (stripline on PCB)
Miscellaneous	
RL1, RL2	KamLing KU1TB 12V
PL1, PL2	SO239 single hole mounting
SW1	Single pole on off miniature
Case	**WR&E**
Heatsink	**WR&E**
Ferrite beads	FX1115 or similar (Ambit).
PCB	**WR&E**
Sleeved gromet	
Large plastic insulating sheet.	

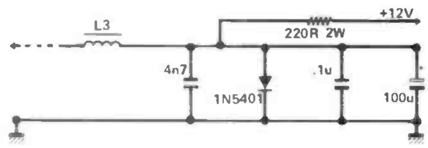
APPENDIX

Now that multimode portables are available (FT290 and Standard C58), an add on linear amplifier is required for SSB use.

The power amplifier described in this article operates in Class C (zero DC bias), this being the most efficient configuration for FM use. In Class C there is not a linear relationship between input and output powers. For SSB (Single Side Band) operation a linear input/output relationship must exist, to prevent distortion of the signal, which would give rise to splattering an adjacent frequencies.

Linear power amplifiers operate in Class AB, giving the best compromise between linearity and efficiency. In class AB a DC bias voltage is applied to the RF power transistor, sufficient to produce a quiescent collector current of a few tens of milli-amps. The bias voltage on the base of the transistor must reduce with increased temperature to keep the quiescent collector current constant, a simple solution is to use the voltage developed across a silicon diode.

It is quite easy to modify the described power amplifier to linear operation, as follows: Remove R1, disconnect L3 from the ground plane and construct the circuit below.



The IN5401 should be in thermal contact with the transistor, it can be positioned across the body TR2. The power amplifier will require re-alignment, after this modification is made.

The modified PA can be equally used for both FM and SSB. Input power should be limited to 2.5W p.e.p., to prevent overdriving the amplifier. The limiting factor in this design, is the power handling capacity of the output relay. As the PA gives more gain in the linear mode, power input on FM should also not exceed 2.5W.

When using an FT290R with the PA, a DC voltage present on the 290's aerial socket on transmit, can be used to switch the relays. A coupling capacitor is then required between input socket and RL1/C8. The DC connection can be made with a 33K resistor between the input socket, and the junction of D2 and C9.

A complete linear power amplifier for 144MHz will be described in a future edition of R&EW.

Your Reactions.........	Circle No.
Immediately Applicable	147
Useful & Informative	148
Not Applicable	149
Comments	150

READERS LETTERS

NB The views expressed herein are not necessarily those of the editor or the publisher.

Dear sir

As I have just bought your first issue, I would be interested to know if it is 'under the control' of Ambit, and if in future most items of a constructional nature will be of Ambit origin?

If the above is the case then I shall have to consider if I should buy any future issues.

What is wanted is items that will work first time - but should they fail to work, fault finding should be straight forward, without the need for a lab full of test equipment, other than a test meter etc. This is where state-of-the-art (whatever that means) can lead to a lot of wasted time and money.

I am certain that other readers would like to know the answers to the questions I ask.

LD
Leeds.

R&EW

Thankyou for your letter of September 20th

I am sorry that you are not certain if R&EW *suits your tastes (yet) - although I would take issue with the criticisms you raise - since we have gone to some pains to provide enough space to accommodate as many aspects of the subject as possible -and to cater for a broad spectrum of 'experience'. I am pleased to say that the reaction has so far been overwhelmingly favourable, but you can't please all the people all the time.*

The content of R&EW *is drawn from whoever contributes material of the required standards. We have gone out of our way to solicit authors' attention in this repect; we pay more than anyone else, and we expect to get better quality material than anyone else. The feature circuits published in the first issue largely contained test voltages throughout, to enable constructors to get them going with the minimum of test equipement. We have verified designs using the biggest and best equipped laboratory available to any publisher, so that featured circuits are generally a great deal more professional than you will find elsewhere. We use the spectrum analysers and the £10,000 oscilloscopes, so our readers can get by with a multimeter, confident that they are not chasing some problem that results from the foibles of an untried author's circuit.*

We are very aware that R&EW *must be an objective publication that stands on merit alone. Curiously enough though, by virtue of our independence from the dogma of major publishing groups, we have a very much freer hand in the choice of article, and the ways they are presented.*

Until such time as R&EW *has been around long enough to be noticed and attract more submissions of the right calibre, then there will inevitably be some features derived 'in house' - we have around 70 pages a month of editorial content to supply, and we aren't going to use any old junk 'filler' features. The articles in the first issue originated from many different sources - 'lead feature' was supplied by one of Ambit's most direct competitors! Only two items were of 'in house' origin we hope that the appointment of Ray Marston will further 'cross fertilize' the content, since Ray's brief is to edit the best monthly electronics magazine on the bookstall, regardless of any other considerations.*

So that constructors/designers should have as little difficulty as possible to obtain parts to follow up features, we have gone to some lengths to provide a means of ensuring that all the parts are not 'junk box' refugees, but are available from at least one source set up to deal with all types of customer. All the components are available individually as well as in the kit packages.□

The Voice of the People

Dear sir

First, I am writing to congratulate your new publication. I must say that every article was to my interest, and I hope future editions contain similar articles.

At last it is good to see a magazine that is not as formal as (XX), but not as 'comic like' as (XX), etc. I do hope that this standard can be maintained, and I shall offer my advertising support if this is the case.

RCSW
Halesowen

Dear Sir

Congratulations on the first issue, it looks like a winner. Despite recently pruning my spending on electronics magazines, I shall certainly stick with *R&EW*, even if it means not eating!

EC
Aylesbury

Dear Sir

I have never felt the urge to write to any magazine before, until I read *R&EW*. wish to congratulate you on your first issue on your remarkable mag., and wish you luck in the future. It's been quite a talking point on the local 2m nets.

One idea that the locals like in the 'Bingo Card' reply coupon, including the idea of interest ratings on features. However, I would like to see these applied to other items in the magazine. For whilst most people - like myself - tend to be reluctant to write in to mags, the multiple choice bingo card does appeal to me and others. And in the long run, if you know what the readers want, you should sell more magazines.

It is a relief to find a magazine that is not full of multivibrators being used as egg timers, or other trivial applications -yet on the other hand not being bogged down with all the calculations that XX appears to suffer from.

The way you handled the IC2E review was praised by many, with the inclusion of the block diagram, and more so a full circuit diagram. Too often the reviews in some mags go on for a page or two describing how many stations were worked through the local repeater, and how they had to cut the 'test' short, due to 'wallies on the box'. Keep it up.

I like the advanced 2m converter design, plus the deviation meter. Along with the DFCM500, it seems we can look forward to some excellent designs for test equipment.

To summarize:

Likes:
Reply paid coupon (though many said they would have paid the postage anyway)
CCT diagrams included with reviews.
Advanced constructional features without too much regurgitated theory, and full kits supplied at reasonable cost.
Encouragement to people to write articles.
Interest rating key.
Lack of 'silly' projects.
Data sheet service.
Dislikes:
No PCBs without kits
Interest rating not on enough features

Your first issue is a 'hit' among the local 2m population, and I hope it will remain so, for many years to come.

PK
Hull

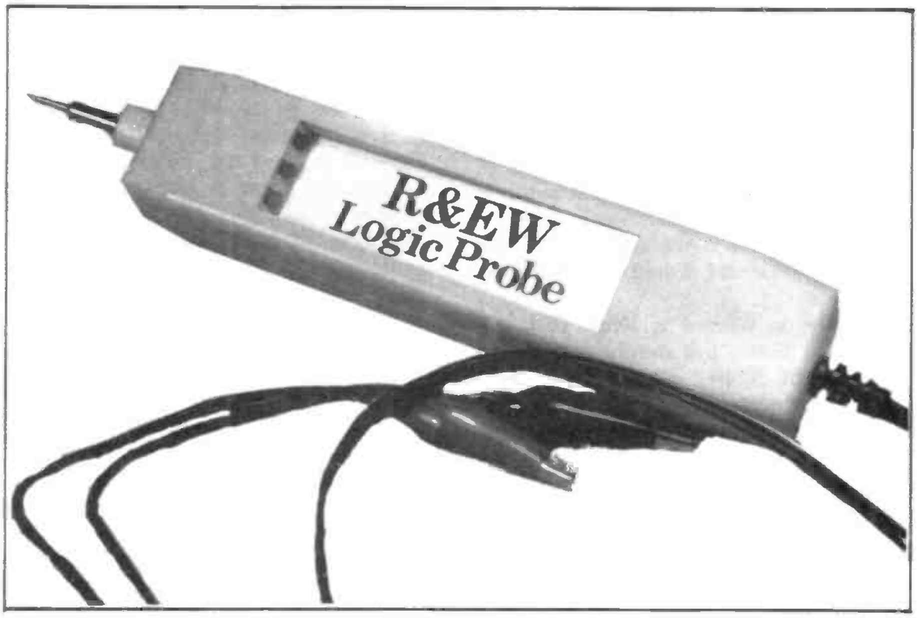
R&EW

Thankyou for your kind comments. Both your dislikes are now rectified with this issue.□

R&EW reserves the right to edit letters published on this page - and whilst we still like to receive them, we promise not to publish too many more adulatory letters. So how about some more reactions to specific features, please?

The Timothy Edwards Universal Logic Probe

Forsaking the black art of RF for a fleeting moment, our rampant RF maestro pauses to provide his awed public with a glimpse of one his many other sparkling facets. (PS:How do you spell 'Hype'?)

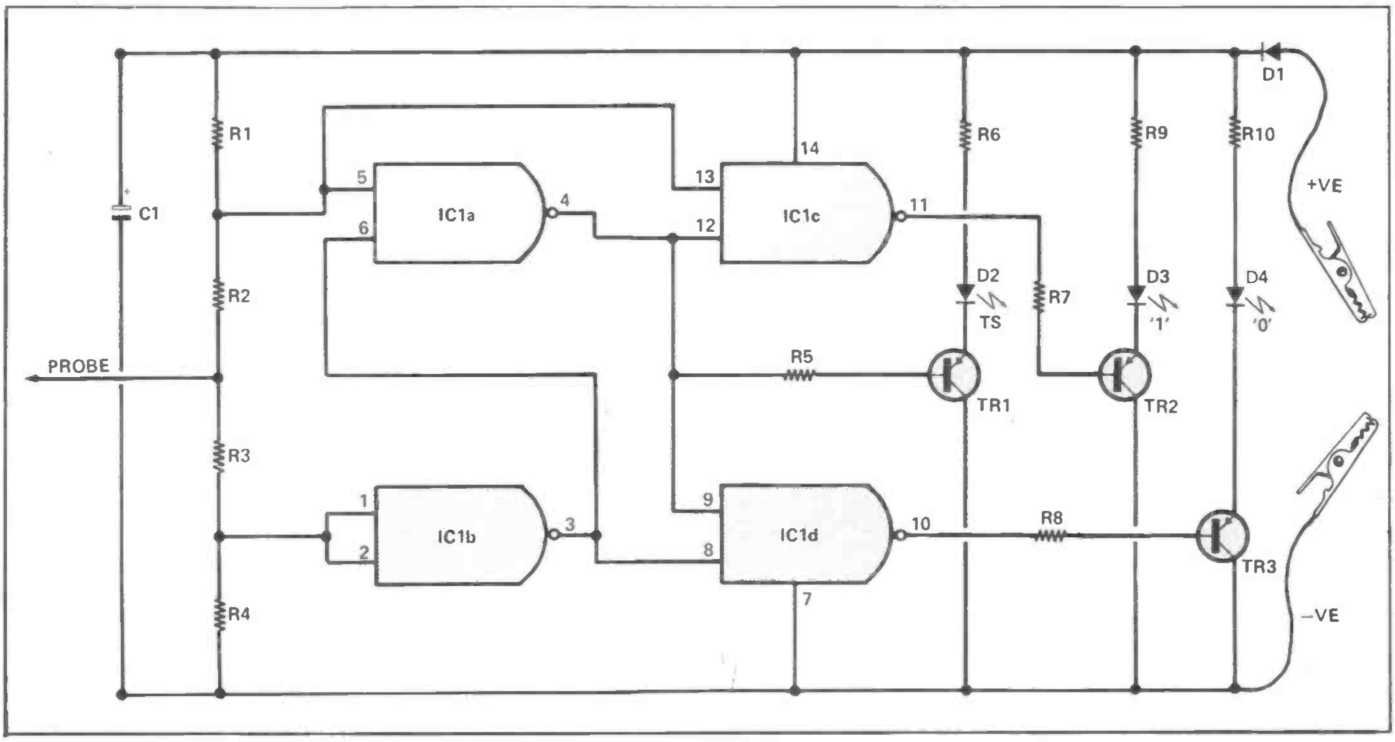


Although the laboratories of Timothy Edwards are usually filled with dark and mysterious black magic projects bordering on the frontiers of RF Technology, occasionally a device such as the Motorola MC145151 catches the author unawares. This wonderful new IC from Motorola is effectively a single chip synthesizer with everything on board except the voltage controlled oscillator, such a device with its need for logic programming and tri-state phase comparator needed the use of a logic probe in its development programme. After a quick look around the market it was apparent that there were very few logic probes available under £10, and none at all which would indicate a tri-state or high impedance condition, therefore this logic probe was designed and has proved indispensable since its construction.

Most logic probes will only indicate whether the probe is connected to a 'high' or 'low'. Many new ICs, including several memory types, are now of the tri-state variety, whereby when the output is not required it assumes an open circuit or high impedance status. This state is difficult and indeed usually impossible to detect with conventional logic probes. The logic probe described, with very few components will accurately indicate all three states.

Circuit Description

IC1 a 4011B is a quad two input Nand gate package. Gates a and b are connected to the probe input via a potential divider string R1, R2, R3 and R4. When the probe is either open circuit, or connected to a high impedance circuit, gate b has both inputs 1 and 2 effectively at zero, which makes pin 3 go high. Gate a has pin 6 high and also pin 5 high, which makes the output pin 4 low. This in turn turns on Q1 via R5 illuminating the 'tri-



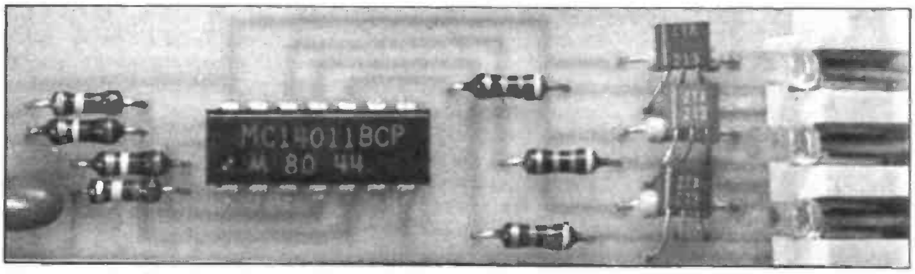
state' (yellow) LED. Gates c and d both have one of their inputs connected to pin 4 which is at zero and therefore both outputs are high, inhibiting both LED D3 and LED D4. When the probe goes to go logic 1, the two inputs of gate b will go high and the output pin 3 will go low. Gate a has pin 6 low from gate b pin 3 and pin 5 high, which will make its output pin 4 go high, gate c has now both pins 12 and 13 high which makes its output pin 11 go low and illuminate the 'logic one' (red) LED. When the probe input goes low pins 1 and 2 of gate b go low, making pin 3 go high, pin 5 of gate a will be low and its other input pin 6 will be high causing its output pin 4 to stay high. Gate d now has both input pins 9 and 8 high driving its output pin 10 low, causing Q3 to switch on the 'logic zero' (green) LED. This might seem a trifle confusing but a few minutes study should reveal all.

Construction and Alignment

First assemble the board with all components except for the LED's. Note that the three transistors are bent over flat on the resistors, *see photograph*. On the side of the case where the LED's fit through the holes cut off the two pillars as close as possible next to the probe retaining moulding. Put the LED's into their plastic carrier, noting their polarities and then put the carrier on to the component side of the board, locate the LED legs through the printed circuit board and pull them tightly through and solder. With the LED side of the case on its back, offer up the board with the components facing down (i.e. track side uppermost) to the case. Push the LED's through the holes in the case and at the same time locate both positive and negative wires in the strain relief grommet in the case. Solder the probe wire to the probe locating it in the moulding and carefully put the back on. Being careful not to strip the self-tapping screws in the plastic moulding, tighten them to just hand tight. Your logic probe is now ready to use.

Components List

Resistors	
R 1	220k
R 2	100k
R 3	100k
R 4	220k
R 5	47k
R 6	330R
R 7	47k
R 8	47k
R 9	330R
R10	330R
Diodes	
D 1	1N4148
D 2	Yellow LED
D 3	Red LED
D 4	Green LED
Transistor	
Q 1	ZTX213
Q 2	ZTX213
Q 3	ZTX213
Capacitor	
C 1	22uF 16V TANT
Integrated Circuit	
IC1	4011B
PCB	Ambit
Case	GSC CTP-1 or RS 508-217



Photograph showing the position of the transistors over R6, R9 and R10.

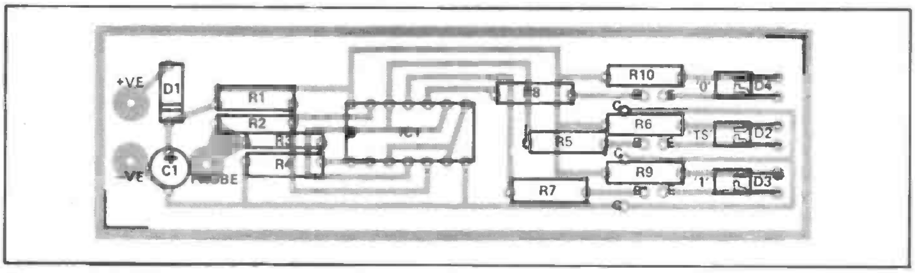


Figure 2: PCB Comp... ...nt Overlay Detail.

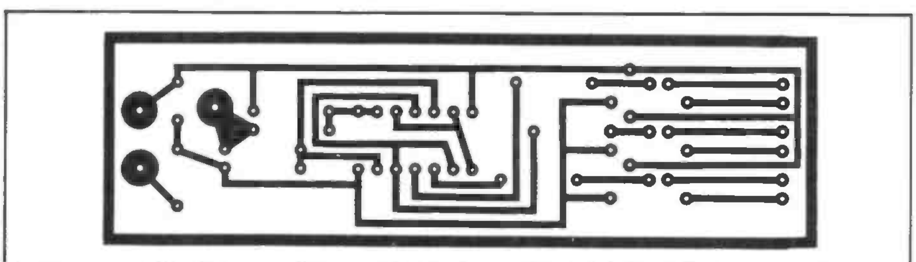


Figure 3: PCB Foil Pattern.

Input Signal Definition

Input	Green	Yellow	Red
HI			X
O/C		X	
LO	X		
Sine	X	X	X
Sine + Offset		X	X
Sine — Offset	X	X	
Square	X		X
Square + Offset		X	X
Square — Offset	X	X	

Input Signal Level

VS	Green	Yellow	Red
15	0-1.5	1.5-11	11-15
10	0-1.5	1.5-7.5	7.5-10
5	0-1.25	1.25-3.5	3.5-5

Operation

The logic probe has been designed to complement the EIA/JEDEC format for CMOS Industry B and UB series specifications. It will automatically select the right threshold voltages for any supply voltage between 5 and 15 volts.

It is useful in semi-linear circuits to determine the amplitude of an input clocking waveform. If for example, the green and yellow LED's are lit then the signal is of too *low* a level, and if the yellow and red LED's are lit, then the signal is DC biased *high* but also of too *low* a level. A sinewave signal of the correct input level will cause all three LED's to light, and a square wave signal of the correct level will cause only the green and red LED's to light. This is because a square wave spends no time in the intermediate position as does a sine wave. For a more detailed analysis of the switching levels see the accompanying table.

Conclusion

By virtue of its automatic threshold selection, this logic probe proved invaluable on both CMOS and TTL circuitry - and especially useful in the 'grey' area of interfacing linear circuitry to logic circuitry. The logic probe has passed the 'finger trouble test' by being immune to voltage or supply polarity errors and in use provides an indispensable tool for development and experimentation. ■

Your Reactions.........	Circle No.
Immediately Applicable	120
Useful & Informative	121
Not Applicable	122
Comments	123

NEW PRODUCTS

New compact 971TR and 970T Axial Fans, from Papst

The 971TR will operate from 6 to 14 volts 50/60Hz and can, therefore, be run from a suitable mains transformer tapping. Although measuring only 62mm in diameter by 35mm in depth, the 971TR is capable of displacing 26 cubic metres of air per hour (m^3/h) (15.3cfm) when connected to a 12V 50Hz supply. The airflow rate can be controlled by varying the supply voltage (as demonstrated on the stand) within specified limits, e.g. the fan blades rotate at 2400 rpm at 12V and 1350 rpm at 6V.

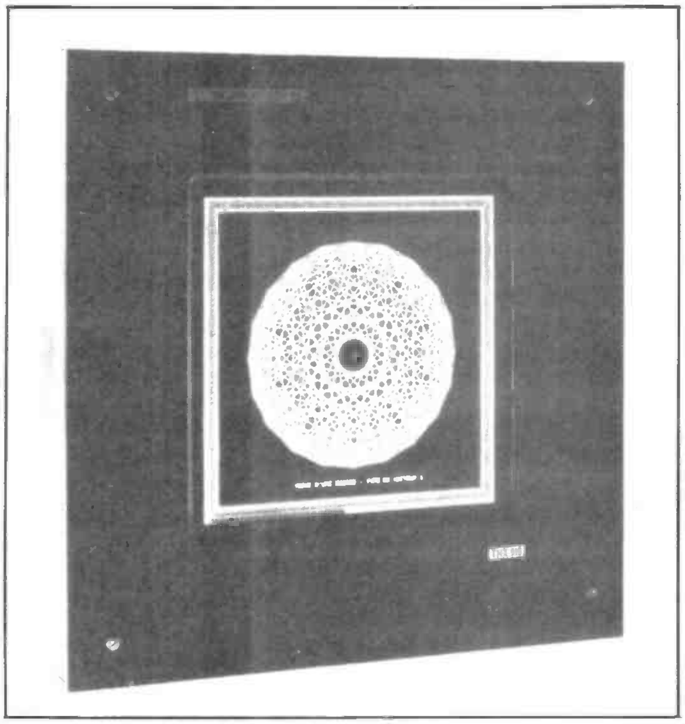
The 971TR employs a slotless eddy current external rotor motor, with lightweight glass fibre reinforced plastic impellers attached directly to the rotor. A reliable and well-proven sleeve bearing system and dynamically balanced rotor/impeller assembly together ensure a long vibration free life of at least 20,000 hours when the fan is operated in a temperature of 55° Centigrade. Noise output of the fan is typically 30dB(A), an important consideration when designing equipment for installation within the office or home.

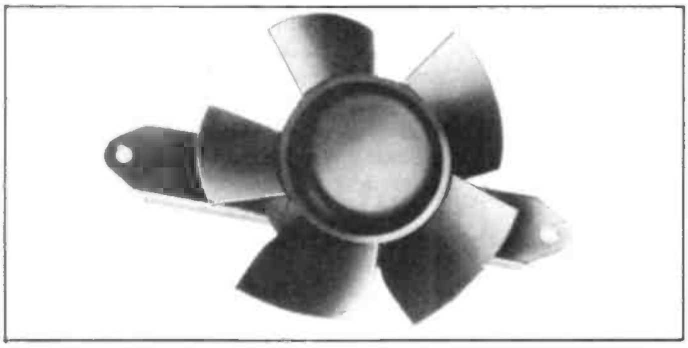
The fan is supplied with a mounting bracket allowing it to be installed in equipment without a venturi, or alternatively, into a venturi that is an integral part of the equipment housing.

The 970T is the same size as the 971TR but employs a 24V AC hysteresis synchronous motor that will drive the fan at a continuous speed even if the supply varies within the permissible range 20 to 28V AC 50Hz. Visitors to the Papst stand will be shown demonstrations of this feature. Capable of displacing $30m^3/h$ (17.65cfm) at 24V 50Hz when installed in 64mm orifice, the 970T generates typically 35dB(A) of noise. Other specifications of the 970T are the same as the 971TR.

Available from Papst Motors Limited, Andover, Hants.

300 for further details





Plasma panel displays, from Thomson-CSF

The TH 7606 is a flat panel display consisting of an AC plasma panel, the associated electronic circuitry ensuring data display and device functions being mounted behind the panel.

The active display area is 235 x 235mm. Arrange in a square matrix of 512 lines of 512 points (pitch 0.46mm), this panel can be used for graphic operation in which all points are individually addressed. In alphanumeric operation, the display capacity is 64 lines of 85 (5 x 7) characters in a 6-by-8 points matrix, or a display of 32 lines of 64 (7 x 9) or (7 x 12) characters in an 8-by-16 point matrix. Addressing in this case is either by simple line or in groups of 16 lines at a time.

Available from Thomson-CSF Components Ltd, Basingstoke, Hants.

302 for further details

New Racal LCD Division announced at Electronic Displays '81

The Racal Electronics Group revealed at Electronic Displays '81 the launching of the Display Products Division of Racal Research Ltd. This division, which formerly supplied sophisticated large area liquid crystal displays exclusively to the Racal Group, is now offering its custom design and manufacturing service to the electronics industry in general. To mark the launch, several exciting new developments, including 'circuits on glass' and LCD keyboards made their public debut at the exhibition.

Also making its public debut is the reconfiguring display/keyboard which links the LCD and the touch sensitive switch. By incorporating touch pads with its large area displays the Racal Display Products Division has created a revolutionary front panel concept.

To initiate a particular command an operator need only apply light finger pressure to a prompt shown on the LCD. This will cause the display to reconfigure and show a new series of prompts, so guiding the operator easily through a complex control sequence, similar to the 'menu' on a computer programme.

Additionally the displays division will exhibit a wide capability in more conventional LCD's. These include twisted nematic, dye phase change, nematic dyed, directly driven and multiplexed types. A specially developed manufacturing unit allows the company to build displays to a high level of performance and reliability, in a wide range of colours and surface areas.

Available from Racal Research Limited, Reading, Berkshire.

301 for further details

Motorola raises power MOSFET limits to 1000 volts

Phoenix, September 8, 1981... Motorola has announced the availability of TMOS TM Power FETs that extends the voltage ratings of such devices to a new limit of up to 1000 volts. These devices are double-diffused, N-channel, enchancement mode, silicon gate power MOSFETs. They are rated at a continuous drain current of 1 ampere, a peak drain current of 6 amperes, and are capable of dissipating 75 watts.

The 1-amp, 1,000 volt FET is particularly useful in equipment operating from a 230-volt source, but in addition it offers a high voltage safe operating area capability not normally available even in the higher current bipolar devices. This device also provides higher speeds coupled with a simplified drive.

103 for further details

Motorola introduces industry's first 500-volt, P-Channel power MOSFETs

Phoenix, September 9, 1981... Motorola has announced a new series of high-voltage, P-channel, TMOS TM power FETs. These are the industry's first 500V, P-channel power MOSFETs. The devices are double-diffused, enchancement-mode, silicon-gate structure. The continuous drain current is rated at 2 amperes with a peak current rating of 8 amperes. They are available with breakdown voltage of 450 and 500 volts.

Powered iron core catalogue

Micrometals catalogue covering iron powder core toroids for EMI and power filter applications is now available from Ambit.

303 for further details

NEW PRODUCTS

Wall plug base, from Silver Fox Ltd

Included among the range of accessories marketed by Silver Fox, as part of their range of re-usable cable ties and accessories is the 'Wall Plug Base".

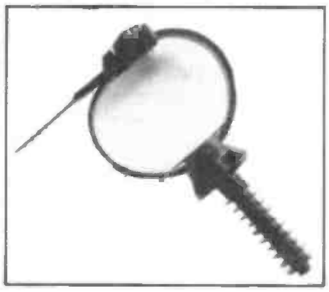
Designed specifically with speed and simplicity in mind. The wall plug base represents a very cheap quick way of mounting cables onto a wall.

Simply drill a hole and then hammer the plug into the hole. Pass the tie through the slot at the top of the plug.

The fixing is now complete, and the operating has taken a matter of seconds.

These are available from Silver Fox Ltd, London.

304 for further details



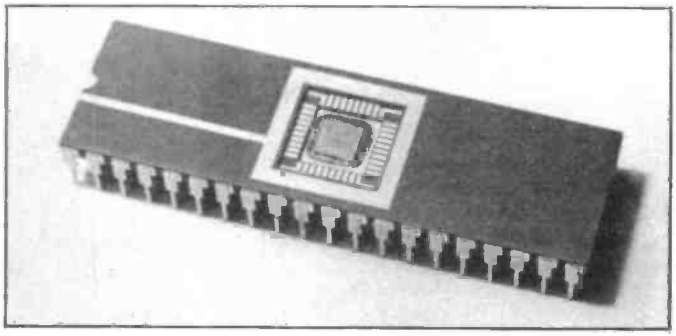
TM76 Microterminal, from Burr-Brown

The TM76 is a robust computer terminal designed for use in industrial environments including the factory floor or even in the control cabins of mobile machinery such as cranes. One of its main advantages is the large key size which allows the operator to input data or begin a pre-programmed function even when wearing protective gloves.

The unit comprises a twenty-nine character keypad (numeric keys, eight programmable function keys and control keys) with tactile feedback, a twelve character alphanumeric display, three indicators (showing the status of the two I/O ports and the buffer), and a thirty-six character buffer memory. Communication with a host processor is via either the RS232C or the 20mA current loop interface, which are brought out of the terminal via a standard twenty-five way 'D' type connector. The complete unit is contained in an 8.51 x 4.5 x 0.6 inch waterproof enclosure.

Available from Burr-Brown International Ltd, Watford, Herts.

305 for further details



MC14444 CMOS analogue to digital converter with built in digital I/O capability, from Motorola

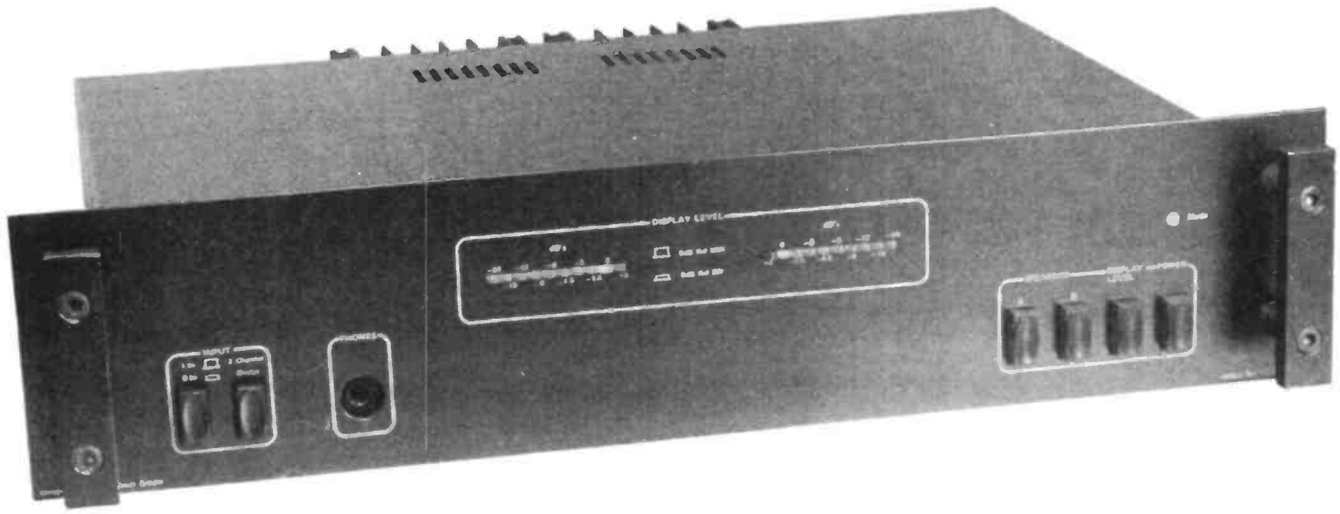
The MC14444, a 40 pin, bus compatible, 8-bit analogue to digital converter with built in digital I/O is available now from Motorola Inc. The device operates from a single 5 volt supply and provides direct interface to the 1MHz bus used with all Motorola M6800 family parts. It can perform an 8-bit conversion in 32 microseconds and allows for up to 15 analogue inputs. In addition, the part contains a 9-bit digital input register; a 3-bit digital I/O port; all necessary logic for software configuration, channel selection, conversion control, bus interface and maskable interrupt capability.

This part is manufactured in the Motorola Silicon Gate CMOS process and uses a binary weighted, all capacitor digital to analogue converter (DAC) and a chopper stabilized comparator to perform the successive approximation analogue to digital conversion. The price will be £14 in quantities of 1000 and will be available in early fourth quarter, 1981.

306 for further details

Higher Fidelity PART III

by Mike Creek



Assembly and wiring of the complete HMOS P.A.

General Description

If you are planning to build a high quality amplifier, and you have read the last two issues of **R&EW**, which describe the construction of the electronics involved in this project, you will be aware of the advantages of a MOSFET power amplifier compared to a bi-polar design.

The next consideration will be the packaging of such a design. You will need a substantial chassis to house the power amp modules, the power supplies, protection circuits, and several other bits and pieces, such as bar graph meters, switches, sockets, and fuse holders etc.

Cosmetics

This still leaves the problem of the front panel, which will need to have holes carefully punched or drilled in it, and will need spraying and perhaps silk screening if you are to be able to live with it in the living room. This now becomes a more daunting task, but don't despair, for help is around the corner in the shape of a ready-made, professionally finished 19" format chassis kit, which is provided with all the necessary holes and hardware to build a no-compromise power amplifier -or a less ambitious but nevertheless highly flexible approach to starting a project which allows for further improvements (funds permitting) as time goes on.

To be more specific, it is possible to build the power amplifier into the hardware using just one power supply, (transformer, rectifier and capacitors) the two power amp modules (PA105) and leave out the offset sensing until later. The requirement of bar graph meters, and bridged output will not be everyone's cup of tea, so these can be deleted also, leaving the amp without any reduction in performance but with a lot of room for refinement.

Assembly

The chassis itself is designed in several sections for ease of construction. These comprise the aluminium control panel, the inner front panel, rear panel, two side panels, middle panel, base plate, vinyl coated cover, and sundry items such as handles and blanking pieces.

For ease of construction it is best to follow a set pattern, and I shall first describe the 'complete' model, with reference to economies as I go along.

As a first step the rear panel should be fitted with its sockets. The two phono sockets should be isolated from the chassis with two plastic inserts, and the earth return should be via a solder tag mounted on one of the two holes used to secure the 600 ohm cannon socket or blanking piece.

The cannon socket is for professional use with balanced lines and will not be described here. The solder tag should also be used for an input and power supply chassis central earth point. This is important for maintaining hum and noise at a low level, *Figure 1*. It is also critical to the stable operating of the amplifier, (see last month's feature on Earth Considerations).

The loudspeaker terminals chosen for this design are screw cap 4mm instrument terminals 30A rating, allowing either twisted wires or 4mm plugs to be used. There are also facilities for two pairs of speakers to be connected, hence 8 sockets which should of course be isolated from the chassis. Next to these is an IEC chassis mounting mains plug for flying lead socket connection, above a chassis mounting fuse holder for the right-hand channel. The left-hand channel mains fuse is on the opposite end of the panel and directly above the socket for remote speaker switching.

The fuse ratings for the mains should be 3.15A slow blow, this is because the initial current surge when switching on a toroidal transformer is extremely high. If one transformer only, is used then the fuse rating may still remain the same.

The side and middle panels should be fitted with the smoothing capacitors (10,000uF 80v) through the three holes provided for mounting the capacitor clips. If one supply is used, then two capacitors only should be fitted to the right-hand side of the chassis. Make sure also that the connections to the capacitors should face each other - and be of opposite capacity, i.e. positive to negative.

The top two are to be joined together with heavy braiding, and the capacitor should then be left free to be rotated until the remaining two connections are the shortest distance away from the positive and negative wires emerging from the bridge rectifier - which is mounted directly below them on the base plate.

The front panel should be fitted with the DC offset sensing board (LS1000), by passing two 3mm (blue) screws through the panel and then through two 9mm metal spacers. The switch bracket is tapped and easily accepts the two screws. At the other end of the chassis there is provision for two switches, which if connected to the BR1000 PCB allow for switchable input sensitivity and bridged output (for those of you who require four times power output in mono). If this is not required, then only fit the switches to give the push buttons a home - and fill the holes in the control panel!

Bar Graphics

Offset each side of the middle of this panel, are large holes for mounting the bar graph meters (BGM1) which gives an inertialess power output indication which has switched dynamic range via the LS1000 PCB. (10W and 160W FSD.)

These are mounted with the highest 'power' LED of each meter in the centre of the panel. This is achieved on one type of PCB by assembling the LED's of the LH meter on the track side and mounting

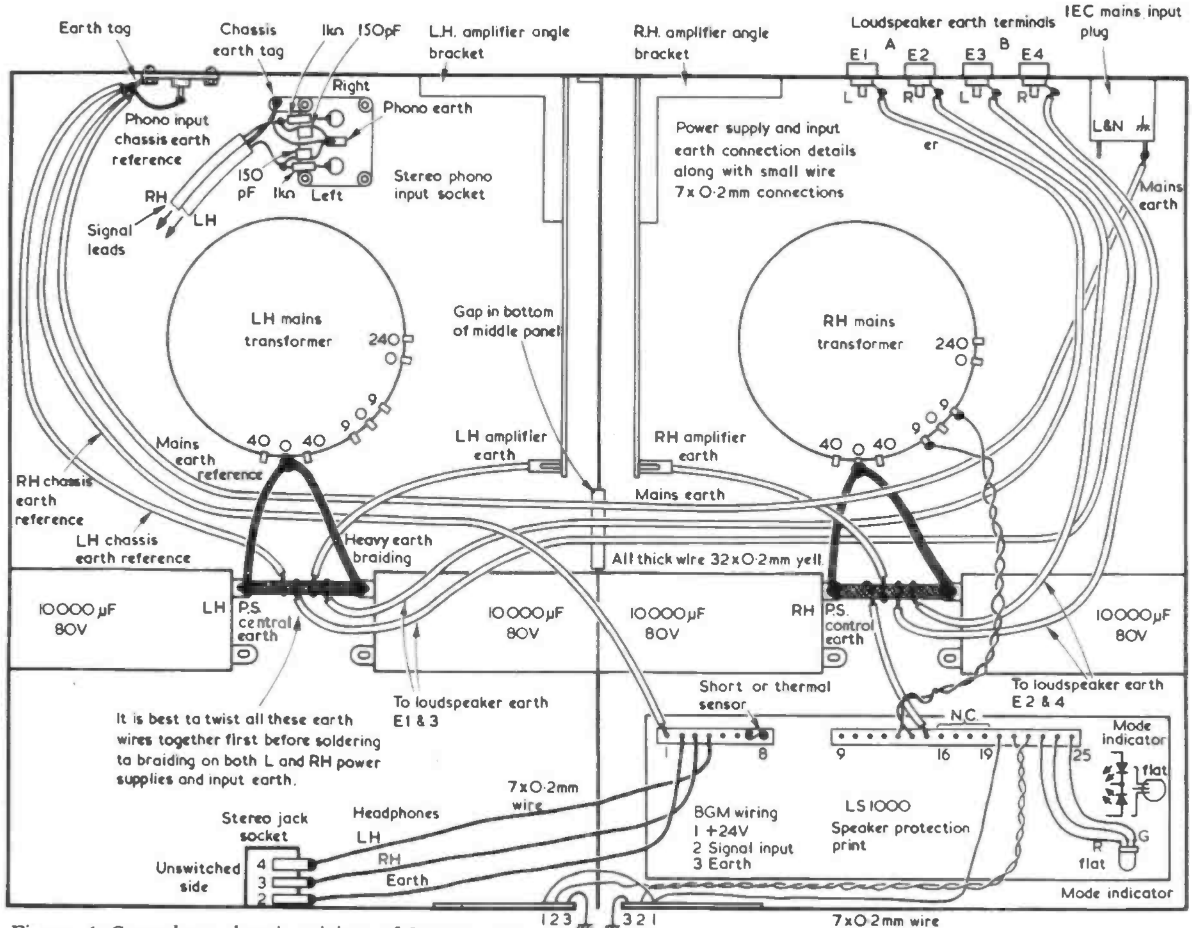


Figure 1 Complete chassis wiring of H.Mos. PA

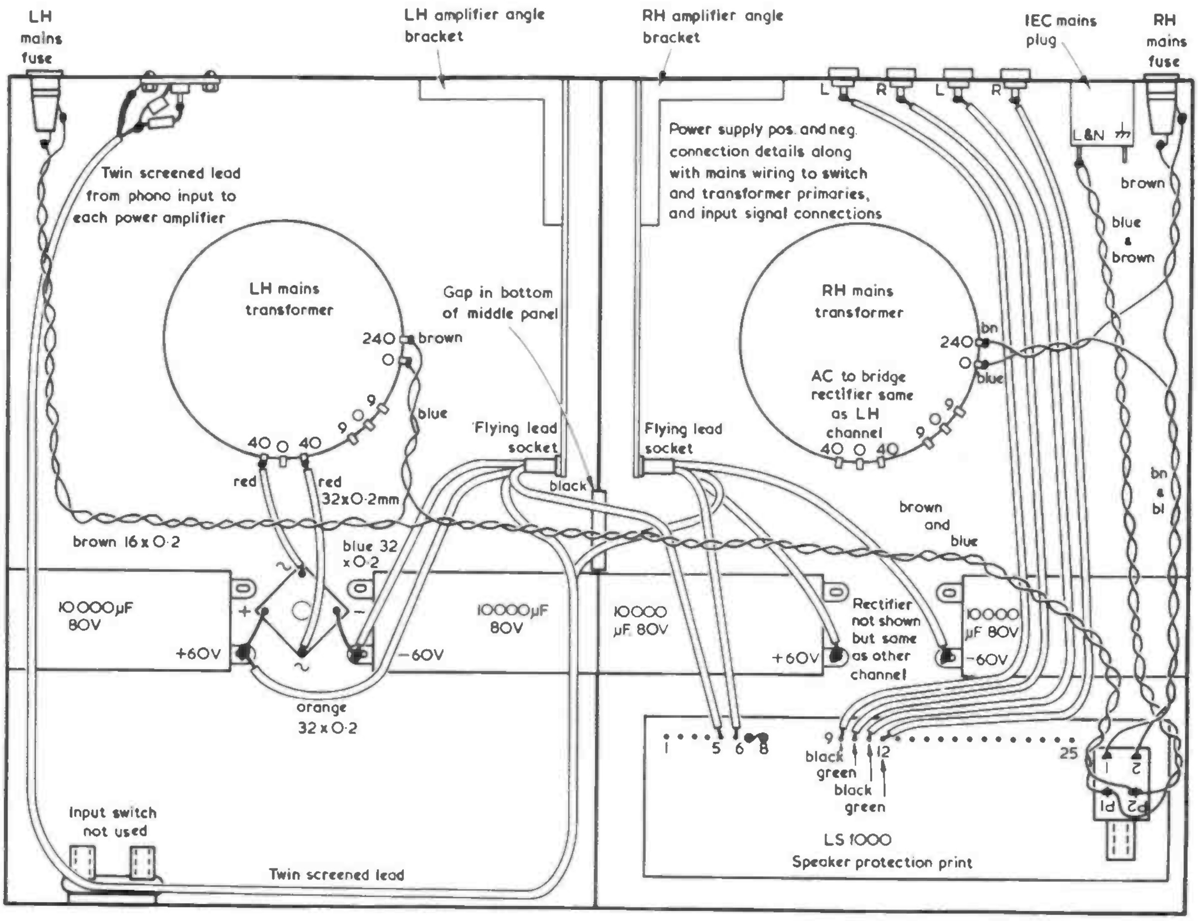


Figure 1a Complete chassis wiring of H.Mos. PA

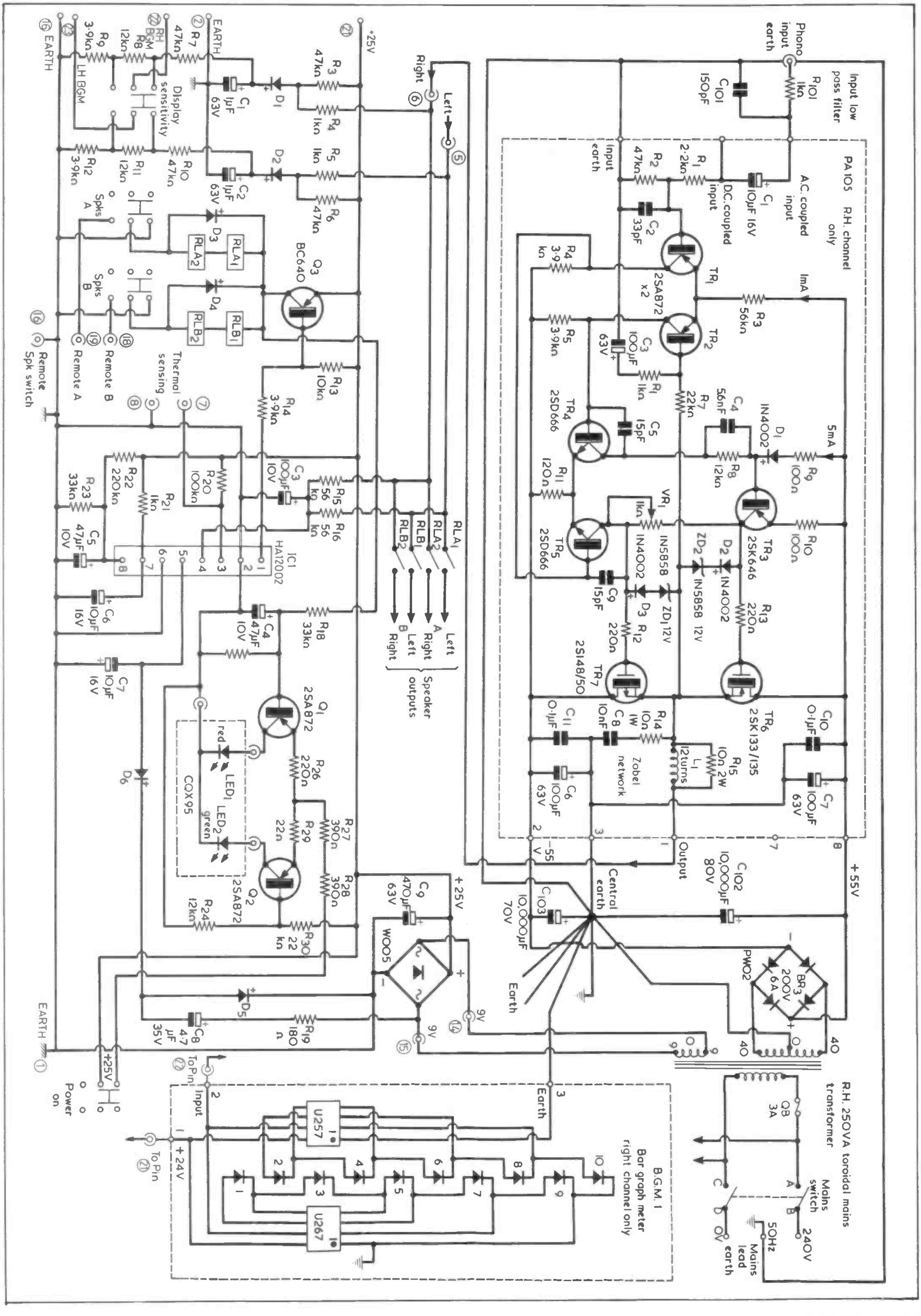


Figure 2 The complete circuit of final amplifier

it inside out on the front panel. Power to the display boards is derived from the LS1000 PCB.

If that is not used, the 25v DC should be sourced separately. Next to the BR1000 there is a hole for fixing a stereo jack socket for headphone connection.

Get it together

At this stage, it is a good idea to screw together all the panels, leaving the base plate until later, as this will facilitate easier wiring of the unit up to the point where the transformers and rectifiers are to be fitted. Nevertheless, the wires to these devices can be prepared and soldered at the 'other' end i.e. mains switch and fuse holder.

For the correct layout of the internal wiring it is advisable to follow the two diagrams *(1&1a)* which have been split for the purpose of simplifying the drawing. It is very important that the correct wire thicknesses are used, as some of the currents involved in the circuit would be severely restricted by too small a conductor, leading to poor performance and reliability.

All loudspeaker leads and earth returns, HT, and high current earth leads should be at least 32/0.2mm type and preferably in various colours. Mains wiring to transformers switch and fuses should be with wire of no less than 16/0.2mm and in different colours (brown and blue).

Apart from the heavy braiding used for the power supply earth and the twin screened lead for the input - the rest of the wires can be 7/0.2mm type in different colours. (see diagram for details).

When wiring up the power amp modules it is possible to either hardwire to the PC plug or make up a flying lead socket which can be assembled before the modules are actually installed into the rear panel. The wires should be cut and stripped to length, trimmed and crimped into large .2" connector pins, finally soldering until perfect high quality connections have been made. They are now ready to be inserted into a vacant 8-way socket strip, making sure that they click home fully.

The base plate can now be fitted and the bridge rectifiers can be soldered into the smoothing capacitor lugs. Fastening the bridge rectifier to the base plate, which will act as a heatsink. The smoothing capacitor clips can now be tightened to secure the whole assembly.

Heave Ho

The mains transformers should be left until now,as they are obviously very heavy and make the task of moving the partly assembled amplifier around more difficult. They also make it difficult to wire around them as they take up a lot of space. It is an advantage to have the connecting wires to the primaries ready to solder, so that when you lower the transformers into place, it is just a simple matter to attach the mains wiring.

Pass the M6 x 75mm coach bolt through the base plate and through the middle of the transformer locating the square section with the square hole, and then fit the 25mm plain washer and 6mm nut - tightening up to a point where it can just be moved round. Final alignment and tightening should be carried out after the secondary connections have been made. Follow *Diagram 1* for details of connections.

Serious hum problems can occur if these instructions are not followed.

Having wired the system completely, install the PA modules. The best technique is to mount the extruded black heatsink onto the bracket that holds the PA105 PCB and FET's. It may be that you have chosen to use the four FET version in which case it is advisable to join the channel bracket to the heatsink first, before hardwiring the second pair of FET's to the PCB.

Unscrew the rear panel so that it can be folded backwards enabling easy access to the eight heatsink fixing holes. Having secured them, refit the rear panel with its PA modules and make the final preparations before switching on. Make sure the LED mode indicator is positioned in a visible position and remove the fuse from the left-hand mains supply.

Test Procedure

Check that the power supply voltage on the right hand PSU is approximately 60v DC on the capacitors, and +25v on pin 19 of the LS1000 PCB. The same should be done for the left-hand supply. **NB** These measurements should be taken with the PA modules disconnected in case anything is wrong.

If all is well, proceed to test the LS1000 circuit. The mode indicator will light - initially glowing red, and in a fault condition change from green to red. The relays will not be switched on while the LED is glowing red. Whilst the PA modules are disconnected, the resistors R4 and R5 (1k) will be floating at about 10v, due to their connection to the +25v rail via R3 and R6 (47k). This will indicate to the HA12002 that there is a DC offset on the PA module, which is false, since it is not connected. To simulate a properly running pair of PA modules' short pins 5 and 6 (LS1000) to ground via pin 8.

(This procedure is slightly different to that given in part I)

After a period of approximately 4 seconds, the red LED should turn green -indicating that all is set to go. **NB.** The relays will only engage if the green LED is 'on', and either the speaker selection switches have been pressed - or pins 17 and 18 have been grounded via pin 16, the remote selector switch.

Taking the heat off

It is also important to make sure that if you are not using the thermal sensor position (low is off, high is on), pin 7, then this should also be grounded via pin 8 - otherwise it will offer a fault condition to the HA12002. If all tests check out on the LS1000, you can pass on to the PA105. The test procedure for this was described in Part II, but briefly: check the modules one at a time without a speaker or load connected, and make sure that the quiescent current is adjusted with pre-set VR1 to approximately 80mA. Start with the preset in minimum resistance configuration (minimum current), and work 'up'.

The LS1000 will obviously not function properly until both PA modules have been connected and shown that there is an acceptably small amount of DC offset present at their outputs. The bar graph meters are supplied with audio via the LS1000. This is rectified and smoothed, and presented to the U257/267 as a variable DC voltage. The ICs used are of logarithmic law, and the scale on the control panel is calibrated accordingly -with OdB being calibrated as 5W and 80W on the low and high level ranges respectively.

Are you getting enough?

The sensitivity of the amplifier at 120W into 8 output is 1.25v RMS. (3.5v peak to peak - but if this is too low, then the BR1000 circuit can be used to boost this to 0.5v RMS. (1.4v peak to peak).

The other function it performs is to phase-split the input signal, so that the positive half cycle goes to one channel and the negative to the other. Providing the loudspeaker is connected across the left and right 'live' terminals and **not** earth, then the unit can be used as a mono-amplifier with approximately 4 times power output potential, i.e. 120W stereo becomes approx 400W mono.

For the 4-FET version run into a 4 load, a potential in excess of 600W is available. This is only designed to handle transient information and not continuous output levels.

Tests have shown that most modestly rated loudspeakers can withstand short term transients, but will give up the ghost if used with small power amps which are run into clipping frequently.

The End is Nigh...

Finally, if everything seems to be working satisfactorily, then proceed to fit the front panel. Line up all the LED's on the bar graph and fitting the panel over them before attempting to fit the push buttons.

Secure the control panel with the bolts running through the handles, fit the push buttons and insert the mode LED into place and glue in if it is not a 'tight' fit. Fitting the vinyl cover is made easier by standing the unit on its handle and putting the cover on from the rear. When the cover reaches the inner front panel, look up the middle so that it can continue to be flush with the control panel. When screwing this to the rest of the chassis, make sure there is a good electrical connection between the two, by scraping a small piece of the vinyl away from the fixing hole if necessary.

Full construction details are supplied with the hardware kit if there is any doubt.

Final Tips

When connecting to your pre-amp, make quite sure that the phono connections are of high quality, and that they are a tight fit. It may be necessary to remove the mains earth lead if a hum loop is occurring (check for hum with the volume control backed completely off) in which case make absolutely sure that the pre-amp is correctly earthed via the mains.

Good Listening. ■

Your Reactions.........	Circle No.
Immediately Applicable	290
Useful & Informative	291
Not Applicable	292
Comments	293

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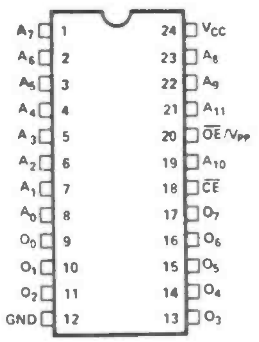
The 2732 is a 32,768-bit ultraviolet erasable and electrically programmable read-only memory (EPROM). The 2732 operates from a single 5-volt power supply, has a standby mode, and features an output enable control. The total programming time for all bits is three and a half minutes. All these features make designing with the 2732 in microcomputer systems faster, easier, and more economical.

An important 2732 feature is the separate output control, Output Enable (OE) from the Chip Enable control (CE). The OE control eliminates bus contention in multiple bus microprocessor systems.

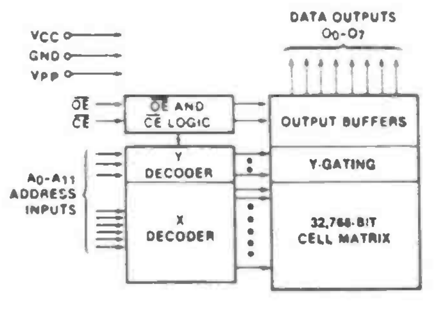
The 2732 has a standby mode which reduces the power dissipation without increasing access time. The maximum active current is 150mA, while the maximum standby current is only 30mA, an 80% saving. The standby mode is achieved by applying a TTL-high signal to the CE input.

Please allow 21 days delivery

PIN CONFIGURATION



BLOCK DIAGRAM



PIN NAMES

A_0-A_{11}	ADDRESSES
$\overline{CE}$	CHIP ENABLE
$\overline{OE}$	OUTPUT ENABLE
O_0-O_7	OUTPUTS

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NEWS BACKGROUND

UOSAT FLIES!

At 1.27pm (BST) NASA fulfilled their launch promise and placed the 70kg 836mm long educational spacecraft within 1Km of the predicted 560Km altitude polar orbit, and within 1.5secs of the orbital timetable. The 2 metre (145.825MHz) downlink can be received using only a simple co-linear aerial.

The narrow band FM (NBFM) signals are circularly polarised to overcome aerial alignment problems which could arise with varying spacecraft attitudes, and with the simple fixed receiving aerials which many people will be using. Thus both horizontal and vertical receiving aerials will be satisfactory. In fact, although the UOSAT team use a computer controlled ten element scanning yagi which is giving S9 signals, they recommend that the receiving stations need use nothing more complicated than, for example, two crossed dipoles thereby giving a wide-beam aerial response. Ground Station operators at University of Surrey will be pleased to receive signal reports, but don't forget to allow for the +/-3kHz Doppler shift on 2m and the 11kHz shift on 70cm.

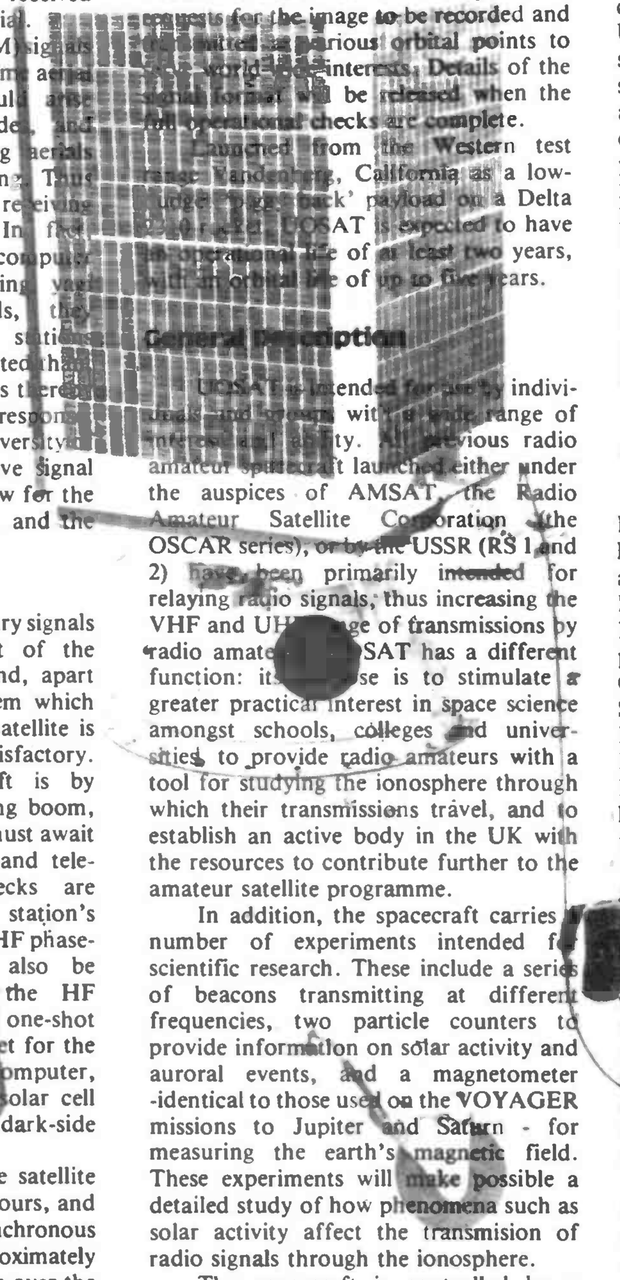
Test Procedure

At the moment, only telemetry signals are being transmitted as part of the satellite check-out procedure and, apart from a low temperature problem which should correct itself when the satellite is stabilized, all appears satisfactory. Stabilization of the spacecraft is by 'gravity gradient' utilizing a long boom, but the extension of this boom must await the proving of the command and telemetry links. When all checks are completed to the ground station's satisfaction the 70cm, HF and SHF phase-synchronised downlinks will also be brought into service, with the HF antennas being deployed by a one-shot explosive bolt. The power budget for the satellite, including the onboard computer, is 11.5W. This is met by the solar cell output with battery backup for dark-side operation.

At the time of writing, the satellite has been aloft for less than 24 hours, and preliminary checks on the sun-synchronous orbit confirm a period of approximately 95.2 minutes with about 6 passes over the UK per day including 4.00a.m. and 4.00p.m. (BST.) The satellite will be above the horizon for up to ten minutes in each pass, during which time it will transmit a single Slow Scan TV frame of 256 x 256 pixells over a period of about 3.5 minutes. The image from the earth pointing camera can be recorded at any pre-determined time during the orbit according to the computer instructions sent from the Surrey Ground Station.

When the satellite is declared fully operational in late October/early November, it will be possible for the Ground Station staff to respond to requests for the image to be recorded and transmitted at various orbital points to [illegible] world-wide interests. Details of the signal format will be released when the full operational checks are complete.

Launched from the Western test range Vandenberg, California as a low-budget 'piggy-back' payload on a Delta 2310 rocket, UOSAT is expected to have an operational life of at least two years, with an orbital life of up to five years.



General Description

UOSAT is intended for use by individuals and groups with a wide range of interest and ability. All previous radio amateur spacecraft launched either under the auspices of AMSAT, the Radio Amateur Satellite Corporation (the OSCAR series), or by the USSR (RS 1 and 2) have been primarily intended for relaying radio signals, thus increasing the VHF and UHF range of transmissions by radio amateurs. UOSAT has a different function: its purpose is to stimulate a greater practical interest in space science amongst schools, colleges and universities, to provide radio amateurs with a tool for studying the ionosphere through which their transmissions travel, and to establish an active body in the UK with the resources to contribute further to the amateur satellite programme.

In addition, the spacecraft carries a number of experiments intended for scientific research. These include a series of beacons transmitting at different frequencies, two particle counters to provide information on solar activity and auroral events, and a magnetometer -identical to those used on the VOYAGER missions to Jupiter and Saturn - for measuring the earth's magnetic field. These experiments will make possible a detailed study of how phenomena such as solar activity affect the transmision of radio signals through the ionosphere.

The spacecraft is controlled by a powerful on-board computer based around an RCA 1802 MPU. The computer's instructions will be 'loaded' from the Surrey University Command Station, and can be changed during flight as desired.

One experiment of special interest to school and college science groups in the earth-pointing camera, covering a 500 x 500km (300 miles square) area of the earth's surface; this is equivalent to most of England south of Newcastle, or the whole of Scotland. The image will be formed on a solid-state charge-coupled device (CCD) and stored in the spacecraft computer until transmission to ground. Unlike images from conventional weather satellites, the picture will be transmitted in such a way that it may be readily received and stored by a simple receiver and can be displayed on any domestic TV set. The pictures will have a resolution of about 2km and will show 16 grey levels, with land features and land/sea boundaried being enhanced. Experimental data in graphical form will also be available by the same link. Among the special features in its communications systems is a voice synthesiser which will 'speak' information, in English, using a vocabulary of about 150 words.

Assembly

UOSAT is being built at the Department of Electronic and Electrical Engineering of the University of Surrey, at Guildford. The project Manager is Dr Martin Sweeting, a graduate of the Department. The primary sponsors of the project are the UK, USA and West German sections of AMSAT (Amateur Satellite Corporation); British Aerospace; British Telecom; Ferranti Ltd; MEL Ltd; Racal Ltd; and the Radio Society of Great Britian. Over twenty other companies have provided components, effort, test facilities and other support.

Project funds amount to about £80,000 - but the true cost is likely to be around £250,000 because of the many gifts in kind and the loan of valuable facilities. In addition many staff and students give assistance in their spare time which is, of course, not costed. As usual, inflation has had a serious effect and it is now likely that the costs are likely to exceed the sums available by some £10-15,000. Means of raising the balance are now being sought.

Progress reports in the form of daily bulletins are available on Guildford (0483) 61202 and on CEEFAX (page 258: BBC2) and ORACLE.

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IN YOUR WORKSHOP

Every now and again Lady Luck smiled on Dick and his endeavours. And on this late Autumn morning Dick's luck had been phenomenal. He had successfully found the snags in no fewer than two colour televisions, one monochrome portable television, one music centre, one record player and an AM/FM clock-radio with digital readout.

This last item had had him worried though. Its label said only 'Dead', with no clue as to the nature of the fault or faults and no indication as to the manner of its demise. Had it been hurled across a bedroom by a sleeper disturbed by the gentle but sudden and unwelcome tones of Terry Wogan? Or had it been accidentally wet-soak tested by a housewife distracted from the dishes by 'Diddy' David Hamilton's doings?

Revelation came as soon as Dick had removed the back. Over enthusiastic use of the earphone jack had loosened it in its single-hole fixing in the plastic case. It had then been rotated once or twice, no doubt by the tangled earphone cord and had broken one of the three multistrand wires soldered to its tags.

A minute later and the set was functional again, thanks to Dick's deft touch with the iron.

Dick smiled to himself as he adjusted the set's clock to read what he thought was the correct time. His first sight inside the set had taken his breath away when he saw a huge 40-legged IC with all the logic and other clever stuff hidden in it's fat black body. It was probably riddled with goodness-knows-what problems. So we can understand his relief on finding that it was only a simple 'wire off' job, which he had easily cleared. And as Dick himself would have admitted, he might not be too hot technically but he could sure solder good.

Still, the easiness of the cure left him with a little nagging doubt, so he placed the set up on the shelf over his bench, tuned it in to Radio 1 and left it to run for a few hours electrical soak test.

Dick then resumed his headlong rout of electrical faults. The next challenger of his technical acumen was an AM radio housed by some imaginative Far Eastern entrepreneur inside a model of 1912 Simplex vintage four seater car. Never let it be said that the life of a service engineer lacks variety.

'Deaf' said the label.

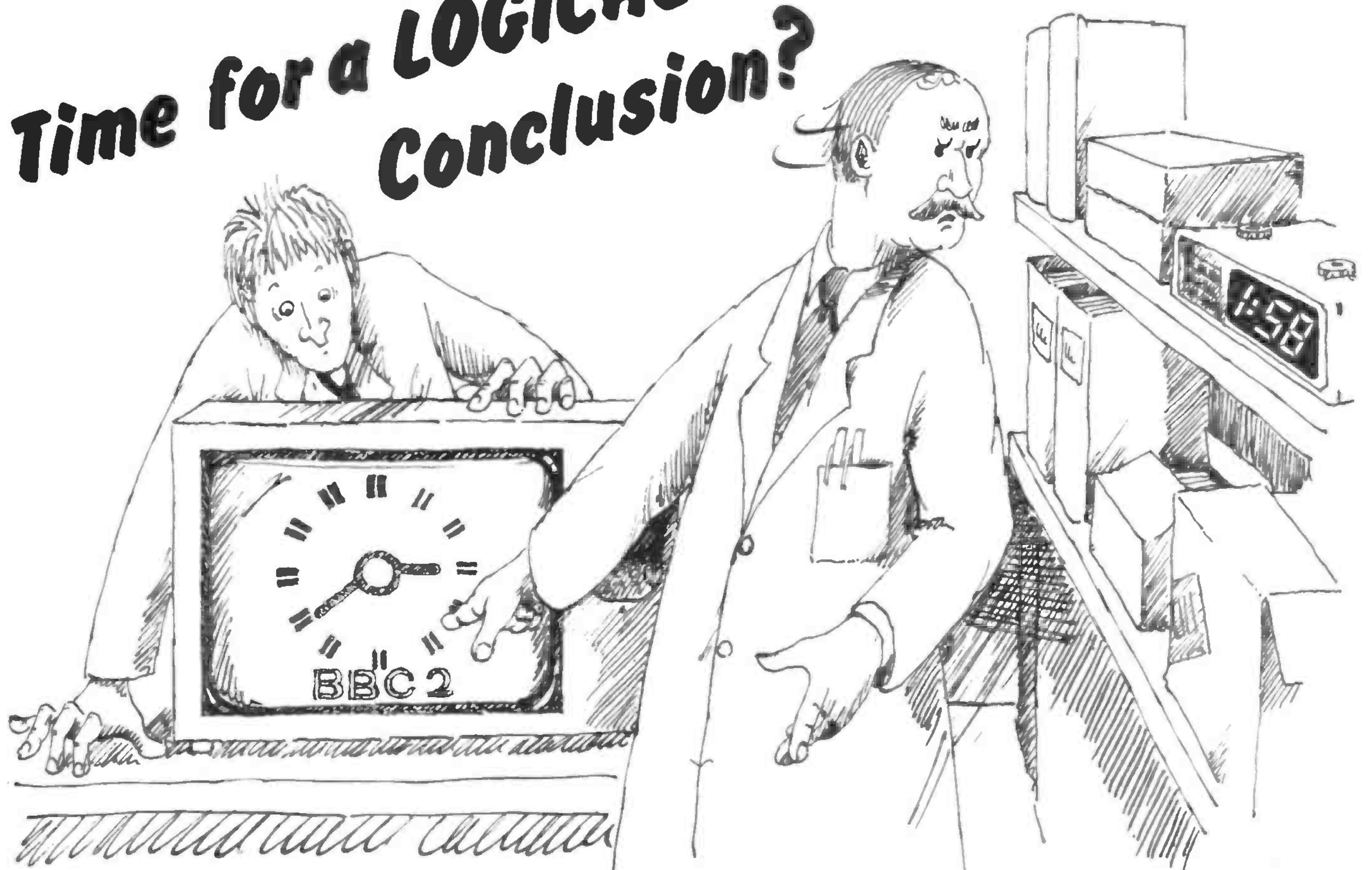
"Simple" said Dick to himself as he undid the single self-tapping screw which allowed the whole model to fall apart, revealing a few transistors, coils and other components, all very badly assembled onto the PCB.

With the aerial rod, PP3 battery and tiny loudspeaker all dangling on thin wires, and with the tinny sound of Radio 2 competing with Radio 1 from the clock-radio on the shelf, Dick peered closely at the board looking for clues.

"There," Dick muttered to himself. "Someone's been having a 'go' at this." Engrossed, Dick picked at the fresh solder joint under one of the transistors. He turned up the volume, waved the aerial rod around and dabbed a finger randomly among the soldered joints. The miniature loudspeaker squawked tinnily and as he dabbed and poked, it screeched and buzzed with surprising ferocity.

Amid the bedlam of Radios 1 and 2 combined, Dick was lost in his own thoughts about soldering practices and customers who tinkered with sets before sending them in and the people who buy radios in model cars and the fragility of wires, especially wires supporting heavy aerial rods and PP3 batteries and the clever Far Eastern gentlemen who made these things and the awful standard of workmanship,

Time for a LOGICAL Conclusion?



mind you it worked OK and they sold all they made which only goes to show, and after all, they probably also made that 40-legged IC so however you look at it...

"Turn it off!" yelled an irate Smithy. "For heavens sake how long are you going to stand there with your mind 'in neutral' - are you life testing the battery - or my nerves?"

Dick jumped visibly and dropped the works of the little radio. There was a sudden silence.

"I'm sorry..." he started.

"OK, OK" snapped Smithy. Then he added, "I didn't mean to shout but honestly do you *have* to make so much noise? You've got one radio on, must you test another one at *full* volume?"

Dick looked crestfallen. He'd had a very successful day so far, and there was no need for Smithy to...

Smithy interrupted his thoughts. "Look," he said, "*I'm* not getting anywhere either. So lets break off for lunch now."

But this was adding insult to injury. Dick had had a very successful morning and now he felt slighted.

"Rubbish," he said, and added pointedly, "*I've* had a good day so far."

"Fine," replied Smithy wearily. "But why all the noise?" Dick looked at the silent 'heap of works' on his bench.

"It's supposed to be deaf," he said. "Ah look," he pointed to one loose wire which had detached itself from the speaker when he had dropped it. Quickly he unclipped the battery, performed another swift exhibition of soldering dexterity and reconnected the battery.

Once more Radio 2 joined the incessant hammer of Radio 1.

"It doesn't sound deaf to me!" shouted Smithy with unnecessary force.

Dick found the little volume control and turned down Radio 2. "Oops sorry," he muttered, and reaching up he also reduced to a whisper the volume of Radio 1 on the digital set.

"Try Radio 1 on that one," said Smithy pointing to the heap on Dick's bench.

Dick tried retuning, but to no avail. All was silent. "Well I'm blowed," he said. "It gets Radio 2 and nothing else!"

"Interesting," agreed Smithy as he went over to Dick's bench for a closer look.

"Awful soldering," said Dick trying to be helpful. "Looks like they've tried to tidy it up," he added.

"Have they indeed," said Smithy. Both servicemen knew who 'they' were. 'They' were the customers who 'bodged' things. "Ye-es, so I see," he said looking closely at the aerial rod. "Look at that."

Dick peered at the coil on the ferrite rod. "What's wrong?" he asked.

"They've glued it that's what," said Smithy. "And they've used UHU, or some such, instead of beeswax."

"Does that matter?" asked Dick.

"Very much so," answered Smithy. "Clean off all that stuff and check the tracking. But fix the coil with *wax* when you've finished."

Smithy continued making the lunch-time tea while Dick made good the ravages of 'them-the-bodgers'.

Soon the little set was squawking again, but now it squawked happily on stations all over the Medium Wave.

"You see only Radio 2 was strong enough to overcome the RF losses caused by that glue," explained Smithy.

"And the aerial tuning was a fair way off," added Dick.

Two minutes later, fitted with a new PP3 the rebuilt model car-radio was sitting on the 'Repaired' rack.

Smithy placed a steaming mug of tea on Dick's clear bench.

"It's been a good morning," said Dick with contrived nonchalance.

"Yes," agreed Smithy. "You've done well. I was watching you tear into some of those faults. But what was the problem with that one?" he asked nodding towards the digital clock radio on Dick's shelf.

"Oh, just a wire off," replied Dick dismissively. "No problem at all."

"I was a *little* worried when I saw you pick it up," remarked Smithy.

"No need - no need," expostulated Dick.

"Did you know it was CMOS?" asked Smithy.

"See what?" replied Dick.

"CMOS," repeated Smithy. "The main IC in that set is a MSM5524. It gives the digital readout of the tuned frequency and its a clock as well."

"Blimey," muttered Dick. "How much logic is there inside it?"

"I really haven't a clue," smiled Smithy. "If you count individual gates and things there must be hundreds perhaps thousands. But the main thing is that when you deal with this CMOS technology, you must avoid the possibility of accidentally damaging it with high voltages from static charges."

"Do you mean static electricity?" queried Dick.

"Exactly," explained Smithy. "You see these CMOS devices can have extremely high input impedances, so any static charge you build up won't be safely leaked away by the device. It will appear as the full voltage."

"But wait a minute," protested Dick. "Who says I've got high static charges ?"

"We all have sometimes," explained Smithy. "Just by walking across a man-made carpet you can build up a charge of hundreds of..."

"Carpet!" cried Dick. "What carpet? We've only *just* got lino!"

"Vinyl floor covering actually," corrected Smithy with a smile. "But for all I know it could have the same effect. And with the electric heating we have now, instead of the old paraffin heater -well the humidity is much lower."

"You mean its drier," commented Dick who, having drained his mug was now refilling to the brim.

"Yes and it all adds up to the probability of static charges building up. You see they can't leak away through the floor or the atmosphere as they used to."

"Well I'm blowed," remarked Dick. "So I'm standing here all highly charged. I wondered where my energy was coming from this morning. I'd better sit down."

"Sitting down isn't the answer," chuckled Smithy. "You can get charged up by wriggling around on a stool, especially if you're wearing things made with man-made fibres."

Dick looked down at his jeans.

"That's why our white dustcoats are cotton and not nylon," explained Smithy. "The nylon coats were cheaper but they would be too likely to cause problems. Natural fibres are better conductors and are less likely to allow charges to build up."

"My mum says she thinks you should have bought nylon 'cos it washes easier," added Dick suddenly.

"It certainly does," agreed Smithy. "And it doesn't get dirty so quickly, but we must remember the static!"

"So what do you do with this-er-see stuff?" asked Dick.

"CMOS," repeated Smithy carefully. "Well first make sure that your soldering iron is earthed," started Smithy.

"Right," said Dick. "But what about our static?"

"Well earth yourself before touching any CMOS circuitry."

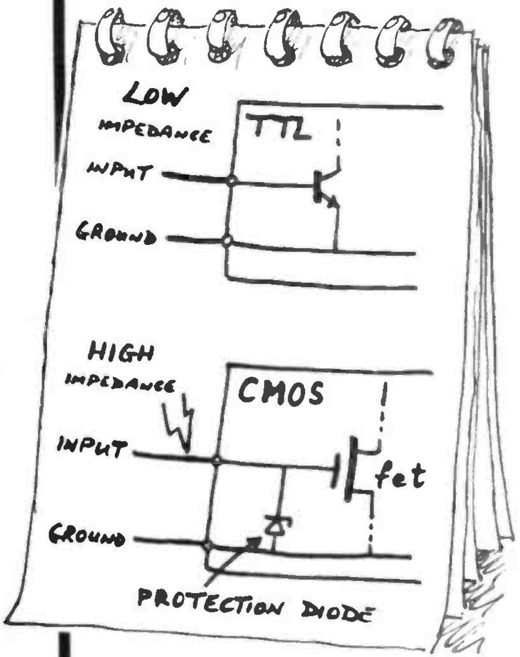
"Oh come off it!" exclaimed Dick. "You always told me when working on EHT never to touch the chassis with my other hand. You even said to keep it in my pocket - not that you ever do!"

Smithy grimmaced. "OK so its a matter of judgement. In the case of EHT *I'm* the one who's likely to be damaged so I avoid being a 'bridge' as best I can. I even put my watch with it's metal strap into my jacket pocket. But when dealing with CMOS we have to be careful not to put these high voltages onto the chip leads. Although they're usually fairly safe when they're soldered into a circuit."

"So what should we do?" asked Dick.

ground, or chassis, with your finger before touching the IC and if you remove the IC from the board, keep it in a piece of that conductive black plastic foam or wrap it in a piece of aluminium kitchen foil."

"How about that polystyrene stuff instead," suggested Dick.



"*Definitely* not," replied Smithy quickly. "You see polystyrene is an extremely good insulator, so in a dry atmosphere it will hold a high charge on its surface even if it is only brushed once by a piece of material. Even separating it from another piece of polystyrene can charge it up."

"But you sometimes use a sheet of the stuff over your bench," objected Dick.

"That's because the benches were always slightly damp and sometimes injected mains hum into working PCBs which were laid straight down on them. So I used to use a sheet of expanded polystyrene to lift the board clear of the bench. But it isn't necessary now since we did up the Workshop. There's the new 'dry' electric heating and I've earthed the bench tops."

Dick snorted. "But they're wood -or chipboard or whatever - how can you *earth* them?"

"I stapled three bare copper wires about 9 inches apart underneath each bench top and connected them all to earth," explained Smithy.

Dick peered under his bench. "Strewth!" he cried. "So you have -we're wired for earth!"

"It's all useful, to cut down hum and static build-up. Mind you, these MOS devices are much more robust these days because they usually have protection diodes included in their fabrication."

Dick looked thoroughly crestfallen. "You know Smithy," he said resignedly, "I'll never understand all this."

You'll manage," said Smithy. "The thing is to learn the basics and then keep up with current techniques and technology."

"But you said these MOS devices have protection diodes - what on earth are *they*?"

"Look here," said Smithy, sketching on his pad. "Here's an input to a MOS device."

"Funny looking symbol," remarked Dick.

"That's an FET," explained Smithy. "It has an insulated 'gate' instead of the usual transistor 'base' which means that among other things it has a *very* high input impedance. In fact its like an open circuit for all practical purposes. But it can only withstand a few volts."

"So if you stick your finger on it, it could get blown," finished Dick.

"Crudely put, but direct and to the point," agreed Smithy. "But this protection diode acts as a zener. If the input volts go too positive or too negative, then it conducts and helps to limit the voltage to safe levels. Normally it isn't conducting at all so it has little effect on the performance of the IC."

"Stands back in amazement," intoned Dick, taking one dramatic step back.

Smithy smiled. There was silence for a few moments while the two companions were lost in their own thoughts.

Dick replenished their mugs again.

"Could we have a session on FETs sometime," he asked.

"Well we didn't finish the logic," replied Smithy, glancing at the clock radio over Dick's bench. "Shall we cover a bit more of that before we start the afternoon stint," he suggested.

"OK," agreed Dick affably. "I understood all that stuff about relay contacts and diodes, and thinking back to their session on the AND and OR gates he added, but tell me again why we have it - I mean what use is it ??"

"It's digital," explained Smithy. "That's one short answer. For example take that colour set over there on my bench. Now, is the convergence correct or not? You can't say exactly because the end result, the picture purity, is a 'variable' so you adjust it to be as accurate as you can get it. Analogue signals are like that. They are never *exactly* right - only as near to correct as we can afford to make them."

Smithy paused as Dick thought about the words 'analogue' and variable.

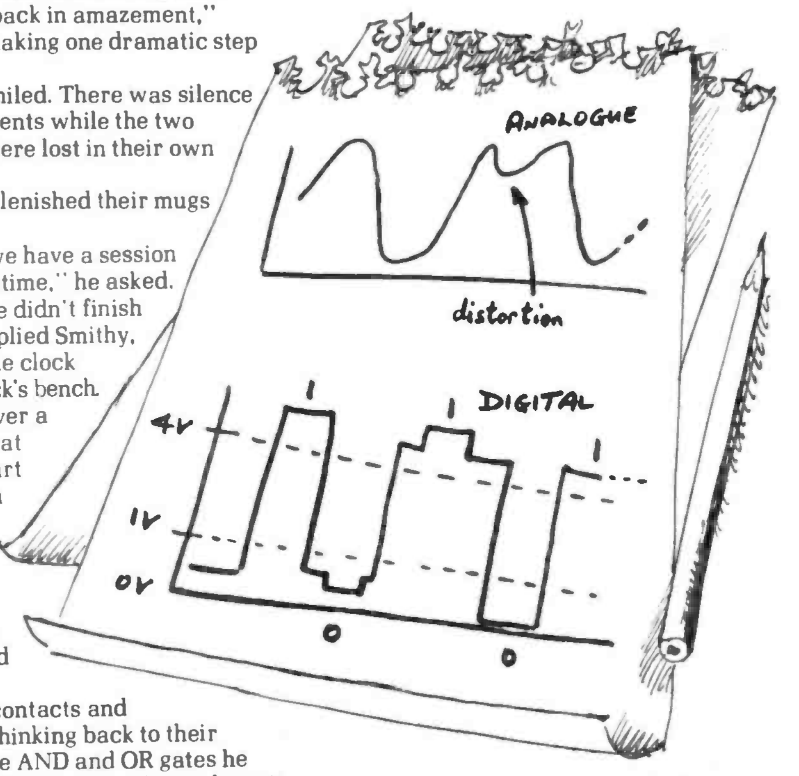
"But now look at the problem you had with the loudspeaker wires this morning," he continued. "Were they connected or not? You can give an absolute answer. Either they are, and the set works - or they're not and it doesn't. Digital signals are like that. Either they are 'high' because the voltage is above say 3 volts, or they are 'low' because the voltage is below say 2 volts.

"What about in between?" demanded Dick.

"Between 1 volt and 4 volts we ignore the signal and assume that it is still where it was before," replied Smithy.

Smithy sketched two signals to illustrate his point.

"You see if the analogue signal is distorted when it's transmitted through a system, or over a communications link, the receiver can't tell. But the digital signal can be very badly



distorted and yet the original information can be correctly extracted because whenever it goes above the upper threshold its a 'one' and whenever it goes below its a 'nought' -and it doesn't matter how high or how low it goes or what it does in between."

Dick looked at Smithy's sketch.

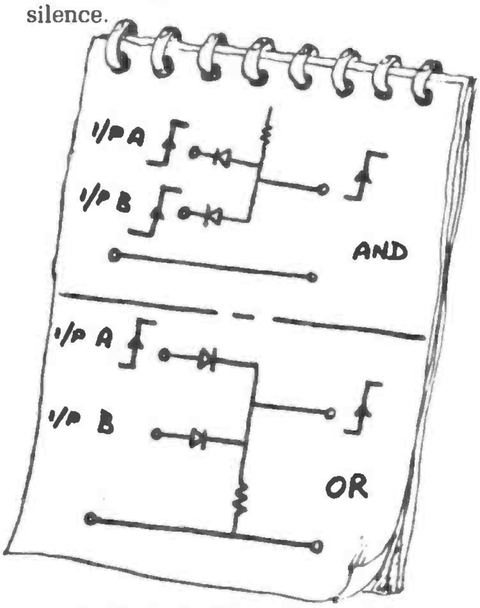
"What good is a signal that only goes up or down?" he asked flatly.

Smithy was stumped for a moment. "Well we can send binary numbers with it," he suggested.

"Then what?" persisted Dick.

"Well then we need to handle them," Smithy added. "With analogue signals we filter them and amplify them and process them in analogue circuits. And it's the same with digital signals, except that then we use digital circuits like counters, registers and logic gates."

Dick digested this information in silence.



Suddenly Smithy said, "Look I can show you both types of signal side by side. In fact they're on the same communication channel." And he pointed to the top of the picture on his Grundig repair job.

Dick peered closely at the picture and after a few moments observed, "OK, so the convergence isn't right. So what?"

"Look more closely," persisted Smithy. "Get right up to the screen."

"The 'height' isn't adjusted, right?" queried Dick.

"Yes, yes, but that's not what I'm talking about," said Smithy. "Look at the top few lines of the raster, just above the proper picture area."

Dick leant forward until his nose nearly touched the screen. "Well I'm jiggered," he said in amazement. 'They're all wriggly and dotty. What's making the lines go like that?"

"That's the digital information for Teletext" said Smithy. Then he glanced at the channel selector and added. "In this case it's the BBC's Ceefax service. All those 'wriggly dots' as you call them are a stream of digital information which is being broadcast simultaneously with the normal programmes. You see they transmit the digital Viewdata signals using the spare lines in the raster. When the height control is correctly adjusted you can't usually see them."

Dick was transfixed, fascinated by the flickering and mysterious signals along the top edge of the screen. "I wonder what it's saying."

"It's building up individual pages of text," explained Smithy. "You see, being a digital signal it's easy to store it and read it out again whenever you want to." Smithy chuckled at Dick's fascination with the strange flickerings and suggested, "perhaps we should have a session on Teletext sometime. But meanwhile I pointed this out to show you one difference between analogue and digital signals. There you have digital signals and on the same screen there are analogue signals giving us..." Smithy paused while he studied the programme, "the BBC2 test programme," he finished.

"How do you store it and read it out again," asked Dick suddenly, still staring at the moving dots. "With lots 'n lots of AND and OR gates?" he added.

"Yes and NAND and NOR gates," enthused Smithy. "Like this look..." And he sketched a couple of simple transistor circuits.

"If you remember those circuits I drew last time, they used only simple diodes," he stated. "Like this AND gate. But the trouble is that the voltage drop of the input diodes means that the output signal levels are always different from the input levels and this gets to be a problem when we use 'lots 'n lots' of them. So we use transistors like this..." and he sketched two more circuits.

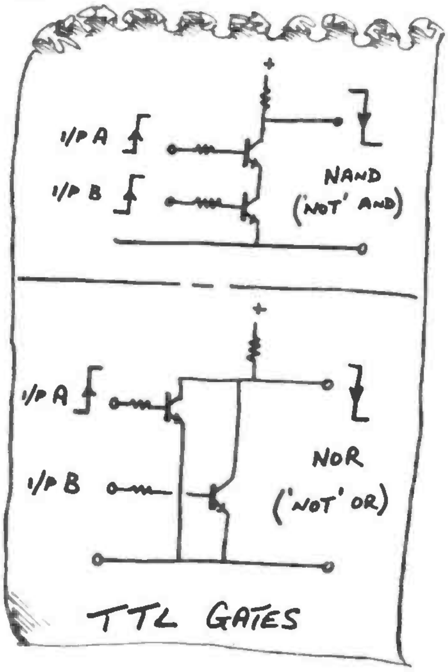
"But we have to be careful of the signal inversion that you get with the transistors so they are called 'NOT AND' or NAND - and 'NOT OR' or NOR -gates. But you see they always give known output voltage levels so we can cascade them."

"Can *what* them?" demanded Dick.

"Put lots of them into complex circuits," explained Smithy. "They can all be put on one integrated circuit to make transistor-transistor logic. Thats TTL. And they put hundreds or thousands onto one chip and that's called Large Scale Integration, or LSI and you can make frequency counters and clocks," and Smithy nodded towards the clock-radio. "And you can make voltmeters with digital readout too - and if you add some memory circuits you can make controllers -*that's* how microprocessors started and..."

But Dick, who had had enough of 'logic' had let his attention wander from Smithy's unstoppable enthusiasm to Tracker the cat who, having finished his lunch time nap, was sidling around for his afternoon saucer of milk. "He's early," remarked Dick grateful for the diversion.

Smithy glanced at the clock-radio over Dick's bench. "Nearly two o'clock. It's only just the end of lunch break," he agreed. Then suddenly he looked again at the TV on his bench. It was now showing the BBC2 clock. In disbelief he went to his jacket and took his wrist-watch from his pocket. "Yes," he cried. "It's twenty to three!" And pointing to the clock-radio he demanded indignantly, "who set that clock wrong?"

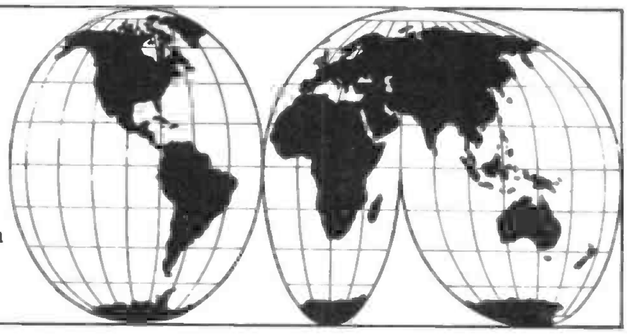


Dick stared unwaveringly at the TV screen. "Wrong?" he said with exaggerated innocence. "But surely it's the BBC1 clock which is analogue. I read that this BBC2 clock is generated digitally so it can't be wrong. Surely that is the logical conclusion!"

SHORT WAVE NEWS FOR DX LISTENERS

Frank A. Baldwin

All times in GMT, **bold figures** indicate the frequency in kHz.



By the time these lines appear in print, the season for the reception of signals from the Far East on the low frequency bands will be in full swing. With some ability and a little luck with the prevailing conditions, the comparative newcomer to the hobby of short wave listening may well find his or her ears assailed by some of the exotic music of Thailand or Indonesia or even from the rarely reported Laos - but more of the latter country next month.

For the period October to March, most of the signal path from these areas to the UK will be in darkness, the path being the short route via Asia, USSR and Northern Europe. It is during this time that Dxers are provided with the best chance of logging Bangkok, Jakarta or even Luang Prabang.

The times to listen are, generally speaking, from around 1430 through to 1630, by which latter time most of the stations have closed down - 1600 being the most common signing off time - and from 2200 to around 0100, the former time being that most favoured for signing on.

The frequencies? Well, why not try the following 60 metre band stations? Rangoon on **4725** try around 1430 just before it closes at 1445; Medan, Indonesia, on **4764** it closes at 1700 but the frequency can vary slightly; Jakarta on **4774** try at 1600; Bangkok on **4830** often received last year and noted for the clanging of gongs and the clashing of cymbals, it closes at 1630; Kuala Lumpur on **4845** features programmes for the Indian section of the population and could be mistaken for a transmission from that country, it closes at 1530 and opens at 2200; then there is Surakarta on **4932**; Hanoi on **4944**; Sarawak on **4950**; Banda Aceh on **4954**; Penang on **4985**; Rangoon on **5040**; or Yogyakarta on **5046**.

Clandestine

Clandestine stations continue to occupy the interest of many listeners, indeed some even specialise in the reception and recording of these transmitters. Two such stations are brought to the attention of readers this month.

"A Voz de Verdade" on **4950** at 2007, OM in Portuguese with a talk about UNITA, this organization being mentioned several times. A Voz de Verdade is anti-Angolian government and pro-UNITA and is thought to operate from Namibia, although some contend it is located in either Central or South Africa - take your pick. The schedule is from 1700 to 1800 in vernaculars and English and from 1800 to 1850 and 2000 to 2050 in vernaculars and Portuguese to Angola. During the 1700 to 1800 period it operates as the "Voice of Namibia".

"La Voz de Cuba Independiente Democratica" on **7355** at 0116, trumpet fanfare, YL with station identification in Spanish with further identification by OM at 0119 and at 0124 each being after a series of chimes. The subject of the harangue was about the Cuban forces in Angola. Sign-off was at 0138 after a further identification, announcements and an Anthem. Schedule unknown at the time of writing.

Namibia

Windhoek on **3270** at 0203, under some utility QRM (interference) the programme material was, surprisingly enough, jazz music Euro-style. This South West African Broadcasting Corporation transmitter operates in English, German, Afrikaans and some vernaculars according to the following schedule, 0400 to 0515, 1615 to 2200. An All Night Service is in operation from 2200 to 0400, this all being in parallel on **4965**. The power is 100kW.

Tanzania

Dar-es-Salaam on **5050** at 1824, a programme of local music in typical-style, it is lilting, non-stop and full of sweet sounding xylophones - that is if you can get under the utility interference often on this channel - try reception on either USB or LSB. This is the Commercial Service in Swahili which operates from 1300 to 2105. The National Service is on the air from 0300 to 0700. The power is 10kW. Dar-es-Salaam may also be logged on **4785** where the National Service in Swahili is in operation from 0300 to 0730 and from 1300 to 2105 except for an English 'slot' from 1600 to 1845. The power is also 50kW.

Comoro State

Nearby the above - well nearly - are the Comoro Islands, just to the north of the Mozambique Channel. Under very favourable conditions it is possible to log Radio Comores, Moroni, on **3331** where it operates with a power of 4kW from 0300 to 0430 and from 1400 to 1500 in Comorian; 1500 to 1600 in Arabic; 1600 to 1700 in English; 1700 to 1900 in French and from 1900 to 2000 in Swahili. Any snags? Yes, plenty. First the frequency can vary down to **3328**; secondly utility QRM abounds and last but certainly not least, Radio Rwanda, Kigali, listed on **3330** tends to either swamp the Comores frequency or even worse to occupy it! Have I logged it? No, but others more fortunate than I have done so this season, all I could hear was Kigali on channel but I did enter Comores into the log book some years ago.

Congo

Pointe Noire on a measured **4843.3** at 2000, OM and YL alternate with announcements in French followed by the National Anthem and off at 2003. This one relays Brazzaville and also features local programmes in the schedule 0445 to 0700, 1030 to 1330 and from 1445 to 2000. The power is 4kW and it is listed on **4843** but wanders at times.

Uganda

Kampala on **4976** at 1955, pop oldies 1960 versions followed by OM with a newscast at 2000 in vernacular. This is the Red Network which operates from 0330 to 2100 in English, Swahili and vernaculars. The power is 7.5kW but from my observations and that of others, this transmitter would appear to be on the air irregularly, disappearing from the channel for long periods only to reappear from time to time. If you really need to log Uganda then a much better chance is provided by tuning to the Soroti transmitter on **5027**, where the National Programme in English, Swahili and French operates from 1300 to 2100 on weekdays, Saturdays and Sundays from 0300 to 0545 and from 1400 (Sunday from 1430) to 2100 with a power of 250kW. Reports to Chief Broadcasting Engineer, Radio Uganda, PO Box 2038, Kampala.

Mozambique

Radio Mozambique on **4865** at 1823, OM with a talk in Portuguese which was also logged in parallel on **3210**. The former channel is not listed and I needed to confirm that it was indeed Mozambique. I have also logged Mozambique on a measured **4981.8**, being entered into the log at 1957, OM with announcements in Portuguese prior to a programme of songs in the same language. It is listed on **4987** with a power of 100kW.

Cameroon

Radio Buea on **3970** at 2110, male chorus with songs in vernacular, YL announcer, orchestra with local music in typical style. This is the Home Service which is scheduled from 0430 to 0800 (Sundays until 0645) and from 1600 to 2200 in English French and vernaculars. Local news in English during the evenings is radiated at 1730 and 2030. The power is 8kW and the address is Radio Buea, PO Box 86, Buea.

Radio Bertoua on **4750** at 1957, OM songs in vernacular, African drums - the drums being the station interval signal. This is also the Home Service (languages as above and the schedule is from 0430 to 0800 and from 1600 to 2208. The evening English programmes are timed for 1800 to 1840. The power is 20kW and the address is Radio Bertoua, PO Box 230, Bertoua, Eastern Province.

Mali

Radio Mali, Bomako, on a measured **4838** at 2021, OM with a newscast in French. The schedule of this one is from 0600 to 0800 and from 1800 to 2400, an English programme is aired on Saturdays from 1820 to 1900. The power is 18kW and if you manage to log this station through the QRM, the address is Radiodiffusion Nationale Mali, BP 171, Bomako.

Equatorial Guinea

Malabo on **6250** at 2006, YL with songs in Spanish complete with guitar accompaniment - reminded me of blood and sand and all that stuff! This is the Home Service scheduled from 0500 to 2205 mostly in Spanish but with some programmes in vernaculars. The power is 10kW and if you are interested in obtaining a confirmation of reception you should write to Radio Malabo, Apartado 195, Malabo, Isla Bioko.

Swaziland

TWR (Trans World Radio) Mpangela on **3240** at 0322, OM in vernacular - presumably a religious programme. To hear this one you must be a real night owl for the schedule is from 0300 to 0345 entirely in vernacular. The power is 30kW.

Tune from the above frequency to nearby **3365** and you will find TWR Mpangela again, as we did one morning at 0327 when a slow sad song by some YL's assailed our ears - there were two of us in the shack at the time - the cat and I. Sooty and me equals we, I do not use the royal we in these articles! Inveterate insomniacs, we both spend many midnight and early morning hours together whilst I go Dxing and he stares utterly perplexed at the strange behaviour of his favourite human being. The **3365** channel is only used however from May to October so you will have to wait until next year for the annual emergency of this one. The schedule is from 0300 to 0330 and the power is 25kW.

Gabon

La Voix de la Renovation, Libreville, on a measured **4777** at 1958, OM with announcements, station identification followed by a newscast in French, all in the National Network which is in French and vernaculars. The schedule is from 0430 (Sundays from 0530) to 0630 and from 1630 to 2400. The power is 100kW and it is a fairly easy station to receive. The address from reports is Radiodiffusion Television Gabonaise, BP 10150, Libreville.

Venezuela

Radio Occidente, Tovar, on **3225** at 0155, Latin American music until OM with station identification at 0200 followed by announcements and then back into the music programme. With a power of 1kW, Radio Occidente operates from 1000 to 0400.

Radio Mudial, Bolivar on **4770** at 0211, OM with announcements in Spanish, local pops on records. Radio Mudial can be heard regularly and often, it is one of the most 'reliable' Venezuelans on the band. The schedule is from 1000 to 0400 and has a power of 1kW. Sometimes operates around the clock and identifies as "Mundia Bolivar".

An unusual Venezuelan is that sometimes heard station YVTO which is a time signal transmitter located in Caracas. Listen on **6100** where the second pips can sometimes be logged. Heard here at 0537 under Cologne broadcasting in English to North America, this D. Welle programme being scheduled from 0530 to 0550, news and commentary only.

Radio Valera, **Valera**, on **4840** at 0332, OM with a pop love song in Spanish. This one identifies as "Su Nueva Radio Valera" and operates from 1000 to 0400 with a power of 1kW.

Ecos del Torbes, San Cristobal, on **4980** at 0305, OM with local announcements in Spanish, YL ballad. The schedule is from 0900 to 0400 and the power is 10kW. This is one of the easiest Venezuelans to receive and if you are interested in obtaining their QSL card, the address is Apartado 152, San Cristobal, Tachira.

Radio Sucre, Cumana, on **4960** at 0308, OM with folk songs in Spanish, guitar music. The schedule is from 1000 to 0400 and the power is 1kW. The address being Apartado 26, Cumana, Sucre.

Chile

Radio Nacional de Chile, Santiago, on **6150** at 0015, OM with a talk in Spanish after identification. Scheduled from 1000 to 1510 and from 1810 to 0350, the power is 5kW.

Colombia

Ecos del Atrato, Quibdo, on **5020** at 0311, OM with announcements in Spanish during a programme of local pops, logged on USB to avoid commercial interference. This Colombian is scheduled from 1030 (variable opening time) to 0400 and the power is 2kW.

La Voz del Cinaruco, Arauca, on **4865** at 0329, OM with announcements in Spanish complete with echo-effect during a programme of local pops. Station identification at 0330. The schedule is from 0900 to 0400 and the power is 1kW. The address is Calle 19, No. 19-62, Arauca.

Radio Super, Bogata, on **6065** at 0020, surprisingly enough, a programme of both English and Spanish pops with the usual announcements in Spanish. This one operates around the clock and has a power of 5kW.

Radio Super, Medellin, on **4875** at 0515, OM with station identification during a selection of sambas etc. Radio Super operates around the clock and has a power of 2kW.

French Guyana

FR3 Cayenne on **6170** at 0005, when radiating a programme of dance music Euro-style, OM with announcements in French.

Peru

Radio San Martin, Tarapota, on **4810** at 0404, OM with folk songs in Spanish after station identification. The schedule is from 0930 to 0605 and the power is thought to be 1kW.

Radio Andina, Huancayo, on **4996** at 0520, OM with station identification in Spanish followed by a programme of Andean music and folk songs in which the theme is repeated constantly, accompanied by pipe music typical of the area - once heard never forgotten. This station is an old friend of mine to which I have tuned many times over the years. Strange to relate, it apparently vanished from the scene some two years ago and was not reported in the short wave press until the beginning of this summer. An old colleague of mine, and a much respected Dxer, Gordon Bennett of Stockport telephoned news of its reappearance as soon as he had identified the signal - thanks again Gordon. Apart from the frequency, which will identify Radio Andina, listen for the hollow echo on the announcements - I have long believed the studio is in a bare brick-walled room!

Radio Libertad, Junin, on **5040** at 0452, Yl with a song in Spanish then Andean guitar and drum music - again typical of the area. The schedule is from 1100 to 0800 and the power is 1kW.

Radio Loreto, Iquitos, on a measured **5049** at 0350, OM with station identification, announcements in Spanish then into a programme of local pops. Radio Loreto operates irregularly but when transmitting is scheduled from 1000 to 0700 with a power of 2kW.

Costa Rica

Faro del Caribe, San Jose, on **5055** at 0420, OM with a talk in Spanish, OM with station identification at 0423. Sign-off with the National Anthem after a further identification at 0426. The schedule is from 1000 to 0400 but the closing time is variable. A programme in English is broadcast daily from 0300 to 0400 and the power is 5kW.

Australia

VLR6 Lyndhurst on **6150** at 2054, OM and YL in English with a news review followed by a weather forecast for Australian regions, 6 pips time-check at 2100 with station identification.

Tibet

Xizang (Lhasa) on **4750** at 2305, OM and YL alternate in Chinese, presumably with a newscast. The schedule is from 2300 to 0130 (Saturdays until 0645), from 0330 to 0645 (not Sundays) and from 1000 to 1545.

Malaysia

Kuala Lumpur on **4845** at 2317, when radiating a programme of Indian type music in the Tamil programme.

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Amateur Radio — Part I
What it's all about!

- by Tony Bailey G3WPO

This is the start of a series of articles about the many facets of Amateur Radio. We will introduce those of you not already aquainted with "*the persuasion*" to an exciting hobby - which will probably last for the rest of your life. We will start with a general introduction, leading to more specific aspects, (including constructional projects), which **WR&E** will be supporting with all the necessary (and sometime 'hard to get') parts, to help you on your way.

Above all, we will be trying to rediscover the art of DIY Wireless along the route, as it seems to have got lost in recent years with the machinations of the Orient appearing everywhere. Hopefully, we will be persuading everyone to dust off their soldering irons, and rediscover which end gets hot.

What is a Radio Amateur?

In many peoples' minds, the Radio Amateur is the 'Ham' with the Hancock image - bumbling around with a lot of ramshackle equipment, and conveying the state of the weather to similar souls in Tokyo or wherever. He doesn't really know what he's doing and can't possibly be of much use to the community.

The reality of the world of Amateur Radio is rather different, and goes back to the days of Marconi and his pioneering experiments - experiments which still go on today albeit in different fields. Do you recall that the 'short waves' were once regarded as unusable - 'so let the amateurs have them as they are no use to any one else'. Consider where modern broadcasting and communication would be without them (better off some would say!). You have the radio amateur to thank for discovering that they weren't so useless after all.

But isn't amateur radio like CB? Definitely not - although CB can provide a useful service if properly used, the restrictions imposed in the licence necessarily limit the communications range and the modes used. With amateur radio you can enjoy world-wide communications (as you can with CB when the rules concerning power get 'bent', but the overall scope is far more limited) on the short wave bands, via voice, morse code, teleprinter, computer, satellite, television and a number of other permitted modes.

You have the *legal* benefit of higher power levels to transmit with (although some amateurs delight in transmitting with the lowest power possible) and can choose to buy your gear, or build the whole lot yourself from the many published designs, or your own if you have the ability.

One of the unique aspects of Amateur Radio, is that when you put out a general call (a 'CQ') you don't generally know who (or what) is going to reply. It may be a 'local' down the road, or someone in Italy - or the only occupant of a remote Pacific Island. Friendships often grow as a result of contacts, and these may be continued for many years, sometimes resulting in visits to places you never dreamed of.

Getting going

How do I start? Well, most amateurs go through the initiation ceremony known as Short Wave Listening (SWL'ing), when they spend long hours just listening on the various bands (HF, VHF, UHF & higher) to amateur stations, and getting to know the various procedures, the language (a rather less jargon-bound form of CB slang), and how to get the best out of their equipment, which may be home built, or bought on the commercial market.

Many concentrate on DX'ing (long distance communications) and try to get confirmatory cards from stations they have heard, called QSL cards. These are usually used to adorn the wall, and can be used to obtain awards of various sorts: from hearing a 100 countries and up, to the more frivolous variety, such as hearing 3 stations in the Old Kent Road!

During this period, most SWL's start to get the urge to transmit and thereby have the capability of *replying* to the stations they hear. Others remain faithful to listening only, and of course there are those who find the hobby is not for them. In order to obtain an amateur transmitting licence (you don't need one to listen though) from the Home Office, a number of formalities have to be completed, including examinations on basic radio theory and practice. You have to be at least 14 years old.

The amateur is going to be let loose with some equipment which has the capability, if improperly used, of creating havoc with other radio services (such as the police, broadcasting and Government stations), so the Home Office wants to make sure that you know how to use (at least in theory) your equipment. You must have a basic knowledge of radio principles, and you must be aware of the various conditions laid down in the Amateur Service licence - notice it is officially called a 'service', and not just a hobby.

This can be equated with passing your driving test - imagine the state of modern traffic with no formal driving test !

This examination is called the RAE (Radio Amateurs Examination) and is held annually (bi-annually in some large towns and cities) by the City and Guilds Institute (subject No.55). A pass in this entitles you to a Class B licence, which has to be separately applied for, together with the fee, and you (or more correctly, 'the station' you operate) will be allocated a callsign, currently in the G6XXX series.

All amateur stations have *callsigns*, the allocation of which is decided by an international authority and these vary from country to country making it relatively easy to identify any one station from the letters forming the prefix.

The *Class B* licence authorises you to transmit in the various bands above 144 MHz by voice (phone) communication only. Many amateurs are content to stay with this licence as it offers many opportunities in a region of the frequency spectrum which still has a lot to offer in the way of pioneering work.

The other form of amateur licence is the *Class A*, and for this it is necessary to learn and be examined on your proficiency with the Morse Code (often called CW). Many people are able to do this with no trouble, others take years and never make it, although the speed requirements are fairly relaxed (12 words per minute transmission and reception). There are a number of aids available to help, from recorded tapes at various speeds, to automatic learning aids based on microprocessors which generate random characters.

Even if you don't actually transmit the code when you get your licence, passing the morse code requirement opens up another world as you can then use all of the short wave bands ranging from 160 metres (1.8MHz) to 10 metres (28MHz). There are currently 6 of these, but another 3 are being added as a result of the recent World Administrative Radio Conference.

To give you an idea of what each band 'does', and the uses it finds, from HF to UHF, a short summary of each band's characteristics follows:

FT-ONE The most sophisticated and expensive general coverage transceiver yet.

160 metres (1.8-2.0 MHz - known as Top Band)

This is the lowest frequency band, just above the high frequency end of the medium wave broadcast band. Power levels are restricted on this band to 10 watts input for a number of reasons, including sharing with other maritime communication services. It is very much a nighttime band for communications up to any distance, and during the day is mainly used for local 'natters'. Aerials tend to be on the large side for good results, but a lot of stations do very well with relatively small aerials, if carefully designed.

'DX' contacts are a real possibility despite the low power, and many more countries have become active over the past year due to changed regulations. Most DX contacts are via CW (Carrier Wave, using morse code), and operating into Europe is no real problem during the hours of darkness. Early morning contacts with the USA are prized, and the ultimate is with Australia (prefix *VK*) during carefully prearranged contacts at certain times of the year - there may only be a few minutes to do this in though!

80 metres (3.5-3.8MHz)

Another of the low frequency bands, and very popular as a 'natter' band throughout the day. Many 'nets' of stations have regular contacts here, especially organisations, clubs and societies such as the Royal Air Force Amateur Radio Society. Daytime contacts tend to be short range within the UK and near Europe; but at night, much longer distances can be covered and DX chasing at the high frequency end of the band is a popular pastime using *phone* (voice).

At this point, it is worth mentioning that phone communication is almost exclusively made using the SSB mode (Single Side Band) on the short wave bands, and has superseded AM (amplitude modulation, as used by broadcast stations on medium wave) due to its far greater efficiency. If you have ever listened on a broadcast receiver with short wave bands, and heard a sound like Donald Duck - then this is SSB - it needs a correctly adapted communications receiver to resolve it properly.

Static interference (lightening etc.) is common on 80 and 160 metres during the summer, and can interfere badly with reception.

40 metres (7.0-7.1MHz)

Some amateurs love this band, others hate it ! During the day it is mainly occupied by stations chatting, nets etc. and covers the UK and Western Europe. At night though, things are rather different, as although the band is

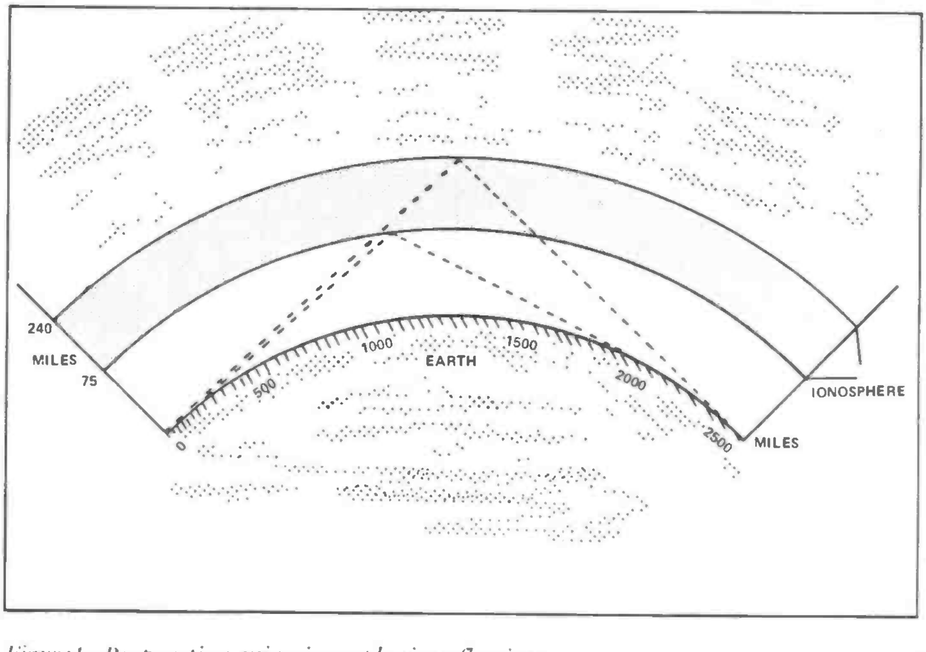

Figure 1: Propagation using ionospheric reflections.

supposedly exclusively amateur (i.e. no other services are supposed to use it) many illicit broadcast stations appear as propagation improves, and these cause considerable interference. These are operating illegally and mainly come from the Eastern Bloc. Needless to say, little can be done to get rid of them. Your ability to make *QSO's* (contacts) through the rubbish depends on how good your receiver is at coping with very strong signals, and the antenna you use.

DX contacts are usual at night if you can find a slot to work them in!

In common with the other 5 short wave bands, the maximum power level is 150W DC input (or 400W peak output on SSB) and as the frequencies get higher, the aerials become more managable in size.

From this frequency upwards, directional *beam antennas* are a possibility, although you will need a rather large garden for this band. Good contacts are common with simple *end-fed* or *dipole* aerials though - a beam is a luxury rather than a necessity.

20 metres (14.0-14.35MHz)

This band is probably the most commonly used for DX contacts throughout the world. Like the other two higher frequency bands (15 and 10m), propagation is very dependent on the current solar activity, due to its influence on the ionosphere, which is responsible for reflecting your signal round the world.

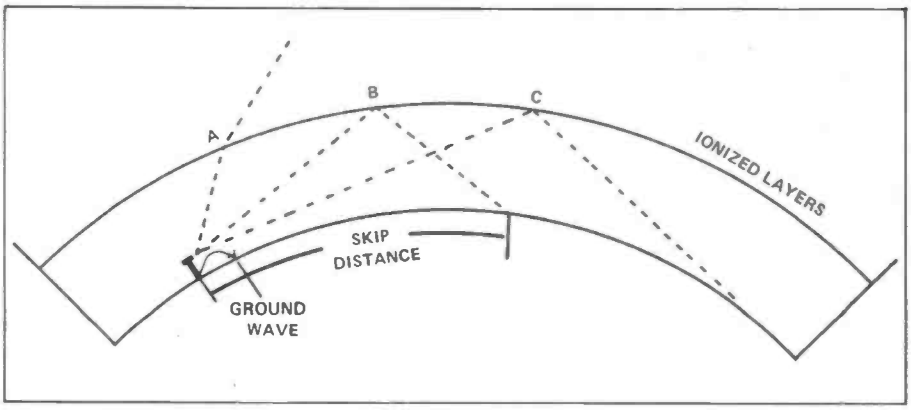

Figure 2: Radiation from transmitter T striking the ionized layers at A is of too sharp an angle to be reflected. Signals entering the layers at B are refracted back to earth. The minimum distance that refracted signals can be heard is termed the Skip Distance.

The season also has an effect. In the summer, contacts during the day tend to be with Europe, although you won't hear many UK stations due to a phenomena known as 'skip distance' (the minimum distance on the earth's surface over which the ionosphere will reflect a signal in one hop). At night, contacts all over the world are usual at various times, but the band 'closes' later in the night as the ionosphere 'evaporates'.

During the winter much better conditions exist, and the band may be open all night. Contacts with the Far East and Australasia are possible during the early morning and evening at all seasons.

In next months continuation, we will have a look at the remainder of the Amateur bands, including the higher end of the spectrum. Also, some more detail of the various facets of the hobby, including satellites and the Amateur Emergency organisation.

If you have any questions about the hobby, write to me care of **R&EW** and I will do my best to answer via this series.

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Get your ears here

R&EW gets you on the air with these high quality transceivers for 27MHz FM:

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The prices, including mic., fitting kit etc. and VAT are:-

CB900 - £79.95 **CB901 - £89.95**

Universal antenna mount (mag/boot/gutter) with as much antenna as you are legally entitled to use - **£13.95**

13.8v/5A mains power supply : it wasn't trivial trying to find one that didn't go haywire in the presence of RF, so we recommend that you use this generously rated unit with the CB900/CB901 in 'home base' applications, **£16.95 + £3.00** postage and packing.

- *Don't forget, invest 60p in a copy of the* **new** *WR&E catalogue, and use the 3 x £1 discount vouchers for an instant £2.40 profit, since you can use all three if you buy either of these rigs.*

You can use the reader service card inside the front cover of this issue to send in your order - or write sending cheque, POs, Access, Barclaycard - not forgetting the discount vouchers !!

R&EW looks at its first UK CB rig

The first FM CB transceiver that actually looks as if it has been purpose designed, and not merely adapted from AM. A serious contender for the low budget PMR (Private Mobile Radio) user?

Getting your ears on

There is a danger that the mere mention of CB will cause countless toes to curl and eyes to glaze over. After the seemingly infinite build up, at last *it's* here (or should be, since at the time of writing, November 2nd has been rumoured from a very reliable source), and like it or not, electronics will never be quite the same again in this country.

The AMSTRAD range

Despite several requests to other manufacturers who have 'announced' CB radio equipment, AMSTRAD were the first firm to actually come up with equipment that they were prepared to let us delve into. Perhaps the fact that our lab is better equipped than any of the other importers made the others nervous of what we might find out about the set.

A brief glance at the quality of the finish of AMSTRAD's set was reassuring. Being Japanese made, rather than Taiwanese or Korean also boosted confidence - there is little doubt that Japanese attention to quality is just that little bit more precise - but a look inside confirmed that we were indeed looking at the first truly custom designed set specifically for the UK market. There were no *piggy back* conversion boards in evidence, and only one capacitor was 'hung' in mid air without a proper home on the PCB. The one piece PCB was tidily laid out, and some of the terminations are even wire wrapped!

The *range* comprises two sets, the CB900 - a basic 40 channel 4W RF model with RF gain, tone, squelch and volume controls - and the 901, with a *Roger* bleep (ugh), and a PA switch to enable the unit to be used as ill-mannered loud hailers. The basic transceiver works are identical for both sets - the extra features are a matter of taste, although the channel 9 priority feature on the 901 is undeniably useful. There is provision in the circuit for a channel 19 priority switch as well, although this feature is presently unused.

Inside the set

The complete circuit of the classier CB901 (*Figure 1*) is reproduced with the kind permission of AMSTRAD. You will see that it is neat, tidy and concise. The main features are indicated thereon, but it will also assist the interested readers if we take a guided tour around the circuit...

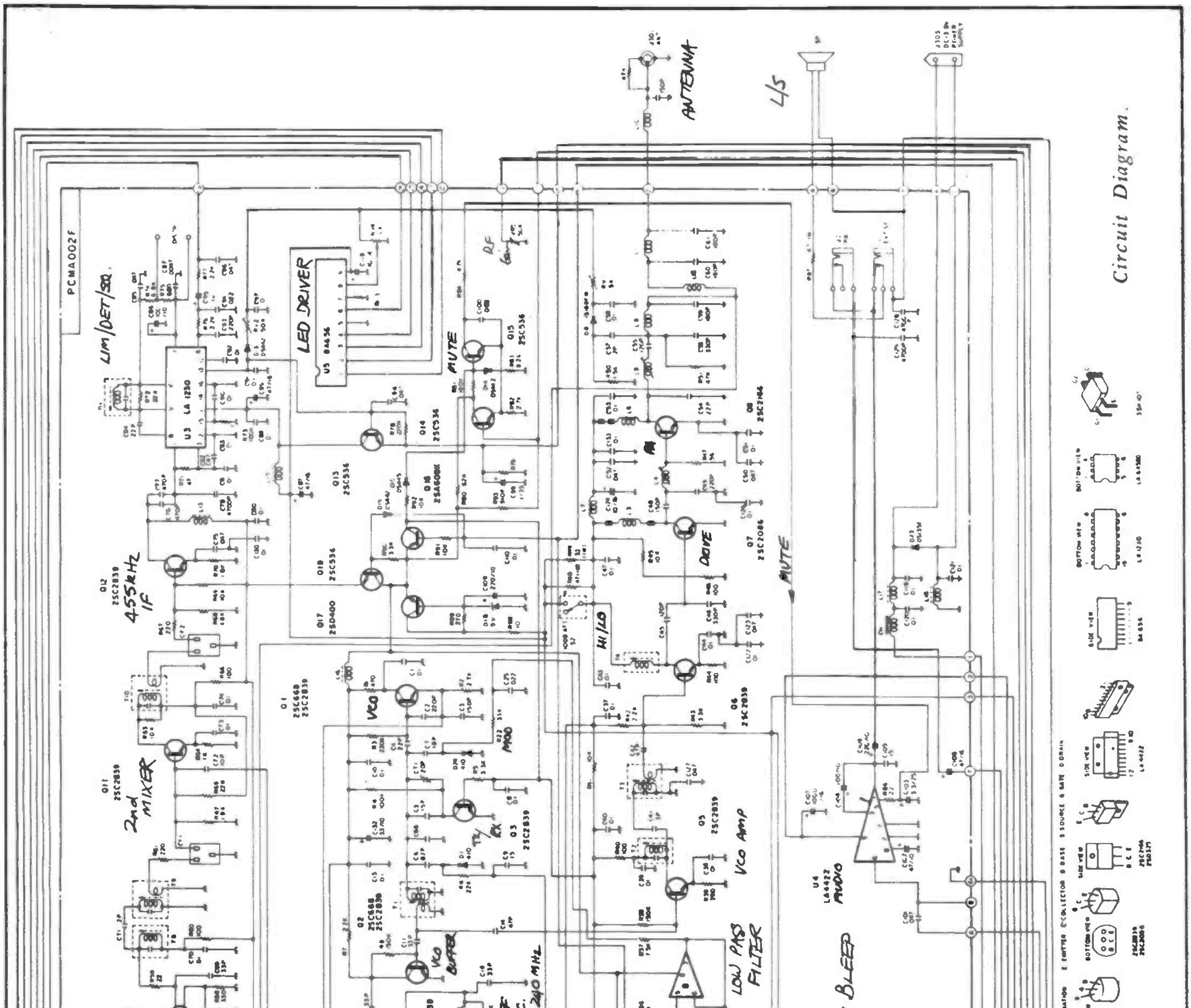
The Receiver:

The antenna reaches the RF stage (Q9) via the low pass filter that is provided to keep the harmonics well away from those nervous users (particularly aeronautical) who fear an incursion into their hallowed MHz. As is common in lower powered transceivers, there is no official antenna switching process, and death and destruction of the receiver input is provided by clamp diodes D10 and D11. RF gain is brought about by winding resistance in and out of the source of the RF JFET - this is probably a useful feature in view of the fact that users frequently find themselves within hailing distance anyway...

D12 biases the FET off during transmit. Selectivity is courtesy of the T6/T7 bandpass pair, feeding the gate of a dual gate MOSFET mixer. All good stuff from the point of view of overload and intermodulation, and many sets we have seen betray their AM around these stages, in the shape of bipolar transistors and AGC on the RF and mixer stages.

Another bandpass pair into the IF filter, CF1, which is a low cost ceramic filter for 'roofing' purposes. The adventurous may like to dive in with a 2 pole crystal filter (or even more) at this point, but the standard filter seemed quite adequate for the purpose. Q11 takes it down from the first IF of 10.695MHz to 455kHz, and Q12 provides a little pregain at 455kHz, after the CFW455 series 6kHz bandwidth filter, and before the LA1230 -which is Sanyo's version of the famous CA3089E series.

Gain, limiting, detection, metering and squelch functions are performed by the IC, with squelch being carrier derived rather than noise derived. This may seem a slightly compromised way of achieving FM muting, but in practice, it worked out well enough. In fact, with the tendency of some FM muting systems to open with low level signals even with 'tight squelch' (i.e. the mute sensitivity wound right back), it could be that this approach will be better able to cope with the nature of 27MHz CB, where there is always likely to be enough of a signal about to cause a noise squelch to open up. Existing multimode CB sets with FM have tended to use signal level derived squelch as part of the AM heritage.



Circuit Diagram.

The metering is provided by a row of LEDs. Any form of metering in equipment like this is a compromise, but the LED system is a good deal more visible than a small meter, and is thus quite a useful feature. It is also surprisingly accurately logarithmic in terms of input level, since the LA1230 meter output is nearly logarithmic across 70dB input range.

Despite the inability of the original CA3089E to provide the meter function output with input frequencies as low as 455kHz (due to the relatively reduced coupling of the 'on-chip' integrated capacitors), the Sanyo device appears to have overcome this problem.

The audio output is correctly de-emphasised, and fed to the audio IC, which includes a mute control input (pin 5). The supply to the set is decoupled reasonably well - most interference experienced in a vehicle installation is only really curable at source anyway.

The receiver sensitivity was better than 0.3uV for 12dB SINAD, leaving little scope for improvement.

The transmitter

The first aspect to consider is the synthesiser device. According to the Japanese, fabrication of this part caused them many problems - and it's the only 'custom' aspect of the entire specification. The LC7137 is derived directly from the LC7135 family-and appears to drop into exactly the same PC foil layout. Even the channel number program codes are identical (albeit the LC7135 is an FCC standard device).

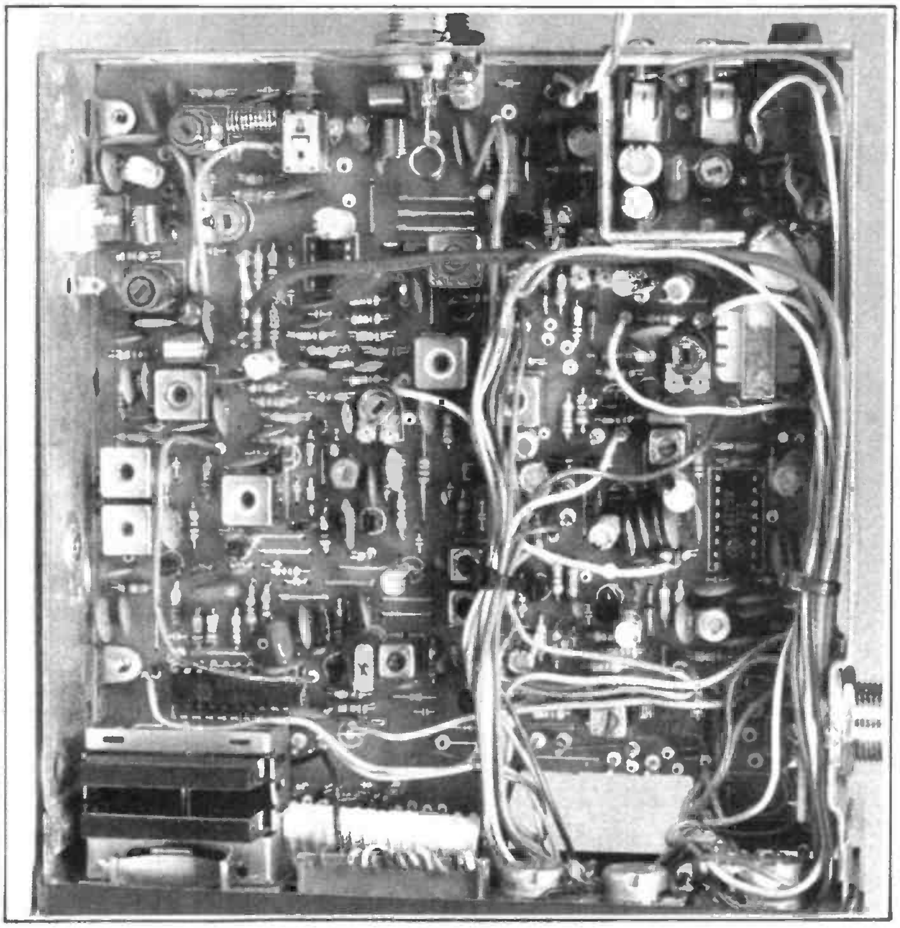
So, if you have a naughty CB set, then this looks like a potentially instant method to get the frequencies onto the UK channels, provided the import duty, VAT and licence fee are paid, and the set is checked to conform with the UK specification with regard to mode and power. It seems likely that it will be cheaper to buy a new set. The synthesiser works well, and once the right numbers have been loaded, the VCO produced an output on half the desired transmitting frequency - due to the reduced speed of the CMOS divider. On receive, this frequency is fundamentally correct (excuse me) for a 10.695MHz offset, but on transmit, it must first be doubled in Q5, and carefully filtered in T2 and T3.

The remains of the transmitter requires only 3 transistors to provide the legal 4W, with the 10dB attenuator provided by switching in R48/R49 to drop the supply to the first of the RF drive stages.

The output is quite immaculately pure (as it needs to meet the specification), we measured:

Fundamental	0db
2nd Harmonic	—83
3rd	—88
4th	—84
5th	—81

and no worse than —81dB to beyond 500MHz.



Note the uncluttered layout. (front panel at bottom of picture).

The modulator

The UK spec lays down that although the deviation is nominally 1.5kHz, 2.5kHz peaks are permitted. However, with the transmitter set up to produce 1.5kHz deviation, the audio input must then be driven up another 20dB without the deviation exceeding the 2.5kHz limit. In other words, some form of limiting is essential.

The technique widely employed for speech clipping in CB involves simply ramming the output of an op-amp mic preamp up and down against the supply rails. This no doubt accounts for the sales of 'power mics' which employ a little more elegance in the shape of audio derived gain control. Of course, limiting (clipping) in this way would produce the most amazing and unacceptable splatter through generation of HF harmonics, so the next stage in the set is the second half of the 758 (LA6458D), which is configured as a most elegant low pass filter that results in really nice quality audio, with just the right amount of pre-emphasis, a feature that makes this set stand out against many others. When all manufacturers are constrained to very largely the same set of *rules*, this is one optional area where a little thought in design can actually make quite a difference.

The set we examined was a shade over enthusiastic on the deviation level, there is a preset control on the board, and it only required a minor tweak to throttle it back. The adjacent channel power (+/—10kHz) was measured as —58.9dB (upper adjacent channel), and —57.8dB (LAC) at 1.5kHz deviation, the assymetry being due to the assymetrical nature of the limiting at the clipper's output. The maximum permitted level is 10uW under the conditions of normal 1.5kHz deviation *+/—20dB* audio input, which is probably rather academic, since any CB receiver close enough to be bothered with a 10uW signal is almost certainly going to be utterly flattened at RF stage, mixer, IF etc.

No IF filter used in CB is likely to possess the sort of shape factor demanded in VHF *private mobile radio* (—90dB adjacent channel on receive), so the Home Office specification is perhaps a shade unnecessary here. However, a tight rein on adjacent channel power covers a multitude of sins, from jittery synthesisers to over deviation and bad frequency response limiting, but it is extremely complex to measure without the right (and costly) equipment. We use an R&S adjacent power meter which reads directly in dB.

The modulator deviates the VCO via D24 at half the output frequency, which means that the deviation excursions seen by the phase detector are relatively small, and the synthesiser copes without problems. D1 is the main VCO control varicap.

The Roger Bleep on the CB901

If you must, there is a button to select the Roger Bleep, which emits a bleep when the PTT is released. It may be a trifle *gauche* for some, but at least you know when the transmission has been handed over, which if you are not acquainted with the vernacular, can be very hard to detect...

The bleeper both provides a tone, and holds the transmitter on for as long as is necessary to get about 100mSec or so over the airwaves. Pressing the PTT instantly discharges the base circuit time constant of Q21, which duly turns on, along with Q22 which operates the main T/R receive at Q17/8/9.

Q20 - the phase shift oscillator - is kept quiet by the fact that D21 effectively grounds the base when the PTT is held on. Let go of the PTT, and Q21 is held on for the charging period of the time constant on the base of Q21 (thus holding Q22 and keeping the transmitter on), and Q20 is let loose to do its worst, since D21 is now reverse biased, leaving Q20 to oscillate.

Conclusions

So there you have it. We suspect this is probably the first 'in-depth' review of a viable UK CB rig, and we were impressed with the value it represents. Quite apart from the the CB aspects, there are many amateurs who are doubtless keen to get these boxes on the 10m band, and attach a legal amount of boost to their outputs, which will still work out a great deal cheaper than an equivalent HF transceiver of more conventional origin. It should be possible to 'transvert' the operating frequency to all sorts of undreamed of places.

On the air

G9BSK rode the airwaves around Brentwood for a few days, managing to attract the attentions of some sideband CBers who were trying to tell us to clear off out of the DX section of the band, but also managing to achieve contacts of between 5 and 10 miles with regularity. In fact, the best *DX* was over 15 miles using a CB900 and CB901.

Using a 12 channel handheld (also UK spec), a vehicular CB901 talked to a rubber ducked 1.5W handheld at a distance of over 5 miles - which frankly surprised many of us.

There is no question that the limiting factor (as long as it lasts) is the continental 'skip' interference on SSB. In a year or so, this should be largely eliminated as the MUF (Maximum Useable Frequency — usually related to given transmission path, though in HF terms it generally boils down to the MUF for transatlantic operation) has dived down to below 25MHz until the next sunspot cycle - by which time, CB DXers may have decided to become legal radio amateurs. (Beware of flying pigs getting caught in the 27MHz verticals.)

A direct comparison was made with an FT290R, and whilst the CB rig didn't bat an eyelid about receiving alongside the FT290R + R&EW booster amplifier, the FT290R gasped at the prospect of 4 meagre watts of 27MHz. No doubt good proof of the fact that the LPF on the CB rig output works both ways.

The range achieved with the CB was undeniably less - although the *flashing* under mobile conditions was arguably slightly better when in range. The FT290R with booster can manage 40 miles and more base to mobile with relative ease in favourable terrain, but car to car with 20 watts is not much better than 10-15 miles. But then again, a 1.5W IC2E in Brentwood can access the GB3KN 2m repeater in Maidstone, and this aspect tends to underline the advantage of the uncluttered nature of the VHF bands with regard to general 'noises' and co - channel interference.

These results tended to emphasise the advantages of electrically *ideal* antenna configurations, and it would be interesting to try a 2m range test using *reduced* antennas such as those available to CB.

Competition time (again)

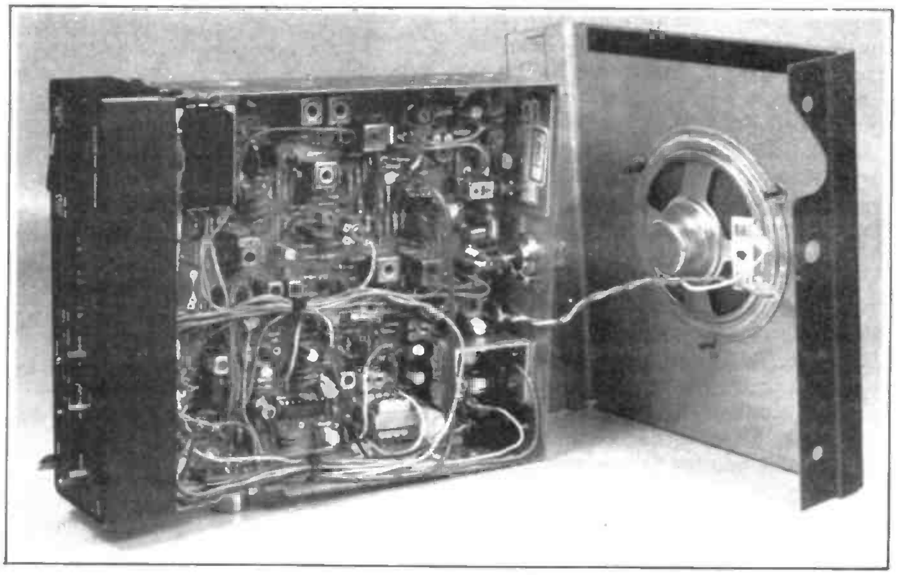
A free CB900 to the reader that manages to spot the two anomalies in the circuit diagram published here (we found two, anyway). They are fairly obvious if you read and follow the above description. If there is more than one winning entry, precedence will be given to the reader who supplies the best explanation of what he wants to do with the rig.

Apart from those inevitable suggestions from the anti CB lobby, we are looking for suggestions of how it is proposed to modify the equipment - either to work more effectively within the confines of the specification, or how it can be adapted for some more enterprising applications.

Suggestions from amateur taxidermists are not required, thankyou.

Your Reactions.........	Circle No.
Immediately Applicable	270
Useful & Informative	271
Not Applicable	272
Comments	273

A tidy package - easily 'got at' and soundly constructed.



BOOK REVIEWS

Review on

"Getting acquainted with your ZX81"

by Tim Hartnell

Having recently acquired an unexpanded ZX81, and wondering what to do with it, I purchased a copy of Tim Hartnell's *Getting acquainted with your ZX81*, second edition. After reading several good reports about his previous book *Making the Most of Your ZX80* I thought I was on to a winner but alas was to be proved wrong.

My first criticism is in the way the book has been bound with one of the many cheap plastic ring binders, found effective on many of these such books today. The binder itself is adequate, but due to the way the pages have been cut it was impossible to open the book properly and lay the pages flat, the more I tried to do so the more damage I bestowed upon the pages. The only remedy to this was to completely take the book apart, trim off the surplus paper and re-assemble, a very tedious job. However this done I proceeded to enter one of the many programs found inside.

All programs have a short piece of text accompanying them, illustrating how the program should be run and used. Occasionally you are told as to whether or not the program will fit into 1k of memory, the rest of the time, with the shorter programs, one has to guess. One such program I picked out was to convert Farenheit to Centigrade. Being as the program consisted of only 33 lines I proceeded to enter it. It did fit but on attempting to run the program I found that the computer refused to accept line 130 INPUT B. After much thought I decided that possibly there was not enough room left in the memory, so I trimmed the program down. I then reran the program and got as far as line 300 when the program stopped itself with Report Code 2 signifying an undefined variable. (I had in fact noted this when entering the program.) Having rectified this point the program then ran satisfactorily. Small problems but unnecessary.

Another program with a similar problem was called "Star Map", designed to produce an everchanging galaxy of stars on your TV screen. This time the text insists that it will in fact fit into 1k, however due to the limited memory it wouldn't run. Not to be discouraged I continued with another 1k program, this time "Noughts and Crosses", a somewhat more complicated program involving long codes, which when run, stopped on line 240 with Report Code B signifying Integer out of range. At the time of writing I have still failed to make the program run successfully.

To date I have found five programs which will not run when copied straight from the book, a discouraging thought for the novice. On reflection I would find it difficult to believe that these programs had been run satisfactorily prior to their being published. For the more experienced programmer, who can overcome these errors, the book might well bridge the gap between Clive Sinclair's excellent manual and more advanced programs.

Bearing in mind that I had purchased the Second Edition which was published in May 81 and that the First Edition was published in April 81 I hope it doesn't take Mr. Hartnell too many editions to sort his programs out.

6809 MICROCOMPUTER PROGRAMMING & INTERFACING — with experiments

by A C Staugaard

1981; 270 pages; 135 x 215mm; Paperback

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This book gives you a sound understanding of how to program and interface the 6809 microprocessor and has a set of questions and answers at the end of each chapter.

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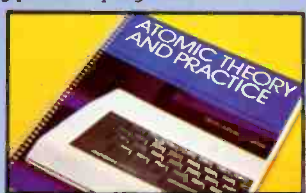

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		TOTAL	

Computer stores are stocking Atoms – there's a list below, but if you have any problems getting hold of one just fill in the coupon and we'll rush one to you within 28 days. If the machine isn't all you expected, or all we've told you, just return it within 14 days for a full refund.

MOM, Aberdeen 22863. Broadway Elect, Bedford 213639. Owl Computers, Bishops Stortford, 52682. Eltec Services, Bradford 491371. Gamer, Brighton 698424. Electronic Information Systems, Bristol 774564. Cambridge Comp Store, Cambridge 65334. Cardiff Micros, Cardiff 373072. Bellard Elect. Chester 380123. Emprise, Colchester 865926. Silicon Centre, Edinburgh 332 5277. Esco Computing, Glasgow 204 1811. Control Universal, Harlow 31604. Unitron Elect, Haslington. Castle Elect, Hastings 437875. Currys Micro Systems, High Wycombe. Customised Electronics, Leeds 792332. D.A. Computers Leicester 708402. Micro-digital, Liverpool 236 0707. Barrie Elect, London 488 3316. Eurocalc London 729 4555. Microage London 959 7119. Sinclair Equip. Int (Export) London 235 9649. Off Records, SW12, 674 1205. Technomatic, NW10 452 1500. NSC Comp Shops, Manchester 832 2269. Customised Electronics, Middlesborough 247727. Compshop, New Barnet 441 2922. H.C.C.S., Newcastle. 821924. Newcastle Comp Services, Newcastle 615325. Anglia Comp Centre, Norwich 29652. Leasalink Viewdata, Nottingham 396976. R.D.S. Electrical Portsmouth 812478. Computers for All, Romford 751906. Intelligent Artefacts, Royston, Arrington 689. Computer Facilities Scunthorpe. Datron Micro Centre Sheffield 585490. Superior Systems, Sheffield 77824. Q-TEC Systems, Stevenage 65385. 3D Computers, Surbiton (01) 337 4317. Abacus Micro Comp, Tonbridge, Paddock Wood 3861. Northern Comp, Warrington 601683. Compass Design Wigan Standish 426252.