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Radio & Electronics

The communications and electronics magazine

World

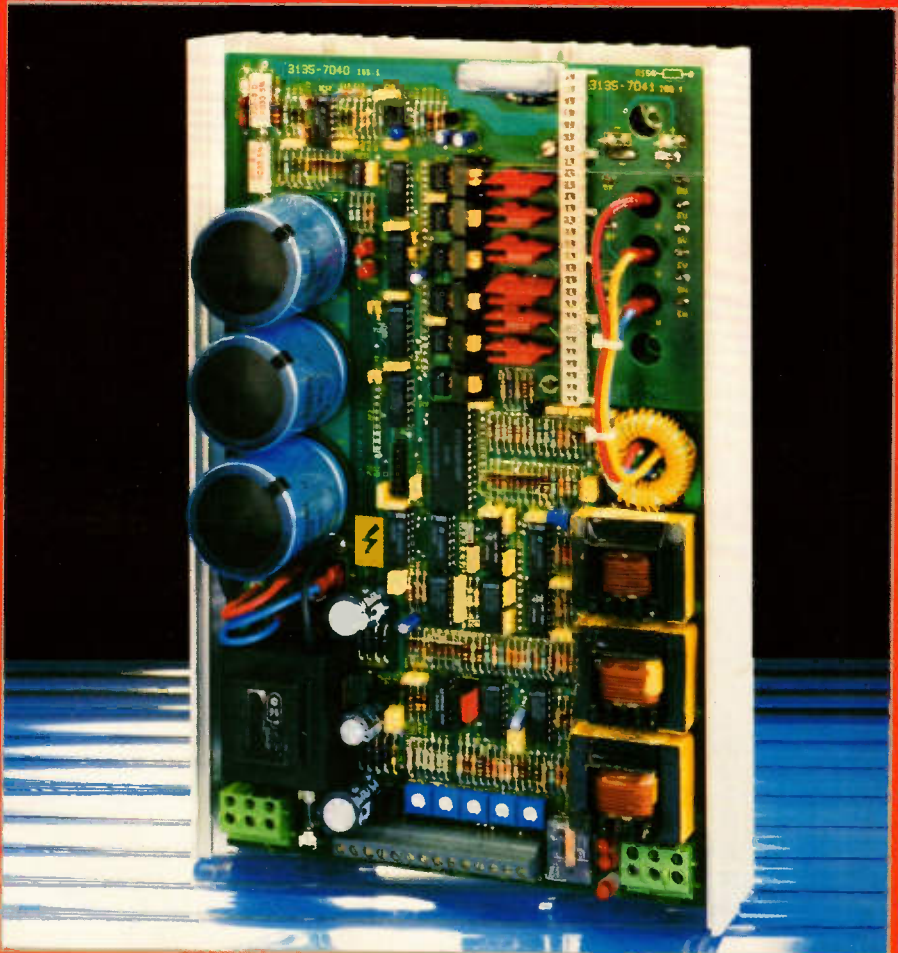
**LOOP ANTENNA:
A PROJECT FOR
LONG WAVE**

**ICOM IC-R71E:
A USER'S REVIEW
OF THIS RX**

**IC-2 MOD:
LISTEN-ON-INPUT
FOR THIS HAND-HELD**

**NICAD PROJECT:
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**IN A SPIN:
VECTORS AND
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**DATA FILE:
COMMON-COLLECTOR AMPS**

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Safety in the shack

Some of the constructional projects featured refer to additions or modifications to equipment; please note that such alterations may prevent the item from being used in its intended role, and also that its guarantee may be invalidated.

When building any constructional project, bear in mind that sometimes high voltages are involved. Avoid even the slightest risk - safety in the shack please, at all times.

Whilst every care is taken when accepting advertisements we cannot accept responsibility for unsatisfactory transactions. We will, however, thoroughly investigate any complaints.

The views expressed by contributors are not necessarily those of the publishers.

Every care is taken to ensure that the contents of this magazine are accurate; we assume no responsibility for any effect from errors or omissions.

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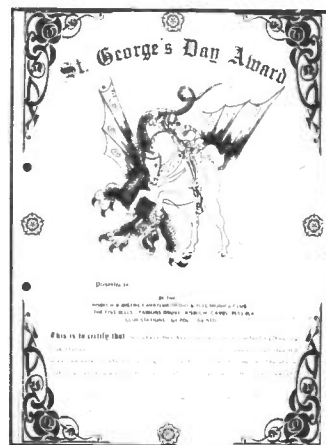
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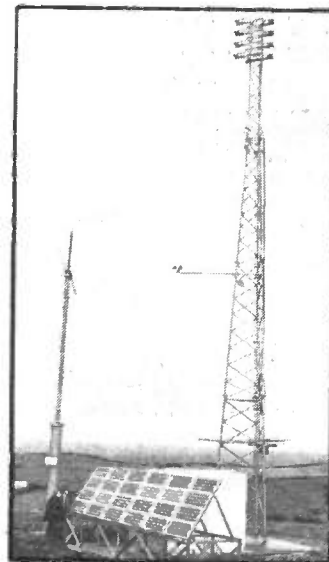
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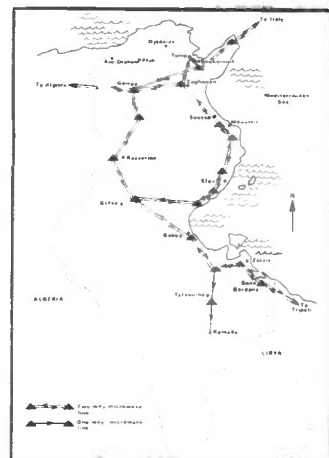
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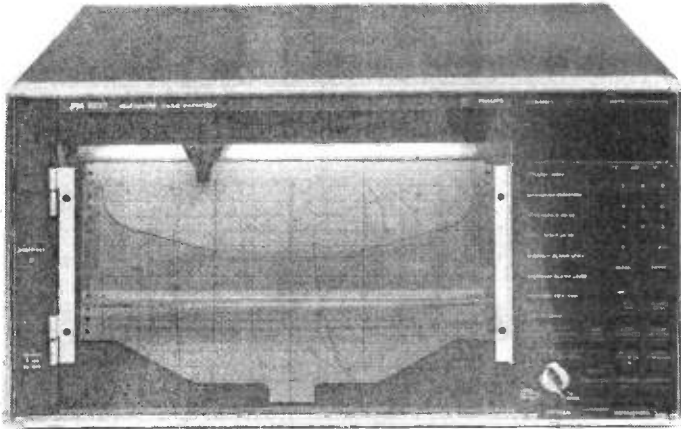


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PRODUCT NEWS

Featured on these pages are details of the latest products in communications, electronics and computers. Manufacturers, distributors and dealers are invited to supply information on new products for inclusion in Product News.

Readers, don't forget to mention **Radio & Electronics World** when making enquiries



MULTIPOINT RECORDER

Philips Test and Measurement's PM8237A 30-channel multipoint data recorder has been upgraded to improve data presentation. New facilities, which simplify analysis, include provision of the date on both front panel and paper and the ability to combine

graphical and numerical data in one recording. These advances make the PM8237A particularly suitable for measuring slow-moving signals.

The new date facility is especially useful as there is a trend towards increasing the length of time for tempera-

TRANSCIVER TESTING

The radiocommunication tester, CMT, developed by Rohde and Schwarz is an intelligent, low cost test assembly for mobile and stationary servicing of transceivers.

In the frequency range of 100kHz to 1000MHz the CMT with its learn mode can handle all measurements on any AM, FM and PM transceivers and test radiotelephones with selective call facilities to different standards, including DTMF (touch-tone dialling). It is compatible with all data transmission techniques and is obsolescence-proof to a high degree, thanks to a wide choice of options being available for extension.

The high accuracy, wide dynamic range and fast measuring rate of the CMT allow a fast go/no go test as well as complete transceiver testing. The low weight and small, compact design in conjunction with the possibility of battery powering from 12V or 24V supplies make the CMT well suited for measurements in mobile servicing.

Complete manual control,

fully automatic operation via the autorun control facility, including data logging by a printer with an external process controller or control via the IEC-bus option with the aid of an external controller, are simple to perform.

The CMT is available with or without an oscilloscope. The oscilloscope integrated in CMT model 54 features

CHECKER

A contact resistance meter, for use by electrical and electronic engineers, is the latest unit in Telonic's range of test and measuring equipment. The AX-123 Checker is designed to assess the contact resistance of relays, connectors, detonators and similar items.

It has two measuring ranges: from 0 to 199.9 milliohms at 1A dc, and from 0 to 1999 milliohms at 100mA dc. Accuracy is 0.3%, and the results of checks are displayed digitally.

Go/no go capability is available from a limit comparator which, with thumbwheel switches, can be preset from

ture tests. The clock/calendar circuit is battery powered which means that, once set, the clock runs continuously even after a mains power failure.

The reading of graphical data can be simplified by adding numerical information. The instrument, which hitherto could be switched to record either graphically or alphanumerically, can now print out numerical equivalents at intervals on graphs in a programmed sequence - every ten, or multiples of ten, minutes.

The PM8237A is also versatile, measuring temperatures with Pt 100 or thermocouples and voltages in any combination.

*Pye Unicam Ltd,
York Street,
Cambridge CB1 2PX.
Tel: (0223) 358866.*

FUNCTION GENERATOR

Global Specialties has introduced the low cost model 2002, a 2MHz function generator which can produce low distortion square, triangle and sine wave signals and TTL pulses in seven frequency ranges from 0.2Hz to 2MHz. Waveform and frequency range selections are quickly and easily made by push-buttons.

The model 2002 features: a sweep input to produce constant changes in frequency; symmetry control for varying the shape of waveforms; and a push-button 30dB attenuator for work with sensitive circuits. Other features of the instrument include: a variable dc offset control to change the locations of outputs to complementary waveforms; and an amplitude control which provides adjustments from 5MV peak-to-peak into an open circuit.

With a frequency accuracy of $\pm 5\%$ of full scale, the function generator also has an input impedance of $10k\Omega \pm 10\%$ and a square wave rise and fall time of less than 100 nanoseconds (ns).

*Global Specialties Corp
Shire Hill Industrial Estate,
Saffron Walden,
Essex CB11 3AQ.
Tel: (0799) 21682.*

additional monitoring and measuring capabilities to meet the special requirements of service and test departments.

*Rohde and Schwarz
GmbH and Co,
Mühldorfstr 15,
Postfach 801469,
D-8000 München 80,
West Germany.*

0000-9999. An LED lamp, a buzzer, and an open collector transistor output indicate the go/no go function. In addition there is a parallel BCD data output. For checking relay contact resistances, coil output voltages of dc 1.5/3/6/12/24 and 48 up to 0.2A

are available.

The AX-123 costs £895 excluding VAT.

*Telonic Instruments Ltd,
Boyn Valley Road,
Maidenhead,
Berkshire SL6 4EG.
Tel: (0628) 73933.*



CLOCK OSCILLATORS

Walmore Advanced Components Limited have announced two new additions to their range of clock oscillators.

The new ECL series, manufactured by Xsis Electronics Inc, has a frequency range of 20MHz to 100MHz, frequency stabilities between $\pm 0.1\%$ to $\pm 0.002\%$ and operating temperature ranges between -55°C to $+125^{\circ}\text{C}$, operating on a -5.2 volt supply rail.

These devices offer a hermetically sealed 4 or 14-pin dual in-line package, meeting military standards for vibration, shock, acceleration, solderability, altitude (operating), salt spray, etc. Typical applications would be for missiles, torpedoes, tactical radios and computers.

LOGIC ANALYSERS

Gould Electronics Ltd has introduced the K40/50, a low cost, easily portable family of logic analysers with a wide range of powerful features.

The K40/50 enables both synchronous and asynchronous data to be captured on all channels, and enables accurate timing comparisons to a resolution of 10 nanoseconds (ns) on up to 12 channels.

Features of the K40 include 32 channels of state at 15MHz, or 16 of state with 16 timing at 25MHz. The K50 has 48 channels of state at 15MHz. Both instruments have a memory of 2K per channel and triggering through four levels of trace control with find, wait, stop, sample, and repeat commands to help solve complicated hardware-software problems.

With a microprocessor disassembler, the K40/50 is ideal for microprocessor-based engineering projects.

Also new from Walmore is a crystal clock oscillator from Toyo in three different package options: 14-pin DIL, 8-pin DIL and a surface mounting package only 13mm x 13mm.

This oscillator, which drives CMOS and TTL ICs without analogue design, is available with frequencies anywhere between 250kHz and 24MHz and with a stability of $\pm 100\text{ppm}$ inclusive of calibration tolerance at 25°C , operating temperature, input voltage change, load change, ageing, shock and vibration. The operating temperature is $0-70^{\circ}\text{C}$.

*Walmore Electronics Ltd,
Laser House,
132/140 Goswell Road,
London EC1V 7LE.
Tel: (01) 251 5115.*

The disassembler simplifies connection to the CPU and converts 0s and 1s into familiar mnemonics.

In the synchronous analysis mode, an external 15MHz clock is used to clock the data in the K40/50. For timing problems, an internal clock with a 40ns resolution on all channels can be used. In the verification of timing relationships between control lines, a 10ns resolution on up to 12 channels can be selected.

Weighing only 6.7kg, the K40/50 is easily portable. Both instruments are supplied with probes, probe connectors, power cord and operating manual. Options include RS232C and Centronics interfaces.

*Gould Electronics Ltd,
Instrument Systems,
Roebuck Road,
Hainault,
Ilford,
Essex IG6 3UE.*

AUTO TIMEBASE



Electronic Brokers has introduced the Grundig MO-53 50MHz dual-channel oscilloscope to the UK market.

The new oscilloscope includes many features designed to make it easy to use in areas such as R & D, production, service and education.

A major new feature included in the MO-53 is automatic timebase selection. Depending on the frequency of the test signal, the timebase is selected automatically and displayed digitally, so that the user has no need to search to find the correct range.

Another important user benefit is the provision of a true separately triggerable second timebase, which enables the trigger point to be independently adjusted by an additional level control to

give an unambiguous expanded display.

The use of the second timebase means that it is possible to isolate features such as the burst in a complex colour video signal to produce a clear trace for exact evaluation. Conventional oscilloscopes with a trigger-delay facility cannot reproduce the user benefits of the second timebase.

An alternating display using different timebases allows the main timebase and second timebase to be displayed at the same time, with any portion of the traces selected for expansion.

Full service and support is provided in the UK by Electronic Brokers.

*Electronic Brokers Limited,
140-146 Camden Street,
London NW1 9PB.
Tel: (01) 267 7070.*

JAY SERIES

A new range of instrumentation from CIL is called the Jay series which allows different modules to be inserted into the front of the instrument to perform many measurement tasks.

The Jay basically consists of a Z80-based microcomputer circuit with RS232 option housed in a bench-mounted case. The front panel has a 2×16 dot matrix LCD display, switches for control functions and access for the modules.

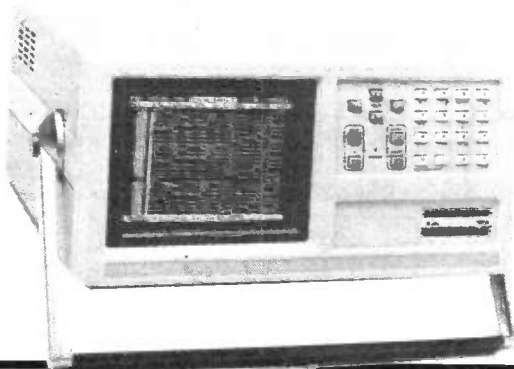
The module installed in the illustrated Jay (see cover) is the 6-channel thermocouple temperature monitor. The microprocessor program is stored in PROM within the module. Each module therefore has a different program to perform its particular task.

This means, for example, that after the instrument is purchased for, say, temperature measurement, other

modules can be purchased to perform almost all measurement tasks.

The price of the basic Jay is £245, the RS232 module is £70 and the DMM201 module is £150. Other modules vary from £50 to £200 each and several new modules will be available shortly.

*CIL Electronics Ltd,
Decoy Road,
Worthing,
Sussex BN14 8ND.
Tel: (0903) 204646.*



PRODUCT NEWS

JAGUAR CUB

IMO Precision Controls has unveiled the Jaguar Cub. Claimed to be the most compact 0.55-1.5kW ac variable speed drive available, the Cub will supercede the existing Jaguar 230V input range since it is smaller and possesses many new features.

The inverter utilises a single phase 2 wire line supply to provide a high grade sine-wave generated by a custom made Anyspeed IC. Protection levels are comprehensive and include protection against both short circuit and earth faults. The incorporation of galvanically isolated control circuits (from the power stages) allows for easy analogue slaving.

The Cub has a 50% overload capability along with noise immune control circuitry, reversing, electronic start, an acceleration/deceleration time of 0.5-300 seconds and many other control features all mounted onto a single PCB so as to reduce any liability to noise injection.

At less than £300 the Cub will find uses in many industries over a wide spectrum of applications ranging from process control and automated manufacturing to heating/ventilating systems and general motor control.

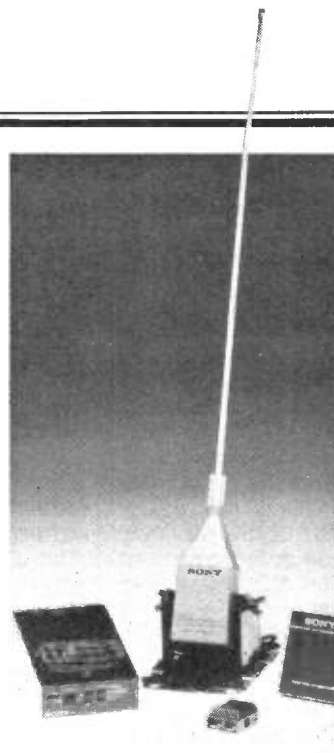
*IMO Precision Controls Ltd,
1000 North Circular Road,
Staples Corner,
London NW2 7JP.
Tel: (01) 452 6444.*

AN-1 ANTENNA

Sony has introduced to the UK market an easily assembled, compact radio antenna. Coded AN-1, the antenna is capable of receiving a wide range of bands including LW, MW and SW (150kHz-30MHz). A low noise and interference-reducing FET has also been used in the built-in RF amplifier.

The AN-1 operates from either the domestic electricity supply or batteries, and is available now at all Sony authorised dealers, priced around £49.95.

*The Grayling Company,
1 Dean's Yard,
Westminster,
London SW1P 3NR.
Tel: (01) 799 9811.*



DATA DEMODULATOR

The two satellites designed and built by the University of Surrey, UoSAT-1 and UoSAT-2 (also known as Oscar-9 and Oscar-11), have been highly successful experiments in low cost spacecraft engineering.

The SUDD program for the ZX Spectrum 48K or Spectrum Plus, now available from G4HLX, makes a low cost ground station possible. All that is required is a simple 145MHz FM receiver, which can be connected directly to the Spectrum (or signals can be recorded first onto a tape recorder).

Features of SUDD are as follows:

It demodulates 1200 baud ASCII data from UoSAT-1 and UoSAT-2;

No interface is required - just direct connection to the Spectrum 'ear' socket from a 145MHz FM receiver or cassette tape recorder;

Data received may be displayed as text, or printed on a ZX, Alphacom 32, or similar printer;

Telemetry frames are decoded to provide all analogue channels and status points. Checksum tests are performed and the algorithm used for interpreting the data minimises loss of information through data corruption;

Screen display during demodulation shows a 'front panel' featuring 'lights' for valid mark and space tones,

parity errors and framing errors, and a bar gauge to show space remaining in the data buffer;

Demodulated data may be saved on tape or microdrive for reading into the user's own programs or loading back into SUDD later;

The program is fully microdrive compatible and copies automatically onto microdrive cartridge.

The SUDD program is supplied on cassette with a detailed 7-page instruction booklet. It is priced at £4.50 (inclusive of postage and packing within UK and Eire. Overseas: add £1).

*G4HLX,
87 Hunters Field,
Stanford in the Vale,
Faringdon,
Oxon SN7 8ND.*

DOV MODEM

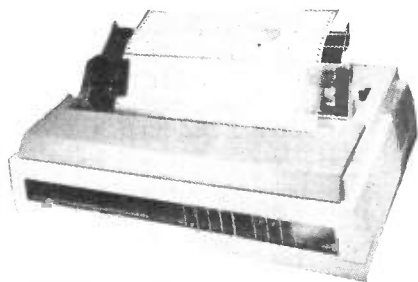
Rapid Terminals has introduced a new data over voice local modem system.

Known as the Line Miser DOV 96, this unit enables an existing PABX system to be used as a local area network for simultaneous voice and data communications. It treats every telephone location within the PABX system as a potential terminal location and adds a comprehensive data switching facility for each terminal when used in conjunction with the Gandalf PACX system.

PC PRINTER

Fast printing for personal computers, in a choice of up to eight colours, is offered by the new PC printer from Data Dynamics. Fully IBM PC printer-compatible, this printer features a word processing output at 100 or 120cps rates. It also permits printing at rates to 400/480cps at data quality and offers high-resolution bit-image graphics output for flexibility in application.

The PC printer is tried and tested with PC software, including Easywriter, Lotus 1-2-3, CA Executive and SuperCalc. Four character sets are provided as standard, with a range of alternative sets and fonts available as options.



Graphics are produced by bit-mapping in four different densities to 144 x 144 dots per square inch.

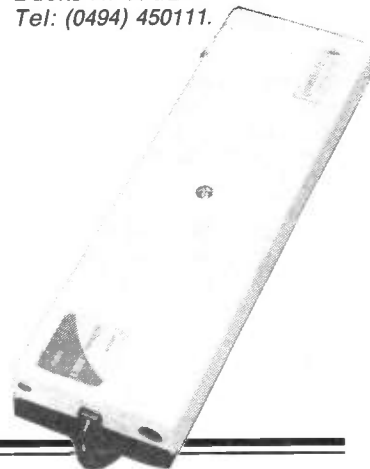
*Data Dynamics Limited,
Clayton Road,
Hayes,
Middlesex UB3 1BD.
Tel: (01) 848 9781.*

The Line Miser's data channel is provided by a frequency shift modulation scheme which generates carrier signals in each direction for transmission above the voice band. The integrity of this channel is maintained by an integral low pass filter arrangement.

Features include asynchronous operation at up to 9600bps and synchronous operation at 600, 1200, 2400, 4800 and 9600bps, at a distance of 6km over standard 0.5mm cable pairs.

The Line Miser DOV 96 is approved for use with telecommunication systems run by British Telecom.

*Rapid Terminals,
Rapid House,
Denmark St,
High Wycombe,
Bucks HP11 2ER.
Tel: (0494) 450111.*



NEW PERIPHERAL

Hobbyists, schools, colleges and small businesses alike will be pleased to hear of an oscilloscope add-on for the ZX Spectrum computer.

Called the AliDin scope, this new peripheral is a plug-in module with three signal input connectors. This connects to the expansion port on the ZX Spectrum computer and the software is provided on tape or microdrive.

Using the AliDin module and software, the Spectrum computer is converted into a digital storage oscilloscope using the TV screen for display. All the normal oscilloscope controls are available, but instead of there being many knobs and dials, the Spectrum's keyboard is used and the settings are displayed on the screen along with the scales and other useful operating information.

The waveform seen on the TV is a continuously updated waveform, as displayed by any normal oscilloscope. However, the waveform may be captured and held on the

screen or in memory while displaying a normal waveform for comparison. A screen copy function is provided so that waveforms may be recorded on a printer. These are useful for reports and handbooks, or for comparison over a period of time. The oscilloscope settings, such as timebase, amplitude and trigger mode etc, will also be printed out since they are displayed on the screen along with the waveforms.

The AliDin module retails at £49.95, complete with a signal lead and handbook. The software to drive the module in a scope configuration retails at £24.95.

Further software is to be introduced enabling the AliDin module to work as an intelligent chart recorder, or as a waveform spectrum analyser.

*AliDin,
39 Kingsclere Road,
Overton,
Hants RG25 3JB.
Tel: (0256) 770488.*

NEW WORKSTATION

The Hewlett-Packard 9817 is a new technical workstation, part of the latest range based on the 68000 processor family with 32-bit internal and 16-bit external architecture, running at 8MHz.

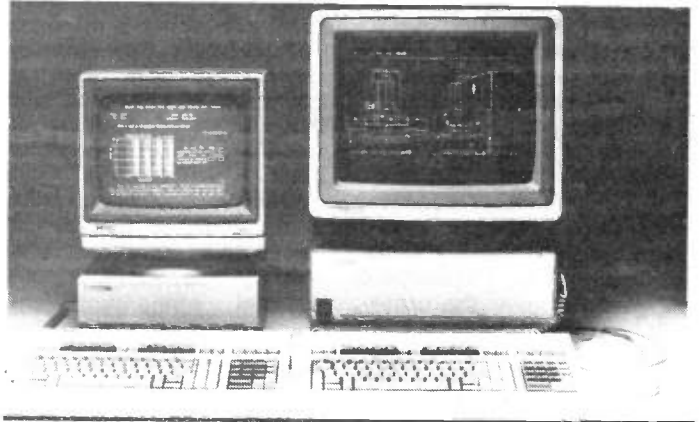
The 9817 includes 512K RAM, and a 14in monochrome monitor with alpha/graphics composite video interface cards. The keyboard is interfaced via the new Hewlett-Packard Human Interface Link (HP-HIL) which provides for daisy-chaining additional input devices, such as a mouse or trackball.

Software compatibility includes HP Basic 3.0 with 60 I/O commands, and Pascal 3.0

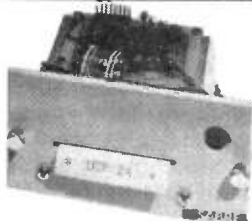
which includes a comprehensive I/O procedure library, plus editing and debugging tools.

The 9817 is ideal for engineering or scientific calculations requiring high speed and intensive data handling, and for HP-IB (IEEE488) instrument control applications. It's available from Microlease plc, the instrument rental specialists, at economical weekly hire rates from £140.

*Microlease plc,
Forbes House,
Whitefriars Estate,
Tudor Road,
Harrow,
Middx HA3 5SS.
Tel: (01) 427 8822.*



COMPACT PRINTERS



The Industrial Products Division of Sabre Computers has added both 32 and 40 column units to its range of ultra compact printers.

They have been designed to provide system builders with reliable, plain paper, dot matrix printers for panel or rack mounting applications.

Sabre's UCP-32 and UCP-40 units are 75mm high, 75mm deep and 125mm wide, and can be fitted in a 2U high panel. The printers feature both physical and electrical interchangeability with UCCP-24.

As with the previously introduced 16 and 24-column versions, these new printers offer parallel (Centronics type) and serial (RS232 protocol) data input formats; an ASCII 64 alphanumeric character set (upper case

only); multiple width, height, and invertable characters, and dot graphics. A +5V supply at around 1A is required to power the unit.

These printers are priced at around £140.

*Sabre Computers
International Limited,
Process House,
43 Selsdon Road,
South Croydon,
Surrey CR2 6PY.
Tel: (01) 681 8241.*

DOT MATRIX PRINTER

The new System 600 colour printer from Data Dynamics allows you to choose from word processing output at 100 or 120cps, data quality printing at 480cps or bit-image graphics output, all with up to 8-colour printing.

The printer has been engineered for heavy duty applications and a range of mini and mainframe computer interfaces and emulations can be selected. Four character sets are built in and others are optionally available in PROMs or may be downloaded into RAM from the

host computer.

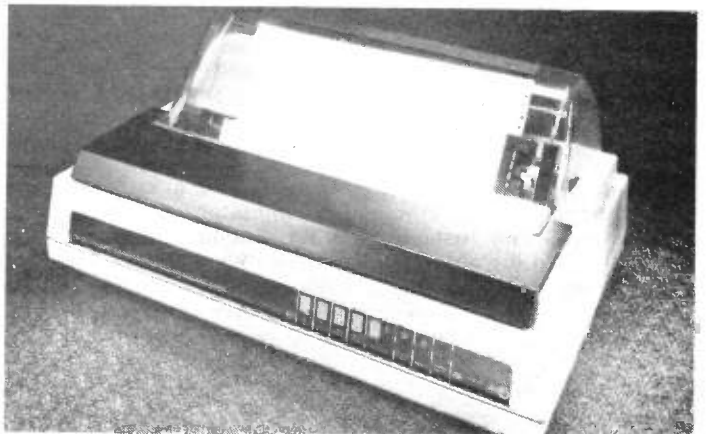
Two staggered rows of nine needles form the print image in one pass, allowing the printer to provide letter quality output at up to 120cps speeds.

Four character sets, each with 16 national variants, are fitted as standard. Fourteen further sets can be fitted (eight in EPROM and six downloaded into RAM), for a

wide choice of printing styles. Teletex and Bar Code character sets are available.

Low noise levels eliminate the need for an acoustic hood, and there is a comprehensive range of paper handling accessories.

*Data Dynamics Ltd,
Clayton Road, Hayes,
Middlesex UB3 1BD.
Tel: (01) 848 9781.*



PRODUCT NEWS

LOW COST CAPACITORS

The new Reccsam Components' DST range of dipped, metallised polyester film capacitors from VSI Electronics offers production engineers a high performance, low cost product for both new and established equipments.

They are available in 5% and 10% tolerances with five working voltages from 63 to 630V dc. Values, according to case size and working voltage, range from 0.01 μ F to 10 μ F.

All popular industry standard lead pitches are available. Metallised electrodes, produced using advanced vapour techniques to ensure uniformity of coating, provide both self-healing and substantial size reduction. Operating temperature range is -55° to $+100^{\circ}$ C.

*VSI Electronics (UK) Ltd,
Roydonbury Industrial Park,
Horsecroft Road,
Harlow,
Essex CM19 5BY.
Tel: (0279) 35477.*

SURGE SUPPRESSORS

Microelectronics Technology (MeTL) have announced the addition of a range of high performance surge suppressors to their list of products.

The suppressors are manufactured by Lucas Semiconductor, the latest franchise to be acquired by MeTL. The diodes, which were developed for telecoms, military and industrial applications, offer high speed and reliability. There are four series in the Transhield range: two cover the breakdown voltage range of 9-275V, a third covers from 6.8-275V and the fourth covers the range 27-230V.

Within each series there are three types of diode with different breakdown characteristics: unidirectional positive, bidirectional positive or

bidirectional negative (foldback). These are indicated by prefixes ZP (Zener), CP (clipper) and FP (foldback). The clipper versions are designed to give low power dissipation.

The surge suppressors are claimed to offer excellent clamping ability, a wide operating temperature range, fast response times and good power dissipation. The devices are suitable for use in automotive applications (electronic ignition, etc), military applications and medical equipment, and numerous other applications.

*MeTL,
Unit 2,
Great Haseley Trading
Estate,
Great Haseley,
Oxon OX9 7PE.
Tel: (08446) 8920.*

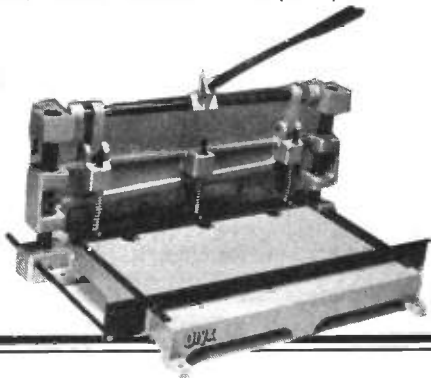
BENCH GUILLOTINE

Oryx has announced a new bench tool which fills a need in the market for a precision guillotine. The two units, GL80-12in and GL90-18in, are principally designed for cutting copper laminated fibre-glass PCBs up to 2mm thick. The guillotines may also be used for cutting other materials, such as aluminium sheet up to 1.6mm, 1mm brass,

0.6mm tin plate, and for trimming plastic and metallised labels.

Both units can be free standing on a bench, or secured by the screw lugs provided.

*Greenwood Electronics,
Portman Road,
Reading RG3 1NE.
Tel: (0734) 595843.*



SURFACE-MOUNTING

Surtech Inter-connection is offering a starter kit and engineering laboratory stock of Murata chip components to encourage the trial use of surface-mounted devices.

The SMD starter kit, priced at £49.75, comprises five PCBs (custom designed for wave/reflow soldering), solder paste, adhesive, and samples of chip resistors, capacitors, inductors, SOTs, trimmers and tantalums, plus a set of application notes. This provides everything needed by newcomers to experiment with and learn the considerable advantages of surface mount technology.

The engineering lab stock packages provide the design engineer with valuable support in the development of prototypes. Three 100 piece ranges of chip resistors are offered: E6, E12 and E24, priced at £98, £196 and £350 respectively. Lots made up of 50 or 100 chip capacitors of 60 different values ranging from 1pF to 100,000pF, and 100 of 145 different values, are also offered. The packages are priced from £265 to £1,150. All of these Murata chip components have nickel barrier layer terminations.



Surtech Interconnection provides full customer support for the development of surface-mounted technology. This includes PCB layout, design and manufacture. Prototype to volume manufacture on three fully automatic placement machines is available to customers, plus active or passive distribution from a £100,000 stock of surface-mounted devices.

*Surtech Interconnection Ltd,
Intec 2,
Wade Road,
Basingstoke,
Hants RG24 0NL.
Tel: (0256) 470848.*

STRETCHABLE INK

A new ink which stays conductive even when stretched to twice its original length is now available from Johnson Matthey Chemicals Limited. The ink is screen printable and designed for application to very flexible substrates such as plasticised PVC.

Known as P1300, the ink comprises 65.2% by weight of silver in a newly developed resin system, and may be applied using automatic or manual screen printers.

When dry the new ink is able to withstand extreme creasing, bending and stretching without detrimental effect on its resistivity, which is estimated to be 0.012 ohms per square sheet at a coverage of 100g/m². The ink possesses excellent adhesion and abrasion resistance and has a shelf life of at least 6 months at room temperature.

*Johnson Matthey Chemicals
Limited,
Orchard Road, Royston,
Herts SG8 5HE.*

POWER CONVERSION

A F Bulgin & Company's Power Conversion Division have designed and developed a new range of high efficiency dc to dc converters.

The new range, the DC40F Series, which is being manufactured at the company's Barking factory, offers 24 or 48 volt dc input options in 100 x

160 x 27mm Eurocard format. The products have triple outputs of 5V 5 amps with two 12 volt floating secondaries at 0.5 amps each.

*A F Bulgin & Company plc,
Power Conversion Division,
Bypass Road,
Barking,
Essex IG11 0AZ.*

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300x133x217mm deep **£10.00 ea (£2.20)**

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 LM317 Metal **£2.20**
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 7805/12/15/24 plastic **50p 1000 + 18p**
 7905/12/15/24 plastic **50p 1000 + 19p**
 CA3085 T099 Variable regulator **£1.00**

COMPUTER ICS

Used Eproms are erased and verified
 27128-300nS **New £3.50 10+ £2.60**
 2764 Intel/Fujitsu 300nS **£2.50 Used £1.50**
 2716 EX EQPT **£2 100+ £1**
 2732 EX EQPT **£2.50**
 2114 EX EQPT 60p 4116 EX EQPT **70p**
 4164-200nS NEW **£1.50 100 + £1.00**
 6264LP15 8K static ram **£3.50**
 6116 LP-2 (TC5517APL-2) **£2.50**
 6116 -2 (TC5517AP-2) **£2.20**

POWER TRANSISTORS

TIP141, 142, 147 £1 ea, TIP112, 125, 42B **2/£1.00**
 TIP35B £1.30 TIP35C **£1.50**
 SE9302 100V 10A DARL SIM TIP121 **2/£1.00**
 2N3055 Ex eqpt tested **4/£1.00**
 Plastic 3055 or 2955 equiv 50p **100/£30.00**
 2N3773 NPN 25A 160V £1.80 **10/£16.00**

DISPLAYS

Futaba 4 digit clock, fluorescent display 5-LT 16 **£1.50**
 Futaba 8 digit calculator, fluorescent display 9CT-01-3L **£1.50**
 Large LCD Clock display 1" digits **£3.00**
 7 seg 0.3" display comm cathode **2/£1.00**

QUARTZ HALOGEN LAMPS

A1/216 24v 150w **£2.25**
 H1 12v 55w (car spot) **£1.25**

MISCELLANEOUS

Linear hall effect IC Micro switch no 613 554 51M R5 304-267 **£2.50 100+ £1.50**
 OSCILLOSCOPE PROBE KIT X1X10 **£10.00**
 Cheap phono plugs **100/£2 1000/£18**
 Ipole 12 way Rotary switch **4/£1**
 Audio Ics LM380 LM386 **£1 ea**
 Coax plugs **5/£1**
 4x4 MEMBRANE KEYBOARD **£1.50**
 INDUCTOR 20µH 1.5A **5/£1.00**
 COAX PLUGS **5/£1.00**
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 MAINS ROCKER SWITCHES 6A SPST **5/£1**
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 MAINS TRANSIENT SUPPRESSORS 245v **3/£1.00**
 TOK KEY SWITCH 2 POLE 3 KEYS - ideal for car/home alarms **£3 £100+ £2.00**
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 12v MES lamps **10/£1**
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 PTFE sleeving pack asstd colours **£1.00**
 250 mixed res diodes, zeners **£1.00**
 Mixed electrolytic caps **100/£2.00**
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 Mono head £1, Erase head **50p**
 Thermal cut-outs 50°, 77°, 85°, 120°C **80p**
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TO220 Micas + bushes 10/50p **100/£2.00**
 TO3 Micas + bushes **20/£1**
 RELAYS 240v AC coil PCB mounting 2 pole changeover £1 3 pole c/o **£1.00**
 Fig. 8 mains cassette leads **3/£1.00**
 KYNAR wire wrapping wire 2oz reel **£1.00**
 PTFE min. screened cable **10m/£1.00**
 TOKIN MAINS RFI FILTER 250v 15A **£3.00**
 IEC Chassis plug/rfi filter 10A **£3.00**
 Mercury tilt switch small **£1.00**
 Min. rotary sw. 4p c/o 1/8" shaft **2/£1.00**
 Thorn 9000 TV audio o/p stage **2/£1.00**
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 6m or 9m CERAMIC FILTER 50p **100/£25.00**
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 2k5 10k 25k 1M Lin **5/£1**
 500k lin 500k log long spindle **4/£1**
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 12FR400 12A 400v small stud **4/£1.50**
 BY127 1200V 1.2A **10/£1.00**
 BY254 800v 3A **8/£1.00**
 BY255 1300v 3A **6/£1.00**
 1A 800v bridge rectifier **4/£1.00**
 6A 100v bridge **50p**
 10A 200v bridge **£1.50**
 15A 100v bridge **£1.50**
 25A 200v bridge £2.00 ea **10/£18.00**
 25A 400v bridge £2.50 **10/£22.00**

SCRs

MCR72-6 400v **£1**
 35A 600v stud **£2.00**
 2N5061 800MA 60V T092 **4/£1.00**
 TICV106D .8A 400v T092 3/£1 **100/£15.00**
 MEU21 Prog. unijunction **3/£1.00**

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diacs 25p

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 R47 1R0 2R0 2R7 3R9 5R0 10R 12R 15R 18R 20R 27R 33R
 36R 47R 120R 180R 200R 330R 390R 470R 560R 680R 820R
 910R **4 for £1**
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 W22 or sim 6 watt 7 OF ONE VALUE for **£1.00**
 R47 1R5 9R1 10R 12R 20R 33R 51R 56R 62R 120R 180
 270R 390R R47 560R 620R 1K 1K2 2K2 3K3 3K9 10K
 W23 or sim 9 watt 6 OF ONE VALUE for **£1.00**
 R22 R47 1R0 3R0 6R8 56R 62R 100R 220R 270R 390R
 680R 1K 1K8 10K
 W24/ sim. 12 watt 4 OF ONE VALUE for **£1.00**
 R50 2R0 10R 18R 47R 68R 75R 82R 150R 160R 200R

270R 400R 620R 820R 1K

PHOTO DEVICES

Slotted opto-switch OPCOA OPB815 **£1.30**
 2N5777 50p **100/£26.00**
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 OPI2252 Opto isolator **50p**
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 MEL12 (Photo darlington base n/c) **50p**
 RPY58A LDR 50p ORP12 LDR **85p**
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 1N5401 3A 100V **100/£1.00**
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 2K 5K 22K 50K 100K 200K

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Zero voltage switching
 Control voltage 8-28V DC **£2.50**
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 10n 250v AC X rated rad 10mm **10/£1.00**
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GLASS BEAD NTC Res @ 20°C **80p**
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 R53 THERMISTOR **£2.00**

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 2u2 20V 8/£1 **100/£8.00**

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 100N 50V axial Shortleads **100/£3.00**
 10N 50V **100/£3.00**
 470N 50V 100/£7 1µF 50V **100/£14**
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STEPPER MOTOR 4 PHASE 2 9v WINDINGS

£3.50 **10/£35.00**

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NEWS DESK

Taxifone

Passengers in London taxi cabs are now able to make local, national or international telephone calls while on the move around the capital.

For the first time cabs are carrying public telephones connected to the new Vodafone cellular telephone network, giving passengers world-wide contact, day and night, as they move around London or travel to and from airports.

For a trial period of six months some 60 taxis on the capital's streets are being fitted with the Racal Taxifone. It is expected that they will quickly spread to hundreds of the city's hackney carriages. The cellular Taxifone will be installed in the passenger compartment close to the off-side door. A specially designed meter shows users how much the call is costing as they speak.

Taxifone is approved by the London Public Carriage Office (PCO) for trial in the capital.

The unit meets stringent safety and security regulations. Calls will cost 20p per unit, with a minimum call charge of 50p.

Airborne telephones

British Telecom International, British Airways and Racal-Decca Advanced Development are teaming up to conduct trials of what is believed will be the world's first satellite telephone service for air travellers.

The trials, which will begin in 1987, will be conducted initially from Racal's Jetstream aircraft. Later, they will be extended to scheduled British Airways flights.

Passengers will make calls by inserting a credit card into a specially adapted payphone. This will unlock the handset and connect the caller with a ground-based operator in the United Kingdom who will connect the call.

Racal Decca, in consultation with British Airways, will produce airborne transmitter/receiver equipment and develop specialised aircraft antennas. On the ground, BTI



will dedicate one of the antennas at its Goonhilly satellite earth station to aeronautical services.

Initially, passengers will be able to make, but not receive calls, although BTI believes it will be able to offer all normal telecommunications facilities if there is sufficient customer demand.

Digital link

The world's first all-digital public telephone link spanning the world's oceans has been set up by British Telecom International (BTI) and its Japanese counterpart KDD.

A new satellite link interconnects modern digital exchanges in London and Tokyo to benefit customers by giving faster call connection and clearer speech transmission.

The factor permitting a total digital path between the two was the commissioning of a new satellite transmission technique known as TDMA (time division multiple access) via an Intelsat satellite over the Indian Ocean and British Telecom's earth station at Madley in Herefordshire.

In a TDMA system, transmissions from different satellite earth stations are separated by time rather than by frequency. Calls are transmitted in short 'bursts', which are carefully timed so that they reach the satellite in a pre-assigned sequence every two milliseconds.

The satellite's amplifier only boosts the power of one burst at a time before it is retransmitted back to Earth. This means the amplifier can be used at higher power, without causing unacceptable distortion. This in turn allows more telephone circuits to be carried by the same satellite.

Efficiency is further improved by the use of digital speech interpolation (DSI). This technique exploits the fact that during a telephone conversation each speaker is silent for about 60% of the time. With DSI, a satellite channel is only assigned when one of the speakers is talking. For the rest of the time the channel is free to carry other conversations.

PC price cuts

The Microcomputer Division of British Olivetti has announced new prices for its range of personal computers. This announcement sees substantial reductions in the price of M24 hard disk base units, the M24SP, and memory and mass storage upgrade products. Hard disk prices are down as much as 47%.

Olivetti believes that users now want PCs in a more sophisticated configuration, as today's generation of productive software frequently demands a hard disk and substantial memory, and it is this software that gives users performance and value for money.

The use of TDMA and DSI transmission techniques means that the number of circuits carried via satellite can be more than doubled.

Test and repair service

A new PCB test and repair service from Testech allows companies to utilise advanced ATE technology without having to purchase their own machine. Customers pay only for the test program development, plus a small sum per board tested.

At the outset of any board test application, the manufacturer need only present a circuit diagram and parts list of the PCB to be tested. Testech responds with a fixed price quotation and delivery time for a comprehensive program and interface fixture between the PCB and ATE system, with unbiased advice on the ATE system best suited to test that particular board. The fixture and program become the property of the manufacturer and are delivered to him at the end of the project.

Test and repair of the units are carried out at Testech's premises. A full record of all faults will be provided so that those recurring will be immediately highlighted and can be remedied.

This approach is more cost effective than manual testing. Use of ATE also provides

More details of the price cuts can be obtained from British Olivetti on (01) 785 6666.



other benefits: faster turn round, guaranteed quality and ready availability of the fixture and program for use with faulty boards returning from the field.

ERA technology

ERA's Radio Frequency Technology Centre and Engineering Materials and Metallurgy Division has set up a fully co-ordinated electrical and mechanical design and test facility for radomes and antennas.

The radome design facility is based on computer programs which accurately predict such electrical performance parameters as transmission loss, boresight error, cross-polarisation, flash-lobes, sidelobe degradation and frequency response. It can be used to optimise new designs or to isolate deficiencies and overcome problem areas with existing systems.

The mechanical design office is supported by a comprehensive stress analysis service which includes finite element analysis and graphics facilities.

The radome and antenna test facilities comprise a microwave laboratory, which includes a semi-automatic network analyser for the measurement of dielectric constant, loss tangent and reflection coefficient up to 98GHz, and four test ranges with frequency coverage up to 80GHz.

The digitised results can be presented as conventional plots, or may be analysed by the facility's computers. Alternatively, the data can be supplied to clients on floppy disc or magnetic tape for their own analysis.

PCB course

A course on the design of printed circuits will be held from 7 to 11 April in the School of Industrial Science at the Cranfield Institute of Technology. The course has been created to benefit draughtsmen/designers starting design work and those converting from mechanical to electrical design.

The full curriculum will cover:

The influence of printed circuit design on board manufacture and assembly;

Converting circuit design into printed circuit design; Using CAD and tapes to make master artwork, plus control of the photographic process; Design to suit subsequent testing;

The influence of new load material and surface mounting on design.

Most of the lecturers will be from industrial companies, including Ferranti, British Telecom and Jaguar Cars, to give an insight into the best current practices. Various CAD systems will be demonstrated, including Racal Redac, Wayne Kerr and IBM, and all course members will have 'hands on' experience in a quiet classroom atmosphere.

For details contact Brian Phelps on Bedford (0234) 750111, ext 2737.

China contract

NovAtel Communications Ltd has been selected to supply the first public cellular telephone system for the City of Chongqing, China.

The finalised initial contract is valued at \$2.5 million dollars and was negotiated in just three weeks.

NovAtel's unique cellular telephone system, which includes land-based and vehicular-mounted units, will be implemented in some of the underdeveloped areas of Chongqing and will form some of the basic communications system infrastructure, in line with the current modernisation plans of the government of China.

Rest in peace

It's not often that I get invited to a wake in the course of my job, so when it happened, PR gimmick or not, my curiosity was sufficiently aroused that I decided to attend (the free lunch at a posh restaurant had absolutely nothing to do with it, of course).

The event marked the demise of the Pocket Terminal, a small hand-held data input device produced by GR Electronics of Newport, Gwent. It has been superseded, naturally, by restyled and improved models.

The Pocket Terminal was born out of an idea from an engineer at National Semi-



Phonethru approval

Hitherto only available for export, IQD's telephone switchboard bypass system, 'Phonethru', has finally been granted fully BAPT approval.

Using state-of-the-art tone signal technology, the Phonethru system enables outside callers to get directly through to any internal telephone extension from anywhere in the world - without going through a switchboard operator. This means they can reach individual extensions after hours or at peak times, and access computers, dictation equip-

ment and answering machines.

Phonethru was previewed at last year's Business Telecom Exhibition and, according to IQD, has already attracted over 600 enquiries and firm orders from around the world. It costs from £460 and IQD is intending to launch a major sales campaign - concentrating on the 320,000 small to medium-sized companies with PABX and key telephone installations in the UK.

conductor. This imaginative chap used the case and display of a pocket calculator as the basis of a demonstration unit for a particular microprocessor, using it to generate look-up tables. GR Electronics seized upon the idea, and with National Semiconductor's approval introduced the Pocket TTY in 1976. It was re-engineered and renamed the Pocket Terminal within a year.

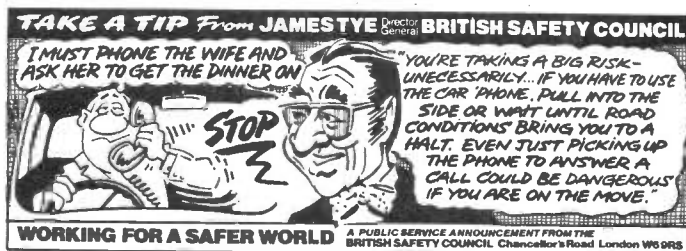
The original case and display were obtained by ripping the guts out of a Texas Instruments pocket calculator, the cases not then being available separately (if you think this is wasteful, there is a company currently doing business in a line of BBC micro-based systems: to obtain the motherboard they buy BBCs and junk the case and associated hardware. Strange world!).

After a slow start in its first two years of life, sales rocketed. Over the years some

50,000 units have been produced, most being sold abroad.

In 1982 a larger unit was produced to satisfy the demand for built-in memory and a larger display. The GR range now includes basic pocket terminals able to cope with Arabic, Hebrew and special characters, larger battery-powered units with memories, a portable terminal, Oyster, with a built-in modem and VT100 emulator, and a barcode input data collector which for ease of use writes its own applications software.

An interesting aspect of the now defunct Pocket Terminal was its price, which was originally £240. The production of electronic components has advanced so much in the last ten years, with associated decreasing costs, that the price when the unit was phased out was, surprise, surprise, still £240. Inflation? Never heard of it!



Some good advice from the British Safety Council

ERS — PRINTERS — PRINTERS — PRINTERS

SUPER DEAL? NO - SUPER STEAL THE FABULOUS 25 CPS "TEC STARWRITER"

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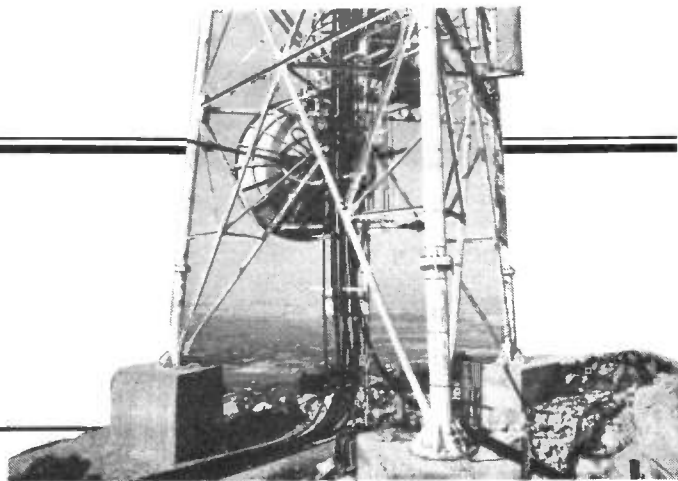
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SPECTRUM WATCH

NIGEL CAWTHORNE G3TXF



The RTT's transmitter site carries VHF-FM, VHF, UHF and microwave links

Arabsat is a twenty-two nation organisation which is providing a satellite based communications and broadcast relay service from Mauritania on the west coast of Africa through to Iraq and the Gulf states in the Middle East. The two Arabsat satellites were launched last year (Arabsat 1A by Ariane in February and Arabsat 1B by the shuttle in June). The number of countries actively using the Arabsat network has increased over the past few months as newly built earth stations have become operational.

Mauritania, the most westerly member of Arabsat, has recently put into service Intelsat A (32m dish) and Arabsat (11m dish) terminals in Nouakchott, the capital city. Mauritania's second Arabsat earth station is being built at the northern port of Nouadhibou and is expected to be operational in late March. The Nouadhibou terminal, with capacity for forty-eight telephone channels plus one video channel, will be used for national traffic. Arab regional and international traffic will be routed through the Nouakchott space centre.

The inauguration of the new Arabsat terminal in Nouakchott was celebrated with a live television exchange between Nouakchott and Tunis.

Tunis plays a key role in the Arabsat network. The secondary control station for the two Arabsat satellites is at Dkhila, some 60km from Tunis, where there are two 11m dishes, one pointing at each of the two Arabsat birds which are positioned at 18.9°E and 26°E. The main Arabsat control station is near Riyadh in Saudi Arabia.

ASBU

Tunis is also a major focal point for Arabsat and broadcasting activity in the Arab world, because the Arab States Broadcasting Union (ASBU) has its HQ in the Tunis suburb of El Menzah.

There are several broadcasting unions for different parts of the world. In Europe there is the EBU, in Africa URTNA, in Eastern Europe OIRT and in Asia ABU.

ASBU is the broadcasting union of the Arab world which represents the twenty-two Arab member nations (there are in fact only twenty active broadcasting members because Palestine, which is an ASBU member, does not have any broadcast facilities and Egypt's ASBU membership is currently in suspension).

ASBU co-ordinates the TV programme exchanges made through the C-band transponders on Arabsat. Arabsat is currently being used for a daily TV news exchange.

Member countries transmit short suitable news items through Arabsat to the Tunisian TV (RTT) headquarters via the Dkhila earth station. The individual news items are edited into a single package, which is then transmitted back through Arabsat for use in the different Arab countries.

Daily newsfeed

Apart from the daily newsfeed, ASBU also distributes a weekly feature programme which is transmitted at 10pm local time on Tuesday evening in each country. Arabsat members take it in turns to provide material for this weekly programme. The Arabsat weekly programme is distributed to members through the satellite on Monday morning at 0800z and held on tape ready for transmission locally the following evening.

ASBU's Tunis headquarters are connected directly into the RTT's Tunis building through a microwave link. This enables ASBU and the RTT to work in close collaboration for the preparation of broadcast material for distribution to Arabsat members.

ASBU's current major project is the construction of a TV news and programme exchange centre in Algiers. The Arabsat programme centre is being designed with sufficient engineering capacity to be able to co-ordinate the transmission of up to three simultaneous programme feeds. The ASBU centre will handle PAL/SECAM (there is a goodly mix of PAL and SECAM among ASBU members) as well as NTSC for exchanges with the US.

Included in the Algiers project is a 30x30 way audio conference matrix which will allow cross connection between sources from any of the twenty-two ASBU members and the three technical consoles (one for each of the three transmission feeds). There will also be provision for cross connection between master control, the VTR/transcoder room, the equipment room, the Arabsat Planning Office as well as the Algiers PTT Lakhdaria earth station.

The specification for the new centre also calls for the supply of a master control 16x16 video/audio switching matrix, 1in VTRs, monitor racks, video equalisers, test line generators, video and audio measurement equipment, as well as broadcast quality standards converters (NTSC to PAL/SECAM) and transcoders (PAL/SECAM).

Algiers has been chosen as the site for ASBU's news and programme exchange centre for a number of technical reasons. The Algerian PTT have at their Lakhdaria satellite earth station Intelsat antennas for both the Atlantic and Indian Ocean satellites. The Algerian PTT also has access to the Soviet Intersputnik network from the same satellite station. The new ASBU centre in Algiers will be connected directly to the Lakhdaria earth station through two fixed and dedicated microwave links.

From Algiers there are also good microwave links both with Europe and along the North African coast. Access to the EBU network from Algiers is via microwave through either Tunis or Spain.

Tunisian broadcasting

In common with many other countries (such as France and Switzerland), Tun-

Tunisia's international SW service is transmitted from Sfax with three 100kW transmitters: winter schedule

Times GMT	Freq (kHz)	Wavelength (m)	Service area
0400 - 0700	7125	42.11	Middle East
0700 - 1400	11750	25.53	
	9680	30.99	
0800 - 1400	11750	25.53	
	15225	19.70	
1400 - 1600	11750	25.53	
	9680	30.99	
1600 - 1800	7285	41.18	
	9680	30.99	
1800 - 2400	7285	41.18	
	7125	42.11	
0400 - 0800	7225	41.52	Western Europe
	0800 - 1600	11730	
1600 - 2400	7225	41.52	

sia has split the responsibilities for programme production and for programme transmission between two different authorities. Since 1982, Telediffusion Tunisienne (TDT) has been responsible for broadcast transmitters and associated microwave across the country, whereas the RTT takes charge of the programming.

National radio

There are two national sound broadcast programmes: one in Arabic and the other in French. Most of Tunisia is covered by both VHF-FM and MW.

The main MW transmitters for the capital are located at the Djedeida transmitter centre, 25km from Tunis. A twenty-five year old Telefunken transmitter installation provides a 600kW signal on 630kHz into a single mast radiator for the Arabic language programme. The French language service is carried from the same site, but with a different antenna, on a 100kW transmitter on 963kHz.

The mast radiator for the 600kW/630kHz Arabic service is located at about 1.5km from the transmitter hall. The two are connected by a long overhead high-power wire feeder system, which passes over a main road at no more than 6m above the road. The writer could not help but wonder what the effect might be on electronic ignition systems as they passed within a few feet of the 600kW wire feeder!

A second high-power MW installation (350kW on 585kHz) at Gafsa in Southern Tunisia also carries the Arabic language national programme. The Djedeida and Gafsa MW installations are the backbone of the RTT's national radio network.

International broadcasting

Tunisia's international radio broadcast services are based at Sfax. There is a 1,200kW transmitter installation (consisting of a pair of 600kW Telefunken MW transmitters) operating into a two element vertical array which has been designed to give two main lobes at 102° (Middle East) and 290° (North Africa). The Tunisian MW international service carries the same programming as the Arabic language national programme and is aimed at Tunisians working overseas.

Short wave

The Sfax station is also the site of Tunisia's short wave broadcast installations. Compared with some other countries that are intent on covering the world, Tunisia's ambitions in short wave broadcasting are relatively modest. Three 100kW Telefunken transmitters are used to provide services to Europe and the Middle East. Tunisia's SW services to Europe are carried on just one of two frequencies (eg during the winter months on 7.225MHz or on 11.7300MHz), whereas the Middle East

service is carried on two frequencies simultaneously (eg from 1400z to 1600z during the winter months, the Middle East service is on 9.680MHz and 11.750MHz at the same time). The curtain arrays for the Middle East service at Sfax permit multi-band operation. One 100kW transmitter is used for Europe and the two others are for the Middle East.

Tunisia does not currently have a long wave service, but it does have an allocation (281kHz) within the Geneva plan. A feasibility study is currently being undertaken by a UK consultancy firm.

Tunisian TV

It was in 1960, at the time of the Rome Olympics, that the first ever TV transmitter was installed in Tunisia. In fact in those days it was a transposer rather than a transmitter, because it received signals off-air from a RAI transmitter in Sicily, and retransmitted the RAI programme to viewers in Tunis. Today the RAI-1 feed is brought to Tunis on a microwave.

Although the RAI rebroadcast service started over twenty-five years ago, it was not until 1966 that Tunisian TV proper got under way.

Viewers in Tunis today have the choice of three programmes. Apart from the RAI-1 rebroadcasts (which are available from one transmitter site only) there are two national Tunisian programmes. The Arabic language service is carried on VHF and the French service on UHF. However, viewers with multi-standard

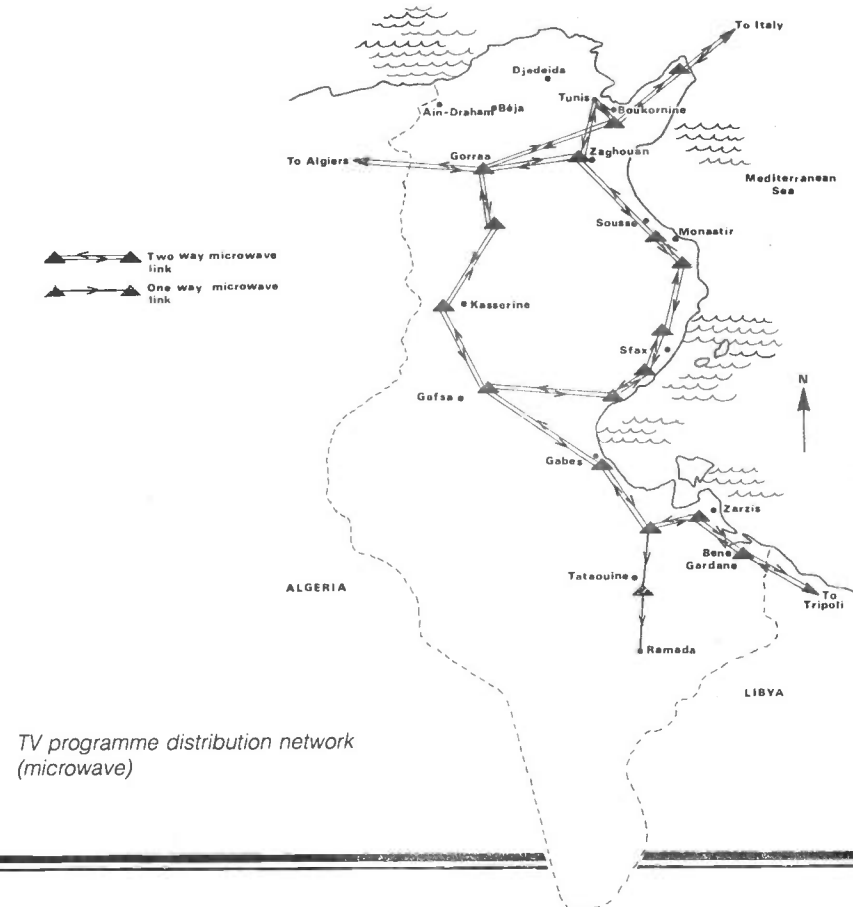
sets located in good sites can also receive programmes from Algeria (PAL) and Libya (SECAM).

Conveniently placed

The capital city is served by two TV transmitter sites, Boukornine and Zaghuan. Although the city of Tunis itself is low-lying, just 15km away there is a conveniently placed 576m high peak called Boukornine, which is used by both the Tunisian TV and the PTT as a transmitter and microwave relay point.

Transmitters at Boukornine carry the two national TV programmes (VHF:Ch E7 and UHF:Ch 26) as well as RAI-1 on Ch E5. The two national VHF-FM stereo services are also broadcast from the same site using 1kW transmitters. The VHF and UHF transmitters at Boukornine are all around the 1kW level. Tunis' more powerful transmitter station is Zaghuan, from where the two FM services are provided through 10kW transmitters (96.5MHz and 92.0MHz). The Arabic TV programme is radiated on VHF Ch E11 with a 10kW transmitter. The French language programme is on UHF Ch 33 with a pair of 20kW transmitters in active reserve (40kW).

The Arabic language TV service is on VHF Band III channels all across Tunisia with one exception: the new station in Ramada in the south of Tunisia, which has had to use a Band I channel (E4) in order to avoid interference from all the high-power Band III transmitters located in Libya.



TV programme distribution network (microwave)

AMATEUR RADIO WORLD

Compiled by Arthur C Gee G2UK

In order to bring to readers the latest news of the amateur radio world, your scribe tries to read as many of the magazines and so on produced for the radio amateur as possible. Of the many he peruses, one, namely *CQ*, can usually be relied upon to produce something of interest. *Zero Bias*, its editorial column, is from time to time pretty controversial, but it does at least attempt to bring some enlightenment to many of the problems besetting the current amateur radio scene, and does make suggestions for dealing with them and planning amateur radio's future.

One of the things which seems to be greatly concerning our friends over in America is the fall off in the number of young people coming into amateur radio. In fact, to read some of the comments about the amateur radio scene in America one would gather that the hobby is 'on the way out'. This most certainly cannot be the case! Maybe what is happening is that it is getting too 'high tech' for some modern youngsters, who seem inclined to want everything presented to them on a plate, enjoying its pleasures with the minimum of effort.

In an editorial in a recent issue, Alan Dorhoffer K2EEK, the editor of *CQ*, examines this problem in some detail, and his comments make interesting reading. He rightly points out that amateur radio is a way of life for many of us, particularly those of us who have been in it for a lifetime. Nowadays, young people simply do not have the same aspirations as many of us had at their age. Amateur radio still has its magic but the approach to it is totally different. For young people today it is at best a part of life – a small part among many other interests.

In this country, amateur radio seems to have benefitted from quite a number of folk who took up CB radio and found that it was not as stimulating as they expected. They then turned to amateur radio, taking up the hobby seriously and eventually finding it of greater interest than CB radio. To judge from the escalation in the number of new licences who are appearing on the bands, there would seem to be no lack of interest among all ages of the community in amateur radio, which is very encouraging. Rather like a diamond, amateur radio has many facets, all of which can shine if

caught in the right light and one or more of which can be relied upon to catch the eye of he who looks carefully at it.

The Challenger shuttle disaster

The disaster which befell the Challenger shuttle was significantly poignant to the amateur radio fraternity because it was from that shuttle that the media attention attracting slow scan TV experiments carried out by radio amateur astronaut Tony England took place on a previous mission.

Whilst NASA's aim is safety first and foremost, all spacecraft crews realise only too well that such trips still carry a large element of risk. As Alistair Cook said in his *Letter from America* radio broadcast following the disaster: 'Something like this catastrophe was bound to happen some day'. Some failures are inevitable in such 'high tech' experimental projects. Even routine aircraft flights still have their failures from time to time.

It is good to know that NASA is determined to continue its shuttle activities and we look forward to further amateur radio experiments such as those carried out from the Challenger before this disaster.

The new bands

There are so many new things coming along in amateur radio these days that it is certainly difficult to keep tabs on all of them. It was not so long ago that we were all excited about the 'new' bands we had been allocated: 10, 18 and 24MHz. So how are they faring? Of the three, 10MHz is the most popular, due obviously to the ionospheric conditions prevailing at present. Despite pretty fierce competition from the commercials still occupying that band, a good number of amateur CW signals can now be found on the band. During midday hours this is mostly short-skip, but enthusiasts can find useful DX if they choose the right hours. 18MHz and 24MHz are not showing quite such an increase in activity, but no doubt as the new solar cycle builds up conditions will improve for them too, with what will undoubtedly be most interesting results.

Council of Europe AR station

It is reported that the Council of Europe has authorised the establish-

ment of an amateur radio station at their HQ in Strasbourg. The callsign is said to be TP21 and the station was scheduled to be operative from the beginning of this year. The address for QSLs, etc, is Amateur Radio Station TP21, 8 Rue de General Ganeval, 67000, Strasbourg.

'High tech'

Your scribe has always thought what fun it would be to run a transmitter with water cooled valves – just like the commercials do! Lo and behold, in the latest edition of the *VHF/UHF Newsletter*, published by the RSGB, there appears a modification to a 7289/3CX 100-A5 valved VHF linear amplifier showing just how increased power can be safely obtained from this valve by water cooling it! Details are given of a nice little water cooled attachment which can be fitted in place of the usual air cooling radiator. That should be fun! I like it!

In the same issue of the newsletter is another good idea. G3SEK uses a fish tank aerator pump to drive dry air through his coax antenna feeder. He finds that in cold weather water vapour from warm air indoors condenses inside the cold feeder, thereby decreasing its efficiency greatly. Passing the dry air through the feeder cures the problem. He uses silica gel crystals contained in a thick plexiglass tube between the pump and the helix. The self indicating grade of silica gel is blue when dry and pink when moisture laden. It can be regenerated by baking for three to four hours at about 150 degrees centigrade. A very good idea!

The Tiros N User Group

In our November contribution to this feature we introduced the Remote Imaging Group, which had just been established to look after the interests of those who are primarily concerned with receiving the pictures sent down to Earth by weather satellites and Earth imaging satellites.

We have just received information of another group whose interests appear to be in much the same field, though its ambitions seem to be focused more on the utilisation of space platform facilities of the future than on present activities.

Peter A Stein of Liverpool has asked us to give as much publicity as possible to the Tiros N User Group. Peter has been

active in the amateur weather satellite field for some 15 years using a wide variety of equipment. His role within the group is to represent the amateur interest. The group aims to provide better links between the UK user community and NOAA in Washington and also improve the methods of providing information to users.

Within the UK, the Tiros-N Data Users Working Group is acting to increase collaboration between various data source groups and data users. In particular, improved data archiving and access systems are being considered. UK requirements and suggestions are forwarded to NOAA for consideration not only in their present programmes but also with a view to the future Columbus programme. There are already some tangible benefits from this co-operation between the UK and NOAA: increased interaction between institutes in both countries, including visits by scientists and exchanges of expertise, plus the setting up of the UK Weatherwatch programme. The group looks at areas of possible development of the Tiros-N programme and more generally acts in the interests of data users in the UK.

Peter would welcome information from amateurs who have working stations so

that an integrated picture of the amateur user can be obtained. He can be contacted at his home address: 32 Lusitania Road, Walton, Liverpool L4 6SX.

The Columbus programme is the European contribution to President Reagan's instruction to NASA to develop a space station by 1994. He subsequently invited the heads of government of the UK, France, Germany, Italy, Japan and Canada to participate in the project.

Phase-3C satellite progress

The next amateur radio satellite in the Phase-3 series is nearing completion. Work in Marburg, West Germany and in the United States is being pushed ahead for a possible launch in August from an Ariane 4 rocket. A hold up in the Ariane launch last January may result in a delay in the launch of Phase-3 C until September.

AMSAT-UK

A colloquium and social evening is being arranged at the University of Surrey, Guildford, Surrey on 5 and 6 July. A series of lectures covering up to date aspects of amateur radio satellite activities and possibly a trade show covering satellite equipment will be staged.

Meals, overnight accommodation, etc. will be available. Details from AMSAT-UK, 94 Herongate Road, Wanstead Park, London E12 5EQ.

The AMSAT-UK net on 3780kHz (\pm QRM!) on Sunday mornings at 1015 local time will in future use the callsign G0AUK, which has been allocated to AMSAT-UK. This net is usually taken by G3AAJ, except on the last Sunday in the month, when G3RWL takes it. On the latter dates, Richard gives an up to date summary of the month's AMSAT news.

G2BVN memorial trophy

Readers who knew Roy Stevens G2BVN personally, as your scribe did, will be delighted to hear that his work for amateur radio is to be commemorated by a trophy to be awarded to any radio amateur who has best exemplified the work and dedication of Roy Stevens in the field of international radio.

Radio amateurs world-wide are eligible. The trophy is to be awarded via a panel of judges set up by Region 1 IARU. Nominations for it must be made through a national radio society and have to be received by the Region 1 IARU secretary before the commencement of the Opening Plenary meeting of a Region 1 conference.

REW

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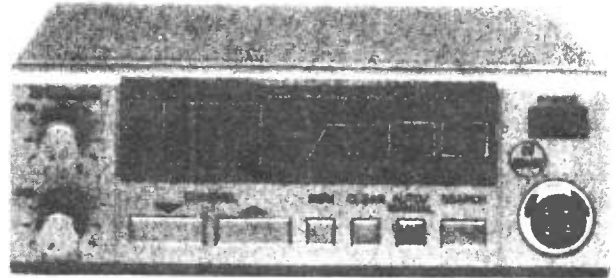
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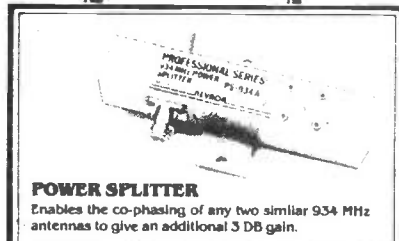
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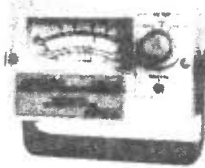
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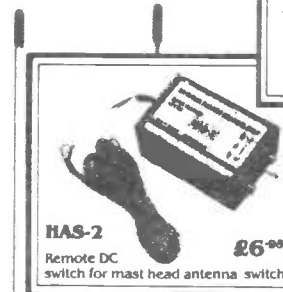
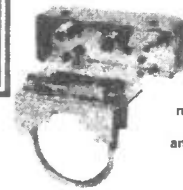
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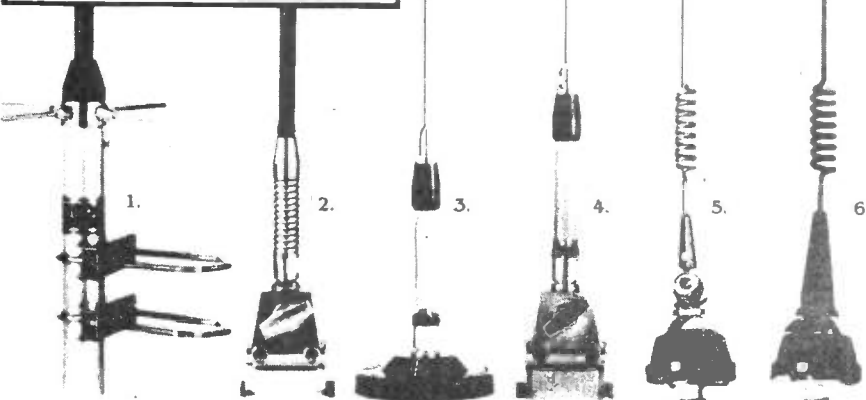
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LISTEN-ON-INPUT FOR THE ICOM IC-2

John Rowles G4ZUH details a conversion which will allow you to listen to the input of a repeater without manually altering the thumbwheel

One of the most useful features of a 2m transceiver is the ability to instantly check the input frequency of a repeater to see if a simplex contact is possible. The Icom IC-2, in common with most other synthesised 2m transceivers, achieves repeater shift by transmitting 600kHz lower than the selected receive frequency. It is therefore necessary to manually alter the thumbwheels to listen to the input of a repeater, a tedious and time consuming operation. The following conversion will allow instant push-button access to repeater frequencies.

Firstly let us consider the method used by Icom to program the phase locked loop of the synthesiser. Frequency selection is by three thumbwheels selecting the units of MHz, 100s of kHz and 10s of kHz, with a further switch adding 5kHz. Each thumbwheel is BCD coded (slightly modified on the MHz wheel to prevent out of band operation) and directly addresses the programmable divider (IC1 on your Icom circuit diagram).

The UK standard for repeater operation is for the repeater to receive

incoming signals 600kHz below its transmit frequency.

It would appear that the simplest solution to providing listen-on-input would be to use a four bit adder to alter the programming from the 100kHz thumbwheel as shown in Figure 1. This will in effect add 4 to the programmed input from the thumbwheel, which has the same result as deducting 6 when there is no 'carry-out' to consider. This method would provide the facility of reducing the programmed frequency by 600kHz when switch S1 is depressed.

Difficult to achieve

Practically this proved to be very difficult to achieve, due to the lack of space inside the IC-2 to accommodate a 16-pin integrated circuit. Alternative methods were therefore considered.

In the UK repeaters use only R0 to R7, that is, output frequencies from 145.600 to 145.775MHz inclusive. Therefore for repeater use the 100kHz thumbwheel will be set to either 6 or 7 and the BCD codes presented to the programmable divider will be either 0110 (6) or 0111 (7). Now the input frequencies to the repeaters range from 145.000 (R0) to 145.175MHz (R7), so to listen to a repeater input frequency the 100kHz thumbwheel would be set to 0 or 1 and the BCD codes generated would be either 0000 (0) or 0001 (1). It can be seen from this that if the two middle bits of the BCD codes for 6 and 7 are reset from logic 1 to logic 0 the effect is to present the codes for 0 and 1 to the programmable divider, in other words 'listen-on-input'.

Disadvantages

The disadvantage of this approach is that a downshift of 600kHz will only occur when the thumbwheel is set to 6 or 7, as can be seen from Table 2. Listen-on-input for R8 (145.800MHz) as used in Europe will therefore not be available.

Practically this approach only requires the switching of the two centre bits of the BCD code from the 100kHz thumbwheel, and enables a more compact board to be produced that can be easily accommodated inside the IC-2.

The method finally decided on to achieve this was to insert two transistor switches between the thumbwheel and programmable divider IC as shown in Figure 2.

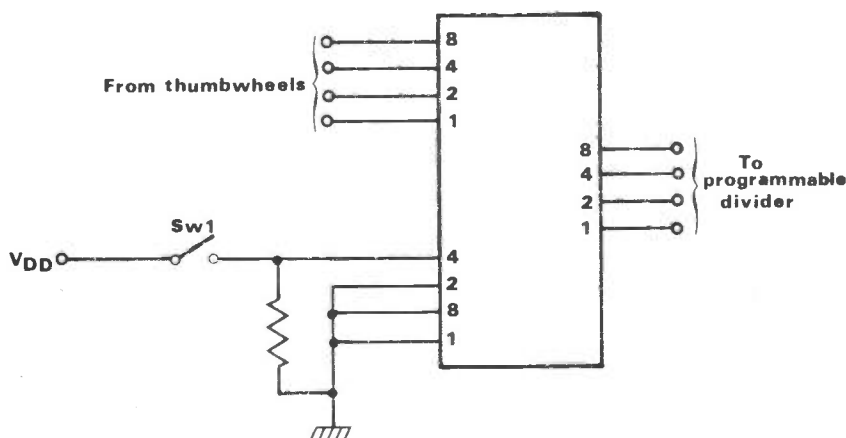


Fig 1 Showing use of a 4-bit adder to alter the programming from the 100kHz thumbwheel

100kHz thumbwheel setting	Normal				S1 depressed			
	1	2	3	4	1	2	3	4
6	0	1	1	0	0	0	0	0
7	0	1	1	1	0	0	0	0

Table 1 Showing BCD pattern

Table 2 Showing that a down-shift of 600kHz will only occur when the thumbwheel is set to 6 or 7

Selected setting	BCD code	Adjusted code	Adjusted setting	Shift
0	0000	0000	0	Nil
1	0001	0001	1	Nil
2	0010	0000	0	-200kHz
3	0011	0001	1	-200kHz
4	0100	0000	0	-400kHz
5	0101	0001	1	-400kHz
6	0110	0000	0	-600kHz
7	0111	0001	1	-600kHz
8	1000	1000	8	Nil
9	1001	1001	9	Nil

Now considering the internal layout of the IC-2, the thumbwheels are connected to the programmable divider by a 'flexible board', which in effect is a specially formed type of ribbon connector. This does not lend itself to easy alteration, and to enable the IC-2 to be easily returned to original specification, if so desired at some later date, it was decided to insert a further board between the flexible board and the programmable divider. The switch S1 can be that incorporated in the volume control of the IC-2 if the previously described conversion to auto-tone (R&EW December 1985) has been done, or alternatively a replacement volume control can be obtained from an Icom dealer and installed in place of the squelch control (both are 10k).

Construction

The PCB should be etched on the thinnest section board you can obtain. SRBP based material is perfectly suitable in this application and is normally available in thinner grades than fibreglass. The board layout itself should be strictly adhered to as space is at a premium inside the IC-2, and the dimensions shown can just be accommodated.

The two transistors and resistors are soldered to the track side of the board, as shown in Figure 4. Tr2 is mounted in line with the board and Tr1 at about 30° from the vertical to reduce height clearance. R1 and R2 are mounted vertically as shown, or if you prefer, alternative mounting holes are provided to allow horizontal mounting. If 1/8W resistors cannot be obtained 1/4W can be accommodated, but R1 will require mounting at an angle to reduce height clearance to about 4mm above the board surface, and R2 can be positioned horizontally on top of Tr2. Take care that R1 will not short-out on the VCO case if the larger resistors are used.

All component leads should of course be as short as possible, and a fine pencil-bit soldering iron is essential. At this stage solder in the flying lead of thin covered flex that will connect to S1. New mounting posts must be provided for the flexible board. This is achieved by cutting twelve 10mm lengths (about the shortest length easily handled) of 20swg tinned copper wire and soldering these into rows B and D on the board so that they stand proud on the track side.

To check that the flexible board will locate easily on these posts use a piece of 0.1 matrix board (Vero etc) to ensure that the newly installed posts are accurately aligned, adjusting as necessary. Cut these pins down to 4mm height above the board and again check them with the matrix board. Finally, on the non-track side of the board cut off any protruding leads flush with the surface.

Before installing the new board it would be prudent to carefully check for

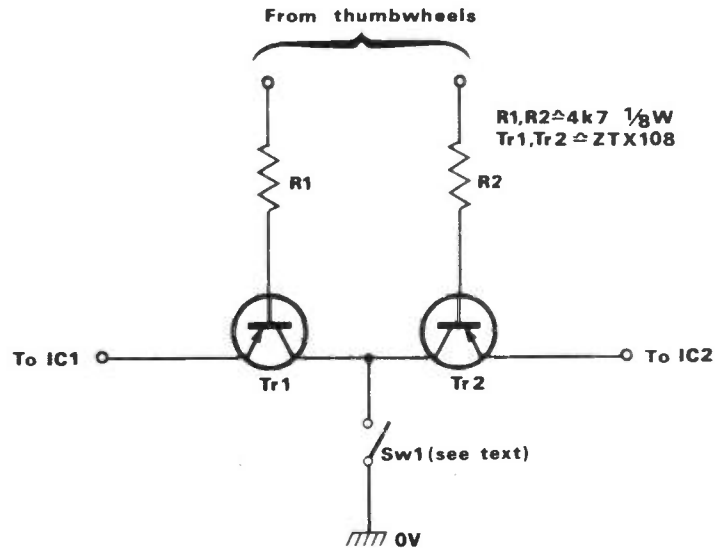


Fig 2 Showing the two transistor switches between the thumbwheel and the IC

solder bridges and then to test the board as follows. Using a 5V dc supply, connect the positive to pin 1 of row B and a logic probe or meter between pin 1 of row A and 0V on the power supply. A reading of about 4 1/2V or logic 1 should be seen. Connect the flying lead to 0V of the power supply and the reading should drop to 0V or logic 0. Repeat for pin 2. If all is well then proceed to the next stage.

Installation

Carefully desolder the flexible board from its mounting posts either side of IC1. Use the minimum heat possible to avoid damage. Ease the flexible board off its mounting and lay it to one side. Locate the new board, track side up, on the mounting posts. It may be necessary to file the bottom corner of the board to clear the electrolytic capacitor mounted next to pins 15 and 16 of IC1.

Check the height clearance of Tr1, R1, R2 and the mounting posts by laying a straight edge across the side members of the IC-2 chassis. Adjust if necessary. If all is well solder the board into position. Check at this stage for solder bridges, as these connections will be obscured by the flexible board.

Next, position the flexible board on its new mounting posts and solder in. Note at this point that there is a break in the tracks of the flexible board adjacent to pins X and Y (see Figure 5). If the break at pin X is bridged then the IC-2 will cover 144 to 148MHz. Do not, however, bridge the gap on pin Y. Finally, connect the flying lead to the position on the volume control switch where the orange lead was removed in the auto-tone conversion, or alternatively to the new switch on the squelch control (the other side of this switch is connected to 0V). Listen-on-input is now installed.

Testing

Set the frequency on the thumbwheels to 145.600MHz, connect a well smoothed and regulated 8 to 9V supply to the IC-2 and switch on. Using a logic probe or meter set to 5V range, check that the programming on the programmable divider, IC1, is 0110 for the 100kHz switch output (see Figure 5). Depress the listen-on-input switch - the programming should change to 0000.

Repeat with the thumbwheels set at 145.700, when 0111 and 0001 should be found respectively.

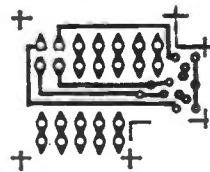


Fig 3 Pattern showing track side

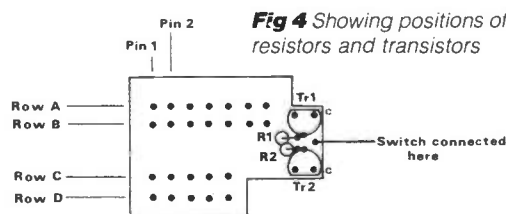
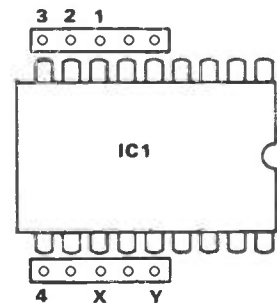


Fig 4 Showing positions of resistors and transistors

Fig 5 IC1 programmable divider



A USER REVIEW OF THE ICOM IC-R71E GENERAL COVERAGE RECEIVER

by Ken Michaelson G3RDG



This is the second user review of a general coverage receiver that I have carried out recently, which makes the examination of this particular receiver all the more interesting. In my review of the Trio R-2000, in the February 1986 issue, I said that I used the Trio R-1000 as my normal receiver and that it was useful to compare the new updated unit with my own equipment.

Well, let me tell you at the start that the Icom IC-R71E is a different kettle of fish altogether. It is in a different class. That is not to deprecate the Trio R-2000, but the cost of the R71E is half as much again as the R-2000 and this is reflected in the facilities which are available. At the outset there are 32 tunable memories, but I think I had better start at the beginning.

Impressive specification

The specifications of the receiver are very impressive. There are 90 transistors, 19 FETs, 47 ICs (including the CPU) and 237 diodes. The frequency control is a CPU-based 10Hz step digital PLL synthesizer with a dual VFO system. The frequency stability is stated to be less than 200Hz between 1 and 60 minutes after switch-on and less than 30Hz after 1 hour. With the optional CR-64 high stability crystal it is possible to improve on this already excellent figure, the crystal giving less than ± 50 Hz from 1 to 60 minutes after switch-on to less than ± 10 Hz after one hour of normal room temperature.

I did not have the necessary equipment to measure this stability for myself, but I

used the unit for the reception of FAX broadcasts emanating from various weather centres. In order to copy these pictures correctly it is essential that the receiver does not drift. I can only say that when this receiver was used the picture reception remained rock steady. This was also the case in the reception of commercial RTTY transmissions.

Quadruple conversion

The unit is a quadruple conversion superhet with continuous bandwidth control (passband tuning). This is similar to several other makes of receivers and transceivers, although it is called different names by different manufacturers.

In the FM mode, when the optional module is fitted, the receiver acts as a triple conversion superheterodyne. The sensitivity on SSB, CW and RTTY is less than 0.15 microvolts for 10dB S+N/N, except between 0.1MHz and 1.6MHz where it is 1 microvolt.

The AM sensitivity is less than 0.5 microvolts, also with the qualification that between 0.1MHz and 1.6MHz it is 3 microvolts. The selectivity is also exceptional: on SSB, CW and RTTY it is 2.3kHz at -6 dB adjustable down to 500Hz minimum, and the -60 dB figure is 4.2kHz. On CW narrow and RTTY narrow (achieved by switching in the 'narrow' filter) it is 500Hz at -6 dB and the -60 dB reading is given as 1.5kHz.

The AM selectivity is 6kHz at -6 dB adjustable to 2.7kHz minimum, and is 15kHz at -50 dB. The FM figures where the module is fitted are 15kHz at -6 dB and 25kHz at -60 dB. The weight of the

unit is 7.5kg (16.5lbs) and it requires 117 or 235 volts $\pm 10\%$ at 50/60Hz. To operate the receiver on 100/200/220 volts requires internal modifications.

The receiver is 111mm ($4\frac{3}{8}$ in) high $\times 286$ mm ($11\frac{1}{4}$ in) wide $\times 276$ mm ($10\frac{7}{8}$ in) deep. It is finished in battle ship grey with the front panel and surround in a darker shade of grey. The six-digit frequency readout, together with the mode, memory channel number and VFO information, is displayed at a window slightly to the right of centre. Immediately under it is the tuning knob, a very substantial affair with a beautiful feel about it. To the right and left of the tuning knob are four push on/push off switches at either side, but these will be examined later.

S-meter

To the left of the frequency display is the S-meter, calibrated in 'S' units to $+40$ dB, and below that is a line of push on/push off switches for the modes of reception.

There are four modes available in standard form: SSB, AM, RTTY and CW. There is an optional plug-in unit to provide for FM reception but this was not available for the review.

Below these four are two more controls, the left-hand one being the pre-amp/off/attenuator switch and the right-hand one the wide/narrow filter switch. At the top left are two more controls and two more push on/push off switches. The right-hand control operates the AGC (off/fast/slow) and the left-hand one works the noise blanker threshold with

the switches for operating the noise blanker below. There are also facilities for altering the blanking time (narrow/wide) and, as mentioned above, the threshold. A very comprehensive facility, this.

Phone socket

To the left again, at the bottom, are the phone socket, the record socket (a 3.5mm one), dual-ganged RF and audio gain controls, and dual-ganged tone and squelch controls. This squelch control is a recent innovation in general coverage communications receivers, and one has to remember its existence. Having said that, there is no doubt of its usefulness. I did not have the FM module of the receiver for review purposes, but I am sure that the squelch control would have been able to show its paces in that mode.

To the right of the tuning knob is the numerical keyboard entry pad, where one can key any frequency and either enter or cancel the operation by means of keys labelled 'CE' or 'ENT'.

There are two VFOs in this receiver, and this fact, added to the 32 memories which are available, gives the operator complete freedom of choice in the matter of deciding which frequencies to use. To the left of the keypad are four more push on/push off switches. From top to bottom these are: 'speech', which if pressed when the optional speech synthesizer is installed announces the displayed frequency in English; 'M to VFO' (frequency transfer switch) which, when in VFO operation, transfers the frequency and mode in the memory channel whose number is shown on the readout to the selected VFO; 'A=B' (VFO equalising switch), which instantly sets the frequency of one VFO to the same as the second VFO; and 'A/B' (VFO switch), which selects either VFO 'A' or VFO 'B' at the user's choice.

Memory channel switch

Immediately below the keypad is the memory channel switch, a rotary one with the 32 positions mentioned earlier, and to the right are the 'write/clear' switch and the notch switch. To the right again is the dual-ganged passband tuning/notch control.

There are eight more switches, four either side of the main tuning control. The top left-hand one is the 'dimmer switch', which does exactly what it says. The next one down is 'scan', which starts and stops any of the scan functions. When the scan switch is depressed on its own the unit will scan all the memory channels continuously, regardless of the mode selected in the memory (it will skip all blank channels, and will not start on a blank channel). If the squelch is engaged, the scan will stop when the squelch is opened and a signal is received, and will restart after a specified time.

The operation of scanning can be stopped at any time by pressing the scan switch again. If both the scan and 'mode-S' are depressed, then the unit will only scan those channels in the memory which have the same mode of operation as the commencing channel. That is to say, if you start with a memory channel in USB the unit will only scan those other channels which are also USB, and so on.

There is also another variation of scanning available to the operator, and that is 'programmed scan'. In this case one puts into the memory in channels 1 and 2 the upper and lower limits of frequency which one wishes to scan, then switches to VFO on the 'VFO/M' switch, presses scan, and behold, the unit scans over the limits of the two frequencies originally put in, starting at the higher frequency and, when reaching the lower limit, reverting back to the higher one again and repeating the process.

The rate of scan is altered by the tuning rate (top switch, right-hand side, labelled 'TS'). In this situation the squelch control may also be used, so that if one is waiting for a sked between, say, 14300 and 14200 the unit can be programmed to scan between these two frequencies indefinitely, stopping at any signal which might open the squelch and which might be the one you are waiting for.

Optional extra

An optional extra which can be obtained is an infra-red remote controller similar to those which control modern day television sets. This contains a keypad with most of the controls which appear on the front panel of the set on it, and which I have discussed above, so that the receiver may be controlled from a distance.

To operate this, the 'remote' switch (bottom left of the tuning knob, finished in chrome) is depressed, and a red indicator appears just to the right of the display area.

The other chrome finished switch (bottom left of the tuning knob) is the 'dial lock', through which the operation of the VFO is electronically locked at the displayed frequency so that an accidental touch will not disturb the tuning. The lock is disconnected by pressing the switch again, which is a good idea.

On the rear panel of the receiver is the usual mains input socket, the fuse holder and a phono socket for the take-off of the 70.4515MHz IF. This is intended to be fed to either an oscilloscope for the displaying of the incoming signal or to a panadapter to show what might be on the segment of the band that is being used.

There are also two antenna inputs, one the normal 50 ohm SO259, and the other a 4mm socket for a long wire intended for frequencies below 1.6MHz. There is also a socket for an extension speaker.

Underneath the set at the front is a little screw which, when screwed in, acts like a brake to the tuning knob. It is therefore possible to get the exact amount of friction that any owner might require in the movement of the tuning knob by the adjustment of this screw.

I was completely at home with the receiver after I had absorbed the instructions in the comprehensive owner's manual, and this is a point I must stress. It is vital for anyone owning this excellent piece of equipment to read and read again the guidance and advice given in the manual. By so doing, full benefit will be obtained from the many facilities available in the receiver and it will be used safely.

Appreciated

Although I have had the receiver since before Christmas, only recently have I begun to appreciate the finer points in the circuitry. I use Amtor a lot and I arranged to connect up my existing transceiver, a Trio TS820S, so that I could use the IC-R71E as the receiving section. I am afraid that I am sadly disillusioned with the receive section of my own rig! Stations which I thought I couldn't copy with my own unit, even on Amtor, have been perfectly readable, although I have a shocking amount of electrical interference on 80 metres.

I can't say that I have any gripes about the unit, except perhaps to wonder at the need for 32 memories! Also, why would one want to control this beautiful piece of equipment remotely? However, what I think is unnecessary may be essential for somebody else.

I was very impressed with the smoothness of the tuning drive and the operation of the 'notch', the latter being of great help on my favourite band, 80 metres. All in all, I can thoroughly recommend the IC-71E as a dream receiver. I was extremely sorry to have to return it to the suppliers.

The cost of the basic receiver is £729 including VAT, and there are twelve optional extras available (see table).

Thanks are due to Thanet Electronics Ltd, Sea Street, Herne Bay, Kent CT6 8LD (telephone: (0227) 363859) for the loan of the receiver for the purpose of this review.

REW

ICOM IC-R71E OPTIONS

CK-70 dc cable kit (12 volt)	£6.50
CT-10 computer interface/terminal unit	£339.00
IC-EX257 FM unit	£37.00
IC-EX309 computer interface connector unit (R71 only)	£44.00
FL-63 CW narrow filter (250Hz/-6dB)	£46.00
FL-44A high grade SSB filter (2.4kHz/-6dB)	£89.00
IC-HP1 headphones	£29.95
RC-11 infra-red remote controller	£56.43
IC-EX319 voice synthesizer unit (R71 only)	£42.00
IC-SP3 external speaker	£55.99

All the above prices are inclusive of VAT

SEE AND HEAR ICOM AT THE N.E.C.

This year at the N.E.C. Exhibition Thanet Electronics will be introducing the complete range of ICOM Amateur Radio Equipment. You will be able to try out and purchase accessories, receivers and transceivers in all popular frequency bands. The range and scope of these will enable you to appreciate the superb specifications and quality of ICOM equipment.

Stand D4

IC-735, The Complete HF Radio



The new ICOM IC-735 is ideal for mobile portable or base station operation. It has a general coverage receiver from 0.1MHz to 30MHz and transmits on all amateur bands from 160m to 10m. SSB, CW, AM and FM modes are included as standard. RTTY and Amtor are also possible. The IC-735 has a built-in receiver attenuator, pre-amp, noise blander and RIT to enhance receiver performance. A 105dB dynamic range with pass band tuning and a sharp I.F. notch filter for superior reception. The twin VFO's and 12 memories can store mode and frequency. The HM12 scanning mic is supplied. Scanning functions include programmes scan, memory scan and frequency scan. The IC-735 is one of the first H.F. transceivers to use a liquid crystal display which is easily visible under difficult conditions. Controls that require rare adjustment are placed behind the front panel hatch cover but are immediately accessible. Computer remote control is possible via the RS-232 jack. Output power can be adjusted from 10 to 100 watts with 100% duty cycle. A new line of accessories are available, including the AT150 electronic automatic antenna tuner and the PS55 AC power supply. The IC-735 is also compatible with most of ICOM's existing line of HF accessories. See the IC-735 at your authorised ICOM dealer or contact Thanet Electronics Limited.

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IC-505, 50MHz Transceiver



The IC-505 is a 50MHz band SSB, CW transceiver, and has already gained an excellent reputation worldwide. The dual VFO system has been developed using advanced computer and PLL technology. The IC-505 features 6 channel memories and can be used independent of emission modes, memory scan, program scan which searches only specified frequency band. LCD ensures clear visibility even in sunlight. The R.F. amplifier, a dual gate MOSFET features high gain and low noise characteristics. The IC-505 accepts a standard dry cell pack, rechargeable nicad battery pack (BP10) or 13.8v external power supply, 3 watts R.F. output, 0.5 watts low power, 10 watts at 13.8v. Accessory circuits include split frequency operation, noise blanker, squelch and CW break-in. Options include: - PS45 AC Power Supply.

All these features make the IC-505 a great transceiver for operation on the 50MHz band

IC-R71E, General coverage receiver.



The ICOM IC-R71E 100KHz to 30MHz general coverage receiver features keyboard frequency entry and infra-red remote controller (optional) with 32 programmable memory channels, SSB, AM, RTTY, CW and optional FM. Twin VFO's scanning, selectable AGC, noise blanker, pass band tuning and a deep notch filter. With a direct entry keyboard frequencies can be selected by pushing the digit keys in sequence of frequency. The frequency is altered without changing the main tuning control. Options include FM, voice synthesizer, RC-11 infra-red controller, CK70 DC adaptor for 12 volt operation, mobile mounting bracket, CW filters and a high stability crystal filter.

The ICOM Control System

If you have a BBC Micro (Model B) or Commodore 64 or 128, the ICOM control system can control up to four (or more) ICOM radios in the range: IC-751, 735, R71, R7000, 271, 471 and 1271 (and 745 with modification). The help menu shows the available functions. The system will be displayed at N.E.C. BCNU.

Stand D4

	H = HELP	↔	Frequency Steps
FO	Frequency	↑ ↓	Up/Down (arrows)
F1	Select Mode	M	Memory Channel
F2	Freq/Memory Scan	..	Memory Up/Down
F3	Mode Scan	/	VFO/Memory
F4	VFO → Memory	B	Bargraph Select
F5	Memory Write	@	Occupancy On/Off
F6	Memory Clear	.	Scan Stop Off/On
F7	Set 'SIG' Level	S	Change Set
F8	Memory File Read	DEL	Speech (If fitted)
F9	Memory File Write	Q	Quit

Thonet ICOM Thanet Electronics
 Sea Street, Herne Bay, Kent CT8 8LD
 Tel: (0227) 363859
 Dept. RW

COMPUTING

LOW-PASS FILTERS

by Brian Kendal G3GDU and Jeff Howell G4BZX

The low-pass filter is one of the most frequently encountered circuits in radio and electronics. It may be used for many purposes, including tailoring the response of an audio amplifier; stereo decoders; cleaning up the output of oscillators; modifying a waveform; or limiting the harmonic output of a transmitter.

Ideally such a filter would have no effect on the circuit of which it forms part below a certain frequency (known as the cut-off frequency), and above this it would act as an open circuit. However, in the real world nothing is that perfect and practical filters exhibit quite a low attenuation below cut-off frequency, rapidly increasing as this is approached and passed until a relatively high level of attenuation is finally reached.

As may be imagined, in attempting to match the ideal characteristic many different low-pass filter designs have been developed, each with its own characteristics and complexities, the best known being the Bessel, Butterworth, Chebyshev and elliptic.

The Chebyshev and elliptic are both capable of extremely sharp cut-off characteristics but to achieve this they require precise component values. In practice, these either use variable capacitors and inductances which are tuned for optimum response or, alternatively, are constructed with very close tolerance components.

The Bessel filter has certain special qualities but these are not likely to be useful in amateur radio equipment.

Finally, there is the Butterworth filter which, although requiring a few more components than other types, is very tolerant to mismatch and component values and exhibits an increasing stop-band attenuation with frequency. In many ways, therefore, the Butterworth filter is the best choice for home constructors.

Construction

The Butterworth low-pass filter consists of a ladder network of series inductors and parallel capacitors whose arrangement and values are decided by

two factors: the operating frequency and the terminating impedances.

The frequency response of the filter depends only on the order, which in this design is equal to the total number of components.

Design procedure

In designing a low-pass filter, three decisions must be made. The first of these is the order, which will determine the frequency characteristic, and the second is the form of the filter, which will be based on the termination impedances and the operating frequency. Finally, the cut-off frequency must be specified.

With this information, the programs in this article will calculate the frequency response of the filter and the component values.

Order of filter

The shorter program is intended to assist the designer in selecting the order of the filter. The user chooses a trial cut-off frequency, filter order and a range of operating frequencies. The program then calculates the frequency response of the filter specified over that frequency range, plus that of filters of one order higher and lower.

The user may then examine the table and determine the filter most suitable to meet the requirement.

Form and cut-off frequency

Since the networks contain only passive components, the filter response is not dependent on the direction in which the signal passes. There are therefore only four configurations with which we need be concerned:

- (1) Equally terminated, capacitor input;
- (2) Equally terminated, inductor input;
- (3) Open circuit on one side;
- (4) Short circuit on one side.

In this context, the terms open and short circuit mean that the impedance ratios are 5:1 or more.

A common base transistor amplifier would therefore usually represent a short circuit load, while an emitter follower may be treated as a short circuit or voltage source. An FET gate input would be an example of an open circuit load.

Designing the filter

The main factor in selecting a filter design is the purpose for which it will be used, because not only has the efficiency of the filter to be considered but the cost may also prove a significant factor. For example, in transmitter circuits coils are relatively cheap to construct, especially at VHF, where low loss, high voltage capacitors may prove expensive and in

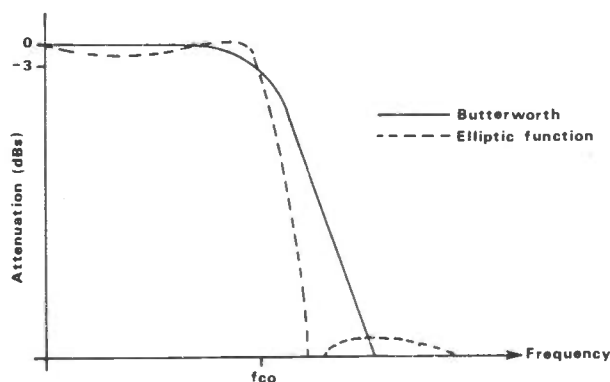


Fig 1 Frequency response of third order filters

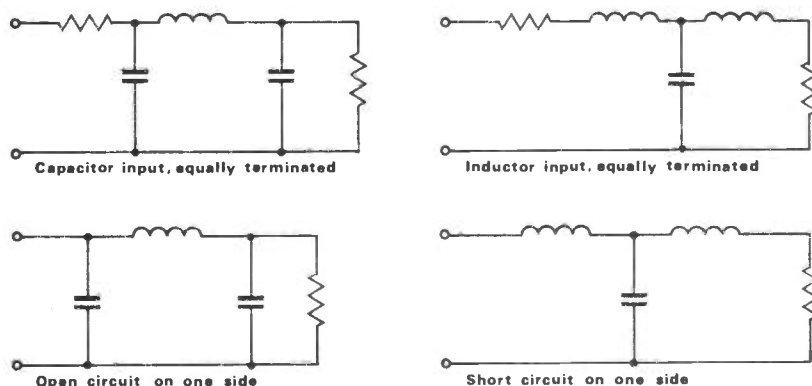


Fig 2 The four filter configurations considered in the text

consequence inductive input designs may prove more economical.

In RF power circuits the equally terminated form of filter is to be preferred, for it is the only type which will show a 1:1 VSWR across the pass-band.

In audio circuits inductance values tend to be high and hard to attain, whilst although miniature inductors up to about 1H are commercially available, in general these easily saturate when subjected to either dc or even modest signal power. It is therefore desirable to use dc blocking capacitors in conjunction with a capacitor input filter wherever possible.

Calculation of component values

The filter transfer function is the basis of the final filter design, uniquely determining the attenuation of the filter at any given frequency. Although this could be calculated from scratch, it would add considerably to the length of the program. The function coefficients have therefore been pre-calculated for up to 8th order filters. Should an application be found which apparently needs beyond 8th order, it would be wise to consider the use of a different filter.

In using this program, the filter configuration and the cut-off frequency, terminating impedance and filter order are selected. Only one terminating impedance is requested, as the other is either zero, infinite or the same.

The program will then calculate the component value which will rarely be seen to coincide with standard preferred values. The effect of errors in component values in this type of filter is to slightly reduce attenuation at high frequencies and increase losses near the cut-off frequency.

The Butterworth filter, however, is very tolerant to component value variations and if the nearest preferred value is used, there will usually be little deviation from the predicted response.

Program descriptions

1. Frequency response predictor

The action of the program commences at line 30 which defines a function that converts relative frequency and order of filter into an attenuation in decibels. Line 60 prints the heading, and lines 80 to 180 invite the user to select the cut-off frequency, order of filter and the range of frequencies to be displayed in the response table. In each case, the validity of the selected parameters is checked and if the selection fails this test the request is repeated.

Lines 190 to 220 then generate the heading for the table, and line 240, which is located within a FOR-NEXT loop, performs the necessary calculations and prints the results within the table.

Finally, at lines 260-290 the user is invited to re-run the program, any reply other than 'Y' for yes terminating the program at line 300.

Program 2

2. Filter design program

This program commences by declaring two arrays, which are later used in the transfer function analysis. Line 40 then restores the data pointer to the start of the program data statements at line 250.

Lines 50 to 120 print a menu for selection of filter type which is entered at line 140 and validated on the following line. Lines 160 to 240 invite the entry of the cut-off frequency, order of filter and terminating impedance, validating each before proceeding.

The transfer function coefficients are then read in from lines 250 to 260 by the nested FOR-NEXT loops in 270 to 330. These start with the 2nd order coefficients, overwriting with each higher order until the desired order is reached. This data is then modified at line 360 to allow for unequal terminations, and is

converted by lines 370 to 420 into the normalised component values for a capacitor input type of filter.

The actual component values are printed at lines 430-500, in which line 460 selects a denormalising routine appropriate to the filter input component type.

These subroutines, which are located at lines 560-690, determine the value of capacity or inductance to achieve the desired impedance, giving the reply in appropriate units.

Since the ladder network branches always alternate between capacitor and inductor, line 480 is required to alternate the type index 'T' after calculating each branch. This is permissible as 'T' is not used again in the program.

In conclusion, the user is invited to re-run the program at lines 520-540, and if this is not accepted it stops at 550.

```

10 REM BUTTERWORTH FILTER RESPONSE
20 REM J.M.HOWELL OCTOBER 1985
30 DEF FNA(N)=-INT(4.342*LOG(1+(F/FCO)^(2*N))*100)/100
40 CLS
50 PRINT
60 PRINT "FILTER FREQUENCY RESPONSE"
70 PRINT
80 PRINT "ENTER CUTOFF FREQUENCY"
90 INPUT FCO
100 IF FCO<=0 THEN GOTO 90
110 PRINT
120 PRINT "ENTER LOW,STEP AND HIGH FREQUENCY"
130 INPUT FL,FS,FH
140 IF FL<0 OR FH<=FL OR FH-FL<=FS THEN GOTO 130
150 PRINT
160 PRINT "ORDER OF FILTER (2-8)"
170 INPUT N
180 IF N<2 OR N>8 THEN GOTO 170
190 PRINT
200 PRINT "DB LOSS AT";TAB(15);"FILTER ORDER"
210 PRINT "FREQUENCY";TAB(11);N-1;TAB(19);N;TAB(27);N+1
220 PRINT
230 FOR F=FL TO FH STEP FS
240 PRINT F;TAB(11);FNA(N-1);TAB(19);FNA(N);TAB(27);FNA(N+1)
250 NEXT F
260 PRINT
270 PRINT "RUN AGAIN (Y/N)"
280 INPUT AS$
290 IF AS$="y" OR AS$="Y" THEN GOTO 40
300 END

```

Butterworth filter response program

FILTER FREQUENCY RESPONSE	FILTER FREQUENCY RESPONSE
ENTER CUTOFF FREQUENCY 180	ENTER CUTOFF FREQUENCY 180
ENTER LOW,STEP AND HIGH FREQUENCY 120 10 180	ENTER LOW,STEP AND HIGH FREQUENCY 450 10 500
ORDER OF FILTER (2-8) 5	ORDER OF FILTER (2-8) 5
DB LOSS AT FILTER ORDER FREQUENCY 4 5 6	DB LOSS AT FILTER ORDER FREQUENCY 4 5 6
120 -.16 -.07 -.03	450 -31.83 -39.78 -47.74
130 -.31 -.16 -.08	460 -32.59 -40.74 -48.88
140 -.54 -.33 -.2	470 -33.34 -41.67 -50
150 -.9 -.65 -.46	480 -34.07 -42.58 -51.1
160 -1.42 -1.16 -.94	490 -34.78 -43.48 -52.17
170 -2.12 -1.94 -1.77	500 -35.48 -44.36 -53.23
180 -3 -3 -3	
RUN AGAIN (Y/N) Y	RUN AGAIN (Y/N) N Ready

Filter response program printout

COMPUTING LOW-PASS FILTERS

```

10 REM BUTTERWORTH FILTER DESIGN
20 REM J.M.HOWELL OCTOBER 1985
30 DIM B(8),X(8)
40 RESTORE
50 CLS
60 PRINT
70 PRINT "    SELECT FILTER TYPE:"
80 PRINT
90 PRINT "1. EQUAL TERMINATIONS - CAPACITOR INPUT"
100 PRINT "2. EQUAL TERMINATIONS - INDUCTOR INPUT"
110 PRINT "3. OPEN CIRCUIT OR CURRENT SOURCE"
120 PRINT "4. SHORT CIRCUIT OR VOLTAGE SOURCE"
130 PRINT
140 INPUT T
150 IF T<1 OR T>4 THEN GOTO 140
160 PRINT "CUT-OFF FREQUENCY (KHZ)"
170 INPUT F
180 IF F<=0 THEN GOTO 160
190 PRINT "ORDER OF FILTER (2-8)"
200 INPUT N
210 IF N<2 OR N>8 THEN GOTO 200
220 PRINT "TERMINATING IMPEDANCE (OHMS)"
230 INPUT Z
240 IF Z<=0 THEN GOTO 230
250 DATA 1.414,2,2.613,3.414,3.236,5.236,3.864,7.464,9.141
260 DATA 4.494,10.103,14.606,5.126,13.138,21.848,25.691
270 FOR I=2 TO N
280 J=INT(I/2)
290 FOR K=1 TO J
300 READ B(K)
310 B(I-K)=B(K)
320 NEXT K
330 NEXT I
340 B(0)=1
350 B(N)=1
360 IF T<3 THEN B(N)=2
370 FOR I=N TO 1 STEP -1
380 X(I)=B(I)/B(I-1)
385 IF I<3 THEN GOTO 420
390 FOR J=I-2 TO 1 STEP -2
400 B(J)=B(J)-X(I)*B(J-1)
410 NEXT J
420 NEXT I
430 PRINT "BRANCH", "VALUE"
440 IF T<3 THEN PRINT 0,Z;TAB(30);"OHMS"
450 FOR I=1 TO N
460 ON T GOSUB 560,640,560,640
470 PRINT I,INT(C*1000)/1000;TAB(30);US
480 T=5-T
490 NEXT I
500 PRINT N+1,Z;TAB(30);"OHMS"
510 PRINT
520 PRINT "RUN AGAIN (Y/N)"
530 INPUT AS$
540 IF AS$="Y" OR AS$="Y" THEN GOTO 40
550 STOP
560 C=159*X(I)/F/Z
570 US$="UF"
580 IF C>.1 THEN RETURN
590 US$="NF"
600 C=C*1000
610 IF C>1 THEN RETURN
620 US$="PF"
630 GOTO 680
640 C=X(I)*Z/F/6.28
650 US$="MH"
660 IF C>.1 THEN RETURN
670 US$="UH"
680 C=C*1000
690 RETURN

```

Butterworth filter design program

Test problem

In accordance with our usual practice, we have included a test problem which will enable the user to confirm that the program has been correctly entered and to gain a little experience.

The requirement is to design a low-pass filter which shows an attenuation of less than 0.5dB at 145MHz but more than 40dB at 470MHz. The terminating impedances are 50 ohms.

As an opening essay, a fifth order filter with a cut-off frequency of 180MHz is selected. The prediction program is then

run twice, once looking at the response just below cut-off frequency and the second for frequencies around 450MHz. The predictions confirm that a fifth order filter will prove suitable. In this application, the second filter configuration is a natural choice.

It now remains to run the design program, which indicates that inductance values of 88nH and 27nH are required. From our coil design program, which has previously been published in *Radio and Electronics World*, it will be found that self supporting coils of 1.5

SELECT FILTER TYPE:

1. EQUAL TERMINATIONS - CAPACITOR INPUT
2. EQUAL TERMINATIONS - INDUCTOR INPUT
3. OPEN CIRCUIT OR CURRENT SOURCE
4. SHORT CIRCUIT OR VOLTAGE SOURCE

```

2
CUT-OFF FREQUENCY (KHZ)
180000
ORDER OF FILTER (2-8)
5
TERMINATING IMPEDANCE (OHMS)
50
BRANCH      VALUE      OHMS
0            50          UH
1            .027        UH
2            28.587       PF
3            .088        UH
4            28.586       PF
5            .027        UH
6            50          OHMS

```

RUN AGAIN (Y/N)

N

Break in 550

Design program printout

turns and 3.5 turns of 24swg close-wound, 5mm in diameter proved suitable.

The calculated capacitor values are 28pF. However, the nearest preferred value of 27pF will be acceptable.

Postscript

This program has been written in standard Microsoft Basic and as such should run with little or no modification on most home microcomputers.

This, like all other programs which we have published over the past year or so in *Radio and Electronics World*, has been tested before submission on both Sanyo and BBC computers. In addition, we have received many letters describing readers' experiences with other machines. To our delight, it would appear that little difficulty has been experienced when using these programs with almost any home or personal computer although, as may be expected, Sinclair machines presented the most problems because of their particular dialect of Basic.

We have now come to the stage, however, where it is getting increasingly difficult to select further topics and we invite readers to write to us, recounting their experiences with programs and suggesting further topics for treatment.

Before making suggestions, however, please note that:

1. We see little point in writing programs which are either adequately covered elsewhere, or are elementary calculations (such as series/parallel resistors, Ohm's Law) which can be performed more easily on a pocket calculator.
2. We will not publish any program which contains any formula which we cannot verify independently. In this context, we have already found certain 'standard' formulae to be in error.
3. We do not include graphics or sound as these would make the programs machine specific.

REW



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DATA FILE . . .

In last month's edition of *Data File* we gave an introductory outline to the discrete bipolar transistor and its basic characteristics, and then went on to present a round-up of popular application configurations. In the present edition of 'The File' we continue the transistor theme by taking a detailed look at the common-collector transistor amplifier and its derivatives.

To refresh the reader's memory, *Figure 1* shows the circuits of the three basic amplifier configurations discussed last month, and *Figure 2* details the comparative performances of these three amplifiers. Note in particular that the common-collector amplifier gives near unity overall voltage gain but features a high input impedance value, while the common-emitter and common-base amplifiers both feature high values of voltage gain but give only low-to-medium values of input impedance.

The common-collector amplifier (also known as the grounded-collector amplifier, the emitter follower, or the voltage follower) can be used in a wide variety of digital and analogue amplifier applications. Let's start off by looking at some digital circuits.

Digital amplifiers

Figure 3 shows the practical circuit of a simple npn common-collector digital amplifier or emitter follower, in which the input signal is either at zero volts or at a substantial positive value that is not greater than the supply rail voltage. Here, when the input is at zero volts the transistor is fully cut off, and the output is thus also at zero volts.

When the input switches to a positive value greater than 600mV (the nominal voltage needed to forward bias the base-emitter junction of the transistor), the transistor turns on and causes a current (I_L) to flow in load resistor R_L and generate an output voltage across this resistor. Intrinsic negative feedback causes this output voltage to take up a value that is precisely one base-emitter-junction volt drop (about 600mV) below the input voltage value. Thus, the output voltage 'follows', but is 600mV less than, the input voltage.

Note in the *Figure 3* circuit that the input (base) current equals the I_L value divided by the h_{fe} value of the transistor (nominally 200 in the 2N3904 device), and that since the circuit gives unity voltage gain the circuit exhibits an input impedance equal to the R_L value multiplied by the h_{fe} value of the transistor, ie a nominal value of 660K in the example shown.

The circuit has an output impedance that approximately equals the value of the input signal source impedance (R_S) divided by the h_{fe} value of the transistor. Thus, the *Figure 3* circuit has a high input impedance, a low output impedance, and provides unity voltage gain, acting

This month Ray Marston takes a detailed look at the common-collector transistor amplifier and its derivatives

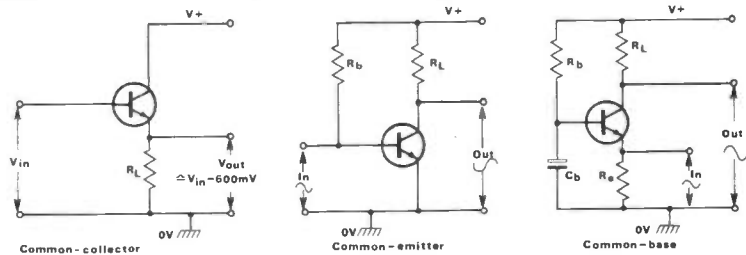


Fig 1 The three basic transistor configurations

	Common-collector	Common-emitter	Common-base
Z_{in}	High ($\approx h_{fe} \times R_L$)	Medium ($\approx 1k\Omega$)	Low ($\approx 40R$)
Z_{out}	Very low	$\approx R_L$	$\approx R_L$
A_v	≈ 1	High	High
A_i	$\approx h_{fe}$	$\approx h_{fe}$	≈ 1
Cut-off frequency	Medium	Low	High
Voltage phase shift	Zero	180°	Zero

Fig 2 (Above) Comparative performances of the three basic configurations

Fig 4 (Right) Effect of C_s on the output pulses

essentially as a unity-gain 'buffer' circuit.

If the *Figure 3* buffer circuit is used with high frequency pulse signals, it may be noticed that the output signal has a deteriorated trailing edge, as shown in *Figure 4*. This deterioration is caused by the presence of stray capacitance (C_s) between the transistor emitter and ground, as follows.

When the leading edge of the input pulse switches high, as in *Figure 4*, Tr1 switches on and rapidly 'sources' or feeds a charge current into C_s , thus producing an output pulse with a sharp leading edge. When the trailing edge of the input signal switches low, however, Tr1 switches off and the charge current of C_s is unable to discharge via (or 'sink' into) the transistor; instead, it has to discharge via load resistor R_L , causing the trailing edge of the output pulse to decay exponentially with a time constant equal to the product of C_s and R_L .

The basic principle detailed above can be deliberately used to make an AM radio signal demodulator. In this case a capacitor is wired across the load resistor, the two components having a time constant that is long compared to the carrier wavetime but short compared to the modulation signal wavetime.

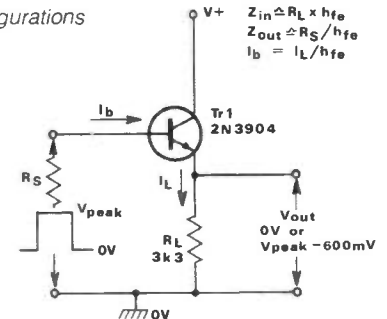


Fig 3 Common-collector digital amplifier

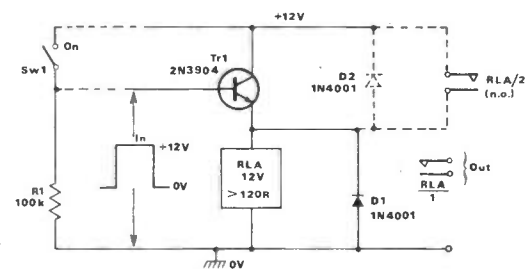
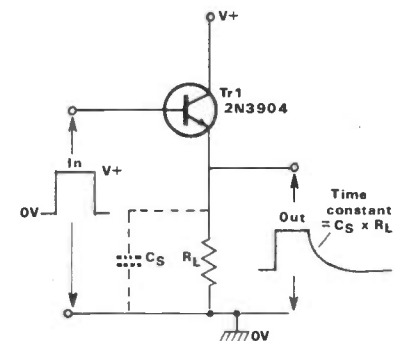


Fig 5 Emitter-follower relay driver

Relay drivers

The basic digital or switching circuit of *Figure 3* can be used to drive a wide variety of resistive loads, including filament lamps and LED-resistor combinations, etc, without modification. If the circuit is to be used to drive inductive loads, such as transformers, coils, or 'speakers', etc, the circuit must be provided with a diode protection network to limit inductive switch-off back emfs to a safe value. A particularly useful type of inductor-driving emitter follower switching circuit is the so-called relay driver, and a variety of examples of this

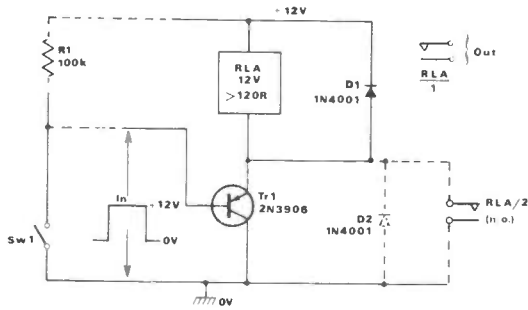


Fig 6 pnp version of the relay driver

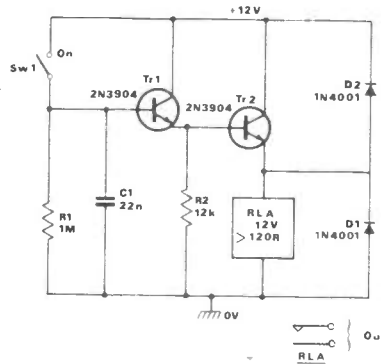


Fig 7 Darlington version of the npn relay driver

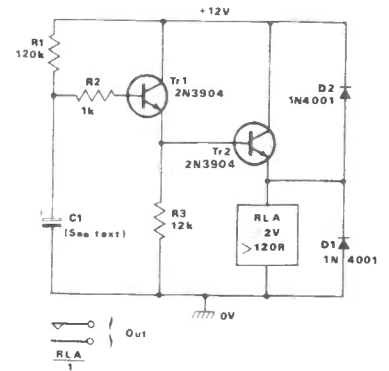


Fig 8 Delayed switch-on relay driver

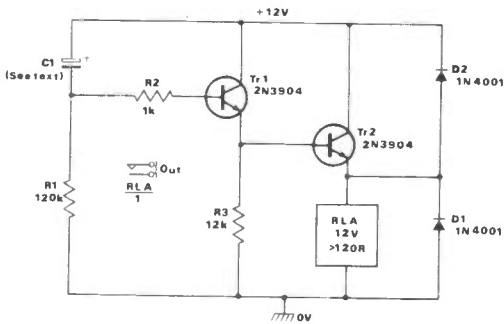


Fig 9 Auto turn-off time-delay circuit

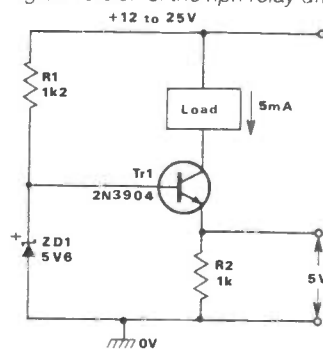


Fig 10 Simple 5mA constant-current generator

needs an input operating current of about $12\mu\text{A}$. Note that C1 protects the circuit against activation via high impedance transient voltages, such as those induced by lightning flashes, RFI, etc.

The Darlington type of circuit is of particular value in relay-driving C-R time-delay designs, such as those shown in Figures 8 and 9, in which the C1-R1 potential divider generates an exponentially rising or falling waveform which is fed to the relay coil via the high impedance Tr1-Tr2 voltage-following Darlington buffer. This causes the relay to change state some delayed time after the supply lines are initially connected: with the R1 value shown, the circuits give operating delays of roughly 0.1 seconds per μF of C1 value, ie a 10 second delay if $C1 = 100\mu\text{F}$, etc.

In the Figure 8 circuit, C1 is fully discharged at the moment of power supply connection, so the C1-R1 junction is initially at zero volts and the relay is off. C1 then charges exponentially via R1, and the resulting rising voltage is fed to the relay circuit via Tr1-Tr2, causing the relay to turn on after a pre-determined delay.

In the Figure 9 circuit, C1 is again fully discharged at the moment of power supply connection, so the C1-R1 junction is initially at full supply volts and the relay is driven on at this moment. C1 then charges exponentially via R1, and the resulting falling C1-R1 voltage is fed to the relay coil via Tr1-Tr2, causing the relay to automatically turn off after a pre-determined delay time.

Constant-current generators

A bipolar transistor can be used as a constant-current generator by wiring it in the basic common-collector mode and using its supply and collector terminals as the constant-current path, as shown in Figure 10. Here, R1-ZD1 are used to apply a fixed 5V6 reference voltage to the base of Tr1, which uses R2 as its emitter load.

Because of the inherent 600mV (approximately) base-emitter volt drop of the transistor, 5V0 is developed across emitter resistor R2, so a fixed current of 5mA passes through this resistor via Tr1 emitter.

electro-mechanical switch (SW1). The circuit action is such that the relay turns on when the input signal is fully positive, or SW1 is closed, and turns off when the input signal is zero, or SW1 is open. Relay contacts RLA/1 are available for external use, and the circuit can be made self-latching if required by wiring a spare set of normally-open relay contacts (RLA/2) between the collector and emitter of the transistor, as shown dotted. Figure 6 shows a pnp version of the same circuit: in this case the relay can be turned on by closing SW1 or by applying a zero volt input signal.

Swing low

Note in Figure 5 that protection diode D1 damps relay switch-off back emfs by preventing this voltage from swinging below the zero-volts-rail value. Optional diode D2 can also be used, if required, to prevent this voltage from rising above the positive supply rail value.

The Figure 5 and 6 circuits effectively increase the relay sensitivity by a factor of about 200 (the h_{fe} value of Tr1). If, for example, the relay has a coil resistance of 120R and needs an activating current of 100mA, the effective input impedance of the circuit will be 24K and the input operating current requirement will be 0.5mA.

The circuit sensitivity can be further increased, if required, by using a Darlington or Super-Alpha pair of transistors in place of Tr1, as shown in Figure 7. In this particular case the circuit has an input impedance of roughly 1M Ω , and

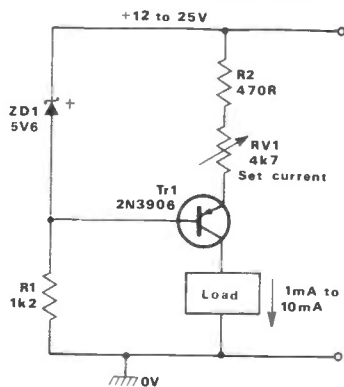


Fig 11 Ground-referenced variable (1mA-10mA) constant-current generator

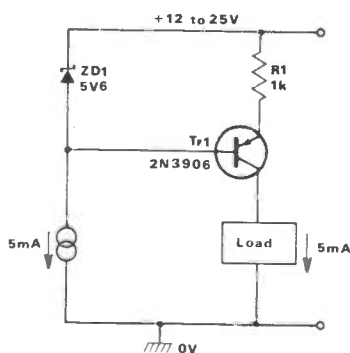


Fig 12 Precision constant-current generator

circuit are shown in Figures 5 to 9.

The Figure 5 circuit is that of an npn relay driver that can be used in either the latching or non-latching modes, and which enables the relay to be activated via either a digital signal or via an

Since the emitter and collector currents of a bipolar transistor are inherently almost identical, a 5mA current also flows in any load that is connected between the collector of Tr1 and the positive supply rail of the circuit, almost irrespective of the load's resistance value (providing that the value is not so large that Tr1 is driven into saturation), so these two points serve as constant-current source terminals.

From the above description it can be seen that the constant-current magnitude is determined by the values of the base reference voltage and the emitter load resistor (R2), so the current value can be altered by varying either of these values. Figure 11, for example, shows how the basic circuit of Figure 10 can be 'inverted' to give a ground-referenced constant-current output that can be varied from approximately 1mA to 10mA using RV1.

Most important

In most practical applications of constant-current generators, the most important feature of the circuit is its high dynamic output impedance (typically hundreds of kilohms), the precise magnitude of the constant current being of only modest importance. In such cases the basic circuits of Figures 10 and 11 will satisfy most practical needs.

If greater precision is needed, the characteristics of the reference voltages of these circuits must be improved to eliminate the effects of supply line and temperature variations.

One simple modification to improve the Figure 10 and 11 circuits is to replace R1 with a 5mA constant-current generator, as indicated in Figure 12 by the 'double circle' symbol, so that the Zener current (and thus the Zener voltage) is independent of variations in the supply line voltage.

If really high precision is needed, the Zener reference should have a temperature coefficient of $-2\text{mV}/^\circ\text{C}$, to match the base-emitter coefficient of Tr1. An easy way round this problem is to use a forward-biased LED in place of the Zener, as shown in Figure 13. In this case the LED voltage is roughly 2V0, so only about 1V4 appears across emitter resis-

tor R1, which has its value reduced to about 270R to maintain the constant-current output level at 5mA.

Analogue amplifiers

The common-collector amplifier (emitter follower) can be used as a linear amplifier of ac-coupled analogue signals by first biasing its base to a quiescent value of roughly half-supply volts (so that maximal signal swings can be accommodated without distortion), and by then ac-coupling the input signal to the base and taking the output signal from the emitter, as shown in Figures 14 and 15.

Figure 14 shows the simplest possible version of the analogue emitter follower circuit. In this case the transistor is biased via a single resistor, wired between the positive supply line and base. This resistor (R1) must have a value equal to the input resistance (R_{IN}) of the emitter follower stage if half-supply biasing is to be achieved. R_{IN} (and thus the nominal R1 value) equals the R2 value (4K7) multiplied by the h_{fe} value of Tr1 (= 200 nominal in this case). The biasing level of this circuit is thus dependent on the h_{fe} value of the individual transistor used.

The Figure 15 circuit uses a slightly more elaborate method of biasing, but its biasing level is independent of variations in transistor h_{fe} values. Here, R1 and R2 act as a potential divider that applies a quiescent half-supply voltage to Tr1 base. Ideally, the R1 value should equal the value of R2 in parallel with R_{IN} , but in practice it is adequate to simply make R1 low relative to R_{IN} and to make R2 slightly larger than R1.

In the Figure 14 and 15 circuits, the input impedance looking directly into Tr1 base equals $h_{fe} \times Z_{load}$, where Z_{load} is equal to the combined parallel impedance of R2 and any external load, Z_x , that is connected to the output. Thus, in these circuits the base impedance value is roughly 1M0 when Z_x is infinite.

In practice, the input impedance of the complete emitter follower circuit equals the combined parallel impedance of the base impedance and the impedance of the bias network. Thus, the Figure 14 circuit gives an input impedance of about 500K, and the Figure 15 circuit has

an input impedance of about 50K.

The Figure 14 and 15 circuits each give a voltage gain that is slightly below unity, the actual gain figure being given by:

$$A_v = \frac{Z_{load}}{(Z_b + Z_{load})}$$

$$\text{where } Z_b = \frac{25}{I_e} \text{ ohms,}$$

where I_e is the emitter current in mA

Thus, at an operating current of 1mA, these circuits give a voltage gain of 0.995 when $Z_{load} = 4K7$, or 0.975 when $Z_{load} = 1K0$: the importance of these gain figures will be shown shortly.

Bootstrapping

The relatively low input impedance of the Figure 15 circuit can be greatly

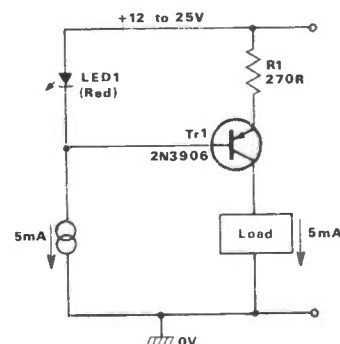


Fig 13 Thermally stabilised constant-current generator, using a LED as a voltage reference

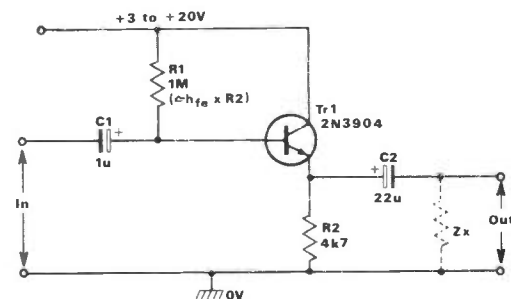


Fig 14 Simple emitter follower

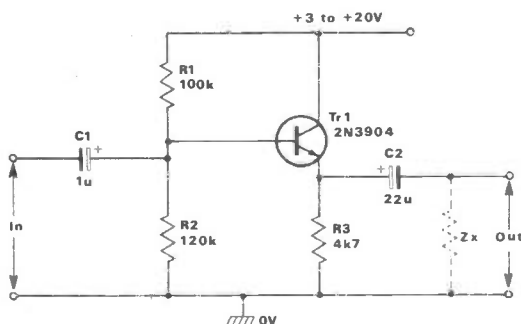


Fig 15 High-stability emitter follower

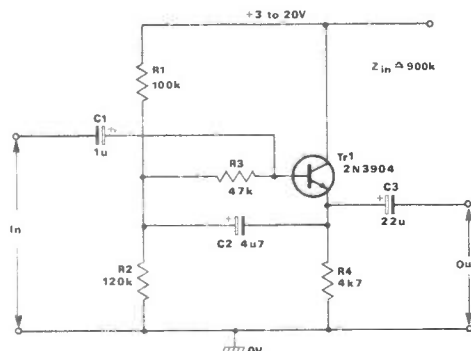


Fig 16 Bootstrapped emitter follower

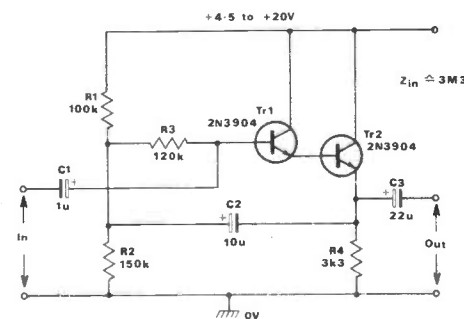


Fig 17 Bootstrapped Darlington emitter follower

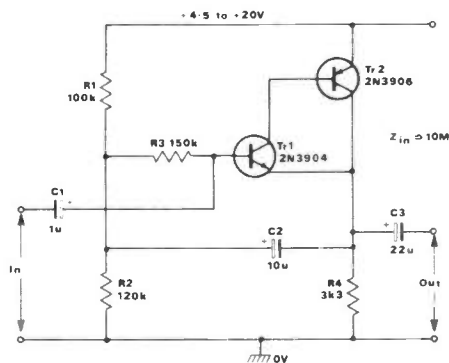


Fig 18 Bootstrapped complementary feedback pair

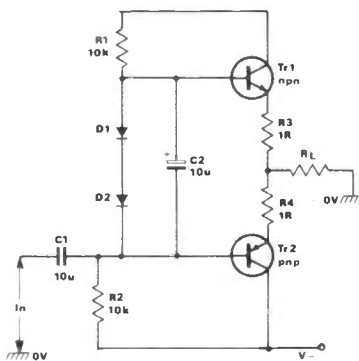


Fig 19 Complementary emitter follower, using split supply and direct-coupled output load

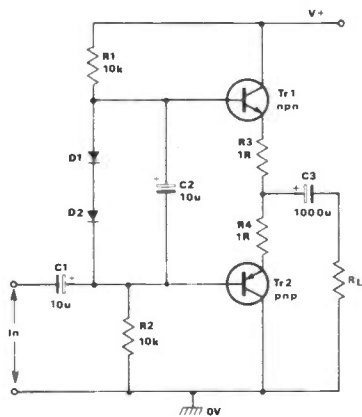


Fig 20 Complementary emitter follower, using single-ended supply and ac-coupled output load

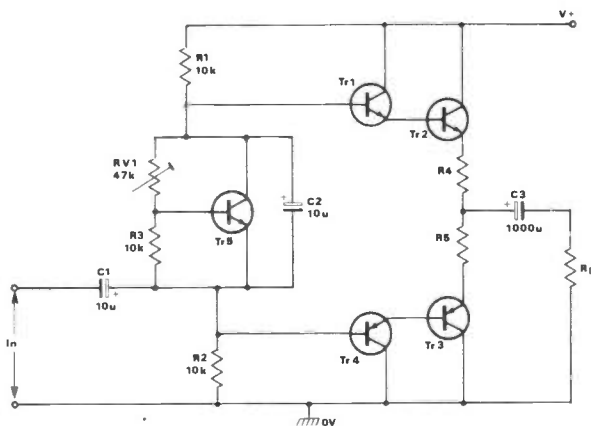


Fig 21 Complementary emitter follower, with biasing via an 'amplified diode' (Tr5)

increased by using the 'bootstrapping' technique illustrated in the circuit of Figure 16. Here, 47k resistor R3 is wired between the R1-R2 biasing network junction and the base of Tr1, and the input signal is fed to Tr1 base via C1.

Note, however, that the output signal of Tr1 is fed back to the R1-R2 junction via C2, so that almost identical signal voltages appear at the two ends of R3. Consequently, very little signal current flows in R3, which thus appears to have a far greater impedance than its true resistance value.

Suppose, for example, that the emitter follower circuit of Figure 16 has a voltage gain of precisely unity. In this case, identical signal voltages would appear at the two ends of R3, so zero signal current would flow in this resistor, which would thus appear as an infinite impedance. The input impedance of the circuit would thus appear to equal R_{IN} , or 1M Ω .

In practice, emitter follower circuits give a voltage gain that is slightly less than unity, and it is the precise value of gain that determines the resistor amplification factor, or A_R , of the circuit, as follows:

$$A_R = \frac{1}{(1-A_v)}$$

Thus, if the circuit has a gain of 0.995 (as in one of the examples already discus-

sed), then A_R has a value of 200 and the R3 impedance is almost 10M Ω . If, on the other hand, $A_v = 0.975$, the A_R value is only 40 and the R3 impedance is almost 2M Ω . This impedance is effectively in parallel with R_{IN} so, in the former case, the complete Figure 16 circuit exhibits an input impedance of roughly 900k Ω .

If required, the input impedance of the Figure 16 circuit can be increased even more by using a pair of Darlington-connected transistors in place of Tr1 and increasing the value of R3, as shown in the example of Figure 17, which gives a measured input impedance of about 3M3.

Alternatively, an even greater input impedance can be obtained by using the bootstrapped 'complementary feedback pair' circuit of Figure 18, which gives an input impedance of about 10M Ω . In this case, Tr1 and Tr2 are both wired as common-emitter amplifiers, but operate with virtually 100% negative feedback, and thus give an overall voltage gain of almost exactly unity. This 'pair' of transistors thus acts like a near-perfect Darlington or Super-Alpha emitter follower.

Complementary emitter followers

It was pointed out last month that a standard npn emitter follower can source current but cannot sink it, and

that a pnp emitter follower can sink current but cannot source it, ie these circuits can handle unidirectional output currents only. It was also pointed out that, in many applications, a bidirectional emitter follower circuit (that can source or sink currents with equal ease) is required, and that this action can be obtained by using a complementary emitter follower configuration, in which npn and pnp emitter followers are effectively wired in series. Figures 19 to 21 show some basic circuits of this type.

The Figure 19 circuit uses a dual or 'split' power supply and has its output direct-coupled to a grounded load. The series-connected npn and pnp transistors are biased at a quiescent 'zero volts' value via the R1-D1-D2-R2 potential divider, with each transistor slightly forward-biased via silicon diodes D1 and D2, which have characteristics that are inherently similar to those of the transistor base-emitter junctions. Capacitor C2 ensures that identical input signals are applied to each transistor base, and emitter resistors R3 and R4 protect the transistor against high output currents.

The action of the Figure 19 circuit is such that Tr1 sources current into the load when the input goes positive, and Tr2 sinks load current when the input goes negative. Note that input capacitor C1 is a non-polarised type.

Figure 20 shows an alternative version of the above circuit, in this case designed for use with a single-ended power supply and an ac-coupled output load. Note in this case that input capacitor C1 is a polarised type.

Note in the Figure 19 and 20 circuits that output transistors Tr1 and Tr2 are slightly forward-biased (to eliminate cross-over distortion problems) via silicon diodes D1 and D2 (one per transistor). In practice, the diode currents (and thus the transistor forward-bias voltages) are usually adjustable over a limited range. If these circuits are modified for use with Darlington transistor stages, a total of four 'biasing' diodes are required. In such cases it is normal practice to use a single transistor amplifier diode stage, rather than four individual diodes, as shown in Figure 21.

In the Figure 21 circuit, the collector-to-emitter voltage of Tr5 equals the Tr5 base-emitter volt drop (roughly 600mV) multiplied by $(RV1+R3)/R3$. Thus, if RV1 is set to zero ohms, roughly 600mV are developed across Tr5, which thus acts like a single silicon diode. If, on the other hand, RV1 is set to 47k, roughly 3V6 is developed across Tr5, which thus acts like six series-connected silicon diodes. RV1 can thus be used to precisely set the Tr5 volt drop and thus adjust the quiescent current values of the Tr2-Tr3 output stages.

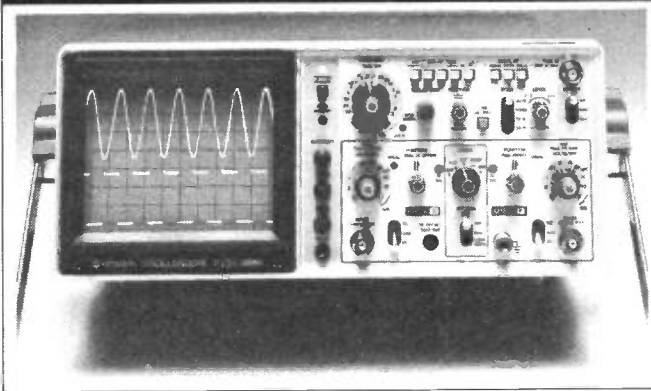
In next month's edition of 'The File' we look at common-emitter and common-base amplifier circuits.

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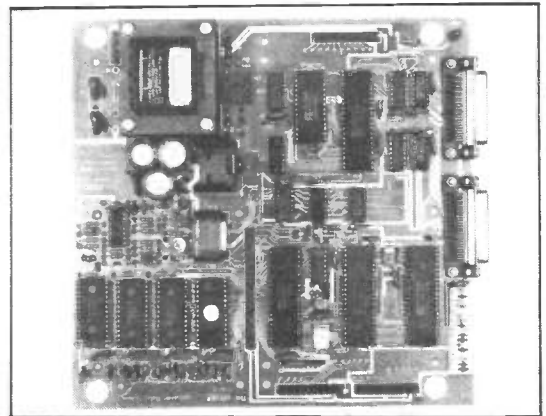
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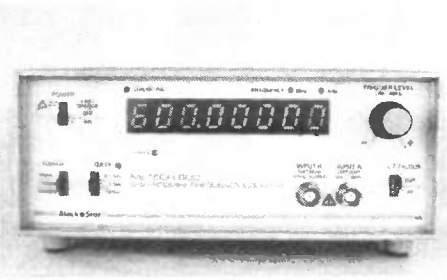
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12V NICAD DISCHARGER UNIT

by David Dawson

Discharge your Nicad batteries in a controlled manner for storage

The growth over the past few years of the market in domestic portable electronic equipment has resulted in a need for battery supplies of low weight and size but high storage capacity. In my own case, I own a portable video recorder which incorporates an internal Nicad battery rated at 12 volts as well as two spares. 12 volt Nicad batteries are generally becoming more widespread, with capacities from about 1 to 12 amp hours.

Sealed lead acid types are available, but for various reasons are not so popular. However, whereas lead acid batteries can be fully discharged, Nicad batteries must not be discharged beyond a certain point, and must also be stored in a discharged state for maximum life.

'Battery save'

Unfortunately most portable videos have a 'battery save' feature which prevent them from being used to discharge the battery unless they are in either play or record mode. This of course causes head wear, so I was faced with trying to design a circuit to discharge my three Nicad batteries, when not in use, in a controlled manner.

The diagram shows the circuit of the

discharger unit devised for this purpose. Operational amplifier IC1 is a voltage comparator that compares a portion of the dc line voltage to a fixed reference voltage derived from the 5.1 volt Zener diode D1.

Zener D2 ensures that the full variation in line voltage is presented to the op amp IC1. With a high line voltage (ie fully charged battery) the output of IC1 is 'low' or zero volts due to the high gain of the op amp.

Careful adjustment

As the 12 volt line voltage reduces, a point is reached, by careful adjustment of RV1, where IC1 output flips over to 'high' or 12 volts. The positive input of buffer inverter IC2 uses the same reference voltage as IC1 so that when the output of IC1 goes high, the output of IC2 goes low. This de-energises relay RLA, whose contact RLA1 disconnects the lamp LP1 and breaks the circuit from the battery. The battery has now received the correct amount of discharge for storage until it is next charged for use.

On initially connecting a battery for discharge, switch SW1 is depressed to 'set on' the circuit. If discharge needs to

be interrupted then SW2, 'set off', is depressed, so disconnecting the battery. Both SW1 and SW2 are simple changeover type push switches.

To set RV1, apply a voltmeter across the dc line and temporarily place a 10 ohm wire-wound potentiometer in series with a good 12 volt battery. Depress SW1 and adjust this potentiometer until the voltmeter reads 11.8 volts, and then carefully set RV1 to switch off the lamp. Check this once or twice, then remove the meter and temporary potentiometer. The circuit should now discharge the battery steadily for a few hours via the lamp load until it reaches 11.8 volts, at which point the circuit will 'cut out'.

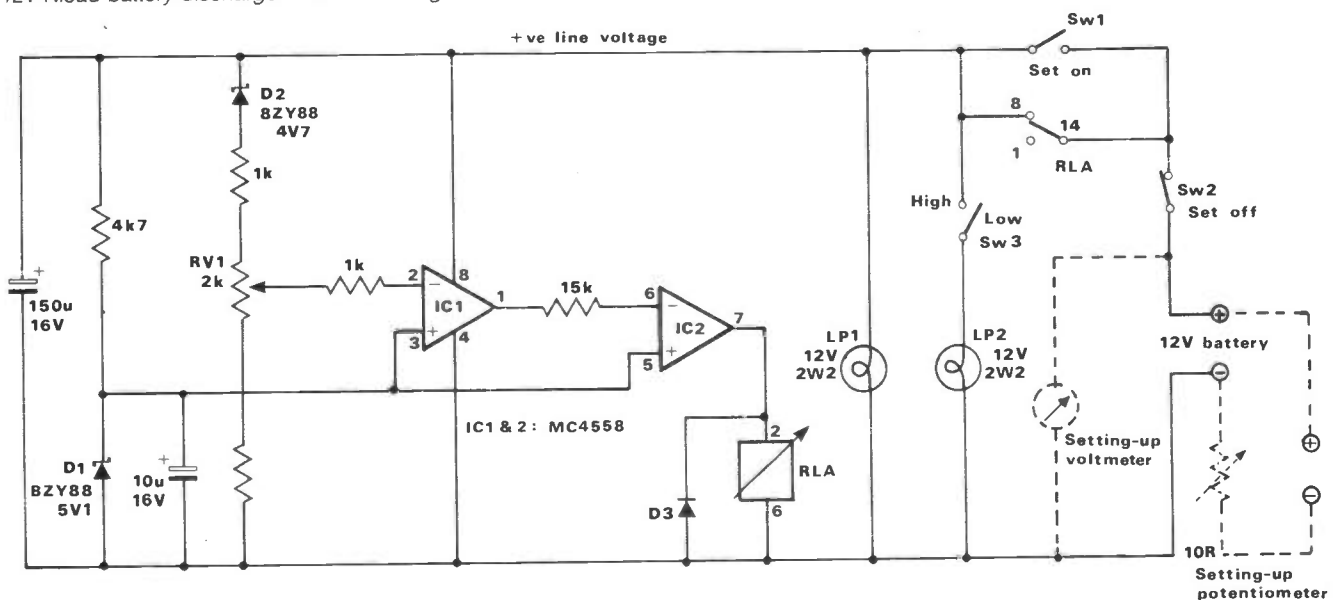
To provide a high or low discharge rate two lamp loads can be used with switch SW3 to operate the second lamp if required. One 2.2 watt 12 volt bulb discharges at about 185mA. Two bulbs at 370mA is a good discharge rate for most 12 volt Nicad batteries.

Not critical

Layout of the circuit is not critical and it can be mounted in a simple plastic box. The capacitors are required to prevent chatter of the relay when close to the 'cut out' point.

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12V Nicad battery discharger unit circuit diagram



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 Mixed metal/carbon film resistors 1/2W E24 series 1R to 10MO..... 1 1/2p
 1 watt mixed metal/Carbon Film 5% E12 series 1R to 10 Megohms 5p
Miniature polyester capacitors 250V working for vertical mounting
 01, 015, 022, 033, 047, 068 4p. 01 5p. 015. 022 6p. 0.33 & 0.47 6p

Mylar (polyester) capacitors 100V working E12 series vertical mounting
 1000p to 8200p - 3p. 01 to 068 mfd - 4p. 0.1 5p. 0.12 & 0.15 6p

Subminiature ceramic plate capacitors 100V wkg vertical mountings. E12 series
 2% 1.8 pf to 47 pf - 3p. 2% 56 pf to 330 pf - 4p. 10% 390p - 4700p 4p

Polystyrene capacitors 63V working E12 series long axial wires
 10 pf to 820 pf - 3p. 1000 pf to 10,000 pf - 4p. 12,000 pf 5p
 741 Op Amp - 20p. 555 Timer 22p
 cmos 4001 - 20p. 4011 - 22p. 4017 40p

DIODES (piv/amps)
 75/25mA 1N4148 2p. 800/1A 1N4006 6p. 400/3A 1N5404 14p. 115/15mA OA91..... 6p
 100/1A 1N4002 4p. 1000/1A 1N4007 7p. 60/1.5A S1M1 5p. 100/1A bridge..... 25p
 400/1A 1N4004 5p. 1250/1A BY127 10p. 30/45mA OA90 6p. 30/15A OA47 8p
 Zener diodes E24 series 3V3 to 33V 400 mW - 8p. 1 watt 12p
 LED's 3 & 5mm Red 10p. Green, Yellow 14p. Grommets 3mm - 1 1/2p, 5mm 2p
 20mm fuses 100mA to 5A Q/blow 5p. A/surge 8p. Holders pc or chassis 5p
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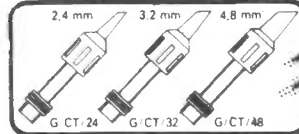
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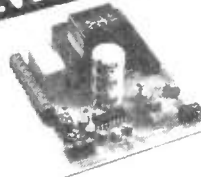
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VECTORS AND ROTATING WAVEFORMS

by Dr C J D Catto

Although one is accustomed to viewing waveforms on an oscilloscope, or drawing them out on paper, it is surprising how many belong to a 'rotating' rather than a 'horizontal' family. In fact, two sinewaves in quadrature (ie 90° out of phase) constitute the simplest form of rotating 'vector', and probably the most prevalent manifestation of such entities is the 3-phase mains supply that forms the national grid.

Power distribution

The CEGB's generators, not surprisingly, are adjusted so as to rotate in synchronism, and the sinewaves sent along the red, yellow and blue phases are 120° apart. A customer can run an induction motor at the fundamental frequency of 50Hz, or 3,000rpm, less a little slippage.

By increasing the number of poles on the motor, or using a clever chopping circuit, lower speeds can be obtained, but most rotating loads are synchronous, or very nearly so. The way the vectors add up to produce a rotation is most easily seen in the two-phase case, since simple geometry shows that:

$$x = R \cos \theta = R \sin(\theta + 90^\circ)$$

$$\text{and } y = R \sin \theta$$

$$\text{or } x^2 + y^2 = R^2$$

which is the equation of a circle, as illustrated in *Figure 1*. The x and y components are often known as the real and imaginary parts—the latter being the j-vector, but that is another story!

Radar

It is quite legitimate to express an object's position in terms of R and θ , rather than x and y. A well-known application of these 'polar co-ordinates' is in radar, where the display is in the form of a Plan Position Indicator, which shows both range R and bearing θ .

Now, this requires the spot on the CRT to be deflected in two quite different ways. The range R corresponds to a simple outward movement of the beam, proportional to the pulse echo time, and so can be derived from a straightforward sawtooth waveform. The angle θ , on the other hand, corresponds to the rotation of the antenna, and in the early days of radar was simply effected by physically rotating the R-scan coils on the neck of

the CRT in synchronism with the dish, as shown in *Figure 2*.

As electronics improved, this somewhat crude mechanical arrangement of the CRT displays could be replaced by a totally electronic scan, feeding $R \cos \theta$ and $R \sin \theta$ signals to a set of fixed orthogonal coils. Nowadays, of course, the radar return signal undergoes a great deal of signal processing (and noise reduction by computer on a large installation), and so there may well be a 'synthetic' display. In other words, the scan on the CRT or TV display is determined by what is most convenient for the processor rather than the raw radar.

Phased arrays

An interesting technique employed in some modern radar installations is the 'phased array', which is a set of elements fed with signals of deliberately varying phase, so as to create the effect of a scanned beam without having physically to turn the aerial assembly. The latter, incidentally, is no longer a dish, but merely a flat rectangle of slatted appearance.

It should be possible to create a swept acoustic beam using these principles: maybe this can be taken as a challenge for those readers expert in audio.

Colour TV

The systems used for public broadcast of colour TV signals in a limited bandwidth at present rely on some form of phase encoding of the colour information so as to squeeze it into a frequency slot originally intended for monochrome.

If we take the case of the PAL method, there are basically two vectors, called U and V (see *Figure 3*), which are related to

the colour difference signals B-Y and R-Y. These vectors rotate 90° out of phase at the subcarrier frequency of 4.43MHz, and an extra complication is that the sign of one of them is reversed every other line, hence the name Phase Alternation Line.

This feature is intended to counteract adverse propagation effects. However, the main principle is unaffected, namely a pair of rotating colour vectors and a reference or colour burst at the beginning of each line so that the receiver can set its oscillator for correct decoding throughout the active part of the TV line. The modulation equation can be written as:

$$E_m = E_y + U \sin \omega t \pm V \cos \omega t$$

$$= E_y + S \sin(\omega t \pm \alpha)$$

where the bulk of the luminance signal is in effect carried by E_y .

Framestores

The German PAL system has served its purpose well over the course of several years, and is arguably superior to the American NTSC and the French SECAM methods. In any event, it is only with recent advances in digital electronics that alternative methods can be considered as viable possibilities. Once there is the ability to store whole frames in RAM and manipulate this data at low cost, then the totality of high-definition colour TV is open to reappraisal.

In fact, a framestore in conjunction with a computer offers new methods in image processing, not just in entertainment TV. There is the important field of analysis of images obtained from optical and electron microscopes, for example in forensic science, biology and metallurgy.

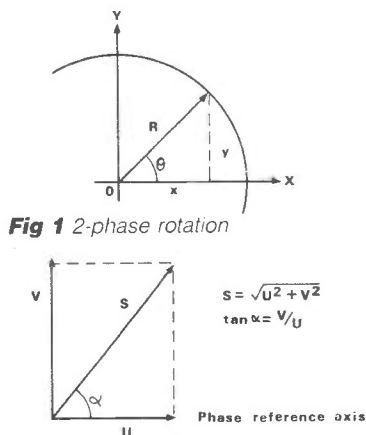


Fig 1 2-phase rotation

Fig 3 PAL vectors

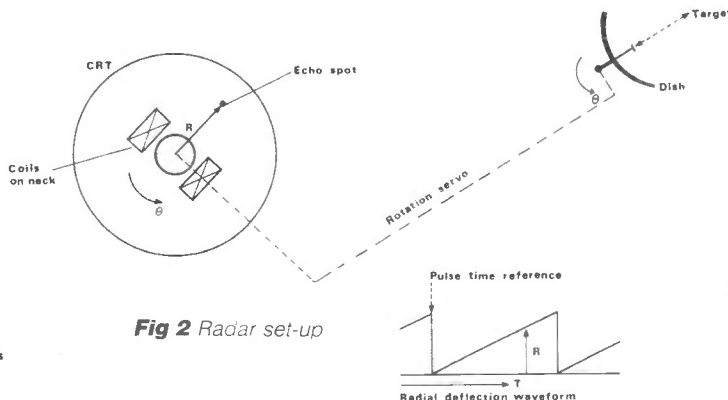


Fig 2 Radar set-up

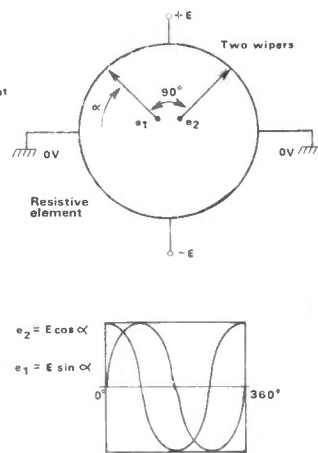


Fig 4 Sine-cosine pot

VECTORS & ROTATING WAVEFORMS

Potentiometers

Sometimes a front panel control with a sine or cosine law rather than a simple linear response is required, for example for a 'stigmator', which is basically a set of coils correcting for astigmatism in an electron microscope.

This is analogous to the correction an optician may have to apply to a spectacle lens to give it slightly different focal lengths $F_1 - F_2 = \Delta F$ in two perpendicular axes. Whether one is dealing with light or electron beams, it is not sufficient to set just the strength of ΔF ; the direction (azimuth angle) is vital.

The traditional form of sine-cosine potentiometer is as shown in Figure 4. The signals are tapped off at e_1, e_2 , and in some versions the spindle can rotate continuously, ie without end-stops. The sine-cosine pot is a precision wire-wound component, manufactured by Bourns, Colvern and Japanese companies, and can cost £100 or more. So, some alternatives are worth considering.

The simplest method is to replace the strength and angle controls by separate x and y ones, but maybe this is cheating. Another way is to use an integrated circuit such as the Analog Devices AD639 (shown in Figure 5), which is a multifunction trigonometric converter using some very clever techniques invented by Gilbert. The open loop transfer function is:

$$W = A_0 \left[(U_p + U_1 - U_2) \frac{\sin(X_1 - X_2)}{\sin(Y_1 - Y_2)} - (Z_1 - Z_2) \right]$$

where A_0 is greater than 15,000, and a preset amplitude of 1 or 10V can be obtained by tying U_p to $-V_S$ or $+V_S$.

In practice, the device is used 'closed loop' (like an op-amp), and so the open loop gain A_0 no longer features. Because $\cos \theta = \sin(90^\circ - \theta)$, it is easy to obtain cosines, tangents etc. In fact, there is no difficulty either in obtaining sec, cosec and cot, and even the inverses, like arctangent.

This IC has many applications, such as

in waveform generation, though its price may be beyond the pocket of most home constructors.

Sinusoidal waveforms

Incidentally, if a project simply requires quadrature sinusoidal waveforms, ie with time t rather than angle θ as the parameter, a simple oscillator can be built around a dual BIFET op-amp, as shown in Figure 6. This circuit is optimised for the Texas Instruments' TL082, but can be used as a starting point for other designs so long as one is aware of the relatively high impedances needed if the amplitude-setting diodes are to work well.

Having produced these waveforms, it is possible to obtain static sine and cosine values with sample-and-hold amplifiers. On the other hand, in many applications it can prove simpler to use a digital approach, with a ROM or a micro-generated look-up table, and a DAC for analogue output.

Shaft encoders

The simplest form of rotating component giving a digital output is the shaft encoder employing a wheel with a single row of stripes and generally two sets of light emitters and detectors, as illustrated in Figure 7.

The optical paths are arranged such that two square-waves, 90° out of phase, are generated. The direction of motion is discovered by asking whether θ_1 leads or lags θ_2 , and many circuits for extracting the direction have been published. For example, Cornwell² has described a complete computer interface, making use of Texas Instruments' 74LS2000 incremental encoder ICs.

Such shaft encoders are called 'relative' or 'incremental', since they rely on pulse counting, and the information is lost if the power is interrupted. However, they are quite adequate for a tracker ball, a mouse and similar pointers, as well as for motor speed control. They are now available at moderate cost from Hewlett Packard (HEDS-5000), and even as a front panel 'digital pot' from Mullard (MPG256): a spin-wheel for counter and DAC.

Without counters

'Absolute' shaft encoders, on the other hand, have several rows of stripes and detectors, and so the absolute position of the shaft can be properly defined. However, they employ a disc with some very fine stripes, and are generally much more complex, both mechanically and electrically, than their 'relative' counterpart, a fact which is borne out in the cost difference.

The discs are normally Gray-coded, which gives just one bit change per step, and is theoretically the smoothest method. Conversion to pure binary or to

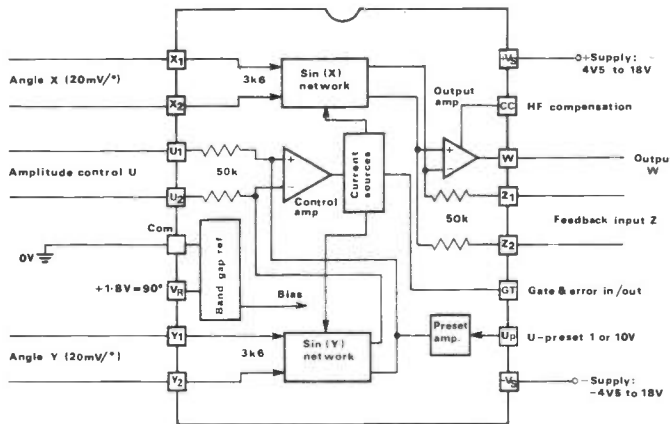


Fig 5 AD639 trig converter

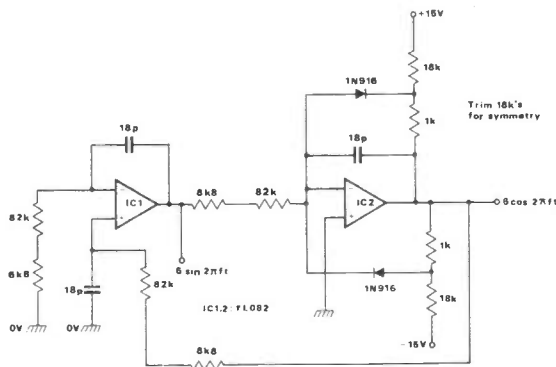


Fig 6 Quadrature oscillator with $f = 100\text{kHz}$

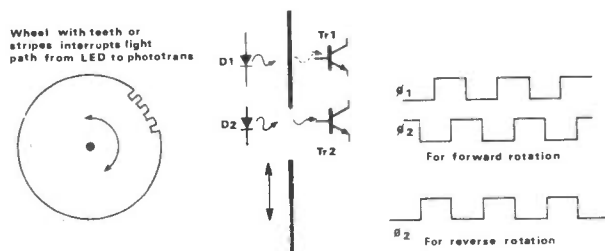


Fig 7 Incremental shaft encoder

VECTORS & ROTATING WAVEFORMS

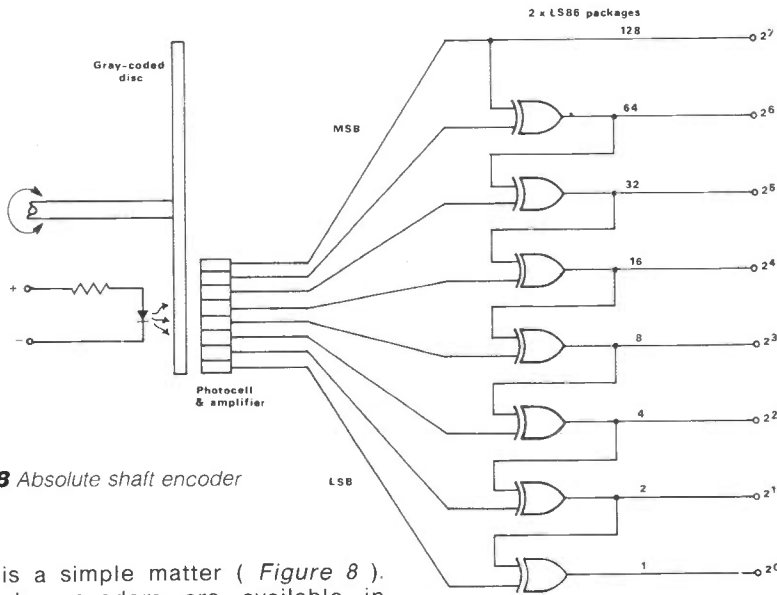


Fig 8 Absolute shaft encoder

BCD is a simple matter (Figure 8). Absolute encoders are available in Britain from firms such as Ferranti, and serve applications like gun turrets, NC machine tools, robots, cranes and radar, to mention but a few.

Synchros and resolvers

A simple rotary control system can be made by connecting two devices rather like ac motors together in the manner shown in Figure 9, where the reference waveforms applied to the stators cause reaction torques in the rotors. These continue until the slave has homed in on the angle held at the master, ie when the rotor voltages balance each other. In fact, surprisingly accurate angular signals can be extracted from brushless 'resolvers' of the type illustrated in Figure 10, where the rotor is excited by transformer action, at a frequency normally between 400Hz and 10kHz.

The outputs from the stator coils can be converted to digital form in a number of ways, of which the tracking loop method is probably the best. In the Analog Devices RDC1740 series, the signals enter via sub-miniature transformers, are multiplied by $\cos\theta$ and $\sin\theta$, and then the difference signal is extracted by a phase-sensitive detector (using the 'carrier' frequency).

The filtered result is $\sin(\theta-\phi)$, and this error signal feeds a VCO which drives an up-down counter till the loop is nulled. The conversion is of the tracking type, ie the output follows the input angle without needing a 'start convert' signal, though for data transfer purposes the output latches can be frozen by the 'busy' signal, which gives a pulse whenever the shaft moves by one LSB or more.

The resolution of a 16-bit system is $360^\circ/2^{16}$, or about 20 arc seconds (one degree is 60 arc minutes, or 3600 arc seconds). Higher accuracies can be achieved by gearing, but with considerable mechanical constraints. Alternatively, there are devices called Rotary

Inductosyns, made by Farrand Controls in the USA; these use rotor and stator discs with dual copper tracks plated on each, in a square-wave fashion.

The clever point is that the outer tracks have one more 'tooth' than the inner ones, giving a sort of electromagnetic gearing. The tracks on the rotor are energised at several kHz, and the stator held close to it (with a 0.2mm gap) picks up signals on alternating sine and cosine

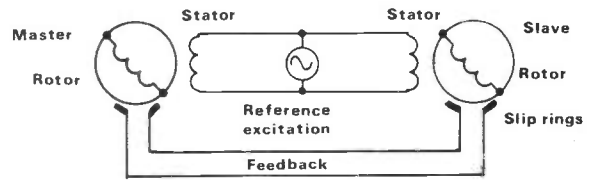


Fig 9 Inductive remote control system

sectors. Conversion is done on the inner and outer tracks separately, and the results subtracted digitally to give the final rotor angle, to a resolution which can be as high as 20 bits (just over one arc second!).

Applications

Rotary signalling systems were developed for gun turrets and similar military purposes, with inductive and optical methods replacing potentiometers because of reliability and accuracy.

Regardless of what sensing method is used in a control system, however, the standard 'laws' apply to any closed loop feedback network. To prevent the system becoming unstable (eg going into oscillation), sufficient gain and phase margins must be allowed. This generally means that the loop gain has to be limited: because of inherent lags in a system, the gain/frequency characteristics must be carefully shaped, eg by

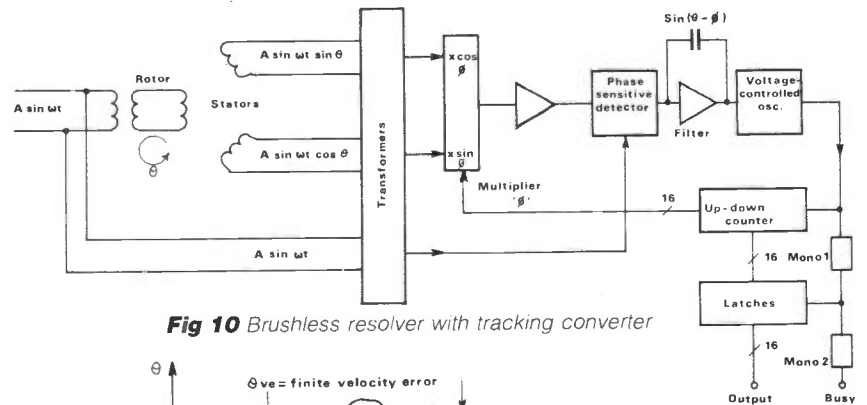


Fig 10 Brushless resolver with tracking converter

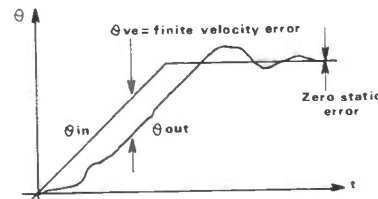


Fig 11 Velocity error in class 1 control system

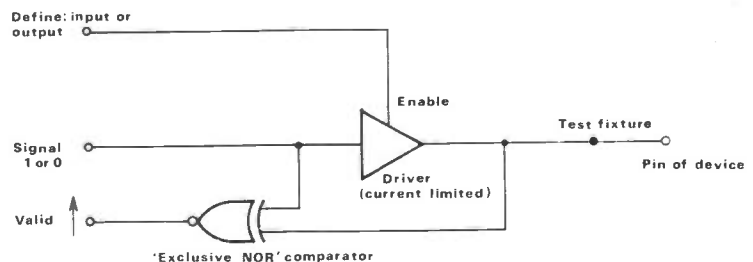


Fig 12 Test set-up for each pin of digital IC

VECTORS & ROTATING WAVEFORMS

applying damping or feedback from a tachogenerator.

An interesting effect is the 'velocity error', which arises when a gun is tracking a moving target. This is illustrated in Figure 11 for a basic control system, known as class 1. The error θ_{ve} can be reduced by increasing the high frequency gain, but with the risk of instability. Alternatively, the system can be raised to class 2, eg (in electrical terms) by adding ac feedforward.

Testing ICs

When testing a complex digital circuit such as a custom logic IC, it is appropriate to consider each pin as a possible input or output, with a zero or one status for every line of the test procedure.

In other words, two bits are required per pin. The test machine must be able to apply, say, a TTL low or high for an input, or to detect these levels for an output. Whether the particular pin is an input or an output, it is useful to have the sensing comparator permanently in circuit (Figure 12), since this will detect inputs that are shorted to one of the supply rails.

For a device with N pins (in addition to the power connections), each line of the test program will need 2N bits of data,

and these can be considered as 2N-dimensional vectors. An alternative method is to consider the IC as a 'black box' or matrix M, which is fed with input vectors N_i and from which are expected output vectors N_o. Then the operation of the device is defined by the vector equation

$$N \times M = N_o$$

A practical limitation of this method is that the pins must be defined at the outset as either inputs or outputs: it is difficult to deal with the strobed in-out ports prevalent in some circuits.

Anyway, in order to get through a comprehensive set of tests in a reasonable time, the tester must be able to 'throw' these vectors at the IC at a rapid rate. In practice, the tester will probably have its data downloaded from the DEC VAX or whatever computer was employed to do the original logic simulation.

To speed things up, the tester may run the vectors through in blocks; also, once the masks have been proved, it is feasible for selected patterns to be employed, rather than attempt to test for every single combination.

With analogue ICs, there are mercifully fewer pins to test, but the inputs and

outputs are no longer simple 2-level signals. To characterise an op-amp, for example, and to capture ringing and other aberrations, a high-speed 10-bit D/A and A/D set-up can easily be required.

Conclusion

Just as most real-life objects exist in three dimensions, and it is only the limitations of paper and of TV screens that force us to represent them in only 2-D, so also do most waveforms belong to some N-dimensional system. For simplicity, we may choose to consider only one dimension at a time, for example drawing logic waveforms from left to right, but when it comes to rotating equipment we are led inevitably to vectors and the extra dimensions, just as our forefathers had eventually to abandon the notion of a flat earth.

References

1. Gilbert, B. A monolithic microsystem for analog synthesis of trigonometric functions and their inverses. IEEE J of Solid-State Circuits, SC-17.6, December 1982, 1179-1191.
2. Cornwell, P.J. Encoders interface low-cost trackerball. Electronic Product Design, December 1984, 71-73. REW

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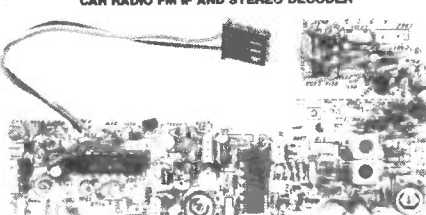
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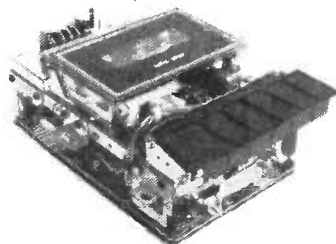
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LONG WAVE LOOP ANTENNA

by Richard Q Harris G2BZQ

Do you remember the long wave band? It covers from around 1000 metres to 2000 metres (300kHz-150kHz), and is now probably the most neglected band in existence in the UK for everyday broadcast listening. Many modern transistor radios do not even cover this band.

Most people in the UK with a long wave receiving facility on their radios usually use it to receive BBC Radio 4 on 1500 metres (200kHz), and use medium wave or FM bands for the rest of their radio entertainment.

Yet many countries pump out mighty signals (up to 200kW) on this band. They include the USSR, France, Rumania, Norway, Germany (East and West), Italy, Sweden, Poland, Turkey, Morocco, Iceland, Denmark, Finland, Czechoslovakia, Algeria and, of course, our old friends Radio Luxembourg. The writer does not

have a clue as to how many countries transmit on this band, or how many stations exist, but can mention that when living and working in the USA a few years ago, and making business trips throughout the USA and Canada, it was possible to hear LW stations on a transistor radio. They were of little interest at the time and so were not identified, but they were there to be heard.

It is fair to assume that all these countries would not be using the LW band with high power unless they considered it to be worthwhile. So, recently it was decided to take a good look at the LW band. A good transistor portable, with in-built ferrite rod aerial, produced quite a number of stations but had limitations in range and separation of stations using the same frequency in distant countries.

It became obvious that a receiver using only an external aerial was required. It was decided to use a 9-waveband Pye 3017A (export) receiver (all valves, 1950s vintage). In spite of its age it is in 'as new' condition, is in everyday use and gives an excellent performance. It is slightly modified for coaxial aerial input. Some time ago, a 2-band external ferrite rod assembly was made to cover the MW and LW bands, connected to the receiver with a length of coaxial cable, and for an apartment dweller it gives quite adequate results for everyday listening. It also gives better results on the long wave band than the transistor radio, but for a more complete look at the band it was felt that a good external antenna was required.

Out of the question

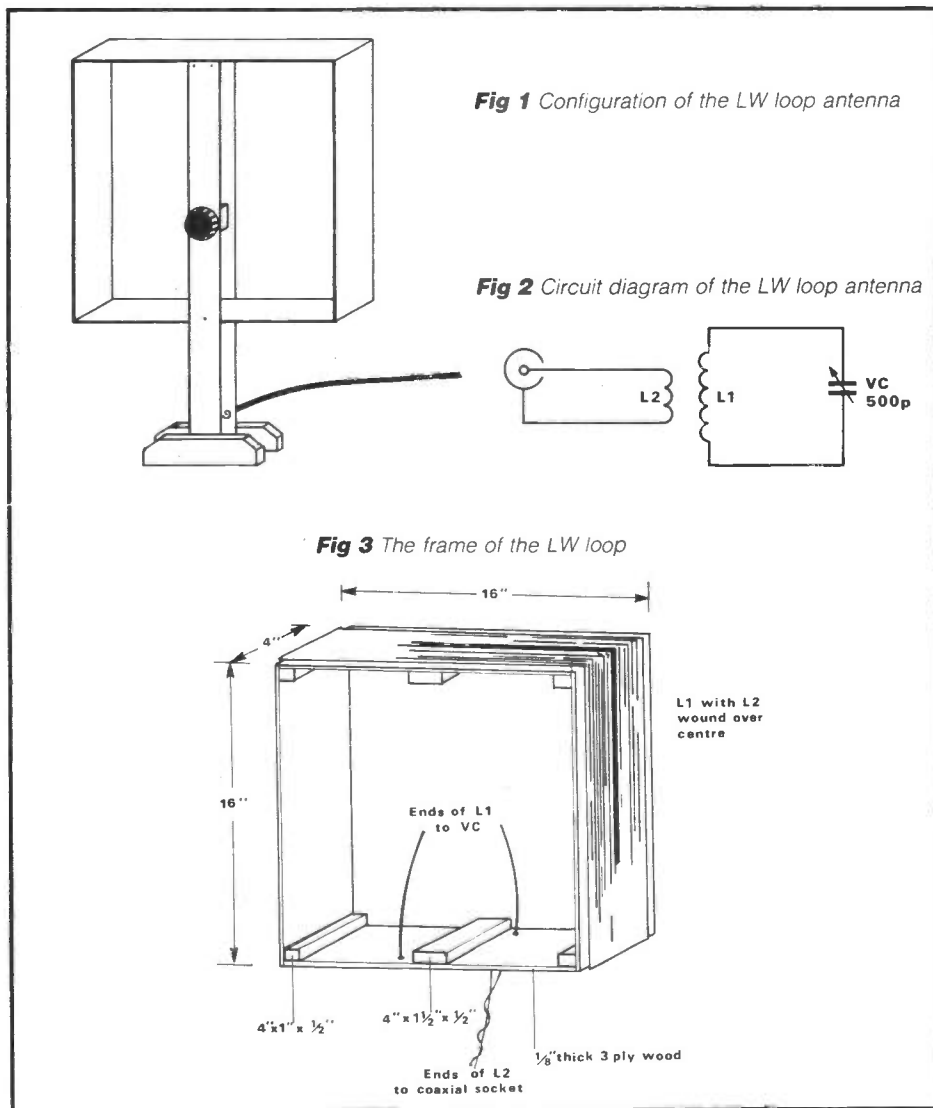
A $\frac{1}{4}$ or $\frac{1}{2}$ -wave antenna on long wave is out of the question. Who knows what the local authorities, and neighbours, would think about a $\frac{1}{2}$ -wave LW dipole? Probably all hell would be let loose, even though our roof-tops bristle with TV and FM aerials! Even if one was erected the noise level would be very high and directivity very poor. Anyway, the writer lives in an apartment, so the proposed aerial had to be located indoors. It had to share a small bachelor flat with the writer, a considerable quantity of equipment and a load of pot plants, so it had to be as small as possible.

Some ancient literature indicated the virtues of a frame aerial on long wave, apparently used in the USA in the early days of wireless and also on ocean-going liners, but no details appear to exist regarding design and construction. Plenty of articles have recently appeared regarding MW-DX loop antennas, with the suggestion that these might be extended to the LW band by adding a vast quantity of capacity across the tuning capacitor, making the device more or less untunable.

A better suggestion is to switch in an RF choke of, say, 5mH in series with the medium wave loop, which would then cover the LW band. This works with somewhat low efficiency.

So it was decided to experiment with LW loop antennas, bearing in mind that the result would have to be small. A good tip when trying to design such an antenna is to get a largish cardboard box from the local supermarket and to wind the turns of wire around this for initial tests. This way time and money are not wasted constructing wooden frames, which may well have to be discarded.

Figure 1 shows the resulting configuration, and Figure 2 shows the circuit. It consists of a coil L1 wound on a



wooden frame, tuned by a 500pF variable capacitor (CV). Over L1 is wound the coupling coil L2, which is connected to the receiver via coaxial cable. Twin feeder could be used as an alternative.

The construction of the frame is illustrated in *Figure 3*, the whole thing being made of thin 3-ply wood, 16in high \times 15in wide with a winding area 4in wide, and was securely glued together with corner blocks and support blocks, as shown. It was dyed with Rustins' wood dye (light teak) which, being spirit-based, dried out quickly.

The L1 winding consists of 56 turns, close-wound, of PVC-covered flex containing 7 wire strands and with an overall outside diameter of 0.9mm.

This L1 winding takes the full width of the frame, apart from about $\frac{3}{16}$ in either side. Over L1 is wound the coupling winding L2, consisting of 3 turns of PVC-covered flex containing 22 wire strands and with an outside diameter of 2mm. L2 is close-wound directly over the centre of L1. Lead-outs are shown in *Figure 3*.

At this stage a 500pF variable capacitor was connected across the ends of L1, a length of coaxial cable from L2 was connected to the receiver, and initial performance, wave-range and nulling was checked. Brown PVC insulating tape was then wound over the windings, and performance and frequency range rechecked.

Support assembly

The frame support assembly was then constructed, as shown in *Figure 4*. It consists of two vertical members, 22in long, and 2 horizontal base members, 8in long, with a block of wood between, which was cut and fitted after the frame with its winding had been secured to the frame support assembly.

The front vertical member has a suitable hole drilled for the variable capacitor (CV) and the rear member has a hole for a coaxial socket. Again these wooden parts were stained light teak.

All that remained was to fit the frame into the support assembly and secure it with wood screws into the ends of the 4in \times 1 $\frac{1}{2}$ in \times $\frac{1}{2}$ in blocks (see *Figure 3*) to produce a finished assembly (*Figure 1*).

A coaxial socket was mounted near the bottom of the rear vertical member, and the lead-outs from L2 soldered to it. A 2 gang 500pF variable capacitor was fitted in position (see *Figure 4*), and the lead-outs from L1 soldered across one section. The other section has been left unused for possible use later when suitable VLF equipment becomes available to switch in parallel and extend the range above 2000 metres.

Figure 5 shows the polar diagram of the loop. The null appears when the flat side points towards the station being received. Maximum signal appears off the ends.

Operation is quite simple. The fre-

quency required is selected, and the aerial resonated with CV for maximum signal. The loop is rotated at the same time for maximum signal. Turn the loop through 90 degrees and the signal should disappear or be greatly reduced. This latter operation proved quite effective, except in the case of BBC4 on 1500 metres (200kHz), where the signal cannot usually be nulled out sufficiently to hear the lower power stations in Warsaw, Turkey and Leningrad which share this frequency.

A further bonus is that it is possible to rotate the aerial slightly to reduce the electrical interference often radiated in apartment blocks.

The frequency range of the loop was measured from 545kHz to 150kHz (550 to 2000 metres), so it obviously covers the whole of the LW band (and also the spectrum between the MW and LW bands). A slow motion drive was not considered necessary on the resonating variable capacitor.

Many European stations can be heard and QRM/QRN can be nulled out by rotating the loop slowly to obtain good listening quality and volume.

The furthest east received, so far, has been Minsk in the Crimea on 281kHz

(1068 metres). It can be located with the loop pointing roughly NW/SE, and is just high frequency of a CW beacon CHT on about 277kHz (1080 metres). Of course, Moscow comes in loud and clear.

To the south, Radio Algiers usually produces a beautiful signal on 254kHz (1181 metres). Programmes are generally in French, but at 2000GMT (2100BST) there is an English news programme with station identification. The loop should be pointed roughly N/S and carefully adjusted, as must the receiver tuning, as there are powerful stations on either side.

Reykjavik (Iceland) presents a problem. There is a West German station on the same frequency, and on a reciprocal bearing, and this obviously cannot be nulled out.

Better results

Better results could no doubt be obtained with a good general coverage communications receiver which covers the LW band. Whatever receiver is used, it *must not* be fitted with an internal ferrite rod aerial, even if it has an external aerial socket as well. No doubt a larger loop along the same lines would also give better results. REW

Fig 4 Frame support assembly

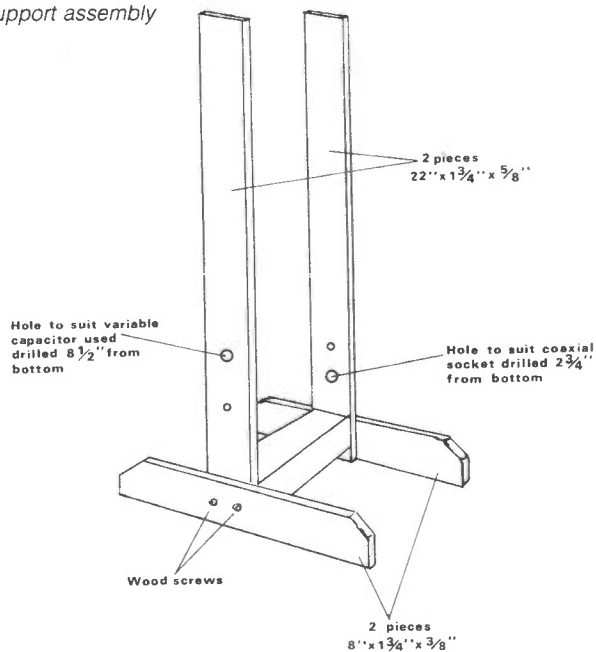
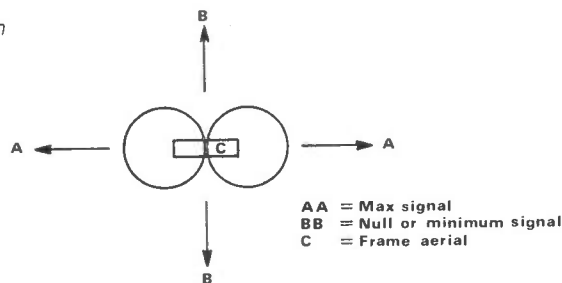


Fig 5 Polar diagram



ATVer of the Year 1985 is Dr Anthony England W00RE, who was nominated by *Spec-Comm*, the American ATV magazine formerly known as A5.

The honour was bestowed upon astronaut England for his efforts in utilising amateur slow-scan TV during last summer's 51-F Spacelab 2 'ham in space' (no, not pigs in space) operation. The award was accepted on behalf of Dr England by fellow astronaut Dr John-David Bartoe N4NYZ at the Octobvention 1985 Grand Banquet, on 2 November last (I think this figures).

Anyway, it's nice to get some recognition for ATV, and the slow-scanners should be jubilant. I have not yet seen any off-screen photos of transmissions from the Space Shuttle; would anyone like to send some in for publication?

Silly-billies

You know those daft people who make trouble for everyone else? Some operators are making a big thing of transmitting full colour and subcarrier sound on 70cm ATV. They seem to think it's macho or an illustration of the state of the art. Seems that it's getting up the noses of non-afficionados of ATV and the latter are contemplating making complaints and naming names. This seems a most unfortunate state of affairs – it is difficult enough keeping ATV picture buzz out of 'phone repeaters and persuading the rest of the ham radio community that ATV alone is responsible for hanging on to the full 10MHz allocation at 70cm.

Continuation of this practice will lose us a lot of friends, quite apart from it being illegal. A few tests at one in the morning are fairly harmless but lengthy transmissions during the evening are antisocial to say the least.

Using a 6MHz subcarrier and double sideband modulation, you will be radiating a signal more than 12MHz wide (with whatever filters you have – or don't) and this will inevitably be spreading outside the band. Above 440MHz you will not be doing much harm in some areas, but at 429 and below you will probably be heard by people who have good friends in the RIS.

I suspect that the number of people doing this is small, and I hope it will soon be nil. There is plenty of scope for worthwhile experimentation at 1.2, 2.3 and 10GHz, and this would give much more satisfaction than blocking the whole of 70cm.

BATC news

There are some ATVers who do not belong to the BATC. No doubt they have very good reasons, but anyone and everyone who is interested in ATV is welcome to visit the BATC's open days. This year's 'do' will again be at the Post House next to the M1 motorway at Crick. Crick is in the frozen north, about 70 miles north of London. In other words, little more than an hour's drive. It is also conveniently sited in the middle of England for everyone else to reach.

This year's event will be bigger than ever, I am told, so reserve the date in your

ATV

ON THE AIR

Andy Emmerson G8PTH puts you in the picture

diaries. It's Sunday 4 May, which happens to be the Bank Holiday weekend. This year there will be more for the rest of the family – an inflatable trampoline fun castle for the children and so on. I'm not convinced how much of an inducement this is because of course the ATVer comes more for the junk stalls and trade stands.

On sale at the rally will be all the BATC's supplies: printed circuit boards, vidicons and other hard-to-find bits. A new projects book, *The Best of CQ-TV*, should be out by then, too, so it should be worth a trip. DX-TV and weather satellites featured prominently last year and doubtless they will again this time. There may well be displays of satellite TV and some vintage apparatus as well.

Foreign despatches

From the Netherlands comes the news that the 70cm 'phone repeaters there are to be relocated from 433-435MHz to 430-432. At last no more interference between ATV stations and repeaters, says Paul Paoson, who is ATV manager of Veron, the Dutch equivalent of the RSGB.

The EATWG, the European Amateur Television Working Group, is taking shape. Representatives from Britain, Germany and Holland are setting up a data bank which will cover: licensing conditions, frequencies, power limits; lists of stations active on 70 and 24cm; a survey of typical transmitting and receiving equipment; ATV repeater technology, antennas, lists and frequencies; details of national and international ATV contests; records and archives; and details of national organisations, conventions and publications.

The aim of the EATWG is to gain recognition from the IARU and its VHF Working Group as the consulting authority for all ATV matters in Europe. A progress meeting will be held later this year and more news should be available after that time.

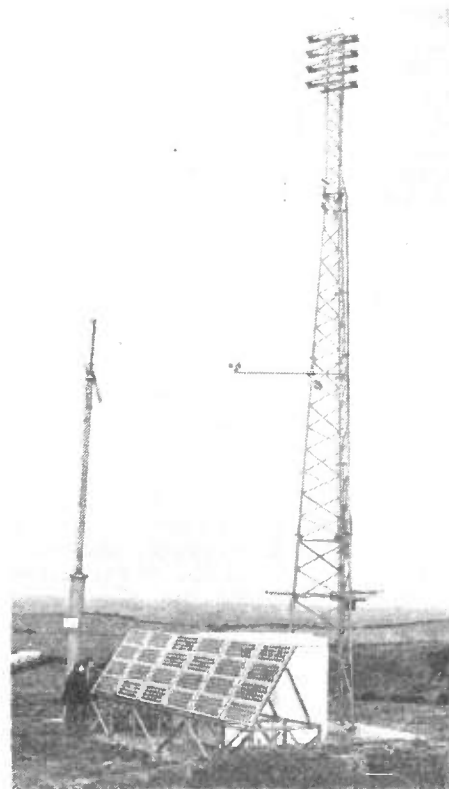
Surprising tests

A factor not often reckoned with in ATV is electrical 'background noise', which acts as a constant level of interference to

received signals. The higher in frequency one goes the less relevant this is, but at 70cm it may be a significant factor.

So thinks Josef DJ6PI, writing in the latest issue of *Der TV Amateur*. In a technical article he describes ATV tests made from the top of Tegelberg, more than 5,000 feet above sea level. The TV repeater DB0DN is located here and indeed it is a superb location with a very wide coverage area, thanks to its height.

The tests were made over a 180km transmission path, so this was no theoretical lab experiment. From his home station in Augsburg, DJ6PI sent signals on both 70cm (AM) and 13cm (FM) and received them via the DB0DN repeater, which has inputs on both bands and an output on 23cm. Path length was 90km in each direction, hence the 180km round trip.



This is how the Independent Broadcasting Authority powers one of its TV repeater stations

The results have been astonishing. On 434MHz a transmitted 1 watt gave a very noisy repeater output, with no colour visible. Ten watts cleared up some of the noisiness and colour was then visible. With 70 watts a good picture was achieved, though still with a light overlay of picture noise.

Turning to 2.3GHz FM, a colour picture was already achieved with 150mW output!

Just 800mW was enough to give noise-free colour and 1.5 watts gave a perfect picture.

Background noise

What does this prove and why? For a start it shows that although the path loss on 13cm is 15dB greater than at 70cm, just one tenth of the output power is needed at 2.3GHz to achieve comparable or better pictures. DJ6PI concludes that this has to be tied up with the constant background noise or QRM on 70cm. With an interference-free band at 70 as well as at 13, the comparison might not have been so impressive. However, given that we live in the real world, perhaps we ought to exploit the advantages of the

microwave bands, which are more or less handed to us on a plate. Less QRM, more gain from smaller aerials and an FM effect which works to our advantage.

Sign-off time

Why don't more people try 23 and 13cm? Are they afraid of roasting next door's homing pigeons? How about sending me some letters? Drop me a line care of Sovereign House in Brentwood or run up your phone bill and leave a message on the answering machine: (0604) 844130. REW



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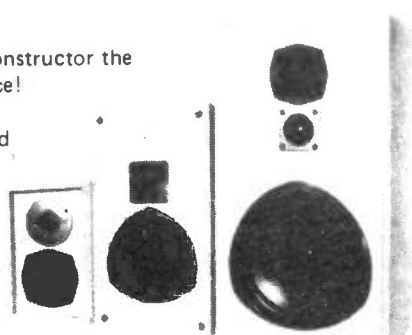
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December wasn't exactly a rip roaring month for DX-TV reception. There is normally a mid-winter peak in sporadic-E activity, and indeed signals were logged but openings were generally insignificant. Tropospheric DX noted on the 16th and 17th produced good quality pictures from Belgium, France, Luxembourg, West Germany and the Netherlands. However, tropospheric ducting towards the end of the month brought in Spanish FM radio programmes and Band III TV signals to DXers in the north-west of England.

On the meteor shower front the Geminids didn't produce anything too startling, although there were some relatively sustained 'pings' on the 13th, 14th and 15th. Unfortunately only programmes were seen, causing frustration all round as the TV services couldn't be identified.

DX-TV log for December

Simon Hamer of New Radnor (Powys) has joined forces with us this time round to provide a log. He has come to the conclusion that after experiencing a good trop opening during the autumn we all pay for it later with dud conditions towards Christmas time. We're inclined to agree with him.

The following signals were noted by the authors in Derby:

2/12/85: SR/SVT-1 (Sweden) on channel E2 with the 'TV1 SVERIGE' PM5534 test card. This was a very short duration signal via sporadic-E.

13/12/85: Meteor shower activity noted during the early evening on channels E2, R1, E3 and E4, all with programmes.

14/12/85: A sporadic-E opening was in progress at switch on with programmes on channels R1, R2, E3 and E4 from 1510GMT. The E4 signal was a football match thought to be of Yugoslavian origin. Meteor shower DX was noted on E2, R1, E3, R2 and E4 during the early evening.

15/12/85: Meteor shower DX noted throughout Band I with programmes - positive identification was not possible.

16/12/85: CST (Czechoslovakia) on channel R1 radiating the 'RS-KH' electronic test card. A co-channel programme was noted at 0844 via sporadic-E; SRG-1 (Switzerland) on channel E3 transmitting the FuBK test card with the usual identification '+PTT SRG1'. This country was received via weak sporadic-E; unidentified programme as co-channel signal to the Dutch E4 outlet at Lopik. NOS were showing the PM5544 test card with the identification 'PTT-NED.1'.

19/12/85: TVP (Poland) on R1 showing their slightly modified PM5544 pattern; ORF (Austria) on E2a with the PM5544 bearing the inscription 'ORF FS1'.

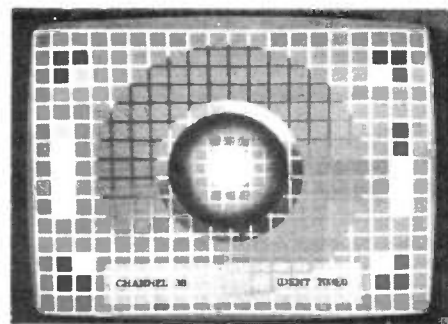
20/12/85: TSS (Russia) on R1 with the UT0167-type electronic colour test card, noted via sporadic-E propagation at 0842.

22/12/85: Unidentified feature film on channel R1 or E2a at 1601GMT.

Simon's DX-TV log for the month consists of signals noted via sporadic-E during lunch-times. His report is as follows:

DX-TV RECEPTION REPORTS

Compiled by Keith Hamer and Garry Smith



3/12/85: RAI (Italy) on IA with programmes; CST R1 on the 'RS-KH' test card.

6/12/85: TVE (Spain) E2 showing the 'tve tve 1' GTE colour test card via SpE.

11/12/85: TVP R1 with the PM5544 (with a dark background).

12/12/85: TVP on channel R2 radiating the PM5544 test pattern.

22/12/85: ORF on E2a with the Telefunken TO5 monoscopic test card and the identification 'ORF FS1' superimposed towards the bottom.

27/12/85: RAI on IA with programmes; CST R1 with the EZO-type test pattern.

1985 DX-TV round-up

With the passing of yet another year, it's time to look back at DX-TV conditions. A glance through reception reports for 1985 shows that it was an exciting and eventful period with lots of surprises. DX-TV records were well and truly broken, both with reception via sporadic-E and tropo.

Early on in 1985 many enthusiasts caught a glimpse of some old discontinued test cards which were radiated for special engineering purposes. Test cards included the monochrome test card 'G' (similar to the BBC test card 'C' but with an outer circle), the RETMA Resolution Chart 1956 (probably from Hungary), the early Czechoslovakian monoscopic pattern (with the identification 'CESKOSLOVENŠKO' at the top) and a Swedish tuning pattern. This consisted of a girl's head and greyscale pattern enclosed within a circle.

A brand new test pattern appeared on our screens from a pirate station in Italy. The test card received on channel IA resembled the West German FuBK type but with a few modifications. The identification was 'Radio Tele Uno'.

For the first time TV signals from a low power outlet in Bulgaria were seen on channel R3 in the Netherlands. Rijn Muntjewerff, of Beemster, was the lucky DXer to log this on June 5th between 1410 and 1429GMT.

Programmes from Syrian TV were logged on channels E3 and E4 in Derby from 1250 on June 21st. Meanwhile, over in East Anglia, Ray Davies noted these transmissions together with an Arabic station on channel E2. Andy Webster in Wigan discovered the 'square' PM5544 test card from Dubai during the same month, and Tony Brittain was overwhelmed to find the 'NTV SOCOTO'

caption appear before his eyes on E3 from Nigeria.

Television signals from Iran were noted on several occasions during 1985 on channel E2. Thanks to the modified version of the FuBK test card being radiated, positive identification was possible. Rijn Muntjewerff (Netherlands) and Iain Menzies (Aberdeen) both saw signals from the 5kW channel E3 outlet at Dhahran in Saudi Arabia. Iain saw them on a caption and Rijn resolved the PM5534 test card for almost an hour on the morning of June 26th. The identification read 'HZ22TV' at the top and 'CHANNEL 3' below.

Jukka Kotovirta in Finland also found this on his screen. He was also astonished to hear FM radio from Iraq on June 19th. Possibly the best record breakers of the year were the Canary Islands on E3 from the Izana outlet and Morocco on E4 from Layoune.

So much for sporadic-E. What about trop conditions during last year? Well, October was a record breaker for distance and quality. Highlights included Russian and Polish DX in Band III. Kevin Jackson and Mark Dent (both from Leeds) saw the Russian signal on channels R9 and R12, while Poland occupied R8, R10 and R12. And let's not forget the Italian FM tropo from Torino noted by Kevin and the Spanish Band III and FM reception by Andy Webster just before Christmas.

All in all, 1985 was a very successful year for DX-TV enthusiasts. It won't be too long before the start of this year's sporadic-E season. No doubt even more records will be broken over the next few months.

Reception reports

Unexpected tropospheric ducting produced Spanish DX for Andy Webster of Billinge (near Wigan) on December 11th. During the afternoon he became suspicious of a foreign sounding FM radio station which peaked with the aerials directed towards the south-west. A check in Band III revealed Spanish (TVE) transmissions on channels E8, E9 and E10. Picture quality was good at times and the opening continued well into the evening. It isn't the first time Andy's seen Spanish TV via tropospheric propagation. Last year he received the ETB service on UHF from the Basque region of Northern Spain.

DX-TV via improved trop conditions was also in evidence on December 17th in the south of England. Harold Brodribb of St Leonards-on-Sea informs us that transmissions from Südwestfunk's channel E9 outlet at Hornisgrinde (West Germany) were present from 0845. The FuBK test card was being radiated with the identification 'SWF BADN 1'. Harold reports that the picture was 'clean'. The pattern was replaced by an ARD/ZDF caption and by programme schedules.

Several French 'Canal Plus' signals were located by Harold throughout Band III on channels F5, F6, F7 and F9. These were viewed as negative images since a standard receiver was being used. The 'RTL+' PM5534 test card from the Dudelange channel E7 outlet in Luxembourg was also present.

How to become a DXer

We frequently receive letters from *Radio and Electronics World* readers seeking advice on how to start DXing after hearing about the exploits and successes of established enthusiasts via this monthly column.

Until comparatively recently, equipment specially suited to the hobby wasn't widely available on a commercial basis. This meant that most DXers had to be either associated with the TV servicing trade in some way, or be in a position to

enlist the help of someone who was, in order to adapt a receiver for DX-TV. Today the situation has changed. Receiver systems and tailor-made aerials for DX-TV reception are available, together with helpful books covering various aspects of the subject. Consequently, anyone with only a minimum of technical knowledge can soon become involved with a very satisfying hobby.

Almost anyone with an interest in receiving television signals from anywhere other than the local transmitter could loosely be termed a DXer. We stress the word 'receiving' as opposed to viewing because the traditional role of the TV DX enthusiast is someone who enjoys resolving a broadcast TV transmission that has travelled hundreds or perhaps even thousands of miles before entering the aerial system, whatever the quality. It is the challenge of capturing these stray signals which, under normal conditions, would travel out into space. The unpredictability of their origin, quality and duration all add to the excitement of the hobby.

Nowadays, with satellite technology being widely available, it is possible to display excellent quality pictures from the USSR or practically anywhere in Europe. That's fine if it's extra channels you are after to supplement the offerings

from the BBC or IBA.

Many established enthusiasts originally started out by exploring the VHF or UHF bands in search of extra British regional programmes. During periods of anti-cyclonic weather distant stations may appear on normally vacant channels. Some of these will have originated within the UK but others will have come from Continental transmitters.

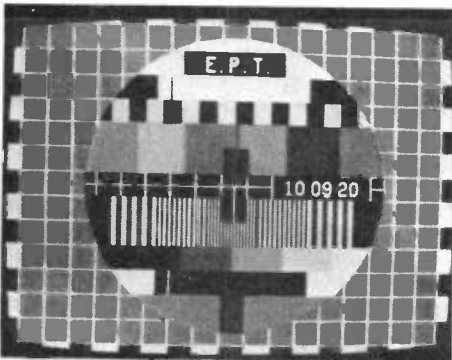
DX via enhanced trop conditions can produce remarkably high-quality, stable pictures at times, especially from Belgium, West Germany and the Netherlands. These signals can be viewed on a standard domestic TV receiver. The sound and vision spacing is different to the UK system and the intercarrier sound stage would require some tweaking in order to obtain the audio. If you want to avoid the risk of family arguments (and electrocution) it may be best to either simply watch the foreign pictures or purchase a receiver featuring British and Continental sound standards.

The lower UHF channels are generally more productive than those in groups C and D. This should be borne in mind when selecting a more efficient aerial to replace the domestic installation.

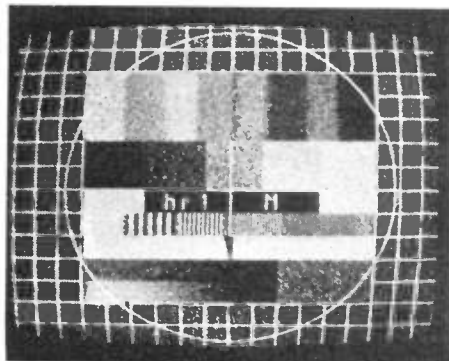
Proagation

Perhaps the most interesting form of TV DX takes place via sporadic-E (or

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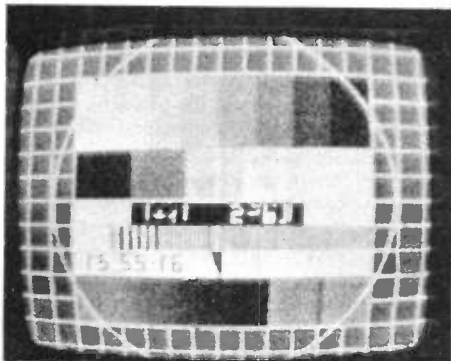
The PM5534 test card. This is used by EPT in Greece



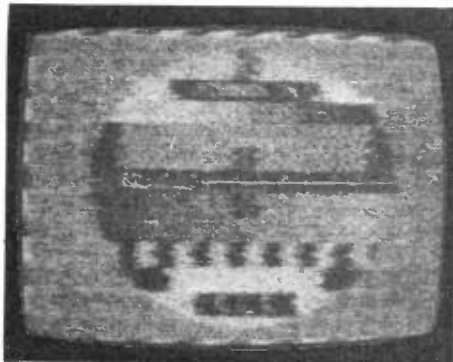
West German FuBK test card transmitted by Hessischer Rundfunk



Caption heralding commercials from CST in Czechoslovakia



FuBK test card radiated by the TV service in Libya. Note clock



PM5534 received in UK on UHF from Spanish 'Euskal Telebista' network



Identification caption used in Spain by Televisión Española

DX-TV RECEPTION REPORTS

METEOR SHOWER DATES FOR 1986

SHOWER	BEGINNING	END	REMARKS
Quadrantids	Jan 1st	Jan 5th	Average
April Lyrids	April 19th	April 24th	Good
Aquarids	May 1st	May 8th	Long showers
June Lyrids	June 10th	June 21st	-
Perseids	July 25th	Aug 18th	Very good
Cygnids	Aug 18th	Aug 22nd	-
Orionids	Oct 16th	Oct 27th	Poor
Taurids	Oct 10th	Dec 5th	Poor
Leonids	Nov 14th	Nov 20th	Fair
Geminids	Dec 7th	Dec 15th	Excellent

Kindly supplied by Pete Sturgess (Derby)

'SpE') ionisation. Because SpE activity is capable of producing high-level signals most enthusiasts are guaranteed some form of long-distance TV reception, even with the simplest of equipment.

Sporadic-E activity usually occurs between mid-May and early September. However, TV stations can be received via SpE at any time of the year. If you're a little short on patience though it may be better to try during the height of summer to avoid disappointment.

SpE reception is provided courtesy of the 'E' layer, which is located some 75 miles above the surface of the Earth. In summer it is ionised by the sun and it then acts as a reflector, thus allowing TV

signals to be redirected towards our planet. Normally the signals would pass straight through the E-layer, to be lost forever in space. The process is actually a combination of reflection and refraction.

When TV transmissions are bounced back to the Earth a 'skip' distance is involved (this is sometimes referred to as the 'hop' distance). Typically the skip distance is between about 600 and 800 miles, hence countries around the Mediterranean area or in Scandinavia may be received while countries closer to the UK, such as Belgium or the Netherlands, may be lacking. With 'double-hop' reception TV stations as far

away as the Middle East or Africa can be resolved with amazing clarity. But remember, reception is totally random and programmes cannot be pre-selected. It's worth knowing this before splashing out on expensive equipment.

Service information

United Kingdom: Stereo TV sound transmissions have been noted from the BBC-2 outlet at Crystal Palace by several Dutch enthusiasts.

Spain: A fourth regional TV service is to open shortly in the province of Navarra. The first regional network in Spain was 'Euskal Telebista', which began in 1983. This covers the northern Basque region. 'TV3' came into operation during 1984 for the Catalunya region and last year the third network began called 'Televisión de Galicia' (TVG).

Greenland: The television service in Greenland, which has been in operation for three years, radiates the PM5544 test card with the identification 'KNR' at the top and 'KAL NUNAAT' at the bottom. There are currently six transmitters in service, all on channel E10 with a maximum ERP of only 5 watts.

This month's service information was kindly supplied by Alexander Wiese (West Germany) and Gösta van der Linden (Netherlands). REW

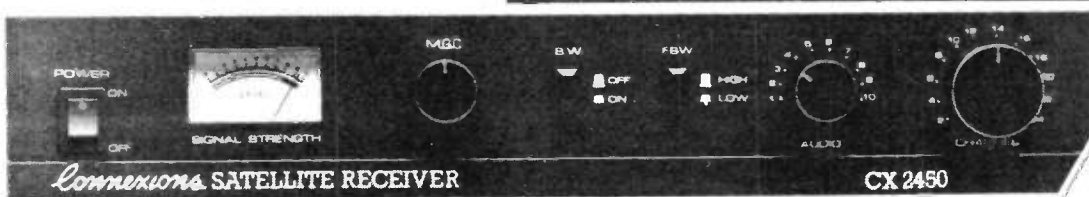
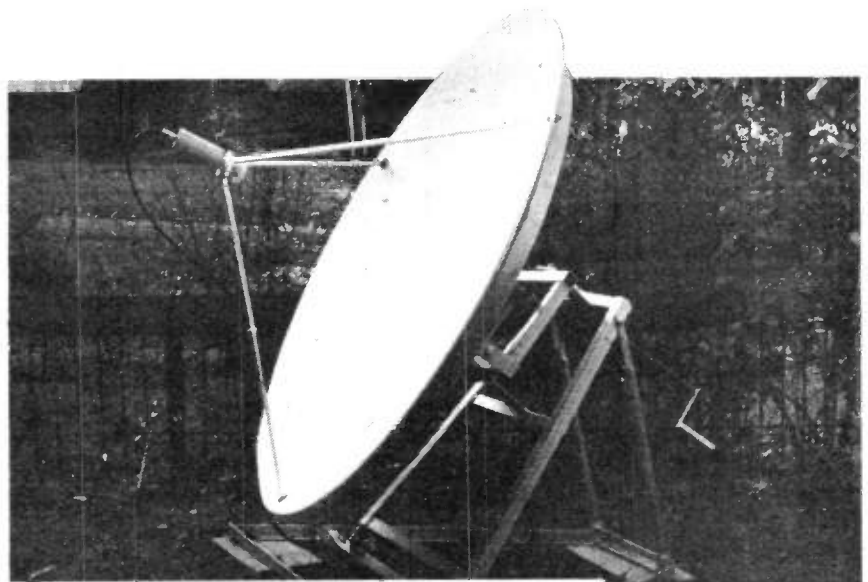
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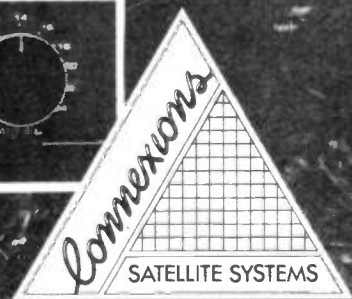


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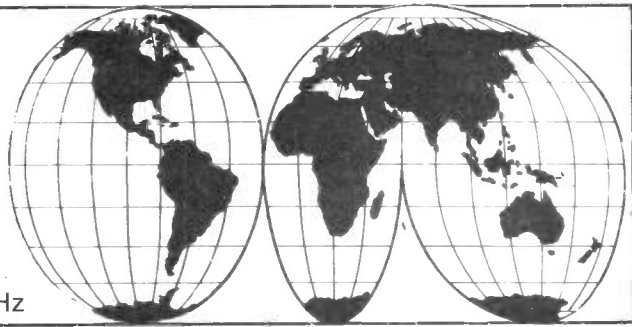
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SHORT WAVE NEWS FOR DX LISTENERS

By Frank A Baldwin

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



Forsaking both the 60 and 90 metre bands, this instalment of the ongoing short wave saga launches readers' longships on a voyage of discovery through the QRM storm-tossed ocean lying between **4000** and **4460**.

Storm-tossed is the right description; this area of the dial abounds in commercial utility QRM (interference) resulting in a welter of cacophonous noises amid which – if one is fortunate – some safe harbours of DX may thankfully be found.

Many of the Far Eastern transmitters listed here are rarely logged by DXers based in Western Europe or the UK, but just occasionally some of the signals do filter through – much to the satisfaction of those lucky enough to be on the receiving end. Some of the stations featured in these paragraphs exhibit relatively low powers. Moreover, as indicated above, many of the channels are affected by ute (utility) QRM. In DXing terms, the frequencies are 'muddy', to say the least.

China

On **4020** Radio Beijing radiates a Foreign Service programme in Korean from 1100 to 1500. The power is 50/120kW. Also reported closing at 1730 after a Swahili programme.

The 50kW Xizang PBS (People's Broadcasting Station) Lhasa, Tibet on **4035**, carries the Home Service in Tibetan from 2230 to 0130, from 0330 to 0545 and from 1000 to 1545, the latter period including a relay of the Radio Beijing Minority Language Service from 1300 to 1325. The Radio Beijing Foreign Service in Hindi is broadcast from 1600 to 1800, the last hour being a repeat of the first.

Further up the dial on **4045** there is the Voice of the Strait at Fuzhou. This 10kW transmitter provides a service to offshore islands and Taiwan, mostly in standard Chinese but also with some program-

mes in Amoy. The schedule is from 1055 to 2355. The power is 10kW.

CPBS (Central People's Broadcasting Station) Beijing relays the Radio Beijing Minority Language Service in Korean from 2130 to 2156, from 1000 to 1026 and from 1200 to 1226. Programmes in Mongolian are transmitted from 2200 to 2226 and from 1230 to 1256. The frequency is **4190** and the power 50kW.

The nearby channel of **4200** is occupied by Radio Beijing with the Foreign Service in English from 1400 to 1600 and in Russian from 2000 to 2055 and from 2100 to 2155. The power is 50kW and, needless to say, the latter programmes are jammed.

Xinjiang PBS in Urumqi radiates the Home Service in Mongolian on **4220**, the schedule being from 0000 to 0230, from 0530 to 0730 and from 1300 to 1700, this latter period including a relay of the Radio Beijing Minority Language Service from 1430 to 1456. The power is 15/50kW, this one also operating in parallel on **5060**. This was recently logged by the writer and reported in this feature.

On **4250** Radio Beijing carries the Home Service 2 in Chinese from 2100 to 2400 and from 0745 to 1600. The power is 50kW.

Voice of the Strait, Fuzhou at 10kW radiates programmes in standard Chinese and Amoy to offshore islands and Taiwan from 1205 to 2355. The channel is **4330**, also recently logged. Voice of the Strait may also be heard on **4380**, at which point on the dial it transmits in Chinese and Amoy from 0355 to 1755. The power is 10kW. Logged at 1509.

On **4460** Radio Beijing transmits Home Service 1 programmes in Chinese from 2000 to 0030 and from 1015 to 1730 with a power of 50kW. Radio Beijing on this channel is often featured in the SWL press.

Mongolia

Ulan Bator on **4080** fairly often appears in DXers' reports. It radiates the Home Service 1 from 2200 to 1600, the schedule of which includes relays of the Moscow Foreign Service in Mongolian from 0600 to 0630, from 0930 to 1000 and from 1200 to 1245. On Tuesday and Friday there is a Russian programme from 1130 to 1200 and one in Chinese from 0830 to 0900. The power is 50kW.

North Korea

The regional North Korean station at Kanggye on **4273**, power not known, broadcasts the Home Service from 1958

to 1800 but features local programmes from 2230 to 2300, from 0430 to 0520 and from 1100 to 1110. Again, it is hardly likely that Kanggye will be logged by UK DXers.

Vietnam

The Vietnam regional station at Vinh Phu, power unknown, on **4243** is on the air from 1030 to 1100, from 1200 to 1230 and from 1300 to 1330 with local programmes. The observation here is that this one is most unlikely to put a signal into the UK at the present point in the sunspot cycle.

Progression from **4460** next month.

AROUND THE DIAL

The purpose of this section is to provide both the SWL and the DXer with facts resulting in a comparable log-book entry. Information having priority, illustrations have been omitted.

AFRICA

Botswana

Gaborone on **4820** at 0345, interval signal of cattle lowing and the sound of cow bells prior to opening with the Home Service in SeTswana, scheduled from 0400 to 0630 and from 1425 to 2100 but sometimes until 2300. There are English newscasts at 0510 Monday to Friday inclusive, at 0600 (BBC relay) and at 1610 and 1910. The power is 50kW. Note, however, that late evening reception on this channel may be a mix of the above with signals from the 25kW Angolan Emissor Regional da Huila now also on this frequency.

Burkina Faso

Ouagadougou on **4815** at 1917, OM with a talk in French. Radio Diffusion-TV Burkina is on the air in French and some local languages from 0530 (Saturday and Sunday from 0700) to 0900 and from 1700 to 2400 with a power of 20kW. The frequency can vary to **4817** on occasions.

Cameroon

Bafoussam on **4000** at 0427, African xylophone interval signal, OM with some announcements in a vernacular, more xylophone, drums then OM with the station identification in both French and English, a choral/orchestral rendition of the National Anthem at 0430, then OM with songs complete with YLs in chorus and drum backing. The power is 20kW and the schedule is from 0425 to 0830 and from 1630 to 2300. There are news bulletins in English and French at 0700, 0800, 1700 and at 2200!

Central African Republic

Bangui on **5035** at 0439, OM with a talk in French. Radio Centrafrique at 100kW operates from 0430 to 0700 and from 1630 to 2300. The channel is a 'muddy' one, being also that of the USSR transmitter at Alma Ata at 50/100kW.

Gabon

Libreville on **4777** at 2031, African xylophone music in the local fast rhythmic style then OMs with a song in vernacular. This one is scheduled from 0430 (Sunday from 0530) to 0630 and from 1600 to 2400 with a power of 100kW. The city of Libreville is the

SHORT WAVE NEWS

capital of Gabon and is a seaport on the Gulf of Guinea.

Transkei

Capital Radio on a measured **3929.8** at 2040, OM with announcements in English amid a programme of UK pops on records. This 20kW transmitter is on the air from 0300 (Sunday from 0400) to 0530 and from 1530 to 2300. Difficulties here for some, Radio Voz de Sao Vicente, Cape Verde at 10kW being on **3930** and the rarely reported South Korean station at Suweon also being on **3930**. If the announcements are in English it will be Capital Radio, if in Portuguese or Creole it will be Cape Verde, and if in Korean you will be lucky!

SOUTH AMERICA

Brazil

Radio Difusora do Amazonas, Manaus on **4805**, at 2330, OM with the station identification in Portuguese followed by some sambas with announcements interspersed. This 5kW Brazilian was reactivated in the early part of last year and has been heard closing around 0200, but is sometimes known to work around the clock.

Ecuador

Radio Popular de Cuenca on **4800** at 0420, OM with announcements in Spanish then some local pops on records. At 5kW, Radio Popular is scheduled from 1000 to a variable closing time around the 0700 mark. The frequency can vary to **4801** at times.

Venezuela

Radio Valera, Trujillo on **4840** at 0347, OM and YL with a discussion about Colombia in Spanish. This Venezuelan is on the air from 1000 through to 0400 at 1kW. The town of Trujillo is the capital of Trujillo State in western Venezuela on the Transandean highway at an altitude of 805 metres.

ASIA

China

Voice of the Strait, Fuzhou on **4045** at 1910, OM with a talk in Chinese. This is the People's Liberation Army Fujian Front Station broadcasting to Taiwan and other offshore islands mostly in standard

Chinese but with some Amoy programmes. It identifies as Hai-xia-zhi-sheng guang-bo dian-tai. The Haixia 1 transmission, logged here, is timed from 1055 to 2355 and the power is 10kW.

Voice of the Strait, Fuzhou has also been logged on **4330** at 1505, OM with a song in Chinese, this also being Haixia 1, timed from 1205 to 2355 and on **4380** at 1509, YL with a talk in Chinese. The latter transmission was Haixia 2 in Chinese and Amoy. Amoy programmes on this frequency are timed from 0645 to 0715, 0945 to 0955, 1400 to 1415, 1445 to 1500, 1600 to 1615 and from 1645 to 1700.

CPBS (Central People's Broadcasting Station) Beijing on **4460** at 1602, OM and YL with a talk in Chinese in the Home Service 1 which is radiated on this channel from 2000 to 0030 and from 1015 to 1730. The power is 50kW.

Xinjiang PBS on **4220** at 1500, OM and YL with a discussion in the Mongolian Home Service which is on this frequency from 0000 to 0230, from 0530 to 0730 and from 1300 to 1700, this including a relay of the Radio Beijing Minority Language Service in Mongolian from 1430 to 1456. Xinjiang PBS at Urumqi has a power of 15/50kW and can also be heard in parallel on **5060**.

India

AIR (All India Radio) Gauhati on **4775** at 0029, the AIR interval signal, then OM with announcements at 0030 followed by YL with a song in Hindi. This 10kW transmitter is scheduled from 0025 to 0400 and from 1030 to 1215. It is seldom logged here in Europe.

AIR Hyderabad on **4800** at 1545, YL and OM with the station identification and announcements then a talk about Pakistan all in English. Hyderabad is on the air from 0025 to 0215 and from 1200 to 1741 with a power of 10kW, it being the chief city of the state of Andhra Pradesh on the River Musi.

AIR Delhi on **4860** at 1548, OM with a talk in English with mentions of Bangladesh and Pakistan, this programme being in parallel with that above. This one is on the air in

Nepali from 0130 to 0215 and on the national network in local languages from 0215 to 0345 and from 1233 to 1741. There are English newscasts at 0240, 1430, 1530 and at 1730. The power is 10kW.

Pakistan

Islamabad on **17660** at 1003, YL with a news bulletin in English which is timed from 1000 to 1010 during the Urdu programme for Europe, scheduled from 0715 to 1100. Also logged in parallel on **15605**.

SOUTH-EAST ASIA

Singapore

BBC Relay, Kranji on **3915** at 1530, OM with announcements and a talk in English in the World Service scheduled on this channel from 1500 to 1745. The power is 100kW.

Indonesia

RRI Jakarta on a measured **4774.6** at 1538, OM with a talk in Indonesian. The schedule is from 2158 to 0100 (Sunday until 0200) and from 0800 to 1300 but irregularly to 1600, 1700 or any time between. The power is 50kW. Jakarta (Batavia) is the capital city of Indonesia and is located in north-west Java.

NOW HEAR THESE

Sistema de Emisoras Atalaya, Guayaquil, Ecuador on **4792** at 0303, OM with some announcements then OM with a folk song in Spanish. This 5kW transmitter radiates from 1000 through to 0455 but at weekends is often on the air around the clock.

Azad Kashmir, Pakistan on a measured **4790.5** at 1452, OM with songs, some local-style music then YL with announcements, presumably in Kashmiri. At 10kW, this station is scheduled from around 1400 to 1804 and claims to be located in Trar-khel. The trouble is that nobody seems able to locate such a place!

Radio Nacional, Sao Tome e Principe on **4805.4** (measured) at 2054, OMs with a discussion in Portuguese, OM with announcements at 2100 then YL with songs. Reactivated during August last year, this 10kW transmitter closes at 2300, other scheduled times being unknown at the time of writing.

NOW LOG THESE

Voice of the Strait, Fuzhou on **3535** at 2302, YL and OM with a talk in Chinese under interference from amateur CW (Morse) signals. Rarely heard on this channel, which is not surprising, Haixia 1 in Chinese programmes here from 1310 to 2355 with a power of 10kW.

Djibouti on **4780** at 0335, YL with a song in Somali with local-style musical backing until 0345 when there is an OM with a newscast in Somali, all overriding signals from the co-channel USSR 50kW transmitter at Petrozavodsk. Djibouti is on the air from 0300 to 0800 (Friday from 0500 to 0900) and from 0900 to 1900 with a power of 20kW, carrying the National Service in Somali, Afar and Arabic.

Ulan Bator, Mongolia on **4080** at 2235, OM with announcements, YL with a talk until 2250 then some stringed instrumental music. This is the Home Service 1 in Mongolian which is on the air from 2200 to 1600 at 50kW.

KCBS Pyongyang, North Korea on **3015** at 1531, European-style orchestral music, YL with a song, YL with some announcements then OM with a talk in Korean until 1530, this being followed by OMs with a marching song. Signal lost under sudden interference at 1542. This 120kW transmitter, seldom reported by European DXers, is scheduled from 2000 to 0900 and from 1530 to 1800, also radiating the Foreign Service programmes in Japanese from 2100 to 2250 and from 0900 to 1455.

DOTS AND DASHES

For a change of occupation, the results of some CW operation are noted here. On Top Band (1.8 to 2MHz) the bag included EA5TX, I5MMX, KA1GE, K2RIH, K3JLT, K4UEE, K5NA, LA5X, LX1EA, OH6LP, RA9AKM, SV1PL, TK0KC/P, UG6GAW, UL7LFB, UP1BZZ, UQ1GWE, UR2QD, UT5AB, VE2FYR, W1FZ, YU2MM and 4X4NJ.

On 7MHz (7.0 to 7.1MHz) CE3IAP, CO6ER, CX6BQ, FM5WU, HK4COK, HP1XLU, J28EG, LU7UBA, OA4IU, PY2LMA, PZ2AC, XU1SS, YV1BD, ZR2HM and 3B8CF were logged. REW

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Particularly for those readers who are recent converts to *Radio and Electronics World*, I shall this month take a closer look at some of the basics of MW-DXing. Perhaps you are reading this column for the first time, or perhaps you've never looked upon the MW band as a source of DX; well in either case you may well be intrigued by what you'll be able to hear on the MW band.

At first sight MW-DXing is a contradiction in terms, since the basic meaning of DX is distance and the MW frequencies are generally used for local or regional broadcasting. However, it is in fact possible to hear stations many thousands of miles away.

Being able to eavesdrop on someone else's local radio station is one of the attractions that DXers find in listening to the MW band. In order to get started on the MW band all you need is a radio (even a domestic portable radio will do for starters) and some idea of where and when to listen. Remember that if you are hunting a specific station there are many thousands of local stations world-wide operating in just over 1MHz of radio bandwidth.

Information

By the time that you read this, the 1986 edition of the *World Radio TV Handbook* will be on the bookstalls at £17.95. Expensive it may seem, but this book is an invaluable addition to any listener's shack, listing as it does just about every radio and TV station in the world complete with details of addresses, transmitter powers, broadcasting times and so on. Of course, MW stations are covered in detail and there are a number of feature articles on radio propagation and receiver performance.

Once you have started listening on MW you will soon want to keep abreast of the latest happenings on the band, such as news about recent station changes as well as information about what stations are currently being heard on the band. The best way to stay well informed (remember that the *WRTH* is published annually) is to join a radio club, of which there are several in the UK interested in MW-DXing. As far as I'm aware, though, there is only one club that specialises solely in this subject, namely the Medium Wave Circle. For further information and a sample copy of the newsletter, write to the club secretary (Ed Baker) at 69 Alderley Way, Cramlington, Northumberland.

Other sources of information for the MW-DXer are DX programmes, several of which are readily heard in the UK using simple equipment. These programmes are specially prepared for the radio enthusiast and often contain material relating to the medium waves. Try listening for Sweden Calling DXers, Tuesdays at 2115 and 2315GMT on 1179kHz; Radio World from BRT Brussels, Sundays 1910-1930 (1 hour earlier in summer) on 1512kHz; or DX Circle from DLF Cologne, which is broadcast at 1930 (also earlier in summer) every Tuesday on 1269kHz.

MEDIUM WAVE

DXING

by Steve Whitt

Propagation

To make the most of this hobby you'll need to have a basic understanding of how a radio signal actually arrives at the receiver from a distant transmitter. A great deal of scientific work has been undertaken investigating the propagation of radio waves, but fortunately for the MW-DXer things can be greatly simplified by considering just two dominant propagation methods.

1) Groundwaves

Long distance MW propagation takes place by means of two entirely different and distinct mechanisms, namely groundwaves and skywaves. The groundwave, as its name implies, travels along a path close to the Earth's surface. How far such a signal goes is dependent on a number of factors, principally transmitter power, operating frequency and Earth conductivity.

Groundwave propagation is heavily

dependent on the frequency, with low frequency signals travelling greater distances. In fact, everything else being equal, groundwave signals from a station on 550kHz will travel twice as far over land as those radiated by a station on 1500kHz. The Earth conductivity is also a very significant factor and it is found that the better the conductivity the further the signal travels. Sandy or rocky soil is the worst terrain whilst sea water is best, and in regions such as the Caribbean, where the sea is particularly saline (and therefore more conductive), groundwave reception of stations up to 1000 miles distant is possible. In contrast, a similar signal travelling over rocky terrain would carry only about one quarter of this distance.

Groundwave propagation is very stable, resulting in consistent reception conditions. It is, however, usually only associated with daytime (although

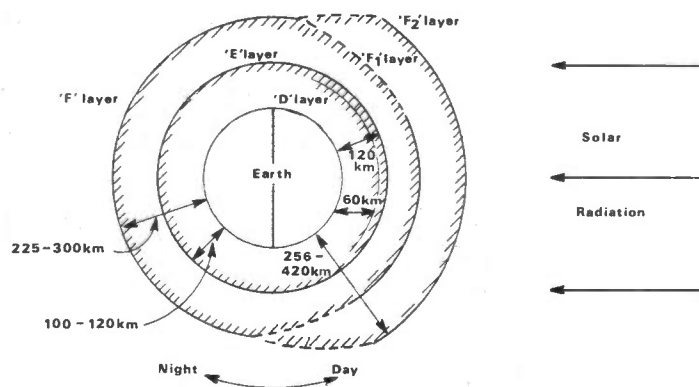


Fig 1 The ionosphere

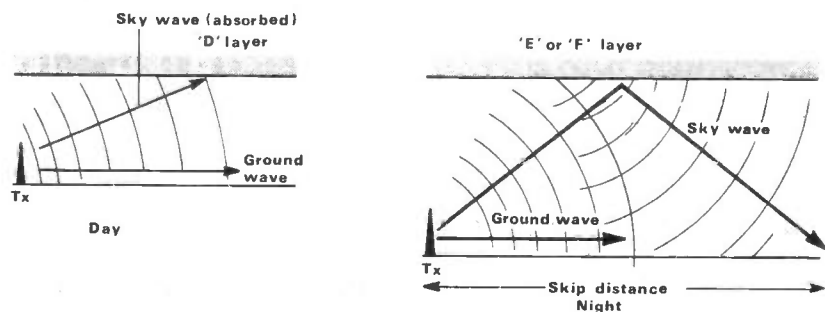


Fig 2 Absorption and reflection by the D, E and F layers

equally present at night) since at night long distant reception is predominantly via the skywave. Because of its stable daytime behaviour, radio stations usually optimise their aerials to radiate as much of their signal as possible via the groundwave, in order to improve coverage.

2) Skywaves

There exists a rarefied region of the Earth's upper atmosphere (above about 50km) that absorbs the intense solar ultra-violet radiation, thereby protecting life on the Earth's surface. This radiation results in a region of ionised gases known as the ionosphere, which, depending on diurnal and seasonal variations, consists of several fairly distinct layers of high ionisation (Figure 1).

These layers have a profound effect upon radio waves approaching them from transmitters on the ground below. Under certain conditions refraction of waves occurs, resulting in the 'reflection' of signals back down to the Earth, whilst at other times signals can be totally absorbed by the ionised gases. During daylight hours solar radiation penetrates the atmosphere far enough to form the lowest layer of ionisation, the 'D' layer, roughly 60km above ground.

The D layer so completely absorbs

signals on MW frequencies that any radio signals radiated by a station other than those parallel to the Earth's surface are completely lost. With the approach of sunset, however, the D layer absorption decreases rapidly and within a few hours MW signals are being reflected back to the ground from higher regions of the ionosphere. Depending on circumstances, reflection occurs in the E region (about 100-120km up) or in the 'F' layer (225-300km).

Figure 2 illustrates this process and shows the skip distance, which for MW frequencies turns out to be about 100 to 500 miles. Longer distance reception is possible when multiple reflections occur between the ionosphere and the Earth's surface. This occurs with least signal loss over ocean paths, hence the possibility of good reception of Brazilian stations here in England.

Whilst the skywave enables good MW-DX at night, it also leads to a deterioration in reception quality for the normal broadcast listener. Firstly, there is a region about 50-100 miles from a transmitter (Figure 3) where the groundwave and the skywave signals are received with roughly equal (but varying) strength, leading to severe distortion. Additionally, all skywave signals are

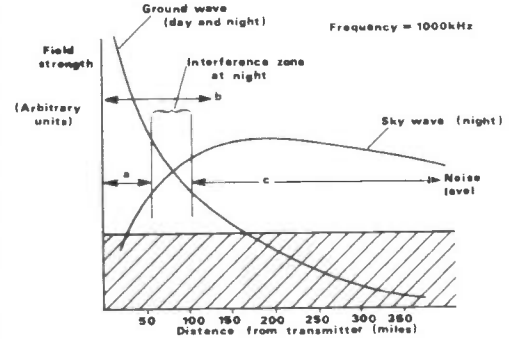


Fig 3 Typical received signal strength (day and night) a=primary night-time service area b=primary daytime service area, c=night-time secondary service area

affected by fading as a result of the continually changing ionosphere.

DX file

Unfortunately, there's not too much to report this month, with recent DX consisting mainly of the usual transatlantic stations such as CJYQ, St Johns, Newfoundland and WINS, New York. There was, however, a period of good DX towards the end of January, when at least 20-25 stations from the Americas could be heard.

REW

NEXT ISSUE

Radio & Electronics

The communications and electronics magazine **World**

COMPUTING TRANSFORMERS

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James Fletcher looks into the new video-recorder timing system now being used in Germany

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On these pages we present details of interesting contacts from clubs and individuals. We would be happy to receive any similar items from readers

Presidential CARS

At the RSGB Presidential Installation, held at Furze Hill, Margaretting, Essex in January, the Chelmsford Amateur Radio Society (CARS) was very much in evidence, with over forty members present.

CARS members witnessed Mrs Joan Heathershaw's retirement speech, after which she presented Mr William Clintock G3VPK with the chain of office.

Mr Clintock was also presented with a scroll giving him life membership of CARS in recognition of his services to amateur radio.

Any old iron

If you have any old government surplus equipment piling up in your shack and want to get rid of some (or, knowing you lot, you may want to add to it!), the Southgate Amateur Radio Club's surplus equipment sale on 10 April should prove interesting.

As with all club meetings, the sale starts at 7.30pm and will be held at the Holy Trinity Church Hall, Green Lanes, Winchmore Hill, London N21.

More details are available from R F Snary G4OBE, QTHR.

How low can you get?

Readers with an interest in low power communication should visit the City of Bristol RSGB Group on 28 April for a lecture on the G-QRP Club, by Norman Field G4LQF.

The group holds its meetings on the last Monday of the month, except on Bank Holidays when the meeting is brought forward a week, at 7.30pm. The venue is the Small Lecture Theatre, University of Bristol, University Walk, Clifton.

For further information on the group and its activities contact: *Colin Hollister, Honorary Secretary, 34 Battersby Way, Henbury, Bristol BS10 7SU. Tel: (0272) 508451.*

Wireless Revival

This annual mobile rally for radio amateurs is being held on Sunday 25 May at the usual venue of the Civil Service Sports Ground, Straight Road, Bucklesham, Ipswich, Suffolk.

Attractions will include traders, a car boot sale, an aerial testing range and vintage radio display, plus non-radio stalls, a children's play area, model flying display and more. Admission is 80p.

Further details are available from Jack Tootill G4IFF, 76 Fircroft Road, Ipswich IP1 6PX. Tel: (0473) 44047.

Stand space can be arranged with Colin Ranson G8LBS, 100 Stone Lodge Lane West, Beacon Hill, Chantry, Ipswich, Suffolk. Tel: (0473) 688204.

How Scilly

A group of Cornish amateurs is organising a special event station in May (provisionally the 23rd to the 26th) in aid of the RNLI.

The event is being supported by the Duchy of Cornwall and the Nature Conservancy Council, who have offered an uninhabited island called Great Ganilly, part of the Scilly Isles, on which to stage the event.

The public relations officer for the station, P A Bevington G4ZUI, is hoping to obtain sponsorship from businesses, clubs and individuals, as well as prizes for a national raffle which will be drawn after the event (a prize already being offered is a free weekend on the Scillies staying with the only resident radio amateur).

As many bands as possible will be used, although this is dependent to a large extent on what equipment is lent or donated. Operation will certainly take place on 144MHz and 430MHz, as well as 3, 7 and 14MHz.

Amateurs wishing to support the event in any way should contact: *P A Bevington G4ZUI, Gwynsow Farm, Underlane, Carnkie, Wendron, Helston, Cornwall TR13 0EH.*

Spaced out

On 12 March, G6HMS and some of his mates at the Lincoln Short Wave Club will be hosting a 'Space Communications' evening.

If you are interested in attending, the venue will be the City Engineers Club, Central Depot, Waterside South, Lincoln at 8pm.

Visitors are also welcome at the club activity nights (5 and 19 March).

For more information on these events and the club generally, contact Pam Rose G4STO, QTHR.

On the move

The South Cheshire Amateur Radio Society has a new QTH: the Crewe LMR Sports Club, Goddard Street, Crewe.

Meetings will continue to be held at 8pm on the second Monday of each month, and the April meeting will be a talk on AMSAT UK and Oscar 10.

Further details are available from: *Chris Wieman G1PUV, 14 Whiteridge Road, Whitehill, Kidsgrove, Stoke-on-Trent, Staffs ST7 4TH.*

Radio award

Ceri Jones GW1JCB has recently introduced the Vale of Glamorgan Amateur Radio Award with the idea of prom-

oting more interest and activity on the VHF bands.

The award can be claimed for any band and any mode of operation except via repeaters. Claimants are required to work four stations within the Vale of Glamorgan, contacts should have been made after 1 January 1985 and log entries should be submitted.

The cost of the award is £1.80. For further details send an sae to Ceri Jones, 7 Dawan Close, Barry, South Glamorgan, Wales CF6 8PZ.

Bulletin board

At the end of March 1986, Hamnet Hull's telephone number will change to (0482) 465150. The baud rate will still be 300, 8 bit word, no parity. The system hours are: Monday to Friday - 12.30 to 13.45 and 17.30 to 08.45; weekends - 17.30 on Friday to 08.45 on Monday; public holidays - 24 hours.

The bulletin board is dedicated to radio amateurs, consisting of information associated with the hobby, but is open to all users. Registration has been made virtually error free by the use of simple one line questions. A unique feature is that apart from the board's normal user log, radio amateurs can leave their call-signs in a special call-sign user log.

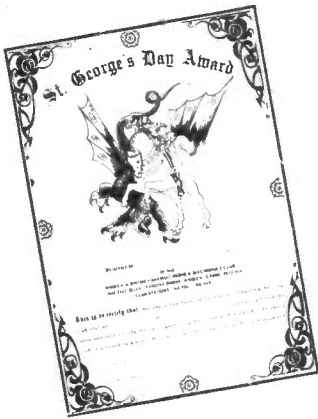
There are various contributors who upload news, particularly about space communications. A regular feature is updated monthly containing Amsat and Orbiter data.

BATC ATV CONTESTS 1986

Date	Occasion	Time
1 April	April Fool's Fiesta 70cm fast scan	0001-2359 (local time)
5 May	May Day Microwave 23cm and 3cm fast scan	0001-2359 (local time)
5/6 July	Summer Fun All bands and modes	0001 (Sat)-2359 (Sun) (local time)
13/14 Sept	International All bands and modes	1800 (Sat)-1200 (Sun) (GMT)
9 Nov	AutumnVision All bands and modes	0900-2100 (local time)

Details, entry forms and log-sheets are available on receipt of an sae from: *M Wooding (Contest Manager), 3 Perkins Grove, Rugby, Warks CV21 4HU.*

For readers interested in ATV, the above table outlines the programme of the BATC ATV contests for 1986



St George's Day Award

Once again this year, Wisbech and District Amateur Radio and Electronics Club is organising special event stations to celebrate the above. The three stations will be GB0SGD, GB4SGD and GB6SGD. They hope to be active on most days between 20 April until 17 May. To qualify, all QSOs must take place between these two dates.

Applications for HF need to QSO with either GB0SGD or GB4SGD plus the following: applications from all G prefix calls need to QSO with 8 other stations from England; applications from EU need to QSO with 5 other stations from England; applications from the rest of the world need to QSO with 3 other stations from England.

Applications on VHF need to QSO with any of the 3 stations plus the following: applications from all G prefix calls need to QSO with any 8 English counties; applications from EU need any other 5 English stations. On VHF all QSOs must be simplex only, no repeaters to be used.

Applications will also be welcomed from all SWLs on the same basis.

The cost of the award, which is printed in two colours on a white background, is as follows: all G prefix applications, £1.50; EU entries, 6 IRCs, rest of the world, 8 IRCs or \$3 US. Applications for the award via: G4KHF, 'Leon', Luton Gowts, Long Sutton, Spalding, Lincs PE12 9LQ.

Golden year

1986 marks the 50th anniversary of the Cannock Chase Amateur Radio Society. The society was started in

1936 and one of the notable events in its history was the organisation of the Worked All Britain Award scheme in 1969.

With this in mind the society will be running a special event station on all bands from 5 to 13 April with the callsign GB4WAB.

Special QSL cards will be available to all contacts, and a specially designed award can be obtained by working the special event station and any one member of CCARS during 1986. The award will cost £1.50 including postage and packing, and all the profits from the scheme will go to the present WAB committee for distribution to the organisations sponsored by them.

Skeds can be arranged through the contest manager Brian G0BXN, on (0543) 77558 or Alan G1AZO, on (0543) 79160, both QTHr.

Other special event stations promoting the society and Cannock Chase will be run throughout the year, the details of which will be announced at a later date.

For further information about CCARS contact: B Robinson, 68 Langholm Drive, Heath Hayes, Cannock, Staffs WS12 5EZ. Tel: (0543) 74521.

Change of venue

From 23 April 1986 the monthly meetings of the Crawley Amateur Radio Club will take place at the new venue of the Crawley Leisure Centre, Maslett Avenue, Crawley. On the above date there will be a talk on antennas by G3TNO.

For further details contact the Honorary Secretary, David Mill G4IQM on (0293) 882641.

The Service Trading Co

In the March issue of the magazine, in Dr Kiam-Laine's article *Variable ac Power Supply*, the Service Trading Co was mentioned as selling second-hand variable mains auto-transformers for £40. In fact, the company sell new units for £19.50!

Our apologies for misleading readers and for any inconvenience caused to the company.

For more information on the Service Trading Co see the advert in this issue.

NOTES FROM THE PAST

Some interesting comments from the 1950's ...

For several months now the BBC have, in the weather reports and forecasts, used the Beaufort Scale to describe wind forces. Yet it is astonishing to find how few people are familiar with this scale. In fact the index numbers seem to be completely meaningless to the vast majority of people. My own interest in wind was greatly heightened when my very first VHF aerial took off in a gale and landed in the garden of an already hostile neighbour. Incidentally, when re-erected, I made provision to lower it whenever gales were threatening – a precaution which, strangely enough, is still far from usual.

In my school days, we had no electric mains within some hundreds of yards, and my first interest in the wind was to harness it for the generation of electrical power. It would save hauling accumulators for recharging and the prospect of getting something for nothing strongly appealed to the faint streak of Scot in me. I also built up a simple anemometer of the Robinson type. It consisted of four metal cups mounted on cross-bars geared to an indicator which moved across a scale relating the number of revolutions to mph. There is another type, the Dines, in which a recorder floating on water is used.

The Beaufort Scale, of course, has long been used for the more detailed type of weather reporting. It was devised by Sir Francis Beaufort in 1805 and the numbers 0 to 12 are used to indicate wind velocities in mph.

During the power cuts of 1946-47 I wrote an article for *Short Wave News* on home-made power by wind-driven generators. Quite a number of amateurs have used them, especially when ex-WD generators of various patterns were cheaply available.

The more weather-conscious reader will have noted that wind forces of from 3 to 8 are common in the British Isles, so with reasonably sized storage cells power for many uses could be available during the rare periods when wind pressures fall below 3.

Writing, at that time, of the Beaufort Scale, I gave the generally accepted effects of the various wind forces to enable those without access to detailed reports to judge wind speeds. Now that the Beaufort index numbers are regularly broadcast the velocity figures can be put to use the other way round – visualising the wind force by knowing the scale number. At least, you will be able to know just how much your aerial is likely to sway!

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■ Shed clear-out. The following items have been gathering dust for too long, may require attention so sold as seen for a low price: colour TV, £5; two mono TVs £2 ea; two video monitors, £5 ea; 1 comp keyboard, £1; 5 record players, £2 ea; 3 car radios, £1 ea; 3 tranny radios, £2 lot; AF signal generator, £10; RF signal generator, £15; or accept only £50 for everything. Buyer collects. K Bailey, 40 Seymour Close, Selly Park, Birmingham B29 7JD. Tel: (021) 472 3688.

■ Valves, all brand new and boxed, Mullard, Mazda, etc: 6F23, 6/30L2, 30C1, 30C17, 30L17, EB91, ECC82, ECC83, ECC84, ECL80, EF85, EF183, EF184, EY86/7, PCC84 at 40p each. Also 30FL12, ECC88, PC86, PC88, PCC89, PCC189, PL81, PL82 at 60p each. ECC81, ECF80, EF89, PC97, PC900, PCF86, PCF806 at 80p each. Several of each type available. Please add 55p postage per order. Other valves - please phone. K Bailey, 40 Seymour Close, Selly Park, Birmingham B29 7JD. Tel: (021) 472 3688 anytime.

■ Radiospares 50W auto-transformer, tapped mains to 115V, £4. FT101B circuit diagram plus new coil, T10Y 5MHz trap, £3. Multi-core cable, 51ft 18 strand 22g, 3 screened, colour coded, 3/8 dia, £4. 5 AR88D pointer knobs, £3. Transmitting coil, 1/4 inch copper tube 4 1/4 inches long, air spaced, 3 1/2 inches dia, £3. Pocket barometer/altimeter, feet, inches, mountain climbing, Japanese, new, £6. Valve xtal converter, 160m on 80m tuning, £4. Alan, 32 Heldhaw Road, Bury St Edmunds. Tel: (0284) 60984.

■ Trio AT230, mint, £123. DX160 gen cov Rx, 0.15-30MHz, SSB/CW, AM, £31. Altai GDO KDM-6, mint, £47. Supertester 680G multimeter, 20kΩ/V. Also measures capacitance, reactance, decibels, bargain £19. PW ZX81 programs 1 and 4, £2 each. Altai mono headphones. 2000Ω, Model OH-10, £3. Miranda chassis punch set, new, size 16, 18, 20, 25, 30mm, £8. All ono, prefer buyer collects or carriage extra. Tel: (021) 777 6086.

■ Straight swap: £460 of following list for a good FT790R 70cm + Nicads. List of swaps: new complete IC4E plus extra BP3 + BP2 + BP4 + 6 Nicads + DC1 + CP1 + LC2 + LC3 + HM9 + BC35 plus IC4E workshop service manual and BC35 service manual, all in boxes, no mods, with bill of sale. The FT790R must be in good cond with no missing parts. Each pay own postage. Ring any time for swap: (04738) 5526.

■ 30 inch dish aerial, waveguide feed and attenuator, £25. Wayne-Kerr cavity resonator W481, 7-14GHz, £15. Collins tuner, TN-140/ULR, 2300-4450MHz and mixer amplifier CV-70/ULR, £30 the two (valved). Microwave Associates multiplier ML1197, 3mW o/p at 7380MHz, £10 (semiconductor). Jason stereo tape link type JTL (valves), £10. No offers. All these are untested but appear to be in good order. J Galvin. Tel: Crudwell (06667) 7820.

■ Eddystone EC10 MkII transistorised GC comm receiver, £60 ono. Marconi 88 R1475 GC comm receiver, 13 valves with PSU, £40. All good order. Also pre-war navy shore station TRF Rx with plug-in coils, dual mains input, offers. Mullard capacity/resistance bridge with magic eye mains operation, £15. Old valves cheap. Mr G J Fowle, 12 Lytham Road, Broad Stone, Dorset BH18 8JS.

■ **Radio and Television Servicing** by Hawker, Molloy and Poole, pre-1953 to 1970 less 3 years. 18 volumes, £40. Tel: Reading (0734) 883799.

■ Microprofessor-One-Plus microcomputer, input/output/memory board, thermal printer. Offers, enquiries SAE. Mr Slater, rear of 25 New Market Street, Coine, Lancashire BB8 9BJ.

■ Murphy A122M valve radio, long, medium and short waves. Beautiful wooden cabinet, superb condition in every way, offers. Also Roberts P4D

portable valve radio, £15. Tel: Reading (0734) 883799.

■ **Practical Wireless**: 20 copies 1934-1935, £15. 33 copies 1942-1949, £10. **Wireless Engineer**, 10 copies 1932-1938, £4. Four books by Briggs: **Loudspeakers, More about L'speakers, Sound Reproduction and Stereo Handbook**, four for £5. Twelve books by F J Camm: **Wireless Const Encyclopaedia, Radio Training Manual**, etc. All different, 12 for £12. Tel: Reading (0734) 883799.

■ Books for sale: **A Guide to Surplus Communication Receivers**, £3; **Time Bases** by O S Puckle, £5; **Second Thoughts on Radio Theory** by 'Cathode Ray', £6; **Freq Modulation Receivers** by J D Jones, £4; **Radio Communication** by Reyner, £6; **1973 World Radio TV Handbook**, £7; **Ilford Manual of Photography**, £8; **Know your Oscilloscope**, Foulsham-Sams, £5; **Electronics and the Photographer**, Towers, £8; **Telegraphy** by J W Freebody, £10. All books post and packing free. Mr D Evans, 29 Malton Road, Woolton, Liverpool L25 8QU.

■ Stentorian speaker (pre-war?) in cabinet, with tapped o/p transformer and volume control, £10. Pre-war TRF MW+LW (make not known), attractive dial and wooden cabinet. Made in early 1930s (back missing, but set works OK - very long aerial and earth required). A collector's item, £45. Lissen 8402 'Caernarvon' LW, MW, SW superhet receiver, made about 1937. Wooden cabinet, unusual dial (containing 4 pilot bulbs), working. A collector's item, £40. Bush DAC90 made in 1947. Nice bakelite cabinet. Works, but may need new rectifier valve. LW, MW, collector's item, £20. Sobell 439. Very unusually designed cabinet (bakelite, sprayed white. Front of cabinet similar in design to a water radiator). Thumbwheel tuning dial. Long aerial and earth required (made about 1946?), £20. Spares for Bush DAC90/A (1951). Knobs and chassis only, £6. Decca 'Empire' (1938) receiver, and HP notes and service data, price to be arranged - not working. Peter Titlow, 13A High Street, Leiston, Suffolk. Tel: (0728) 831812 or 831610.

■ 'Maplin' electronic telephone exchange. Complete kit, assembled but not tested. Lost interest! £60. Andy Emmerson, 71 Falcott Way, Northampton. Tel: (0604) 844130, any time.

■ Canadian 52 set, WWII C1944, complete transmitter and receiver, ac mains power unit, manual. National HRO comm Rx, 6 coils, power unit, £48. AVO seven, wooden case, shunts, £18. Yaesu SP901, £15. Linear relay FRB707, £16. Tektronix 422 d/beam scope, £285. Several 1930s-1940s domestic radios available. Jim Taylor, 5 Luther Road, Winton, Bournemouth. Tel: (0202) 510400.

■ Yaesu FT707 plus FC707 ATU, £350, or swap for BBC B, disk drive and monitor. Tel: Dave on (061) 928 8924 ext 218, work, or (0706) 228347 evenings.

■ Fluke probes for sale: a range of active and passive current voltage and temperature probes. All in mint condition and unused. For full details: Mr I Robinson, 78 Dora Road, Smallheath, Birmingham B10 9RD.

■ Datong active Rx antenna AD270, as new, boxed, £30. Tel: John (01) 642 4562.

■ Sony ICF2001D latest portable 32 memory air LW, MW, SW, scan 118-136, 150-30, 76-108MHz. Cost £349, as new £290. Two mains adaptors, SW handbook, air book, etc. No offers, £50. Cheaper than shop price. Ferragraph 632 stereo reel to reel with two AKG mics, reel of tape, 3 speed trick recorder, hi-fi, £90. VHS video recorder plus one 3 hour tape, £200. NVT370 Pan job. Mr Fordham, 31C Anerley Park, London SE20.

■ Spectrum Microdrive Interface One, plus four microdrive cassettes. Boxed, as new, £50 ono, or will swap for an antenna tuning unit. Mr J Deighton, 9 Canon Green Court, West King Street, Salford M3 7HA. Tel: (061) 834 5743.

■ Data Dynamics teletype ASR33 with stand. RS232 interface, little used, £65 or offers. J Dowdall, 56 Goetre Bellaf, Duntun, Swansea SA2 7RP. Tel: (0792) 202287, evenings.

■ Yaesu FT290R with Nicads, charger plus YH1 headset, and flexiwhip, vgc, £265. Also FC757AT auto ATU suitable FT757 or FT980, little used and in vgc, £200. G0CCU, Bristol. Tel: (0272) 721744.

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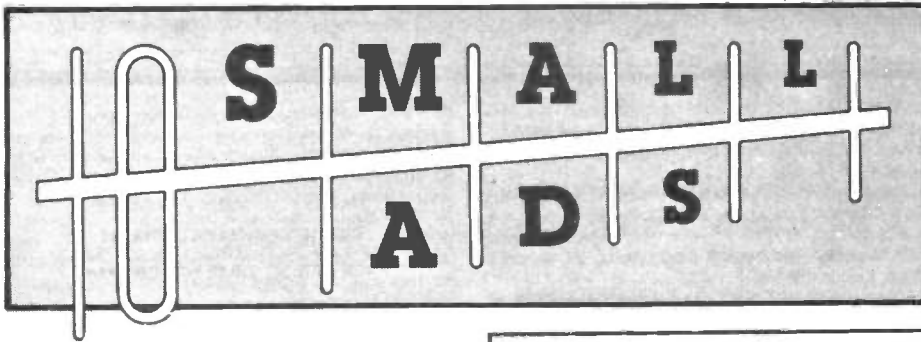
■ Free, free, free! I am clearing out a friend's electronics hobby box. It's mostly wire, plugs, switches, coils, pots etc, which makes it a bit heavy, so send £1 for post/packing. By post only to Martin, 7 Griffin Crescent, Littlehampton, Sussex.

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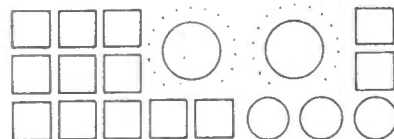
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Double County Guide	3	£94.00	6	£176.00	12	£316.00

PAYMENT ENCLOSED

£ —

Cheques should be made payable to Radio and Electronics World. Overseas payments by International Money Order

Conditions — Payment must be sent with order form. No copy changes allowed. Ads accepted subject to our standard conditions, available on request.

Registered No 2307667 (England)

C P I

**VALUABLE
SPACE FOR
SALE!**

**Telephone
the advertising
department on:
0277 219876
for details**

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Radio & Electronics
The communications and electronics magazine **World**

ADVERTISING RATES & INFORMATION

DISPLAY AD RATES		series rates for consecutive insertions			
depth mm x width mm	ad space	1 issue	3 issues	6 issues	12 issues
61 x 90	1/8 page	£91.00	£86.00	£82.00	£73.00
128 x 90 or 61 x 186	1/4 page	£160.00	£150.00	£145.00	£125.00
128 x 186 or 263 x 90	1/2 page	£305.00	£290.00	£275.00	£245.00
263 x 186	1 page	£590.00	£560.00	£530.00	£475.00
263 x 394	double page	£1140.00	£1070.00	£1020.00	£910.00

COLOUR AD RATES		colour rates exclude cost of separations	series rates for consecutive insertions			
depth mm x width mm	ad space	1 issue	3 issues	6 issues	12 issues	
128 x 186 or 263 x 90	1/2 page	£420.00	£395.00	£375.00	£335.00	
297 x 210	1 page	£810.00	£760.00	£730.00	£650.00	

SPECIAL POSITIONS	Covers:	Outside back cover 20% extra, inside covers 10% extra
	Bleed:	10% extra [Bleed area = 307 x 220]
	Facing Matter:	15% extra

DEADLINES		*Dates affected by public holidays			
issue	colour & mono proof ad	mono no proof and small ad	mono artwork	on sale thurs	
May 86.....	13 Mar 86.....	19 Mar 86.....	21 Mar 86.....	10 Apr 86.....	
June 86.....	10 Apr 86.....	16 Apr 86.....	18 Apr 86.....	8 May 86.....	
July 86.....	15 May 86.....	21 May 86.....	23 May 86.....	12 Jun 86.....	
Aug 86.....	12 Jun 86.....	18 Jun 86.....	20 Jun 86.....	10 Jul 86.....	

CONDITIONS & INFORMATION	
<p>SERIES RATES Series rates also apply when larger or additional space to that initially booked is taken. An ad of at least the minimum space must appear in consecutive issues to qualify for series rates. Previous copy will automatically be repeated if no further copy is received. A hold ad is acceptable for maintaining your series rate contract. This will automatically be inserted if no further copy is received. Display Ad and Small Ad series rate contracts are not interchangeable.</p>	<p>If series rate contract is cancelled, the advertiser will be liable to pay the unearned series discount already taken.</p> <p>COPY Except for County Guides copy may be changed monthly. No additional charges for typesetting or illustrations (except for colour separations). For illustrations just send photograph or artwork. Colour Ad rates do not include the cost of separations.</p>
<p>Printed — web-offset. PAYMENT Above rates exclude VAT. All single insertion ads are accepted on a pre-payment basis only, unless an account is held. Accounts will be opened for series rate advertisers subject to satisfactory credit references. Accounts are strictly net and must be settled by publication date.</p> <p>FOR FURTHER INFORMATION CONTACT Radio & Electronics World, Sovereign House, Brentwood, Essex CM14 4SE. (0277) 219876</p>	<p>Overseas payments by International Money Order. Commission to approved advertising agencies is 10%.</p> <p>CONDITIONS 10% discount if advertising in both Radio & Electronics World and Amateur Radio. A voucher copy will be sent to Display and Colour advertisers only. Ads accepted subject to our standard conditions, available on request.</p>

SAA5000A £1.50	P2775-TIP41c 40p	MR 502 10p	2SC458 50p	10 Mixed	PHILIP	
SAA5012A £5.00	RTP-TIP47 40p	RCW71R 10p	2SC515 10p	TV & radio speakers	Philips stereo headphones	min £3.50
SAA5020 £3.50	S2008B 80p	BYF 1202 10p	2SC532 10p	2x Hi-Fi Philips car tune up	Philips solder irons, 25w mains	£4.00
SAA5030 £3.50	2SC904 £1.00	BYF 1204 10p	2SC573 10p	tweeter EN8320 £1.00		
SAA5040 £3.50	BU 105/04 80p	BYF 3126 40p	2SC1030 £1.00	ITT CVC45 8 way resistor unit		
SAA5040A £4.40	BU 108 1.00	BYX 10 5p	2SC1172A 5p	for/v cap £3.00	8000/30v	50p
SAA5050 £3.50	BU 124 50p	BYX 36/600 35p	2SC1173 5p	4700/10v x 10 50p	4700/40v x 10 1.00	1.00
SAA5060 £3.50	BU 150 50p	BYX 49/600R 75p	2SC1194 20p	68/16 x 10 50p	22/100v x 10 1.00	1.00
SAA5070 £3.50	BU 180 50p	BYX 55/350 10p	2SC1275 20p	150/16 x 10 50p	100/350v 70p	70p
SAF1032P £2.50	BU 204 70p	BYX 55/600 (Bead) 10p	2SC2068 20p	47/25 x 10 50p	400/350v 70p	70p
SAF1039 £2.50	BU 205 1.00	BYX 71/350 50p	2SC2073 8p	220/25 x 10 50p	.47/500v 25p	25p
SA5660 £2.00	BU 208 80p	BYX 72/300 20p	2SC2122A 1.00	1/250 x 10 50p	1/600v 25p	25p
SA5660 £1.00	BU 208A 1.10	BYX 36/600 50p	2SC2229 1.5p	G8Speaker £1.00	02z/klv 1p	1p
SL9018 £4.50	BU 208B 1.10	BYV 95B 10p	2SD180 TO380V6A 1.5p			
SL912 £1.15	BU 208D 90p	BYV 95C 12p	6A 50p			
TA9320A £5.00	BU 222 1.00	BYZ 106 10p	2SD200 £2.00			
TAA470 £1.50	BU 326 1.00	BPW 41 18p	2SK30A 10p			
TAA570 75p	BU 407 1.00	BYW562/A1000V G11 8p	BC107 10p	6x48r £1.00	VM6101	
TAA811B 50p	BU 409 60p	BZU 15/24 54p	BC108 10p	TA2581 £2.50	MULLARD TELETEX	
TAA821 £2.00	BU 426V 60p	BZY 93/75 8p	BC109 5p	TA2590 £1.00	DECODER	
TAA861 50p	BU 500 1.10	BZV 15/18 30p	BC113 10p	TA2593 £1.00	With interface panel and	
TAA861 £1.50	BU 508A 1.20	BZV 15/30 30p	BC114 10p	TA2593 £1.00	data command panel	
TA7117 £1.10	BU 526 1.00	BZV 70C6v2 10p	BC115 10p	TA2600 £5.00	New £6 Post 2	
TA7120P 50p	BU 705 1.00	BZX 79.3v 10p	BC119 10p	TA2611A £1.00		
TA7154P 50p	BU 824 1.00	BC414 10p	BC121 10p	TA2611AQ £1.00	12 Volt Aerial Charger	
TA7607AP 40p	BU 826 1.00	BC416 10p	BC122 10p	TA2653 £1.00	over Relays 144 Mc/s	
TA7609P 50p	BUJW 84 30p	BC440 30p	BC125 10p	TA2660 £2.00	45 watts 50p	
TBA120A 40p	BUJW 84 30p	BC454 10p	BC126 10p	TA2680 £1.00		
TBA120AS 50p	BUJW 84 30p	BC455 10p	BC129 10p	TA2690 £1.00		
TBA120SA 40p	BUJW 84 30p	BC456 10p	BC130 30p	TA2693 £1.00		
TBA120SB 40p	BUJW 84 30p	BC460 25p	BC140 30p	TA2693 £1.00		
TBA120SQ 1.00	TIC 106A 40p	BC462 10p	BC141 10p	TA2693 £1.00		
TBA3120U 75p	TIC 116m 40p	BC463 10p	BC142 25p	TA2693 £1.00		
TBA120Q 30p	TIC 116m/Y 1003 35p	BC478 10p	BC147 10p	TA2700 £1.00		
TBA120C 40p	TIC 126N 40p	BC527 10p	BC148 10p	TA2700 £1.00		
TBA1441 1.00	TIC 206m 30p	BC532 10p	BC149 10p	TA2700 £1.00		
TBA231 75p	TIC 225S 40p	BC547 10p	BC152 10p	TA2700 £1.00		
TBA395Q 50p	TIC 226E 40p	BC547 10p	BC154 10p	TA2700 £1.00		
TBA396Q 1.00	TIC 226m 30p	BC547 10p	BC157a 10p	TA2700 £1.00		
TBA396 75p	TIC 236m 30p	BC547 10p	BC158 10p	TA2700 £1.00		
TBA400P 1.00	TICV 106D (T092 case	BC547 10p	BC159 10p	TA2700 £1.00		
TBA1440C 20p	2A 1400V) 20p	BC547 10p	BC160/16 25p	TA2700 £1.00		
TBA480Q 1.00	TIP 29 20p	BC556 10p	BC171 10p	TA2700 £1.00		
TBA520 £2.00	TIP 30A 35p	BC557 10p	BC172 10p	TA2700 £1.00		
TBA530 £2.00	TIP 30B 40p	BC558 10p	BC173 10p	TA2700 £1.00		
TBA540 £1.00	TIP 30C 45p	BC558 10p	BC174 10p	TA2700 £1.00		
TBA550Q £1.75	TIP 30C 45p	BC559 10p	BC183 10p	TA2700 £1.00		
TBA380CQ 40p	TIP 32 25p	BC565 10p	BC184 10p	TA2700 £1.00		
TBA570 £1.50	TIP 32B 25p	BC565 10p	BC204 10p	TA2700 £1.00		
TBA625 50p	TIP 33B 70p	BC565 10p	BC207 10p	TA2700 £1.00		
TBA641 £2.00	TIP 34A 50p	BC565 10p	BC207 10p	TA2700 £1.00		
TBA651 £2.00	TIP 34B 50p	BC565 10p	BC212 10p	TA2700 £1.00		
TBA673 £1.00	TIP 34C 70p	BC565 10p	BC213 10p	TA2700 £1.00		
TBA720A £1.50	TIP 35B 50p	BC565 10p	BC214 10p	TA2700 £1.00		
TBA750Q £1.50	TIP 35C 70p	BC565 10p	BC214 10p	TA2700 £1.00		
TBA780 £1.50	TIP 35D 80p	BC565 10p	BC217 10p	TA2700 £1.00		
TBA800 50p	TIP 36 50p	BC565 10p	BC217 10p	TA2700 £1.00		
TBA810AP 50p	TIP 36C 40p	BC565 10p	BC217 10p	TA2700 £1.00		
TBA810S 60p	TIP 36C 40p	BC565 10p	BC217 10p	TA2700 £1.00		
TBA890 £1.00	TIP 41D 70p	BC565 10p	BC217 10p	TA2700 £1.00		
TBA900 £1.50	TIP 42/BRC6109 30p	BC565 10p	BC217 10p	TA2700 £1.00		
TBA920 £1.50	TIP 48 40p	BC565 10p	BC217 10p	TA2700 £1.00		
TBA920Q £1.50	TIP 49 30p	BC565 10p	BC217 10p	TA2700 £1.00		
TBA950 £1.50	TIP 100 30p	BC565 10p	BC217 10p	TA2700 £1.00		
TBA990Q £1.00	TIP 102 30p	BC565 10p	BC217 10p	TA2700 £1.00		
TMS1000NL £2.00	TIP 112 30p	BC565 10p	BC217 10p	TA2700 £1.00		
TMS1943 clock chip £1.00	TIP 115 50p	BC565 10p	BC217 10p	TA2700 £1.00		
TMS990 £2.00	TIP 117 30p	BC565 10p	BC217 10p	TA2700 £1.00		
TMS2716L £1.00	TIP 125 35p	BC565 10p	BC217 10p	TA2700 £1.00		
TMS3529 £1.00	TIP 130 30p	BC565 10p	BC217 10p	TA2700 £1.00		
TMS3720ANS £3.00	TIP 131 25p	BC565 10p	BC217 10p	TA2700 £1.00		
TMS4014 70p	TIP 136 30p	BC565 10p	BC217 10p	TA2700 £1.00		
TX-012 £1.00	TIP 136C 30p	BC565 10p	BC217 10p	TA2700 £1.00		
TMS9902 £1.00	TIP 140 50p	BC565 10p	BC217 10p	TA2700 £1.00		
ULN2216 75p	TIP 255S 35p	BC565 10p	BC217 10p	TA2700 £1.00		
SN29848 50p	T6032 40p	BC565 10p	BC217 10p	TA2700 £1.00		
SN29770BN £1.00	T6036 40p	BC565 10p	BC217 10p	TA2700 £1.00		
SN29772BN £1.00	T6040 40p	BC565 10p	BC217 10p	TA2700 £1.00		
SN7402N £1.00	T6047 40p	BC565 10p	BC217 10p	TA2700 £1.00		
SN7472N £1.00	T6049 40p	BC565 10p	BC217 10p	TA2700 £1.00		
SN74107 £1.00	T6051 40p	BC565 10p	BC217 10p	TA2700 £1.00		
SN74167 70p	T6052 40p	BC565 10p	BC217 10p	TA2700 £1.00		
SN7472N 20p	T9004 40p	BC565 10p	BC217 10p	TA2700 £1.00		
SN75108AN £1.00	T9005 40p	BC565 10p	BC217 10p	TA2700 £1.00		
SN76001 £1.00	T9010 40p	BC565 10p	BC217 10p	TA2700 £1.00		
SN76003 £1.00	T9015 40p	BC565 10p	BC217 10p	TA2700 £1.00		
SN76013ND £1.00	T9016 40p	BC565 10p	BC217 10p	TA2700 £1.00		
SN76018 £1.00	T9017 40p	BC565 10p	BC217 10p	TA2700 £1.00		
SN76036 £1.00	T9018 40p	BC565 10p	BC217 10p	TA2700 £1.00		
SN76039 £1.00	T9019 40p	BC565 10p	BC217 10p	TA2700 £1.00		
SN76033 £1.50	T9020 40p	BC565 10p	BC217 10p	TA2700 £1.00		
	T9021 40p	BC565 10p	BC217 10p	TA2700 £1.00		
	T9022 40p	BC565 10p	BC217 10p	TA2700 £1.00		
	T9023 40p	BC565 10p	BC217 10p	TA2700 £1.00		
	T9024 40p	BC565 10p	BC217 10p	TA2700 £1.00		
	T9025 40p	BC565 10p	BC217 10p	TA2700 £1.00		
	T9026 40p	BC565 10p	BC217 10p	TA2700 £1.00		
	T9027 40p	BC565 10p	BC217 10p	TA2700 £1.00		
	T9028 40p	BC565 10p	BC217 10p	TA2700 £1.00		
	T9029 40p	BC565 10p	BC217 10p	TA2700 £1.00		
	T9030 40p	BC565 10p	BC217 10p	TA2700 £1.00		
	T9031 40p	BC565 10p	BC217 10p	TA2700 £1.00		
	T9032 40p	BC565 10p	BC217 10p	TA2700 £1.00		
	T9033 40p	BC565 10p	BC217 10p	TA2700 £1.00		
	T9034 40p	BC565 10p	BC217 10p	TA2700 £1.00		
	T9035 40p	BC565 10p	BC217 10p	TA2700 £1.00		
	T9036 40p	BC565 10p	BC217 10p	TA2700 £1.00		
	T9037 40p	BC565 10p	BC217 10p	TA2700 £1.00		
	T9038 40p	BC565 10p	BC217 10p	TA2700 £1.00		
	T9039 40p	BC565 10p	BC217 10p	TA2700 £1.00		
	T9040 40p	BC565 10p	BC217 10p	TA2700 £1.00		
	T9041 40p	BC565 10p	BC217 10p	TA2700 £1.00		
	T9042 40p	BC565 10p	BC217 10p	TA2700 £1.00		
	T9043 40p	BC565 10p	BC217 10p	TA2700 £1.00		
	T9044 40p	BC565 10p	BC217 10p	TA2700 £1.00		
	T9045 40p	BC565 10p	BC217 10p	TA2700 £1.00		
	T9046 40p	BC565 10p	BC217 10p	TA2700 £1.00		
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	T9048 40p	BC565 10p	BC217 10p	TA2700 £1.00		
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	T9050 40p	BC565 10p	BC217 10p	TA2700 £1.00		
	T9051 40p	BC565 10p	BC217 10p	TA2700 £1.00		
	T9052 40p	BC565 10p	BC217 10p	TA2700 £1.00		
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	T9060 40p	BC565 10p	BC217 10p	TA2700 £1.00		
	T9061 40p	BC565 10p	BC217 10p	TA2700 £1.00		
	T9062 40p	BC565 10p	BC217 10p	TA2700 £1.00		
	T9063 40p	BC565 10p	BC217 10p	TA2700 £1.00		
	T9064 40p	BC565 10p	BC217 10p	TA2700 £1.00		
	T9065 40p	BC565 10p	BC217 10p	TA2700 £1.00		
	T9066 40p	BC565				