FEBRUARY 1982

ISSN 0262–2572

RADIO & ELECTRONICS WORLD

70p

PROJECTS

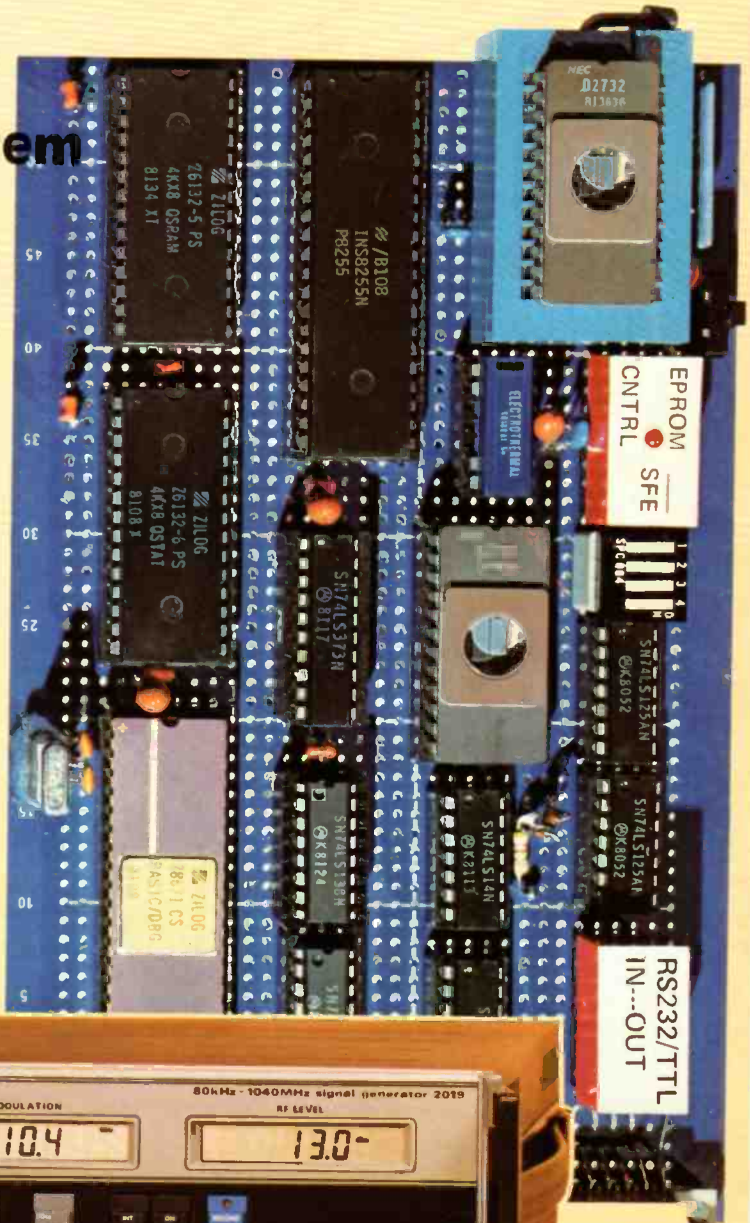
Z-8 Development System
40-Channel CB Rig
TV Pattern Generator

FEATURES

22 CMOS Circuits
Analogue Switch IC

REVIEWS

2019 Sig Generator
4¾ Digit DTM
+ The Big Match



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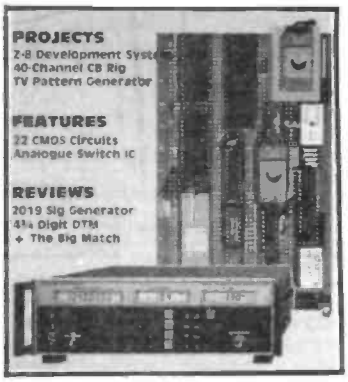

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TECHNICAL QUERIES: While we always try to help readers in difficulties with R&EW projects, we cannot offer advice on modifications to our designs, nor on non-R&EW projects or products. Telephoned queries will only be accepted between 2.00-5.30pm on Thursdays. Written queries MUST contain a stamped self-addressed envelope and must deal with only one project.

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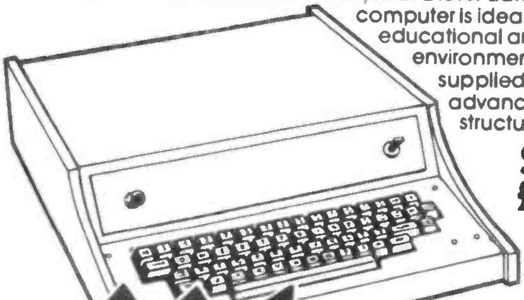

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28 St Judes, Englefield Green, Egham, Surrey TW20 0HB.
Tel: (0784) 33603. Tlx: 264475.

SKYTRONICS,
2 North Road, The Park, Nottingham.
Tel: (0602) 45053/45215

TARGET ELECTRONICS
16 Cherry Lane, Bristol BS1 3NG.
Tel: (0272) 421196.

INTERFACE COMPONENTS LTD.
Oakfield Corner, Sycamore Road, Amersham, Bucks.
Tel: (02403) 22307. Tlx: 837788.

HENRY'S RADIO
404 Edgware Road, London W2.
Tel: (01) 402 6822.
Tlx: 262284 (quote ref: 1400).

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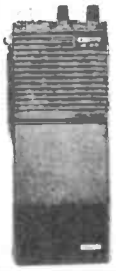

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EDITORIAL

Catastrophe!

R&EW had a little bit of a problem getting the issue together this month. We had a fire. Well - not WE, but a couple of our staff members. Their house burnt down. It burnt to the ground in a mere seven minutes, destroying (amongst other things) the prototype, artwork and write-up of a major project and the complete file on one of our 'computing' features. By all accounts, the incident was quite spectacular (**R&EW** always does things in a big way).

One result of this little incident is that we are unable to present the final part of the "Using UARTs" feature in this issue, but hope to have it ready for the March edition. Sorry about the delay. In the meantime, any sympathy donations (TV sets, video recorders, money, etc) will be gratefully received and should be addressed to the R&EW CATASTROPHE FUND at our usual address (if it's not a smouldering ruin by the time you read this).

Progress Report

R&EW was launched with our October edition way back (it seems way back to use, anyway) in 1981. The launch was preceeded by much heart-searching, hand-wringing and head holding - all done simultaneously. Would readers like the new magazine? Oh - worry! worry! groan! groan!

Now, in issue 5 of the magazine, we can answer these questions. Yes, readers and advertisers DO like it; to an embarrassing degree, greatly exceeding our initial expectations. Total readership, for example is estimated at about 90 000 (some of whom actually buy - rather than borrow - the journal). A few canny people actually SUBSCRIBE to it, thereby making themselves eligible for all sorts of special benefits. You can see from the present issue that the advertisers also like **R&EW**.

The most frequent comment that we get from readers, regarding the actual magazine, is that "each new issue is better than the previous one" - which may be a polite way of saying that **R&EW** is progressively becoming less bad!

Of course, we at **R&EW** are not getting all smug and complacent about this apparent success. Quite the opposite. We are people that think laterally. We reckon there are still 55.9 million Brits out there who are NOT reading **R&EW**. Oh - worry! worry! groan! groan!

The Price of Success

As a direct result of the unpredicted success of **R&EW**, we're having to introduce a few 'policy' changes; readers will find some of these changes good news, while others may be bad news.

First - The Bad News

The bad news concerns reader's enquiries. Our design engineers (that's most of us) are spending so much time answering readers enquiries that we're left with little remaining time for designing projects and writing features. So, from now on, we shall be accepting telephoned 'technical enquiries' only on Thursday afternoons, between 2.00 and 5.30pm. Subscription members get priority treatment.

Similarly, written enquiries will only be dealt with if they contain a stamped, self-addressed envelope. Regrettably, we cannot assist readers with design work, or with advice on modifying projects to satisfy their individual requirements.

Next - The Good News

The first bit of good news will affect all **R&EW** readers. It is that, in line with our basic policy of presenting more editorial material than advertising, we are, as from the March '82 issue, adding another sixteen pages to the magazine. This will, of course, make the journal heavier and more difficult to carry home; **R&EW** is in no way liable to pay compensatory damages to any persons suffering physical injury whilst humping this additional burden.

The next bit of news will affect only one of our readers. We need a full-time Sub-Editor (bug eliminator) to help us cope with the additional work load resulting from our sixteen extra pages. If YOU are really keen on radio/ electronics, tolerably literate, live within striking distance of Brentwood and don't mind working ludicrously long hours for a mere pittance, why not get in touch with us?

Ray Marston.

NEW PRODUCTS

Portable Microcomputer.

DVW Microelectronics, a member of the AID Group of companies, has developed what is claimed to be the first practical robust hand-held computer for use in outdoor environments, the Husky 144. The unit is ergonomically designed, weighs less than two Kilograms and measures 9¼" x 8" x 2" -little larger than a book.

The Husky 144 is claimed to be the most powerful small computer yet developed. Internally it has a low-power microcomputer, linked to a memory of up to 144 K (over a million bits): This is equivalent to over 70 pages of a typical novel, greater than many desk-top machines. The unit uses a large LCD screen, capable of displaying up to 128 characters in 4 lines.

The Husky 144 is specifically designed for use in hostile field environments by non-specialised operators. It is fully waterproofed and housed in a rugged aluminium alloy case. The unit 'communicates' (talks in - talks out) in plain English - not 'computer speak'. The keyboard uses 40 multi-function keys, with a 'number pad' placed centrally for easy data entry but with all alphabetic characters placed in standard typwriter format.

A unique key, aptly named 'HELP', virtually dispenses with the need for an operators manual. The key may be pressed at any time during operation, causing part of an internal 'manual' to be displayed on the screen giving exact information about 'what to do next'.

The Husky 144 is battery powered, using three sets of cells. The main batteries, a set of alkaline 'C' cells, give up to 100 hours of continuous use. A stack of mercury 'button' cells provide stand-by operation, and a lithium 'Emergency' cell ensures memory integrity in the event of main-battery failure.

The British-designed Husky 144 is compatible with most other computers, allowing information to be easily transfered via telephone, floppy disk or printer, etc., and is supported by a large library of commercial programs.

The price of the Husky 144 depends on specification and quantity required. As a guide, the basic 16 K version costs £ 1399. For more information, contact:

DVW Microelectronics,
10 The Quadrant,
Coventry.
CV1 2EL
Telephone 0203 27535.

5 for further details

Sine/Square Generators.

A compact RC generator providing sine and square wave signals from 10 Hz to 100 kHz with low (0.02%) distortion at 1 kHz has been introduced by Philips Test & Measuring Instruments and is available from Pye Unicam of Cambridge. The PM 5109 provides a choice of asymmetrical or dual floating symmetrical outputs as well as TTL level and DIN loudspeaker outlets.

The generator operates either in low-distortion or fast-settling mode, the latter being ideal for fast, routine work. The DIN connection allows direct checking of loudspeakers, and the TTL output enables work at TTL levels and external synchronisation.

Open-circuit output is 30 V peak-to-peak - around 10 V RMS -on the asymmetrical output. Both sine-wave and square-wave signals are available, with stepped calibrated attenuation up to 60 dB plus 20 dB continuous attenuation. LED range indication is provided together with display of op-circuit voltage on a front-panel meter. Output impedance can be switched between 600 ohms and 50 ohms.

Sine-wave signals up to 10 V peak-to-peak (3.16 V RMS) open-circuit voltage are supplied across two independent floating symmetrical outputs. These provide a choice of two separate 300 ohms outlets, 600 ohms in series or parallel operation. A low impedance selection provides high output power. Variable attenuation up to 20 dB is included, again with front-panel meter reading of open-circuit voltage and LED range indication.

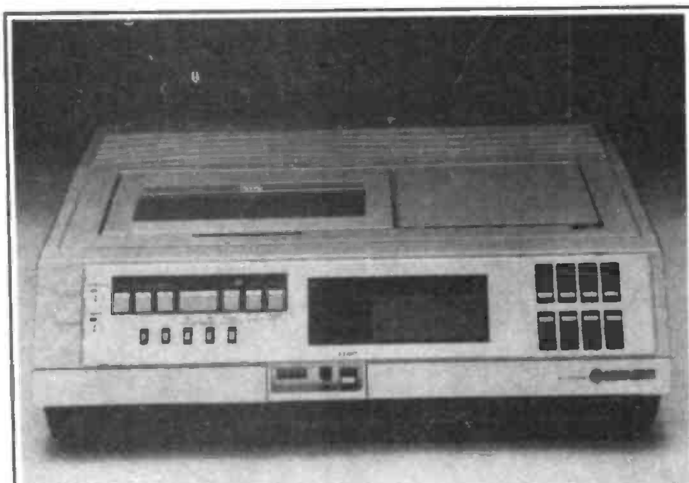
The floating output simplifies applications in telecommunications audio work, and the low distortion makes the instrument ideal for testing audio music lines and audio line amplifiers.

For general purpose applications, an economical version of the generator is available with only asymmetrical output - the PM 5109S. This model is designed for audio service work where high signal purity is required but the symmetrical floating output is not applicable.

The PM5109 is priced at £ 495 and the 'S' version at £ 425 (exclusive of VAT).

Pye Unican Ltd,
York Street,
Cambridge, CB1 2PX.

6 for further details



Video Recorder.

Hitachi's latest video recorder is the VT 8300, an up-dated version of the popular VT 8000 with many technical improvements in both the electronic circuitry and the motor drive system. The new recorder features a 4-digit tape counter to cater for the length of 4 hour tapes, which can be programmed up to 10 days in advance.

The VT 8300 has a useful visual search facility, which enables the playback to be speeded up 5 times so that a particular section of tape can be visually located. Another feature is the automatic rewind facility which rewinds the tape as soon as it reaches the end of the spool.

Other unusual features are a built-in black and white test pattern generator, which enables the TV video channel to be accurately tuned in, and a dew detector/indicator which disables the tape drive system (to protect the tape) if excessive moisture condensation appears on the tape head.'

The VT 8300 is supplied complete with an RF connection cable, a 10-function remote control keypad, E120 video tape and a protective dust cover. The price is £ 619 including VAT.

7 for further details

NEW PRODUCTS

* * * * * * * * * * * * * * *

Sinclair Award Scheme.

To help meet the urgent need for more ZX81 educational software, Sinclair Research is sponsoring a special award scheme, offering six ZX Printers as prizes for the best programs accepted into the MUSE software library by the end of March 1982.

With over 100 000 ZX81s sold, and with sales to more than 2 300 secondary schools under the company's recent subsidized purchase scheme, Sinclair is keen to support wherever appropriate the development of educational software. "We have a very strong commitment to expanding computer applications in schools" commented Clive Sinclair, chairman of Sinclair Research.

MUSE, the teachers' organization for computer users in schools and Educational ZX80/81 Users Group (EZUG), are to administer the scheme and in consultation with Sinclair, judge submissions in the following categories: primary maths and science; other primary; secondary maths, science and computing; other secondary and special education.

Entries and enquiries should be sent to Eric Deeson,
EZUG organizer, Highgate School,
Birmingham B12 9DS.
Closing date is February 27.

8 for further details

* * * * * * * * * * * * * * *

High-Gain DC AMP.

The new Model 13-4615-20 high gain D.C. amplifier from Gould Instruments Division has a maximum sensitivity of 50 uV full scale, a measurement range from 50 uV full scale to 250 V full scale, extremely low output noise, excellent zero line stability, and calibrated zero suppression for more precise examination of complex waveforms.

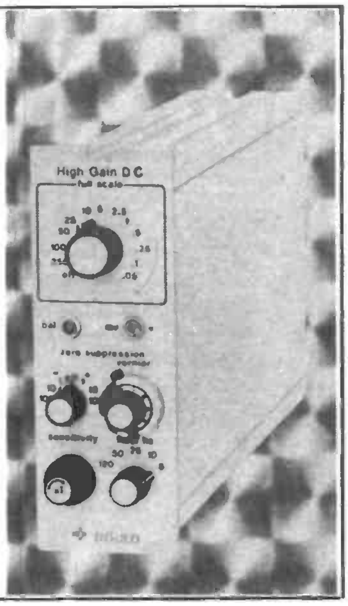
The amplifier uses a solid-state input chopper for long life, low noise and high reliability, and an internal 'master-slave' switch allows two or more amplifiers to be operated at maximum sensitivity within the same physical environment or to be operated from a common signal source.

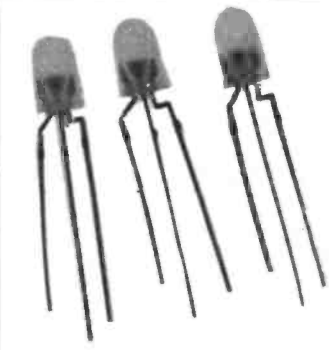
The input circuit is differential, fully floating, isolated from input to output, and guarded by an internal floating shield. It can be operated up to 250 V off-ground at any sensitivity or up to 250 V between input and output. It can be used with signal sources that are grounded, floating, or driven off-ground without experiencing 'ground-loops', damaged equipment or other problems normally associated with grounded input circuits. The high input impedance of 1MO on all measurement ranges prevents the measurement errors that frequently result from 'loading' the signal source.

The 13-4615-20 amplifier is designed for operation with Gould 200 and 2000 Series direct writing recorders, or in a portable case for use with other types of readout instruments.

Gould Instruments Division,
Roebuck Road,
Hainault,
Essex.

10 for further details





TV Monitor/Scope

The new OS3351 from Gould Instruments is a 30 MHz, dual-trace, TV monitoring oscilloscope incorporating a BBC-designed timebase module (made under licence by Gould) which provides a wide range of video triggering and display modes for the monitoring and measurement of broadcast television signals. The oscilloscope timebase generator allows the instrument to be used for the line-by-line examination of 625-line television waveforms or to display a television picture.

In operation, the OS3351 accepts a standard-level composite video signal, which may contain 'sound-in-sync.' signals, and then provides six different triggering modes. Any line can be selected for display by front-panel push-buttons, with the line number indicated on a 3-digit light-emitting-diode display, and line pairs can also be selected in the range 16/329 to 22/335.

Triggering can be delayed continuously by up to 90 us via a multi-turn control, which allows parts of a line to be studied in detail.

The displayed signal can be clamped or not, as required. When the instrument is used to display a television picture, the triggering point selected may be displayed as a 'bright-up' line on the picture, allowing a direct relationship to be established between waveform and picture. The changeover from waveform to picture is effected by a single front-panel switch.

Standard video insertion test signals such as the 2T pulse and bar can be examined by selecting the appropriate line pair, and these measurements are simplified by the inclusion of very fine Y-position and gain controls in channel 2. An 'overlay' mode is also provided, which allows the timebase to be triggered twice during each line period so that pulse and bar components can be overlaid.

When not used in the TV monitoring mode, the OS3351 becomes a conventional 30 MHz dual-trace instrument. Full display and triggering facilities are available in this mode, and a sensitivity of 1 mV/cm is achieved over a bandwidth of dc -10 MHz.

The OS3351 is priced at £ 2199 + VAT.

Gould Instruments Division,
Roebuck Road,
Hainault,
Essex.

9 for further details

TRI-Colour LEDs.

Recently introduced by ZAERIX Electronics Ltd for supply to the trade only, a new TRI-COLOUR LED device type L59 HGW is capable of producing Red, Green or Yellow illumination.

Comprising a red and green light emitting diode, housed in a 5 mm diameter white diffused package with a three way lead frame, a common cathode connection is used thereby allowing independent operation of the red or green LED's plus simultaneous operation of both, giving yellow illumination.

Having leads on 0.1" (2.5 mm) spacing and capable of operating over a temperature range of -40 to +80°C, typical Luminous Intensity at 20 mA is 3 mcd and power dissipation is between 105 mw and 120 mw.

ZAERIX Electronics Ltd,
46 Westbourne Grove,
London W2 5SF.
Telephone 01-221-3642

11 for further details

LCD Display.

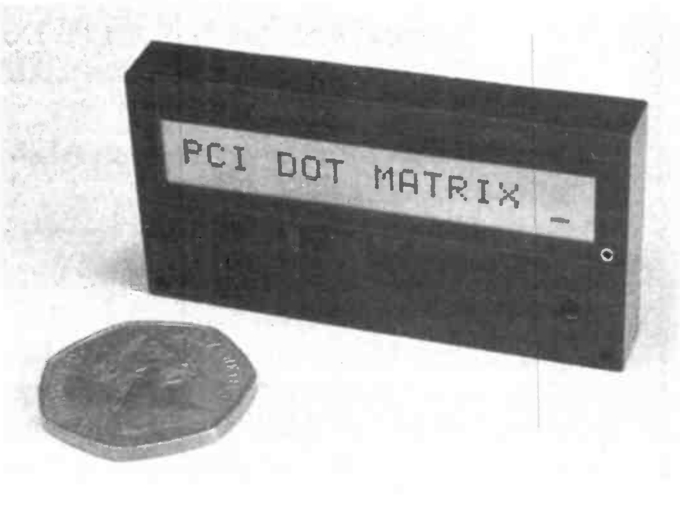
The latest addition to the AMBIT LCD module range is a parallel ASCII driven dot matrix display type DM200. The device comprises 16 characters on a 5 x 7 matrix, with row 8 for use as a cursor.

The display can decode and display 64 ASCII characters (upper case only), with a temperature compensated LCD drive voltage, automatic display refresh (latched display), bus orientated to interface directly to MPUs.

The one off price of the DM200 is £ 39 95.

Ambit International.
200 North Service Road
BRENTWOOD
Essex
CM14 4SG.

12 for further details



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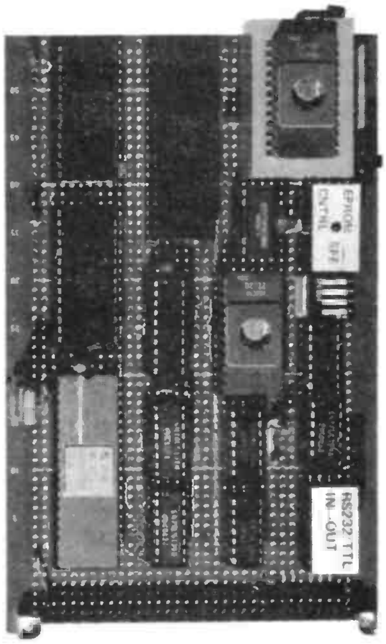
Z-8 PROGRAM DEVELOPMENT SYSTEM



by Jonathan C Burchell

The Z-8 program development system is a first for any magazine. A cheap single board computer allows the development of dedicated microprocessor based controllers, what's more they are directly programmed in Tiny BASIC.

The **R&EW** Tiny BASIC program development system supports the complete design cycle from initial program development through hardware debugging to production of code in EPROM.

Construction is made easy by the availability of a Computer designed, plated through hole printed circuit board.

IN UNDER FIVE YEARS the cost of a powerful 8 bit processor has fallen from several hundred pounds (the first 8080's retailed at over £200 each) to little more than the price of a pint of beer, (about the cost of a Z-80 to Sinclair). So much so, that a complete personal computer with display, keyboard, and high level language interpreter (usually BASIC) can now be purchased for less than the original price of the processor chip only. Countless thousands of small personal computers based upon just such hardware have now been sold. They make very good games machines and amusing little toy's, but frankly, they are not much good for anything else. As many disillusioned owners of a system "powerful enough to control anything from a train set to an electricity sub-station", will have discovered, you can't, for as soon as an attempt to interface most of the currently available personal computers to the outside world is made, a number of inherent and almost insurmountable problems occur.

Most small computer systems do not provide sufficient input/output (I/O) lines to interface them to the outside world. Even if they do, the cost of using a complete system as a dedicated controller is prohibitively high. Also there is the problem of program storage: a dedicated controller must have it's program stored in non-volatile memory and provide for auto-execution of the software on power-up. Both these tasks are nearly impossible with many currently available small computers, even assuming that you've found a way to program the EPROM.

Enter the Z-8 Tiny BASIC Program Development System

The availability of a new single chip Tiny BASIC micro from Zilog changes all of this quite dramatically. The **R&EW** Z-8 TBPDS is a single half eurocard computer, costing around £150, which acts as a complete hardware and software development system when connected to an RS232 terminal. The Z-8 TBPDS can be programmed directly in Zilog's Tiny BASIC, a powerful control-optimised subset of Dartmouth BASIC.

Once the program has been entered and debugged under control of the BASIC interpreter and the hardware of the project debugged using the Z-8 I/O lines, the code can be transferred from the RAM in which it was developed into EPROM using the on-board EPROM programmer.

Intermediate storage of partially developed code is possible via the on-board PROGRAM DUMP/RETRIEVE port, which may be interfaced to an audio cassette via a simple modulator/demodulator arrangement. Software for controlling the EPROM programmer and PROGRAM PORT is provided in an on board 4K byte UV EPROM which, as it is written in Tiny BASIC, may easily be adapted to specific user needs.

However, the real joy of the Z-8 is yet to come. Once the code has been developed and blown into EPROM, it may be unplugged from the development card

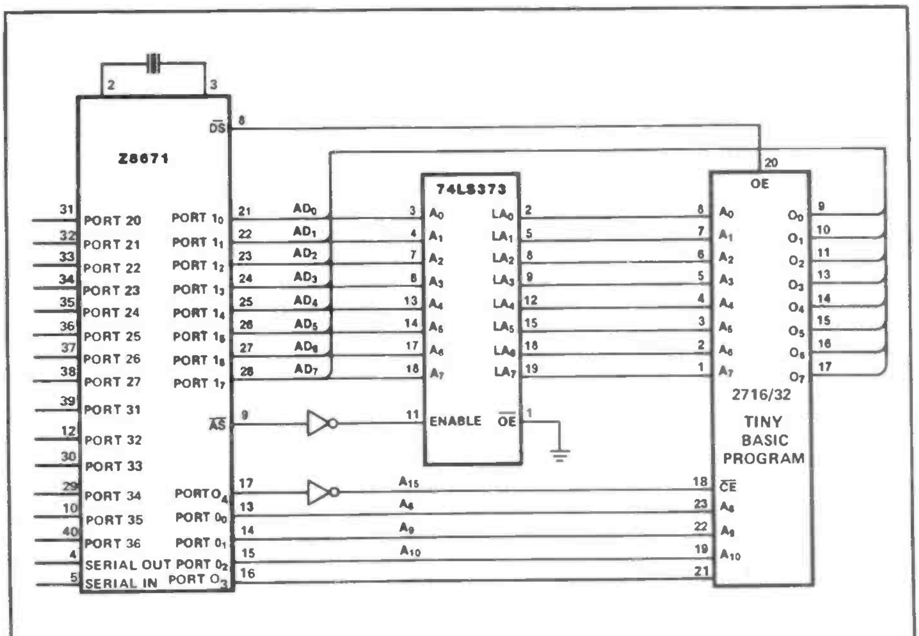


Figure 1: Z–8 Tiny BASIC minimum chip system.
14 I/O lines, full UART, counter-timer, and 4K of Tiny BASIC program controlling it all!

and plugged into a minimum chip Tiny BASIC system, (see *Fig 1*). Such a controller has 8 bi-directional I/O lines, 3 output only lines, 3 input only lines, two counter timers, and a full duplex UART. Furthermore, it is running Tiny BASIC code held in EPROM, which may easily be modified and maintained via the Z-8 TBPDS.

The cost of a minimum-chip Z-8 Tiny BASIC system including PCB is around the £50 mark at the one-off level, cheap anyway in my opinion, but as with all new processors destined to get even cheaper. To fully understand the Z-8 features we must take a look at the processor itself.

The Z8601 and the Z8671, a BASIC Development

The Z8601 is a powerful single chip microprocessor containing in a single 40 pin package (see *Fig 3*), 32 input/output lines, two counter timers, full duplex UART with baud rate generation provided by one of the counter timers, a 144 byte register file, and 2K bytes of MASK programmable ROM. The Z8671 is a Z8601 masked by Zilog to contain a 2K byte Tiny BASIC interpreter.

The Z-8 can be made to 'talk' to external memory by appropriately configuring two of its I/O ports, Port 1 provides multiplexed 8 bit address/data information, whilst Port O provides the high order address bits. Port O is nibble programmable and so may be split into four address lines and four bi-directional data lines.

Bus transactions are under control of three Z-8 generated lines: AS, Address Strobe, which is pulsed low at the beginning of every valid external memory cycle.

DS, Data Strobe, which is pulsed low whenever the multiplexed address/data bus contains data information; R/W which indicates the direction of data flow on the address bus.

The two counter/timers are very powerful and are provided with programmable prescalers. They may count internal or external clock events, or generate and measure variable pulse widths via the I/O lines. In addition, the Z-8 has a very comprehensive interrupt structure allowing a mixture of internal and external interrupts. Registers are provided to both mask and prioritize the interrupts. All interrupts are vectored via external memory on the Z8671.

Whilst a later part of this article will deal with these features in more detail, readers are advised to buy the **R&EW** Z-8 data pack, as there are over 100 pages of related Z-8 information.

Hopefully, you now have some appreciation of the power of the Z8601 silicon. All of the on-chip registers, and I/O devices, are fully available to the Z8671 user via Tiny BASIC statements. For

SUMMARY OF TINY BASIC COMMANDS AND FEATURES

CONSTANTS

Decimal constants may range from −32768 to 32767
Hexadecimal constants, which are prefixed by %, %0 to %FFFF.

VARIABLES

26 variables are allowed referenced by A-Z. Each variable is two bytes long, and may take the same range of values as constants.

OPERATORS

+	Addition	=	Equal
−	Subtraction	<=	Less than or equal
*	Multiplication	<	Less than
/	Division	<>	Not equal
\	Unsigned division also Logical right shift	>	Greater than
		>=	Greater than or equal to

MEMORY REFERENCES

These allow direct manipulation of any memory or CPU register address.
@ byte reference. EG A=@%1000 Assign A the value of the byte at memory address 4096
∧ word reference. As @ but for 16 bit values.

FUNCTIONS

AND	(value,value) Boolean AND, Negated produces OR
USER	(address,value,value) Jumps to user subroutine, passing up to two parameters, subroutine may return one parameter.

EG A=USER (%4096,B,C)

OTHER COMMANDS IN BRIEF

GO@	address,value,value Direct machine language call. No parameters returned.
GOSUB	goto BASIC subroutine.
IF/THEN	Standard BASIC construct, in most cases THEN may be omitted.
INPUT/IN	Operator input commands, IN uses value in buffer first, may be used like a DATA statement.
LET	Almost always optional, may be used for variables or memory addresses.
LIST	Lists current program, may be used in a program.
NEW	Clears Program space
PRINT	Prints strings in quotes, constants etc.
PRINTHEX	Prints in hexadecimal
REM	Allows programs to be REMarked.
RETURN	From BASIC subroutine.
RUN	Run a program.
STOP	End of program.

ADDITIONAL FEATURES

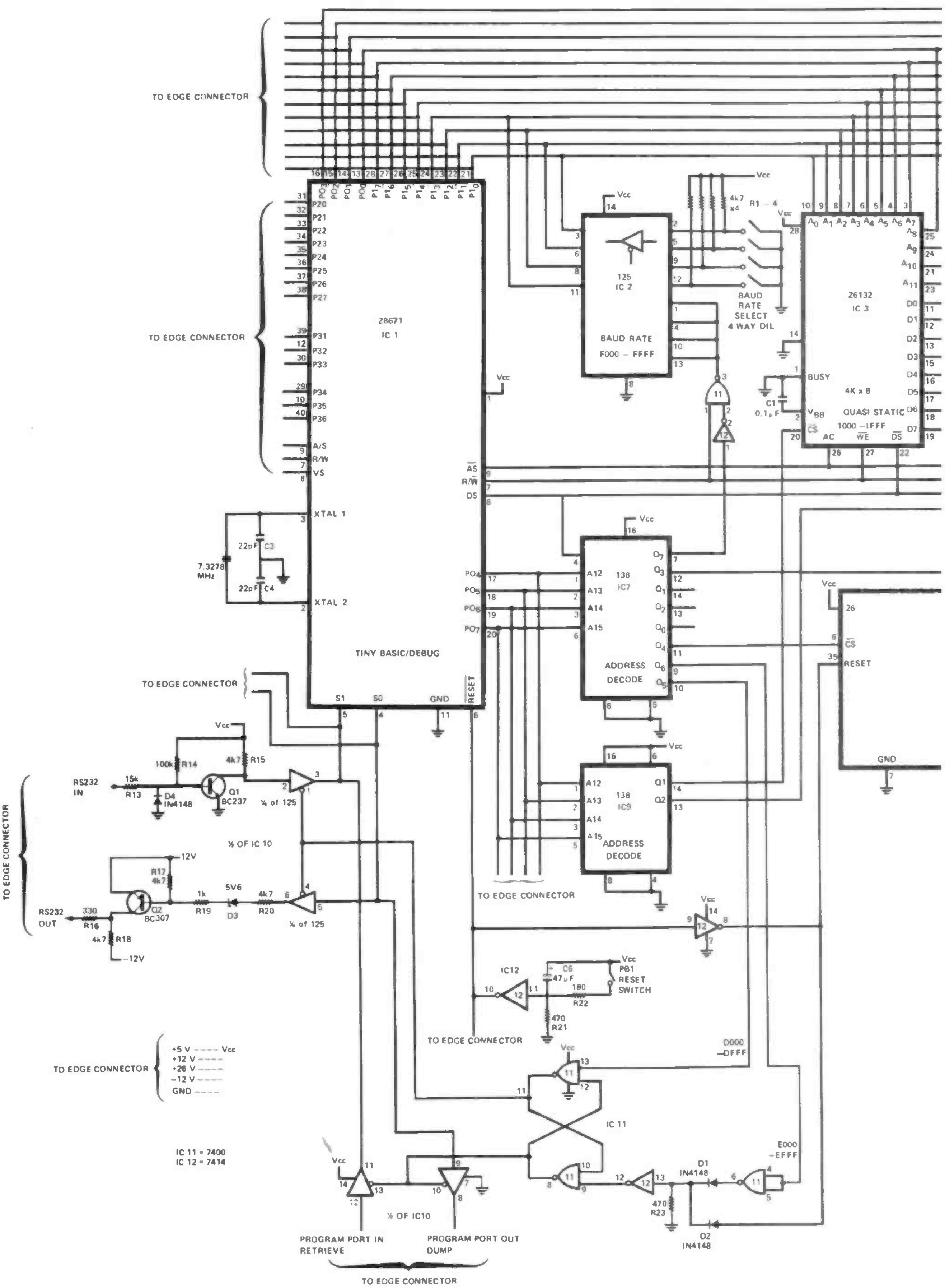
Multi-statement lines if separated by colon : .
Different programs may exist at the same time, they are RUN by changing the value in the program pointer register.

Automatic start-up allows a program stored in ROM to be executed on reset without operator intervention. Automatic execution occurs on power-up/reset when the program:

- is stored in ROM
- begins at 1020 (hex)
- begins with a line number between 1 and 254 inclusive

Table 1.

Z-8 PROGRAM DEVELOPMENT SYSTEM



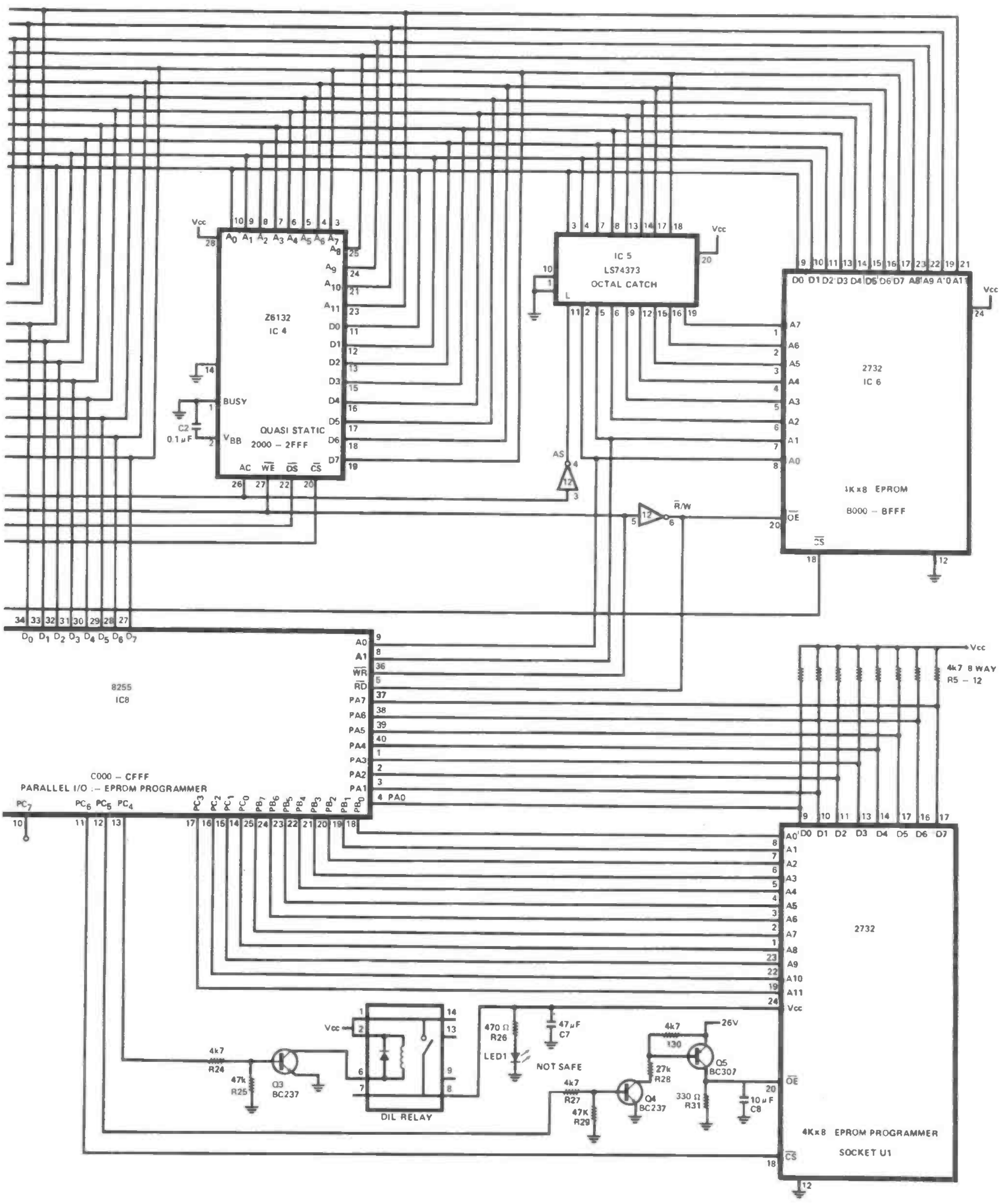


Figure 2: Full Circuit diagram of the Z-8 Tiny BASIC program development system.
As can be seen from the photographs the prototype was constructed using wire wrap techniques, but constructors are advised to use the R&EW PCB, or at least take up yoga first!

faster speed, Tiny BASIC supports direct machine language calls in two very powerful ways.

Z-8 Tiny BASIC

Z-8 Tiny BASIC is fast (due in part to the pipelining of Z-8 memory references) efficient, and easy to use. Table 1 shows the Tiny BASIC command, statement and function set. If at first glance it seems a bit limited, then remember that Tiny BASIC is intended for control applications, not stock control and ledger balancing. The statements supplied allow all other basic constructs to be easily simulated, for instance, FOR... NEXT, is simulated by an IF THEN/GOTO type of construct.

Tiny BASIC is integer only. Expressions must evaluate within the range 32767 to —32768, or 0-65536 in the case of memory references. 26 variables are allowed (A-Z) and multi-line statements separated by a colon : Input, output and constants may be either decimal or hexadecimal, if prefixed by a percent sign. In addition, the operators @ and ∧ provide memory byte and memory word references. Thus, direct access in hexadecimal to any CPU register I/O port or memory location is provided for.

Machine language sub-routines are supported both with and without parameter passing. Although the source code of Tiny BASIC is not available (and in view of the ROMmed nature of the code would not be frantically useful in any case) the position of every variable and pointer is documented, making it easy for machine language sub-routines to directly manipulate the BASIC environment.

When the Z-8 powers up it searches external memory to see if any RAM is present in the system. If it is, pointers are set to allocate stack and variable storage externally. If there is none, then they are allocated internally, (such as in a minimum chip system).

Next, the Z-8 tests whether or not ROM is present at 1020 HEX (1000-101F is used for interrupt vectors). If it is and the ROM contains Tiny BASIC code starting with a line number between 1 and 254, the interpreter automatically begins execution of the code stored in the ROM. If ROM is not present at 1020 HEX and RAM is present in the system, Tiny BASIC signs on at the terminal connected to the Z-8 serial I/O pins, and is ready to be programmed directly in BASIC. The terminal baud rate is found out by reading a code stored on some dip switches mapped at FFFD HEX, during the power on sequence.

The Circuit of the R&EW Z-8 TBPDS

Figure 2 is the complete circuit diagram of the TBPDS. The facilities offered are impressive:

8K bytes of user RAM for program development.
On board 2716/32 EPROM programmer.
4K bytes of utility software in EPROM -EPROM blowing and cassette interface.
Program dump and retrieve port.
RS232 110-19200 baud interface.
All major Z-8 bus and I/O lines available via edge connector.

Complete constructional details for the Z-8 computer, cassette interface and power supply appear in part 2 of this article, so we will now limit our discussion to the salient points of the circuit diagram.

To communicate with the Z-8 board you need an RS232 terminal or a personal computer with 232 capability. The circuitry of Q1 and Q2 provides TTL ⇄ RS232 buffering.

8K bytes of user RAM are provided, for program development, by two Z6132 4K by 8 quasi-static RAMs. (See November **R&EW**.) Address decoding is provided by IC9 and the Z-8 signals AS, DS, and R/W. IC3 is configured to start at 1000 Hex. By changing an internal Z-8 pointer, code will be entered at 1020 hex, thus allowing machine code sub-routines to be developed at the same memory locations as in the final EPROM auto-start system.

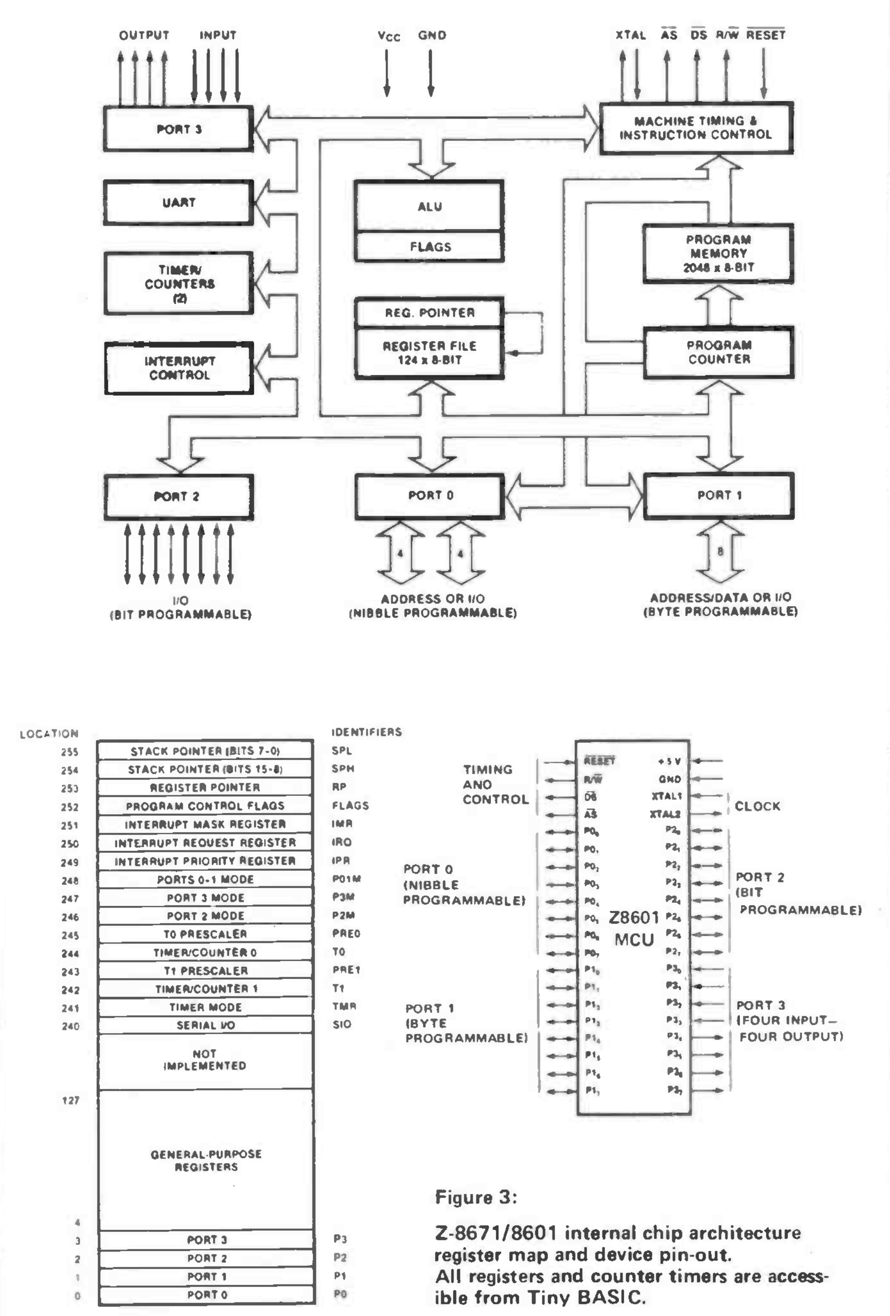
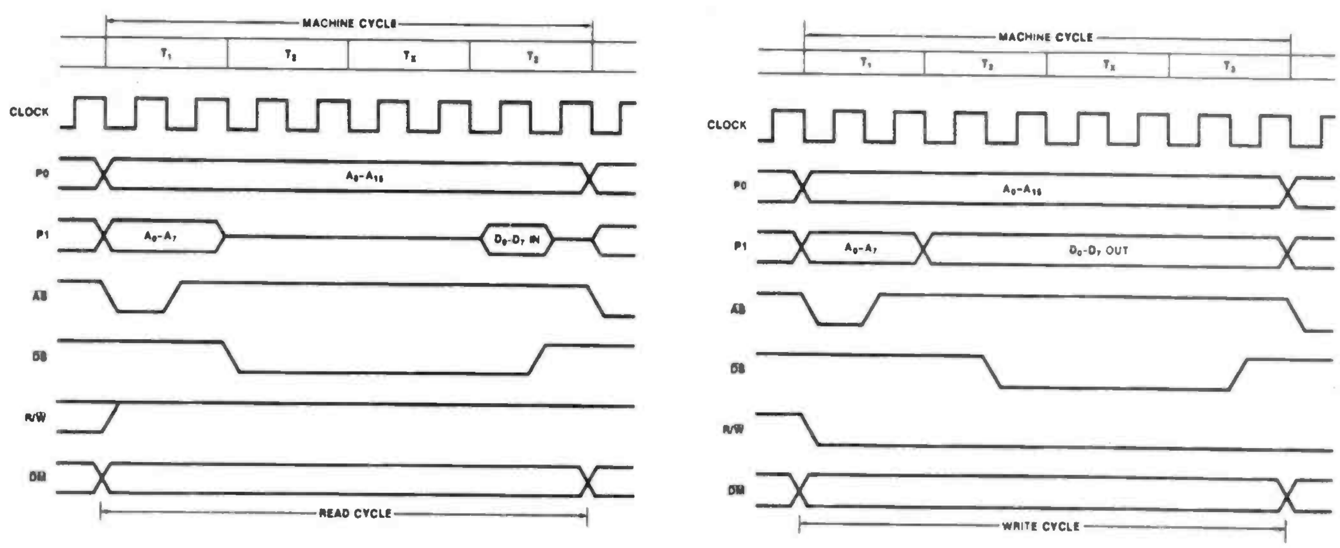


Figure 3:

Z-8671/8601 internal chip architecture register map and device pin-out.
All registers and counter timers are accessible from Tiny BASIC.



Extended External Instruction Fetch, I/O or Memory Read Cycle

Extended External I/O or Memory Write Cycle

Figure 4: Z-8 bus transactions, showing timing diagrams for external memory read and write.

NB. The Z-8 external memory interface bus is, in fact, extremely complex due partly to the multiplexed nature of the low order address and data lines and, also, because the Z-8 use pipelining. Thus, a second instruction fetch occurs before the previous instruction has finished executing.

IC6 is a 2732 4K by 8 EPROM containing utility software (which will be published in part 3) to program EPROMs with the code currently in RAM and to drive the program dump retrieve port provided by half of IC10. IC5 is an octal latch which demultiplexes the address and data bus for ICs 6 and 8.

IC8 is an 8255 PIO which provides 24 lines of I/O used to program an EPROM in socket U1. Alternatively, the lines can be used as extra processor I/O. Utility routines in IC6 provide for reading EPROM to RAM memory, transferring RAM memory and verification of RAM against EPROM.

IC7 provides further address decoding and chip select lines for the PIO and the 2732, DS is gated in with the address lines so that the output only becomes valid during the DATA portion of the bus transfer.

Power to the EPROM programming socket is switched via a small relay, allowing EPROMs to be safely inserted and removed without having to power down the rest of the Z-8 board. Transistors Q5 and Q4 provide a 26V programming pulse to the EPROM plugged in to socket U1. As 2732s may be partially programmed the software asks for starting and ending address in EPROM. Power on reset is provided by C6, R21 with a manual reset provided by PB1.

A facility for program storage and retrieval is provided by the program in and out port; software in IC6 switches the UART stream from the terminal to the program port and changes the baud rate. A formatted dump or load of a program can then be carried out; again, software to achieve this exists in IC6. The prototype was used with a paper tape punch and reader plus a simple audio cassette modulator/demodulator, details of which will be published next month.

The system works well, but such is the convenience of having an on-board EPROM programmer that the author found himself using EPROMs as the main program storage medium. At the end of a programming session the partially developed code was transferred to EPROM (about 8 minutes for a full 4K bytes) and at the start of the next session read back into memory (about 10 seconds). By using a cheap (£40) EPROM eraser it was necessary to only have 4 or 5 EPROMs in use. I even considered writing a program to include a directory at the beginning of the EPROM to index the programs in the EPROM.

Expansion of the R&EW Z-8 Board

The design is quite modular and the initial system may be built up in stages, adding such facilities as the second Z6132 and EPROM programmer, as time and funds allow.

All of the critical Z8671 lines are available on the edge-connector, thus off-board expansion is feasible. The Z8671 will drive one standard TTL load, or four LS loads. If it is desired to drive more discrete logic than this from a processor line, then National Semiconductor's new family of high speed CMOS based 74xx replacements should provide an answer, as they have speed compatibility with 74LS devices and only 1 micro-ampere input current requirements.

R&EW and the Z-8

The most exciting feature to us here at **R&EW** about the Z-8 is the speed and ease with which microprocessor based applications may be developed using Tiny BASIC. We will be supporting this view by publishing a number of projects based upon Z-8 controllers. Part four of this article will include a PCB design for the 'minimum chip Z-8 system'.

Next month we will continue with the construction of the Z-8 computer, the PSU and cassette interface. □ **R & EW**

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LBO 513	10 MHz	5 mV/1 mV	Single Trace	5"	
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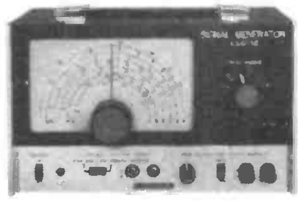

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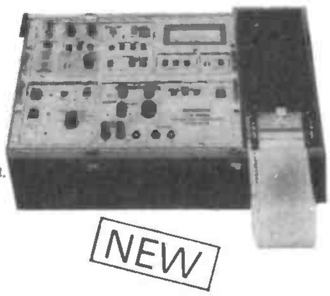

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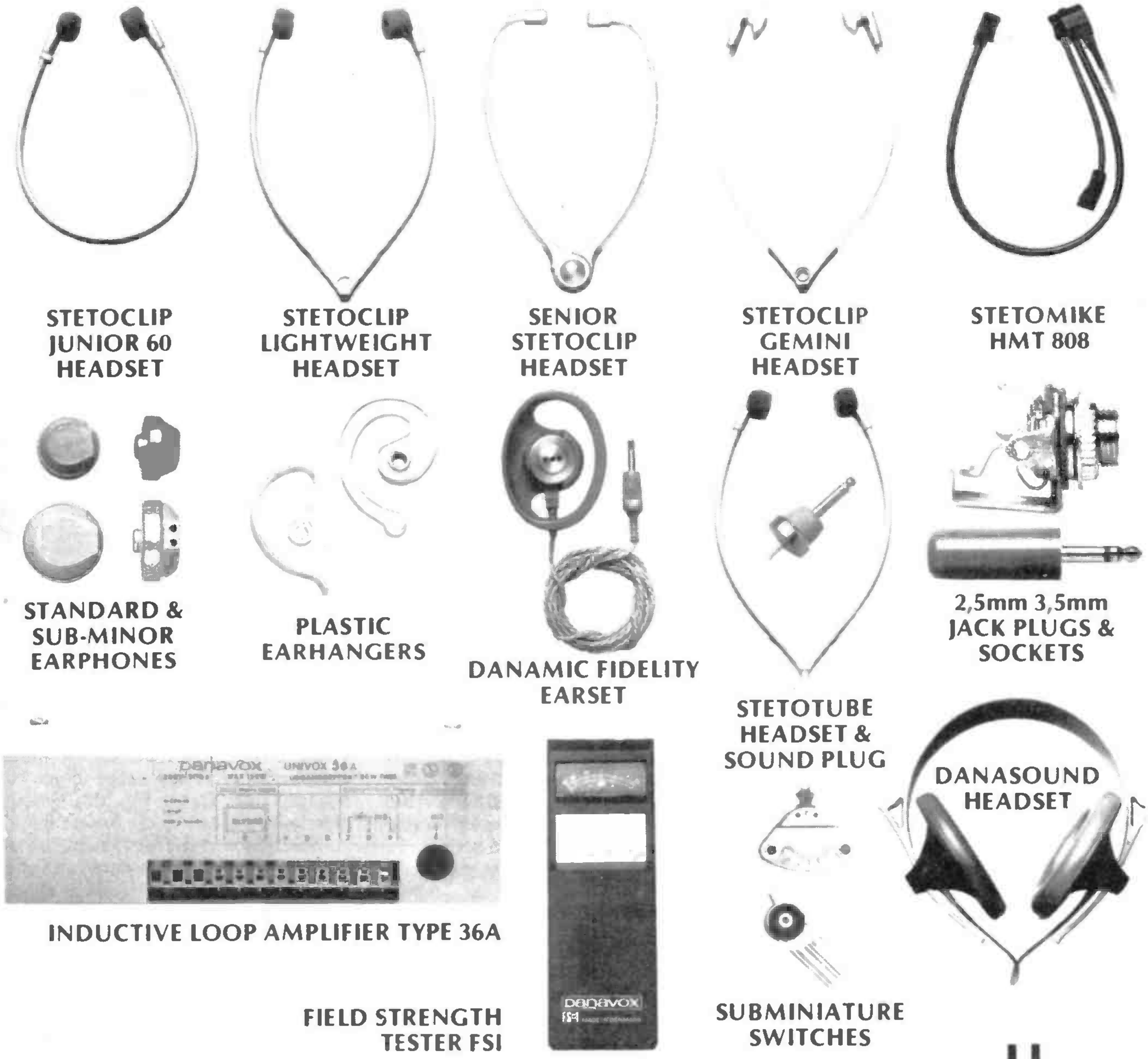

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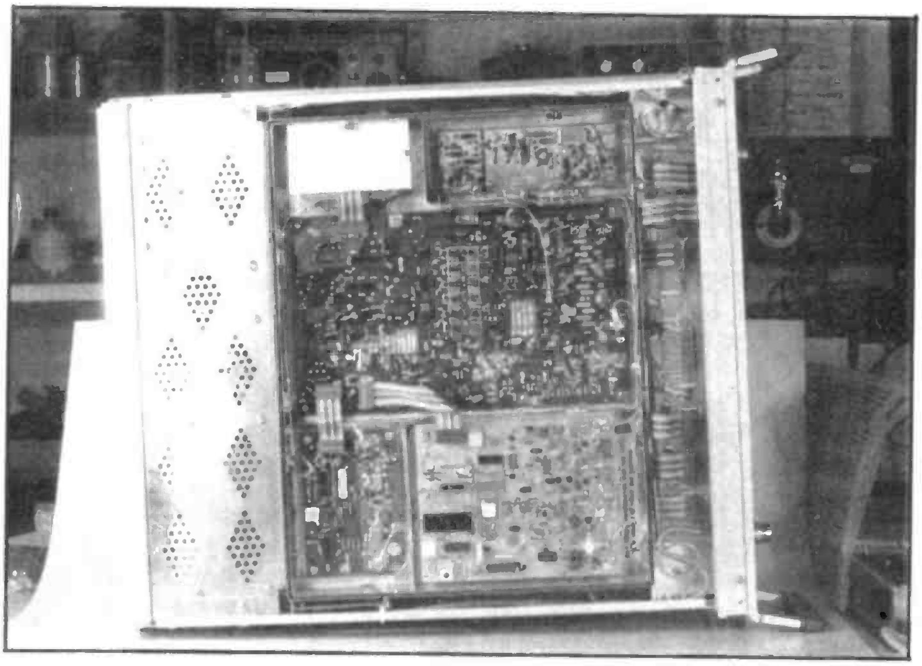


Making Waves.

Marconi Instruments have avenged their reputation as manufacturers of 'unexciting' RF signal sources rather dramatically in the past year. First the servo-driven cavity tuned 2017 joined established 'standards' in terms of performance, and then went a few steps ahead with a multiplicity of MPU functions to delight the RF design engineer. At the recent London Testmex show, the 'economy' models were wheeled on in the shape of the 2018 and 2019.

Broadly speaking, the 2018 and 2019 equate to the Hewlett Packard 8640B in terms of overall functions and facilities. The frequency range of the 2018 is 80 kHz to 520 MHz, and the 2019 covers 80 kHz 520 to 1024 MHz. Both are cited as being 'usable down to 30 kHz' - and both are fully synthesised with a GPIB interface.

This neck of the market is getting to be quite well populated by various manufacturers. The most direct 'comparison' can be made with the Rhode and Schwarz SMS series generator, although the Anritsu MG545B at £7000 highlights the fact that all the competition costs rather more than the 4019's modest £4200.

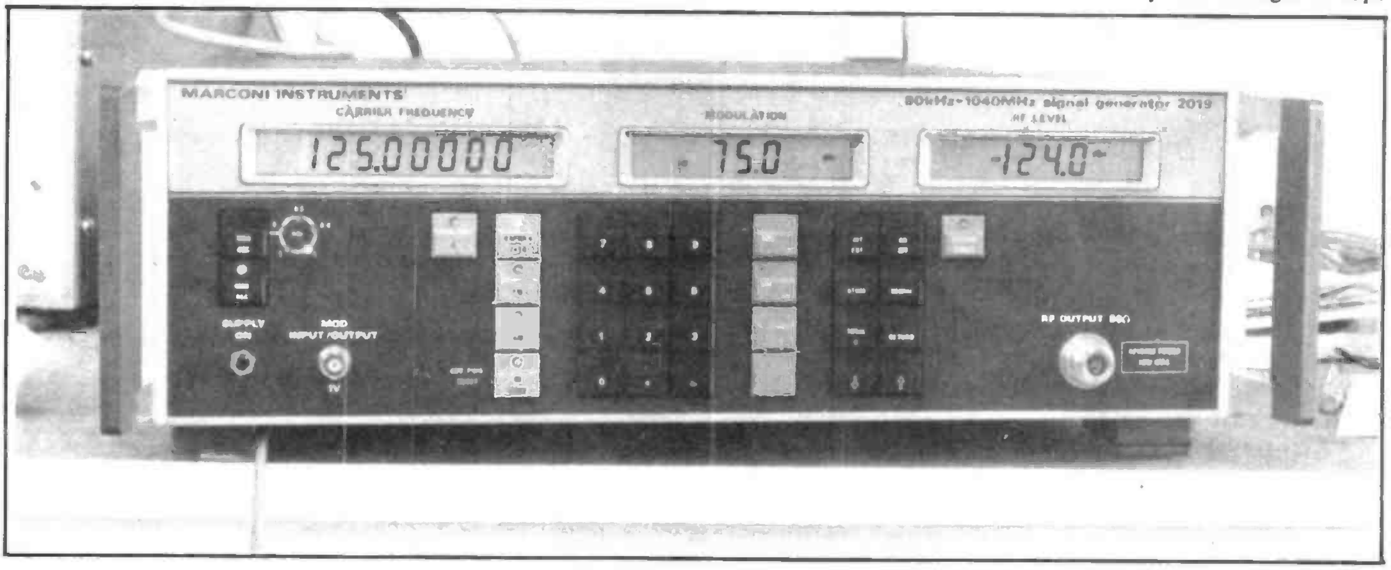
My one is bigger than your one...

In view of the nature of this type of test equipment, direct comparisons are neither possible nor desirable - some applications may find the Anritus's 0.01 Hz resolution relevant, and the 2019's 10 Hz resolution a nuisance. Equally the Anritus runs out at 500 MHz, whereas the 2019 ploughs on to 1040 MHz. So the purpose of this review is to try and establish a *user's* point of view - as we have said, the **R&EW** lab is probably the most 'general' situation any test equipment is likely to find itself in, so we feel able to give an average engineer's viewpoint.

Around the functions.

Let's get the gripe over with first. Development engineers like tuning knobs. There is no substitute for the vernier digital accuity (I am indebted to Mike Albinson of Quad for this priceless descriptive phrase) to the human hand.

The reason given for the absence of a tuning knob is that the step rate of the device is not really fast enough to cope



SPECIFICATIONS

CARRIER FREQUENCY

Range 2018: 80 kHz to 520 MHz, usable down to 30 kHz.
2019: 80 kHz to 1040 MHz, usable down to 30 kHz.

Selection By keyboard entry.

Indication 8 digit LCD – see under KEYBOARD AND DISPLAYS.

Resolution 10 Hz up to 520 MHz. 20 Hz from 520 to 1040 MHz.

Accuracy Equal to the frequency standard accuracy. See FREQUENCY STANDARD.

RF OUTPUT

Level 0.2 µV to 2 V e.m.f. in c.w. and f.m. modes. 0.2 µV to 1 V e.m.f. in a.m. mode.

Selection By keyboard entry. Units may be µV, mV, V e.m.f. or p.d., dB relative to 1 µV, 1 mV, 1 V e.m.f. or p.d., dBm.

Indication 4 digit LCD with units annunciators. See KEYBOARD AND DISPLAYS.

Resolution 0.1 dB or better over entire voltage range.

Output level accuracy ±1 dB up to 520 MHz. ±2 dB above 520 MHz.

Output impedance 50 Ω, type N female socket. For output levels below 300 mV e.m.f. the VSWR is better than 1.2:1 for carrier frequencies up to 520 MHz and better than 1.5:1 for carrier frequencies above 520 MHz.

Reverse power protection An electronic trip protects the generator output against reverse power of up to 50 W from d.c. to 1 GHz. The trip may be reset from the front panel or via the GPIB.

SPURIOUS SIGNALS

Harmonically related signals For output levels less than 1 V e.m.f. Better than −30 dBc for carrier frequencies up to 520 MHz and better than −20 dBc for carrier frequencies above 520 MHz.

Sub-harmonics None for carrier frequencies up to 520 MHz. −20 dBc for carrier frequencies above 520 MHz.

Non-harmonically related signals −70 dBc for carrier frequencies from 2.03126 MHz to 1040 MHz. −60 dBc for carrier frequencies from 80 kHz to 2.03125 MHz.

Residual f.m. Less than 6 Hz r.m.s. in CCITT telephone psophometric band at 520 MHz and improving by approximately 6 dB per octave with reducing carrier frequency down to 2.5 MHz.

Single sideband phase noise Better than −130 dBc/Hz at 90 MHz and 20 kHz offset from the carrier. Typical performance curves are shown in the text.

RF leakage Less than 0.5 µV p.d. generated in a 50 Ω load by a two-turn, 25 mm loop, 25 mm or more from the case of the generator with the output level set to less than −10 dBm and the output terminated in a 50 Ω sealed load.

FREQUENCY MODULATION

Range Peak deviation from 0 to 100 kHz for carrier frequencies up to 2.03125 MHz. Peak deviation from 0 up to 1% of carrier frequency for carrier frequencies from 2.03126 MHz to 520 MHz. Peak deviation from 0 up to 1% of carrier frequency for carrier frequencies above 520 MHz.

Selection By front panel keyboard. Internal modulation oscillator (see MODULATION OSCILLATOR) or external modulation input may be selected.

Display 3 digit LCD. See KEYBOARD AND DISPLAYS.

Deviation accuracy ±5% of deviation at 1 kHz modulating frequency excluding residual f.m.

Frequency response ±1 dB from 50 Hz to 100 kHz relative to 1 kHz. Usable down to 10 Hz with reduced deviation.

Distortion Better than 3% total harmonic distortion at 1 kHz modulating frequency and a deviation of up to 70% of maximum available at any carrier frequency. Better than 0.3% total harmonic distortion at 75 kHz deviation at carrier frequencies from 88 MHz to 108 MHz at 1 kHz modulating frequency.

External modulation With modulation a.l.c. on, the deviation is calibrated for input levels between 0.8 V and 1.2 V p.d. With modulation a.l.c. off, the deviation is calibrated for an input level of 1 V p.d. Input impedance: 100 kΩ nominal.

AMPLITUDE MODULATION

Range 0 to 99% in 1% steps.

Selection By front panel keyboard. Internal modulation oscillator (see MODULATION OSCILLATOR) or rear panel external modulation input may be selected.

Display 2 digit. See KEYBOARD AND DISPLAYS.

Accuracy Better than ±(4% of depth setting +1%) for modulation depths up to 95% at 1 kHz modulating frequency and carrier frequencies up to 400 MHz.

Frequency response ±1 dB from 20 Hz to 50 kHz relative to 1 kHz at 80% depth, d.c. coupled.

Envelope distortion Better than 3% total harmonic distortion for modulation depths up to 80% at 1 kHz modulating frequency and carrier frequencies up to 400 MHz. Better than 2% total harmonic distortion for modulation depths up to 90% at 1 kHz modulating frequency for carrier frequencies up to 32 MHz.

External modulation input With the modulation a.l.c. on, the modulation depth is calibrated for input levels between 0.8 V and 1.2 V p.d. With the modulation a.l.c. off, the modulation depth is calibrated for an input level of 1 V p.d. Input impedance: 100 kΩ nominal, d.c. coupled.

MODULATION OSCILLATOR

Frequencies 300 Hz, 400 Hz, 1 kHz, 3 kHz and 6 kHz selected sequentially by repetitive pressing of the Mod. Osc. key.

Display Five LEDs indicate selected frequency.

Frequency accuracy ±5%.

FREQUENCY STANDARD

Internal or external frequency standard may be selected from the front panel. Annunciators show which is selected.

Frequency standard input/output A rear-panel BNC socket provides an output from the internal frequency standard when internal standard is selected and becomes the external standard input when external standard is selected.

INTERNAL FREQUENCY STANDARD

Frequency 10 MHz

Temperature stability Better than ±0.1 p.p.m. over the temperature range 0 to 40°C.

Warm-up time Within 0.5 p.p.m. of final frequency 5 min. from switch-on at 20°C ambient.

Internal standard output 10 MHz at nominally 3 V p-p square wave. Source impedance: 100 Ω nominal.

EXTERNAL FREQUENCY STANDARD

External standard input Accepts a 10 MHz signal of at least 1 V r.m.s. Maximum input 2.5 V r.m.s.

AUXILIARY INPUTS AND OUTPUTS

Modulation input/output A front-panel BNC socket provides an output from the modulation oscillator when internal modulation is selected and becomes the external modulation input when external modulation is selected.

Internal modulation oscillator output 1 V e.m.f. nominal from 1 kΩ source impedance at selected modulation frequency.

External modulation input Input level nominally 1 V into 100 kΩ. See FREQUENCY MODULATION and AMPLITUDE MODULATION.

Alternative RF output A blanked hole is provided so an RF output socket can be fitted to the rear panel for systems use.

KEYBOARD AND DISPLAYS

Main keyboard functions All instrument settings are controlled by the front panel keyboard. The main key functions are:

CARRIER FREQ	7	8	9	MHz/V
FM	4	5	6	kHz/mV
AM	1	2	3	Hz/µV
RF LEVEL		0		%/dB

Settings are entered by selecting the required function, keying in the value and pressing the appropriate units key. Other functions provided are:

Δ Increment key. When pressed before a function key, an increment value is entered for that function.

↑ and ↓ Increment or decrement the selected function.

TOTAL Δ Display total incremental shift from last keyed-in value.

RETURN Return setting to last previously keyed-in value for the selected function. (In remote operation requests return to local control.)

INT EXT If pressed after Carrier Freq., toggles between internal and external frequency standard. If pressed after AM or FM, toggles between internal and external modulation.

ON OFF If pressed after Carrier Freq., toggles between RF output on and off. If pressed after AM or FM, toggles between modulation on and off.

MOD OSC Sequentially selects one of five internal modulation oscillator frequencies.

MOD ALC Toggles between modulation a.l.c. on and off.

STORE and RECALL Provides storage and recall of instrument settings in non-volatile memory. Up to 10 complete instrument settings and up to 40 carrier frequencies may be stored.

SECOND FUNCT. Selects second function entry mode.

Secondary keyboard functions The following secondary functions may be selected using the Second Function key followed by a number key.

- Ø Second function protection
- 1 Display instrument status (GPIB address, RF output level units etc.)
- 2 Display/change GPIB address
- 3 Direct addressing of internal bus system (servicing aid)
- 4 Display/change GPIB SRQ mask
- 5 Display/change RF level units (i.e. voltage e.m.f. or p.d. and dB reference)
- 6 Display/change RF level calibration offset.
  Functions 4, 5, 6 are protected functions
- 7 RF calibration
- 8 FM calibration
- 9 2018/2019 software switch
  Functions 7, 8 and 9 are doubly protected functions intended for use in manufacture and servicing only

Displays Three liquid crystal displays provide simultaneous readout of Carrier Frequency, Modulation and RF Level.
Carrier frequency display: 8 digit display with annunciators to show frequency units, external frequency standard, frequency limit exceeded, remote operation and GPIB address displayed (second functions 1 & 2).
Modulation display: 3 digit display with annunciators to show modulation units FM, AM, modulation off, external modulation selected and modulation limit exceeded.
RF level display: 3 digit display with annunciators to show RF level units, RF output off, reverse power trip operated and RF level limit exceeded.

GPIB INTERFACE

A GPIB interface is available as an accessory for the customer to fit. All functions except the supply switch are remotely programmable.

Capabilities Complies with the following subsets as defined in IEEE 488: 1978: SH1, AH1, T6, TEØ, L4, LEØ, SR1, RL1, PPØ, DC1, DT1, CØ, E1.

RADIO FREQUENCY INTERFERENCE

Conforms with the requirements of EEC Directive 76/889 as to limits of r.f. interference.

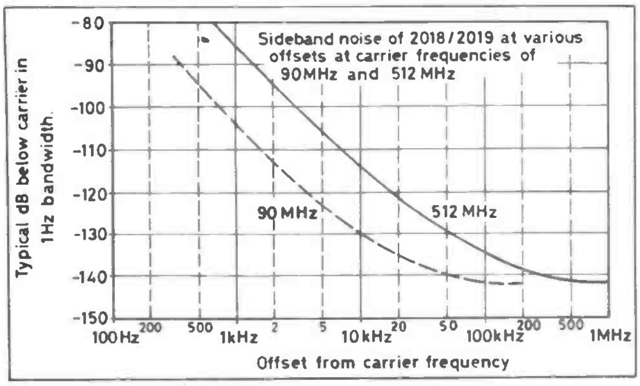
POWER REQUIREMENTS

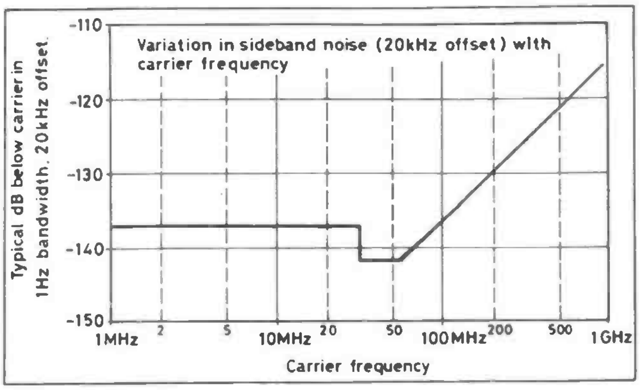
AC supply Switchable voltage ranges 105 to 110 V, 115 to 120 V, 210 to 220 V, 230 to 240 V, all ±10%. 45 to 440 Hz. 70 VA maximum.

DIMENSIONS AND WEIGHT (over projections but excluding handles)

Height	Width	Depth	Weight
152 mm	425 mm	525 mm	16 kg
6 in	16.7 in	20.7 in	35.2 lb

MARCONI 2019.





with a 'spun' knob - and besides, there are many problems associated with determining the step size. Other manufacturers (notably Fluke) have devised solutions that sense the spin rate to determine step size - but then we are moving into the realms of the 2017 at around £9000. No contest.

The 2019 is aimed very much at test applications with its GPIB interface option at only £150. In fact, the instrument is virtually entirely tested via this facility during manufacture. As you can see from the *internal photographs,* there is a distinct shortage of preset controls anyway. This is indicative of the design concept, which has obviously been to produce a truly 'mass production' piece of engineering.

The 8085 MPU controls everything from the keyboard. All test parameters bar the modulation frequency are entered by a combination of 'Function/Value' on the keyboard. The results being displayed on the custom LCD array, which although not the most readable of display systems, helps keep power consumption low - and avoids the problems of the hash from a strobed LED display.

The 'delta' tune function is very versatile for the radio engineer. Any size step can be entered - say 12.5 kHz if you are working on mobile radio - and then the 'up/down' sequency buttons step a channel at a time. For those of us who cannot remember where it all started, MI have thoughtfully included a 'granny button' (marked 'Return') to get back to base. A further refinement also allows you to check the total shift from the datum frequency. After a little while, the tuning knob seems quite unnecessary.

In fact, given a straight choice between the Delta Tune functions of the 2019 and a knob, the 2019's approach must surely win every time. But if only both were available....

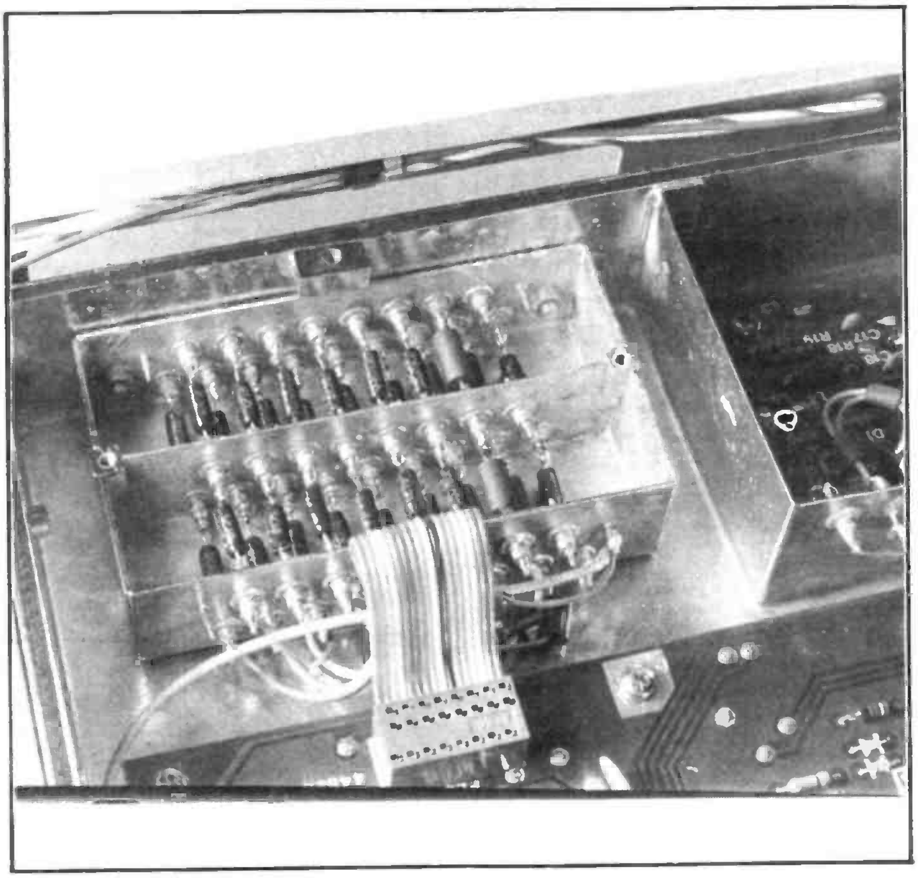
Modulation.

The 2017 provides 0-99% AM (in 1% increments), and up to 100 kHz FM up to 2.03125 MHz. Above that, 1% of the carrier frequency. The frequency response is within 1 dB from 10 Hz to 100 kHz, and it is interesting to note that the specification pays special attention to the 88-108 MHz range, with better than 0.3% (-50 dB) distortion at 75 kHz deviation in Band II FM.

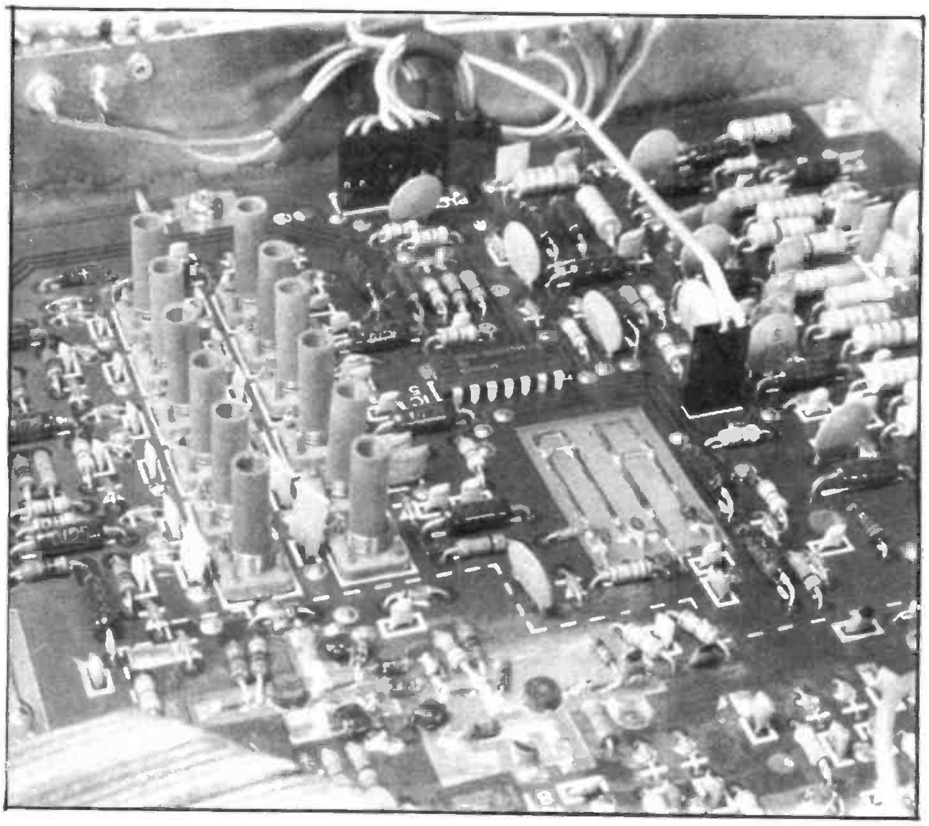
Stereo separation from an external multiplex input was around 45-50 dB -and the external input has an ALC feature to level off inputs from 0.8 V to 1.2 V PD.

Marconi Instruments have asked us to make the following comments regarding this review:

1. The attenuator fault on our review model was in fact due to logic driver fault and was connected with the Reverse Power limit.
2. The programming language used is in fact 'PLM'.
3. Marconi believe their quoted 'leakage' specification of 0.5uV to be better than most of the competition.



Close-up view of the copious networks used to decouple the PSU and logic bus, to prevent RF leakage.



Inside the Oscillator Box - Note the striplines tuned with shorting links

Spurii and noise.

One of the major concerns of the communications business is oscillator noise. Noise in oscillators affects every aspect of performance, so the less noise the better. Signal generator manufacturers have tended to regard this parameter as the major benchmark test, so here's a table establishing the 2019 in this league. *Fig 1* gives the variance across the operational range of the 2019.

2019	Marconi	(c£ 4 200)	-135 dBc/Hz at 20 kHz offset (90 MHz)
7100D	Adret	(c£ 8 500)	-130 dBc/Hz at 20 kHz offset (650 MHz)
MG545	Anritsu	(c£ 7 000)	-120 dBc/Hz at 10 kHz offset (500 MHz)
8656A	HP	(c£ 5 500)	-125 dBc/Hz
6070A	Fluke	(c£10 000)	-132 dBc/Hz at 20 kHz offset
SMS	R&S	(c£ 4 000)	-120 dBc/Hz at 20 kHz offset
8640B	HP	(c£5 500)	-140 dBc/Hz at 20 kHz offset (256 MHz)

The 'classic' HP 8640B is included to illustrate the fact that non-synthesised generators can achieve better SSB phase noise more easily than synthesised types.

The MI device comes through this test rather well - and apart from the R&S SMS and HP's 8656A, there is no really comparable generator in sight.

Processor power.

The beauty of the 2019 is that it is very much part of the new generation of test equipment where the MPU has been used to achieve results that cannot be implemented any other way. Early MPU applications tended to be 'electronic' button pushers and knob twiddlers, this instrument uses the MPU (with a prodigious amount of program, believed to be 'PLM', although all we were able to ascertain was that it is not machine code) to provide a second function key that allows the user to alter an Earom option program, covering such things as the GPIB address, units used in the display (volts EMF/PD or dB),etc.

The output level can be 'recalibrated' with an offset to account for cable or test fixture losses - in fact, the entire calibration can be fiddled with if you know the correct sequence of 'keys'.

User conclusions.

What a pleasant change it is to be able to report a British designed and made product that really stands a good chance of dominating its market sector. The loss of a tuning knob is not an insurmountable problem, and the versatile Delta Tune functions easily cover its omission. We would have liked to look at it for longer, but while we are still having problems persuading manufacturers about the nature of **R&EW**'s approach to electronics equipment assessment, we shall have to suffer from being 'squeezed in' to tight schedules.

Our review model had a problem with the attenuator block - funnily enough, the only mechanical (solenoid operated) part in the whole unit! The 2019 has the very tempting legend 'Reverse Power 50 W Max' printed next to the output socket. This is an excellent feature for transceiver testing where it is perilously easy to hit the transmit switch - but it may tempt the engineer to give it a go and see what happens. Maybe this particular model was given a shade too much, and the attenuator complained.

The keyboard entry system can be assimilated in a few minutes, and thereafter isn't a problem. Separate incremental controls on the output level, frequency and modulation depth would have been useful, but at £4200, perhaps this is greedy. The competition certainly doesn't bear close examination in these areas either.

The output leakage of the instrument is not perhaps as good as it might be. But then again, those of us who have sought entry to the inner sanctum of something like the 901's oscillator will appreciate that extremely low leakage is only accompainied by the most copious multiple screening. MI acutally bother to state the leakage level, unlike most of the opposition. The minimum output is 0.2 uV - which is actually rather high for many modern receiver tests, so a plug-on 10 dB in line attenuator is not a bad accessory to have handy. Remember to check for leakage pickup at extremely low levels.

Stop me and buy one.

Marconi Instrument's UK Sales Manager -Tony Boyle - expressed understandable enthusiasm at the way in which the instrument had been greeted by the industry. Deliveries already stretch into the dim distance, and that's with an instrument that is not particularly 'hand made' when compared to some.

MI have set out to create a new generation of universal signal generators - the 2017 represents the very 'top end' of the market in terms of just about everything, and the 2019 represents the workhorse tool. Please may we swap some advertising space for one?

■ R & EW

Your Reactions.........	Circle No.
Immediately Applicable	262
Useful & Informative	263
Not Applicable	264
Comments	265

R&EW Data Brief

TDA1083
ULN2204

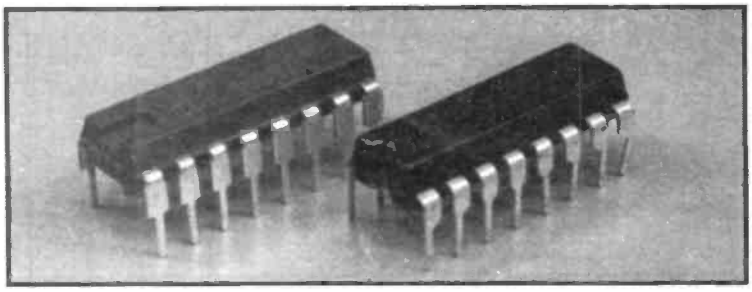
DATABRIEF — ULN2204/TDA1083

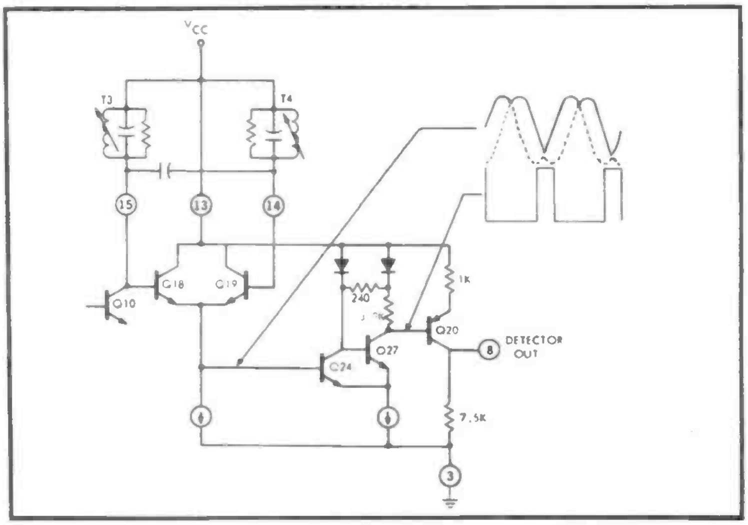
The ULN2204/TDA1083 — (Sprague/AEG) — is a complete portable radio receiver on a single IC. It includes all functions except the FM tunerhead, and operates over the very versatile supply voltage range of 2-12 V.

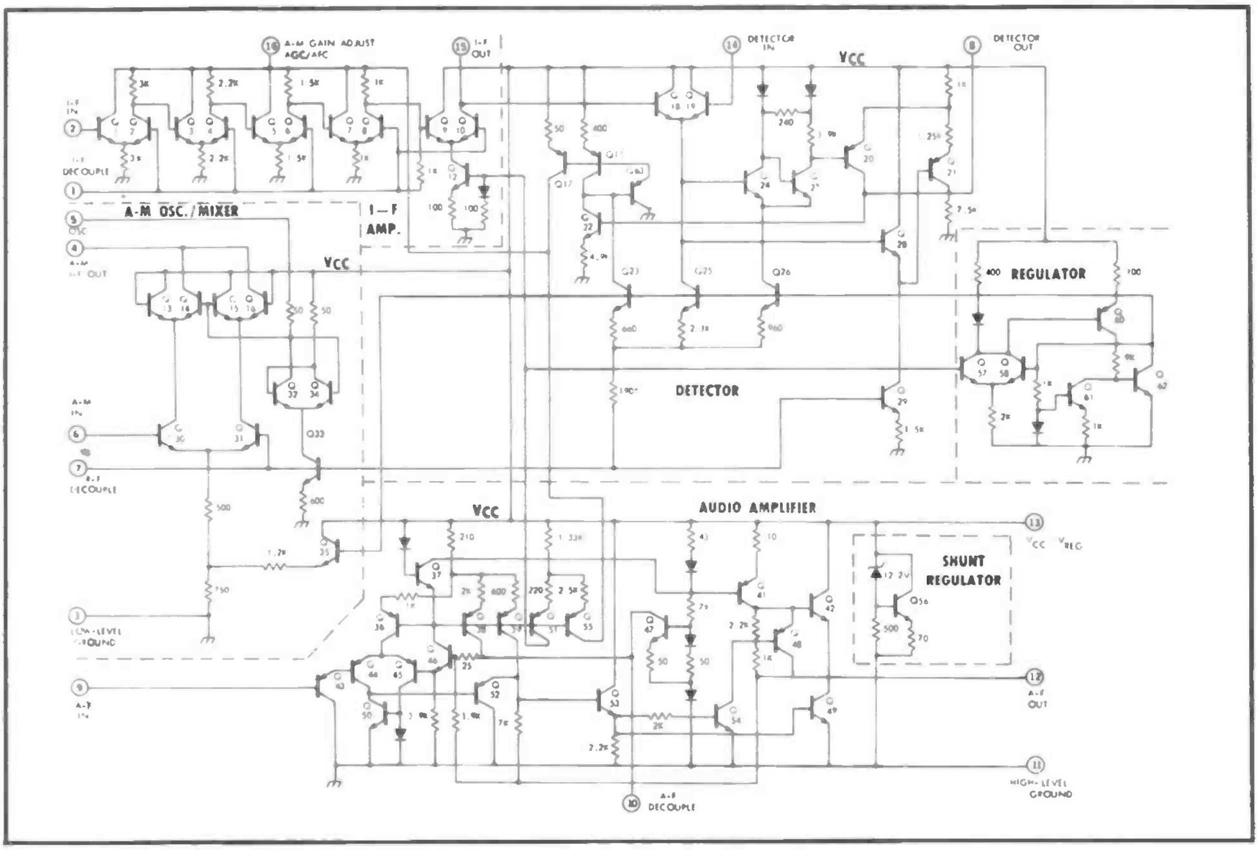
In the AM mode, the device operates as a single conversion superhet, with all the signal and audio functions, 'on chip'. Referring to the internal diagram, the single ended signal from the ferrite rod/RF tuned circuit is fed to the input at pin 6, which is one of the ports of the double balanced mixer formed by Q13-16, Q30,Q31. The other input to the mixer, Q31, is decoupled to AC ground, but it may be used in a balanced configuration if required.

The oscillator is a negative resistance oscillator, formed by Q32-34, where the frequency is determined by the tuned circuit from pin 5 to the supply voltage - the output at this stage is directly coupled to the bases of Q14,15 in the mixer. The oscillator and mixer bias rail (appearing at pin 7) is fed from the AGC detector, thus the current through the oscillator coil can vary according to the input level, causing the oscillator and mixer to work through to about 50 MHz.

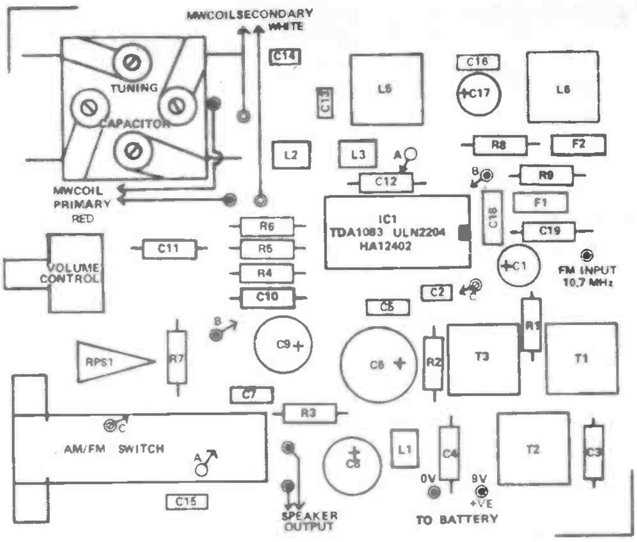
The output of the mixer is fed to the IF filter via pin 4, and thence to the IF amplifier input at pin 2. Pin 2 must be supplied from the IF bias rail at pin 1, and this can be done either via an IFT, or a resistor of around 2k2. The overall AGC of the IF is set by Q17, fed from the detector stage output at pin 8. The maximum IF gain may be adjusted by pulling pin 16 to ground through a 10k preset.



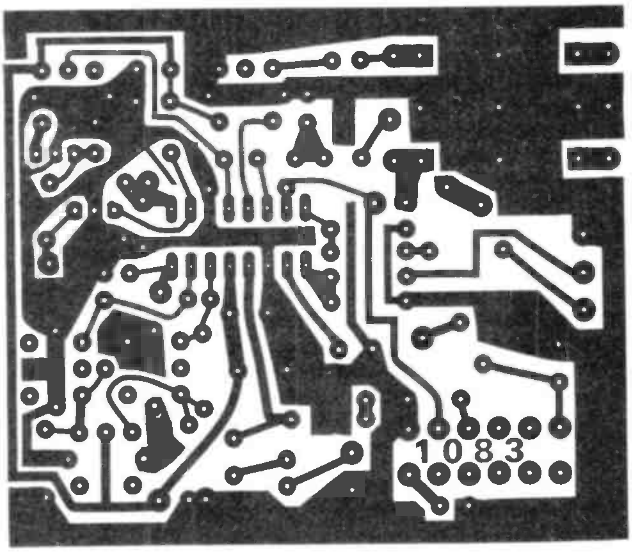




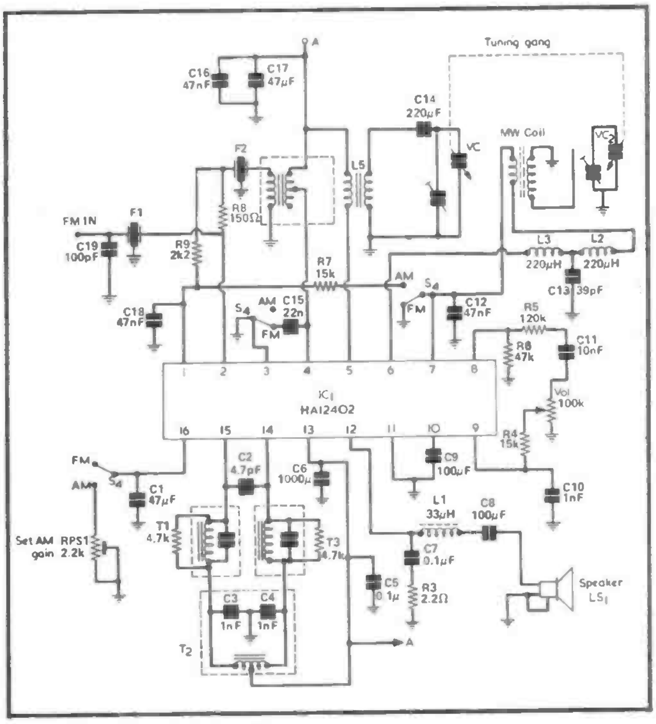
ELECTRICAL CHARACTERISTICS at T_A = +25°C, V_{cc} = 6.0 V (unless otherwise noted)						
Characteristic	Symbol	Test Conditions	Limits Min	Typ	Max	Units
F-M MODE: f_o = 10.7 MHz, f_m = 400 Hz, Δf = ±75 kHz, Peak Separation = 550 kHz						
Input Limiting Threshold	V_a		—	30	40	μV
Detector Recovered Audio	V_r		—	300	—	mV
Detector Output Distortion	THD_o	V_a = 10 mVrms	—	1.0	—	%
A-M Rejection	AMR	V_a = 10 mVrms, 30% A-M, f_m = 400 Hz	35	40	—	dB
I-F Input Impedance	Z_i		—	40	—	kΩ
I-F Input Capacitance	C_i		—	4.0	—	pF
Quiescent Terminal Voltage	V_1		—	1.9	—	V
	V_6		—	1.2	—	V
Quiescent Supply Current	I_{cc}	V_{cc} = 6.0 V	—	13	—	mA
		V_{cc} = 9.0 V	—	16	22	mA
A-M MODE: f_s = 1 MHz, f_o = 455 kHz, f_m = 400 Hz, 30% A-M						
Sensitivity		Maximum Volume	—	5.0	10	μV
Detector Recovered Audio	V_o		—	300	—	mV
Overload Distortion		80% A-M	—	10	—	mV
Usable Sensitivity			—	20	30	μV
Mixer Input Impedance	Z_4	Also, see note	—	4.5	—	kΩ
Mixer Input Capacitance	C_4		—	5.5	—	pF
Mixer Output Impedance	Z_8		—	2.5	—	kΩ
Mixer Output Capacitance	C_8		—	3.0	—	pF
I-F Input Impedance	Z_7		—	100	—	kΩ
I-F Input Capacitance	C_7		—	3.0	—	pF
Quiescent Terminal Voltage	V_4		—	1.3	—	V
	V_8		—	1.7	—	V
Quiescent Supply Current	I_{cc}	V_{cc} = 6.0 V	—	10	—	mA
		V_{cc} = 9.0 V	—	13	—	mA
AUDIO AMPLIFIER f_o = 400 Hz, R_L = 8Ω						
Audio Gain	A_v		37	43	46	dB
Output Power	P_o	V_{cc} = 3.0 V, 10% THD	—	50	—	mW
		V_{cc} = 6.0 V, 10% THD	250	350	—	mW
		V_{cc} = 9.0 V, 10% THD	700	900	—	mW
Output Distortion	THD	P_o = 50 mW	—	2.0	—	%
A-F Input Impedance	Z_9		—	250	—	kΩ
Quiescent Terminal Voltage	V_{10}		—	1.1	—	V
	V_{12}		—	2.2	—	V



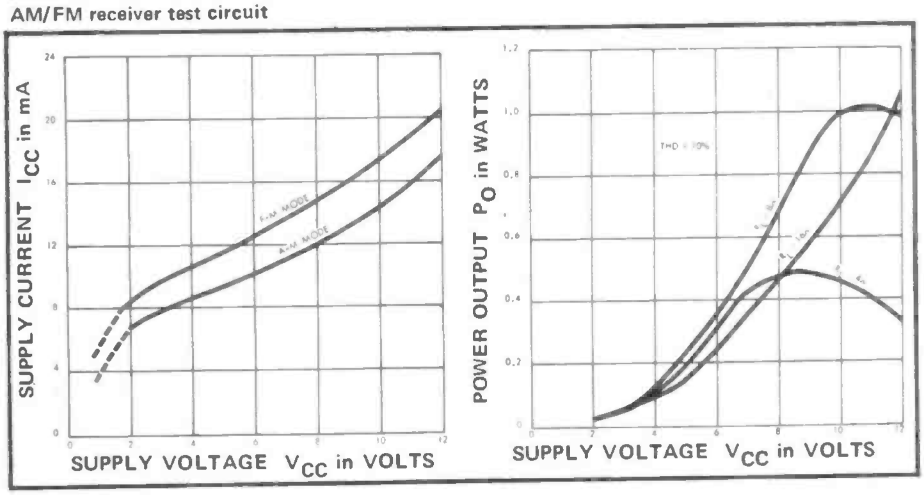
PCB Overlay



PCB Foil



AM/FM receiver test circuit



The IF output appears at pin 15 (maximum 1 V p-p), where a tuned circuit with a minimum impedance of around 18 k gives best results. The resonating capacitor for the AM output IFT is split differentially to provide a good AC ground for the 10.7 MHz used during FM operation. The IF signal is applied differentially across Q18 and Q19, resulting in a full wave detected signal at their emitters. Integration of this signal is acheived through the on-chip capacity of the input to Q28.

During FM operations, the oscillator is disabled, and the IF gain increased to provide limiting. The detector combines positive going quadrature (pin 14) and reference (pin 15) signals, evaluating the duty cycle at the emitters of Q18,19 - and then squaring the result in Q24 and Q27 to produce a variable duty cycle pulse train (see illustration), integrated in a low *ft* transistor, Q20 to provide the corresponding audio output.

The audio amplifier section is a relatively straightforward device with quasi-complementary output stage. Care should be excercised when designing the layout, to take into account the wide-ranging current demands of the IC - a full application note is available from R&EW readers data services for 75p.

■ **R & EW**

THE BIG MATCH: ROUND 3

FRG7700 versus R1000.

Will there be a technical KO, or can they both live to slug it out another day? One thing's for sure, you get your money's worth......

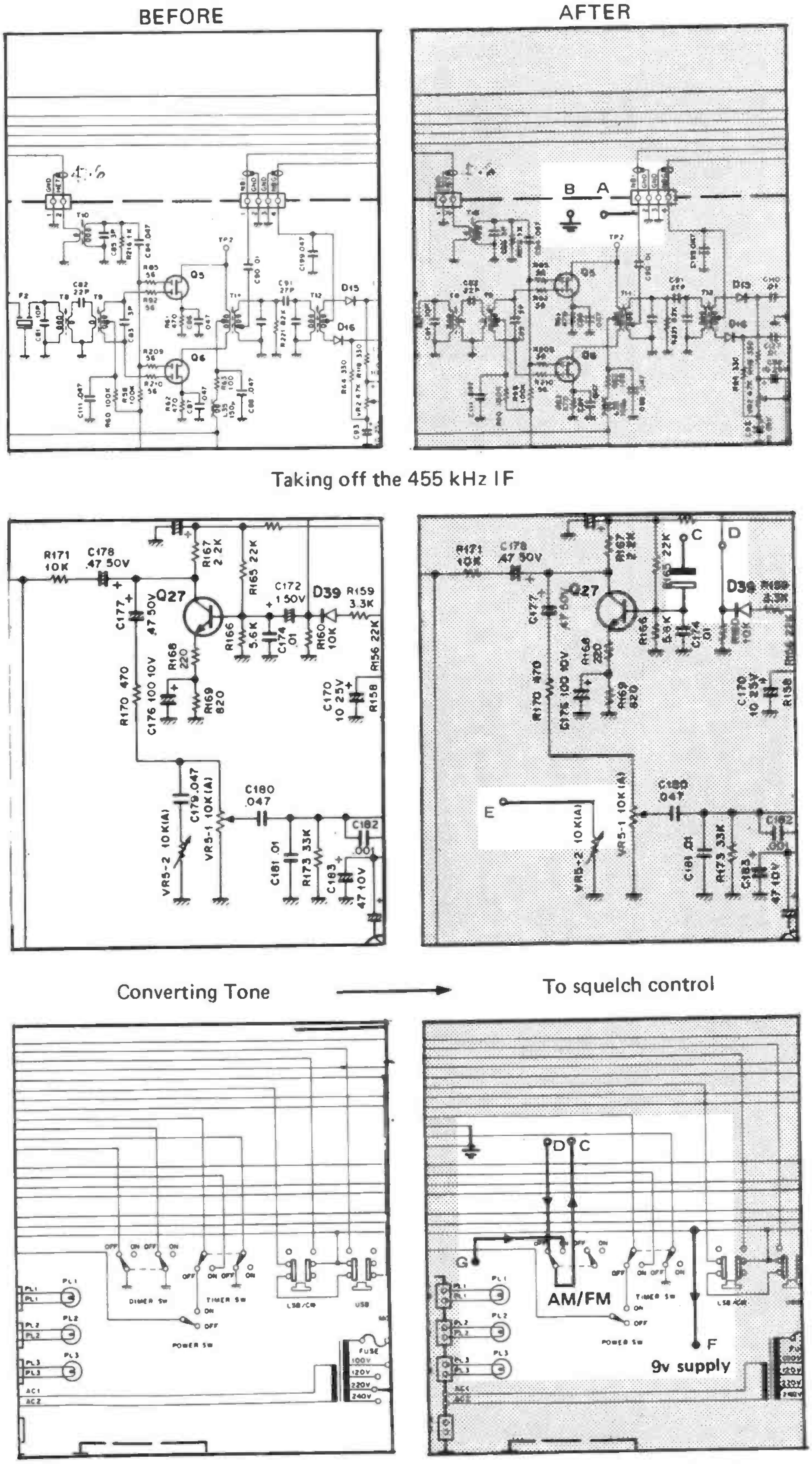


Figure 1: Areas of the R1000 to be modified when fitting the FM facility.

Shake hands....

Conclusion time. Parts one and two led you round the circuit diagrams, and if you recall, both sets have emerged with a startingly similar performance - albeit the R1000 SSB filter is a shade nicer, and the FRG7700 comes complete with many desirable features such as FM demodulator and switchable AGC time constants.

The optional memory facilities of the FRG7700 are certainly a very significant advantage for some users - such as regular short wave listeners. The utility of the £100 approx. that the facility cost is a matter of individual judgement. We are aware of some avid R1000 fans who have provided memory facilities for this receiver as well -it really isn't quite as daunting as it sounds for the experienced electronic engineer with adequate motivation and time.

FM for all.

In case you are one of the many thousands of R1000 users, and you would like to add an FM facility, we describe herewith two ways of fitting a suitable demodulator with squelch - one method is to fit the whole unit inside the existing receiver - but in view of the skill required to perform this in the shape of 'getting at' existing parts of the R1000 circuitry, the faint hearted would be better advised to follow the guidelines for the 'outboard' demodulator.

Figure 1 highlights the areas of the R1000 circuit that are attacked to fit the internal system. You can see that the existing front panel if left alone, and the infrequently used dimmer switch and tone controls are pressed into service as the FM demodulator switch and squelch control respectively.

When expertly fitted, this scheme is quite unobtrusive *(PHOTO)*, although finding room to house the NBFM demodulator is not simple. The unit is based on the Ambit 933357 *(Fig 2)* where you can see that the MOSFET is retained in circuit to ensure that the adapter does not load the output of the 2nd mixer.

Alternatively, the IF can be fed to a socket (preferably BNC) on the back panel of the receiver. A MOSFET buffer should be used to isolate the rest of the IF amplifier - and then you have a low level, relatively broadband 455 kHz signal available for external processing for NBFM or any other function. The IF take-off could be moved along the circuit

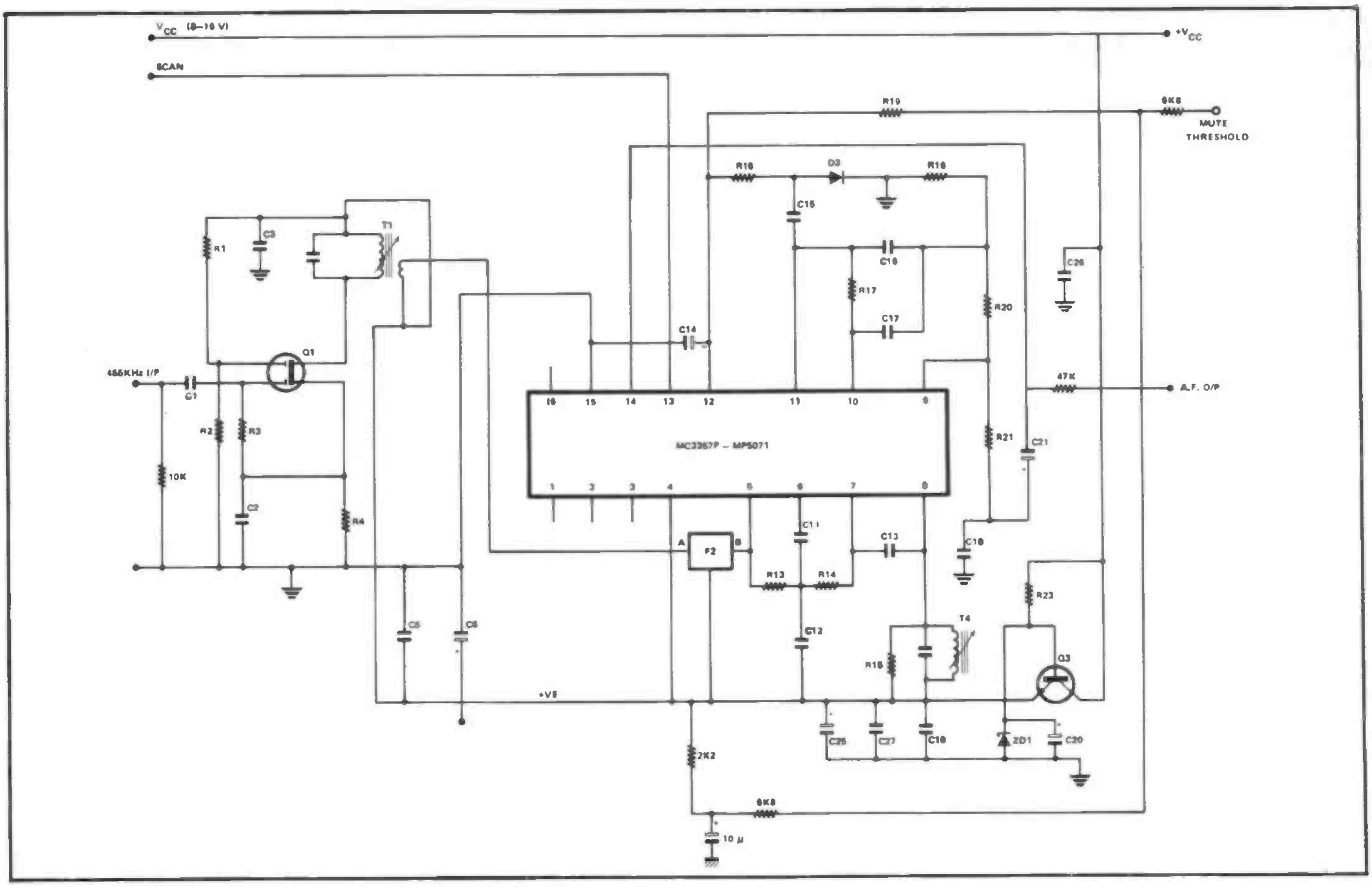


Figure 2: The Ambit 93357 circuit as modified for 455 kHz operation.

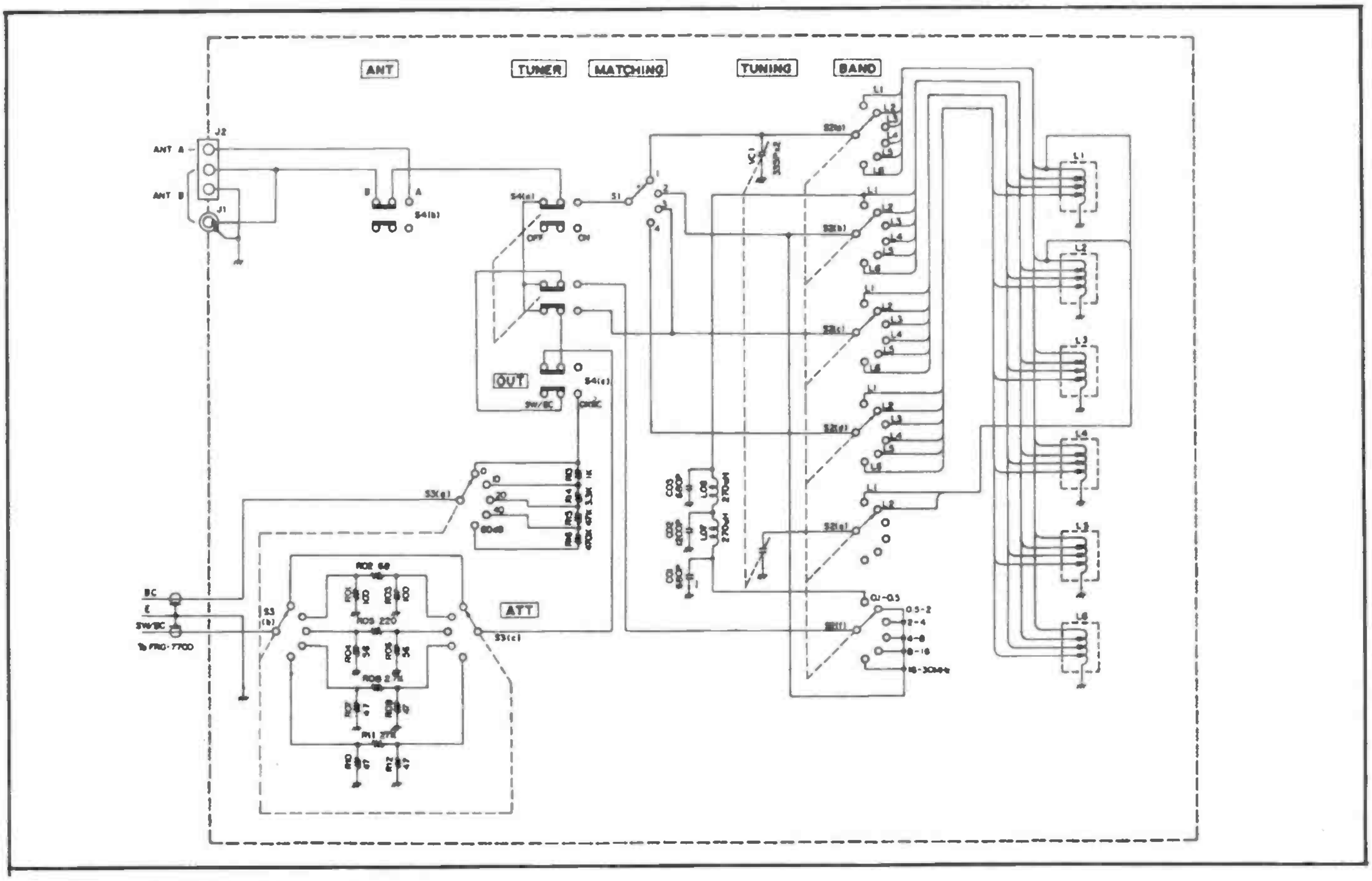
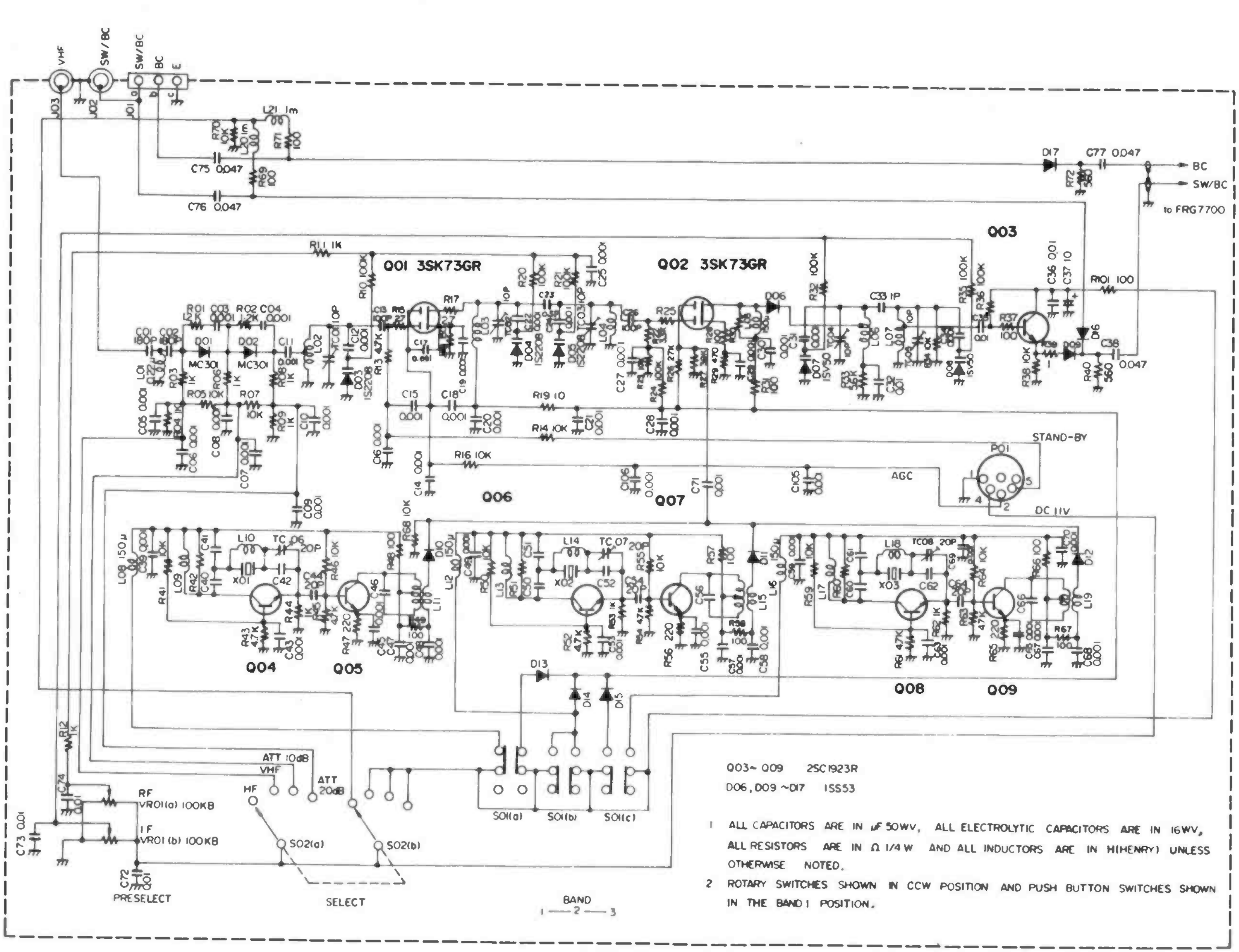


Figure 3: Circuit of the FRT7700 antenna tuner.



TYPE	A	C
X'TAL		
X 01	100MHZ	120MHZ
X 02	110MHZ	130MHZ
X 03	120MHZ	140MHZ
RESISTOR		
R25	2.7	10
R30	68 K	4.7 K
R42	1 K	1 K
R51	1 K	2.2 K
R60	1 K	2.2 K
CAPACITOR		
C 40	36P	24P
C 41	36P	24P
C 42	20P	20P
C 46	24P	16P
C 50	27P	16P
C 51	27P	16P
C 52	20P	20P
C 56	20P	13P
C 60	24P	15P
C 61	24P	15P
C 62	20P	20P
C 66	16P	10P
INDUCTOR		
L 10	0.33µ	0.33µ
L 14	0.33µ	0.22µ
L 18	0.33µ	0.22µ

Figure 4: Circuit of the FRV7700A converter.

Photo: The R1000 'moded' to accept the FM facility.

TEST PERFORMANCE : FRG7700									: R1000					
Parameter	Makers Spec			R&EW Tests					Makers Spec		R&EW Tests			
Sensitivity (uV) for 12dB SINAD	AM	SSB	FM	AMn	AMm	AMw	SSB	FM	AM	SSB	AMn	AMm	AMw	SSB
0.15 - 0.3MHz	30	3		1uV	1.8	2.8	0.6							
0.3 - 2MHz	26	2		1uV	1.6	2.0	0.5		20		18uV			5.0
2-30MHz	5	0.5	1	0.7	1.0	1.2	0.22	0.28	2	0.5	1.0		1.2	0.22
Image rejection				66dB							94dB			
IF rejection				95dB (48MHz) 58dB (455kHz)							98dB (48MHz)			
Intermod ratio				62dB							64dB			
Crossmod				Over 100mV							Over 100mV			
Spurii				11.558, 15.487, 23.572MHz							10, 11, 20 & 30MHz			
S meter				S5: 1.5uV S9: 50uV S9+40: 2.0mV							S5: 1.0uV S9: 5.0uV			
Attenuator range at 15MHz				82dB					60dB		61dB			

to a position after the filters and some gain - such as the drain of Q9 - and incoming signal waveforms can be directly observed on any reasonable oscilloscope.

SSB Filters for the FRG7700.

The all-purpose 'narrow AM' and SSB filter on the FRG7700 has a delightful shape factor (witness part 2 of this article), but it is too wide for many hardened SSB enthusiasts. The filter supplied in the set can be replaced with the same type as used in the R1000 (CFJ 455 K types) to good effect. The matching is unaffected - and depending on which of the existing filters you choose to lose, it may be necessary to make some slight compromise on fitting.

The trimmings.

In their inimitable fashion, Yaesu have provided a range of accessories in the shape of an antenna tuner and a series of VHF converters to ensure that the FRG7700 purchaser keeps his cheque-book open. The antenna tuner (FRT7700) is a tidy box/knob combination that certainly helps sort out matching odd bits of wire - the attenuator seems to suffer leakage on the higher attenuation settings at HF (no doubt the switch capacity etc.) - and £37 odd is rather a lot in view of the value represented in the main receiver *(Fig 3)*.

Wait until you have the receiver to see if you can get by without the tuner, most people probably can - or better still, roll your own with a little ingenuity. Build in a lightning arrestor or automatic antenna grounding system and generally show them what we Brits can do when we try. Tell **R&EW** readers about it and earn the price of the FRG7700!

The VHF converter is a similarly nicely styled unit - Amateur Electronics kindly loaned us the FRV7700A, covering 118-150 MHz in three ranges. It is an interesting 'eaves dropper' add-on, but in view of the ambitious range covered, it cannot match up to the standards of a purpose-designed communication converter. The till rattles open to the tune of about £ 70, and dare we suggest that something like a Bearcat 220 or SX200 might be a more useful investment if you can hang on and save the extra? Doubtless most Yaesu dealers supply such scanners as well, so check out the relative merits.

The converter just about scrapes through on its published 'sensitivity' specification, although this is written in rather unspecific terms. 0.5 uV for 10 dB S/N on FM was just beginning to stretch the imagination a shade.

For your edification and delectation, *Fig 4* illustrates the circuit - which reveals that perhaps the performance is compromised in the switching and the varicap tuning. Both the RF and IF sections are 'track tuned' in view of the broad range of frequencies covered, and this means that you must have a rough idea of the setting you want when searching. The high level of IF breakthrough on the HF bands is not good news when dredging in the noise from a weak VHF signal, so the first thing you should do is chop off the tag ends of the connector to the HF receiver and fit a PL259.

3SK73s have been replaced by 3SK88s in the **R&EW** lab before now -and to good effect. Although this swap was not tried with the FRV converter, it is worth trying for the useful 'up-front' gain and noise enhancement it might provide. Note that Yaesu switch complete oscillator/buffers rather than try and fiddle around switching crystals.

It's all over

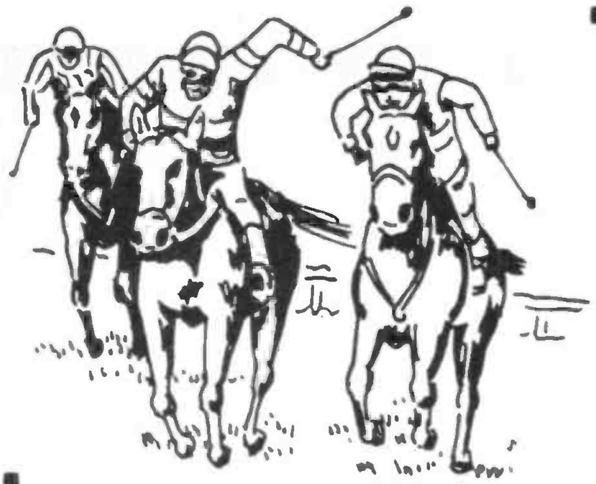
Well, our first mammoth test is just about done, and the conclusions show that both the R1000 and the FRG7700 are good value for money. It is difficult to detect any difinitive difference between the two, and preferences come down to a personal level.

The R1000 was preferred by most engineers - for no more rational reason than the circuitry is less cluttered. But -and it's a big 'but ' - the facilities on the FRG7700 are probably going to swing the choice in favour of Yaesu with many users. A brief field check of users of both showed the R1000 had virtually no problems reported, whereas the FRG7700 suffered from the sort of constructional troubles we discovered.

The Surrey Electronics version is certainly a useful addition to the market for the professional broadcast user, and the fact that the receiver used by Surrey Electronics is given a thorough check, might head off some of the more trivial problems.

We look forward to the next contest when no doubt the ubiquitous MPU will have emerged to make a contribution in the shape of more meaningful memory and scanning operations - particularly where entire panel settings are stored for future recall. We doubt if you will have to wait long. ■ **R&EW**

Your Reactions.........	Circle No.
Immediately Applicable	266
Useful & Informative	267
Not Applicable	268
Comments	269



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DISTORTION	< 0.05% from 50Hz to 15kHz, < 0.1% from 10Hz to 50kHz, < 0.2% from 5Hz to 150kHz, < 1% at 1Hz and 1MHz.
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SYNC OUTPUT	< IV r.m.s. sine in phase with output
SYNC INPUT	± 1% freq. lock range per volt r.m.s.
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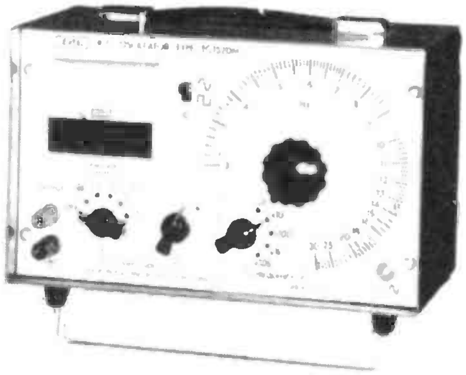

FREQUENCY	3Hz to 300kHz in 5 decade ranges.
ACCURACY	± 2% ± 0.1Hz to 100kHz. Increasing to ± 3% at 300kHz.
SINE OUTPUT	2.5V r.m.s. down to < 200μV
DISTORTION	< 0.2% from 50Hz to 50kHz. < 1% from 10Hz to 200kHz.
SQUARE OUTPUT	2.5V peak down to < 200μV.
SYNC. OUTPUT	2.5V r.m.s. sine.
METER SCALES	0/2.5V & —10/+10dB on TG152DM.
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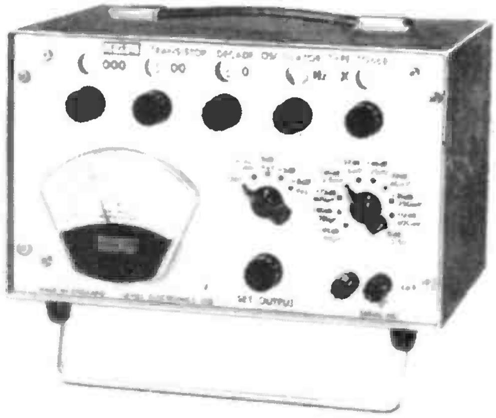

FREQUENCY	0.2Hz to 1.22MHz on four decade controls.
ACCURACY	± 0.02Hz below 6Hz. ± 0.3% from 6Hz to 100kHz. ± 1% from 100kHz to 300kHz. ± 3% above. 300kHz.
SINE OUTPUT	5V r.m.s. down to 30μV with Rs = 600Ω.
DISTORTION	< 0.15% from 15Hz to 15kHz. < 0.5% at 1.5Hz and 150kHz.
METER SCALES	2 Expanded voltage and —2/+4dBm
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R&EW Data Brief

TK10320
TK10321

TK10321 ANALOGUE SWITCH IC

Quad latched and interlocked DC activated analogue switch systems

Various attempts at switching audio with CMOS analogue switches (CD4016 etc) have tended to prove the efficacy of using a part that is specifically designed for the job. CMOS switches cannot achieve the dynamic range and noise performance demanded in exacting audio switching applications. The Philips TDA1028/1029 devices have enjoyed the market to themselves for the past couple of years, but these have recently been joined by TOKO's TK10320 and TK10321. (The TK10320 is supplied in a miniature flat package encapsulation.)

The IC comprises a stereo 4 channel audio switch, with single 'push to make' momentary switching, with a full interlock guard and priority scheme to ensure that only one input can be selected at a time. A mute output pulse (of programmable length - see tables) is also available to provide completely silent switching - since although the basic system is 'noiseless' (i.e. no extraneous noise introduced as contacts 'wipe' etc), it is inevitable that the change will be 'abrupt' when switching from a silent channel to one where signal is present. When used in conjunction with a muting preamplifier system such as the TOKO KB4438 IC, this abrupt transition can be avoided.

ABSOLUTE MAXIMUM RATINGS

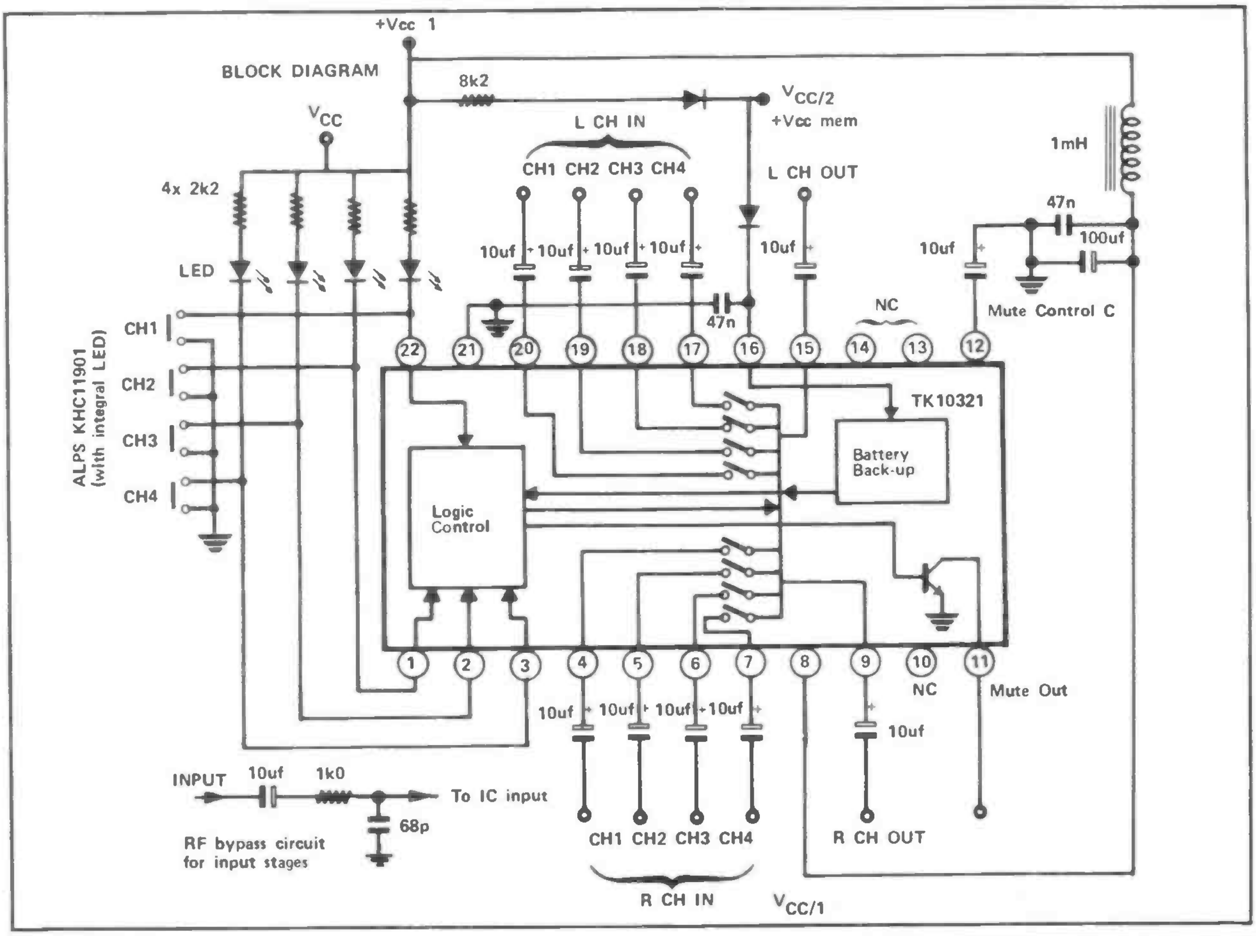
Supply voltage	Vcc	24v DC	
Op. temp. range	Top	-20 to +70°C	
Storage temp. range	Tstg	-55 to +125°C	
Power dissipation			
TK10320	Pd	450mW	
TK10321		700mW	
Input voltage	Vinc	-0.3 to Vcc+0.3	Logic control
Input current	Iinc	30mA	Logic control
Input voltage	Vina	-0.3 to Vcc+0.3	Analogue sw.
Output current	Iouta	3.0mA	Analogue sw.
Mute control	Vccm	-0.3 to Vcc+0.3	Mute control
Output current	Ioutm	30mA	Mute control

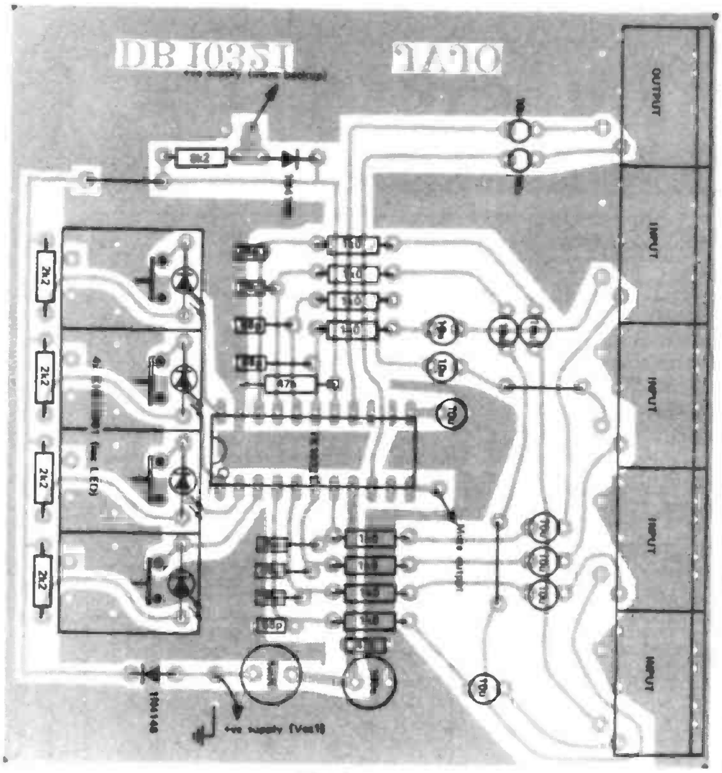
ELECTRICAL CHARACTERISTICS (Ta = +25°C)

Item	Symbol	min	typ	max	notes	
Supply current	$I_{cc}1$		7	13	mA	
Back-up supply	$I_{cc}2$		200	270	uA	
Input current (logic)	Iin	7.0			uA	
Low level input voltage	V_{ilc}			0.3	V	
High level input voltage	V_{inh}		1.2	2.0	V	
THD	THD		0.005	0.1	%	
Noise level	N.L.			10	uV rms	1
Crosstalk		-40	-53		dB	2,4
Dynamic range				4.5	V rms	
DC operation range		3.6		16.6	V	3
Bias voltage			$V_{cc}/2$		V	

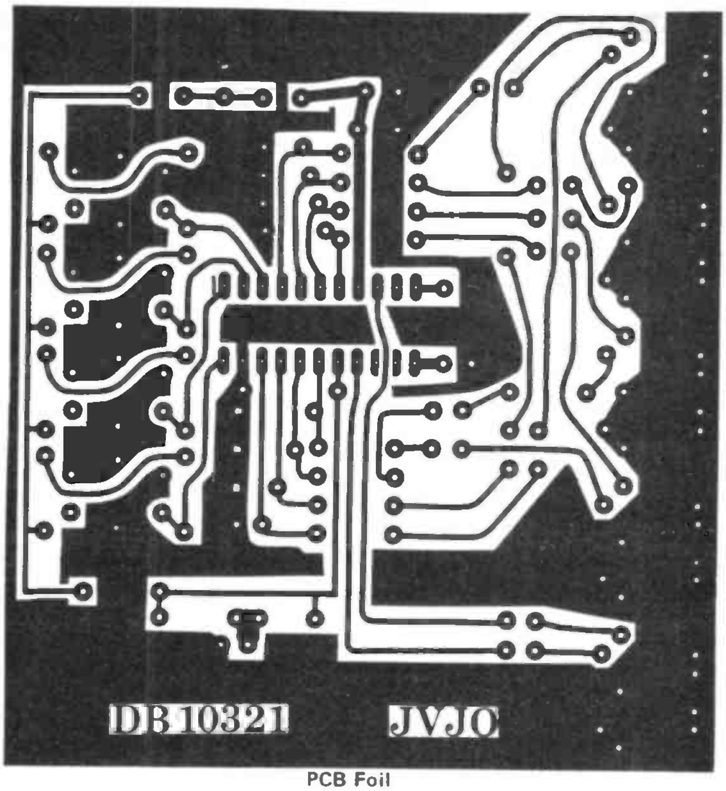
Notes 1 : Into 10k ohm load resistance, input AC ground
2 : 1v input, at 10kHz with 10k ohm load resistance
3 : with 3mA output current
4 : unused outputs grounded via 47k/10uF

BLOCK DIAGRAM

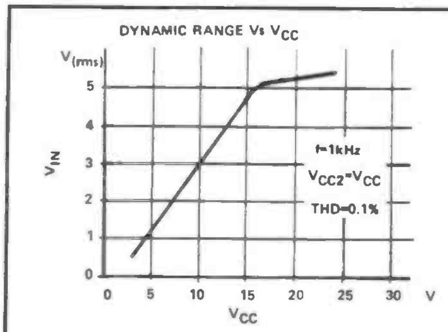


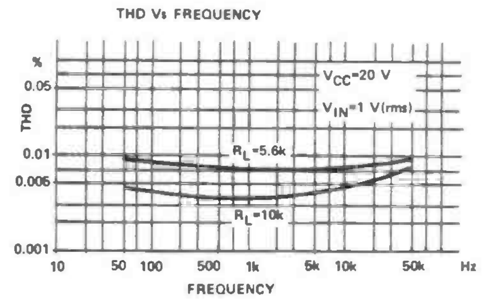


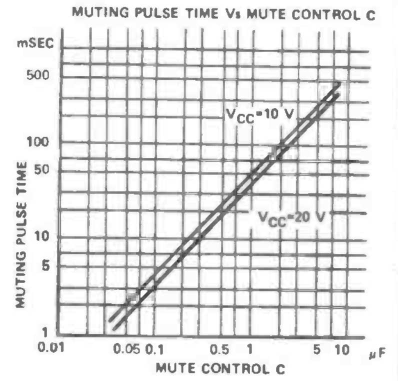
PCB Overlay

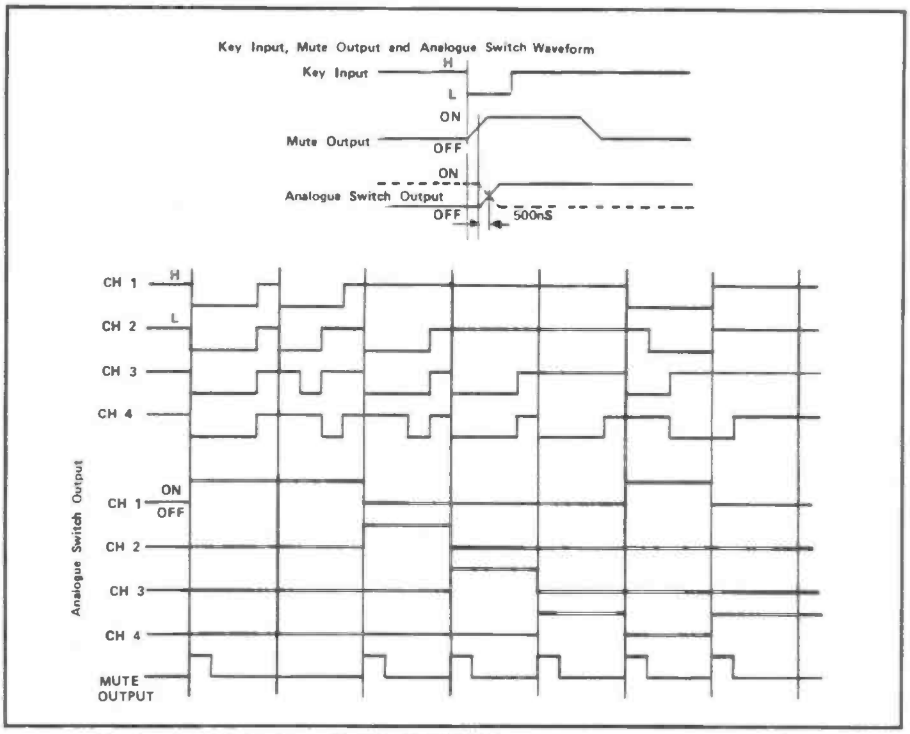


PCB Foil









Key Input and Analogue Switch Timing Chart.

The input selection can be directly interfaced to a MPU, remote control system or a simple touch sensitive switch - remember, the device performs the latching for you . Apart from obvious applications in preamplifiers, the device can be used in mixers, test equipment, communications systems. Simple logic can be used to cascade a number of units together to provide a versatile input switching array.

The last station selected is held 'in memory' as long as the appropriate backup voltage is maintained on the device.

DATABRIEF application PCB

The circuit follows the one illustrated, with the exception of a low pass filter on each audio input. With the increasing use of CB, some form of RFI filtering is becoming necessary at the inputs of most audio designs - severe cases may benefit from the use of chokes instead of resistors.

DIN PCB mounting input/output connectors are used on the edge of the board. Although switches are shown on the board (version with built in LEDs), the switching can be placed remote from the PCB - one of the prime advantages of this technique of audio selection.

■ R & EW

Step-by-step fully illustrated assembly and fitting instructions are included together with circuit descriptions. Highest quality components are used throughout.

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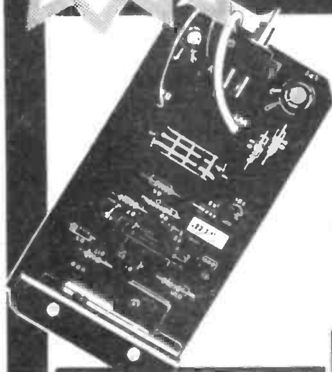

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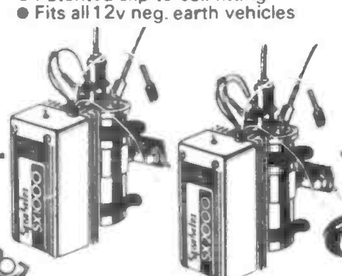

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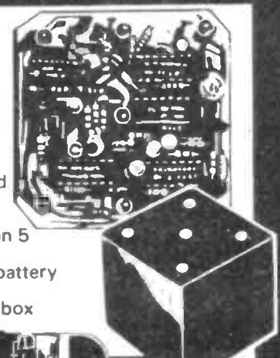

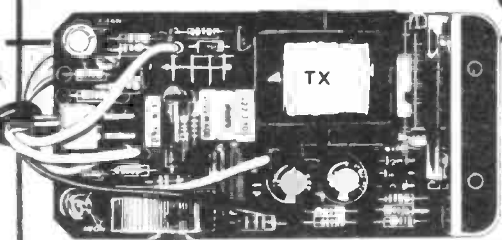

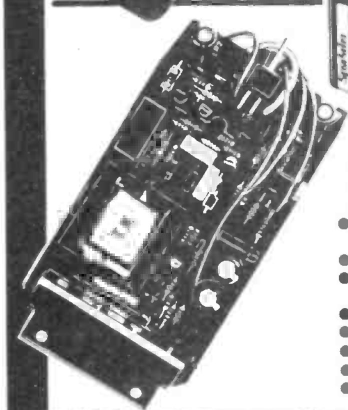

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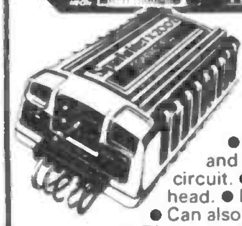

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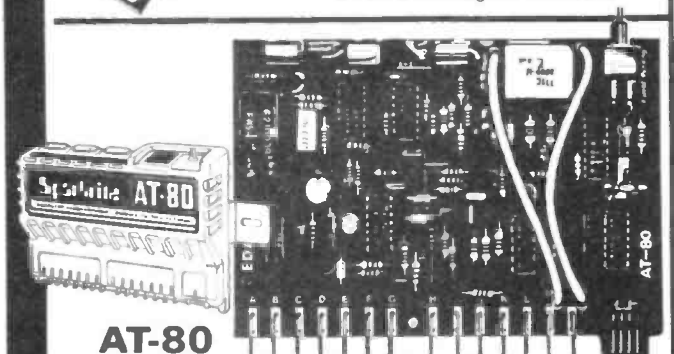

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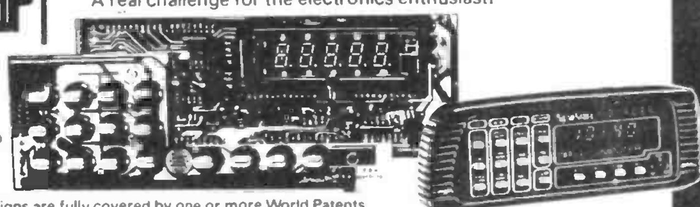

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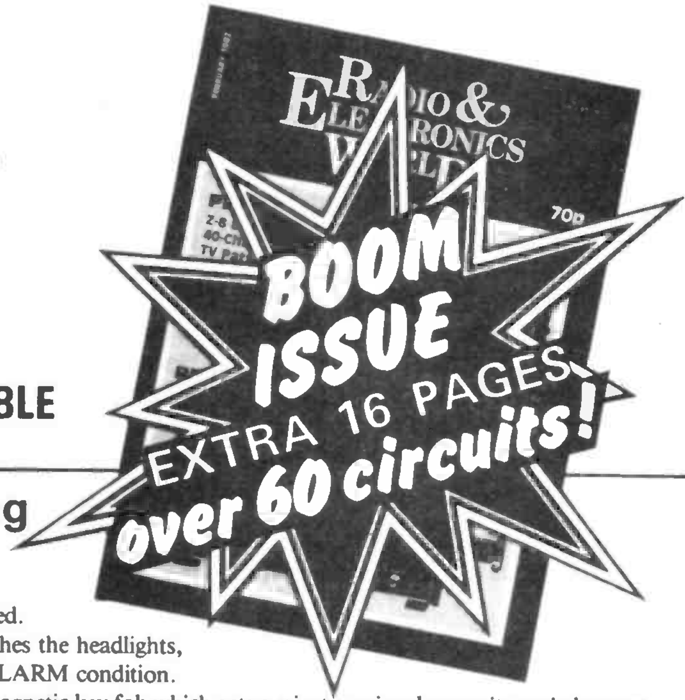

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+ wait for it — yes R&EW's 40 CHANNEL CB RIG — THE CIRCUIT!!

At last what thousands (well several) of you have been waiting for. The ACTUAL circuit of the all-singing, all-dancing, fully-synthesised R&EW 40-Channel CB transceiver, designed by William Poel, who has promised to eat his fur-lined boots (kicking, for the use of) if the design does not outshine all others published for the UK specification!

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Dual modulus prescaling? Pulse swallowing?

Ian Campbell explains these and other dark mysteries in this second part of his 'synthesiser' feature.

IN LAST MONTH'S FEATURE we explained the basic principles of PLL frequency synthesis and demonstrated the operation of a practical CB synthesiser system. There is, of course, more than one way of skinning a cat and, similarly, there are lots of variations in PLL synthesiser design, the major challenge being to synthesise stable high frequencies while using low-speed programmable counter. This leads us on to the subject of....

MIXING

One technique which can be used for overcoming the problem of producing a stable high frequency and yet use a low-speed programmable counter is that of mixing. It has been successfully used for many years and is one employed in some "black box" FM rigs e.g. the ICOM IC240.

The principle of operation can be grasped if reference is made to *Fig 13*. The VCO output frequency *fo* is passed to the output of the synthesiser and at the same time to a mixer. This mixer works in an anlogue fashion and mixes a frequency *fx* from a stable crystal oscillator with the VCO frequency *fo*. The output from the mixer contains the sum and difference frequencies *fo* + *fx* and *fo* — *fx*. The *fo* + *fx* signal is removed by a low pass filter positioned after the mixer, while *fo* — *fx* is allowed to pass through. The trick here is that although *fo* is far too high a frequency for the ÷N counter to handle, *fo* — *fx* is within its range. Let us look at some actual frequencies at this point.

Suppose the ÷N counter can handle frequencies in the range 2-3 MHz and we want the VCO to generate a local oscillator signal of 135 MHz for a 2 m band receiver. The crystal oscillator will have to run at 132 MHz which will make *fo* — *fx* equal to 3 MHz. After emerging from the low pass filter this signal will be at quite a low level so it has to be amplified up to the logic level of the ÷N counter.

The reference frequency *fr* can be the same as the channel spacing in this design of PLL, which means that lock up time will be short and jitter of the VCO will be low, as long as a reasonably large channel spacing is used.

There are a few disadvantages to the system, however, and they include the increased parts count over other systems. Also, as the modulus of the programmable counter alters, the bandwidth of the loop changes, which affects its stability across its frequency range. Additional functions are also present in the loop and can add noise to the system.

These disadvantages may, in some applications (e.g. portable equipment), be ignored, since the power consumption of the mixer configuration can be made very low.

PRESCALING - FIXED MODULUS

A less complicated approach to the problem is one that has already been mentioned with regard to the CB synthesiser, but not in detail. That is prescaling, which is a very useful technique, as will become apparent.

In it simplest form (See *Fig 14*), the VCO output frequency *fo* is sent to the output of the synthesiser and at the same time directed to a fixed modulus divide-by-M counter. The output from the 'M' counter divides the VCO frequency down to a range which can be handled by the programmable divide-by-N counter. The output frequency of the VCO is now equal to N.M. *fr*.

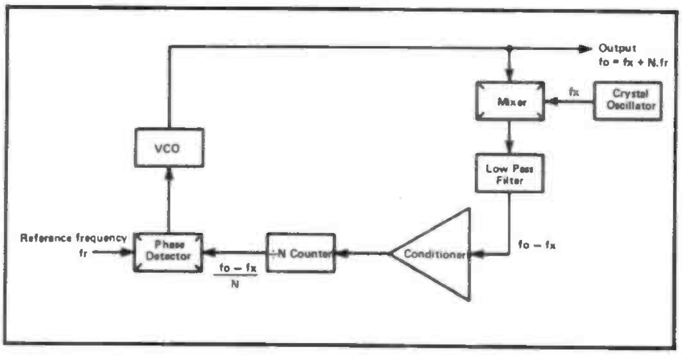


Figure 13: Mixer synthesiser.

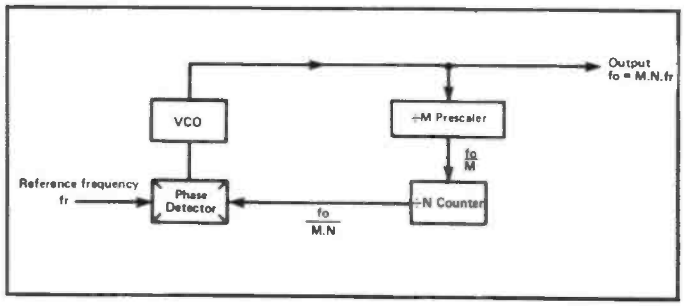


Figure 14: Synthesiser with prescaler.

This approach has the advantage of simplicity, and the bandwidth of the loop is unaffected by the N-number of the divide-by-N counter. There are however a number of disadvantages compared with the mixing approach. The prescaler device usually has to be a fast logic type, e.g. ECL (emitter coupled logic), and often carries a high price tag and uses a lot of current: Prescaling produces noise which can be troublesome to prevent getting into the rest of the system: The reference frequency has to be a multiple of the channel spacing, and the value of this multiplier will be the value of the modulus of the prescaler. This means for example that if the channel spacing is 25 kHz and a ÷20 prescaler is used, the reference frequency will have to be 1.25 kHz. As has been mentioned already, the lower the reference frequency the longer the lock-up time of the loop and the more difficult it is to get rid of the reference frequency in the loop filter.

Despite these drawbacks a synthesiser employing prescaling can be very simple to construct and get going and need not be expensive.

PRESCALING - DUAL MODULUS

Some of the limitations of the system previously described can be overcome if dual modulus prescaling is used. This system allows relatively low frequency programmable counters to be used as high frequency programmable counters with a speed capability of several hundred MHz. There is no reduction of the reference frequency in order to achieve a certain channel spacing, as there is in single modulus prescaling. ▶

Table 1 A glossary of terms used in PLLs.

Capture range	**The range of frequencies over which the loop can detect a signal and respond to it.**
Damping factor	**The ability of the loop to respond to a change in input frequency both quickly and without excessive overshoot.**
Free-run frequency	**The frequency of the VCO with no input signal.**
Lock range	**The range of frequencies over which the loop will remain in lock. It may be different to the capture range.**
Loop gain	**The product of all the DC gains of elements in the loop.**
Low pass filter	**A filter which allows only DC and very low frequencies to pass round the loop.**
Phase detector	**A circuit which compares the relative phase between two inputs and produces a voltage dependent on the difference.**
Voltage Controlled Oscillator (VCO)	**An oscillator which will change frequency according to an applied control voltage.**

Look at *Fig 15*, where a block diagram of a synthesiser using dual modulus prescaling has been shown. The immediate reaction should be that there is a marked increased in complexity over the single modulus prescaled synthesiser of *Fig 14*. Also apparent should be that the divide-by-N programmable counter has been joined to another programmable counter (divide-by-A) via control logic which in turn is connected to the M/M + 1 dual modulus prescaler. The M/M + 1 prescaler feeds its output to both the N and A counters. The rest of the synthesiser i.e. phase detector etc. is the same as in other designs.

We ask ourselves at this stage just how such a system works. Well, firstly the prescaler is held, by the modulus control line, to divide by M + 1. Its output is fed to both the A and N counters, which start to count. Where the A counter has counted down to zero from the value programmed into it, the modulus control changes state and signals the prescaler to divide by M until the N counter has finished counting down to zero from its programmed value (N-A additional counts, since both the N and A counters started together). The modulus control then changes state again and the programmable counters reload their respective programmed values and the whole thing repeats itself.

The control logic connected to the A counter, the N counter and the prescaler, coordinates the switching of the modulus control line according to the state of the A and N counters. It also inhibits the A counter from dividing when the N counter is counting down from N-A to zero.

SOME EQUATIONS

So what is so good about this and how does it keep the reference frequency and channel spacing the same? To answer the question we must return to the single modulus prescaler design and look at the equation for calculating the output frequency to be expected.

This is $fo = fr.M.N$......[1]

Where M is the value of the modulus of the prescaler and N is the number programmed into the divide-by-N counter.

The equation can be modified, to account for the divide-by-A counter and for the new prescaler which divides by M + 1 as well as M, thus:

$fo = [M(N - A) + (M + 1)A]fr$ .....[2]

Where M is the prescaler factor, N is the number programmed into the divide-by-N counter, A is the number programmed into the divide-by-A counter and represents the number of divisions of the prescaler at M + 1.

Let us take a practical example and fill in some values to equation [2].

We want fo to equal 175 MHz. Reference frequency and channel spacing must be 25 kHz. Prescaler divides by 40 and 40 + 1. The N counter must be loaded with 175 and the A counter with 0.

$fo = [40(175 - 0) + (40 + 1)0]\,0.025 = 175$ MHz ......[3]

A little study of equation [3] should reveal that the slow counter combination of the N and A counters has made the fast prescaler divide by 40 one hundred and seventy-five times and by 41 zero times. This technique is called pulse swallowing. The A counter is crucial to the operation and can be named the 'swallow' counter.

The proof of the technique, as far as maintaining channel spacing equal to the reference frequency is concerned, becomes apparent if in the previous example the A counter is loaded with one (rather than zero), fo should now be 175.025 MHz. Let us try it out and see what happens.

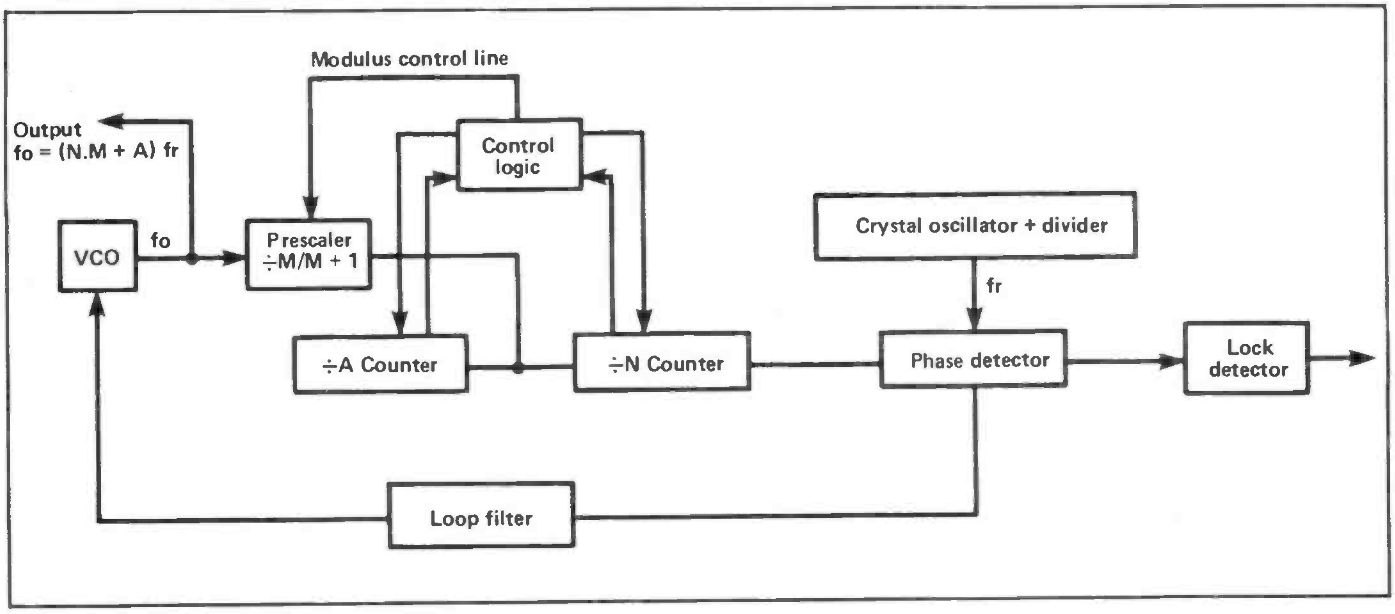


Figure 15: Synthesiser with dual modulus prescaler.

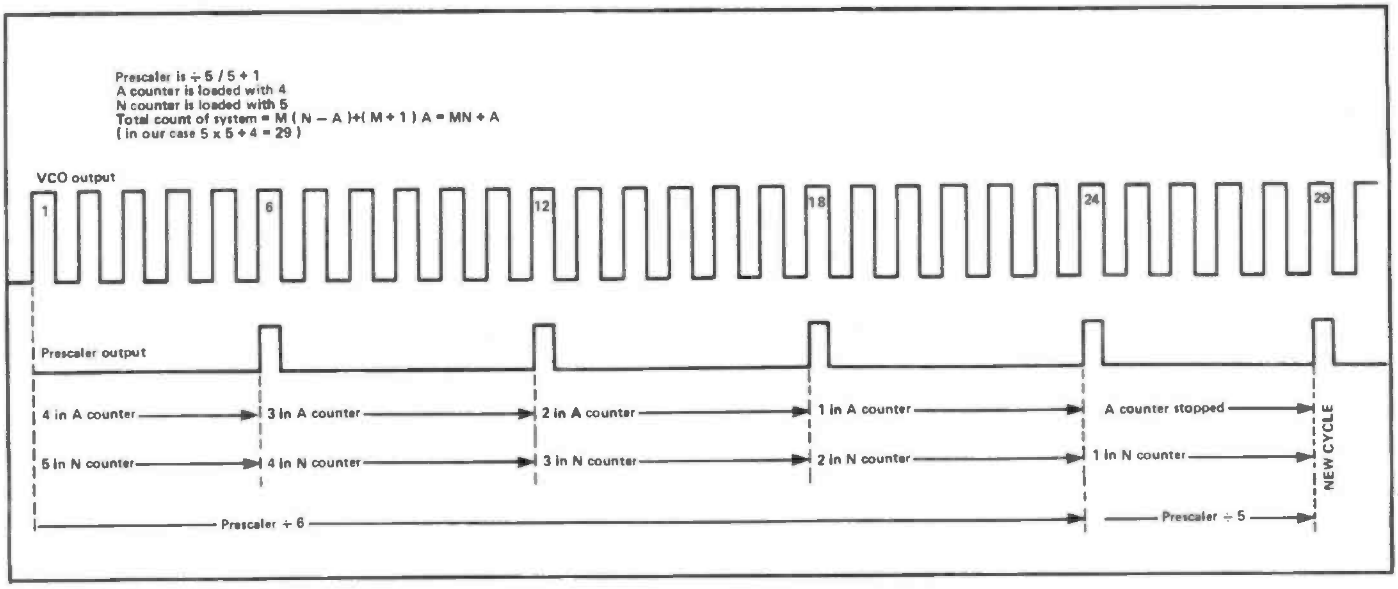


Figure 16: Pulse swallowing.

Equation [2] becomes [40 (175 — 1) + (40 + 1) 1] 0.025 and by the use of an electronic calculator (if the brain cells are a little rusty) we see that *fo* will indeed by 175.025 MHz.

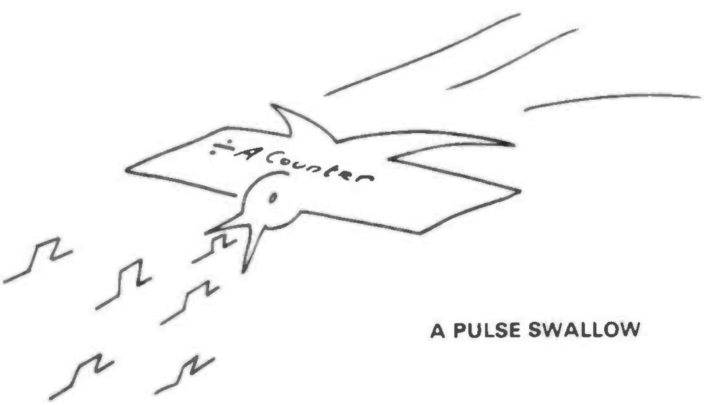
This relationship will be continued each time the A counter is loaded with an integer producing channels that are 25 kHz apart.

There are some constraints on the system however, and they include that N must always be greater than A, the maximum value of A is M — 1 (N minimum is therefore greater than M — 1). In view of these constraints the maximum number by which the system can divide must be:

N max. M + A max.

It will of course be obvious that the maximum value of the synthesiser output divided by M must not exceed the capability of the N and A counters.

SWALLOWS



A PULSE SWALLOW

It might now be prudent to give a somewhat clearer explanation of what is meant by 'pulse swallowing'. Imagine we have the synthesiser of *Fig 15* set up with a 30 Hz waveform from the VCO, the A counter loaded with 4 and the N counter loaded with 5. The sequence of events will be clear if *Fig 16* is examined. The A and N counters start counting down to zero from their respective loaded numbers. The modulus control line will make the prescaler divide by 6 until the A counter has reached zero. Every six pulses from the VCO will produce one from the prescaler and reduce the number in the A and N counters by one. When the A counter has reached zero, 24 pulses will have been counted. At this time the prescaler is made to divide by 5 and the N counter will thus reach zero on the 5th pulse after the A counter reaches zero. The total number of pulses counted is thus 29.

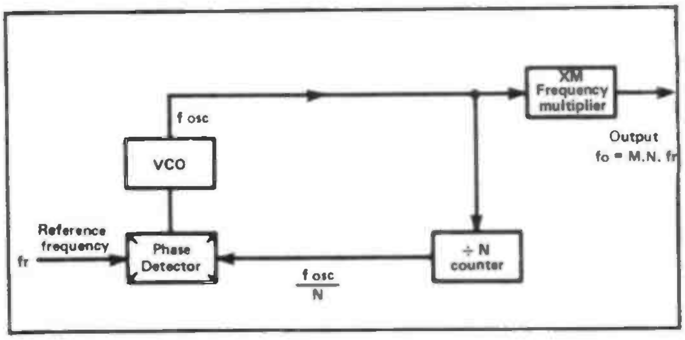


Figure 17: Synthesiser with output multiplier.

If the A counter had been missing, the prescaler could only have been single modulus and would have divided by 5. This would have given a total count of 25 for the N counter/prescaler combination. The discrepancy between the 29 and 25 counts means that the extra counts have been made because of the involvement of the A counter. The A counter would appear to have swallowed one pulse, for the N counter, every time it counted down by one, which was four times.

FREQUENCY MULTIPLICATION

Yet another way of obtaining a high or very high frequency from a synthesiser using low speed dividers is to make use of frequency multiplication. In this instance the VCO frequency is not the required output frequency of the synthesiser but one which has to be multiplied up. This means that following the VCO (*Fig 17*) there has to be a number of stages of frequency multiplication.

This type of synthesiser has drawbacks. There is the increased complexity of the system. There are multiplier stages which introduce noise. There are harmonics produced by each multiplication stage and these have to be reduced to acceptable levels in the output.

It is so much better to have the VCO running at the correct frequency, than to multiply up, that nothing more will be said about this particular system except that 'it does work'.

To be concluded next month. □ **R & EW**

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

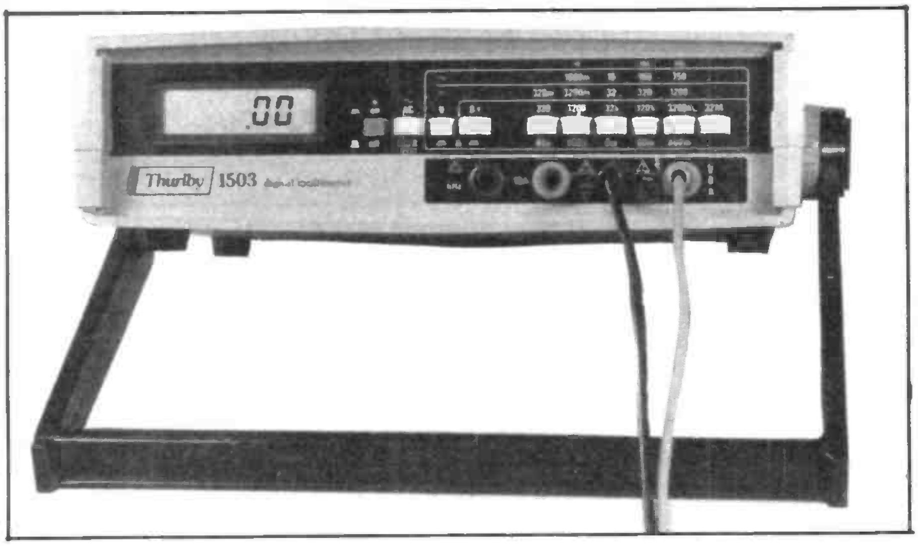
DMM review: Thurlby 1503

At around £150, the Thurlby 1503 is probably the lowest cost 4¾-digit DMM on the market - and even runs some 3.5-digit DMMs fairly close. The techniques employed in the A/D process are interesting and slightly different - the stuff R&EW features are made of....

Thurlby have established a very good name in comprehensively equipped bench power supplies, and the 1503 is their spearhead into the DMM market. They have avoided getting bogged down in the morass of ICL7106 based 3.5 digit DMMs, and have thus leapfrogged straight in with a very neat solution to the 4¾-digit problem.

No crib from an LSI manufacturer's data sheet is this machine: Thurlby have kindly given us permission to reproduce the internal circuitry of the 1503 (which is contained in their beautifully explicit but under-illustrated service manual).

The 1503 is designed around a pre-packaged count/display module (available separately), which is based on the OKI MSM5527 frequency counter LSI. This versatile module does all sorts of things -including offset received frequency display up to 399.99 MHz with suitable prescalers. The conventional unit counter mode of operation is used in the DMM application, whereby the number of input pulses accumulated during the A/D converter 'de-integrate' (more later) period is stored and displayed by means of the hold and rest control function pins.



Inside the 1503

This is going to be a fairly long and arduous piece of reading for many of you, but in view of the fact that this multimeter really achieves it's results from 'first' principles, it is a valuable and informative insight into DMM concepts. As a result of a number of 'black-box' solutions that are currently available, you may do worse than find how a 'real' engineer has arrived at a solution.

Once the sanctuary of an LSI solution has been abandoned, circuit design comes hurtling back down to 'basics' - and one

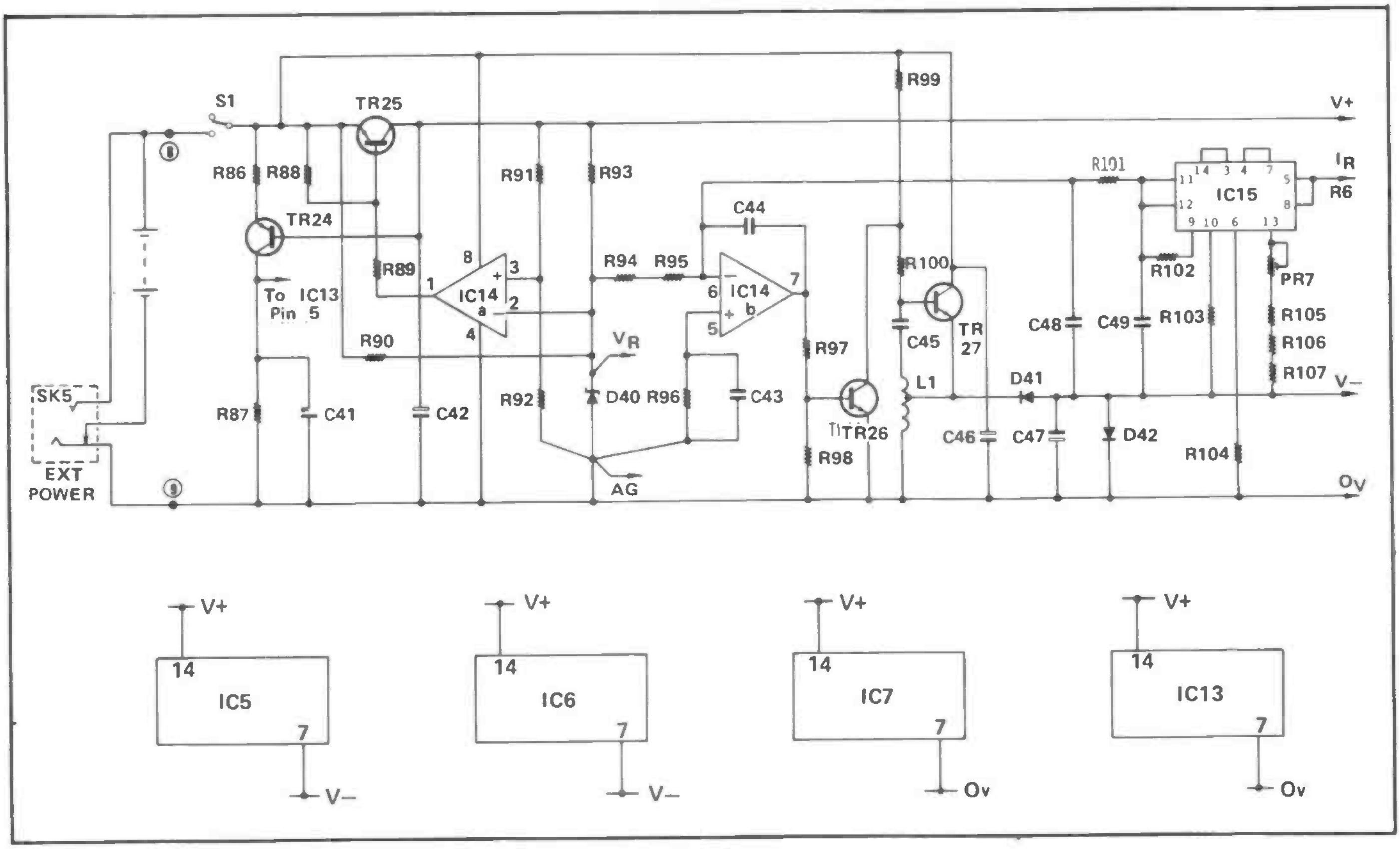


Figure 1: 1503 DMM - Power Supply and Reference Generators.

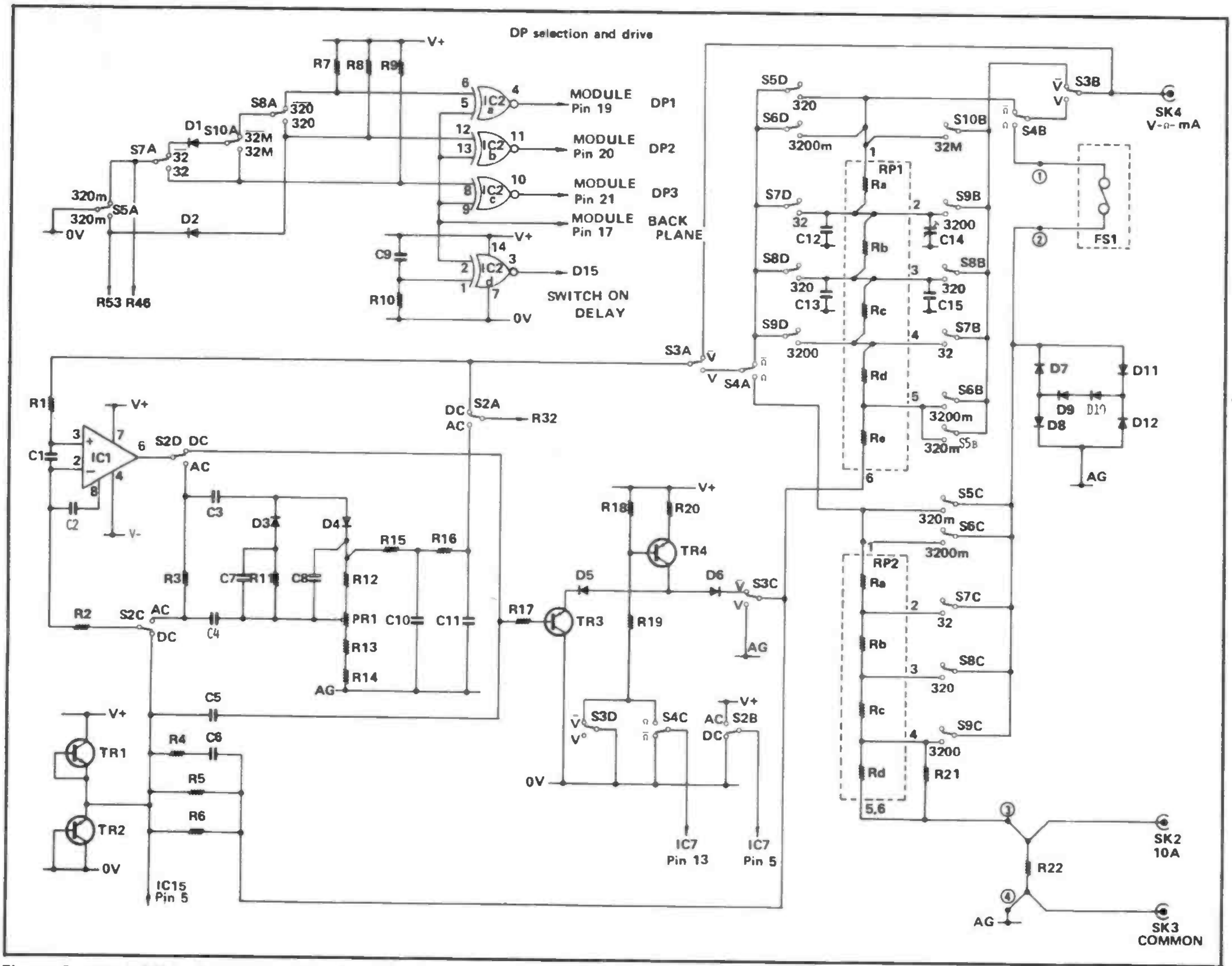


Figure 2: 1503 DMM - Signal Conditioning Circuitry.

of the most vital and basic aspects of a good analogue-to-digital converter design is the provision of accurate and stable reference voltages and currents *(Fig 1)*.

The V + line is derived from TR25 in a series regulator mode, with IC14a providing control according to:
$V+ = V_R \times (R91 + R92)/R92$.
D40 is a band gap reference diode with a temperature coefficient of 25 ppm or better.

The negative supply line is derived from a throughtfully designed switching inverter (IC14, TR26, TR27) with controlling feedback where:
$V- = V_R \times (R101 + R103)/(R94 + R95) + (0.65)$.

IC15 an NPN transistor array which generates a precision 6.6 uA reference, according to:
$I_{ref} = V_R/(R94 + R95) \times R102/(PR7 + R105 + R106)$.
TR24 detects low voltage conditions at 6.8 volts, although operation is not affected until the input voltage drops to 6 V DC.

From 1200 V to A/D input

The basis on any DMM is an A/D that operates over a fixed voltage/frequency conversion range. The converter is thus analogous to the meter movement in a moving needle instrument - *(Fig 2)*.

Ohms law suffices to get things into shape on the DC voltage range, using a ubiquitous Caddock precision trimmed resistor/attenuator network (RP1). AC voltage treads the same path through the input attenuator, but diverts through an RMS rectifier that bears a close examination:

When S2 is switched in to read SC, the signal is applied to the non-inverting input of IC1, and diodes D3 and D4 feed the negative and positive portions of the signal back to the inverting input. R11,12,13 and 14 form a potential divider, which results in a negative voltage (proportional to the AC input voltage) appearing on C7, with an equal positive voltage appearing on C8. This positive voltage is then filtered to remove the AC components, and adjusted by PR1 until the output is equal to the RMS value of the AC input.

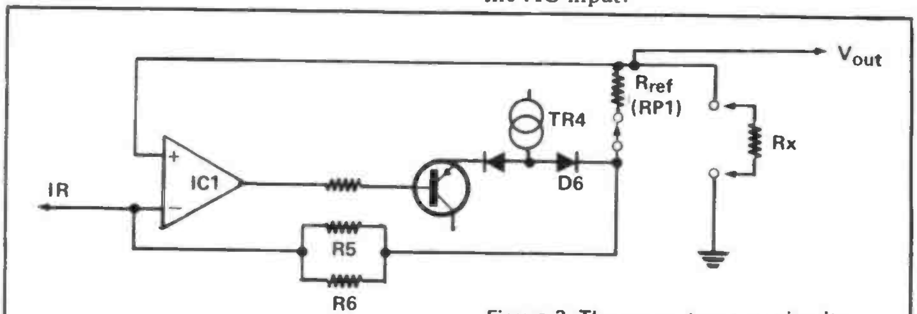


Figure 3: The current-source circuit.

DC current (up to 800 mA) is fed via the fuse to a second high precision resistor pack RP2. The current flowing in the shunt generates a voltage at the top of the chain which is fed to the A/D as a DC voltage. Diodes D7 to D12 protect against overloads - which is a good thing, since the current selection technique on the 1503 is not the most obvious of things. This not only can be just a bit difficult to find in the first place (two switches are depressed simultaneously) - it is easily left switched in when you are about to grope amongst the volts once again.

Yes, we know the legend on the panel shows what to do (just). And yes, we know we are supposed to have read the instructions - but very few engineers feel they need an instruction course in driving a multimeter, so trial and error is all too frequently the technique adopted.... "Where's the current range? What happens if I press this??...oops."

The Big Stuff, (currents up to 25 amps) goes in via the high current input, and gets fed through to 10 milli-ohm shunt (remember that lead and plug/socket resistances are frequently more than this anyway), which sits in series with RP2. R21 is used to compensate for the effects of R22 on Rd (inside RP2).

AC current goes through the same process, but then via the AC/DC converter (described above) before further processing is applied.

Resistance

When S2 and S3 are released, IC behaves as a current source *(Fig 3)*, where the current output equals:
(Iref x R5//R6) + VosIC1))/Rref
but Iref x R5//R6 + VosIC1 equals 1volt, Vout + RX/Rref volts.

Where RX is the resistance to be measured, and Rref is the RP2 value selected. So if the Rref value is made equal to decade values - direct readings of resistance can be obtained. D5, D6 and TR4 prevent overvoltage overload taking the current source to the pictures when you forget which range you are switched to....

Although the count/display module displays up to 39,999, the linearity of the various processes preceeding this expire somewhat earlier. The DC voltage overrange is set for 32,768 counts (via IC7- *Fig 4)*. AC voltage is limited to 16,384, and current clamps out on 8,192 counts.

A/D operation

We finally get inside the 'discrete' A/D with *Fig 5*. This uses a dual slope principle where the voltage to be measured is used to charge a capacitor for a fixed time period (established by IC3, driven from the 50 Hz quartz-derived signal from the display module), then a reference voltage

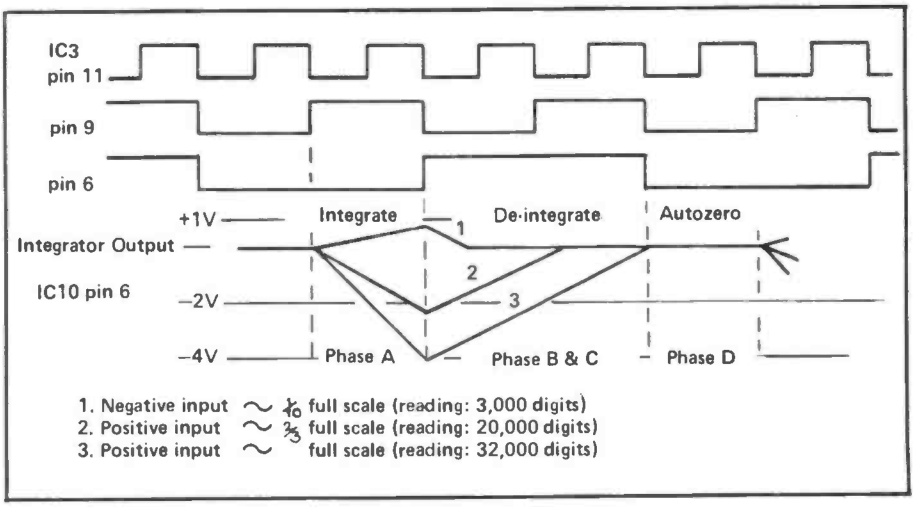


Figure 5: A/D Converter Waveforms.

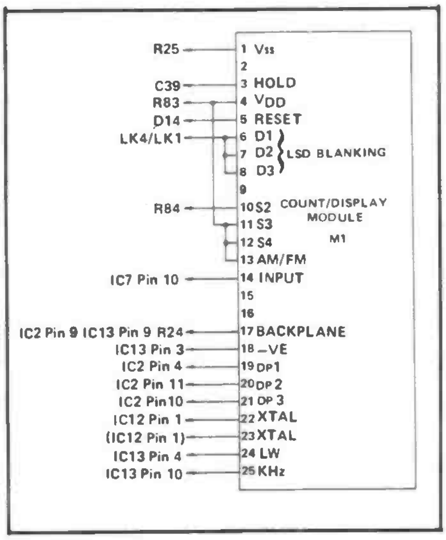


Figure 4: Count/Display Module.

is used to discharge this capacitor. The time taken to return to the initial level is measured and displayed. Simple, eh?

The voltage to be measured is integrated for 80 mSec (IC3 pin 6 low, pin 9 high) - the de-integrated period lasts between 0 and 160 mSec with pin 6 high. This is followed by two auto-zero periods which remove the system offsets. Phase C lasts for a fixed 80 mSec (pin 6 and 9 both low).

During the auto-zero period, the integrator output (IC10) is held at the threshold of the comparator (TR14-TR22) - which is approximately 0 volts. At the same time, analogue switches IC5a, IC5d and IC6b, IC6c, IC6d are closed to ground the buffer amplifier IC9. This produces a negative feedback loop around IC9, IC10 and the comparator, which causes the system offset voltages to be stored on C26 and C27. At the same time, C23 is charged to 1.6384 volts on the slider of PR3, which is fed from Vref.

During the integrate period (phase A), IC5c closes, connecting Vin to the buffer input causing C30 to charge via R59. During de-integrate (phase B), either IC5b or IC6a is closed depending on the polarity of Vin. This takes the buffer input to +1.6384 or -1.6384 volts repectively, and C30 is discharged back to the comparator threshold.

The displayed count is given by fc x TB - where fc is the equivalent count frequency (204.8 kHz), and Tb if the period of phase B (de-integrate).
TB = TA x Vin/Vref
where TA = 80 mSec (integrated period), and Vref is 1.6384

The sensitivity of the converter is basically 100 uV/count, with the buffer being fixed at unity gain. However, if IC6c is closed instead of IC6b, then the buffer has a gain of x10 during phase A, and the converter sensitivity increases to 0 uV/count. This is brought about by pressing S5, whereupon S5A pulls R53 low, and releases R46 - causing TR10 to switch in IC6c via TR8 and TR9.

Polarity

At the end of phase A, the integrator output polarity is opposite to Vin. The comparator inverts and amplifies (x10,000) this, so that the collector of TR22 is either at V+ for positive Vin, or at 0V for negative Vin. IC3 pin 6 now clocks the D-type bistable IC11a, and this latches the polarity information as Q high or $\overline{Q}$ high respectively. This then selects the correct polarity reference via IC4, (NAND gates), and controls the '-' symbol on the display via the ex-OR IC13c.

Zero crossing Bistable (IC11b)

At the end of phase B, the integrator output returns to zero, causing the comparator to change state. The comparator output is then fed to IC13d, along with the polarity bistable output. The output of this gate goes high when the comparator changes polarity - regardless of input polarity, thus taking the data

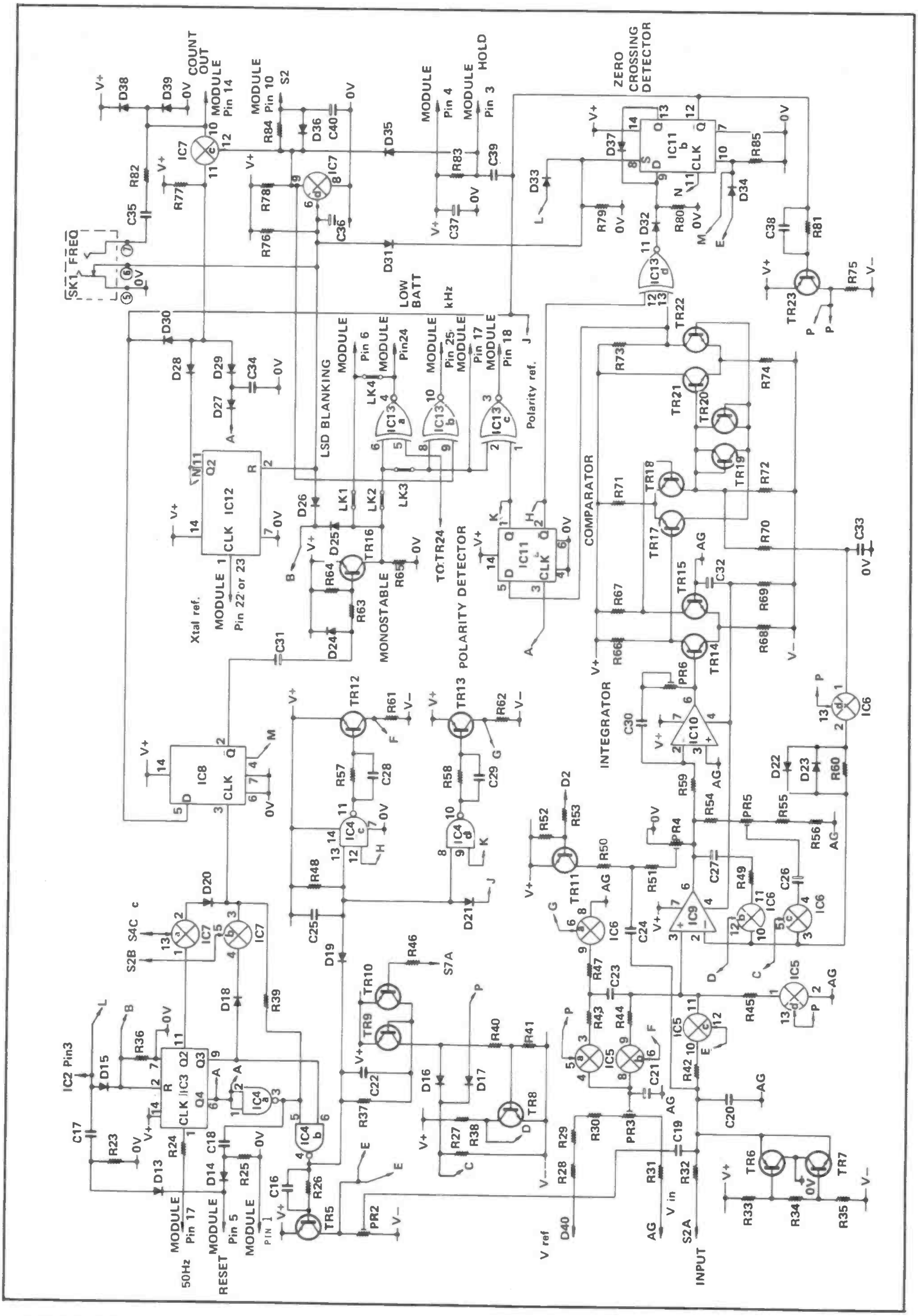
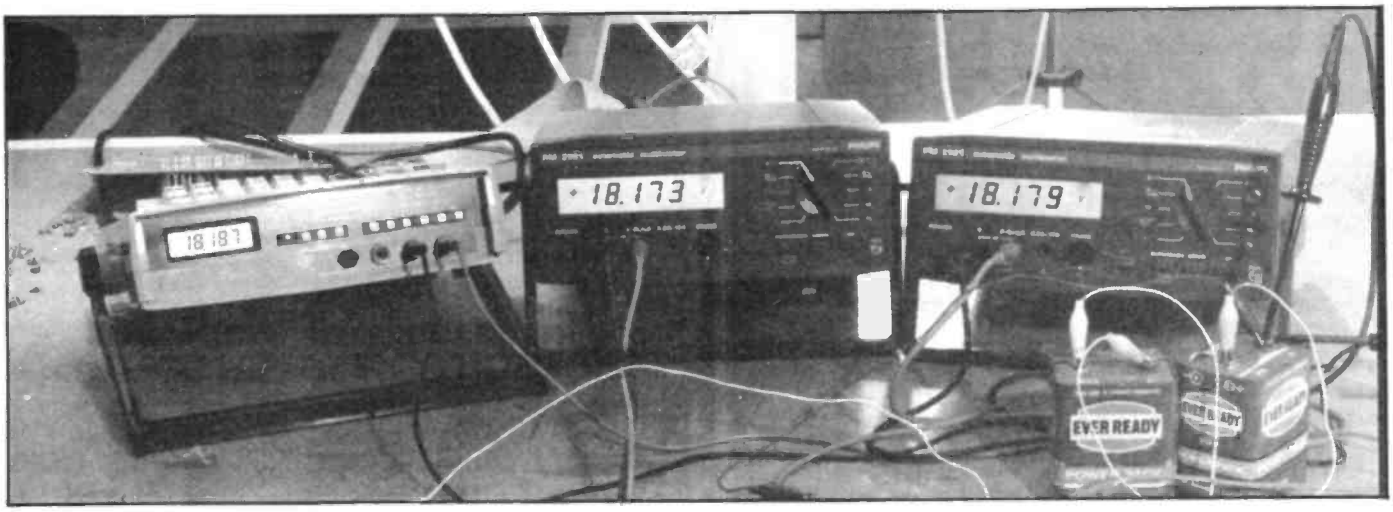


Figure 6: 1503 DMM - The A/D Converter circuit.

DMM review: Thurlby 1503



DC VOLTAGE	ACCURACY	INPUT IMPEDANCE	MAX. INPUT
± 320.00mV	± (0.1%r +4 digits)	10M	370VDC/250Vrms
± 3200.0mV	± (0.05%r +1 digit)	10M/>1000M	370VDC/250Vrms
± 32.000mV	± (0.1%r +1 digit)	10M	1200VDC/750Vrms
± 320.00V	± (0.1%r +1 digit)	10M	1200VDC/750Vrms
± 1200.0V	± (0.1%r +1 digit)	10M	1200VDC/750Vrms

RESISTANCE	ACCURACY	EXCITATION CURRENT	MAX. INPUT
320.00Ω	± (0.2%r +5 digits)	1mA	370VDC/250Vrms
3200.0Ω	±(0.1%r +1 digit)	1mA	370VDC/250Vrms
32.000kΩ	± (0.1%r +1 digit)	100uA	370VDC/250Vrms
320.00kΩ	± (0.1%r +1 digit)	10uA	370VDC/250Vrms
3200.0kΩ	± (0.2%r +1 digit)	1uA	370VDC/250Vrms
32.000MΩ	± (1.0%r +2 digits)	0.1uA	370VDC/250Vrms

AC VOLTAGE Input Impedance - 10M / /<50pF. Max. Input 750Vrms, except 1600mV (250Vrms)

ACCURACY (above 800 counts)

	45-65Hz	65-400Hz	400Hz-5kHz	5kHz-10kHz
1600.0mV	± (0.2%r +5 digits)	± (0.25%r+5 digits)	± (0.3%r+10 digits)	± (0.5%r+15 digits)
16.000V	± (0.25%r+5 digits)	± (0.5%r +5 digits)	± (2.5%r+10 digits)	± (5%r + 15 digits)
160.00V	± (0.25%r+5 digits)	± (0.5%r +5 digits)	± (5%r + 10 digits)	
750.0V	± (0.25%r+5 digits)	± (2.5%r +5 digits)		

DC CURRENT	ACCURACY	VOLTAGE BURDEN	MAX. INPUT
± 80.00uA	± (0.2%r +4 digits)	10uV/count	1A (fused)
± 800.0uA	± (0.15%r+1 digit)	100uV/count	1A (fused)
± 8.000mA	± (0.15%r+1 digit)	100uV/count	1A (fused)
± 80.00mA	± (0.15%r+1 digit)	100uV/count	1A (fused)
± 800.0mA	± (0.3%r +1 digit)	100uV/count	1A (fused)
± 10.00A	± (2.0%r +2 digits)	<150uV/count	25A (10 seconds)

AC CURRENT	ACCURACY (45Hz-1kHz Above 800 counts)	VOLTAGE BURDEN	MAX. INPUT
800.0uA	± (0.3%r +5 digits)	100uV/count	1A (fused)
8.000mA	± (0.3%r +5 digits)	100uV/count	1A (fused)
80.00mA	± (0.3%r +5 digits)	100uV/count	1A (fused)
800.0mA	± (0.5%r +5 digits)	100uV/count	1A (fused)
10.00A	± (2.5%r +5 digits)	<150uV/count	25A (10 seconds)

DIODE TEST	ACCURACY	EXCITATION CURRENT	MAX. O/C VOLTAGE
3200.0mV	± (0.05%r+1 digit)	1mA	5½V approx.

FREQUENCY	ACCURACY	SENSITIVITY 1KHz-1MHz	SENSITIVITY 1MHz-4MHz	MAX. INPUT
4000.0kHz	± (0.0025%r+1 digit)	1V pk-pk ¼V/µsec.	2.5V pk-pk	250Vrms 50Hz

input of the D-type bistable IC11b high, and causing the Q output to be latched high on the next clock edge. With Q low, the converter is switched into auto-zero by TR23.

At the start of phase A, IC11b is reset by TR5 via D34.

Count/display control

The start of the integrate phase resets the counter via C18. During this phase, the count input is inhibited by D27, D29. At the start of phase B, the inhibit signal is removed, and the count commences with a 1.6384 MHz signal derived from the display module's 6.5536 MHz crystal oscillator, divided by 4 in IC12. The display module's internal /8 prescaler results in an accumulation rate of 204.8 kHz.

At the end of phase B, IC11 inhibits the count input via D30, and pulses the hold input low via C39, thus transferring the new input to the display output latches.

Overrange

The three overrange conditions correspond to 8192, 16384, or 32768 counts. The time for these is provided by IC3 via C17a, IC7b or R39 respectively - according to the function switch selection. The selected +ve edge clocks the D-type bistable IC8a, and the overrange condition is detected if Q of IC11b is still high at this time (indicating that zero crossing has not taken place). In this case, IC8a $\overline{Q}$ goes low, triggering the monostable TR16, and making the LSD blanking pin of the display module go high. During the monostable time constant of 250 mSec, IC3 is reset and the system waits for a zero crossing to occur before switching to phase D.

User comments

The 1503 comes housed in a neat plastic cabinet, with adjustable handle/leg. The battery compartment is only accessed after removing the 4 screws that hold it all together. Not a serious problem when the battery drain is only 25 mA, and the battery capacity (if NiCad) is around 1200 mAh. (An external DC power source is provided for).

The push buttons are rather 'clunky', and the selection of the current range isn't all that clear. In fact, the general front panel legending is a shade confusing if you're too impatient to read the handbook before switching on.

The functioning of the meter is excellent. As you can see from our *photographs,* we used two Philips PM2521 units for a second (and third) opinion on volts and amps, and given the possible variance in lead resistances, the results were consistent with the specifications. In the current mode, all three instruments were strung in series, and the 1503 kept up a very respectable degree of rapport with its Dutch colleagues - even when down amongst the microamps. We have no grounds to doubt the accuracy of the 1503's published specification on the basis of our comparisons - which only served to highlight the errors that can arise in experimental measurements due to probe and plug/socket resistance.

One of the 'let outs' in reviewing this type of equipment is that, unlike 'HiFi' each product must be assessed on its own individual merits. There is no real cause for direct A/B comparisons, so when we compare the 1503 to the Philips PM2521, we must remember that the PM2521 has many extra features - such as auto-ranging, dB, essentially flat audio band response and a 'datum' level setting facility to name a few. It costs twice as much as the 1503, and although a battery option is now available this is one of the great joys of the 1503.

The 1503 reads 32000 'units' on most ranges, and the 2521 reads 21000 'counts' per range, making the 1503's lack of auto-ranging a little less problematical. In fact, when you think about it, leaving the 1503 on its 320.0 volt (or even the 32.000 volt) range is tantamount to an 'auto-ranging' 3.5 digit DMM anyway for most us working with 28 volts or less. Very few applications can sensibly use readings at the second decimal place. The response and settling times are very good - in average use, slightly faster than the PM2521.

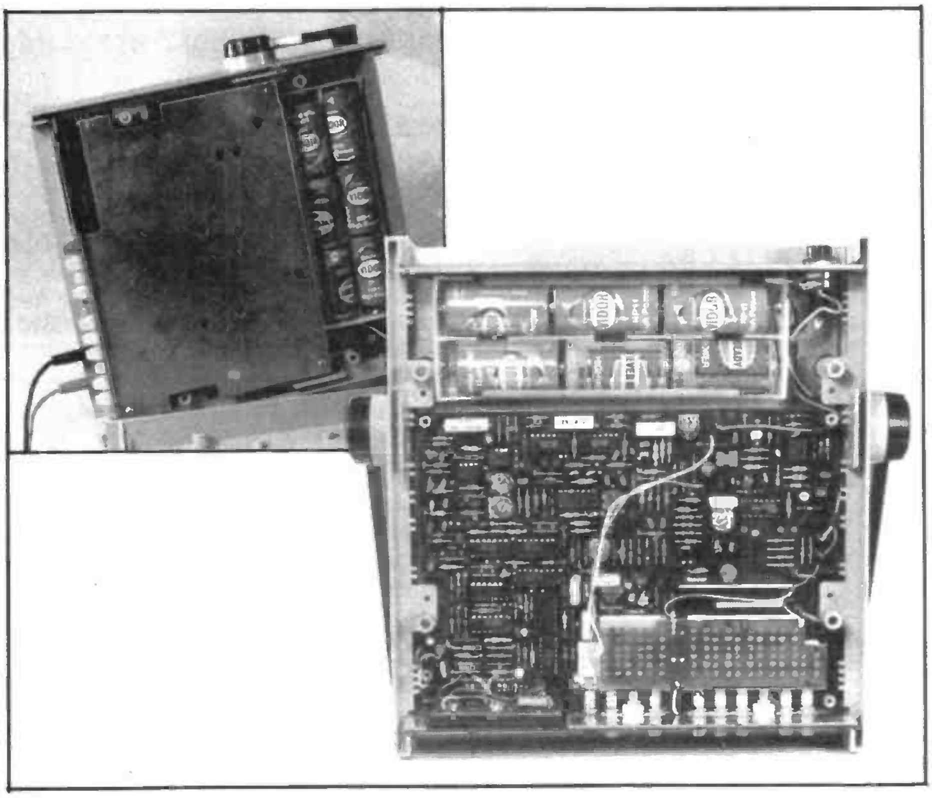
The overvoltage protection described on the front panel conflicts somewhat with the published specification. The difference between 250 V RMS and 750 V RMS is the difference between life and death for a DMM, so this anomaly should be cleared up quickly. The reduced AC response at high frequencies could possibly be tweaked with a little compensation applied to the input attenuator - but this instrument doesn't really set out to deal with audio in quite the same way as the Philips device.

RFI and the 1503

The 1503 wasn't keen on 2 W of 145 MHz closer than 1 meter away from its input leads. The resistance range was distinctly scrambled, but the voltage ranges are only marginally affected. Nevertheless, susceptibility to RFI can be a very 'individual' thing for equipment that is inherently designed without RFI in mind, so if you have an enviroment in which RFI is rife, make your own checks. 'Passing' CB - about 4 watts of FM about 20 metres away, did not upset the readings at all.

In common with virtually every DMM we have ever looked at, the 1503 is not suited to doing measurements on a 'live' transmitter - even when run into a dummy load. The case contains an electrostatic screen *(see photos),* and this is quite adequate for the purpose of keeping out mains hum and the like, but certainly it isn't an RFI shield.

On the plus side, the 1503 radiated very little descernible RFI. There is a minor family of spurii apparent at the input sockets between 10 and 40 MHz - these seem to be related to half the 6.653 MHz crystal frequency, but there is nothing likely to cause the sort of trouble experienced with some vintage LED DMMs. But like any good RF engineer, you should always check noise levels in receivers with and without the DMM switched on in the vincinity - just in case.



The inside of the 1503 with a view of the electrostatic screen.

Conclusions

The 1503 appears to be out on its own market sector. At £ 150, it must be rated as a 'best buy' - and might even find its way into the hands of some keener enthusiasts. It certainly ought to find its way into many commercial, educational and industrial applications - and it's certainly the serviceman's friend, with it's portability and tolerance of those who connect the test leads, and only then bother to set the range switch.

It doesn't do all that the PM2521 does - but then the instrument is a down-to-earth DMM - even if it does have a kHz frequency range tacked on in afterthought fashion. It certainly offers value for money, and dare we say, if you don't have a use for the bells and whistles machinery, it is certainly a best buy in 4.5 + digit DMMs.

The kHz frequency range is presented as a bit of an afterthought. Maybe Thurlby have plans to more fully exploit this aspect of the count/display module in a future instrument - such as capacitance/inductance meter perhaps. We shall be providing a very versatile low cost frequency counter, based around a similar module - the FC177 **(WR&E)** - in a future issue.

■ R & EW

Your Reactions.........	Circle No.
Immediately Applicable	278
Useful & Informative	279
Not Applicable	280
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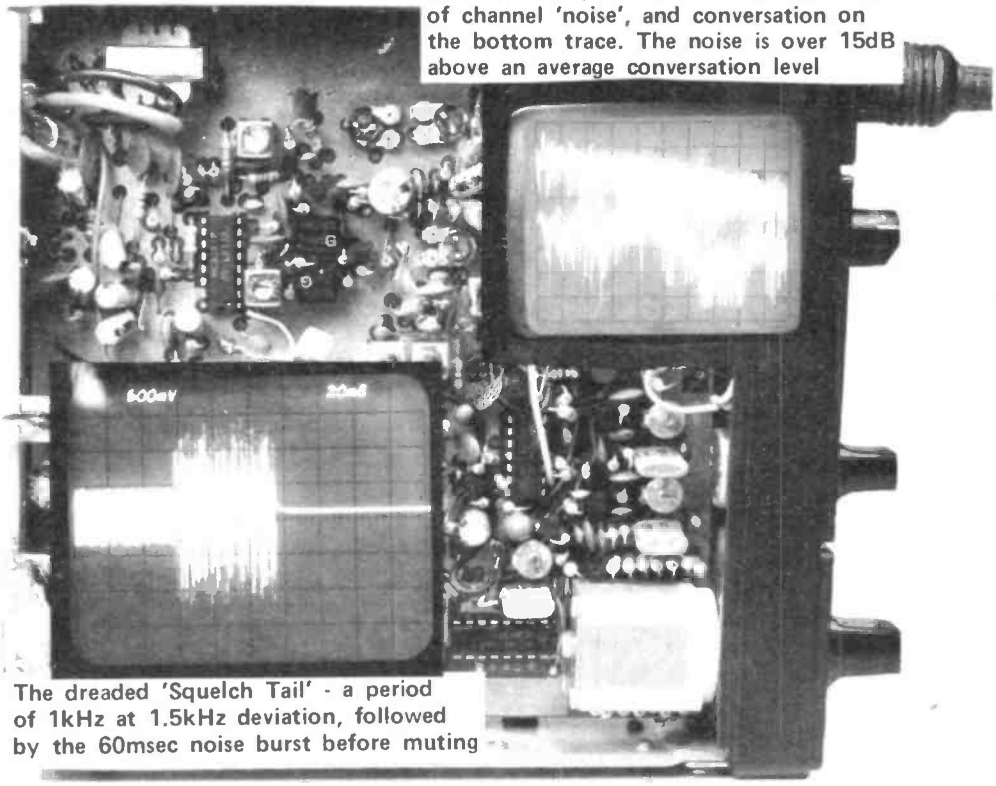
CB

R&EW 40-CHANNEL CB RIG.



The audio response (10dB/div - 0-5kHz) of channel 'noise', and conversation on the bottom trace. The noise is over 15dB above an average conversation level

The dreaded 'Squelch Tail' - a period of 1kHz at 1.5kHz deviation, followed by the 60msec noise burst before muting

AS MANY OF YOU WILL be finding out the hard way, there are a few failings in the way in which many UK-specification (FM) CB transceivers have been designed. CB radios are made to a price - the manufacturer's parts costs are usually multiplied 5 times on the way to the consumer, so every cut corner adds up. Our basic philosophy in conceiving the 40-channel **R&EW** CB rig has been to provide the reader with a comprehensive system that is not penny pinching in terms of either design, componentry or sophistication.

R&EW proudly presents the UK's first FULL SPEC DIY 40-channel CB transceiver project. Featuring fully synthesised tuning and optional auto-scanning, the rig produces 0.4/4 watts of RF output and is battery powered at 12 volts, making it suitable for either portable, mobile or 'shack' use.

In the next few pages we introduce you to some of the basic concepts of this unique design, to be followed next month with a full circuit description and constructional details.

Although it is not a 'money no object' design, the **R&EW** rig has been designed to achieve standards that would not be amiss on a £200+ mobile radio, and to overcome the operational problems experienced by many users of the first avalanche of UK rigs. Let's look at some of these problems, before moving on to a description of the new **R&EW** rig.

PROBLEMS.

The most frequently cited problem associated with 'conventional' CB rigs is that of interference from AM and SSB signals radiating within the UK or even from Italy and other parts of Europe: Many sets use squelch systems that are based on carrier level - so AM and SSB interference comes whistling straight through once the threshold has been exceeded. The trouble is that the brief pauses in SSB speech are filled by characteristic FM noise - and before the mute can catch up, the SSB is off again, creating an unpleasant mess in the audio.

Photos 1 and 2 show an oscilloscope and spectrum analyser view of this effect, illustrating the 'power' contained in the noise. What can be done? Even a genuine noise mute (such as the MC3357 provides) can't cure the problem completely, since noise quieting will occur on strong SSB and AM signals as well as FM. Once again, the time constants can not be set to a suitable compromise between 'catching the skip' and not chopping up the desired conversation to an unbearable point.

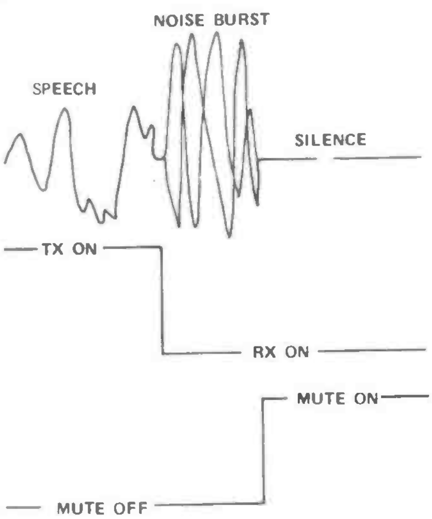


Figure 1: Timing of squelch action between 'overs'.

Another problem with many CB rigs is the noise burst between 'overs'. Again, the time constant on the mute has to be set to a compromise between 'chattering' in and out as the signal from a moving vehicle (or person) flutters, and acting quickly enough to chop off the 'squelch tail' - as it is known. *Fig 1* illustrates the timing of the sequence, and the photo' shows the effect 'off air' (using and AMSTRAD CB900). You can see that the end of the previous 'over' is followed by a noise burst until the mute catches up with it.

Yet another criticism of low-cost CB rigs is that they use a rather indifferent system for the microphone amplifier and limiter. The usual trick is to run a high-gain amplifier hard into clipping, followed by an active filter to clean up the splatter. The trouble is, that without any form of AGC on the microphone pre-amp, whenever there is a pause in the speech the background noise in the vehicle comes rushing through to garble the transmission.

The final problem is the ease with which the determined can remove a rig from a vehicle. Sooner or later the tedium of removing the rig each night ends up with the rig permanently left out - or left in overnight when the local fellons are abroad.

.....AND SOLUTIONS.

The **R&EW** rig has been designed to overcome all of these problems, and we believe it represents the best and most original solution yet seen on the market. It has been designed to be transportable, so that the basic unit can be used in the car, or taken out with a battery pack for portable use - or slotted into a mains powered base station adapter.

The system is a full spec 40-channel synthesised unit utilising the latest Sanyo LC7137 CMOS PLL circuitry. In the 'transmit' mode, the unit pushes out 0.4 to 4 watts of RF power via a pre-aligned transmitter module (thus eliminating the constructors need for expensive test gear).

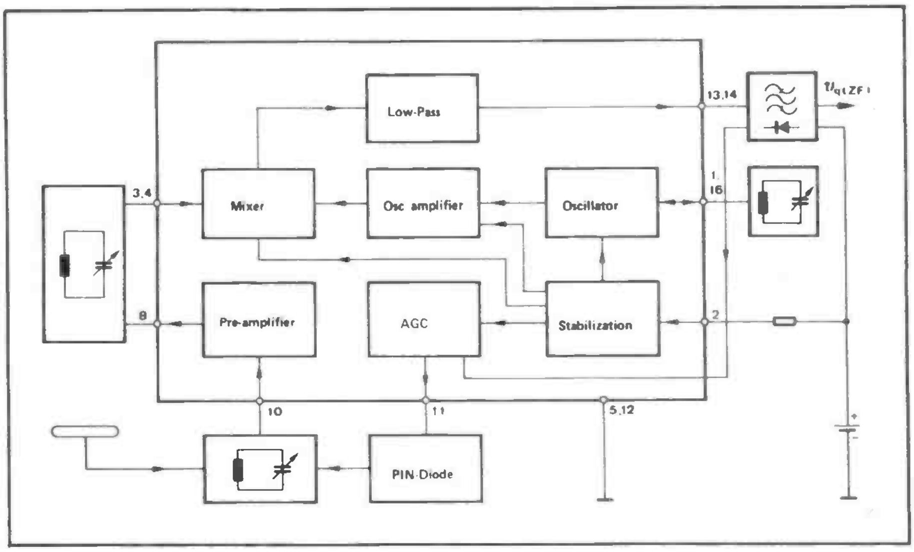


Figure 3: The TDA1062 combined RF/OSC/MIXER chip.

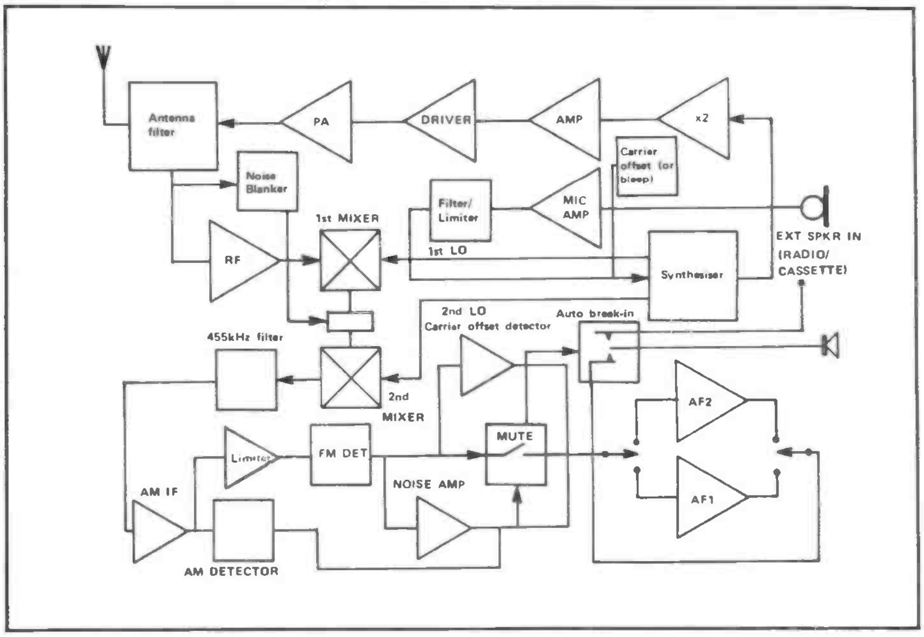


Figure 2: Block diagram of the R&EW CB rig.

The rig incorporates some very neat optional facilities, including automatic channel 9/19 selection (to give emergency channel monitoring on a timeshare basis), automatic scanning (to give automatic selection of an 'active' channel), and 'clear channel' search (to give automatic selection of the nearest unused channel).

Another very useful facility is 'loudspeaker autoswitching'. This feature enables the operator to listen to a broadcast station while simultaneously monitoring one of the CB channels; if the channel 'comes in', a relay automatically switches the loudspeaker over to that channel. The rig is actually provided with two built-in audio power stages (to suit alternative power sources); a low-cost battery 1 W stage is normally used, but a thirstier 5 W version is selected automatically when an external speaker is plugged in for mobile/home use.

The **R&EW** rig, like any truly 'classy' piece of mobile radio equipment, uses only three of four variable controls, these being ON/OFF-volume, Mute threshold, the Channel selector and an optional 'Selective Call' selector. We've eliminated the need for 'RF gain' and 'mic gain' controls by designing sensible AGC circuitry into the system, and we have not bothered to incorporate unnecessary features such as signal level meters, tone controls or panel-light dimmers etc. As one designer of 'respectable' transceivers was heard to say; "If you want a 'Play Centre', then I understand Fisher Price have an excellent line in such things...."

RECEIVER ANALYSIS.

Now that we've (hopefully) convinced you that the **R&EW** CB rig is the greatest thing since sliced bread, let's move on and discuss some of the basic design concepts of the circuit, with particular reference to the design options that were open to us and the solutions that were finally adopted. Our final solutions are laid out in the block diagram of *Fig 2*.

The **R&EW** CB rig actually uses fairly straight forward methods of signal processing in both the receive and transmit modes - the Home Office specifications leave very little room for manoeuvre in this respect. Let's start off by looking at the front end of the receiver.

UP FRONT.

The 'front end' of the receiver comprises an RF pre-amp stage and a mixer. Ideally, the mixer should be of the 'balanced' type. One possible choice here is the Plessey SL6440, an active balanced mixer with a modicum of conversion gain and low local oscillator power requirement. Unfortunately, however, this chip needs

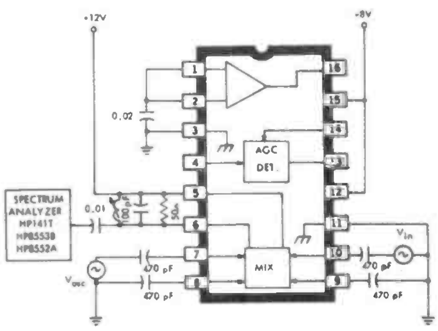


Figure 4: The ULN2243A mixer/limiting IF amplifier.

R&EW 40-CHANNEL CB RIG.

60 mA of current, and thus does not fit in with our 'battery powered' requirement.

Other possible choices were the TDA1062 combined RF/OSC/MIXER from AEG *(Fig 3)*, which also provides a PIN diode AGC detector and driver and requires only 30 mA, or the Sprague ULN2243A mixer/limiting IF amplifier *(Fig 4)*, which also consumes about 30 mA.

So the solution is either a trade-off of strong-signal performance against power consumption, or a trade-off of battery life in favour of better strong-signal performance. An ideal solution might use two RF/mixer stages - one for base and mobile operation using thirsty but meaty mixers, and a portable version with a less greedy mixer, bearing in mind the fact that strong signals are not likely to be a problem on a portable anatenna.

IFs AND BUTs.

The next part of the receiver circuit is the

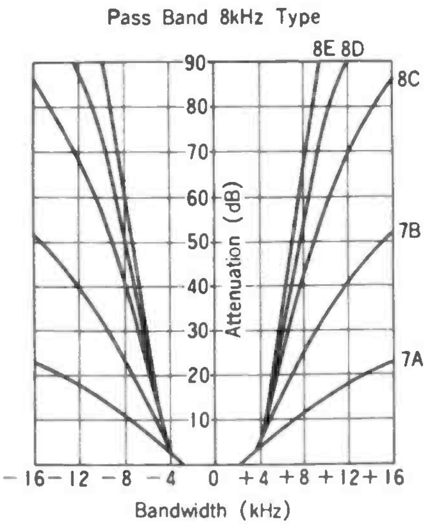


Figure 5: The relative shape factors for multipole crystal filters of a given 3 dB bandwidth centred on 10.7 MHz.

10.7 MHz IF filter. There are two basic design options here. One is to go for a low cost ceramic filter for 'roofing'. The alternative is to invest a few pounds on a crystal filter.

The function of this filter is to keep as many unnecessary signals as possible away from the second mixer, which has to cope with the added gains of all preceeding stages. The scope for IMD arising from a multiplicity of strong signals arriving at the second mixer is considerable, so the option of using top-rate filters should not be dismissed, in spite of the cost. We've left the filter option open to the individual constructor by designing the PCB to accept a low-cost filter for 'excellent' performance or an expensive filter for 'incredibly wonderful' performance.

Figure 5 illustrates the relative shape factors for multipole crystal filters of a given 3 dB bandwidth centred on 10.7 MHz. The **R&EW** CB rig uses a double-conversion receiver, with a second IF of 455 kHz, and *Fig 6* shows the ease with which a low cost 455 kHz ceramic ladder filter can provide a similar bandpass performance at around 10-20% of the cost. In our design, the second IF filter has a nominal bandwidth of 6 kHz.

SORTING THE PROBLEMS

We now come to one of the most interesting parts of the receiver, the squelch-control circuitry. Here we use the MC3357 but, although the *basic* squelch-control signal is noise-derived in the usual fashion, we use an additional peak detector that keeps the mute shut in the presence of AM or SSB signals. Only when a 'usable' FM signal is present does the mute open and let the user hear the channel's goings on.

Squelch tails are 'docked' in two ways. Some sets use a 'Roger' bleep. This otherwise tiresome tone can be pressed into useful service by using a detector in the receiver to recognise the toneburst and mute the receiver in the period between the incoming transmission ceasing and the local 'noise mute' catching it up. *Fig 7* illustrates the timing of such a process.

The second technique of docking the squelch tail is to replace the 'Roger' bleep tone by a technique that applies a DC offset to the modulator diode during the period otherwise occupied by the tone. The DC offset is such that the output frequency is deviated by 2.5 kHz for a

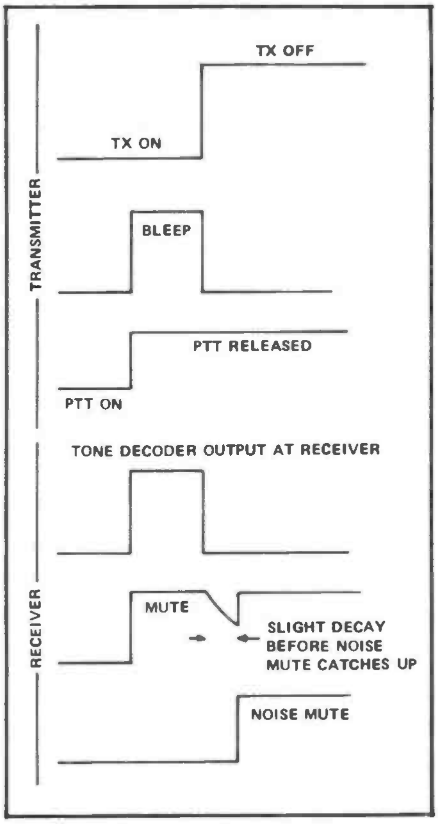


Figure 7: Timing action of a 'Roger' bleep noise mute system.

period of 100 mS or so, and the receiver then employs a variation of deviation or 'detune' muting to clamp the mute completely silent. Again, this deviation mute bridges the gap between the end of the incoming transmission and the activation of the local noise muting - exactly in the same way as you find in most decent FM tuners these days. See *Fig 8* for details of this approach. The time constant on the deviation mute drive is designed to ignore speech (300 Hz to

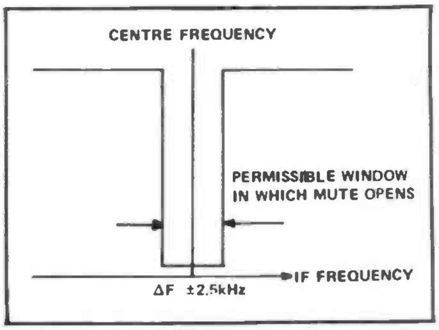


Figure 8: Principles of 'deviation mute' systems.

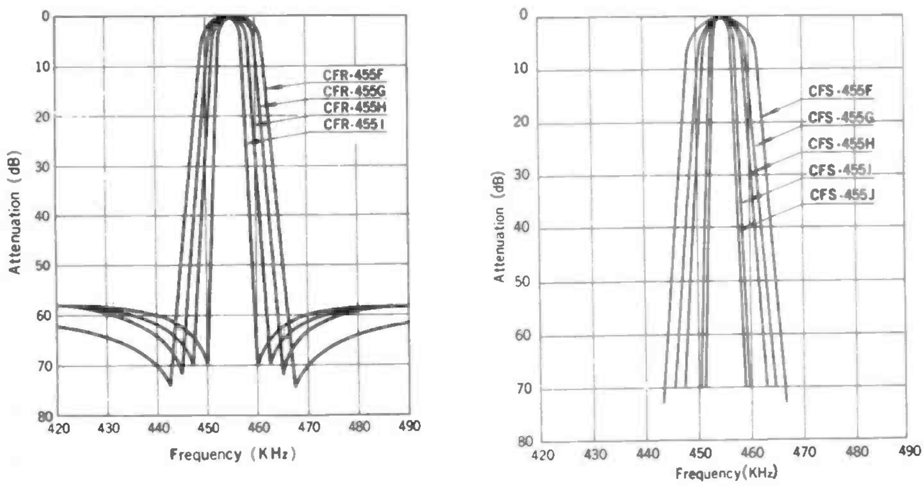


Figure 6: Relative shape factors for low cost 455 kHz ceramic ladder filters.

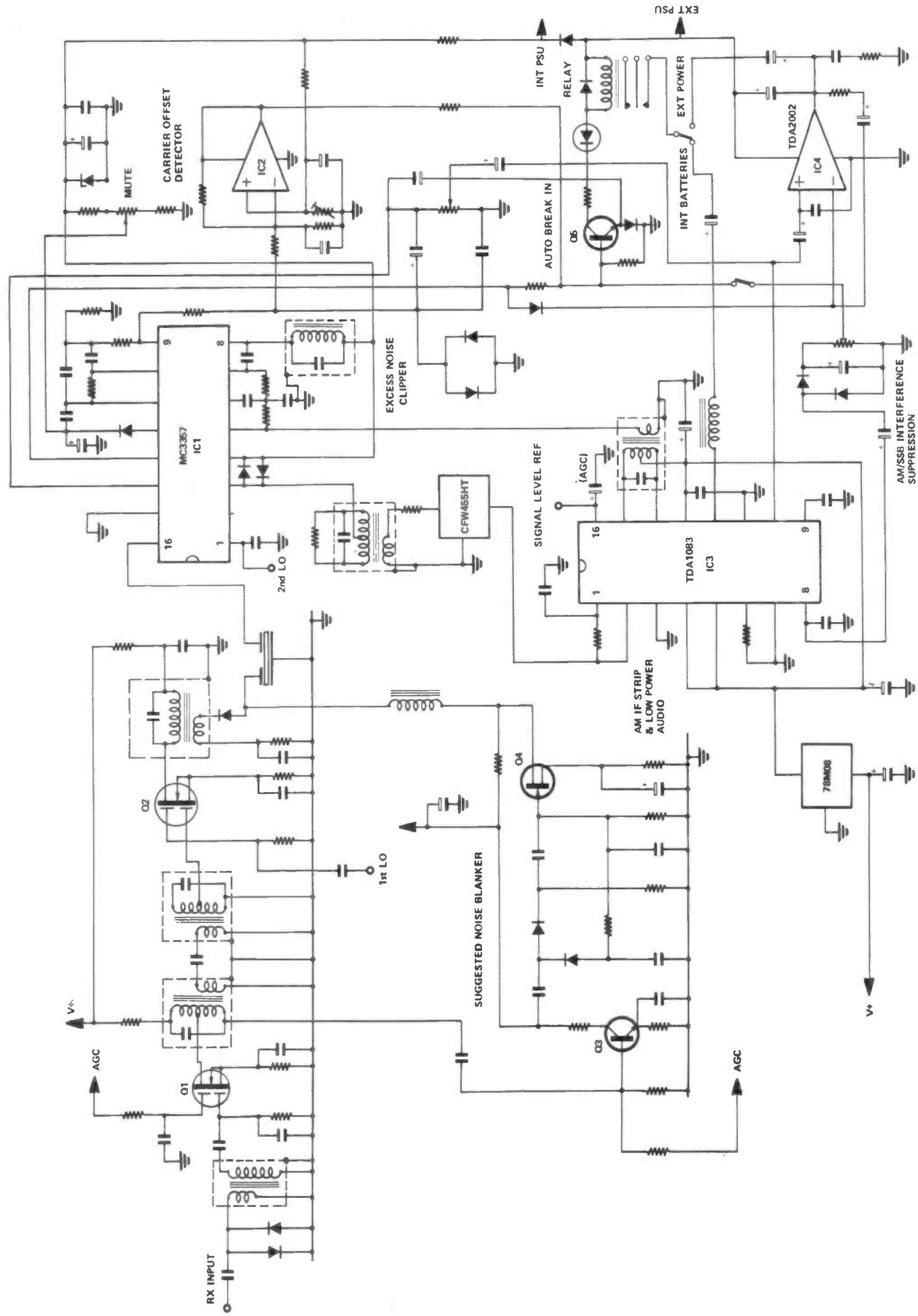


Figure 10 The proposed receiver circuit - first thoughts on paper.

R&EW 40-CHANNEL CB RIG.

3 kHz), but act only upon 'steady state' frequency offsets.

SO FAR SO GOOD

We have now offered solutions to the problems identified at the outset of this piece - as far as the receiver goes. The question of the audio stage presents the same power consumption problems as faced the mixer choice, except in this instance it is a very simple matter to offer two alternatives - one low cost battery 1 W amplifier stage, and a thirstier 5 W version that is selected when the external speaker is plugged in.

Let's move on now to a brief analysis of the transmitter circuit, stopping on the way to look at the frequency synthesiser, which also forms part of the receiver circuitry.

TRANSMITTER ANALYSIS.

The heart of both the transmitter and the receiver is the LC7137 PLL frequency synthesiser chip. Last month's 'Databrief' covered this particular chip in depth (back issues are still available), and we won't repeat a great deal here. Suffice it to say that the chip provides the receiver's mixer with the appropriate oscillator offsets, and the transmitter output is provided at half the final frequency.

The available output level is adequate to drive a reasonably simple 4-transistor transmitter strip and, because of the need to observe the conditions of the MPT specification, we've designed our rig around a pre-aligned and fully tested transmitter strip. Persons who remove the strip's output filter in the hope of obtaining a dB or two extra output deserve to be shot - or fined £400, whichever hurts the most.

The modulator uses a gain-controlled mic amplifier, as previously mentioned, together with copious amounts of low pass filtering to prevent adjacent channel splatter. This mic amp and filter is easily enough built without reference to esoteric test equipment, although establishing the modulation level at 2.5 kHz maximum is not so simple - unless you have also built the **R&EW** CB FM deviation meter (October issue).

SUMMARY.

The **R&EW** CB rig has been designed specifically to cope with the problems of the UK user and to overcome most of the problems encountered with other (usually imported) rigs.

In view of the complexity of the circuitry and the size of the project, we want to present complete constructional information in as few instalments as possible - the last thing we need is a number of half finished CB rigs being hustled on to the airwaves by builders who are too anxious to wait for the next instalment.

Next month's instalment includes the full circuit diagram and detailed operating theory, together with an analysis of the behaviour of each stage. If we have space, we hope to fit in the full contructional information as well.

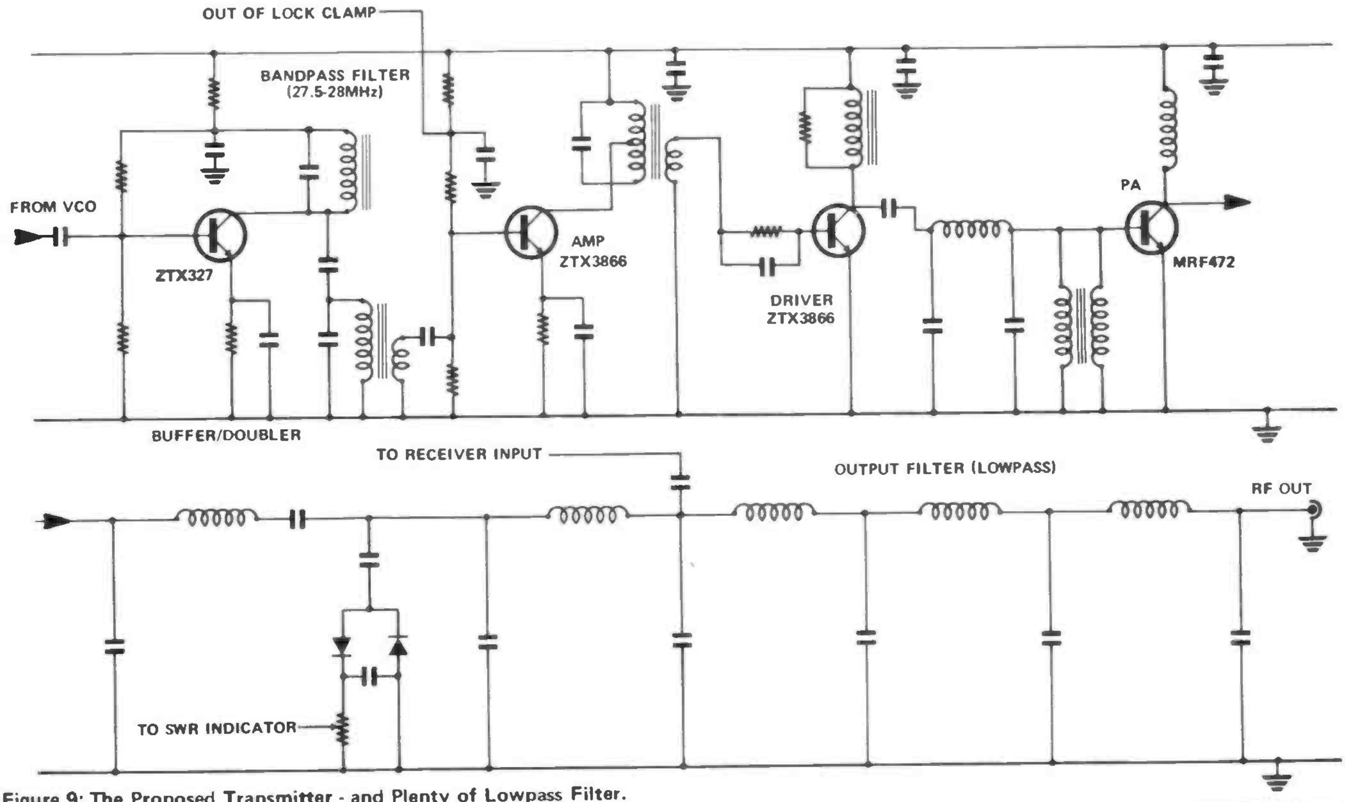


Figure 9: The Proposed Transmitter - and Plenty of Lowpass Filter.

Most magazines present constructional features on a 'Here it is - take or leave it' basis - with perhaps a paragraph or two of design background. This approach can fail to convey the story behind the evolution of the design, from inception through first thoughts, breadboards and finally into a form suitable for 'presentation'. In keeping with our policy of being different, the **R&EW** CB transceiver evolves before your eyes, complete from first ideas, through trials and tribulations, and ending up with a solution.

You have our response system to register your reaction to this type of approach - it may take a little longer to present this type of feature, but you should certainly have a far better appreciation of the design at the end of it. Remember too that something as complex as this is a whole series of 'small circuits' and circuit ideas welded together to perform a common task. You can still abstract bits and pieces for individual experimentation along the way. □ **R & EW**

Your Reactions.........	Circle No.
Excellent - will make one	282
Interesting - might make one	283
Seen Better	284
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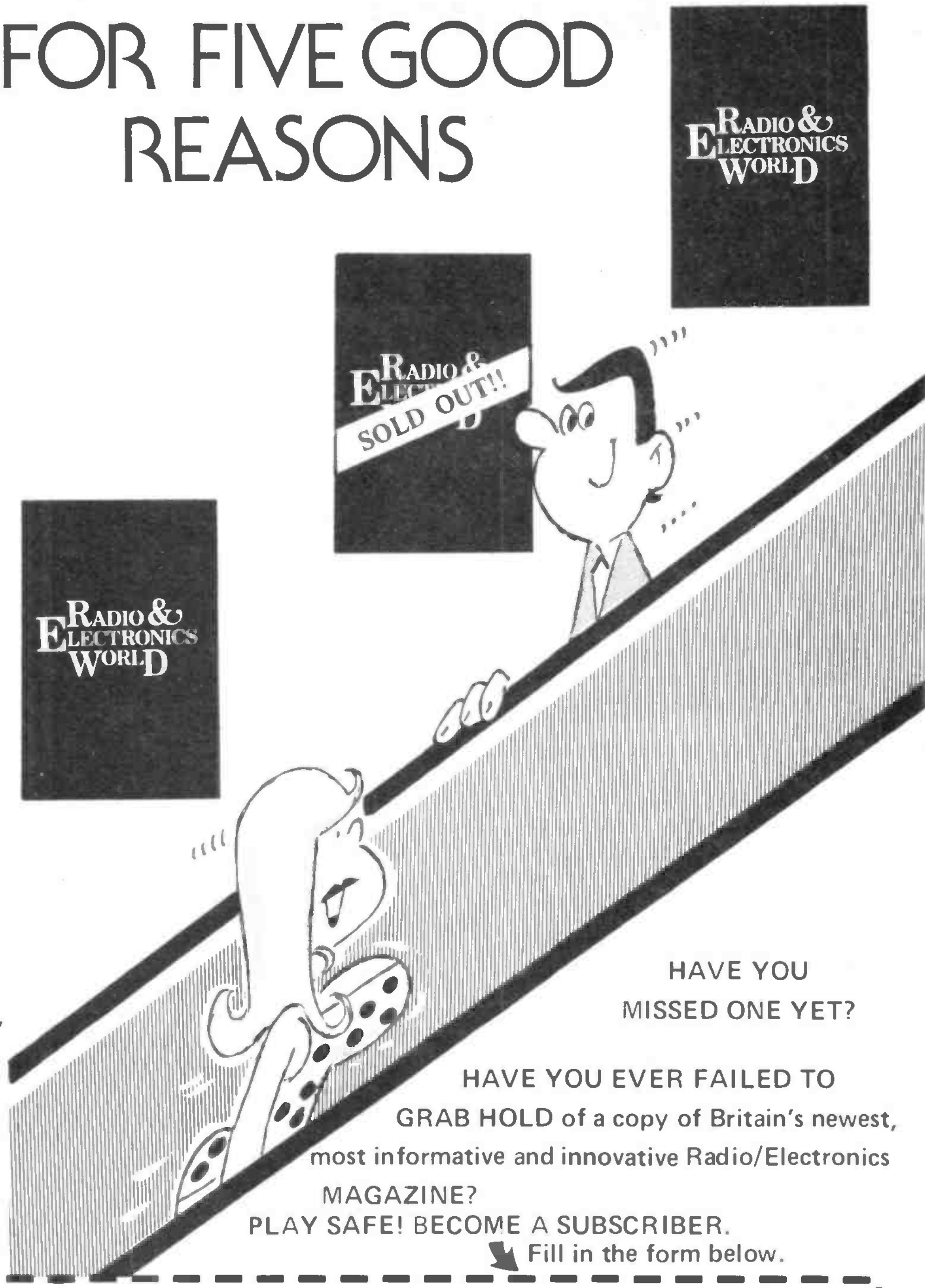

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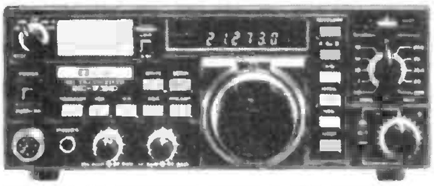

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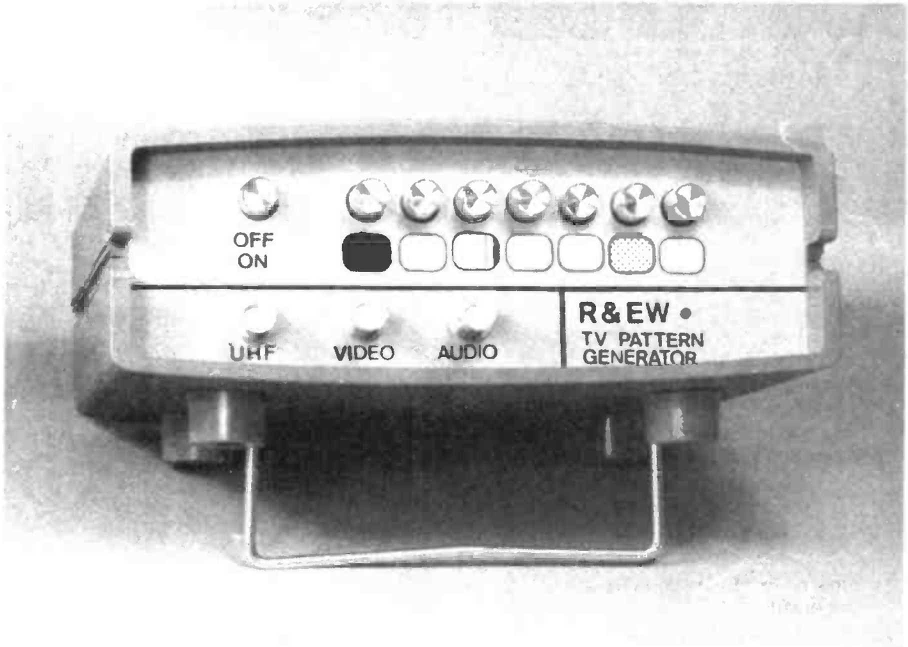


A state-of-the-art piece of test gear generating dot, cross hatch, grey scale and line patterns on Video and UHF outputs. The project incorporates internal/external sound modulation facilities and gives a truly sophisticated performance.

IN THE EARLY DAYS of monochrome TV broadcasting, 'setting up the tube' was a task calling for the trained eye of the experienced engineer. In more recent times the added complexity of colour TV technology has resulted in the spawning of a host of alignment aids to assist the hard-pressed TV technician. Chief amongst these aids is the so-called 'pattern' generator.

Commercial TV pattern generators seem to slot into one or other of two distinct classes. The first class is the ultra-simple, modestly-priced type that generates little more than a cross hatch pattern. At the other end of the scale, there is the all-singing, all-dancing type that tends to be rather expensive and vastly overcomplicated to use. The **R&EW** generator has been designed to bridge this gap. It is a unit that gives a sophisticated performance, at a modest price, and is very easy to use.

The **R&EW** generator produces five basic patterns, these being DOTS, CROSS HATCH, VERTICAL LINES, HORIZONTAL LINES, or GREY SCALE. The patterns are selected via push-buttons. The unit is crystal controlled, provides both VIDEO and UHF outputs (for monitor and TV alignment) and incorporates sound modulation facilities on the UHF channel; sound modulation can be provided from either an internal 1 kHz generator or from an external source. The unit is a state-of-the-art 'single chip' design, based on the Ferranti ZNA234E TV waveform generator IC.

The complete unit is designed to be 'mains independent', for use in those awkward situations where an alignment is carried out in a customer's house where there is only a single, overloaded, mains outlet. The unit is normally powered via 4 NiCad 'C' cells, but can also be mains-operated via a Sabtronics BS mains adaptor. When the adaptor is used, it powers the generator and trickle-charges the cells when the generator is switched on, or simply re-charges the cells when the generator is switched off.

CONSTRUCTION

PCB layouts/overlays are on page 84 *Fig 4*. BNC sockets have been used on the prototype - standard TV coax sockets are all very well on TV sets where they get 'operated' about twice a year on average, but they are not well suited to the front panel of a piece of test equipment.

A standard Sabtronics equipment case is used to house the generator, with the sound input, composite video output and modulated UHF TV output on the front panel. An 8 way push button array is used for on/off and pattern selection.

R&EW KIT PRICES

PCB & PCB-mounted components:
£28.50 + VAT (£32.78 Total)

COMPLETE KIT including case and plain front panel (less Ni-Cads)
£43.43 + VAT (£49.95 Total)

COMPLETE KIT including Ni-Cads (1.2 AH)
£50.39 + VAT (£57.95 Total)

Construction is quite straightforward - the Sabtronics case is supplied with a blank plastic front panel that is easily drilled to accommodate the various knobs and sockets. The BNC sockets should be assembled after first soldering the connector braid to the tag washer - don't solder to the tag washer with the socket fixed into the plastic panel.

Pin 2 on the ZNA234E IC determines the line rate at either 525 or 625. (Pardonnez-nous all you 819 line fans.) It is hardwired in this example, but could be switched if you anticipate multi-standard operation. If you have a switch for the rate, remember that a well known law of

(contd p.57)

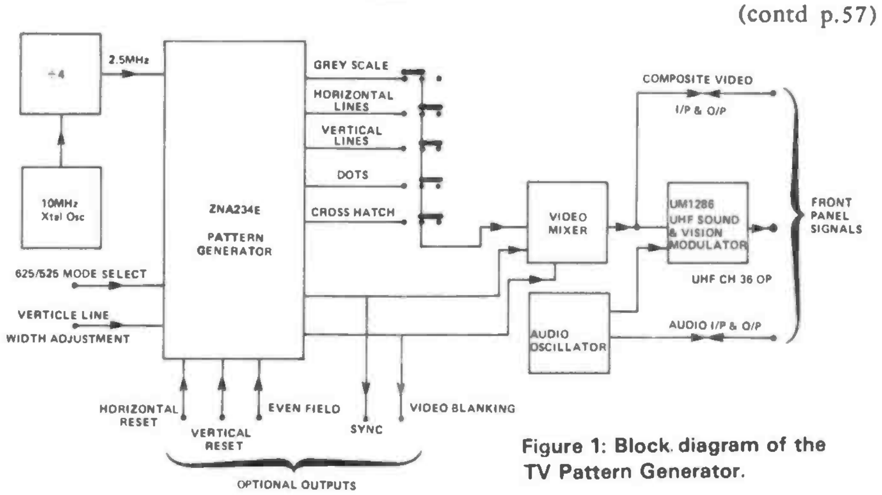


Figure 1: Block diagram of the TV Pattern Generator.

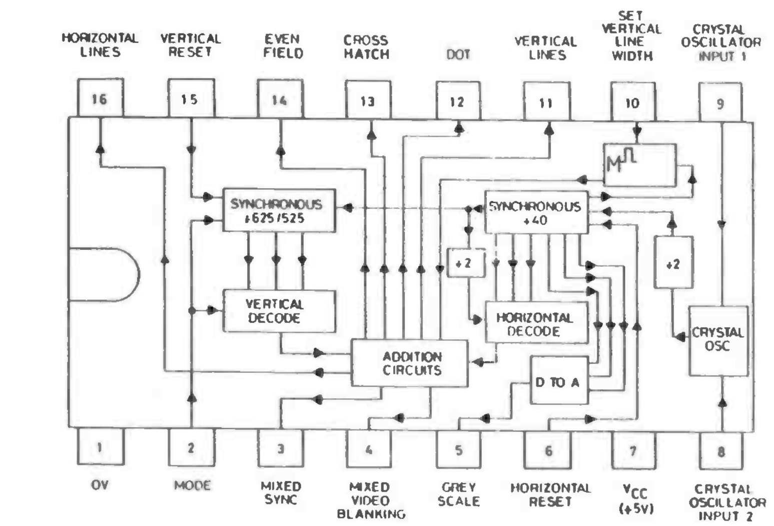


Figure 2a: System diagram of the Ferranti ZN234 TV pattern generator IC.

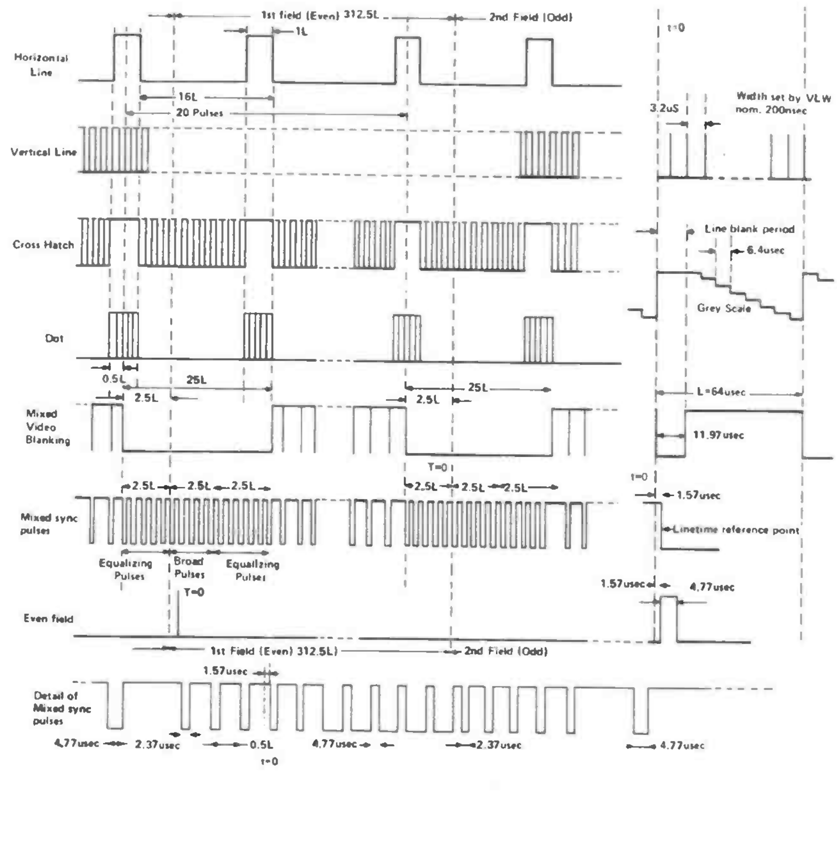


Figure 2b: Video, video blanking and sync waveforms from the ZN234.

CIRCUIT DESCRIPTION

The R&EW TV Pattern Generator owes much of its simplicity to the use of the Ferranti ZNA234E TV waveform generator device - a customised version of the ULA series. A sound and vision modulator is also used, since many test generators do not provide a facility for checking the TV receiver's sound channel. The Aztec UM1286 is set up for a 6 MHz intercarrier frequency - readers in other countries will need to observe local standards.

The internal arrangement of the ZNA234E is shown in *Fig 2a* which contains everything but the video sync mixer. One function available on this device, that is not very common on other pattern generators, is a grey scale facility, derived from the horizontal counter. A simple form of D/A converter is formed by switching the output of a 60 uA current sink in 8 equal steps of approximately 0.3V. *Fig 2b* illustrates the various waveforms present at the outputs of the device.

The ZNA234E can operate directly from a 2.5 MHz crystal - or from an external oscillator. In view of the fact that 2.5 MHz crystals cost around 2 to 3 times as much as readily-available 10 MHz types, a 10 MHz crystal has been used in conjunction with an external divide-by-4 circuit in our design. TTL is used for this function: with the main IC consuming around 100 mA, there seems little point in worrying about a few more mA.

The outputs are switched into the buffer/sync mixer, and the output of this is then interfaced to the UM1286 to provide the correct modulation level. The transfer characteristic of this device is shown in *Fig 2d*, showing the need to drop the reference into the modulator. The zener diode could have been used to raise the 'ground' level of the modulator, but that would have entailed problems elsewhere.

A simple sinewave oscillator at 1 kHz is used to drive the function - although external modulation may be applied if required. Indeed, an external video source can be applied if you want - the necessary sync pulses are available at a buffered output if you want to experiment with various video inputs.

For computer interface applications, Don Lancaster's books - "The Cheap Video Cookbook", and "Son of Cheap Video" provide an excellent course of instruction for the would-be computer video enthusiast.

The pattern generator consumes a relatively high current (120 mA or so), and so an adequate power source must be supplied. The on-board regulator is designed to work with the Sabtronics BS 01 9V 350 mA mains adapter - which can then also trickle charge the NiCad battery supply consisting of 4 NiCad C cells.

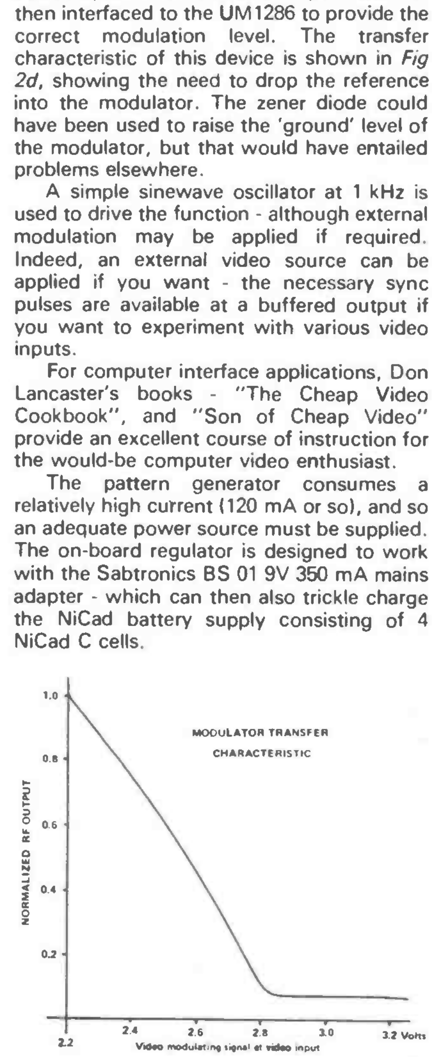


Figure 2d: Transfer characteristics of the UM1286. ▷

R&EW TV PATTERN GENERATOR

electronics clearly states that whenever you spend an hour dismantling the vertical hold section of a TV set, it is because some innocent soul has been fiddling with your pattern source, and left it in the wrong mode...

SETTING UP

It is a good idea to check the current consumption without the main ICs in circuit - this should be around 15mA for the modulator alone. Anything much more than this probably represents a short on the PCB, and this should be traced out and rectified before proceeding. If you have access to the appropriate gear, check out the operation of the crystal oscillator and divider before inserting the ZNA423E.

The Aztec TV modulator will work without any problems - just make sure the supply voltage is correctly applied, and you should immediately be able to find an output on a UHF TV set around channel 26. When you have got as far as finding a UHF signal, switch off and plug in the main device.

The trimmer potentiometers are set up according to:

RPS1 and RPS2 are interdependent - they establish the composite video level, and the video to sync ratio. With cross hatch selected, RPS1 should first be adjusted for a 1V pk-pk composite signal at its wiper - the only way to establish this is in conjunction with an oscilloscope.

RPS2 should be adjusted for a 7:3 video to sync ratio (again using an oscilloscope) on the composite video line (wiper of RPS1).

Repeat as necessary. Most modern TV sets are very tolerant of sync ratios, and it is quite possible that the green fingered may be able to establish a working set of adjustments - although accurate alignment of the grey scale may be difficult.

Select the grey scale output, and then adjust RPS3 until 8 vertical bars appear on the screen, ranging from peak white (left hand screen) to black (right).

RPS4 sets the vertical line width to match the horizontal line width when crosshatch is selected. NB: The horizontal line width is two lines wide.

RPS5 is adjusted for 3.2V on the wiper to set the sound carrier frequency to 6 MHz. Tune in until all sounds well with RPS6 set to a low level.

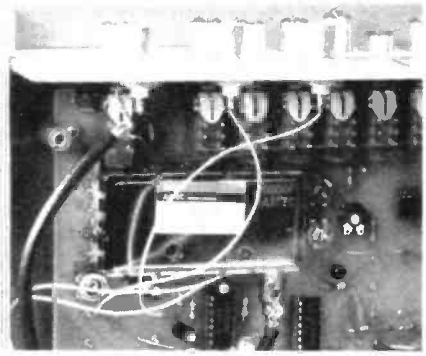
RPS6 is used to set the audio level at about the level used for broadcast test tones.

The two switches at the rear of the case are used for switching the audio source between external or internal source -external audio is fed in the BNC on the front panel. When no audio is required, simply switch to external input - and don't provide any!

Similarly, the UHF modulator can be fed from either an internal or external composite video source. The UM1286 modulator has sufficient bandwidth to accept colour composite video if required - but beware the delaying effects of long cables.

Additional rear panel BNC sockets provide sync and video blanking signals, simple banana-plug sockets provide access to vertical reset, horizontal reset and even field operation.

The video modulator output frequency may drift slightly towards the end of the NiCad charge life - most TV AFC circuits will hang on to the signal until it has gone a long way off. Fully charged batteries give 12 hours operation, which ought to be enough for most purposes.



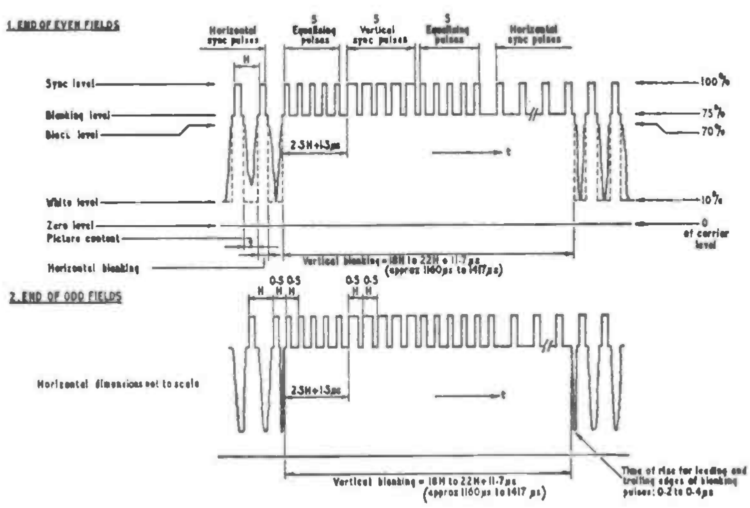


Figure 2c: Composite video waveform of a normal TV picture. The picture information is positioned line by line between the horizontal sync pulses during the 'Video Blanking Off' period.

COMPONENTS LIST

RESISTORS (¼W 5%)	
R1,2,3,4	470R
R5	22R
R6	47k
R7	10k
R8	330R
R9,10	3k3
R11	100k
RPS1,2	1k0 pre-set
RPS3,6	4k7 pre-set
RPS4	100k pre-set
RPS5	47k pre-set
CAPACITORS	
TC1	30p trimmer
C2,9,10,11,12,13,14	10n ceramic
C3,4	2u2 16V electrolytic
C5	120p ceramic
C6,7	22n ceramic
C8	10u 16V electrolytic
SEMICONDUCTORS	
D1,2	IN4148
D3	IN4001
ZD1	2V7
ZD2	5V1
Q1	BF274
Q2	BD245
IC1	7404
IC2	7474
IC3	ZNA234A
MISCELLANEOUS	
SW1-SW8	7-way interlocking + 1 push-push push-button switch.
Push-button knobs (8 off)	
SW9,SW10	1-pole 2-way miniature slide switches.

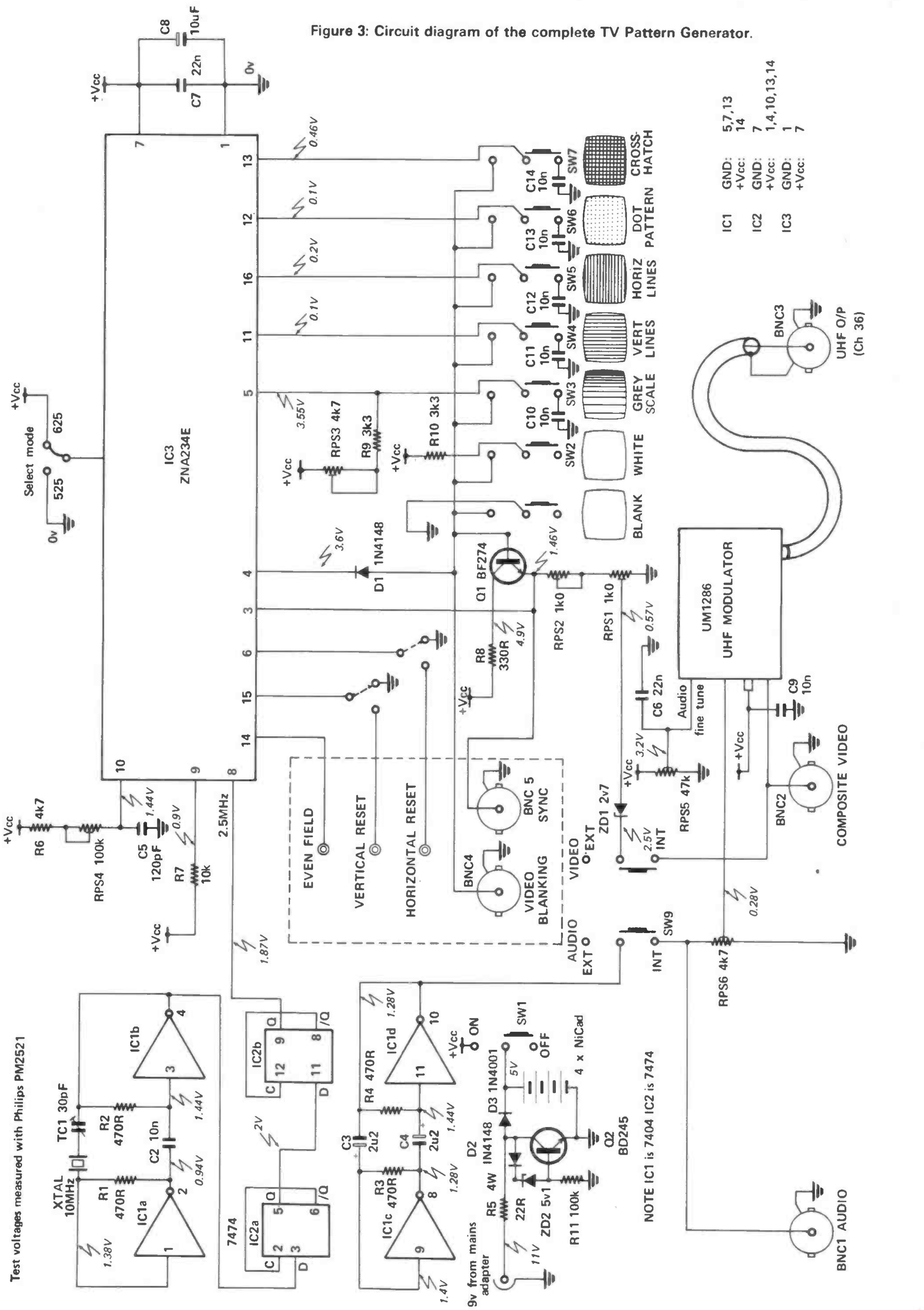
16-pin IC socket (1 off)
14-pin IC sockets (2 off)
BNC1-5 BNC sockets (5 off)
Phono plug (1 off)
5mm DC socket
10MHz crystal
4 off NiCad 'C' Cells
Holder for 4 'C' Cells
Astec modulator, type UM1286
Sabtronics case and front panel
PCB Sabtronics mains adaptor Type BS-01

■ R & EW

R&EW TV Pattern Generator continued on page 84 ▶

Your Reactions.........	Circle No.
Excellent - will make one	130
Interesting - might make one	131
Seen Better	132
Comments	133

Figure 3: Circuit diagram of the complete TV Pattern Generator.



TV ANTENNA SELECTOR

Roger Ray shows how to remotely switch two television aerials, and boost the signal strength at the same time. This arrangement uses the existing co-axial downlead to carry the TV signal and switching voltage simultaneously.

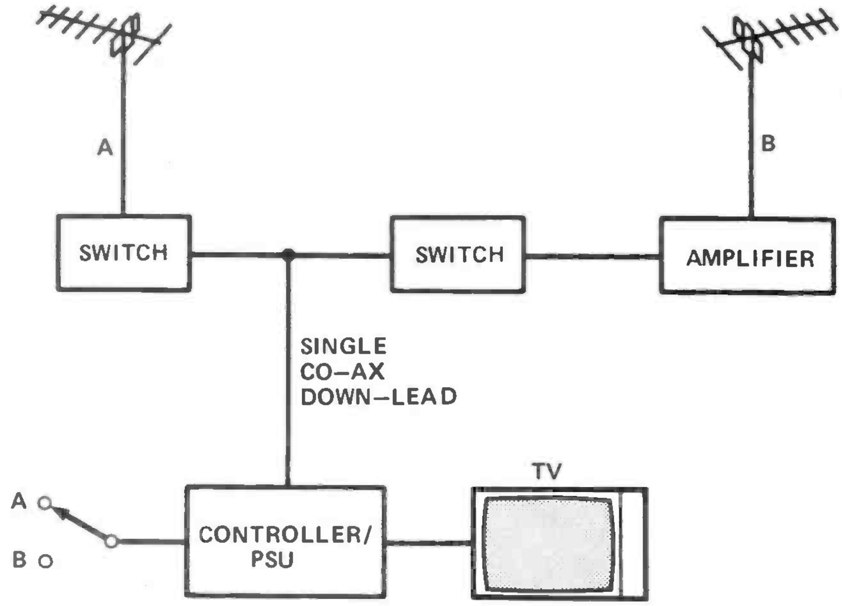
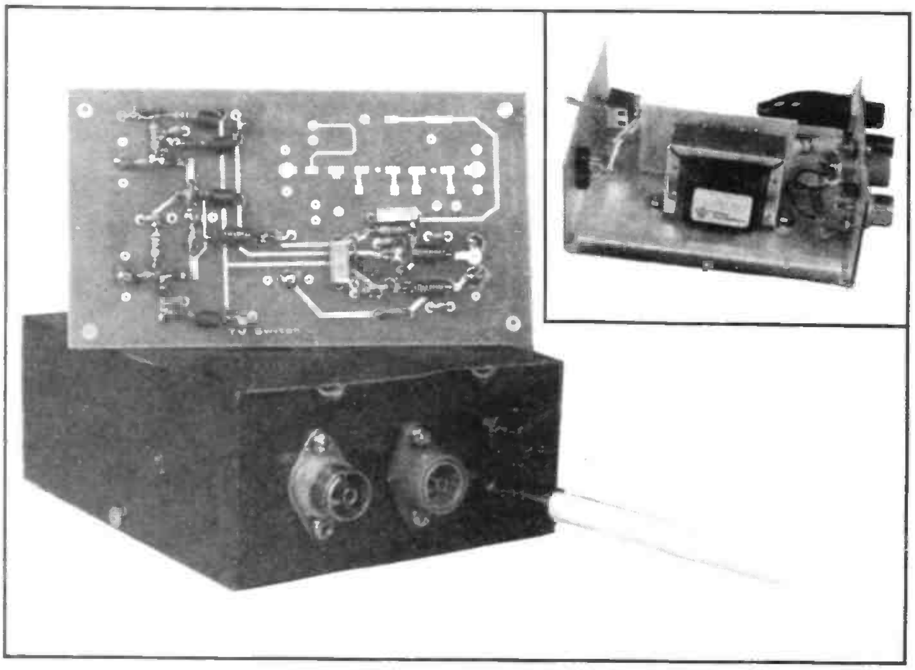


Figure 1: Block diagram of the basic switching arrangement.

IN MANY AREAS, UHF TV pictures can be received from more than one transmitter. This usually requires more than one aerial for optimum results. As co-axial cable is relatively expensive and having two downleads is untidy, a method of combining the signal is required. A simple resistive or inductive combiner is one solution. This works in some situations, but in many instances the aerial aimed at the more distant transmitter also picks up a strong reflected signal from the local one. This manifests itself as bad ghosting on the picture. Commercial CATV receiving stations use separate tuned filters for each station, to overcome this problem. This is an expensive solution for the home viewer, a cheaper solution is to use a remote PIN diode switch. This has the advantage that its use is not restricted to television.

This project comprises a remote PIN diode switch to be mounted near the aerials and a power supply/controller conveniently placed near the TV set.



Three in One

The most usual switching arrangement is shown in *Fig 1*. Here aerial A is receiving signals from the local transmitter, while aerial B is trained on a more distant station. The amplifier is used to improve the signal/noise ratio of the weak station. A masthead TV amplifier was described in **R&EW** January '82. The same amplifier is used in this project and provision is made for it on the PCB. As this has already been adequately described in **R&EW**, circuitry and constructional details of this section are not reprinted herein.

The remote unit is divided into three separate parts, this means various configurations are possible as shown in *Fig 2*. Arrangement (a) is suitable when both signals are reasonably strong and the co-ax downlead is not excessively long. (b) is used when one station is weaker than the other, and (c) is required when there is a high 'loss' between aerial and TV set caused by a long downlead.

CIRCUIT DESCRIPTION

The PIN diode switch arrangement provides a change-over action between inputs A and B. The circuitry around D1 and D2 is identical to that around D5 and D6. When the switch is in the 'closed' position diode D2 is forward biased giving a low resistance. At the same time D1 is reverse biased, giving an open circuit condition. When the switch is in the 'open' position, diode D2 is reverse biased giving an open circuit to the signal path. D1 is at the same time forward biased, effectively shorting the signal input, and providing further isolation. The switch comprising D5 and D6 operates in the same way, but in anti-phase to switch D1/D2. If carefully constructed each switch gives an insertion loss of 2 dB and isolation exceeding 30 dB up to 860 MHz.

Chokes L2 and L3 provide a DC path, while appearing as open circuits to the UHF signals. Capacitors C10, 11 and 12 provide DC blocking, while passing the TV signals. The DC is applied to the diode bridge D4, this gives a negative 12 V supply whichever way round the DC polarity is, on the co-ax input. A reference voltage for the PIN diodes is obtained from this negative supply, the voltage being developed across zener D3. The switching voltage is taken from L2 and L3 to the PIN diodes, forward bias current being limited by the resistors R1-3, R5-7.

The PSU is fairly conventional, giving a 12-14 V DC supply. The LED's light to indicate which polarity is selected by S1. The chokes and blocking capacitors work in the same way at the remote end.

Construction

The project comprises two separate modules, one being the remote switch, and the other the combined controller/▶

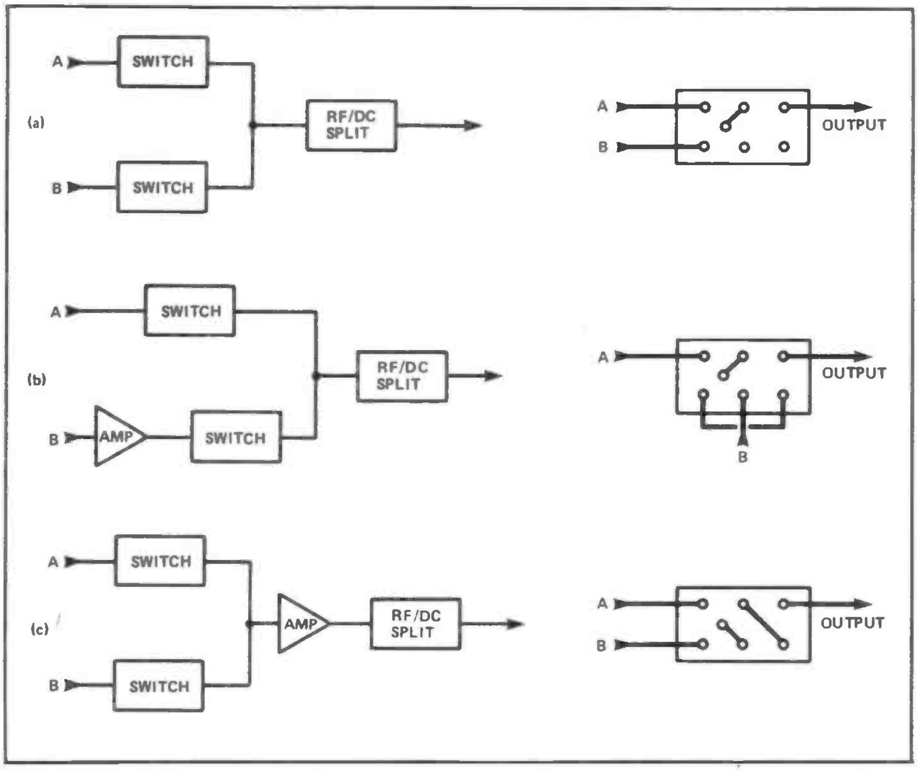


Figure 2: The three possible arrangements of the remote switching unit. The diagrams on the right-hand side show the interconnections on the remote unit for each circuit arrangement.

PSU. Start off by constructing the remote switching unit, the circuit of which is shown in *Fig 3*. This is built on double sided PCB. First etch the board as shown in *Fig 4*. The board is then drilled. When drilling the holes for the centre spigot of the co-ax socket, use a drill that is just big enough for the socket being used. The PCB has been laid out to take either the PCB mounting or chassis mounting types. On some types of socket extra clearance of the earth plane may be required; this can easily be done using a large drill held in the hand. Assemble the board as shown in *Fig 5*. Solder the sockets on first, soldering the body of the socket on the earth plane side, and the centre spigot on the track side. Now proceed with the assembly of the remaining components.

Through connections (A and B) are made by soldering a wire to both sides of the board. Coils L1, 2, 3 can be wound on an eighth inch drill or similar sized screwdriver. Take care to assemble the diodes the right way around, and to thread the ferrite beads on resistors R2, 3 and R6, 7. If the amplifier is to be used refer to last month's **R&EW** for details. Three extra capacitors are used with the amplifier (C19, 20, 21) to provide RF coupling from the isolated sockets.

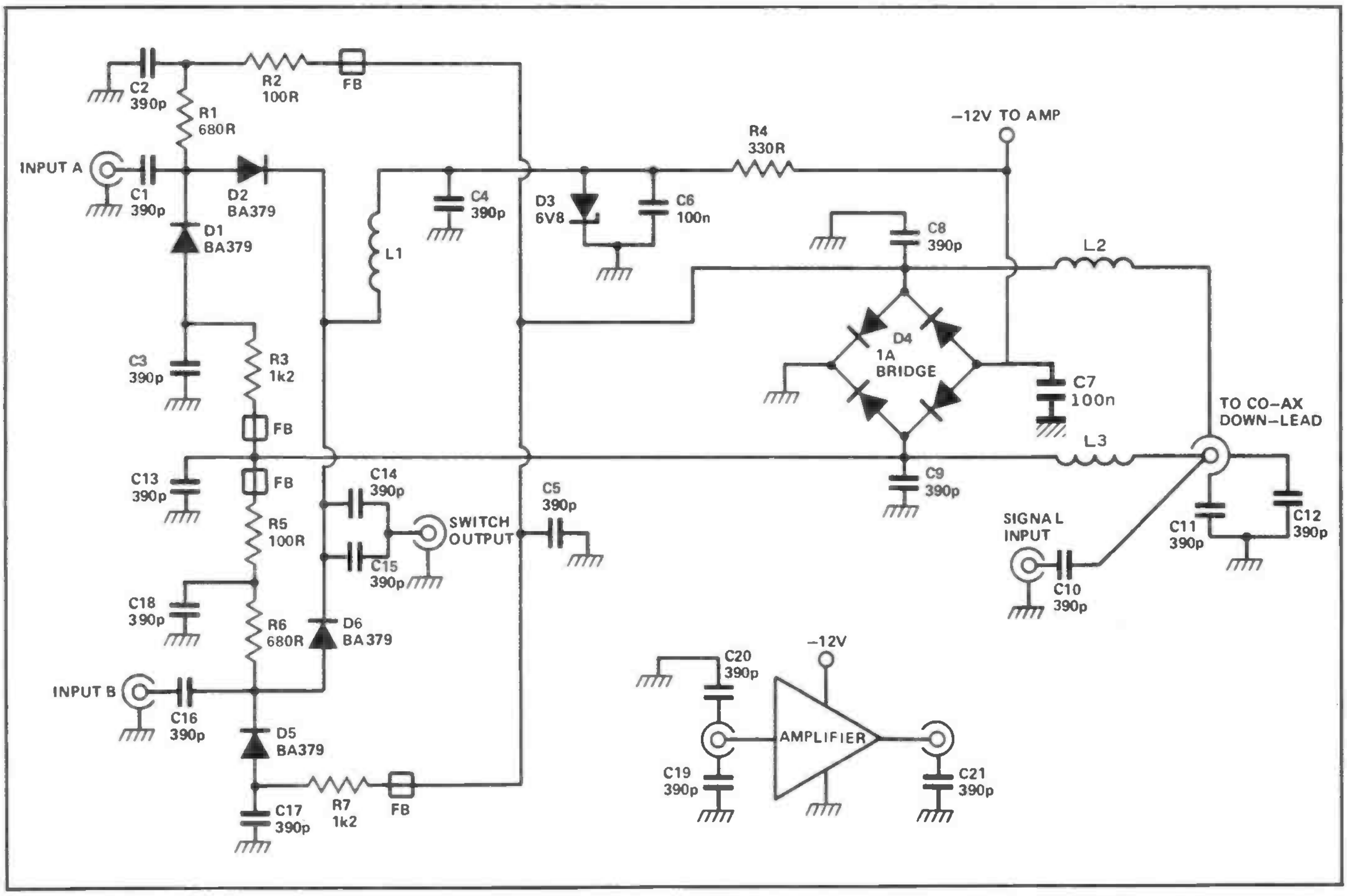


Figure 3: Circuit diagram of the remote Aerial switch.

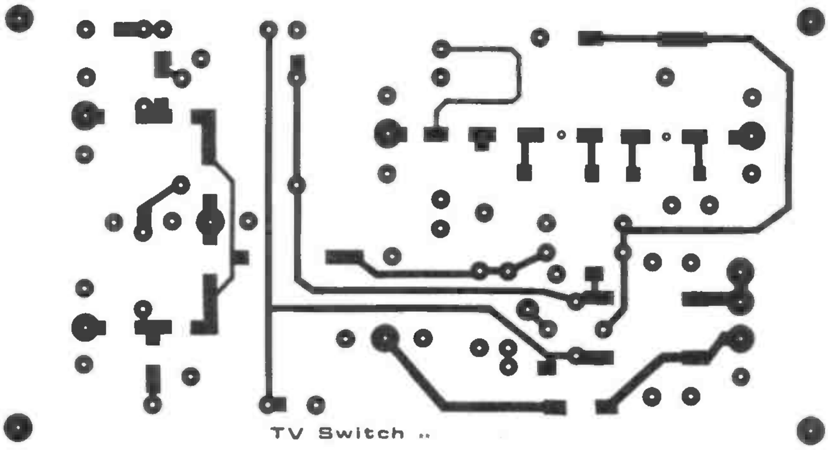
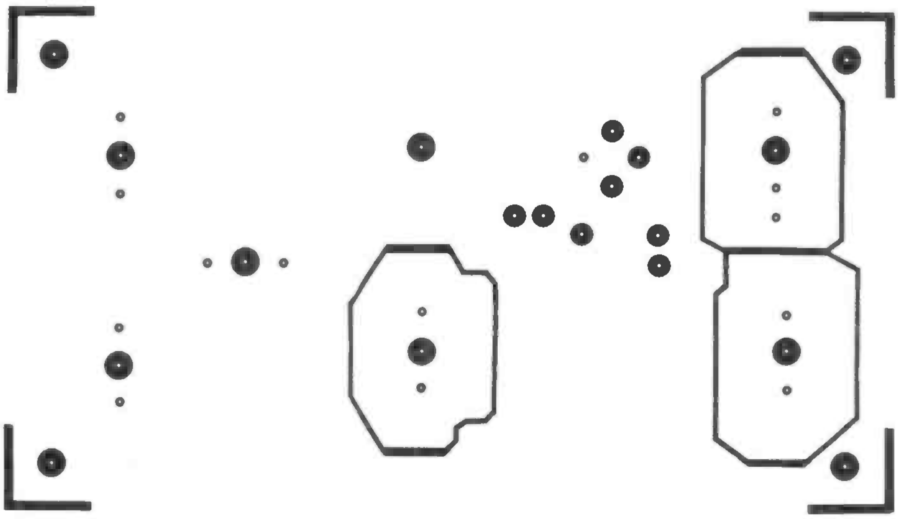


Figure 4: Remote aerial switch, foil pattern — track (component) side above, earth plane (reversed artwork e.g. black = no copper) below.



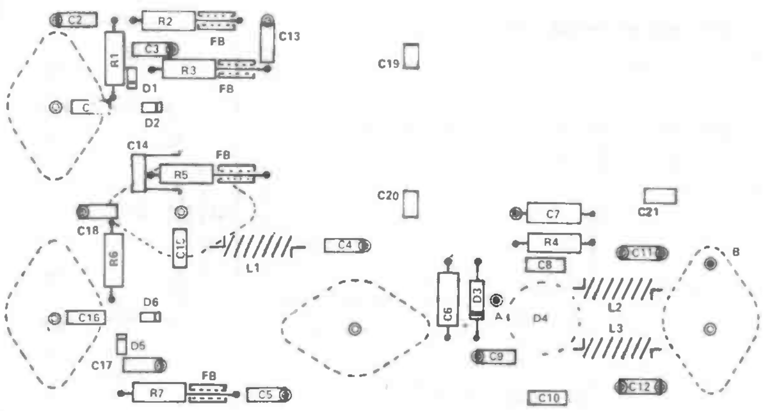


Figure 5: Remote aerial switch, component overlay.

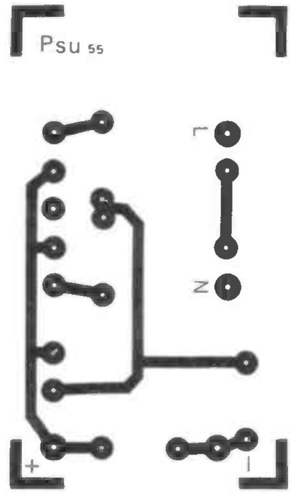


Figure 6: Controller / PSU, foil overlay.

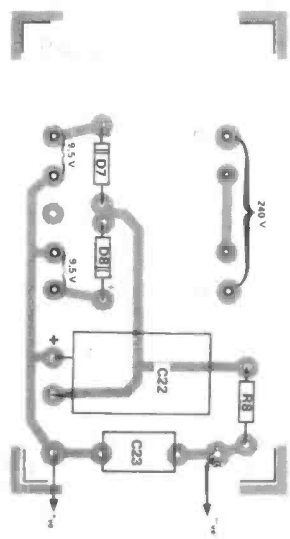


Figure 7: Controller / PSU, component overlay.

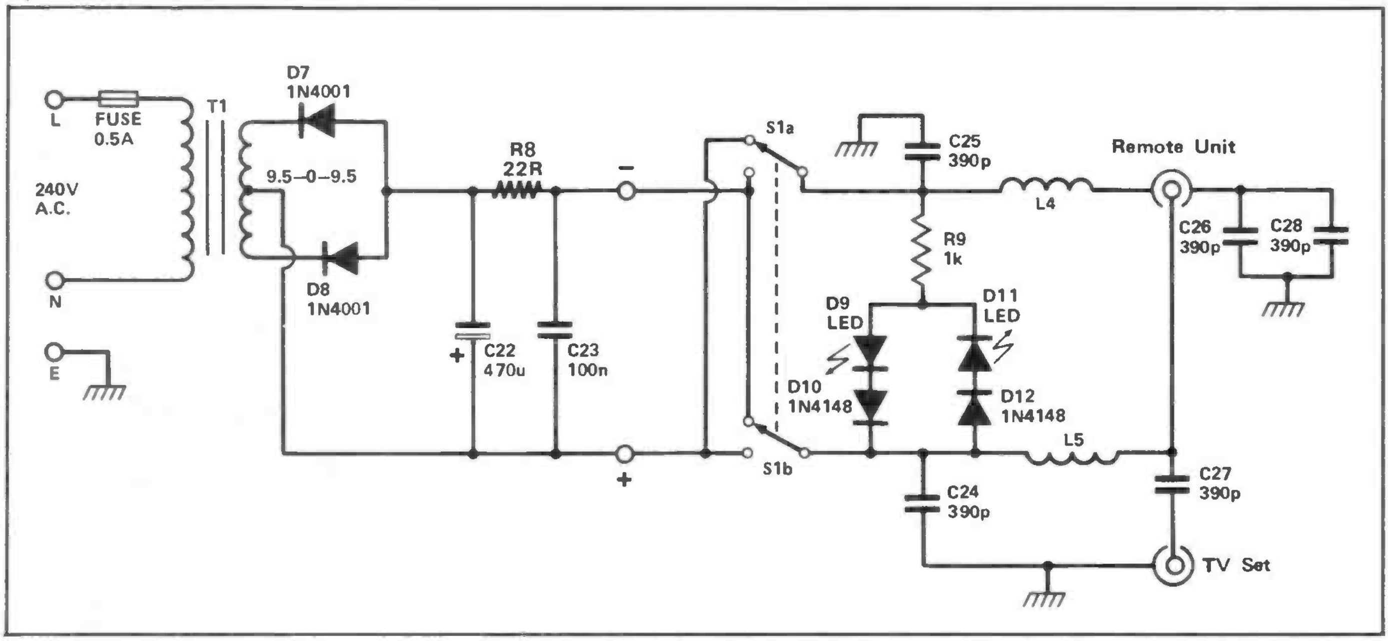


Figure 8: Controller/Power Supply circuit diagram

PARTS LIST (Excluding Pre-amp)

Resistors (.25W, 5%)	
R1,6	680R
R2,5	100R
R3,7	1k2
R4	330R
R8	22R
R9	1k0
Capacitors	
C1,2,3,4,5,8,9,10, 13,14,15,16,17,18, 19,20,21,24,25, 26,27,28	390p ceramic
C6,7,23	100n polyester
C22	470u 16V electrolytic
Semiconductors	
D1,2,5,6	BA379
D3	6V8 400mW Zener
D4	1A Bridge (W005)
D7,8	1N4001
D9	Red LED
D10,12	1N4148
D11	Green LED
Inductors	
L1,2,3,4,5	10 turns 0.5mm poly wire
T1	Mains, 9.5-0-9.5V, 3VA

Miscellaneous

Ferrite bead FX1115 (4 off)
PCB Mounting TV Co-ax socket (5 off)
Chassis mounting TV Co-ax socket
Insulated chassis TV Co-ax socket
Mains fuse holder
S1 DPDT switch
PCB's and case
Die-cast box (optional)

Building the Controller/PSU

The circuit diagram of the combined controller and power supply is shown in *Fig 8*. A single sided PCB etched as shown in *Fig 6* is used for part of the construction. Components are mounted on the track side of the board (*Fig 7*), and the assembled board is then pushed onto the interconnecting pins of the transformer T1 and soldered into place. The box is drilled to take the switch and LED's on the front panel, and co-ax socket and mains fuse on the back.

The exact layout of the box has been left up to the constructor, the only proviso being that the two co-ax sockets are mounted close together. The usual precautions should be taken as regards mains wiring. The earth connection should be made to a solder tag on one of the transformer fixing screws. Wiring of the DPDT switch is detailed in *Fig 9*. Use an insulated co-ax socket for the connection to the remote unit.

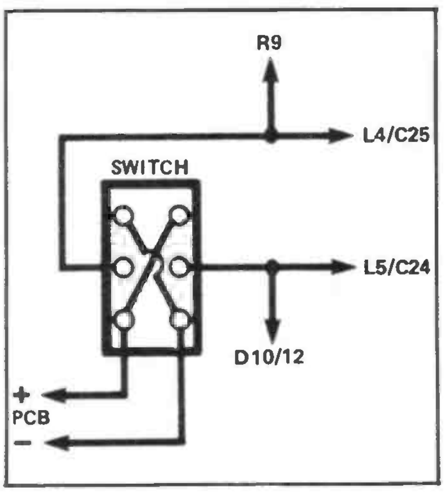


Figure 9: Wiring on rear of switch.

Testing

Test the controller/PSU first and check that approx 15V DC (off load) is present on the output of the PCB. This DC voltage should also be present on the insulated Co-ax socket (between inner and outer connections on the socket). When S1 is switched the polarity of the supply on the socket should reverse, if it does and the LED's change over, all is well.

Connect the insulated socket on the controller to the output of the remote switch and check the DC voltages shown on the circuit diagram. Preferably test switch action of the PIN switches before mounting the unit in a remote location.

Installation

The remote switching board is used as the lid of a die-cast box to provide screening. Use co-ax jumper leads to make the arrangement chosen from *Fig 2*. The unit can now be installed in any dry location close to the aerials being switched e.g. loft space, etc. The controller box can be located anywhere convenient near the TV set. Operation of the switch routes the signals from the desired aerial to the TV set.

■ R & EW

Your Reactions.........	Circle No.
Excellent - will make one	274
Interesting - might make one	275
Seen Better	276
Comments	277

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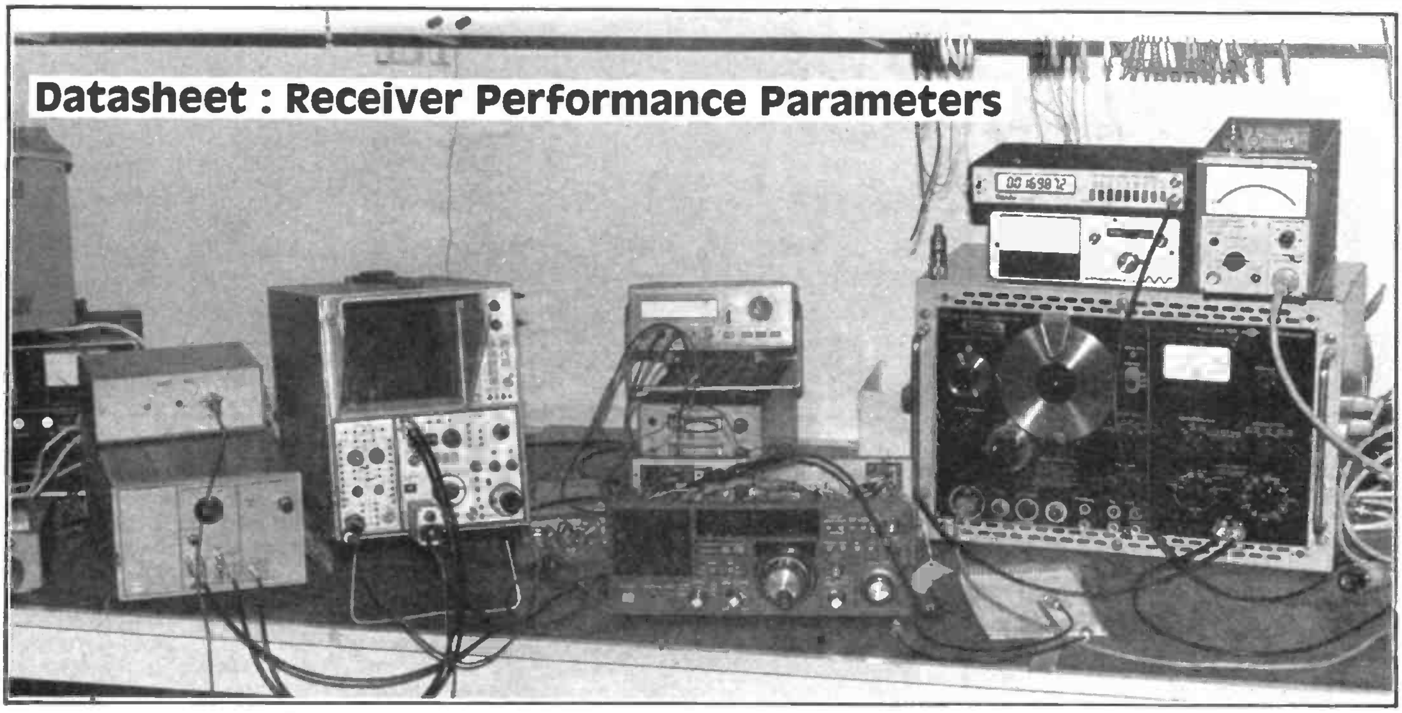
29 for further details

Datasheet : Receiver Performance Parameters



R&EW is in the course of 'standardising' the formats of tests performed on various categories of equipment that pass through our lab. There are many different approaches adopted based on various national standards organisations (BS, DIN, ASA, etc.) but none really manages to capture the 'concise' functional parameters required to convey the 'user' or 'operator' appreciation of the equipment concerned.

The first subject of this series of 'Datasheets' is the vexed question of radio receiver performance. One man's intercept is another man's SFDR, so a clear definition of terms is essential to establish the **R&EW** standard. Since the main premise of these tests are to establish user acceptability, the finest measurement techniques are possibly those associated with the measurement of the most 'user friendly' sets - mobile radio telephones as specified in accordance with MPT1301.

The MPT1301 are definitive specifications as applied to receivers (and transmitters) that fall into the category of single knob operation. The mobile radio user neither knows nor cares about the finer aspects of RF gain controls, and the specification is accordingly concise and to the point.

The datum levels established here represent the performance capability of a satisfactory receiver - they are not representative of any statutory approval.

1. Maximum Usable Sensitivity

MUS is the minimum level of signal (60% FM system deviation, 30% AM) at the receiver input that will produce an audio frequency output signal having a S + N + D/N + D (SINAD) ratio of 12dB.

The MUS is measured by applying 1 mV to the input (at a stated frequency), and adjusting the audio output level to 50% of rated output across a dummy load. The level is then reduced until 12 dB SINAD is obtained, and this test signal is recorded as the MUS. In the case of SSB receivers, the tuning is set to produce an audio beat of 1 kHz with the generator supplying only carrier wave input (CW), and the test procedure is carried out as above.

Where narrowband CW filters are available, the test will be repeated at each bandwidth setting. The maximum FM deviation is nominally set to be 20% of the equipment's channel spacing where no other guidelines exist.

2. Adjacent Channel Selectivity

ACS is the ability of a receiver to receive a wanted signal without excessive degradation due to the presence of an unwanted modulated signal on an adjacent channel.

ACS is measured with two signal generators combined according to *Fig 1.* One generator (modulated at 400 Hz, 60% FM, or 30% AM) is set to produce a SINAD of 12 dB on the desired frequency, and the second (unmodulated) generator is then tuned to an adjacent channel, and the output increased until the SINAD on the wanted frequency has been reduced to 6 dB. The ACS is then the ratio of the levels of the wanted to the unwanted signal source.

Datum:

HF receivers	VHF receivers
CW/SSB: 0.5uV PD (—113 dBm) 12dB SINAD	CW/SSB: 0.2 uV PD (—119 dBm)
	FM: 0.3 uV PD (—117 dBm)

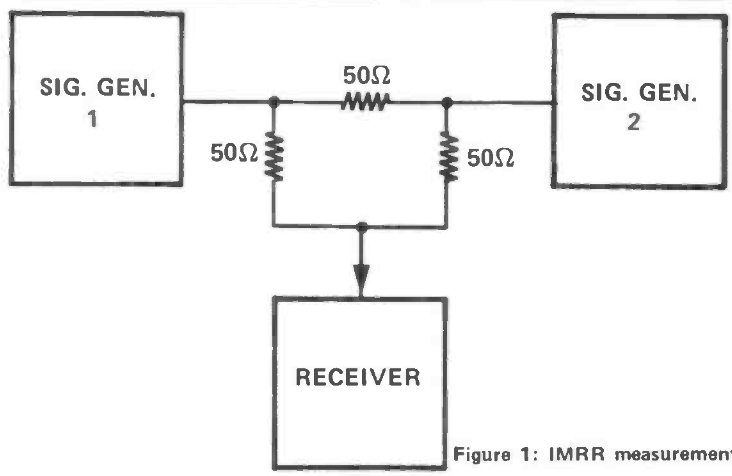
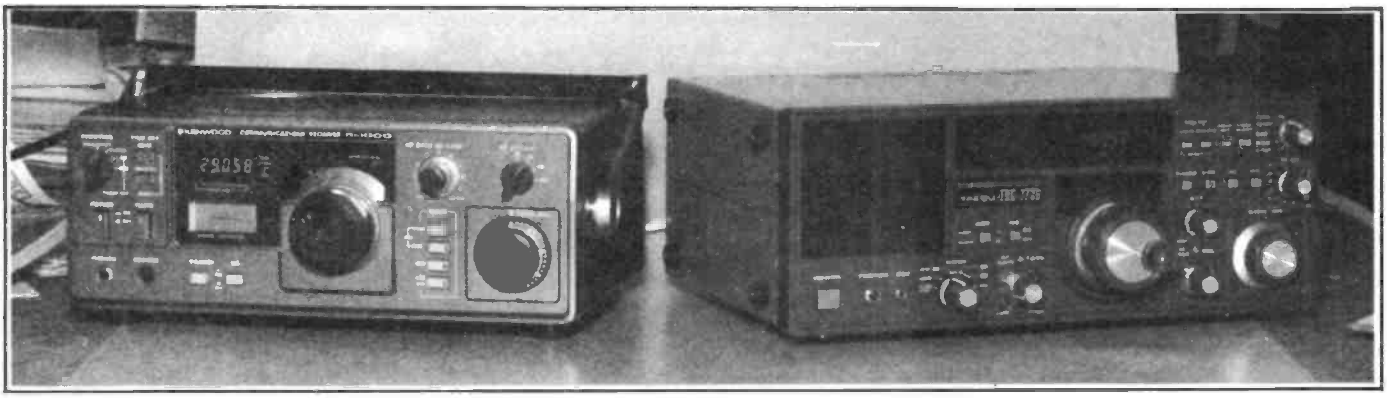


Figure 1: IMRR measurement set-up.



Where an equipment does not possess a specific channel spacing, the channel spacing will be assumed to be 2 times the nominal 6 dB bandwidth.

Datum:
HF receivers
AM: 50 dB
SSB: 60 dB
VHF receivers
FM: 55 dB (25 kHz channels)
FM: 45 dB (12.5 kHz channels)

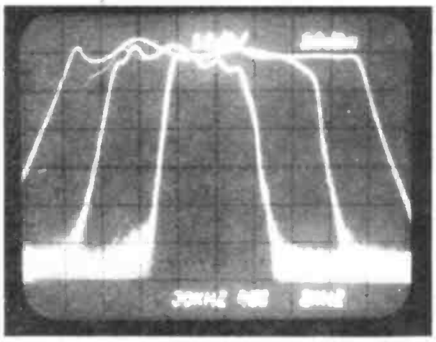
3. Inter-Modulation Response Rejection

The IMRR is the measure of the capability of a receiver to prevent the generation of in-band spurii caused by the presence of two or more signals at unwanted frequencies.

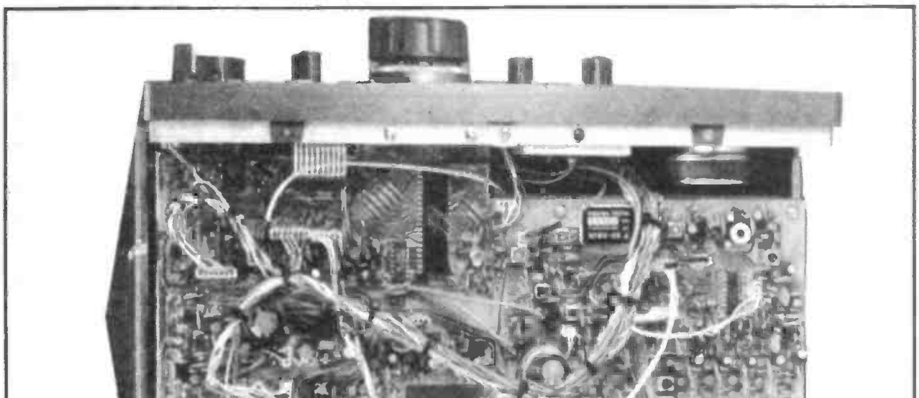
IMRR is measured using two signal generators, again according to the test procedure outlined in *Fig 1*. The wanted signal is used to establish a 12 dB SINAD output (according to the procedure in (1.) above), and the level is then noted.

The wanted signal generator is then shifted to a frequency 8 channels above the receiver's tuned frequency, and the second generator is tuned to a frequency 4 channels above the tuned frequency of the receiver.

Keeping the output levels of these two generators the same, the output levels are raised until a 12 dB SINAD signal is present (the 3rd order product) at the receiver's output. The IM rejection ratio is then the ratio of the signal required to produce the desired 12 dB SINAD response, relative to the levels of the two generators on the unwanted channels.



Datum:
HF receivers
65 dB is good, 80 dB is desirable
VHF receivers
55 dB is adequate in most cases, 65 dB is achievable.



4. Blocking and Reciprocal Mixing

Blocking is the reduction in SINAD as a result of an unwanted signal on another frequency. The measurement procedure is the same as in (2.), except that the unwanted signal is varied between +/—(2-8)MHz from the desired frequency.

The unwanted signal level is increased until the wanted signal SINAD is decreased by 6 dB and this level is recorded as the onset of blocking.

Reciprocal mixing is measured with the unwanted signal approximately 5 channel spacings away from the desired signal.

Datum:
HF receivers
75 dB is good, 85 dB desirable
VHF receivers
55 dB/65 dB

5. Spurious Response Rejection

SRR is a measure of the receiver's ability to ignore any unwanted signal that is not covered in any of the foregoing tests. 12 dB SINAD is set up as in (2.), and the unwanted signal level is set 80 dB higher. The unwanted signal is then tuned through the range set down in the report (can be up to 100 kHz to 1 000 MHz), and whenever a response is obtained, the level is set so the SINAD of the desired signal is reduced from 12 dB to 6 dB. Sub-harmonics of the desired frequency may tend to be derived from the generator output, and suitable generator output filtering should be applied in cases of doubt.

Notes:

The tests are carried out with all controls in maximum sensitivity positions. Test modulation is 60% of the maximum permissible FM deviation, or 30% AM. SSB inputs are simulated by applying an unmodulated carrier wave, and setting the tuning for 1 kHz beat note.

Other parameters used in **R&EW** tests will either be self explanatory, or defined in the table of results. ■ **R & EW**

Your Reactions.........	Circle No.
Immediately Applicable	270
Useful & Informative	271
Not Applicable	272
Comments	273

Data Sheet · Data Sheet · Data Sheet

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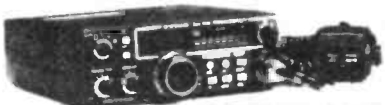

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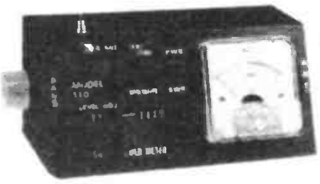

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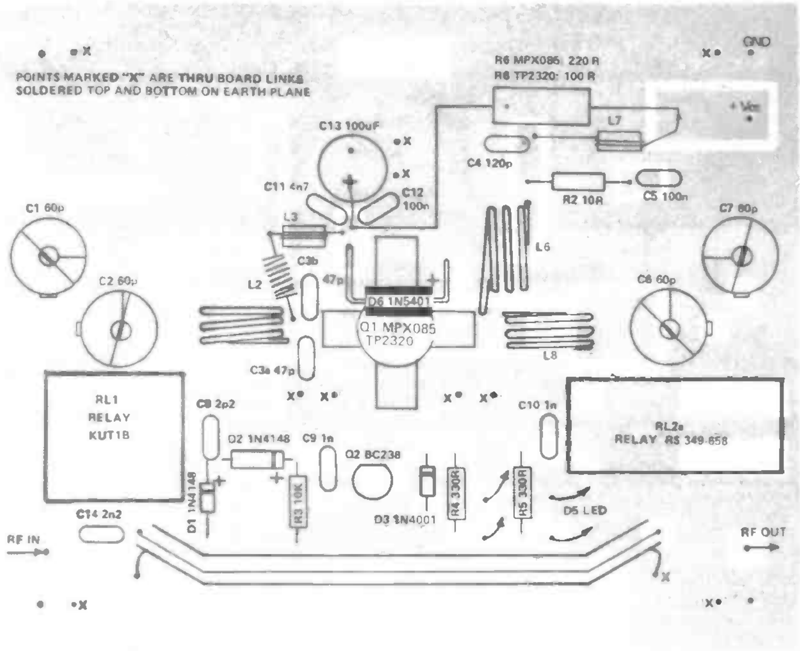
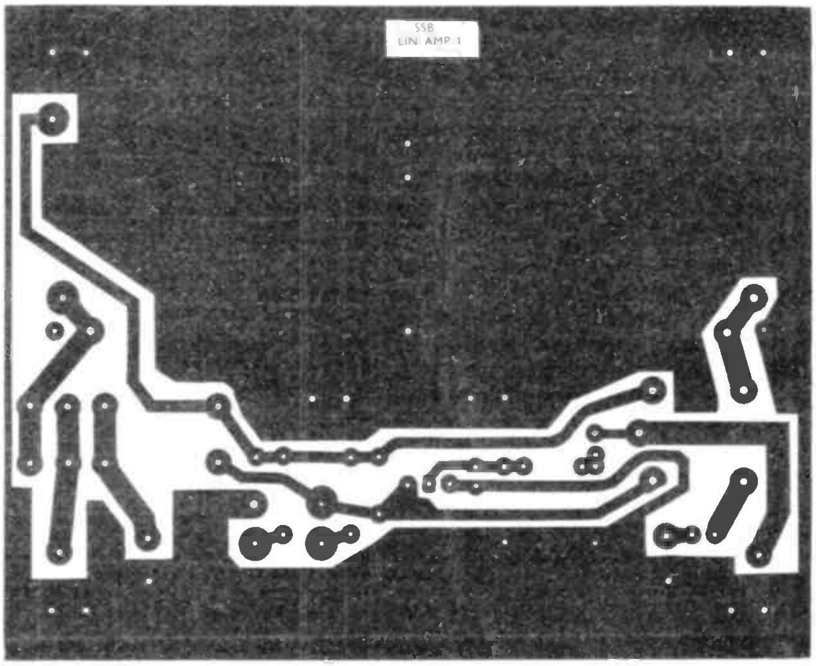
FEEDBACK

THE 2m PA: LINEARIZED VERSION.

Following the article in the December issue on the subject of a 15/20 W 2 m class C PA, here's a re-run with the class AB bits added on, plus a few more notes.....





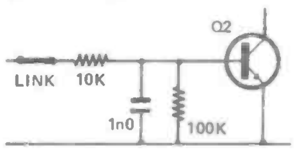
Powerful stuff.

The Timothy Edwards 2 m PA was designed just before the onslaught of the mulitmode portables for the 2 m amateur band. We included a footnote for a simple class A modification, but here's a revised layout with the class AB bits stuck down on the board.

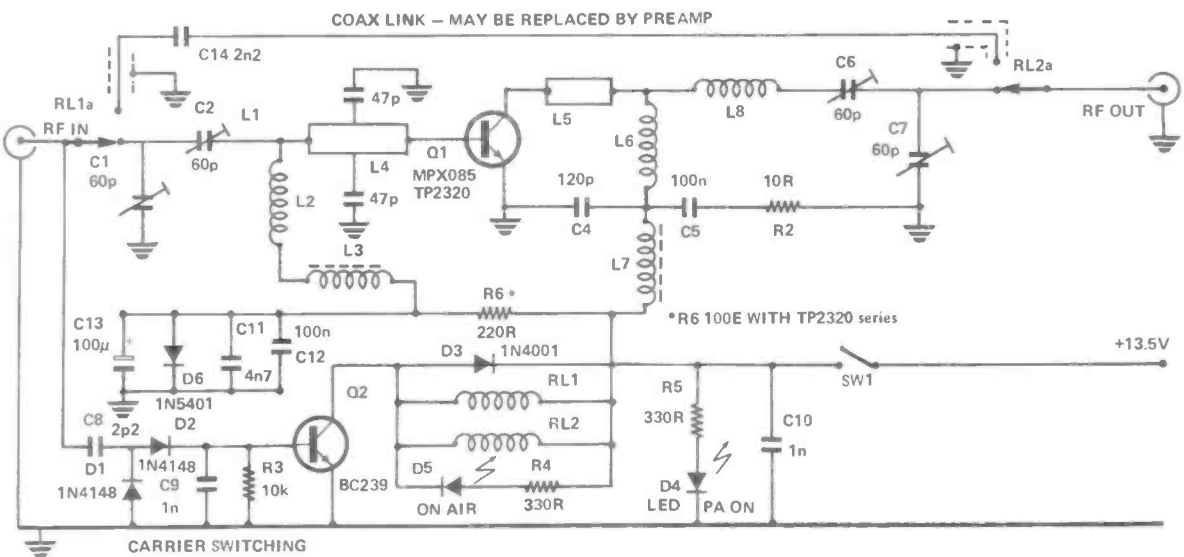
We have also uprated the output relay, since although originally intended for 20 W operation, it has been found that many units have been giving in excess of 25 W when used in conjunction with FT290's - and the output relay will gradually sag under the strain of getting overheated with this sort of power. In fact, unless you are careful, it is possible to get over 30 W out with this circuit when used with an FT290 fed from a car voltage supply that is on the generous' side. The unit will work quite happily at this power (relay permitting), but the safety margins built into the original design will be eroded, and destruction of the output transistor is made a good deal easier.

The new relay is a Magnetic Devices version, suitable for up to 40 W.

If you missed the December **R&EW**, we still have issues available from the subscription department, so we will bot be repeating the remainder of the article here.



FOR SSB OPERATION, DC FROM FT290 ANTENNA SOCKET CAN BE USED TO SWITCH DIRECTLY. C8 IS REPLACED BY LINK, D2 BY 10K, D1 OMITTED, R3 BY 100K



Heaven preserve us from Word Processors

December's feature on the 2 m power amplifier illustrated what happens when technology is permitted to rampage through the age old art of printing.

In view of the house policy of using 'Q' as our transistor abbreviation, some smart typesetter thought he would use the computer's facility for searching and replacing characters and/or character strings to swap 'TR' for 'Q'.....

Ahem, our apologies to messrs. TRW and Trio (TR2400)

2m converter - October

No mods to relate here, but a couple of points arising from experience in the field. The first concerns the fact that 3SK88 MOSFETs are rather good at UHF - if the converter is not fitted in an adequately screened box, the PC track on the input to mixer can behave as an effective 'antenna' for 512 MHz in the London area.

The interesting phenomenon can be confirmed by listening around 145.2 MHz, and if you are in range of London ITV, then you can short out just about any signal path up to and including the output of the Helical filter without affecting the pickup of the wideband FM signal. The confirmation of the nature of this pickup is available when you short out the input gate of the mixer to the top screen (the only really effective way to earth it), and it all disappears!

A lowpass filter on the converter input will help in extreme cases, and Mr Edwards is investigating a simple filter to place between the oscillator multiplier output and the input to the mixer. Watch for news.

Reports of much success with UOSAT reception have been received, and the general signal performance of the unit is living up to expectation.

Competition roundup

By the time this note appears, all outstanding competitions will have been closed. The response to the 'spot the mistake' competition in the AMSTRAD CB circuit has been quite an eye opener.

We have had over 100 entries to what was a well hidden and very minor paragraph - and the two 'main' errors in the circuit have been supplemented by one eagle eyed reader who spotted some five other 'lesser' ambiguities. The lesson we draw from all this is to invite a panel of **R&EW** readers to check all the **R&EW** proofs...

THE PHILIPS DMM competition has proved that it is difficult to get the readers off their terylene and worcestered backsides when a little work with a soldering iron is required. Despite a thin entry, there are one or two star entries in contention for the prize, and we would like to take a few inches here to reiterate the comments made concerning 'AVO' in the last issue.

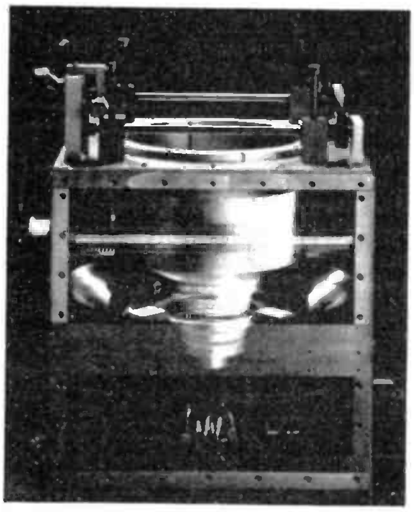
In reference to 'an AVO' we failed to take into account that although the term 'AVO' is often used in the electronics trade when referring to amp/volt/ohmmeters, 'AVO' is the registered trade mark of AVO Limited, who are anxious that the mark 'AVO' should not lose its identity by indiscriminate useage. In any event, our reference to AVO in the competition was not meant to cast any slight on the AVO range of products, and we apologise for any embarrassment this may have caused.

A brief glance through their current catalogue reveals a large range of sophisticated electronic instrumentation bearing the 'AVO' pedigree at surpisingly low prices - the 'standard' hand held 3.5 digit DMM costs only £56.50 (ex VAT). Circle No. 21 and we will pass your name onto AVO for more details.

Get in the loop

If you have any comments to make about **R&EW** features, then please let us hear them. It is extremely useful for us - and *you* - to support popular items in this way, since when the 'Mark II' versions appear, we should be able to keep everyone happy - from the user who lives within sight of a UHF TV transmitter mast, to those of you tucked away in the wilds of East Anglia, where scarcely a sniff of RF ventures through the ether. We will also be able to expand our 'register' of readers in 'difficult' areas, where perhaps we might send prototypes for examination under a variety of extreme conditions.

NEWS



Philips high-power tetrode

Gloeilampenfabrieken??

Philips (simply years ahead) announced some new valves recently.

The YL1610/YL1630 tetrodes offer 1 kW and 38 kW respectively, with 17 dB of gain at VHF TV frequencies (175-230 MHz). For those of you with trouble 'getting out', the YL1640 and YL1660 have 21 dB of gain with 125 kW and 520 kW respectively. In push-pull Class-B, this becomes 150 kW and 660 kW respectively.

Radio amateurs and CBers wishing to take advantage of these devices are advised to contact their local electricity board for an additional substation (or two) before plugging in.

Oh yes, the big word at the beginning. 'Gloeilampenfabrieken' means 'electric light bulb works' in Dutch. In recognition of its humble origins in such things, the mighty Philips still uses this quaint title.

DEC's 16 bit workhorse, with Spice

DEC have introduced a £300 (100 up US domestic price) 16 bit single board computer with 4 Kbytes of static RAM, and 32 Kbytes of EPROM. A 24 line parallel I/O, and 2 line serial I/O provide communication, together with an LSI-11 interface. (The board can run PDP-11 programs under MicroPower/Pascal.)

Nortek Inc (Portland, Oregon - home of Tektronix) has introduced a Forth-based operating system known as 'Spice' (available in EPROM) to support the Falcon. The versatility of Forth is combined with additional user friendliness, making the Falcon/Spice package a formidable solution to many problems that probably don't know they exist.

The Star of Compec

This month's star feature (the Z8 development board) was generously given some stand space by Zilog at this year's Compec show at Olympia. The moment the board display was screwed on the wall, the pile of descriptive leaflets disappeared - so we hope to be welcoming some new readers to this issue.

The instant appeal of this board helped to confirm the validity of **R&EW's** policy of relating computing features to 'real' applications - there wasn't much else of substance to excite the 'component level' computer user/freak on view - but then again, Compec isn't really that sort of show.

Robb Wilmot gets out the chopper (again)

1500 more ICL employees aren't any longer, if you see what we mean. Plymouth Grove in Manchester is closed, and 200 jobs go in the product development division of all places. ICL's Managing Director, Robb Wilmot, hopes these cuts will be the last.

Neve announce a digital mixer

With a sampling rate of 48 kHz or 44.1 kHz, Neve Elecronics of Cambridge have produced the first fully digital 48 channel mixing desk. Compatibility with analogue signals is provided, together with facilities for most proposed digital systems. Yours for £200,000 - but get in line, since the first production desk is scheduled for the BBC on OB operations.

Now about this request for £50 licence fee....

Information Technology Year - 1982

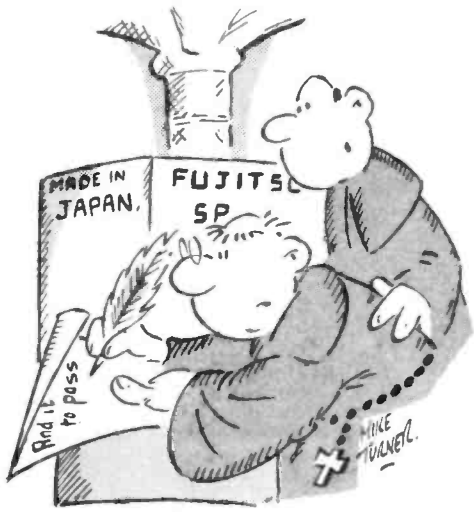
In order to try and emphasize their sudden discovery of the microelectronics industry, the government has wheeled in the political 'brasshats' to endorse Kenneth Baker's brainchild. The EEC's IT (information technology, you'll see a lot of this abbreviation during the year) supremo, Viscount Davignon was persuaded to leave his bridge for a moment, and come and talk to the National Economic Development Office about the most effective dispersal of resources to maximize benefits.

Curiously enough, the EEC has actually spent more on the promotion of MPU activities than Japan - although the greater concentration of Japanese effort in volume applications has resulted in the Japanese enjoying a 40% share of the world market. The lesson from all this seems to be that once a market has been identified, the Japanese go all out to exploit it. Us Europeans seem to place too much store by the technological niceties of interesting projects of minor commercial appeal.

Enemy at the door

Nippon Electric's plans to establish a $96 m VLSI manufacturing plant at Roseville, California are on target for Spring 1982 completion. The rest of the US semiconductor industry must view this move with understandable trepidation, as it offers NEC a foot in the door when there is talk of 'unfair' trading practices leading to a tighter control on electronic imports to the US.

The production of items, ranging from 64 k DRAMs to microcomputer, is aimed to be $140+ m a year, based on some 36 million LSI units.



"I'M AFRAID THERE'S BAD NEWS BROTHER PAUL.."

Daisywheel print speed in the 80's

Fujitsu's SP830 'GT' daisywheel printer flashes past the paper at 80cps. Servo positioning and a high speed hammer contribute to this significant acceleration in daisywheel technology.

NB. Users of Diablo and Qume printers may like to learn from **R&EW's** experience that the Prestige Elite 12 pitch typewheel seems to outlive virtually all other type styles. The popular Pica 10 and Courier 10 typewheels are particularly short lived in our Spint 5 machine. Reports on Spinwriter lifespan will follow when we've had it long enough for trends to emerge.

" LESSON ONE.. WHEN IN BRITAIN NEGOTIATE AS THE BRITISH DO..

Pass the Monkey

The somewhat incongruously named 'Electrical Electronic Telecommunications and Plumbing Union' denies having signed a no-strike agreement with Toshiba. The arrangement in question is simply a conciliation procedure.

★ ★ ★ ★ ★ ★ ★ ★ ★ ★

The World comes to Acton.

WE are pleased to announce the opening of a **'World of Radio and Electronics'** component shop - at 102 Churchfield Road, Acton, West London - just off the High Street. Many of the items covered in the **WR&E** catalogue are available, and those that are not yet included in the shop stock can be obtained in a couple of days.

We are very aware of the preference of many people to buy over the counter, rather than trust to the vagueries of the Post Office, so we hope that many of you will take the opportunity to call in. Parking is available nearby - with various services from London Transport and British Rail within easy range.

Bernie Jordan will be pleased to serve both trade and enthusiast customers, and he will be listening out for your likes and dislikes so that we can continue to expand the content of both **R&EW** and **WR&E** along the lines that suit you. More news next month.

★ ★ ★ ★ ★ ★ ★ ★

Sanyo broadens its base

Yet another bastion of UK consumer electronics has come under the control of a Japanese company. This time it's the turn of Philips' Lowestoft factory.

Sanyo estimate that 400 workers will be turning out 60,000 colour TV sets a year, on a 24 acre site which Philips were apparently unable to operate sufficiently viably to warrant its retention.

Government assistance (i.e. taxpayers' money) is reported to be available for the project.

New Japan Radio ICs.

The joint IC manufacturing venture between Japan Radio and Raytheon is about to be brought to the export market via Raytheon's sales network. The aim is for NJR to export about 20% of its production, which comprises a rather more interesting selection of linear devices than the usual bland range of 16 k DRAMs, EPROMs etc.

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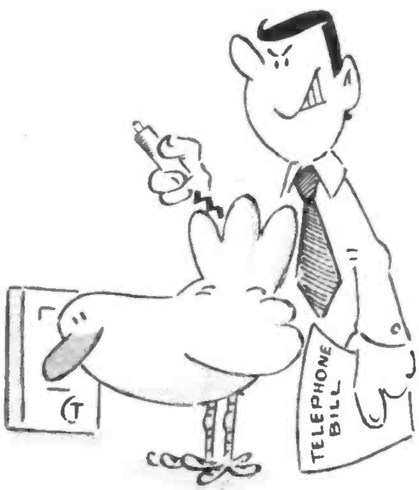
National and Motorola exterminate standard LPSN

The announcement of a family of silicon gate logic parts to update the old 74C image could easily wipe out standard LPSN and CMOS logic families. For only 15% extra cost, you get LPSN speed with CMOS power consumption - there will be a further feature on this very significant new family of devices in an early issue.



Telecom plugs in

British Telecom (nee Post Office) has announced a new style of phone plug to replace the quarter inch jackplug. The idea is to exploit moulded connector technology with a shuttered outlet (not too easy with a jack plug format), and to present a new and arguably superior standard for the rest of the world.

Up the (semiconductor) Junction...

The long running high technology soap opera at Inmos closes another episode with the departure of co-founder Dr Paul Schroeder in what is described as a 'bitter' parting on October 9th. Now that Inmos is actually in the process of confounding some of its initial critics with some very clever and successful products, it seems a shame that the man broadly responsible for assembling the technical brains of the operation should be departing.

VTR indicators still healthy

Ten of the members of the giant magnetic materials group TDK, are expecting to top $95 m for the current year, largely as a result of the boom in VTR production. TDK produces most of the ferrite materials for coils and heads, as well as other types of transformer, and capacitors. Plus, of course, tapes themselves. 1979 sales were $57 m, followed by $83 m in 1980. Doubtless the CBI will join with us in wishing them every good fortune for the future?

Toshiba to sort out Buzby?

Toshiba's latest mail sorting machinery can handle just about anything - even mixers of handwritten and typed postal codings present no problems. One of the keys to its success is the use of a red box on handwritten envelopes where the well disciplined Japanese are encouraged to write the postcode -but the fact that this machine can handle Japanese characters is quite a feat in itself.

27,000 pieces of general mail - or 36,000 postcards - can be handled per hour, and the machine is fitted with a terminal to collate the statistical analysis of the sorting operations. The machine is specifically designed to handle 'arrival sorting' as well as 'despatch sorting'.

Computer cooperative

President Mitterand has decided to establish a centre in Paris for the development of a 'pocket sized' microcomputer 'that can be used by anybody'. Whilst the president's heart is in the right place this sort of pronouncement seems about as realistic as a request from the Pope for there to be less sin in the world. Funding is set around £10m a year.

" .. AND HE FEELS YOU'RE JUST THE MAN TO DESIGN IT... "

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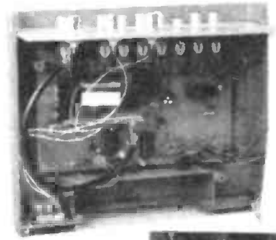

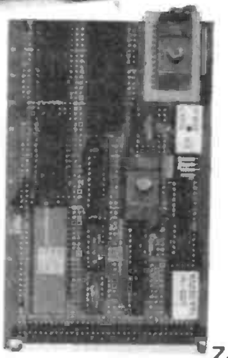

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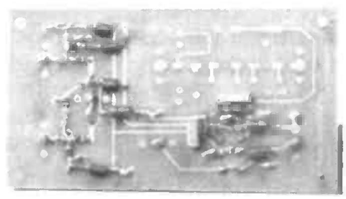

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Data File No.3

As a direct follow-up to last month's 'Data File', Ray Marston takes a further look at square wave or 'clock' generator circuits, but this time devotes the 'File' entirely to CMOS-based designs.

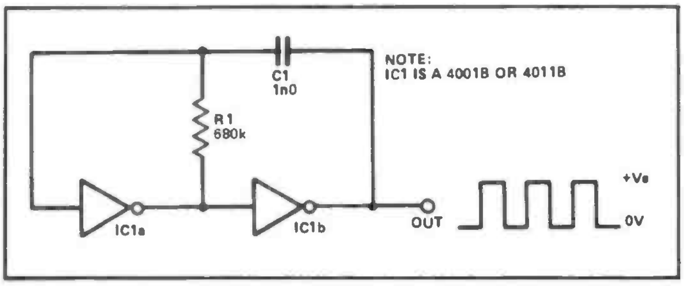

Figure 1a: Circuit of the basic '2-gate' CMOS astable. The circuit operates at 1 kHz with the component values shown.

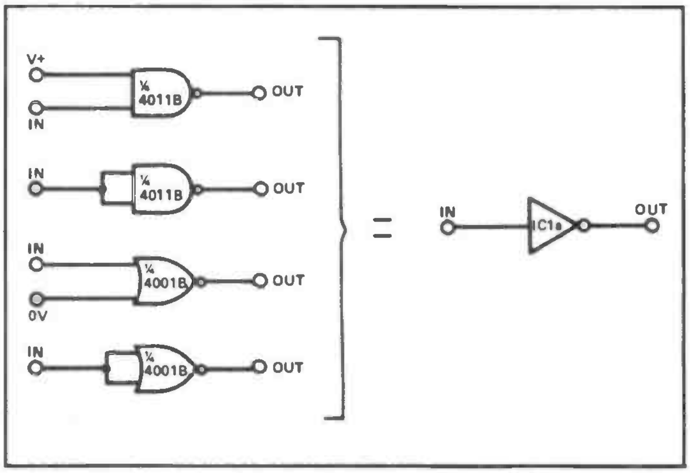

Figure 1b: Ways of connecting a 2-input NAND (4011B) or NOR (4001B) gate for use as an inverter.

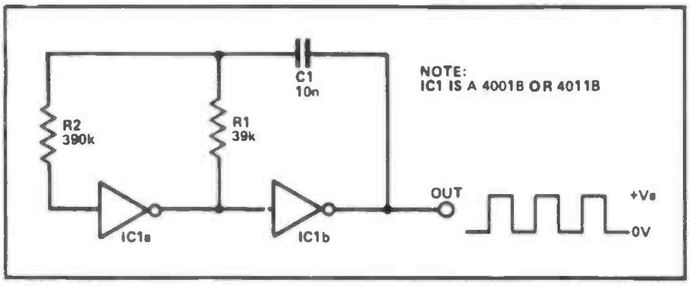

Figure 2: This 'compensated' version of the 1 kHz astable has excellent frequency stability with variations in supply voltage.

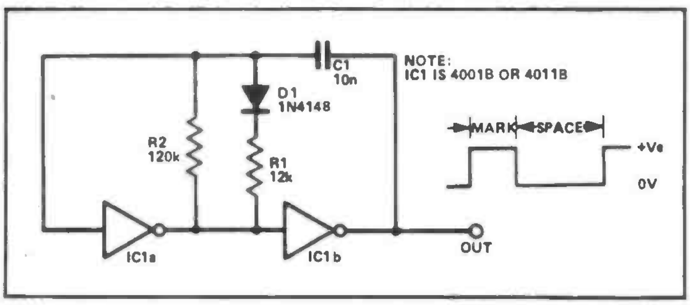

Figure 3: Modifying the astable to give a non-symmetrical output: MARK is controlled by the parallel values of R1 and R2: SPACE is controlled by R2 only.

INEXPENSIVE CMOS LOGIC ICs such as the 4001B and the 4011B can easily be used to make very inexpensive but highly versatile square-wave or 'clock' generator circuits. They can be designed to give symmetrical or non-symmetrical outputs, and can be of the free-running or the gated types; in the latter case, they can be designed to turn on with either logic 0 or logic 1 gate signals, and to give either a logic 0 or a logic 1 output when in the 'off' mode. You can even use these 'cheapo' circuits as simple voltage controlled oscillators (VCOs) or as frequency modulated oscillators.

If you want really good VCO operation from a square wave generator, with excellent linearity and versatility, you can turn to the slightly more expensive 4046B CMOS IC. We'll look at some applications of this chip later in this edition of 'Data File'. Let's start the 'File', however, by looking at some basic 2-gate CMOS square wave generator or astable circuits.

BASIC 2-GATE ASTABLE CIRCUITS

The simplest way to make a CMOS astable circuit is to wire two CMOS inverter stages in series and use the C-R feedback network shown in *Fig 1a*. This circuit generates a decent square wave output and operates at about 1 kHz with the component values shown. The frequency is inversely proportional to the C-R time constant, so can be raised by lowering the values of either C1 or R1. C1 must be a non-polarized capacitor and can have any value from a few tens of pF to several uF, and R1 can have any value from about 4k7 to 22M; the operating frequency can vary from a fraction of a Hz to about 1 MHz. For variable frequency operation, wire a fixed and a variable resistor in series in the R1 position.

Note at this point that each of the 'inverter' stages of the *Fig 1a* circuit can be made from a single gate of a 4001B quad 2-input NOR gate or a 4011B quad 2-input NAND gate by using the connections shown in *Fig 1b*. Thus, each of these ICs can provide two astable circuits. Also note that the inputs to all unused gates in these ICs must be tied to one or other of the supply-line terminals: The *Fig 1a* astable (and all other astables shown in this feature) can be used with any supplies in the range 3 to 18 V; the 'zero volts' terminal goes to pin 7 of the 4001B or 4011B, and the '+ve' terminal goes to pin 14.

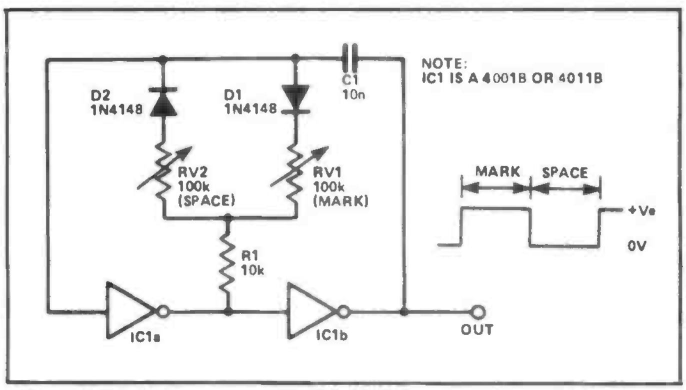

Figure 4: This astable has independently variable MARK and SPACE times. ▶

Data File

The output of the *Fig 1b* astable circuit switches (when lightly loaded) almost fully between the zero and positive supply rail values, but the C1-R1 junction is prevented from swinging below zero or above the positive rail levels by built-in clamping diodes at the input of IC1a. This characteristic causes the operating frequency of the circuit to be somewhat dependent on supply rail voltage: Typically, the frequency falls by about 0.8% for a 10% rise in supply voltage; if the frequency is normalised with a 10 V supply, the frequency falls by 4% at 15 V or rises by 8% at 5 V.

Also, the operating frequency of the *Fig 1a* circuit is influenced by the 'transfer voltage' value of the individual IC1a gate that is used in the astable and can be expected to vary by as much as 10% between individual ICs. The output symmetry of the waveform also depends on the 'transfer voltage' value of the IC and, in most cases, the circuit will give a non-symmetrical output. In most 'hobby' or other non-precision applications, these defects of the basic astable circuit are of little practical importance.

Some of the defects of the *Fig 1a* circuit can be minimised by using the 'compensated' astable of *Fig 2*, in which R2 is wired in series with the input of IC1a. This resistor must have a value that is large relative to R1, and its main purpose is to allow the C1-R1 junction to swing freely below the zero and above the positive supply rail voltages during circuit operation and thus improve the frequency-stability of the circuit: Typically, when R2 is ten times the value of R1, the frequency varies by only 0.5% when the supply voltage is varied between 5 and 15 volts. An incidental benefit of R2 is that it gives a slight improvement in the symmetry of the output of the astable.

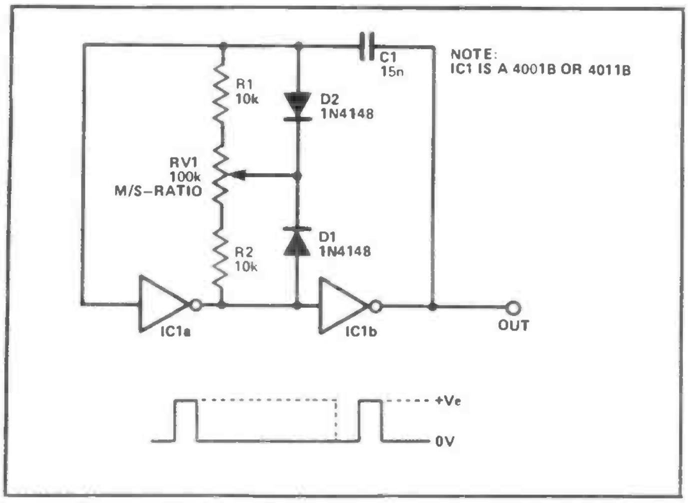

Figure 5: The mark/space ratio of this astable if fully variable from 1:11 to 11:1 via RV1; frequency is almost constant about 1 kHz.

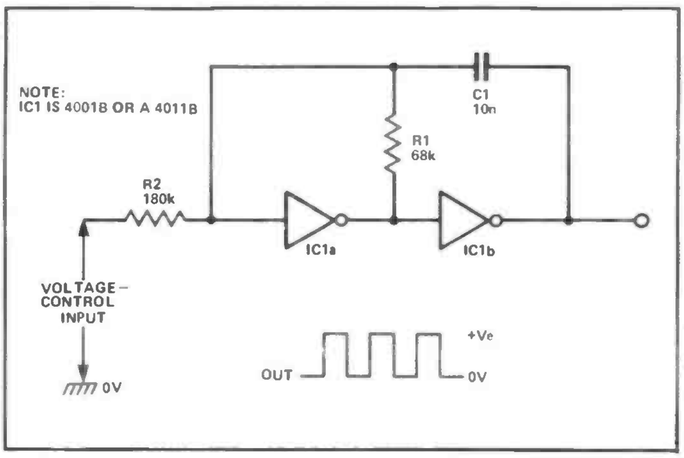

Figure 6: Simple VCO circuit.

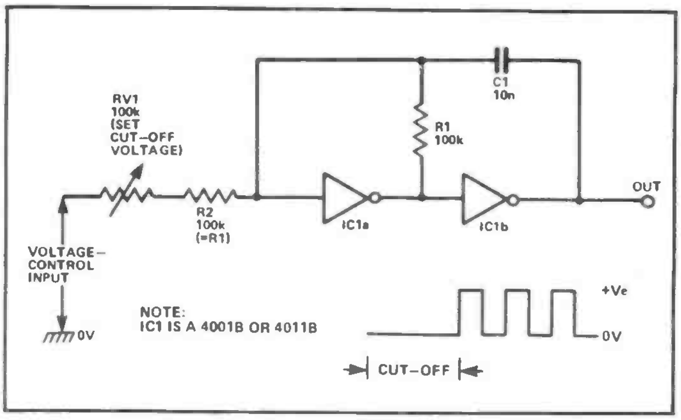

Figure 7: Special-effects VCO which cuts off when V_{IN} falls below a pre-set value.

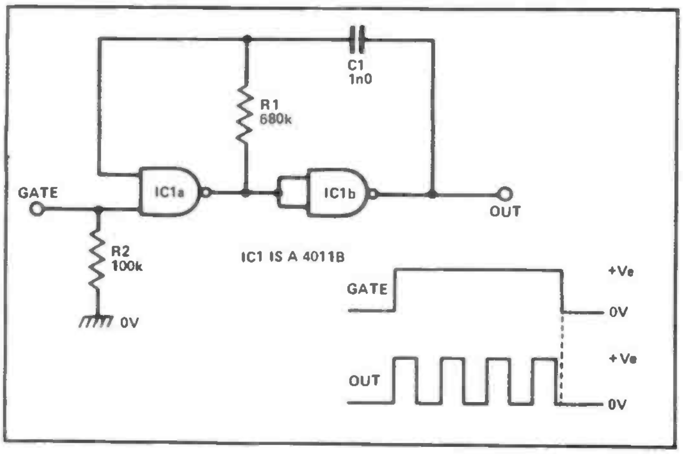

Figure 8: This gated astable has a normally low output and is gated on by a high (logic 1) input.

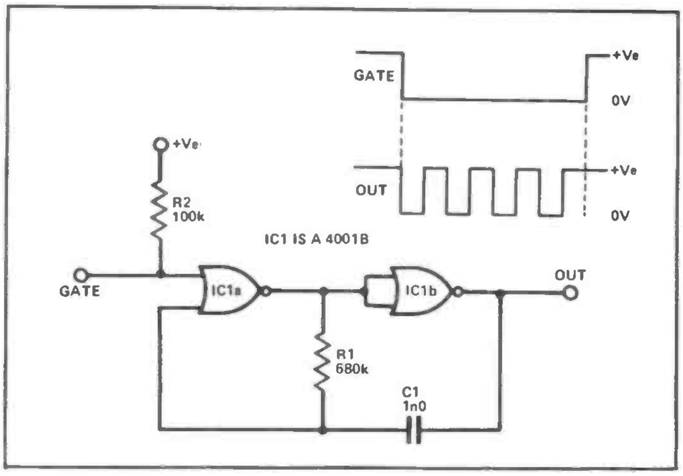

Figure 9: This version of the gated astable has a normally high output and is gated by a low (logic 0) input.

The basic and compensated astable circuits of *Figs 1 and 2* can be built with a good number of detail variations, as shown in *Figs 3 to 6*. In the basic astable circuit, for example, C1 alternately charges and discharges via R1 and thus has a fixed symmetry: *Figs 3 to 5* show how the basic circuit can be modified to give alternate C1 charge and discharge paths and to thus allow the symmetry to be varied at will.

The *Fig 3* circuit is useful if you need a highly non-symmetrical waveform, equivalent to a fixed pulse delivered at a fixed 'time base' rate. Here C1 charges in one direction via R2 in parallel with the D1-R1 combination, to generate the MARK or pulse part of

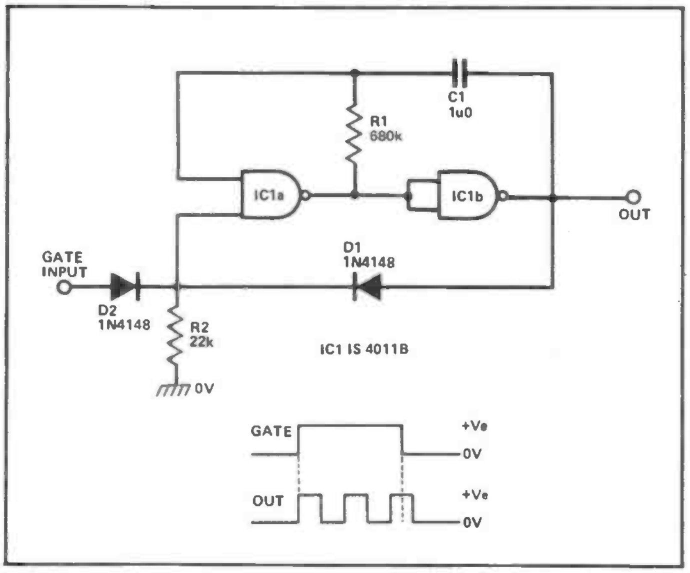

Figure 10: Semi-latching or 'noiseless' gated astable circuit, with logic 1 gate input and normally-zero output.

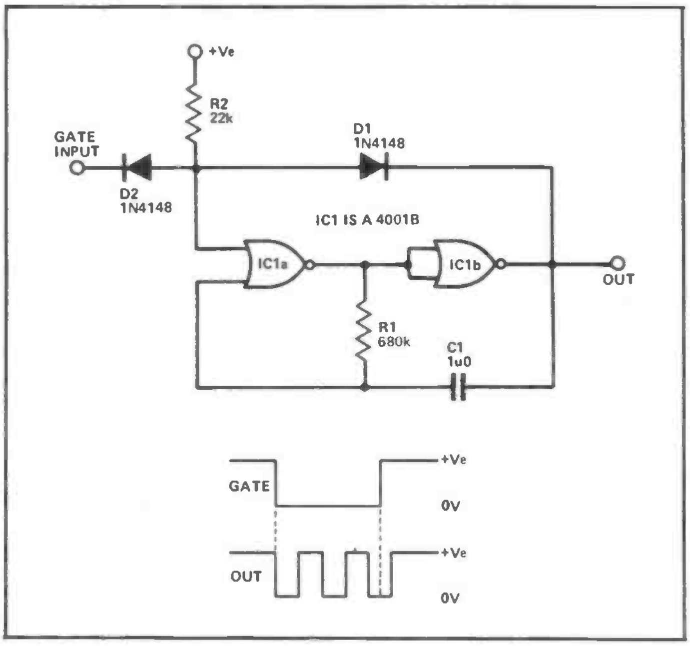

Figure 11: Alternative semi-latching gated astable, with logic 0 gate input and normally high output.

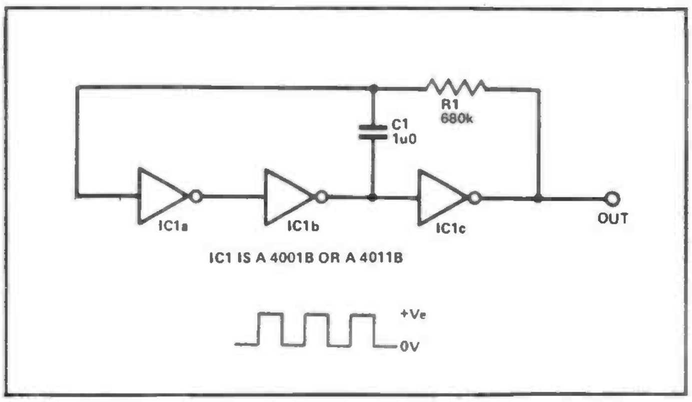

Figure 12: This 'ring-of-three' astable makes an excellent clock generator.

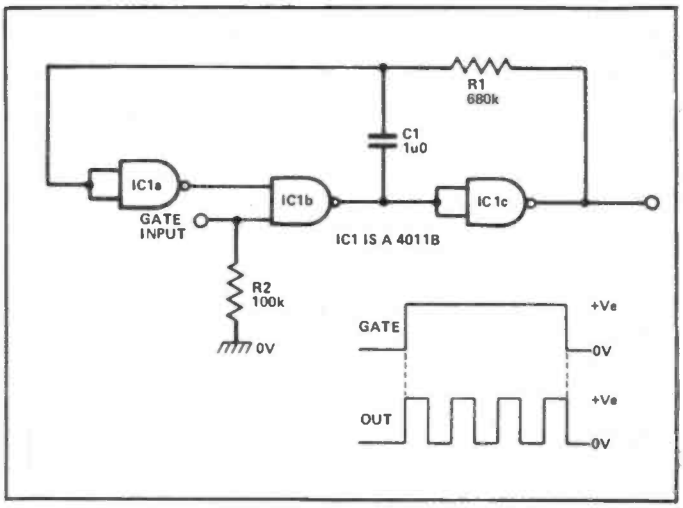

Figure 13: This gated 'ring-of-three' astable is gated by a logic 1 input and has a normally low output.

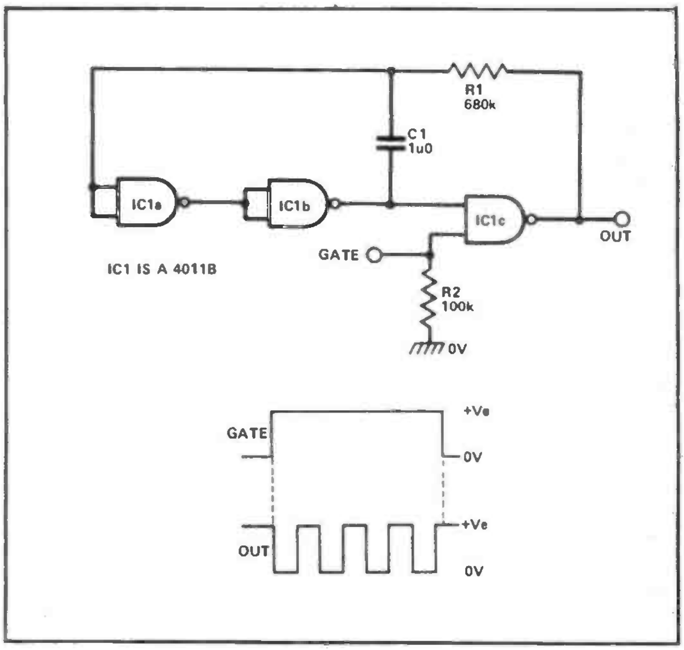

Figure 14: This gated 'ring-of-three' astable is gated by a logic 1 input and has a normally high output.

the waveform, but discharges in the reverse direction via R2 only, to give the SPACE between the pulses.

Figure 4 shows the modifications for generating a waveform with independently variable MARK and SPACE times; the MARK time is controlled by R1-RV1-D1, and the SPACE time is controlled by R1-RV2-D2.

Figure 5 shows the modifications to give a variable symmetry or mark/space ratio output while maintaining a near-constant frequency. Here, C1 charges in one direction via D2 and the lower half of RV1 and R2, and in the other direction via D1 and the upper half of RV1 and R1. The M/S ratio can be varied over the range 1:11 to 11:1 via RV1.

Finally, *Figs 6 and 7* show a couple of ways of using the basic astable circuit as a very simple VCO. The *Fig 6* circuit can be used to vary the operating frequency over a limited range via an external voltage. R2 must be at least twice as large as R1 for satisfactory operation, the actual value depending on the required frequency-shift range: A 'low' R2 value gives a large frequency-shift range, and a 'large' R2 value gives a small frequency-shift range. The *Fig 7* circuit acts as a special-effects VCO in which the oscillator frequency rises with input voltage, but switches off ▶

completely when the input voltage falls below a value pre-set by RV1.

GATED ASTABLE CIRCUITS

All of the astable circuits of *Figs 1 to 5* can be modified for gated operation, so that they can be turned on and off via an external signal, by simply using a 2-input NAND (4011B) or NOR (4001B) gate in place of the inverter in the IC1a position and by applying the input gate control signal to one of the gate input terminals. Note, however, that the 4001B and the 4011B give quite different types of gate control and output operation in these applications, as shown by the two basic versions of the gated astable in *Figs 8 and 9*.

Note specifically from these two circuits that the NAND version is gated on by a logic 1 input and has a normally low output, while the NOR version is gated on by a logic 0 input and has a normally high output: R2 can be eliminated from these circuits if the gate drive is direct coupled from the output of the preceedng CMOS logic stage, etc.

Note in the basic gated astable circuits of *Figs 8 and 9* that the output signal terminates as soon as the gate drive signal is removed; consequently, any noise present at the gate terminal also appears at the outputs of these circuits. *Figs 10 and 11* show how to modify the circuits to overcome this defect. Here, the gate signal of IC1a is derived from both the outside world and from the output of IC1b via diode OR gate D1-D2-R2. As soon as the circuit is gated from the outside world via D2 the output of IC1b reinforces or self-latches the gating via D1 for the duration of one half astable cycle, thus eliminating any effects of a noisy outside world gate signal: The outputs of the 'semi-latching' gated astable circuits are thus always complete numbers of half cycles.

'RING OF THREE' CLOCK-GENERATOR CIRCUITS

The 2-gate astable circuit is not generally suitable for direct use as a 'clock' generator with fast-acting counting and dividing circuits, since it tends to pick up and amplify any supply line noise during the 'transitioning' parts of its operating cycle and to thus produce square waves with 'glitchy' leading and trailing edges. A far better type of clock generator circuit is the 'ring of three' astable shown in *Fig 12*.

The *Fig 12* 'ring of three' circuit is similar to the basic 2-gate astable, except that its 'input' stage (IC1a-IC1b) acts as an ultra-high-gain non-inverting amplifier and its main timing components (C1-R1) are transposed (relative to the 2-gate astable). Because of the very high overall gain of the circuit, it produces an excellent and glitch-free square wave output, ideal for clock-generator use.

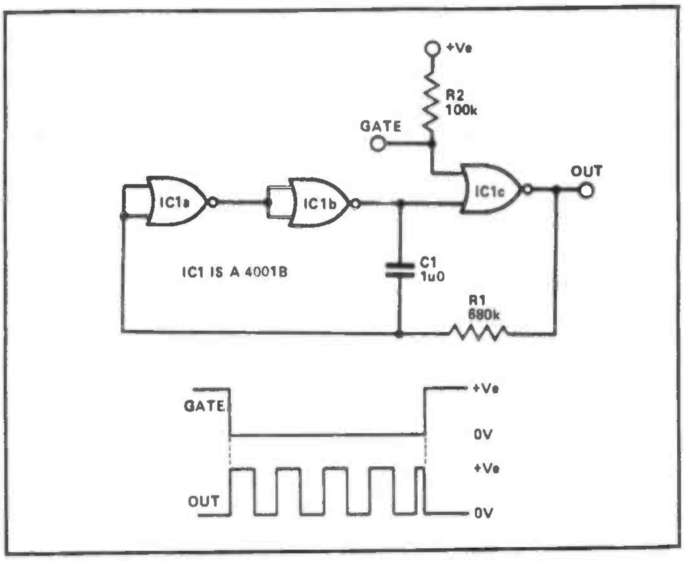

Figure 15: This gated 'ring-of-three' astable is gated by a logic 0 input and has a normally low output.

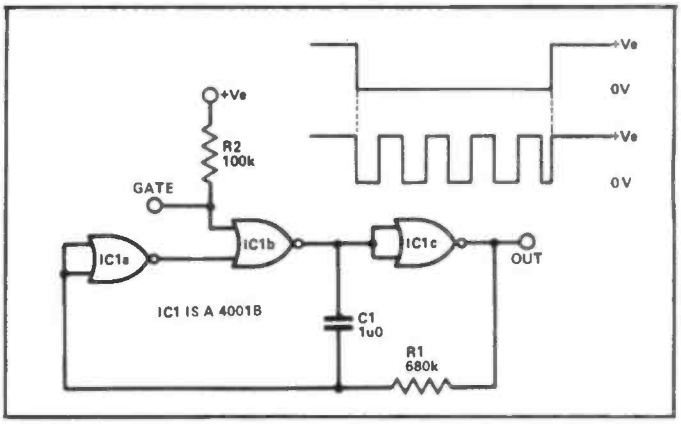

Figure 16: This gated 'ring-of-three' astable is gated by a logic 0 input and has a normally high output.

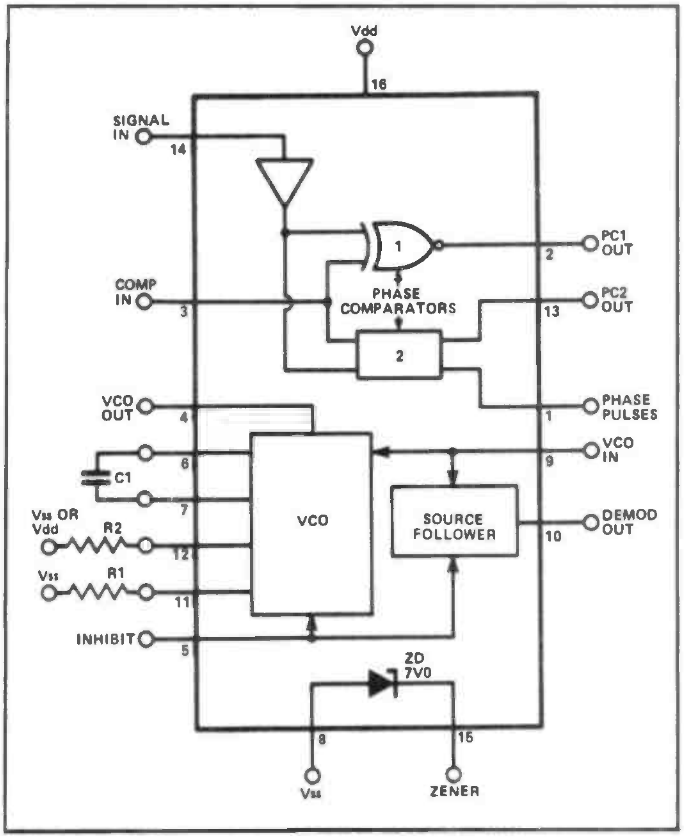

Figure 17: Internal block diagram and pin-outs of the 4046B.

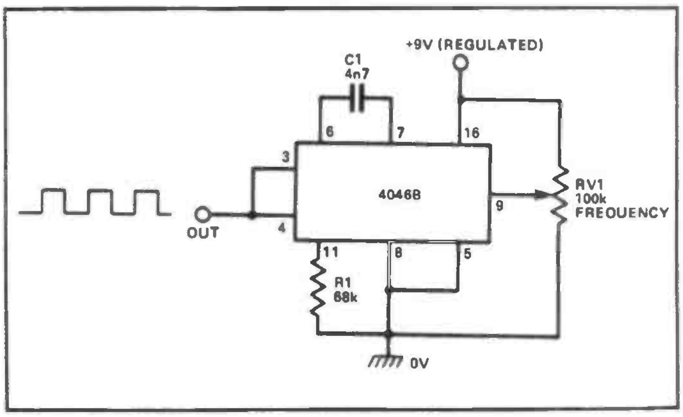

Figure 18: Basic wide-range VCO, spanning near zero to roughly

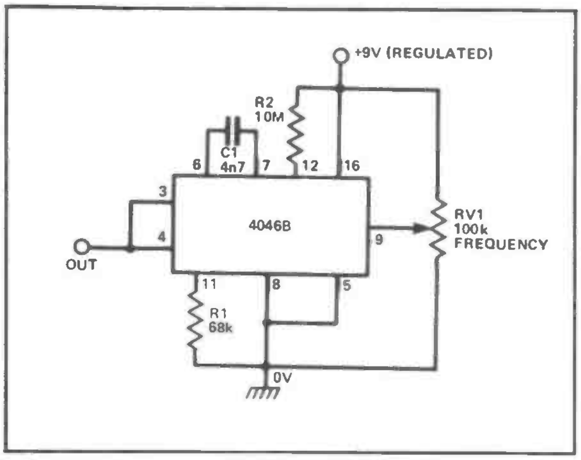

Figure 19: The frequency of this VCO is variable all the way down to zero.

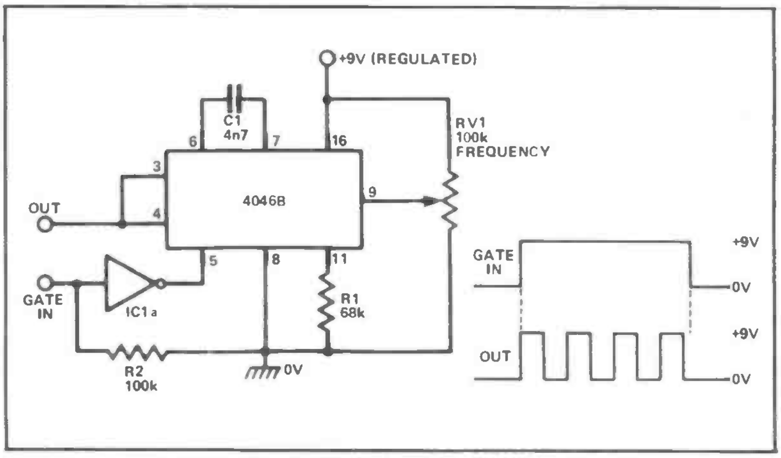

Figure 22: Gated wide-range VCO, using an external gate inverter.

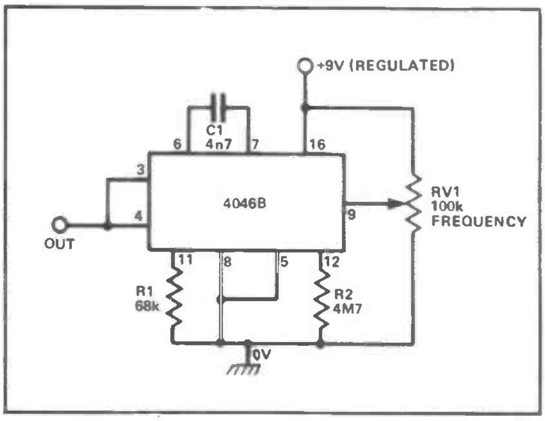

Figure 20: Restricted range VCO, with frequency variable from roughly 72 Hz to 5 kHz via RV1.

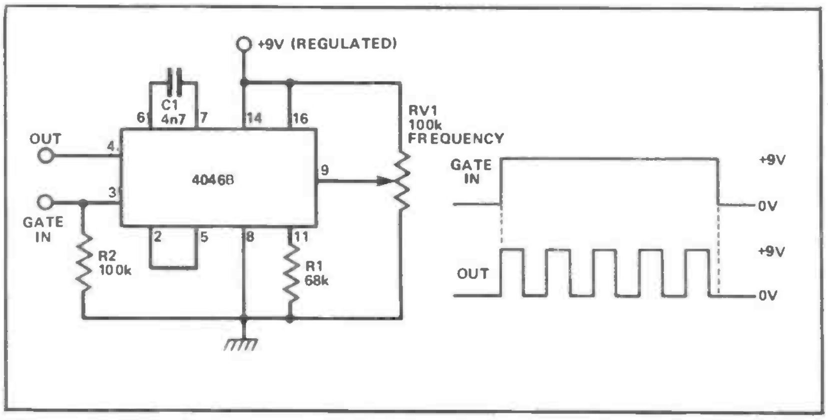

Figure 23: Gated wide-range VCO, using one of the internal phase comparators as a gate inverter.

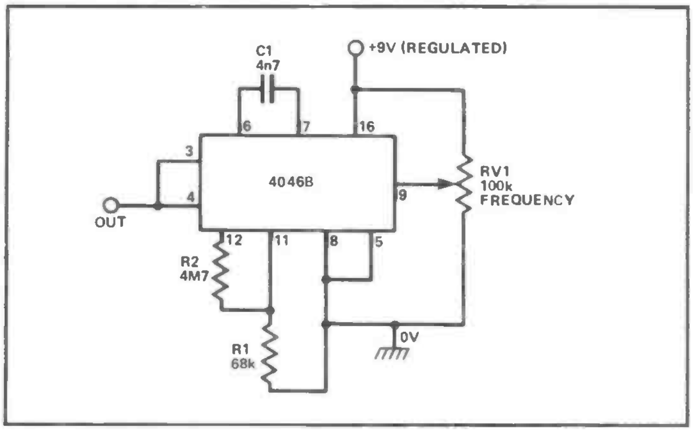

Figure 21: Alternative version of the restricted range VCO: f_{max} is controlled by C1-R1, f_{min} by C1 - (R1 + R2).

The basic ring-of-three astable can be subjected to all the design modifications that we've already looked at for the basic 2-gate astable, e.g. it can be used in either basic or compensated form and can give either a symmetrical or non-symmetrical output, etc. The most interesting variations of the circuit occur, however, when it is used in the 'gated' mode, since it can be gated via either the IC1b or IC1c stages. *Figs 13 to 16* show four variations on this 'gating' theme.

Thus, the *Fig 13 and 14* circuits are both gated on by a logic 1 input signal, but the *Fig 13* circuit has a normally low output, while that of *Fig 14* is normally high. Similarly, the *Fig 15 and 16* circuits are both gated on by a logic 0 signal, but the output of the *Fig 15* circuit is normally low, while that of *Fig 16* is normally high.

4046B VCO CIRCUITS

To close this look at CMOS square wave generator circuits, let's look at some practical VCO applications of the 4046B phase-locked loop (PLL) IC. *Fig 17* shows the internal block diagram and pin-outs of this chip, which contains a couple of phase comparators, a VCO, a zener diode and a few other bits and pieces.

For our present purpose, the most important part of the chip is the VCO section. This VCO is a highly versatile device: It produces a well-shaped symmetrical square wave output, has a top-end frequency limit in excess of 1 MHz, has a voltage-to-frequency linearity of about 1% and can easily be 'scanned' through a 1 000 000:1 range by an external voltage applied to the VCO input terminal. The frequency of the oscillator is governed by the value of a capacitor (minimum value 50pF) connected between pins 6 and 7, by the value of a resistor (minimum value 10k) wired between pin 11 and ground, and by the voltage (any value from zero to the supply voltage in use) applied to VCO input pin 9.

Figure 18 shows the simplest possible way of using the 4046B VCO as a voltage controlled square wave generator. Here, C1-R1 determine the maximum frequency that can be obtained (with the pin 9 voltage at maximum) and RV1 controls the actual frequency by applying a control voltage to pin 9: The frequency falls to a very low value (a fraction of a Hz) with pin 9 at zero volts. The effective voltage-control range of pin 9 varies from roughly 1 V below the supply value to about 1 V above zero, and gives a frequency span of about 1 000 000:1. Ideally, the supply voltage to the circuit should be regulated.

We've said above that the frequency of the *Fig 18* circuit falls to near-zero when the input voltage is reduced to zero. *Fig 19* ▶

Data File

Continued from previous page.

shows how the circuit can be modified so that the frequency falls all the way to zero with zero input, by wiring a high value resistor (R2) between pins 12 and 16. Note here that, when the frequency is reduced to zero, the VCO output randomly settles in either a logic 0 or a logic 1 state.

Figure 20 shows how the pin 12 resistor can alternatively be used to determine the minimum operating frequency of a restricted-range VCO. Here, f_{min} is determined by C1-R1 and f_{max} is determined by C1 and the parallel resistance of R1 and R2.

Figure 21 shows an alternative version of the restricted range VCO, in which f_{max} is controlled by C1-R1 and f_{min} is determined by C1 and the series combination of R1 and R2. Note that, by suitable choice of the R1 and R2 values, the circuit can be made to 'span' any desired frequency range from 1:1 to near-infinity.

Finally, it should be noted that the VCO section of the 4046B can be disabled by taking pin 5 of the package high (to logic 1 level) or enabled by taking pin 5 low. This feature makes it possible to gate the VCO on and off by external signals. Thus, *Fig 22* shows how the basic VCO circuit can be gated via a signal applied to an external inverter stage. Alternative, *Fig 23* shows how one of the internal phase comparators of the 4046B can be used to provide gate inversion, so that the VCO can be gated via an external voltage applied to pin 3. ■ R & EW

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R&EW TV PATTERN GENERATOR

R&EW TV Pattern Generator
continued from page 59

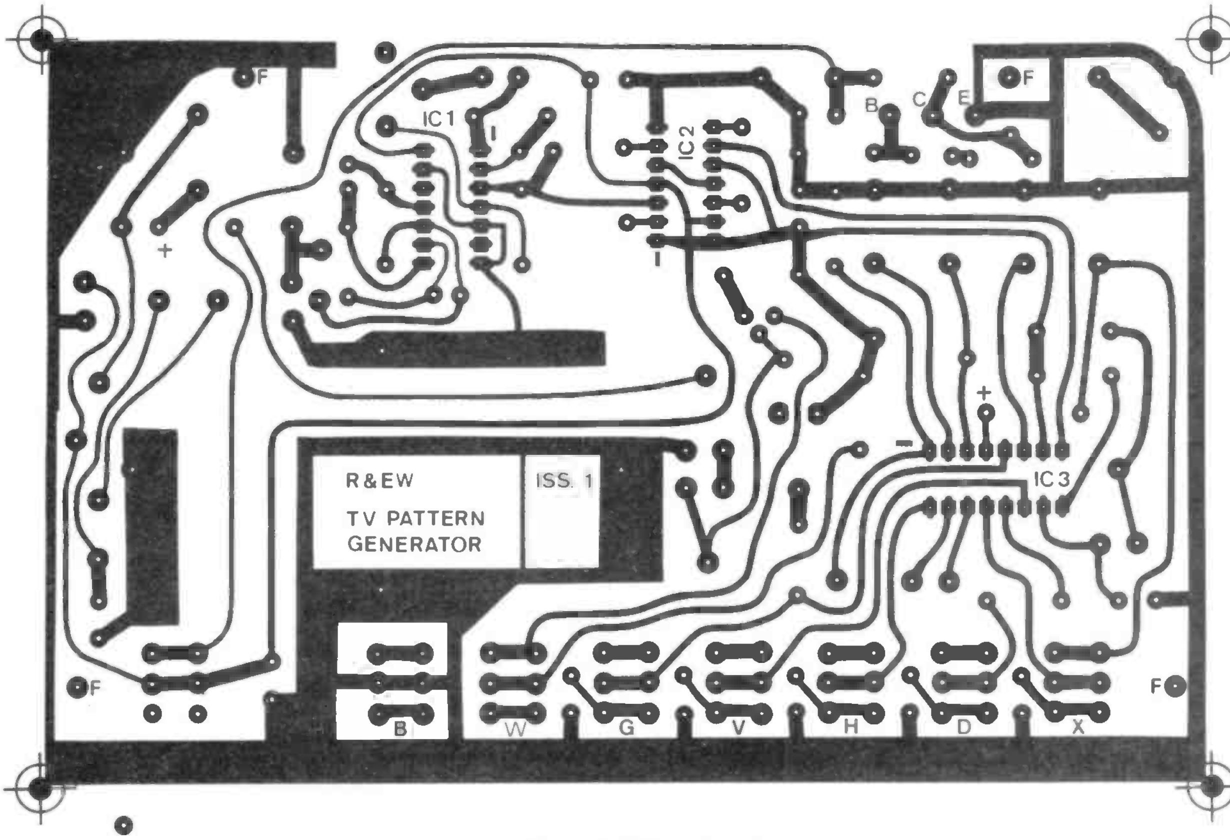
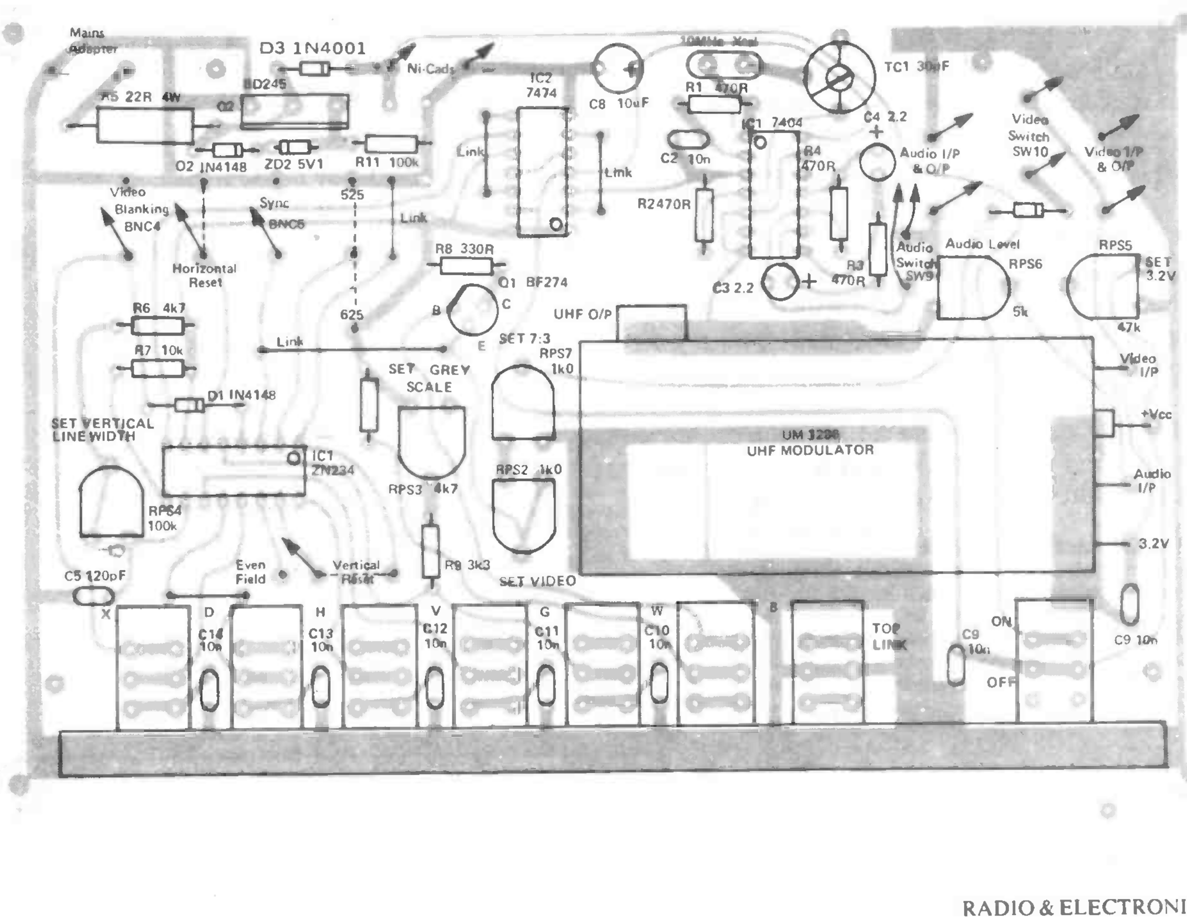


Figure 4: PCB and overlays.



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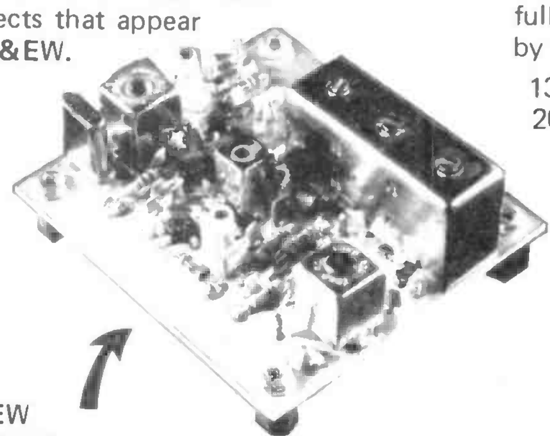

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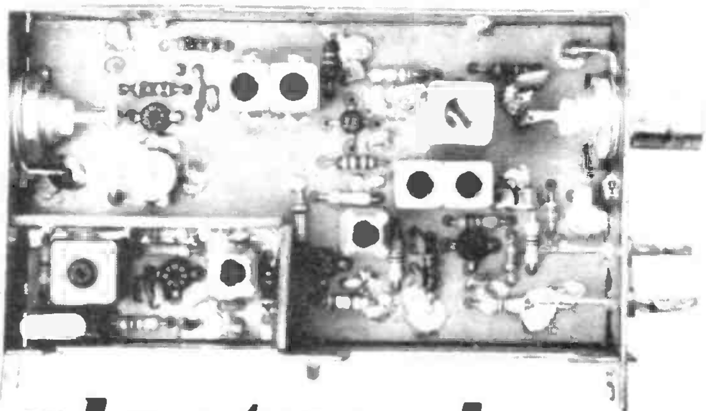

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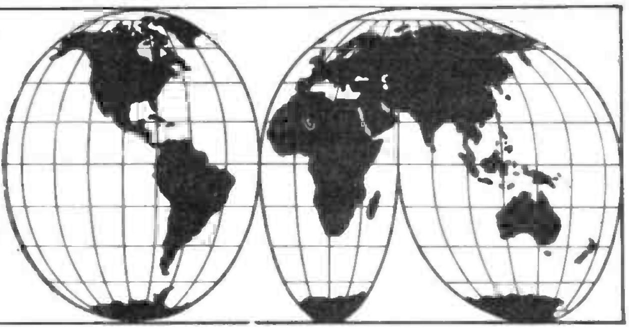
SHORT WAVE NEWS FOR DX LISTENERS

Frank A. Baldwin



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

Low powered transmitters in small provincial towns which are regional centres located deep in the tropical forests of Laos are the 'target areas' for many dyed-in-the-wool Dxers at this time of the year. Right now is the season for the reception of these stations - if you are lucky enough!

The best times to listen for these stations are around 2300 and 1330, in that order of preference - you are more likely to succeed at 2300.

Laos

Following up on the details given in the last issue of this journal, further information is provided as follows:

Savannakhet on **7384** with the Domestic Service in Laotian from 2230 to 0030, 0430 to 0530 and from 1100 to 1400 with a power of 3 kW.

Udomsai on **6850** with the Domestic Service in Laotian from 2300 to 0100 and from 1000 to 1400. This one is not currently listed but information from Laos has been sparse to say the least and not always complete, although things are slowly improving.

Xieng Khouang on **5602** and **7183** with the Domestic Service in Laotian, and Lao Soung from 2300 to 0100 (Sundays until 0130), 0400 to 0600 and from 1000 to 1400, with a power of 1 kW.

The announcement of identification from a regional station is 'Thini Withayu kachai siang heng Sat Xieng Khouang' (for example) and the interval signal from Vientiane (see last issue) is that of a Khene, a type of mouth organ, and a Solo, a bamboo pipe instrument.

The address for reports is National Radio of Laos, Box Postale 310, Vientiane; and I wish you all the luck in the world -you'll most certainly need it if you are to successfully terminate your Quest for Laos.

AROUND THE DIAL

In which are presented some of the transmissions recently logged, being of some interest both to the SWL and the Dxer. All details are correct at the time of writing.

Afghanistan

Radio Afghanistan, Kabul (at least according to the station identification) on **7280** at 1910, OM (Old Man-male announcer) with a commentary all about Israel and the West Bank in the English programme intended for European consumption and scheduled from 1900 to 1930 on this channel. Into a programme of local-style music at 1914 followed by station identification and announcements at 1915. This transmitter is almost certainly located in the USSR.

Saudi Arabia

Riyadh on **15060** at 0525, OM with a talk in Turkish presumably about internal affairs in Turkey according to the place-names used. This is the External Service, the Turkish programme being timed from 0400 to 0600. A programme in English is listed from 1100 to 1300 on this frequency and from 1800 to 2100 on **11855**. On Thursdays and Fridays the morning transmission commences at 1000. Riyadh is the capital of Saudi Arabia, being situated some 368 km inland from the Persian Gulf. Riyadh is linked by rail with the port of Zahran. The address is Broadcasting Service of the Kingdom of Saudi Arabia, PO Box 570, Riyadh.

Egypt

Holy Qur'an Station, Cairo on **9755** at 0454, OM with quotes from the Holy Qur'an in a programme directed to the Middle East, North and Central Africa and Southern Europe, the schedule being from 0300 to 0900 and from 1200 to 2100. The Holy Qur'an is often westernised into 'the Koran', quite incorrectly I may add and offensive to some. Quotes from the Holy Qur'an are sung in a hymn-like style. Cairo is sited on the East bank of the Nile at the head of the Delta, it is the capital city and the largest urban area in the republic.

Whilst living in Cairo, my favourite fruit - of which there was an abundance - were the melons, they were enormous and tasteful. It was in Cairo that I became addicted to the delight of devouring corn-on-the-cob slowly roasted over a camel-dung fire, purchased for a couple of piastres from one of the many street traders who operated mobile contraptions very much like the roasted chestnut dealers who once frequented our own streets.

Clandestine

Voice of the Egyptian People on **9670** at 1937, OM with a political tirade in Arabic with a programme scheduled from 1900 to 2000 daily. Hostile to the present regime in Egypt, the transmitter is thought to be located in Aden. Identification in Arabic is 'Sawt ash-Sha'b al-Misri'.

Bulgaria

Sofia on **15110** at 1957, OM with station identification and announcements, then further programme details at the end of the English transmission for Europe, scheduled on this channel from 1930 to 2000.

West Germany

Cologne on **11905** at 0547, OM with station identification as 'Radio Voice of Germany' just prior to the closing of the English programme beamed to North America and scheduled from 0500 to 0550.

Romania

Bucharest on **11940** at 0558, OM with station identification and schedule details at the closing of the English service transmission to Africa, timed from 0530 to 0600.

Greece

Athens on **11955** at 0603, OM & YL (Young Lady - female announcer) with the Greek programme intended for Cyprus and the Middle East, scheduled from 0500 to 0615. At the time it was logged, a newscast of local events was in full swing. Athens, in Greek 'Athinai', is sited on the plain of Attica and was in ancient times the centre of Greek art and learning. The Acropolis and other temples are a tourist attraction. The address is Hellenic Radio-Television, PO Box 19, Aghia Paraskevi, Attikis, Athens.

Israel

Kol Yisrael (Voice of Israel), Jerusalem on **15485** at 0510, OM with a newscast in English, station identification and time-check at 0515, then into the French programme. The English transmission at this time is scheduled from 0500 to 0515 and is directed to Western Europe, North America, Australasia and South and East Asia.

Philippines

FEBC (Far East Broadcasting Company), Manila on **11890** at 0915, OM with a talk in English during the programme for South East Asia and Australasia, scheduled from 0800 to 1000 on this channel. The power is 50 kW and the address is Box 1, Valenzuela, Metro-Manila.

Tahiti

Papeete on **15170** at 0317, YL with station identification as 'O Tahiti' then into a programme of Polynesian-style choral songs - all soft and lilting like - complete with a local orchestra mainly composed of flutes and drums. Also logged on **11825** at 0435, OM with a cultural talk in French although the schedule lists Tahitian at this time. This is the Home Service scheduled from 1600 to 0730 (Saturdays until 0900), the power being 20 kW on each channel. Papeete is the capital of Tahiti and of French Settlements in Oceania (France Regions 3). Exports are mother-of-pearl, copra, vanilla and phosphates - just in case you are interested!

Australia

VLH9 Lyndhurst on **9680** at 1420, a programme of rather dull classical orchestral music, OM with announcements in English. If it had been Rimsky-Korsakov's Sheherazade or even Tchaikovsky's Swan Lake I might have been interested, being something of a middlebrow where this type of music is concerned. VLH9 transmits the Domestic Shortwave Service from 0830 to 1502 daily. The power is 10 kW.

New Zealand

Wellington on **15485** at 0657, OM in English with a talk all about the local wildlife. Time-check (6 pips) at 0700 with the announcement 'This is the National Programme, the time is 8 o'clock'. My advice to Pacific Dx hunters is to 'watch' this channel from around 0300 onwards. If the transmission is loud and clear and the S-meter pointer is swinging over towards S 3 to S 4 then switch to **15170** for Tahiti and, if conditions hold up, tune to **5045** (see below). The schedule of Wellington on this frequency is from 1700 to 0730 and the power is 7.5 kW. The interval signal - the call of the New Zealand Bellbird - has to be heard to be believed. The address is Radio New Zealand, PO Box 2092, Wellington. If you send them a report, include three IRC's (International Reply Coupons) to cover the cost of a reply.

Cook Islands

Rarotonga on **5045** at 0710, male choir with Polynesian songs, YL's with songs in the unmistakable local style. Signal partly lost under noise and an adjacent carrier at 0722, the QRM carrier slowly becoming dominant. ZK 5 Rarotonga is scheduled from 1600 to 0900 and the power is just 0.5 kW. Should you manage to log them, the address for reports is Cook Islands Broadcasting and Newspaper Corporation, PO Box 126, Avarua, Rarotonga.

China

Lanzhou, Gansu on **4865** at 1420, OM with songs in Chinese, YL with announcements. The schedule is from 2130 to 0200 (Saturdays until 0330), from 0330 to 0600 and from 0900 to 1600.

India

AIR (All India Radio) Kurseong on **3355** at 1555, OM with a talk in English on local affairs. The schedule is from 0030 to 0400 and from 1230 to 1740, the power 20 kW.

Air Hyderabad on **4800** at 1640, OM announcer in vernacular with a programme of typical Indian music. The schedule is from 2300 to 0330 and from 1130 to 1740 and the power is 10 kW.

AIR Delhi on **11620** at 2040, OM with a talk in English, all about radio communication between India and the Soviet Union in the English programme directed to the UK, Western Europe and Australasia, being timed from 2045 to 2230 daily. If you wish to report to them, the address is The Director, External Services Division, All India Radio, PO Box 500, New Delhi.

Malaysia

Radio Malaysia, Kuala Lumpur on **4845** at 2210, Indian-style music, YL with songs in the Bahasa Malaysia/Indian service, scheduled on this channel from 2130 to 0130, 0540 to 0630 and from 0830 to 1530 weekdays. Saturdays from 2130 to 0330 and from 0545 to 1530, Sundays from 2130 to 1530. The power is 50 kW. Reports should be sent to Radio Television Malaysia, PO Box 1074, Kuala Lumpur.

Colombo

RRI (Radio Republik Indonesia) Banda Aceh on **4954** at 1550, OM announcements in Indonesian, religious chants until 1558, then some guitar music until carrier off at 1600. The schedule is from 2300 to 0015 (Sundays until 0600) and from 0800 to 1600. The power is 10 kW.

RRI Jambi on **4927** at 1530, OM with station identification in Indonesian, announcements followed by a few bars of local music then OM & YL alternate with more announcements. Jambi is sited in Propinsi (Province) Jambi on Sumatera (Sumatra) in the Greater Sundas islands. The schedule is from 2230 to 0600 (Sundays from 2350 to 0700) and the power is 7.5 kW.

RRI Bukittinggi on **4909** at 1542, OM with religious chants - a common feature with all Indonesian short wave stations just prior to closing. Bukittinggi is listed on **4910** and transmits from 2300 to 0300, from 0500 to 0715 and from 0930 to 1600. The power is 1 kW. Bukittinggi is located in Propinsi Sumatera Barat, the capital of which is Padang.

Colombia

Radio Sutatenza on **5095** at 0102, OM with station identification, then a newscast of local (by that is meant South American) events, judging by all the place-names mentioned. Also logged in parallel on **5075**. The schedule on this latter frequency is from 0900 to 0130 (variable closing time) and the power is 25 kW. On **5095** the transmission times are from 0845 to 0400, the power being 50 kW.

La Voz del Cinaruco, Arauca, on **4865** at 0205, OM with announcements and 'promos' (commercials), local-style pop music complete with vocals. HJLZ La Voz del Cinaruco - to give the full title - operates from 0900 to 0400 and has a power of 1kW.

Venezuela

Radio Valera on **4840** at 0229, OM with a talk in Spanish, heard with some difficulty under co-channel CW (Morse) interference that could not be cleared either by tuning to the upper or lower sidebands. Radio Valera times its transmission from 1000 to 0400 and has a power of 1 kW.

Radio Sucre, Cumana on **4960** at 0236, OM with local pops and announcements in Spanish amid which some tuneful guitar music was heard. YVOA Radio Sucre is scheduled from 1000 to 0400 with a power of 1 kW.

World Dx Club

Having recently featured details of the Danish Short Wave Club International, I should now like to draw attention to a British Club that has been in operation for many years. World Dx Club produces an excellent monthly publication entitled 'Contact', the issue sent to me for review was of 42 pages A4 size, clearly duplicated.

'Contact' is well edited, virtually error free and packed with items of interest to SWL's, Dxers and Medium Wave enthusiasts alike. Such headings as QSL Ladders; Media Magazine; Under the Microscope - in which a small segment of the short waves was featured, listing the stations to be heard; QSL Report - which station is QSL'ing and how long it takes etc; Broadcasting Review - which dealt with programmes of interest from Radio Cairo; Propagation Report; Amateur Radio Amalgam - what to hear, where and when; Shortwave Logbook - in which members report frequencies and stations logged; Making Contact -members letters and views; DX News - a 4 page mass of useful information edited by my colleague Mike Barraclough; Medium Wave Scan which also incorporates VHF, FM and TV Dx. All-in-all a very useful and informative monthly SWL publication.

Membership for UK readers is (a) standard second class internal delivery at £5 per annum or (b) first class at £5.60. Surface mail throughout the world £5; European all-up rate (air mail if faster delivery) is £6.50, Airmail outside Europe is £8.50. All payments in sterling drawn on a British Bank.

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BOOK OF THE MONTH

ACTIVE FILTER COOKBOOK
By Don Lancaster
1975; 240 pages; 135 x 215mm; Paperback
£10.45

Don Lancaster will be a familiar name to many electronics engineers and enthusiasts. The various 'Cookbooks' he has written have rapidly established themselves as the best sellers in their field - and it isn't difficult to see why.

The 'Active Filter Cookbook' explains everthing you've always wanted to know about active filter design with Op-Amps - and you will be amused to see just how many regular magazine feature writers earn a reasonable living by simply plaguerising and re-phrasing this work. Remember, **R&EW** insists on keeping readily accessible textbook material in its place - and the Active Filter Cookbook is about as good a place as you are likely to find.

Don Lancaster's style is possibly the most readable in the business. The information is conveyed concisely and informatively, without perpetual recourse to the sort of mathematical analysis that can quickly alienate readers seeking a solution, rather than a course in further mathematics.

The book covers active filters from basic, through first and second order networks - low pass, high pass, bandpass - you've heard it before. Design tables and formulae are set out in a completely comprehensible fashion, complete with worked examples that leave little room for misunderstanding.

The devices used in the illustration are not quite the latest things in op-amps, but the information supplied enables the reader to extrapolate the behaviour of the latest low-noise op-amps without trouble. The basic theory remains unaltered.

Curiously, no mention seems to be made of the ubiquitous Baxendall tone control circuit, or the twin 'T' filter. However, this is not a serious omission, although I would expect to see a subsequent revision including these configurations. The advance of personal computing and programmable calculators leaves a lot of scope for an appendix of programmes to complement the design formulae. Shall we pitch in and give Don a hand?

Review on
DISCRETE ELECTRONIC COMPONENTS
By F F Mazda

It is difficult to know how to approach a book that sets out with such an enormously broad scope as the title implies. Far from being a simplistic review of resistor colour codes and transistor base connections - "Descrete Electronic Components" is already into bulk semiconductor crystal purification by page 2!

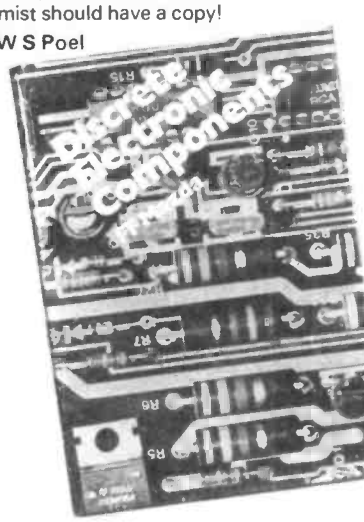
The book is written at 'A' level standard for the professional non-electronic 'engineer' who is not necessarily familiar with electronic terminology, but who can relate via the scientific language of chemistry and physics. As such, it is a valuable work for the increasing numbers of engineers who are finding electronics invading their 'territory'.

Even the electronic engineer may find that the concise descriptions and definitions can help clear away ambiguities and misconceptions, since the book covers every aspect from the basic physical and chemical properties through to the component's symbolic representation.

For a book costing £18, the diagrams and typesetting leave something to be desired. Coils and chokes are not indexed (inductors are), and the only transformers that exist in Mr. Mazda's world appear to operate below about 10 kHz - but perhaps I am displaying too much of a communications engineering bias? And perhaps the author betrays his association with Xerox with the inclusion of an apparently spurious (but nonetheless interesting) piece on holography.

Every architect, civil engineer and industrial chemist should have a copy!

W S Poel

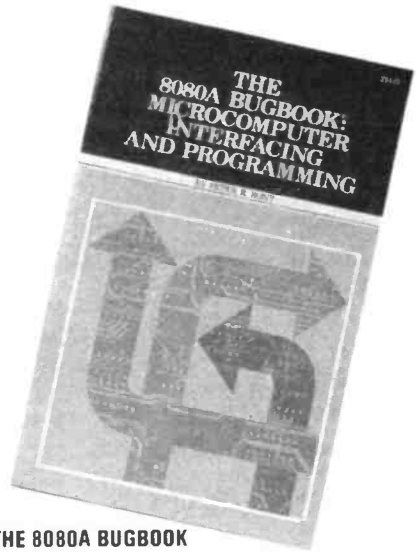


CB RADIO CONSTRUCTION PROJECTS
By Len Buckwalter
1976; 126 pages; 135 x 215mm; Paperback
£2.75

These projects include add-on accessories, operating aids, test instruments to monitor the output of your equipment, the devices are simple and also inexpensive. No prior knowledge of electronics is required to complete these projects, and a minimum of tools is necessary.

APPLE BASIC FOR BUSINESS FOR APPLE II
By A J Parker & J F Stewart
1980; 300 pages; 175 x 230mm; Paperback
£11.20

This book has presented problems from the business data processing environment as a reason for learning BASIC. Of course, not all facets of a problem can be explained at once, since different parts require different approaches and tools. But step, by step as it looks at the many facets of a problem and introduces the necessary BASIC statements the student will collect the tools needed to solve all these problems.



THE 8080A BUGBOOK
By P R Rony
1977; 416 pages; 135 x 215mm; Paperback
£9.05

The principles, concepts, and applications of an 8-bit microcomputer based on the 8080 microprocessor IC chip. The emphasis is on the computer as a controller. Covers the four fundamental tasks of computer interfacing: (1) generation of device select pulses; (2) latching of output data; (3) acquisition of input data; (4) servicing of interrupt signals. Intended to help develop the skills needed to use an 8080-based breadboard microcomputer system.

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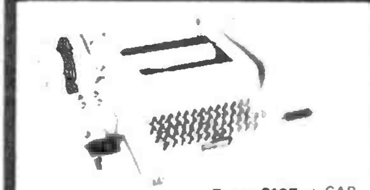

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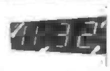

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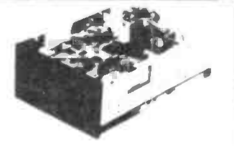

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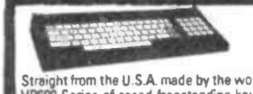

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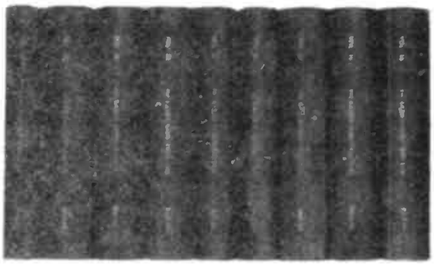

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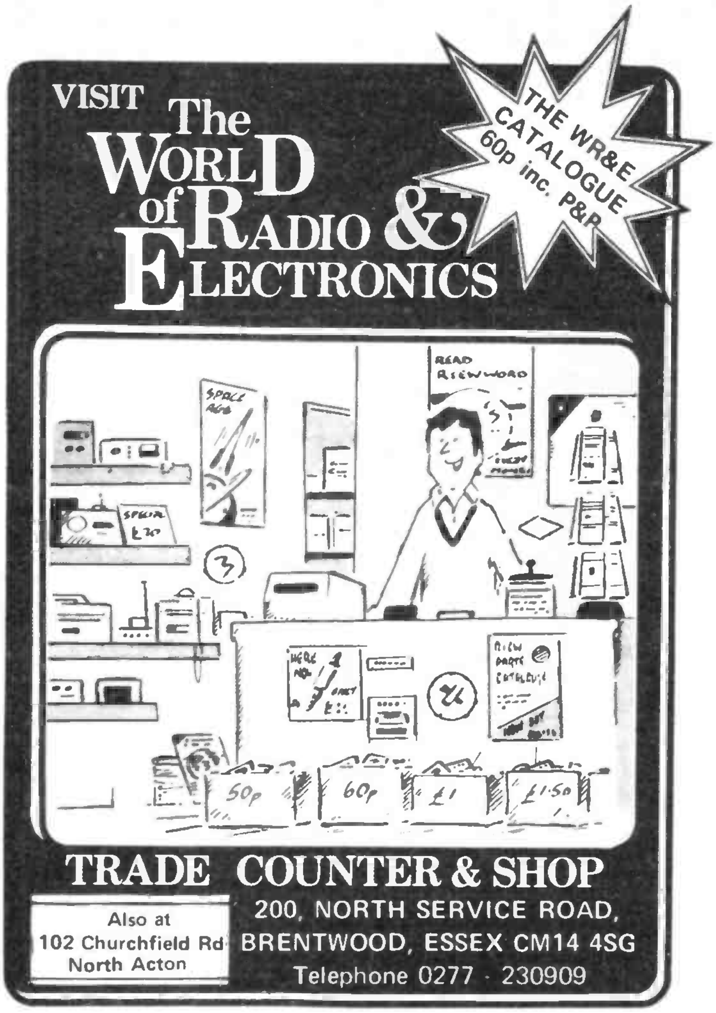

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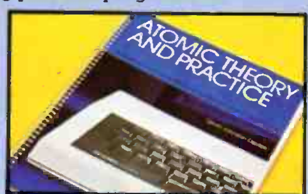

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