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Accounts Jack Burrows FCA
Design Martin Sheehan
& Production Helen White
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SPECIFICATIONS

1. General Specifications
   Transmission frequency: 144.00000 – 147.99999 MHz (E)
   Type of emission: FM (P), SSB (AU), CW (A)
   Frequency stability: ±300Hz within 1-60 minutes after power on
   Power supply: 13.8V DC
   Power consumption: Transmission: HI 4-7 amp LOW: 1.5A
   Microphone input impedance: 600Ω
   Antenna impedance: 50Ω
   AF output impedance: 4 or 8Ω
   Grounding system: Negative
   Dimensions: 145mm (W), 55mm (H), 218mm (D)
   Weight: 1.90 kg

2. Reception Specifications
   Reception system: FM, Double super heterodyne
   Intermediate frequency: FM: 1st IF 10.7 MHz, 2nd IF 455 kHz
   SSB, CW: 10.7 MHz
   Sensitivity: FM: 0.19μV (12dB S/NAD)
   SSB, CW: 0.15μV (10dB S/N)
   Pass bandwidth: FM: ±6kHz, SSB, CW: 2kHz
   Selectivity: (60dB)
   SSB, CW: 4.2kHz
   AF output: More than 2W (into 8 ohms with 10% THD)

Price: £359 inc.

C5800 MULTIMODE

SPECIFICATIONS

1. General Specifications
   Frequency coverage: 144-146MHz
   Mode of operation: F3
   Voltage: DC 13.8V
   Power drain: 2.8 Amp TX, 0.4 Amp RX-Standy
   Polarity: Negative only
   Dimensions (H x W x D): 31 x 139 x 178 mm
   Weight: 1.1kg
   Transmitter
   RF power output: 10 watt minimum
   Spurious emission: ±5 KHz
   Maximum deviation: ±5 KHz
   Modulation: Reactance modulation
   Receiver
   Sensitivity: -10dB (12 dB S/NAD)
   Bandwidth: ±7.5 KHz (6-60dB)
   Receiver system: Double superheterodyne
   Intermediate frequency: 1st IF 10.7 MHz, 2nd IF 455 KHz
   Selectivity: More than 60 dB
   Squelch sensitivity: -16 dB
   Audio output: 2W (into 8 ohms with 10% THD)

Price: £359 inc.

These specifications are subject to change without notice in the event of improvements.

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Other products include a free-standing Audio Frequency Sound Measuring Set to CCIR 468-2, a free-standing PPM Measuring Set to BS 5428 and IEC 268 specifications together with a range of On-Air and Rehearsal Lights.

Literature giving full technical specification, dimensional drawings and installation data for individual products is available on request.
Video Boom

The number of video recorders in use in Western Europe will climb to well over 15 million units by end of 1983, and 15% of the 100 million European TV households will be scheduling their viewing habits to suit their own requirements and accessing alternative programming available on pre-recorded cassettes.

Analysis from Mackintosh International shows that the UK is spearheading this video revolution. In the few years since the domestic video recorder established itself as a mass consumer product, more than 4 million UK households have bought or rented machines and a staggering 27% of UK homes will have video recorders by the end of this year.

Consumer spending on pre-recorded video cassettes in Europe is already well in excess of £1 billion per annum, though current business relies heavily on feature film rental.

Setting Standards

A group of 20 companies from the electronics, camera and magnetic tape industries have announced agreement on basic specifications for the magnetic disc to be used in electronic still camera systems (still video camera based on magnetic recording). Future plans call for work on finalising further specifications as well as promoting their standardisation within the related industries.

In August 1981, Sony Corporation announced the electronic still camera as a new application in electronics technology. As a result of the great interest shown when the announcement came, Sony called an Hitachi, Canon and Matsushita to join with other domestic and foreign electronics, camera and magnetic tape manufacturers in a series of technical discussions on the electronic still camera system. Just as a standard film is used in traditional still photography, the group quickly realised that standardisation of the magnetic disc to be used in this system was an indispensable prerequisite for commercialisation of the electronic still camera. Consequently, a great deal of attention was given to developing the specifications for this magnetic disc.

The 20 companies involved are: Asahi Optical, Canon, Fuji, Hitachi, Konishiroku Photo, Matsushita, Minnesota Mining and Manufacturing, Minolta, Mitsubishi, New Nippon Electric, Nippon Kogaku, Olympus, Philips, RCA, Sanyo, Sharp, Sony, TDK, Toshiba and Victor.

Highlighted this month is some 'hot news' for satellite fanatics: At one of the meetings at Goddard Space Centre on Wednesday 4th May, Jan King and Dick Daniels, recently returned from Karou, gave the update information that there had been a major delay to Areawe/Phase IIIIB Flight. Hence their return. If they had a telephone call from ESA by 10th/11th May they would return for flight fuelling and thus a June 3rd Launch. As of today (11th May), no such call has been made and therefore the Launch seems doomed to yet another HOLD at least for June 3 plus three weeks.

Trouble has been found in the third stage fuel pump (as per L05) and instrumentation control system. As the ESA Programme would appear to rise or fall on this launch, the French are being understandably exact in all their checking. I can only say that we will give update information as received on all our NETS until Launch. The Launch NET will take on the same form as we had for USOSAT.

7-10 days prior to Launch. AMSAT will broadcast (on 14,280kHz and 21,280kHz during their early evenings) the state of play. We, AMSAT-UK will probably get the information via twisted pair in any case, I or Richard will be on 3,780kHz and 141,200kHz at the usual 7.00 pm NET times every night until Launch.

On Launch day, I will be on 3,780 and/or 7,080 plus 144,280 with G3RVL and one or two others to give information as it happens. It is hoped that the University of Surrey will assist with the direct link telephone if our link with Karou is bogged down in the MUF (or whatever).

All stations checking into any NET please observe:
1) Short overs
2) Good manners to other users
3) Be patient. Last time, USOSAT Launch, we had excellent reports of a well conducted, full of information NET, which even the non-satellite user enjoyed. Let's keep it that way.

SNIPPETS

Fibre Optics

A contract for the development and supply of a Fibre Optic High Integrity Local Area Network (HILAN) has been signed by New Scicon International Limited and Beale Electronic Systems Limited (BES). Under the terms of the contract BES will develop the HILAN in close collaboration with Scicon, and both companies will manufacture the system. BES estimate that sales of the HILAN will exceed £2.5M per annum.

Oric Offer

Oric Products International will be mounting a summer promotion from 1st July until mid September offering a start-up pack of software valued at £40 absolutely free with every 48k machine sold.

The software package will contain four tapes: Home Finance, Teach Yourself BASIC, Oric Flight and Multi Games. Although the titles are subject to change, the programme of one home business, one educational and two games programs will remain unchanged.

Handling Heathkit

Zenith Data Systems has appointed Maplin Electronic Supplies to handle the distribution of its range of Heathkit PC products marketed under the Heathkit brand-name. This appointment allows Zenith to concentrate on its rapidly expanding microcomputer operation.

Maplin Electronic Supplies is a major UK supplier of electronic components and a leading distributor of home and hobby computer products. A selected range of Heathkit products, including kits and training courses, will be added to the existing product range that Maplin handles.

Ferranti And The Beeb

Ferranti Computer Systems Limited has recently concluded a contract with computer dealer Supersoft Support Limited of Oldham to undertake the servicing of the successful BBC microcomputer system. This contract is expected to be the first of a range of servicing agreements with Computer Dealer Support Limited which will eventually cover other products.

British Software

Britain's biggest computer users, British Telecom and the Ministry of Defence, have for the first time joined forces to underwrite the development of new software projects.

Along with GEC and Plessey, they are jointly funding the development of CHAPSE (CHIL and Ada Programming Support Environment). This will speed the introduction of two high-level computer languages — CHILL and Ada — to be used in future real-time telecommunications and defence computer projects.

The work will be carried out by Ada Group Ltd (AGL), a consortium of four British software and computer-aiding companies: BPL International, Systems Designers, Software Sciences and ICL AGL has been working on the Ada project, funded by the Department of Industry and MoD, for the last four years and its members represent a major part of Britain's expertise in such a high level language development.

Mounting Olympus

The increasing importance of British Aerospace to its European partners as suppliers of communications satellites to a world-wide market was emphasised by Mr Peter Hickman, Managing Director of the Space and Communications Division of British Aerospace, speaking in London at the 1983 Satellite Summit organised by the American journal "Satellite Week".

Mr Hickman announced plans for the world-wide marketing of a new class of multi-purpose communications satellites called OLYMPUS, which will be the largest and most powerful commercial satellites yet built and are expected to provide a substantial proportion of the world's business service.

REwgrets

FRG 7700 Memory Expansion (June '83): The diagram in Figure 3 showed a wire coded "white-violet". It should have been "2711A". Also the switch mentioned in the text is available from Ambit International.

Central Heating Controller (July '82): A couple of errors here — finally, IC2 should be 7211A and not 7211AM, and secondly a section of text was omitted from the Start-Up Procedure. Readers wishing to have copies of the latter should write in (enclosing a SAE) to receive the missing instructions. Finally, EPROMs and program store should be 5½ and £2.50 respectively, from D A Pickles, 96 Perran Avenue, Fishermead, Milton Keynes.
A valuable test instrument for identifying logic levels and pulse signals.

Design by Barry Dawson, MA(Cantab), G8XXY.

Normally, logic probes are designed for use with a single logic family such as TTL or CMOS and are carefully optimised to match the characteristics of that family closely. However, few real circuits consist exclusively of one type of logic, and even the archetypal TTL digital system based on a microprocessor will probably contain circuits such as an RS232 interface running on ±12V supplies.

The analogic probe was inspired by working on a wide range of complex, mixed technology circuitry where a single dedicated probe would not normally be very useful. The probe will indicate logic levels in all kinds of TTL and CMOS logic (at all normal supply voltages), and give useful indications across a wide range of analogue and interface circuits.

The probe contains two functional blocks; a bidirectional edge detector and an analogue level indicator. The edge detector indicates the presence of any fast transitions, with separate indication of +ve and -ve going edges. The level indicator uses a bargraph display to indicate the level of the input, automatically referenced to the supply voltage.

The probe operates from a supply voltage of 4V to 24V (or ±12V), with little change in its performance or current consumption. Despite the large number of LEDs flashing in operation, the current switching circuitry in the probe maintains a fairly constant 50mA consumption. The edge detector controls two LEDs, a red one indicating +ve going edges and a green one for -ve going edges. Each edge triggers a LED 'on' for 100ms, whilst a continuous pulse train causes constant illumination of both LEDs. Pulses as short as

**Figure 1:** Some of the displays that can be obtained with the probe and their corresponding significance. Note that the list is not exhaustive.

<table>
<thead>
<tr>
<th>DISPLAY</th>
<th>NOTES</th>
</tr>
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<tbody>
<tr>
<td>a. 5</td>
<td>TTL</td>
</tr>
<tr>
<td>b. 5</td>
<td>TTL a/c</td>
</tr>
<tr>
<td>c. 5</td>
<td>TTL</td>
</tr>
<tr>
<td>d. 5-15</td>
<td>CMOS</td>
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<tr>
<td>e. 5-15</td>
<td>CMOS</td>
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<tr>
<td>f. 5</td>
<td>TTL</td>
</tr>
<tr>
<td>g. 5</td>
<td>CMOS</td>
</tr>
<tr>
<td>h. 5</td>
<td>TTL</td>
</tr>
<tr>
<td>i. ±12</td>
<td>1kHz 10V pk</td>
</tr>
<tr>
<td>j. ±12</td>
<td>1kHz 10V pk</td>
</tr>
<tr>
<td>k. ±12</td>
<td>1kHz 10V pk</td>
</tr>
</tbody>
</table>

Notes:
- a. TTL 1 level approximately 3V.
- b. TTL open collector 1 level 4.5V (depends on loading).
- c. TTL 0 level 0.4V.
- d. CMOS levels 0V and V+ (at any supply voltage).
- e. Square waves trigger edge detection.
- f. Relative brightness of LED's indicates waveform.
- g. Sharp edges trigger edge detectors (only one in the case of the saw-tooth waveform).

KEY: G — Green
Y — Yellow
O — Orange
R — Red
Circuit Description

A linear bargraph driver, IC1 (set to dot drive mode) is the heart of the level indicator, directly driving 10 LEDs. An internal divider network, between pins 6 (RH) and 4 (RLO), sets the thresholds for switching these on. The divider is fed from the supply rail, such that the switching thresholds are spaced at 5% of the supply — the first LED is triggered by an input signal on pin 5 (SIG) of 5% +V and the last LED at 50% +V. D17 is used to compensate for the forward voltage drop of the reverse polarity protection diode, D1, and R1 must be a slightly smaller value than R11, which is sized with the internal divider resistance of 10k. These four components are fairly critical and the specified types must be used to ensure exactly half of +V is present on pin 6. The input signal to pin 5 is also divided by two, via R12 and R13. This results in the sensitivity at the probe tip being one LED per 10% of +V. Pin 7, the reference of IC1, has 2 functions: it generates a stable voltage of 1V2 and the current drawn from it determines the current fed to the LEDs. R14 thus sets the LED current to approximately 12mA. Q7 and R17 form a current source, also of 12mA, to feed another LED, which is used to indicate an input at or near ground. As soon as the input rises to the threshold of one of the LEDs, Q4 is switched on and D3 goes off, giving the desired 11-step level indication. The input to IC1, in conjunction with R12 and R13, can withstand inputs of ±100V without damage.

A standard CMOS dual monostable, IC2, forms the edge detector part of the probe circuitry. The specified device, a 4538B, is an improved and faster version of the more common 4528. Unfortunately the maximum supply voltage of this IC is less than the 24V required in this design, so a simple series regulator consisting of Q1, R3 and D18 is included. R6, R7, C3 and C4 are used to set the monostable pulse widths to 100ms and the outputs drive two LEDs via Q2, R4, Q3 and R5. These are once again driven by current sources Q5, Q15, Q6, Q16 derived from the 1V2 reference of IC1. The trigger inputs of IC2, pins 4 and 11, are connected to the network R8, R9, R10, D15, D16, C5, R18, C6 and R19, which is optimised to ensure adequate speed and sensitivity to cope with TTL type signals. The simplest circuit needed to trigger the monostables is a CR differentiating circuit (C5, R9 and C6, R8). However, on a +5V supply, CMOS needs a 3V5 swing to guarantee switching — TTL does not normally supply this, so the +ve going edge sensitive input (1A, pin 4) is biased to +12V (that handy reference again?) and the —ve going, edge sensitive input is biased to 12V less than +V (D15, D16 and R10). This results in reliable triggering on edges of 2V or less, which is readily available from TTL. R18 and R19 are included to enable IC2 to withstand input overloads — the internal protection diodes clipping excessive voltages so long as the current is limited.

Construction

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

1. Take great care with the LEDs to ensure they are all correctly orientated, and at the correct height above the board to fit in the case. The specified types have a slightly longer anode lead, and this side should face the edge of the board. A space of approximately 5mm should be allowed between the board and the base of the LEDs.

2. The four pillars inside the upper half of the case need to be shortened by 1 or 2mm to allow for the thickness of the PCB.

3. A rectangular cut-out is needed in the case (as shown), and with a few guide holes drilled, a sharp knife will do the job.
ANALOGIC PROBE

PARTS LIST

<table>
<thead>
<tr>
<th>Resistors</th>
<th>capacitors</th>
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<td>R1</td>
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<tr>
<td>R2</td>
<td>150R</td>
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<td>R3</td>
<td>680R</td>
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<tr>
<td>R4,5,18,19</td>
<td>10k</td>
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<tr>
<td>R6,7,8,9</td>
<td>1M</td>
</tr>
<tr>
<td>R10</td>
<td>68k</td>
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<td>R11</td>
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<td>R12,13</td>
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<td>R14</td>
<td>820R</td>
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<td>R15,16,17</td>
<td>47R</td>
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<tr>
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<tr>
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<tr>
<td>D2,3,4</td>
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<td>ZD1</td>
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<table>
<thead>
<tr>
<th>Miscellaneous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probe case, IC sockets (2 off), wire, solder etc.</td>
</tr>
</tbody>
</table>

**Testing**

After thoroughly checking the PCB, attach the probe tip and the supply cable (supplied with the case). Connect to a 5 or 6 volt supply/battery and the yellow LED only should light. Touch the probe tip onto the +ve supply and the yellow LED should go out, the top orange LED should light and the red and green LEDs may flash. If all is now well, disconnect and re-check the PCB and all components.

**Operation**

This compact device can give a great deal of information about the state of all kinds of circuits, but it does require some experience to get the best from it. A function generator and an oscilloscope will enable the displays given to be verified and expanded to gain experience. Then it's off into some real circuitry — good luck!

R&EW

**CASSETTE MECHANISM**

★ Full Solenoid Operation
★ Complete with Canon Heads
★ Front loading
★ Simple IC Control Logic

This month's databrief reveals the design of suitable logic control, using the recommended IC's to drive the solenoids.

To follow soon a tape counter mechanism, a simple add-on to know where you are.

For special large quantity orders a variety of heads can be supplied, for details contact Ambit Industrial Marketing.

Full data can be obtained by sending £1.95 plus A4 SAE.

**SPECIFICATION**

Rated Operating Voltage: Motor +12V DC ±10%, Solenoids +12V DC ±10%
Installation: Vertical or Horizontal
Wow and Flutter: >0.1% WORMS(USL)/Test Tape: TEAC MTT-111
Spooling Time: FF or REW >115 seconds (TDK DC-60)
Tape Speed: 3.000 Hz ±2%
Motor Consumption: (Play, FF, REW) >100mA
Heads: REC/REP: Canon H5332-0202 (2 channel sendust)
Erase: Canon HS3211-02 (2 channel, double gap, metal capable)

<table>
<thead>
<tr>
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<th>25-99</th>
<th>100+</th>
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<tbody>
<tr>
<td>TN3920-01 deck</td>
<td>72-03600</td>
<td>26.00</td>
<td>26.00</td>
<td>22.00</td>
</tr>
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<td>BA443 Cassette deck control IC</td>
<td>61-00843</td>
<td>1.95</td>
<td>1.95</td>
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<tr>
<td>LB1288 Darlington Driver (for solenoids)</td>
<td>61-01288</td>
<td>1.35</td>
<td>1.25</td>
<td>1.05</td>
</tr>
</tbody>
</table>

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RADIO & ELECTRONICS WORLD
Cassette deck control circuits

The BA843 from ROHM has been especially developed for the electronic control of tape deck functions where the actual mechanical operations required are controlled or assisted by solenoid action, or electronically switched.

Features include:
1. Input key signals have a latching function, allowing use of non-interlocking keys.
2. Internal logic circuitry to prevent damage in the event of two keys being accidentally pressed together.
3. Automatic reset to stop mode upon application of power.
4. Internal pull-up resistors on all input pins, allowing direct connection of input keys with an adequate noise margin.
5. Output circuitry drives DTL, TTL, CMOS or transistor loads.
6. 1st process — low power consumption with no static handling problems.

The BA843 has 8 inputs (1-7 & 9), six of which are for operational inputs (Play, Stop, F/F, Rew, Pause and Record) and the other two are memory and accidental record prevention (AR). Output pins 10 to 15 are for Rec, Pause, Rew, F/F and Off, and seven output modes (Stop, F/F, Rew, Play, Pause, Rec/Play and Rec/Pause) are available. Other modes are not available as direct outputs from the BA843, but simple diode logic may be used at the outputs to initiate such functions as cue and review (ie, Play, Pause and F/F, or Play, Pause and Rew solenoids selected together respectively).

**Figure 1: Pin Arrangement of BA843**

**Figure 2: Block Diagram for BA843**

### SPECIFICATION Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Item</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>VCCmax (Supply Voltage)</td>
<td>Vcc</td>
<td>4.5</td>
<td>—</td>
<td>5.5</td>
<td>V</td>
</tr>
<tr>
<td>Pd (Dissipation)</td>
<td></td>
<td>500mW</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Tt (Operating temp range)</td>
<td>—</td>
<td>-20 to +75°C</td>
<td>—</td>
<td>—</td>
<td></td>
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<tr>
<td>Vtmax (Input voltage range)</td>
<td>VIl</td>
<td>2.0</td>
<td>—</td>
<td>—</td>
<td>V</td>
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<tr>
<td>Vtmax (Input voltage range)</td>
<td>IIL</td>
<td>4.0 mA</td>
<td>—</td>
<td>—</td>
<td>mA</td>
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<tr>
<td>Vtmax (Output voltage range)</td>
<td>VCC</td>
<td>2.2</td>
<td>—</td>
<td>—</td>
<td>V</td>
</tr>
<tr>
<td>Vtmax (Output voltage range)</td>
<td>VCC</td>
<td>0.4</td>
<td>—</td>
<td>—</td>
<td>V</td>
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<tr>
<td>Ith (High level output current)</td>
<td>L0H</td>
<td>-1.0 mA</td>
<td>—</td>
<td>—</td>
<td>mA</td>
</tr>
<tr>
<td>Ith (Low level output current)</td>
<td>L0H</td>
<td>60 mA</td>
<td>—</td>
<td>—</td>
<td>mA</td>
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</table>

### ELECTRICAL PERFORMANCE:

- Supply voltage range
- High level input voltage
- Low level input voltage
- Input open voltage
- High level output voltage
- Low level output voltage
- High level output current
- Current consumption
FEATURES:
High maximum drive current 400mA  
High dissipation 1.15W  
Wide supply voltage range 5.0 to 20.0V  
Wide operating temp range -20 to +80°C  
High current amplification >2000

APPLICATIONS:
Relay, solenoid or motor drive  
Digit or segment driver (LEDs etc.)  
Interface for MOS-Bipolar logic  
Power amplification or fan-out extension

OPERATING TEMPERATURE:  
Top = -20° TO +80°C  
Ta = -40° TO +125°C

STORAGE TEMPERATURE:
Tstg = -65° TO +150°C

NOTE:
PINS (1,8,14) = N.C.  
SUBSTRATE CONNECTED TO PIN (7)

The Sanyo B1288 is configured as a five stage Darlington transistor array (NPN transistors), capable of high current drive. The tables set out some of the features and applications for the device. In use, it makes an ideal complement to the main control circuit.

ABSOLUTE MAXIMUM RATINGS:
Collector-base voltage $V_{CEO}$ 20V  
Collector-emitter voltage $V_{CEO}$ -0.7 to -20V  
Power dissipation $P_{Dmax}$ 1.15W  
Input voltage (per unit) $V_{IN}$ -0.7 to 45V  
Collector Current (per unit) $I_C$ 500mA  
Junction Temperature $T_J$ 125°C

Graph 1: $I_C$ vs. Duty Cycle for LB1288

Graph 2: $P_{Dmax}$ vs. $T_a$ for LB1288

Graph 3: LB1288 ASO

Figure 3: Internal circuit of LB1288

Figure 4: Typical Application with Basic Functions
Wideband HF Linear

Disturb the air-waves with our 10W 2-30MHz RF amplifier. This low distortion design features push-pull output stages, active biasing and an input stage which can be driven from mixer outputs.

Next month, in conjunction with Arcom Control Systems, we are running an easy-to-enter competition, based around the Zilog Z8000 tutorial series (yes, you'll need to have read lessons 1-5). Arcom are donating one of their single board computers as the prize. It runs the Zilog Z8000 and uses the latest technology — Zilog's new support SCC CIO, CMOS RAM and PALs for on-board logic — to produce a fast, powerful computer supported by a sophisticated monitor.

PLUS:

- Distortion Analyser — high quality test gear.
- Weather Facsimiles — using our digital scan converter.
- REWTEL routines — software for the NASCOM.

September Edition — On Sale 4th August

AUGUST 1983
SYNthesiser CONTROL SYSTEM III

The concluding part of this project, by Ian Chapman, describes the synthesiser/mixer board.

Having discussed the development of a versatile synthesiser control system, it is now necessary to consider how that digital circuitry interfaces with, and programs, the MC 145151. In this section, the Synthesiser/Mixer containing the circuitry necessary to build a complete system, with the exception of the VCO, modulator, and frequency multipliers, is discussed.

Circuit Description
The MC 145151 phase-locked-loop frequency synthesiser (IC 105) handles both digital and analogue signals. In Fig. 1 it can be seen that the digital inputs and outputs interface to the main control board via PL4, whilst the analogue signals are associated with the VCO and reference oscillator stage (for a complete description of the MC 145151, see the data sheet in R & E W for March '82).

A + regulated voltage is needed by the MC 145151 and the four CMOS devices (ICs 101-4), which have to interface to TTL logic levels from the main board, and this is supplied from the +10V line to the synthesiser/mixer board by IC106, a 78L05. The 10V line also appears on connector PL4 (pin 12), which feeds the main control board.

A two-stage binary counter is required on this board to provide the strobing for the main board on address lines A0 and A1. For economy of packages, a CMOS 4060 14-stage counter/oscillator is used. The values of timing capacitor and resistors are not critical — those quoted cause the oscillator to run at about 1kHz (90 microsecond period). Outputs Q4 (divide by 16 — 1.5ms) and Q5 (divide by 32 = 3.0ms) are fed via connector PL4 pins 3 and 4, to the main board (see Fig. 3). The reset line (pin 12 on the 4060) is wired low, to enable continuous counting. Pins 1, 2 and 3 of the 4060 are brought out to Pins A, B and C respectively. These outputs of 2.4Hz, 1.2Hz and 0.6Hz are available for use during adjustment of the loop filter circuit values when optimising its damping and lock-up time parameters to suit the chosen VCO circuit characteristics.

The MC 145151 requires a 14-bit parallel data word to select the desired frequency. Two of these bits can be hard-wired to ground (N12 and N13), since they do not change over the entire frequency range. The other 12 bits are obtained from the main control board as three ‘chunks’ of 4-bit data on the bus 00-03. The three lines S1, S2 and S3 are used to strobe this data into three 4-bit latches (ICs 101-3) each time that it appears on the bus. The outputs from these three latches are presented to the MC 145151 as a 12-bit parallel word, as required.

The Transmit/Receive input of the MC 145151 (pin 21) is not used in this design. Grounding this pin serves to add an offset to the selected division ratio in order to provide an IF offset on receive. However, since this requirement has already been met within the 2532 EPROM on the main control board, which has the additional advantage of catering for repeater and other shifts at the same time, T/R is left unconnected (an internal pull-up disables the offset addition).

The fixed reference division ratio is set by programming the control inputs RA0, RA1 and RA2 (set to 0, 1 and 1 respectively). The crystal oscillator (Q 101) is fed both to ‘OSC IN’ (pin 27 of the 145151) and to Q 102, which is a doubler stage. Q 103 is a x2 multiplier for 2m and a tripler for 70cms. It produces an output frequency of 60.250MHz (70cms) or 45.66MHz (2m). This local oscillator frequency is fed to the double balanced mixer, IC 108, along with the VCO output frequency, which ranges 68.1-73.3MHz (70cms) or 44.43-49.33MHz (2m). The difference frequency is fed via a low-pass filter and a buffer amplifier stage (Q 104) to ‘Fin’ — pin 1 of the 145151.

An RC network and a Schmitt trigger (IC 109) are used to perform ‘de-glitching’ in this design. One input of each NAND Schmitt trigger gate is wired high, so that the gates can, in fact, be regarded as Schmitt inverters. When the PLL is in lock, the input to the first device will be almost +5V, as the output on LD is predominantly high and the capacitor does not have time to charge through the resistor during the ‘glitch’. Thus, the input is high and the output is low (at point X). However, when the PLL is out of lock, a stream of wide pulses will appear on ‘LD’. The capacitor will be charged when LD goes low and discharged when LD goes high. The smoothing effect of the RC network ensures that the stream of pulses from pin 28 is interpreted as a logic zero by the Schmitt trigger input, producing a logical high at its output (point X).

Since the polarity of the ‘out-of-lock’ indicator that is desired will depend on the particular application, this is selectable by appropriate linking on the underside of the PCB. If link XY is made, the output from the first Schmitt trigger is fed directly to a ZTX 108 (Q 105) transistor which has an open-collector output. If link YZ is made, the output signal is inverted before it is fed to the transistor. Pin 7 on the connector PL2 carries this ‘out-of-lock’ signal from the board (see Table 1).

<table>
<thead>
<tr>
<th>Link</th>
<th>PL2 connector Pin 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>XY</td>
<td>OPEN when in lock</td>
</tr>
<tr>
<td>ZO</td>
<td>GROUND when OUT of lock</td>
</tr>
<tr>
<td>YZ</td>
<td>OPEN when OUT of lock</td>
</tr>
<tr>
<td>ZI</td>
<td>GROUND when IN lock</td>
</tr>
</tbody>
</table>

Table 1

RADIO & ELECTRONICS WORLD
Figure 1: The Synthesiser/Mixer Circuit.
Design

Fig. 2 shows the block diagram of a synthesiser that will accommodate either the 70cm or the 2 metre band and which can be built using a combination of the control logic and the mixer board to be described. Since the MC 145151 cannot handle RF signals in excess of about 25MHz when used with a 5 volt supply, Motorola recommend a down-mixing technique using a single crystal oscillator at 10,04167MHz. This reference signal is divided by 2410 (within the MC 145151) to produce a comparison frequency of 4.1667kHz.

The 10,04167MHz signal is also frequency-multiplied in order to produce a local oscillator signal with which the input frequency from the VCO unit is mixed. The resulting difference signal is fed to the programmable divider input of the MC 145151. Phase comparison then produces an error signal voltage, which is fed via a Loop Filter circuit to the VCO in order to stabilize its output frequency.

Construction

The synthesiser/mixer unit has been designed to fit into a screened box. Before mounting any components on the PCB, it is recommended that the bare board be used as a 'stencil' to facilitate the marking out of the 5 fixing holes in the box. Either 6 BA or 8 BA, 1/4" countersunk screws can be fitted from the underside, and secured with a nut on the inside of the box to space away the PCB.

Referencing to the layout diagram (Fig. 3), the components should be mounted in the following order:
1. Jumper links across top of PCB.
2. Through-board pins.
3. ICs sockets and MOLEX connectors.
4. Toko coils and inductors.
5. Resistors, capacitors and diodes.
6. Transistors and 5 volt regulator (IC 106).

The other ICs and the crystal should not be fitted at this stage; nor should 'Y' be linked to either 'X' or 'Z' yet. Note that C19 is not a real capacitor, but is produced by stray capacitance across PCB tracks.

Where the end of a capacitor or resistor is shown to be connected to the ground line on the circuit diagram it should be soldered to top and bottom sides of the board. The two Toko transformers must also be grounded in the same fashion and their tuning cores adjusted to be level with the top of the can.

Aligning The RF

A +10V regulated supply can now be connected to the input tags adjacent to PL1 on the synthesiser/mixer board. Measurements are made as follows:
1. Check that the on-board regulator (IC 106) is operating correctly by measuring the voltage at pin 3 of IC 105. This should be +5 volts ± 5%.
2. Check that this same voltage appears on pin 16 of ICs 101-104. Then switch off the power.
3. Temporarily connect an LED and series resistor (1k) from the +10V line to the collector of Q105, which is brought out to pin 7 of PL2.
4. Temporarily connect a lead from the PCB point 'Y' to IC104 pin 3 ('C' on circuit diagram).
5. Insert IC 104 and switch on the +10V supply. The LED should now be flashing at about 0.6Hz. Switch off the supply and remove lead from pins 'Y' and 'C'. Leave IC 104 in place.

Voltage Controlled Oscillator

The heart of any synthesiser is the Voltage Controlled Oscillator and, for this reason, great care should be taken to ensure that it is both electrically and mechanically sound since poor design technique in this area can result in significant noise modulation and instability of the output carrier.

The frequency/voltage characteristic of the VCO should be chosen so that the frequency swing is no more than necessary after allowing sufficient reserve at each extremity of the tuning range to cope with overshoot, thermal variations of oscillator component values and such-like. The coverage should not span both transmit and receive oscillator frequencies, since better performance is achieved by bandswitching with a diode controlled by the PTT line. A suitable diode can switch in an extra capacitor to give a low-frequency shift when forward-biased in the 'RECEIVE' mode, whilst also providing the means to frequency-modulate the VCO when it is...
reverse-biased on 'TRANSMIT'.

A junction FET (such as the J 310) can form a very good low-noise oscillator at VHF, and will function well in a Hartley or Colpitts configuration up to at least 150MHz. It should be built into a small screened box with a printed circuit tuning inductor to reduce microphony, and leadless decoupling capacitors to prevent stray resonances. A double-sided PCB should be used to provide an earth-plane.

For frequencies above about 150MHz, a better circuit can be designed using the same device in a grounded-gate arrangement, with drain-source feedback introduced by a small capacitor. The FET gate can be connected directly to the circuit earth-plane, thereby minimising stray inductance and improving stability. Whatever arrangement is chosen, the RF outputs to the transmitter driver stages and to the receiver local oscillator chain must both be very well buffered, as also must the separate feed from the VCO to the synthesiser/mixer board. Efficient decoupling of the power supply and DC switching lines is essential in order to reduce the stray pick-up of unwanted signals - particularly those associated with the reference frequency of 4.1667kHz.

The original design was built to provide an output in the 72MHz band in order to modify existing equipment, and provide band coverage of 70cm in 24kHz steps. Simple alterations to this design produced a 2 metre version, which was capable of covering that band in 12 1/2kHz steps. However, a constructor building the system without such constraints could achieve a much better result by operating the VCO at a rather higher frequency.

For 2 metres, the VCO could function directly at final frequency without the need for any frequency multipliers, although to operate with the synthesiser system described here it would be necessary to divide the 144MHz signal by 3 where it feeds the synthesiser/mixer board. This is not as difficult as it sounds, since Plessey produce a single chip ECL divider, the SP 8720, which is ideally suited to this application. Buffering of the VCO at the divider and good supply filtering will ensure satisfactory operation.

The 70cm VCO could operate at around 144MHz, although there are advantages in running at half-frequency (215-220MHz), since doubler circuits for both transmitter, and receiver local oscillator would be straightforward to construct, other harmonics being rejected easily using miniature Toko helical filters. The same divide-by-three IC could then be used to provide the synthesiser/mixer board with the required 72MHz input.
Loop Filter
Assuming, then, that a suitable VCO design has been chosen and built, it will be necessary to determine its frequency-voltage characteristic, in order to start calculating the loop filter component values. This can be measured using the setup shown in Fig. 4, which also illustrates one typical 48/72MHz VCO circuit.

For a range of control voltages applied to the varicap diode, in both transmit and receive modes, the output frequency should be recorded. Ideally, the lowest desired operating frequency should be attained at around 20-25% and the highest at around 75-80% of maximum voltage. This allows for overshoot of the control signal from the loop filter, as well as thermal drift in the VCO. Having determined the average frequency swing per volt, the VCO conversion gain can be calculated from the formula $K_o = 2\pi f_0 C_{varicap}$, multiplied by (frequency change in Hz/ control voltage change in volts), where $K_o$ is expressed in radians per second per volt.

Testing
Once a set of component values has been calculated using the references at the end of this article, the complete system should be assembled and powered up. If the basic checks for dry joints, shorted PCB tracks, reversed transistors, capacitor polarisations and inter-unit wiring have been satisfactorily completed, together with the setting-up described earlier in this article, everything should be OK.

A receiver covering the VCO tuning range, or harmonics of it, and an oscilloscope are almost essential for fault-finding and final adjustment. Remember that the parallel-programming inputs of the MC 145151 are static once a channel has been selected, so that the selected division ratio can be determined by reading each input pin as a binary '0' or '1', and calculating accordingly.

With an LED and resistor connected to pin 7 of PL2 (see notes on setting-up of synthesiser/mixer board) and 'X' linked to 'Y' underboard, the LED should go out when phase lock is achieved. Temporarily shorting out the VCO input should cause the LED to light, verifying that this circuitry is functioning.

The loop filter characteristics should now be measured to confirm that they meet the required performance in terms of lock-up time, frequency response and damping, and changes should be made if necessary.

If it is intended that the VCO be modulated, as would be the case in an FM transmitter, then rather more care will be necessary in correctly arranging the loop cut-off frequency, since unwanted phase shifts in this part of the system can give problems of modulation distortion. The circuit of Fig. 5 will enable the filter lock-up time and damping to be measured on an oscilloscope.

Referencing to Figs. 3a and 3b, the S/SEL line on the control circuit can be used to switch the synthesiser rapidly between two frequencies — one set up on the thumb-wheel switch and the other set up on the rotary switches. If SW4 is left open, and the S/SEL line is taken to the collector of the transistor shown in Fig. 5, then frequency switching will occur at one of three rates, depending on which of the three outputs 'A', 'B' or 'C' from IC104 is selected. If the oscilloscope is triggered on one edge of this switching signal, the transient response can be seen by connecting the Y input to the output of the loop filter at pin 5 of PL2.

Whilst the only satisfactory way to measure the noise and spurious performance of a synthesiser is to use a VHF spectrum analyser, most good quality amateur receivers covering the appropriate frequency range will readily reveal any severe problems. Modulation quality, excessive reference-sideband levels and VCO microphony can all be assessed and suitable steps taken to improve them if necessary.

References
1. "Design of phase-locked-loop circuits" — Howard M. Berlin
3. MC145151 data sheet — Motorola
4. "An ADF frequency synthesiser utilising phase-locked-loop ICs" — Motorola Application Note AN564
5. "Phase-locked-loop design fundamentals" — Motorola AN535
6. Motorola data sheets for: MC 12040 MC 4344/4044
7. "Radio Communications Handbook" — Plessey Semiconductors

STOP PRESS...
A few points, which have arisen following publication of the first two parts of this...
### PARTS LIST

**Resistors (All 1/4 Watt 5%)**

<table>
<thead>
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<th>Value</th>
<th>Component</th>
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</thead>
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<tr>
<td>10k</td>
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<tr>
<td>4.7k</td>
<td>R3,25</td>
</tr>
<tr>
<td>100R</td>
<td>R4,7,8,12,15,20,24</td>
</tr>
<tr>
<td>22k</td>
<td>R5,9,21</td>
</tr>
<tr>
<td>2k</td>
<td>R6,10,14</td>
</tr>
<tr>
<td>330R</td>
<td>R11</td>
</tr>
<tr>
<td>220k</td>
<td>R16</td>
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<td>820R</td>
<td>R17</td>
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<tr>
<td>560R</td>
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<td>R19</td>
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<td>470k</td>
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<tr>
<td>(4 off, see text)</td>
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<tr>
<td>(2 off, see text)</td>
<td>Rb</td>
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**Capacitors**

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<tr>
<td>100n monolithic</td>
<td>C2</td>
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<tr>
<td>10n disc</td>
<td>C3,4,10,12,13,15,16,18,23,25,26,32,33</td>
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<td>C6</td>
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<td>3-36p foil trimmer</td>
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<td>C35</td>
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<td>(2 off, see text)</td>
<td>Ca</td>
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<td>(2 off, see text)</td>
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### Semiconductors

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<td>4060</td>
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<td>IC105</td>
<td>MC 145151</td>
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<td>IC106</td>
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<td>IC107</td>
<td>741CN</td>
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<td>IC108</td>
<td>SL1641</td>
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<td>4089</td>
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<td>Q101,105,108</td>
<td>ZTX 108</td>
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<td>Q102,103,104</td>
<td>BF 241</td>
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### Miscellaneous

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<tr>
<td>L1,2</td>
<td>(70cm version) S18,4,5 YELLOW</td>
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<tr>
<td>L1,2</td>
<td>(2m version) S18,7,5 VIOLET</td>
</tr>
<tr>
<td>L3,4</td>
<td>Toko 144LY-47R</td>
</tr>
<tr>
<td>T1,2</td>
<td>Toko 199CA-127EK</td>
</tr>
<tr>
<td>X1</td>
<td>10.0417MHz crystal</td>
</tr>
<tr>
<td>8 pin DIL IC socket (2)</td>
<td>14 pin DIL IC socket</td>
</tr>
<tr>
<td>16 pin DIL IC socket (4)</td>
<td>28 pin DIL IC socket, PCB plug (12 way), PCB plug (10 way), PCB shell (10 way), Crimp terminals (18), PCB pins, PCB, case, nuts, bolts etc</td>
</tr>
</tbody>
</table>

---

**Accurate Digital Multimeters at Exceptional Prices**

**NEW ANALOGUE METER WITH CONTINUITY BUZZER AND BATTERY SCALE**

**28 RANGES, EACH WITH FULL OVERLOAD PROTECTION**

**SPECIFICATION MODELS 6010 & 7030**

- 10 amp AC/DC
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- AC DC Current: 200mA to 10A
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- DC Voltage: 200V to 1000V
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**SPECIAL FEATURES:** Auto polarity, auto zero, battery low indicator, ABS plastic case with tilt stand, battery and test leads included, optional carrying case.

**OTHER FEATURES:**
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- Decibel: -20 to +22dB
- DC Current: 0-50, 500µA, 0.5, 5, 50, 500mA
- Ohmmeter: 0-1 Megohms in 4 ranges, 30 ohms Centre Scale
- Power Supply: One 1.5V size 'A' battery (incl.)
- Size & Weight: 300 x 80 x 28mm, 280gr.

**NEW HM 102 BZ SPECIFICATION**

- DC & AC Voltage: 0.1-50, 250, 1000 volts, 20,000 ohms/volt.
- Decibel: 10 to +22dB
- DC Current: 0-100mA
- Ohmmeter: 0-1 Megohm in 2 ranges, 60 ohms Centre Scale
- Power Supply: One 1.5V size 'A' battery (incl.)
- Size & Weight: 90 x 15 x 32mm, 29gr. incl. battery
- Price: £8.99

**NEW HM 102 BZ SPECIFICATION**

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<td>Power Supply</td>
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<td>Size &amp; Weight</td>
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<td>Price</td>
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TELEX No 939885

AUGUST 1983
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**KEY TO TRANSMISSION SYSTEMS**

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A new series of projects, designed by Stephen Ibbs, which can be built, tested and working in an evening. We begin with a Crystal Calibrator.

Each month during this series, we will present a small design which can be built in a few short hours. These will include indicators, calibrators, timers, checkers, etc. aimed at the beginner. The projects will be easy to build, either on veroboard or PCBs (PCB designs will be given), but no casework details will be given, so that the finished projects can either be mounted in existing equipment or in separate enclosures. At the same time it is hoped that the circuit descriptions will be straightforward enough for those just starting to build projects to understand.

Crystal Calibrator
There is quite often a need for a reasonably accurate signal source in the constructor’s shack, and this little piece of test equipment generates square waves at 4MHz, 2MHz, 1MHz, 100kHz, 50kHz and 10kHz, all with one crystal and 4 ICs. A crystal frequency of 4MHz is used since it is very common and most component suppliers have it as a stock item.

Construction
Veroboard construction is possible with care, but a PCB is easier. Mount all the components the correct way round and then check carefully before applying power. Trim IC1 against some sort of reference or frequency meter, then the unit can be mounted in a suitable box. I used a verobox, with an SUE bank to switch the output to panel mounted sockets. The frequency will vary slightly as the battery runs down and if constructors are worried about this, a voltage regulator can be easily included to stabilise the voltage and make the unit more reliable.

Circuit Description
IC1a and b comprise the oscillator circuit, with IC1 incorporated to adjust the crystal onto frequency. IC1 c is used as the 4MHz output buffer, and ICd acts as a buffer to the next IC, a dual flip-flop. Each half of this 4013 divides the frequency by two, so we have 2MHz at pin 1 and 1MHz at pin 13. The output then goes into a 4518 dual divide-by-ten (IC3) to give 100kHz at pin 5 and 10kHz at pin 13. The 100kHz signal also drives another flip-flop to give 50kHz at pin 1 and 25kHz at pin 13 of IC4.

Figure 1: Circuit diagram of the calibrator.

Figure 2: The component overlay.

Figure 3: Foil pattern
Who Stocks a Range of PIEZO ACOUSTIC SOUNDERS with prices that start below 20p?
A couple of months ago (15th May), the most spectacular radio blackout occurred, which effectively closed down all communication on the amateur bands from 10 metres right through to 80. Things seemed normal at eight o’clock in the morning, but by nine o’clock all bands were dead. So much so, that my first inclination was to check over the aerial system, the receiver, aerial relays and so on. It was comforting to hear a local station saying exactly the same thing to another local and to realise they too had gone out to see if the sky-wire was still there! All bands stayed dead for most of the morning and it was not until the afternoon that things were back to normal.

Such a fade-out is now called a “Sudden Ionospheric Disturbance” — SID. The cause is thought to be sudden bursts of solar radiation from a part of the sun’s surface facing the earth, so that the ionosphere surrounding that part of the earth facing the sun is intensely ionised; to a degree far exceeding normality. Ionisation of the lower D layer occurs, so that radio waves from the earth’s surface passing up towards the ionosphere which have reached the highly ionised D layer, thus do not pass through to the upper F layers. So, no propagation takes place by reflection from these higher layers and only very local ground-wave communication can occur.

It was established in the 1930s that these fade-outs were related to the appearance on the sun of solar flares. These phenomena are sudden releases of radiated energy occurring in the vicinity of active regions on the sun. They eject atomic particles and emit radiation across the entire range of the electromagnetic spectrum, from X-rays to radio waves. The first flare to be recorded was seen in 1859 by the English Astronomer Richard Carrington and was visible in white light, a rare phenomenon indeed as usually they cannot be seen at all against the brilliance of the sun. They are normally observed nowadays through light filters which remove all but one band of light wavelengths. The filters pass the light from Hydrogen or Calcium, by which the flares can be seen.

A flare reaches its maximum brightness within a few minutes and declines slowly thereafter, its total duration varying from a few minutes to several hours. They are classified into five groups labelled from 1 to 4 and a group labelled “5”; Group 4 being the largest.

Enquiries revealed that a major flare occurred at 0839 hrs UTC on Sunday 15th May 83, the radio effects of which lasted about an hour — it was of Type 2. It gave heavy radio noise on 10cms and bursts of radio noise were heard on several other radio frequencies. It was accompanied by a weak proton flare for an hour or so.

So those amateurs who were trying to have their usual Sunday morning skeds and nets on that day, may have been unsuccessful, but at least they had the interesting experience of witnessing a true SID of considerable magnitude.

Our hopes that AMSAT's Phase III satellite would be launched in June have not been fulfilled due to various “glitches” which have resulted in a series of further delays. Apparently the motor which gave trouble on the previous ill-fated launch is giving trouble again, as is some of the control equipment. So we must continue to wait!

Oscar 8 has been giving some cause for concern. Battery temperatures have been running high, for some time, for reasons which are a bit puzzling. It seems the batteries are overcharging. So its usual operating program of so many days in Mode A and so many in Mode J, has been interrupted and the control stations are controlling as seems best day-by-day. So, some days Mode J will be on the usual Mode A days and some days both Mode A and J will be on together. Also, some days it will not be on at all. So check both Modes before assuming it’s "suddenly died"!

Karl Jansky, one of the pioneers of Radio Astronomy, was the first to establish that radio waves did come from outer space. This was made public on 27th April 1933. The 50th anniversary of this event was celebrated in the USA by some special moonbounce tests conducted from the National Radio University at Green Bank, West Virginia, under the guidance of Dr. Tom Clark, W3IWI, President of AMSAT. The huge radio telescope there, 140 feet in diameter, was used to provide some really powerful moonbounce signals, so that those radio amateurs interested in this form of amateur activity could have a chance of making some contacts on this difficult mode. The tests were quite successful, some 200 contacts being made, though it was the “big boys” who were mostly the lucky ones, rather than those with less sophisticated equipment, for whom the tests were primarily designed.

— R&EW

Solar Flares. Seen Edge on they resemble huge flames appearing over the edge of the sun. Seen from above, they appear as large areas of radiation.
MEMORY AND PERIPHERAL MANAGEMENT

MEMORY MANAGEMENT

The microprocessor began as a four-bit-wide device that could handle simple tasks in certain control, intercom, games, and similar products. It could do these tasks more flexibly and at less cost than alternative devices based on discrete logic circuitry. For the applications, few circuits, including memory, were needed. As the practical capability of large-scale integration (LSI) increased, processors with increasing power, both in data size and instruction set, became more commonplace.

The memory needs of present day applications have now been greatly expanded. Systems such as the Z80, first made possible the construction of microprocessor systems that could emulate many of the abilities of mini- and large-computer systems. These opened applications in small fields outside small control systems. With these new applications comes a need for more and more memory to computerize the design process. In mathematical terms, a more powerful instruction set makes new types of computations be attacked with a microprocessor. It is impossible to conserve the amount of time and memory needed to complete any computations picked at random. Thus, it is important to have as little processor headroom as memory hardware is available on hand and at speed.

With the Z8000 microprocessor, instruction set and memory architecturization capabilities have now entered the realm of standard (mini- and large-) computer systems. One task, therefore, is to provide and efficiently organize enough memory for the most general tasks to which the Z8000 might be applied, enough memory for the instruction set memory still a scarce resource, possibly shared by multiple, complex computing tasks. The segmented address feature of the Z8001 is a considerable step toward attack this problem of memory management.

Memory is a resource for computations, as the processor is a resource for computations in a machine being used. There are two basic reasons for wanting to manage this resource: it must be made available to all computations using it, and it must be partitioned when programs are uniquely defined for particular memory regions.

In any physical system, only a finite amount of memory exists. Some of this memory can be fast and directly accessible to running programs as RAM or ROM (usually because of cost and addressing limitations). This is only a small portion of total system memory. The remaining memory must serve two purposes: long-term storage (tape or disk) or intermediate, medium (speeded backup storage, drum, or drum). This backup storage serves to make physically addressable memory (RAM or ROM) appear larger to programs than it is really is, at least as large as the processor’s full addressing capability (32K bytes per Z8001 space). Such backup storage is optional. It can be made to provide virtual memory in complex system designs, be used and memory management effectively simulate an extension of last memory.

Memory Partitions: Pages and Segments

Microprocessor programs are typically a task divided between a hardwired controller and software in an operating system. Memory can be partitioned into segments and pages in much the same manner as programs are. In some systems, the partitioning is only used for virtual memory implementation, but the memory pages and segments are used for hardwired purposes. In others, variable-sized partitions, called segments, are defined as the system runs. These segments may themselves be broken into pages for translation in the case of virtual memory implementations. The Z8000 can address 128 segments, each as large as 2.5M bytes. In any case, the allocation of physical memory in pages or segments provides an essential interface for data translation. Physical addresses are meaningless to anything but the operating system. Only logical addresses are emitted by programs running under the system. The system maps logical to physical addresses as needed.

Relocation and Reentrancy

Dividing the addresses used by all but the system programmer from those used to reach physical memory cells allows the operating system to place programs and data anywhere where it chooses within physical memory and still have them run properly. This is relocation. It depends on the presence of a control hardware that is programmable by the operating system dynamically. Such hardware will allow any address emitted legally by a program to be translated into the proper physical address holding that program or its data. (For the Z8001, such a programmable device, the Z8010, is available for memory management, but its specific capabilities will be described in a separate course.)

Dynamic relocation allows the operating system to provide efficient operation and other benefits to multiple users. A program may be physically located anywhere in memory and still be accessed by whatever physical addresses were defined when the program was assembled/compiled and linked. Thus, it can exist as exactly one copy of itself, but be used at the same time by many other programs, as if they were linked into a single copy of an editor program, for example, to serve a hundred time-sharing users, provided the system keeps track of data in a free set. Reentrancy is necessary. Each program (task) or user running by the system has its own logical starting address, which can be associated with any physical address — the address of the shared program, for instance. As long as data is kept in each user’s space and the shared program contains only instructions, it is reentant and can perform its service for each user in a single sequence defined by the operating system. Obviously, the savings in memory space are large and increase with the number of users. However, the memory management hardware must translate logical to physical addresses and may need reprogramming to change the logical-physical relations as each user begins to run. There are both clear and subtle design considerations for these systems, and a combination of memory segmentation and paging with virtual support may be needed in the most general applications.

Page/Segment Properties

Apart from relocation and reentrancy, memory management typically also implies that properties be established for memory pages and segments. For the Z8000, an examination of its status outputs suggests some useful properties that might be identified by management systems (some are allowed by the Z8010). System versus minimal mode, for instance, can be used in multitask applications to segment memory devoted to the operating system from memory assigned to tasks or users. Similarly data, stack and instruction memory can be segregated for both system and normal mode — to prevent accidental execution of data. In the Z8002, this allows six spaces of 65,536 bytes each to be defined. In the Z8001, the defines spaces of 128 segments, each of 65,536 bytes, for a total of 48M bytes.

Memory management could thus consist of monitoring the AD15.0, SN6.0 (Z8001), ST3.0, and N/S lines from the CPU to see if the present access is a legal one. It the process, or Memory Management Unit is programmed, then some process or task responsible for that address (or segment) when the system was programmed, is some process to the operating system (a segment trap on the Z8001) can be registered by the memory controller/manager. Note that memory management is not a meaningful concept in Z8002 system designs, but requires custom hardware and software support.

Other properties can be assigned to pages/segments areas according to the needs of the system being designed. Read-only areas are protected from unhappy accidents, execute-only are protected from accidents and theft. Some properties might relate to use by devices other than the CPU (say a DMA). These properties might also possibly be logically disconnected from the CPU, for instance, so that a new process area can be loaded or a closed file can be written on disk. Memory management in general, therefore, is not CPU-oriented but memory-centered. It relates the logical and physical structures as necessary to make memory efficiently available to devices on the system bus other than the CPU.

Z8001 Segmentation with the Z8010 MMU

The Z8001 provides a lim bus for segmented memory management via segmented addressing and its provision for segment trap processing. External hardware limitations on the Z8010 Memory Management Unit (MMU) must be designed into the system to provide the particular features required. Segment numbers emitted by the Z8001 are logically distinct from the values on AD15.0 of the offset). Still they can be used in the simplest implementa- 

A segmented address, however, can be exploited more thoroughly when the supporting hardware (say a Z8010) is programmed to allow full relocation. The segment number then becomes a protection from accidents and theft. These locations in turn provide a previously programmed descriptor for each segment. The descriptor for the target defines the segment's properties (for example, read only), and also defines part or all of its starting location in physical memory.

The Z8001 and Z8010 are designed to work together in this way, and the actual address transformation used by the Z8010 is shown below.

Figure 2 MMU Address Translation

The segment number is simply an address into external 28010 RAM which produces a 16-bit, preprogrammed value. That value is then shifted left eight bits and added to the offset portion of the logical segmented address. The result is the physical address of the target memory cell. This is the content of the operating system which programs the Z8010 appropriately per- 

Figure 1 Memory Partitions: Pages and Segments

The page number is an address into an internal 28010 RAM which produces a 16-bit, preprogrammed value. That value is then shifted left eight bits and added to the logical segmented address. The result is the physical address of the target memory cell. This is the content of the operating system which programs the Z8010 appropriately per- 

Figure 2 MMU Address Translation

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Physical Address Generation in the MMU

The internal RAM access in the memory controller must be done before the offset is valid (during AS), so that the addition can take place. The 28001 emulates segment numbers early, in T3 or T4 of a preceding memory cycle, to give the Z8010 (or a custom memory manager) a chance to begin its work. The addition time then becomes critical in determining the speed of memory access. Addition has been simplified by allowing the lower offset byte (A7:0) to bypass the Z8010 and simply be concatenated logically to the rest of the computed physical address. Because of the imposed timing concerns, the Z8010 must see the same clock as the Z8001. It is, therefore, not a Z-Bus peripheral, but a synchronous, CPU-support device.

Properties defined for each segment must be verified by the Z8010 for each memory access. The 28001 must supply full status information to the Z8010 in a typical configuration:

Virtual Memory Management

Segments for all running user/tasks might not fit into available physical memory. Therefore, for some users only some of their segments may be in memory when they are to run. If the segments that are missing are marked in the memory manager (say a Z8010) as being nonexistent, a trap will occur at the last reference to any of them. In this case, the trap routine would read long-term or intermediate storage (disk, drum, etc.), retrieve the missing segments as they are needed, and restart the trapped access. Space for them must, of course, be found by bumping one or more other segments from memory. This done effectively, gives the appearance, for each user, of a physical address space as large as the logical space, even though a user's actual physical memory may be small.

Managing Memory Dynamically

It is important to understand that memory is managed dynamically as tasks/user run. Each program and data area needed to run a user is a relocatable set of memory segments, each of which has associated properties. Thus, segment numbers used by each program in addressing itself and its data have nothing to do from the user's standpoint with where those segments actually reside in physical memory space. Physical memory can be allocated to hold different users simultaneously, even if their programs contain some segmented addresses with identical segment numbers.

Two Users Sharing a Common Segment

It is, therefore, important in an effective virtual memory management system to keep track of which segments have been used, how often, and in what way. Obviously, a segment that has not been used at all since last being loaded into memory is a logical target for bumping when another segment must be brought in. For such decisions, based on frequency of use, may need to be made in the few unused segments exist. Typically, the most frequently accessed segments should be kept in memory as much as possible. This lends to the notion of a working set or kernel of memory segments. For efficient servicing of a particular user/task, these segments should be identified by the memory manager and not only be kept in last memory as much as possible, but also be kept there as a unit. Without this statistically identified working set in memory, the user cannot run efficiently.

A Large System Memory Configuration

Virtual memory is clearly an extension of the simplest forms of memory management, whether segmentation is used or not. In Z8001–Z8010 systems there is some support for elementary management procedures that can be extended by system software to allow some forms of virtual memory simulation. For instance, the Z8010...
maintains a primitive record of segment usage. Segments that have been written on can be distinguished from those that have only been read, and both can be distinguished from those that have never been accessed. This is generally sufficient to establish true working sets for users, but it allows management software to identify segments that have or have not been used. For example, it can allow such software to decide whether or not to spend time writing a segment back to long/intermediate term storage if it is to be bumped. Segments that are portions of files and have not been written on (thus not changed) need not be rewritten to disk, for instance.

Demand Paging

Finally, it is important to understand that memory segmentation, used alone, requires a continuous physical chunk of memory for each logical segment, whatever its size. When such a system services many user/tasks over time, segments of widely-ranging size are brought in and out of memory. Whatever procedure is used by the management software, holes inevitably develop and these may be large enough to hold the next segment needed by a user. Thus, another segment must be bumped, or the manager must reassign existing segments to coalesce holes into a usable piece of memory. Thus, in general, is a difficult mathematical problem that has no method of guaranteed solution (no algorithm). It was a significant limiting factor in early timesharing systems.

One approach to solving this fundamental problem is called demand paging. Just as segments can be moved into and out of memory as tasks need and release them, page memory can be managed in the same way. Since pages are all of equal size, there are no holes going to waste and virtual memory management software can concentrate on statistical analysis of each task's page demands to establish working sets. Demand paging, of course, requires a larger hardware investment, since relocation, property and usage data must be provided for each physical page.

This leads to a tradeoff, because mathematical analysis and experience both show a clear relationship between page size and optimal performance in virtual memory systems. Smaller page sizes are required by the seek and transfer times of the available storage (disk, drum, etc.), the smaller the page size (in words) the better. However, taking to the range of tens to hundreds of words is typical. When files are also pages, page size determines storage compactness, because on the average, half of the last page of any file is empty. Segmentation can be imposed on a pagged hardware environment, to gain many advantages of both approaches. The Z8001 and Z8000 cannot, however, support more than straightforward segment management based on relocation, sizing, protection and other access parameters.

PERIPHERAL MANAGEMENT

Z-Bus Peripheral Interface

As the first of a family of Z-Bus processors, the Z8000 interacts with Z-Bus peripheral devices in a straightforward manner. Furthermore, because Z8000 timing cycles are modular, the timing of I/O transfers is quite similar to that of memory transfers — with the addition of one default wait state (TWA).

Figure 9

I/O Transfer Cycle Timing

Because only AD15:0 are used to address normal Z-Bus devices, segmentation mode in the Z8001 has no effect on I/O operation. The Z8002 and Z8001 thus deal identically with I/O devices. Because address and data transfers are asynchronous, all peripheral clocks may be independent of the CPU clock. Clock, therefore, is not a Z-Bus signal and would only be needed if not.

28000-family peripherals (250, for instance) were used

Figure 10

Z-Bus Signals

The status outputs from the CPU (ST3.0) can be used for various purposes. The ST3.0 lines can and should be decoded to acknowledge peripheral interrupts; they can also be used to define two 16-bit peripheral address spaces by conditioning chip selects with the special normal I/O distinction (see Figure 11).

**Basic Z-Bus Transactions**

There are four basic types of Z-Bus transactions: memory, peripheral, bus sharing, and multiprocessor. The latter three types are discussed here.

**Peripheral Transactions**

From the standpoint of a normal Z-Bus peripheral, general interactions with a Z8000 require normal asynchronous addressing. This ultimately activates a chip transfer.
Two signals, IEO (Interrupt Enable In) and IEO (Interrupt Enable Out), link the chained peripherals. Each peripheral can tell, via IEO line, if a higher priority device (to its left in the figure) has received an acknowledge signal from the CPU and is being serviced.

A given peripheral must obey the following rules to be a socially acceptable member of a Z-Bus daisy chain:

- Copy IEO from IEO unless it has received acknowledge.
- Pull IEO low and begin service if acknowledge is received for its INT request and IEO is high.
- Pull IEO high on receipt of such decisions to allow for daisy-chain propagation time, and;
- When service is complete, release IEO so lower priority devices that have been waiting can get service.

The Z-Bus protocol, via its interrupt-acknowledge cycle, adequate time for such daisy chains to settle priority conflicts for simultaneous interrupts from chains as long as ten peripherals. For default wait states are in cluded in the acknowledge portion of the cycle, they determine when an interrupt vector may be sent from peripheral to the CPU (see Fig. 13).

In a normal protocol, interrupting peripherals on a chain assert INT until acknowledge is received (after the current CPU interrupt routine terminates). Their relative priority by looking at IEO when INT goes low. The winning peripheral is then considered under service. It issues IEO, releases INT, perhaps sends back a vector when INT goes high, and awaits the running of its service routine.

Apart from the default wait states, Z-Bus peripherals can delay their priority resolution by asserting WAIT at the clock period before INT goes low. The winner can delay its vector response by again asserting WAIT at the needed peripherals connected to the VI input of the Z8000 are not alone in being able to respond with vectors during acknowledge cycle. The content of the 16-bit bus is sampled by the CPU at T3 in the cycle and this value is pushed on the system stack. Any service routine run in response to any interrupt may actually receive useful information in this way. The peripherals on a VI chain are, of course, obligated to respond with an 8-bit value on the low half of the bus. This value is then used to index into the VI subarea of the status area. The high-order byte is, therefore, freely usable even in the VI case, so long as all 16 data lines propagate between peripheral and Z8000.

Byte and Word Peripherals

Memory and I/O transactions are logically quite similar in the Z8000. Thus, byte or word peripherals may behave, as long as bytes that are to be read by the CPU are put on the right half bus, and the left half of the bus by the peripheral. Address line A0 determines that if A0 is high, the Z8000 will execute an input byte (INB) instruction. If A0 is low, reading lower 8-bit data lines is lower, the upper byte will be read. The position (odd or even) of a peripheral in the I/O address space is important, but only during routing (and acknowledge). The Z8000 duplicates written bytes during output byte instructions, just as it does when dealing with memory in 1688.

Interrupt Service Routine

Normally interrupt requests result in context switches within the Z8000 body (status changes). These cause particular interrupt subroutine to run when the acknowledge cycle is complete. At this instant, one peripheral will know it is under service and it will be ready to handle reads and/or writes produced by its service routine.

When the routine has completed its tasks, however, the peripheral must be told it is no longer under service. With Z-Bus devices, this is done simply by writing to a control register within the peripheral. A service routine can terminate a time out of its current activity, do whatever other bookkeeping is required and finally execute an IEE instruction to restore the Z8000's status (FCW and PC) to the values in effect before the interrupt occurred.

Nested Interrupts

Service routines can also be interrupted if the FCW contains interrupt bits that are on. This is, of course, under the routine's control. Such nested interrupts, however, must also prevent more than one peripheral from thinking it has the CPU's attention. The IEO daisy chain also handles this. A peripheral knows it has interrupted and been acknowledged. It checks to see whether its INT is low, and that a higher priority device has gone under service and the original service routine is not running. This nesting is totally dependent on the value of FCW established in the status area for the first interrupt routine and on any EI (enable interrupt) instructions it might have executed.

Within the Z-Bus family, peripheral themselves may be compounded of standard building blocks some of which are not true Z-Bus devices. The Z8038 buffer is a Z-Bus component, but some may be extended with interposed Z8064s, which are not Z-Bus devices.

Figure 14

An Extended FIFO Storage Peripheral

System Bus Sharing

CPUs like the Z8000 possess the ability to remove themselves from the system's address/data bus if necessary. For example, a request by a DMA (direct memory access) or a busy I/O routine can be made via the bus-sharing line to the Z8000 during any of its instructions. At the end of the current memory I/O or other cycle, the request will have driven the Z8000's data bus lines to the bus connections (see Figure 13) and the DMA can use these to access memory at will.

When the bus-sharing device is released, it reclaims BUSRQ and the Z8000 (or other waiting device) resumes bus activity.

Just as daisy chains can be used to resolve priority of simultaneous interrupt requests, so can they be used with bus requests.

Figure 16

Bus Request and Acknowledging Timing

When the bus-sharing device is released, it reclaims BUSRQ and the Z8000 (or other waiting device) resumes bus activity. Just as daisy chains can be used to resolve priority of simultaneous interrupt requests, so can they be used with bus requests.

Figure 17

Bus Request Daisy Chain

The Z-Bus structure allows nonpreemptive (no nesting) sharing of the bus. BUSRQ provides both a request path and a busy-bus indicator to all bus-sharing devices. The protocol is therefore that a device must first look at BUSRQ to see if it is busy. If it is, the device waits. If it is not, the device asserts BUSRQ (same line) and waits for the acknowledge (BUSAK) to propagate through the chain to its BTA input. When this occurs, at or is eventually should, it raises BTA to forestall lower priority devices and resuming on to use the bus. When done, it simply releases BUSRQ and copies its BTA line to its

BTA line. This process is similar to interrupt daisy chaining except that nesting is impossible and the daisy chain signals are negative logic values.

Resource Sharing in Multiprocessor Systems

Multiple Z8000s may also share a resource and the Z8000 has been designed with some instructions and signals to allow this. The micro-in and micro-out lines (A1, A0) in conjunction with instructions that read and alter their values (MBIT, MSET, MRES and MREQ) are used here. They allow the system designer to write algorithms for managing chains of Z8000s which share a common resource in a priority-managed, non-preemptive way. The MREQ instruction, in fact, implements an algorithm that is complete and satisfactory for most purposes.

Given a device to be shared, along with some simple logic and some Z8000s, the Z-Bus definition allows a sharing structure to be created.

Lower priority Z8000s simply see either status or the daisy chain, depending on whether they have made a request (A0 low) or not (A0 high).

The protocol for sharing is a look at resource status (via A1). If busy, terminate request; if not busy make a request (via A0). Float A0 and wait for acknowledge (via A1). If after waiting the correct time no acknowledge appears, terminate indicating failure; if acknowledge occurred, terminate indicating success so that a service routine can use the resource, when done with the resource. Release the request (A0) and proceed with the daisy chain input.

This procedure is designed to let Z8000s communicate with each other's resources. Thus, the right time to wait when looking for acknowledge depends on communication path delays and must be established for each Z8000 independently.

The Z8000s MREQJ instruction, in fact, implements the entire algorithm. It uses the content of a word register to establish the waiting time, and it uses the Z and Z-Bus in FCW to signal success or the type of failure to the system program. Note that this is essentially a system I/O instruction and, like all I/O, it can only be executed in system mode. The waiting time is determined by decrementing the register named in the instruction, at one seventh the CPU clock rate until zero is reached. The MRES instruction is not interruptible and can be used to generate delays up to 90ns for 4MHz clock rates if the resource-sharing function is not used.

The Z-Bus protocol provides a wide variety of structures and device management in Z8000 systems. It is important to remember that it is a logical specification, relating signals, defining their electrical properties and timing relationships, and defining several levels of bus complexity — from simple to extended addresses for instance. It is not a physical structure in the sense of pin and connector specifications. That is up to the designer.

Figure 18

Resource Sharing Daisy Chain

Figure 19

Resource Sharing Logic

RADIO & ELECTRONICS WORLD
Quiz for Lesson 4

QUESTIONS

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

2. Which of these Z8001 signals could be used to define memory segments?
   — A. SYSTEM/NORMAL
   — B. ST3.0
   — C. SN6.0
   — D. All of the above

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

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

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

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

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

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

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

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

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An extremely sensitive continuity tester.

Design by Colin Edwards.

This circuit provides a means of checking the wiring on a PCB or wired board with all the components inserted. At first glance it's fairly straightforward, but with this circuit a very low voltage is applied to the board avoiding damaging any delicate components or obtaining misleading results from turning on semiconductor junctions.

The voltage between the probes is about 90mV and the unit will only sound on a resistance of less than 2 ohms.

Using a normal 555 timer, the current drawn when idle is about 15mA, so if you forget to turn it off, the battery soon goes flat. For a small investment (less than the cost of one PP3) a CMOS 555 can be used and the standby drain is reduced to less than 2mA. When the probes make contact the drain is 100mA — so don’t leave it sounding for long.

Circuit Description

Resistors R1 and R2 provide a voltage reference of 90mV, IC1 and Q1 form a voltage follower and hence produce 90mV across R6 and the probes. When the probes are shorted together the current required to maintain 90mV on R6 increases and so does the voltage at the top of R5.

While the voltage on the emitter of Q1 is low, R5 holds the timer (IC2) reset low. As soon as the voltage on R5 reaches approximately 2V, the reset is removed and the timer oscillates producing an audio tone.

Diagram and parts list:

Figure 1: The PCB foil pattern (left) and component overlay (right) for the tester.

Figure 2: The full circuit diagram.

PARTS LIST

Resistors
R1 220k
R2,3,7,9 2k2
R4 100R
R5 47R
R6,9 10k
R8 47k

Capacitors
C1 100p ceramic
C2,3,4 10n ceramic
C5 100u 16V al. electrolytic

Semiconductors
D1 1N916
Q1 BC182
IC1 3130
IC2 7555

Miscellaneous
Two test probes, PP3 battery, piezoelectric transducer.
A complete guide to getting started as a Radio Amateur.
Compiled by Stephen Ibbs.

Since the introduction of CB there has been a considerable upsurge of interest in amateur radio. The World Administrative Radio Conference was held at Geneva in 1979 so that nations might discuss the various frequencies desired for TV, broadcast radio, defence, satellite telecommunications etc. Amateur Radio was defined as "a radiocommunications service for the purpose of self-training, intercommunication and technical investigations carried out by amateurs, that is, by duly authorised persons interested in radio technique solely with a personal aim and without pecuniary interest." This rather weighty sentence deserves closer examination. Leaving aside "radiocommunication", and what it actually is, there are three motives for amateur radio.

1. Self Training
This has unfortunately sunk to quite a low order of priority in many amateurs' minds, partly due to the influence of CB. Whilst it is wrong to hanker nostalgically for the old days of crystal radios and cat's whiskers, there are advantages in home construction, for instance, because the amateur is learning more about the electronics side of the hobby. Tremendous satisfaction can be gained from building a very simple piece of test equipment. The converse is also true however - radio operators not interested in home construction should not be condemned as second class. Amateurs interested primarily in operating, object to the implication that because they didn't build the rig they are not real amateurs. Self training also relates to operating procedure, and anybody listening to some popular bands or any band during a contest will realise the need for more self training. A contest is generally where amateurs try to get as many contacts as possible within certain restrictions. The effect of these can be devastating with overcrowding, treading on each others transmissions, bad manners etc. There is a body of opinion that believes that there are far too many contests, many arranged unilaterally, blocking off the bands for normal amateur use.

2. Intercommunication.
This is surely the central core of amateur radio and its appeal – the ability to talk to somebody anywhere in the world. My very first listening session with a battered old receiver brought in a very faint Italian station (unusual in itself as many amateurs will tell you – they are always tremendously powerful), telling somebody in America about a recent Italian earthquake. There is a world-wide network, whereby amateurs can confirm their contacts with each other by sending confirmation cards, known as QSL cards, and many people set great store by their collections.

The contact, however, does not have to be by voice. It can be by RTTY (teletype), morse code, or by television – yes, amateurs are allowed to transmit their own television pictures, and it is not as difficult as the BBC/ITV would perhaps suggest. Signals can be bounced off the ionosphere, off meteors, satellites, and even the moon, each demanding a different technique, skill and enthusiasm.

3. Technical Investigations
This obviously links up with self training and a great deal of experimental work still goes on – it has not yet all been discovered. Boundaries of communications are being broken all the time with the developing satellite systems and the new semiconductor devices for microwave work becoming cheaper and more available. Some of the most challenging work comes from operating very low power and trying to establish long distance (DX) contacts. A club exists which promotes low power work called the QRP club (these letters will be explained later), which promotes the use of very low power transmitters, often very simple to make.

What Is Radio?
It all started in 1864 when J C Maxwell put forward the theory that invisible waves, as yet undiscovered, could travel through the air like sound and light, all being part of the electromagnetic spectrum. Nobody believed him. Then in 1888 H Hertz proved him right – if a wave of high enough frequency could be produced, it could be launched from a wire into the atmosphere. He developed a spark gap transmitter – a device that generated high voltage pulses between two spheres (Fig. 1). When another two spheres were placed some distance away – with no direct connection – sparks could be seen jumping.
between the two receiving spheres. Wireless communication
was born, because if the spark generation at the transmitter
could be controlled, or modulated, the spark production at the
receiver would follow the changes, and if done according to a
system, messages in a coded form could be transmitted. Morse
code is the simplest way of modulating the transmitter by
switching it on and off in a set pattern.

Most people know that light waves vary in length, with red
being longer than blue. Similarly, radio waves vary in length
with different characteristics as the wave gets shorter. The size
of the piece of wire needed to get the radio wave into the
atmosphere (aerial), is directly associated with the wave's
length — hence the plethora of different sized aerials for the
various amateur bands. The early radio experts believed that all
wavelengths below 200m (above 1.5MHz) were useless and so
amateurs were pushed into this area. Far from being deterred,
amateurs were soon contacting each other across the oceans,
and the authorities realized that the usable radio spectrum
was far wider than they had expected. The result was that they
started taking huge chunks back off the amateur. With the
rapidly increasing demand for radio, amateurs the world over
are always under pressure from governments who want the
amateur bands for their own use. However, we have retained
several bands from HF, through VHF, UHF, microwave etc, up
to 24 gigahertz (24,000 million cycles per second — though most
activity is below 500MHz).

A Licence To Transmit And Receive
There are two types of licences, A and B, and if the test of
proficiency in morse code is not taken amateurs can apply for
a B type licence, assuming the other qualifications are met, (see
later), which allows use of any amateur band above 100MHz —
the two most popular being 144 — 146 known as '2 metres'
because of the approximate wavelength of the frequency,
rapidly becoming overcrowded, and 430 — 440 known as
'70cms'.

Many amateurs like to operate whilst mobile in a car and
range can be limited because of aerial problems. To alleviate
this, several 'repeaters' have been designed and built by
amateurs for anybody to use but with priority to mobile or
portable operators. These are completely automatic, sited
usually on top of a hill. They pick up an amateur's transmission
on the repeater frequency and retransmit it, usually with an
increase in power. Good location of the repeater means that the
signal can get further before being absorbed or reflected by hills
and buildings. A comprehensive repeater system exists in most
countries for both 2 metres and 70cms and most amateurs can
tell you where the 'local box' is sited. Voluntary contributions
are encouraged to help finance the repeater, but they are free
and open for any amateur to use. Only one person can transmit
at a time, because the box can't distinguish between two input
signals on the same frequency.

Amateurs are all issued with a 'call sign' and each country
has a different prefix — England being G-----, Scotland being
GM------, Australia is VK----- and New Zealand ZL-----. Some (eg,
Pacific Islands), may have only one amateur on them, so when
he transmits the radio waves go crazy as thousands of amateurs
try to contact him and get the precious, rare QSL card. Once
the morse test has been passed, an 'A' licence can be applied for
which allows use of all UK amateur bands — effectively
meaning being let loose on the world. You will no doubt hear
a lot of complaints about the morse test being archaic, why the
test when CBers are on an HF 27MHz band. However, many
are in favour of the morse test, because morse (known as CW)
is by far the most effective form of communication and can be
deciphered amidst large amounts of background noise. It is
quite true that it is very easy to distinguish amateurs by their
morse sending style and once mastered it is a surprisingly
relaxed form of communication.

<table>
<thead>
<tr>
<th>The RST code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Readability</td>
</tr>
<tr>
<td>R1 Unreadable</td>
</tr>
<tr>
<td>R2 Barely readable, occasional words distinguishable.</td>
</tr>
<tr>
<td>R3 Readable with considerable difficulty.</td>
</tr>
<tr>
<td>R4 Readable with practically no difficulty.</td>
</tr>
<tr>
<td>R5 Perfectly Readable.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Signal Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1 Faint, signals barely perceptible.</td>
</tr>
<tr>
<td>S2 Very weak signals.</td>
</tr>
<tr>
<td>S3 Weak signals.</td>
</tr>
<tr>
<td>S4 Fair signals.</td>
</tr>
<tr>
<td>S5 Fairly good signals.</td>
</tr>
<tr>
<td>S6 Good signals.</td>
</tr>
<tr>
<td>S7 Moderately strong signals.</td>
</tr>
<tr>
<td>S8 Strong signals.</td>
</tr>
<tr>
<td>S9 Extremely strong signals.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tone</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1 Extremely rough hissing note.</td>
</tr>
<tr>
<td>T2 Very rough ac note, no trace of musicality.</td>
</tr>
<tr>
<td>T3 Rough, low-pitched ac note, slightly musical.</td>
</tr>
<tr>
<td>T4 Rather rough ac note, moderately musical.</td>
</tr>
<tr>
<td>T5 Musically modulated note.</td>
</tr>
<tr>
<td>T6 Modulated note, slight trace of whistle.</td>
</tr>
<tr>
<td>T7 Near dc note, smooth ripple.</td>
</tr>
<tr>
<td>T8 Good dc note, just a trace of ripple.</td>
</tr>
<tr>
<td>T9 Purest dc note.</td>
</tr>
</tbody>
</table>

Table 1: Details of the RST code.

The RSGB
The body which exists to formulate policies and present them
to the government is the Radio Society of Great Britain, which
attempts to advise amateurs, represent their views and
hopefully protect their interests. Amateur journals will reveal
a great deal of unrest about the attitudes, real or imaginary,
being displayed by the RSGB. Vitriolic statements have been
voiced and written down, but possibly the truth lies in a failure
of communication, and an inertia invariably present in large
organisations. The RSGB seems to be primarily interested in
protecting and enhancing the HF bands, with VHF, UHF and
microwaves being thought of as a bit freakish. Whether this is
a genuine attitude is irrelevant, because enough people believe
it to make it an issue to be dealt with since most of the unrest
comes from amateurs operating above 100MHz.

Who's Who Of Radio Amateurs
Enough politics — how do radio amateurs recognise one
another? There does not exist a freemason-like hand shake for
hams and so radio societies and clubs throughout the country
organise radio rallies — huge gatherings at country parks,
exhibition halls etc where the latest black boxes can be
purchased (commercial rigs, invariably from Japan, invariably
black, a phrase often used to run them down in favour of a
home-brew rig in a bent aluminium tin with a magically
superior performance), cheap components are available and
swaps can be arranged. In my own area of the West Midlands
the local rallies occur at the National Exhibition Centre
Birmingham, Drayton Manor Park, Elstavon Castle, Littleover
School (Derby), Telford Shopping Centre. Most magazines,
including R&EW, publish dates and venues and they are great for putting dates to call-signs and getting bargains – recommended for everybody who has an interest in amateur radio.

**Banding Together**

The bands that an amateur can operate, range from 1.81MHz (known as Top Band) to 24 GHz where operation is experimental to say the least, and construction technique is probably aided by a microscope and micrometer. The HF bands (up to 30MHz) exhibit different characteristics, many of which are dependent on the sun. Rays ionise the atmosphere, and this causes certain radio frequencies to be bent and reflected back to earth, acting as a mirror so that signals can bounce off it, sometimes several times, to get all round the earth. Of all the HF bands, probably 14 — 14.350MHz, known as 20 metres, is the most consistent and popular for DX work. 21 — 21.450MHz is also a popular band, not for having thousands of Americans on, but because the bottom segment has ‘novice Americans’ able to transmit and receive slow morse, and listening to them is a good way of learning CW. 28 — 29.7MHz has very similar characteristics to the CB band so close to it, but the difference is that amateurs can operate up to 400 watts PEP and have exotic aerial arrays.

VHF bands incorporate 70.025 — 70.5MHz, very scarcely populated, which is a pity because it has characteristics that probably make it a better band for mobile work than 2 metres. Rumours are always around that we are going to lose the band — which is admittedly why I have never bothered to equip myself for it. Also in the low VHF region, some amateurs have been granted a special licence for investigative work at 50MHz (occupied by the old VHF TV network), and many are optimistic about getting a slice of frequencies around 50MHz eventually. This could be very interesting because American amateurs, for instance, already have the band, meaning that commercial equipment is available and DX contacts possible.

R&EW has already published a design to enable operation on this band, should we ever get it.

Without doubt, the 2 metre band is one of the most popular amateur bands — being available to new licencees — with an abundance of equipment, home brew designs, etc, being available. It is a rare amateur that does not have a 2 metre rig, and one result of this, and the extensive repeater network, is that the band is rapidly getting overcrowded, generating a greater interest in 70cms. Unfortunately, it is also one of the worst bands for offenders without an amateur licence, which prohibits (amongst other things) bad language and transmitting without the call sign being given.

Partly as a desire to get away from this, many migrate up to the 70cms band, which has an increasing amount of equipment becoming available. It is very similar to 2 metres, but because the frequency is much more affected by buildings, hills etc, distance contacts are more difficult.

The once totally ignored microwave bands, the lowest being 1.3GHz are attracting more interest and some repeaters have appeared. Techniques are more difficult, and good quality cable and connectors are a must (the popular PL259/S0239 used in CB rigs are not recommended). The additional millimetres of PCB track can make all the difference between working and a dud, so it is not recommended for beginners. However, there does still exist the experimental thrill of hearing somebody else — anybody else.

**Amateur Accoutrements**

With all these bands available, how do you use them? What equipment is available and how is it driven? To listen to a signal, you need a receiver and to communicate with others...
you need a transmitter. Combine the two together and you have a transceiver. A brief glance at any radio magazine will show that each manufacturer has the definitive rig — the one by which all others are judged. Most are now bristling with microprocessors (computer controlled), lights and bleeps, to the extent that we are surely only one step away from rigs doing the actual contact for us.

The main requirement for a receiver is: sensitive — able to hear faint contacts; selective — able to isolate them so that they are separate from other transmissions; and stable — when found the contact isn’t lost due to the receiver frequency drifting away. Many books have been written about receiver design and anybody preparing for the RAE will soon come in contact with TRF, heterodyne, front end, cross-modulation; terms that may sound alarming but in fact very soon make sense (see R&EW July ’83).

A transmitter needs to produce the desired frequency at the desired power, with some sort of modulation applied, whether by voice, morse-key etc. It too must be very stable otherwise the receiving station will need constant adjustment to stay with the transmission. If the power is not sufficient, it is possible to add power amplifiers to boost the output up to (and beyond) the legal limit. These are called ‘linear’ because they amplify with no distortion — very important if the transmission is SSB (single sideband), but not as efficient as a ‘class C’ amplifier which produces more distortion but is suitable for FM transmissions.

Some Technicalities

Earlier on, we mentioned the word ‘modulation’ — the means by which a radio wave is affected to carry information or speech from the transmitter to the receiver. To try and explain the different types in a couple of sentences is impossible, but at the risk of over-simplification the following may help. A radio wave can be drawn as in Fig. 3. If this is combined with another signal (eg, a sine wave), the effect will be: the carrier now being affected in its strength/loudness/amplitude. The wave has been amplitude modulated (AM). Instead of a sine wave, it can also be controlled by speech, music etc, and the result is what you hear on the long and medium wave broadcast bands. The disadvantage is that it uses up a lot of radio space, called bandwidth. If Fig. 3 is looked at again, it will be seen that one half (sideband) of the diagram is a mirror of the other (carrying identical information), so if only half was transmitted the receiver would still collect all the necessary information, but with only half the bandwidth being used. A study of the various processes involved has shown that half the transmitter power is used in transmitting the original carrier wave, which in itself carries no information. If this can be cut out, more power can be concentrated on sending out the information. However, this is not as simple as it may sound, because the receiver has to put back this carrier wave, albeit at very low power, to understand the transmission, otherwise it’s like coding a message and then throwing away the code. This form of transmission is known as SSB (single sideband), and receivers equipped for it will have a CIO (carrier insertion oscillator) or BFO (beat frequency oscillator) control to reinsert the carrier (if this is not adjusted properly the reception sounds like ‘Donald Duck’).

Instead of affecting the amplitude, the carrier wave can be modulated by moving its frequency slightly from side to side. Information can be sent depending on how far it moves and how quickly. This has proved to be an extremely effective form of communication, known as FM (frequency modulation), and very high quality transmissions can result. For amateur radio communication, such quality is not needed and effective speech transmission only needs about 5kHz bandwidth (±2.5kHz either side of the centre frequency). Known as narrow band FM, it enables many channels of communication to be crammed within a small frequency band. FM, for various reasons, tends to be easier to resolve (tune in), and tends to cause a lot less interference to other radio users.

Investigating Interference

A radio transmitter can be a very complicated piece of equipment, particularly if a synthesiser is used. This generates the various radio frequencies needed to operate over a full amateur band, eliminating the need for separate frequency generators (oscillators). Unless great care is taken, spurious radio frequencies can emerge and mix with each other to cause interference. Even a rusty bolt on an aerial mast has been known to cause interference. However, it should be said that

**Table 3: The use of ‘Q’ codes as nouns.**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>QRA</td>
<td>Address</td>
</tr>
<tr>
<td>QRG</td>
<td>Frequency</td>
</tr>
<tr>
<td>QRI</td>
<td>Bad note</td>
</tr>
<tr>
<td>QRK</td>
<td>Signal Strength</td>
</tr>
<tr>
<td>QRM</td>
<td>Interference from other stations</td>
</tr>
<tr>
<td>QRN</td>
<td>Interference from atmospherics or</td>
</tr>
<tr>
<td></td>
<td>local electrical apparatus</td>
</tr>
<tr>
<td>QRO</td>
<td>High power</td>
</tr>
<tr>
<td>QRP</td>
<td>Low power</td>
</tr>
<tr>
<td>QRT</td>
<td>Close down</td>
</tr>
<tr>
<td>QRX</td>
<td>Stand by</td>
</tr>
<tr>
<td>QSB</td>
<td>Fading</td>
</tr>
<tr>
<td>QSD</td>
<td>Bad sending</td>
</tr>
<tr>
<td>QSL</td>
<td>Verification card</td>
</tr>
<tr>
<td>QSO</td>
<td>Radio contact</td>
</tr>
<tr>
<td>QSP</td>
<td>Relay message</td>
</tr>
<tr>
<td>QSY</td>
<td>Change of frequency</td>
</tr>
<tr>
<td>QTH</td>
<td>Location</td>
</tr>
</tbody>
</table>

**Figure 3:** Amplitude modulation — a HF signal is modulated by an audio signal, varying its amplitude.
very often the fault lies within the receiver. Part of the revenue for the amateur and CB licences goes to provide an interference investigation department, and no doubt many amateurs will have experienced the somewhat unnerving arrival outside the front door of a yellow van with aerials all over it. Loaded with sophisticated equipment, these test the transmissions and trace the cause of the interference, hopefully with little blame resting on the amateur. The licence does require that transmissions 'cause no undue interference to other radio users' and note that word 'undue'.

To eliminate all interference is virtually impossible and sometimes tact and diplomacy are called for to say whether the tiny, imperceptible mark on the TV screen is acceptable or unacceptable. Various sorts of interference aids, suppressors braid breakers, filters, ferrite rings etc, are available and are usually effective in solving the problem. Attention to detail when setting up the station also helps to reduce potential causes of interference. Good quality connectors and leads should link the various items of equipment together. Most modern transceivers have good filtering on the output to get rid of all but the desired frequency. Otherwise a filter, low pass for the HF bands, band pass for the VHF/UHF bands, should be inserted in the path to the aerial, which needs to be well tuned and matched.

**Special Duties**

Under the terms of the licence, amateurs are required to assist in times of emergency. An organisation called the Radio Amateur Emergency Network (formerly known as RAEN, now RAYNET) was established for this purpose. It is curious that if CB operators help the police in an operation, it receives wide media coverage, yet the highly efficient RAYNET groups receive few accolades. When there was an ambulance strike some time ago, radio amateurs provided the important communication services to control the St John's ambulances. They have also been vital factors in finding missing persons, or helping during floods etc.

RAYNET went through a period of uncertainty last year, whilst licences were being reviewed, but I was assured at the NEC rally that all is now fine and they are back with renewed vigour.

Another amateur organisation, The Radio Amateur Invalid and Blind Club (RAIBC) is worthy of mention here. Radio is a marvellous hobby for the disabled or handicapped, and this society exists to help them overcome their difficulties; from passing the exam to operating. Able amateurs help by installing equipment and aerials, whilst others design special aids (eg, a talking frequency meter, or an automatic power/ SWR meter). Their publicity handout states: 'There are now ways of overcoming almost every obstacle, even deafness, by adapting standard equipment, positioning microphones etc to suit the needs of each individual'.

One final organisation worth mentioning is BYLARA — The British Young Ladies Amateur Radio Association. The term 'young' is employed in its widest possible sense, and stems from the common amateur abbreviation 'YL', meaning a female. There is a rapidly increasing number of female operators, and far from the traditional image of being an all-male preserve, they have proved to be effective and competent operators.

**ADRESSES**

Home Office,
Radio regulatory dept,
Waterloo Bridge House,
Waterloo Road,
LONDON SE1 8UA

RAIBC,
Mrs. Frances Woolley G3I.WY
9 Kinnouh Court,
Adelaide Road,
SURREY K76 4TE

BYLARA,
Anglica Voss (Editor, mag),
PO Box 49,
COLCHESTER,
Essex CO4 3SF

RSGB,
Alma House,
Cranborne Road,
POTTERS BAR,
Herts EN6 3JW

**LIST OF RECOMMENDED BOOKS**

'How to become a Radio Amateur' (Home Office, Waterloo Bridge address)

'A Guide to Amateur Radio' (RSGB)

'Radio Communications Handbook', 'Vols 1 & 2 (RSGB)

'Radio Amateur Handbook' (ARRL)

'Passport to Amateur Radio' (IPC), Westover House, West Quay Road, Poole, Dorset.

'Radio Amateurs' Examination Manual' (RSGB)
The Precision Direction Finder (PDF) recently announced by AKD of Hendon, provides a compact unit for pinpointing the location of radio frequency emissions centred around the 27MHz Citizens' Band. As distinct from standard direction finding receivers, the PDF is designed for definitive location of close proximity radio transmissions.

As the unit is essentially of broad-band design, it is not necessary to know the exact frequency within the band.

The PDF-11M is supplied with a very compact antenna, unusually designed in the shape of a triangle. It gives the PDF a range of up to a few hundred metres, dependent on the ERP of the offending transmitter. For longer distances, the standard antenna can be replaced by a beam antenna which will increase the range considerably. However, it will only give an approximate bearing and once homed in, the special aerial should again be used to pinpoint the source.

The PDF has both audio and visual cues to locating the signal. Either meter strength indications can be selected, or both meter and audio together via a slide switch on the case side. This switch also functions as an on/off for the unit. Audio and meter levels are controlled by two variable controls on the front, one for audio output from the built-in 1W audio amp, and the other to keep the meter reading from going "off the end" when closing in on the source. Two LEDs indicate which functions are selected, and the meter can be illuminated by a small pushbutton located on the side. Audio output is via a 3.5mm jack socket to either the earphone supplied, or any external speaker required. The antenna is connected via a BNC socket thereby allowing other antennas to be connected without difficulty. Power is supplied by a PP3 or similar (not supplied) and battery life depends on the number of times the audio monitor is in use.

**Use And Abuse**

The PDF has many other uses other than straight 27MHz CB direction finding. Any radio bugs using frequencies near to 27MHz can be traced easily, also the unit will track down fluorescent lights, dirty heating thermostats and will locate accurately, case radiation hot spots from transmitters.

Since the PDF is a broad band unit, the audio monitor has to take the form of an AM detector. Naturally, it will resolve AM, but it will also cope with FM transmissions – the audio resolved from FM transmissions will be of a lower level than AM. SSB cannot be resolved, but is still detectable. As SSB is a constantly varying signal, it is very difficult to DF anyway. The audio monitor's function is to enable the user to determine that the correct signal is being tracked when more than one transmission is being received.
Review

The PDF is robustly constructed in a brown hand held case. The antenna acts as a pointer, when fixed to the case, and full operating instructions are provided on the back of the unit.

Supplied with the PDF is a very well written handbook which covers basic operation, along with comprehensive instructions for basic direction-finding, how to recognize and handle reflections and adjacent transmissions along with general notes on the care of the PDF. The PDF carries a two-year guarantee against faulty workmanship or defective components.

The PDF can be supplied to special order for most frequencies within the HF spectrum and AKD hope to offer models for VHF use in the near future. The existing PDF, however, does cover the 10m Amateur Band with no loss of performance and it makes a useful field strength indicator for tuning antennas or for comparisons between different antennas.

Units are currently being supplied for use by British Telecom and are available from AKD's sole distributors — Telecomms of Portsmouth.

- R&EW

Eurocard

Switched Mode

30, 50, 55, & 60Watt versions

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Telephone 01594 5588 Telex 897255

AUGUST 1983
Having now used the prototype of the electronic test card on the air, it has become apparent that a range of extra displays would be useful. This can be achieved by changing the original EPROM for another, programmed to generate a different display. A more practical alternative is to use a larger EPROM, together with a small switching circuit, which allows for any one of three displays to be selected from the front panel.

Both of the new patterns shown use the large print format, as did the original callsign. One of the displays is for use in establishing contact, by giving basic information to adjust aerial beam headings and complete log entries. The other consists of a 'message' which must be sent by video only for contest use.

Each of the display formats can hold a page of text in large or small characters, or a test card.

In order to store all three displays in one EPROM, an 8Kx8 (2764) device is required. This replaces the 4Kx8 EPROM (2732) and socket on the original PCB. As well as having an extra address input, the 2764 has four extra legs, so an adaptor board is required to mount the EPROM and provide addressing logic. In the original 2732, only half of the device was used for the display format (2Kx8), so with a small amount of switching logic, three displays, the sequencing logic and character generator can be fitted into a 2764. Of the 24 pins on the socket, 23 can be connected directly to the adaptor board, with only one link.

Construction
First wire the PCB link, after which the board can be assembled as detailed. Connect a stiff piece of tinned copper wire, on the solder side from point X. Next cut legs 1, 2, 23, 27 and 28 from IC2 flush with the board on the solder side, so they connect only with the track on the adaptor.

Circuit Description
The function of this circuit is to convert the address used by the 2732, to address a 2764, without wasting any space by duplicating data.

When the most significant address (A11) to the 2732 goes 'high' the character generator is being accessed. As this is identical for all display formats, the top two addresses on the 2764 are both forced "high" regardless of the switch position, so that all formats share the same character generator and sequencing data.

The display pattern is stored in the bottom half of the 2732 and is accessed when A11 is "low". In the case of the 2764 there are now 3 display blocks available, in the 64K bytes, which are selected using a switch and address decoder IC.

The decoder allows the top two address bits of the 2764 to be selected by the switch when A11 (point X) is "low", and forced "high" when A11 is "high".

Trying to find an IC that performed the required switching function proved difficult and the one chosen (74LS139) is connected in an unusual configuration. This is an example of using the truth table of an IC, rather than the normal function described at the top of the page in the data book.

Figure 1: Circuit diagram.

A compact, plug-in board to expand the display capabilities of last month's Test Card Generator. Design by Colin Edwards.
PARTS LIST

Resistors
R1,2  2kΩ

Capacitors
C1  2uF 16V tantalum bead

Semiconductors
1C1  74LS139
IC2  2764

Miscellaneous
PCB, 28 pin wire-wrap socket, wire, switch

Then remove the socket from the Test Card PCB and solder the adaptor board to the same location with pin 3 of the 2764 replacing pin 1 of the 2732. The wire link from the adaptor is pulled taut and soldered into pin 21.

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REW&822
The recent article describing Polar Orbiting Weather Satellites and showing some of the pictures received from them (R&EW March 1983) generated a lot of correspondence. The most frequently asked question was, ‘How do I find the Satellite?’. It is hoped to answer this question.

The Polar orbiters transmit in the 136-138MHz band. The American NOAA series use 137.5MHz, and 137.62MHz, as their prime frequencies. Obviously continual monitoring of these frequencies will eventually bring success, but such a method is time consuming to say the least. The Polar Orbiters, as their name suggests, have orbits which take them almost over the North and South Poles. The NOAA series are placed in orbits which are described as ‘sun synchronous’. This type of orbit takes the satellite over an observer at the same ‘local time’ each day for any location. Currently NOAA 6 is the morning satellite and NOAA 7 the afternoon one. Once the ‘local’ orbit has been found, it should be possible to hear the former and the following orbits on subsequent days.

To predict when satellites can be heard from a given location, it is necessary to have certain reference parameters. The minimum requirements are: the orbital period and the time the satellite crosses the equator together with the point at which the satellite crosses the equator. This crossing point is conventionally given in degrees West of Greenwich. Such data, as it applies to the NOAA satellites, is obtainable on a regular basis from the National Oceanographic and Atmospheric Administration in the United States. The information is given as a reference orbit for each satellite for the first day of the month. As an example, here is the data as received for February 1983.

<table>
<thead>
<tr>
<th>NOAA 6</th>
<th>NOAA 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orbit No.</td>
<td>18968</td>
</tr>
<tr>
<td>Date/time 01 Feb.</td>
<td>0053.81Z</td>
</tr>
<tr>
<td>Long. Asc. Node</td>
<td>80.28W</td>
</tr>
<tr>
<td>Nodal Period</td>
<td>101.1474</td>
</tr>
<tr>
<td>Inc bet. Orb.</td>
<td>25.28</td>
</tr>
<tr>
<td>Frequency</td>
<td>137.50</td>
</tr>
</tbody>
</table>

Given this data and making certain assumptions about the behaviour of satellites in near circular orbits, it is possible to predict the equatorial crossing times of the satellite for any day in the following month. Predictions for longer periods are unreliable because of error introduced by the gradual changes that occur in the orbital parameters. To calculate the reference orbit for any day in the month is fairly straightforward using a pocket calculator. There now follows a worked example for 15th February 1983. As an aid to understanding it is suggested that the reader follows the instruction on a calculator.

<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Input to calculator the number of days since the reference orbit</td>
</tr>
<tr>
<td>14</td>
</tr>
<tr>
<td>Multiply by 1400 (no. of mins in day)</td>
</tr>
<tr>
<td>21060</td>
</tr>
<tr>
<td>Divide by 101.9784 (period of Sat.)</td>
</tr>
<tr>
<td>197.6889</td>
</tr>
<tr>
<td>Thus since the reference time on 1st of February to the same time on 15th February there have been 197.6889 orbits. We now have to calculate the time taken to travel .6889 of an orbit. So back to the calculator.</td>
</tr>
<tr>
<td>Subtract 197</td>
</tr>
<tr>
<td>.6889</td>
</tr>
<tr>
<td>Multiply by 101.9784 (period)</td>
</tr>
<tr>
<td>70.25291</td>
</tr>
<tr>
<td>Thus on 15th February the satellite crossed the equator some seventy minutes before the reference time (00.30.65). On a piece of paper subtract 70.25 mins from 00 hrs 30.65 mins. This will give a new reference orbit time.</td>
</tr>
<tr>
<td>hrs</td>
</tr>
<tr>
<td>00</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>23</td>
</tr>
<tr>
<td>on the 14th of February 1983</td>
</tr>
<tr>
<td>To find the crossing point divide 70.25291 by 4</td>
</tr>
<tr>
<td>17.56322</td>
</tr>
<tr>
<td>Thus the satellite crossed the equator 17.56 degrees East of the reference crossing point</td>
</tr>
<tr>
<td>143.28 + 17.56 + 125.7 degrees West.</td>
</tr>
<tr>
<td>So a reference orbit for 15th February is 23 hours 20 minutes 24 seconds on the 14th February crossing the equator at 125.7 degrees West.</td>
</tr>
</tbody>
</table>

Subsequent orbits for the day are obtained by adding 1 hour.
5 REM Satellite Prediction Program by Terry Weatherley
10 CLS
300 REM WHERE IS THAT SATELLITE?
400 PRINTTAB(8)BK
500 PRINT
600 PRINT "This simple program will calculate the time of each equatorial crossing of the satellite for the day requested."
700 PRINT
800 PRINT "The program uses a simple iterative loop and the further the wanted day is from the Reference Orbit the longer it takes."
900 PRINT "It is suggested that Orbital data more than a month old should not be used because of changes in orbital parameters."
100 F=TIME+560
110 REPEAT
120 UNTIL TIME<560
130 CLS
140 PRINT
150 INPUT "THE NAME OF THE SATELLITE, NS"
160 PRINT "CHR$(17)"
170 INPUT "THE ORBITAL PERIOD IN MINUTES";Period
180 PRINT "CHR$(17)"
190 INPUT "THE REFERENCE ORBIT NUMBER";R
200 PRINT "CHR$(17)"
210 INPUT "REFERENCE ORBIT DATE(DD.MM.YY)";RR,Month,RYear
220 IFRR>31 OR Month/12 OR RYear>100 THEN PRINT "Please re-enter data";GOTO 210
230 INPUT "REFERENCE ORBIT TIME(HH:MM:SS)";Rhr,Rm,Rs
240 IF Rh>23 OR Rh<0 OR Rm<0 OR Rs>59 THEN PRINT "Please re-enter figures and press RETURN each time";GOTO 230
250 INPUT "REFERENCE CROSSING POINT "DC
260 CLS
270 PRINTTAB(15);"DATA ON FILE"
280 PRINT
290 PRINT "Name of satellite: ";NS
300 PRINT "Orbital Period: ";Period;" mins."
310 PRINT
320 PRINT "Date of reference orbit: ";RR;"/";Month;"/";RYear
330 PRINT
340 PRINT "Time of reference orbit: ";Rhr;"=";Rm;"=";Rs
350 PRINT "CHR$(17)"
360 INPUT "ENTER day month year for display, ., , , month, year";BSCLS
370 PRINT "CHR$(17)"
380 PRINT "Orbital Data for ";RR;"/";Month;"/";RYear
390 PRINT "CHR$(17)"
400 PRINT
410 PRINT Tab(8);"ORBIT";Tab(20);"TIME";Tab(70);"DEGREES W"
420 FOR 1=1 TO Month:READ davno:NEXT:READ davno,RAD:READ RESTORE 510
430 FOR 1=1 TO month:READ davno:NEXT:READ davno,RF:READ RESTORE 510
440 FOR 1=1 TO month:READ davno:NEXT:READ davno,RF:READ RESTORE 510
450 IF W THEN T=145+F
460 IF Time<TimePeriod;N:imax
470 IF Time>1446 THEN Time=Time-1446;imax
480 DC+=Period/1440%;
490 IF DC>560 THEN DC=DC-560
500 IF W THEN T=570
510 IF W THEN T=570
520 GOTO 46
530 HINT=Time/60
540 HINT=INT(Time/60)
550 Time=-(HINT*60)+INT(Time/60)
560 E=DC+0.5*INT(10/10)
570 PRINT HINT;"=";E;
580 GOTO 46
590 INPUT "DO YOU WANT TOMORROW'S DATA(Y/N),";IF S="Y" THEN T=T+11600;D
600 IF S="N" THEN STOP
610 DATA 31.35, 90, 90, 120, 151, 181, 212, 243, 273, 304, 335.

Table 1: Source code for the satellite locator.

Figure 1: Satellite finder (drawn to scale). The lower curved rule is fixed over the centre of the map and rotates to give satellite positions.

42 mins to the time and 25.5 degrees to the equatorial crossing.

It will be readily seen that orbital predictions can be prepared by personal computer. A simple utility program for the BBC Micro is given (Table 1). This is very much a users program and is not 'idiot proofed'. It can be added to, adjusted etc to suit the individual's needs. The program is self explanatory and invites the user to input the reference data. This is then displayed as data on file and the user is asked to input the date for which data is required. This is then displayed as:-

<table>
<thead>
<tr>
<th>Orbit Number</th>
<th>Time</th>
<th>Crossing point</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The other piece of equipment required is the satellite finder depicted in Fig. 1. This consists of a Polar Projection map of the northern hemisphere together with a cursor showing the path of a satellite. If the figure is mounted on thin card, cut out and pinned together with a paper fastener it will enable the user to find the satellite at any instant in its orbit.

The cursor is rotated until the arrow points to the equatorial crossing point. The cursor now traces out the satellite's track over the earth's surface. While the satellite is within the area bounded by the thick circle it can be heard in central UK. The time the satellite comes into and goes out of range can be calculated using the 5 minute markers on the cursor.

If a directional antenna is used for reception the satellite finder will show the direction to point the antenna.

Armed with pocket calculator and the satellite finder it should now be fairly easy to find the satellite.
AERIALS

FOR TV & RADIO

Garry Smith and Keith Hamer present a definitive survey of the latest in aerial developments.

The advent of satellite and cable television has sparked off a growing interest in being able to receive additional radio and television programmes. A visit to any major European city will reveal spectacular aerial systems in use, towering above every building, with arrays of many shapes and sizes aimed in all directions. Perhaps the Europeans have a lust for programme material foreign to them, or maybe they are taking advantage of what the airwaves have to offer.

Along the East and South coast of England, many European TV and FM transmissions can be present on a daily basis. In most parts of the UK, one or more neighbouring IBA regions can be received providing a minimum of five television channels. On the FM radio band many distant ILR stations are possible. If an extra IBA region is present via the aerial used for local viewing, there is every possibility that the use of a high-gain aerial of the correct channel group, and suitably aligned, will produce a remarkable improvement. If several regions are available, but in different channel groups, a wideband UHF array and rotator can be used, the cost of which will be justified by the dedicated viewer.

The correct choice of receiving aerial is very important and a glance through the various manufacturers' sales literature will reveal a bewildering selection. Factors such as the type of receiving aerial used and the terrain over which the signal must travel, will influence the success of reception; a secluded receiving site, in a valley location for instance, will hamper the chances of extra channels.

An array must not be selected on the merit of gain performance alone. Its directional properties and front-to-back ratio must also be considered if problems due to co-channel signals are to be avoided. This particular problem is increasing as more Channel 4 relays are introduced. During periods of enhanced tropospheric propagation conditions, co-channel interference will become more apparent. The DX-TV enthusiast who relies upon various modes in ionospheric propagation for results will be only too aware of this.

Figure 1: The Antiference INTERCEPTOR MH308 array. This is a combined Band I/III aerial mounted on a single boom. It consists of a 3-element Band I array comprising a folded dipole, reflector and director. The 8-element Band III section comprises a folded dipole, reflector, four directors and two resonators. The MH311 version has three extra Band II directors giving improved gain and directivity.

Figure 2: Gain characteristics of the Antiference INTERCEPTOR array, type MH311.

Figure 3: Gain characteristics of the Antiference INTERCEPTOR array, type MH473. The aerial (not shown) comprises a 4-element Band I array (double-driven folded dipoles plus reflector and director) giving up to 6dB gain. 21 colinear directors, 3 colinear reflectors and 3 resonators provide up to 11.5dB gain in Band III.

Broadcast Reception Aerials

The design of most broadcast receiving aerials has been based upon the tried-and-tested Yagi principle, comprising a half-wave dipole cut to the required frequency with parasitic elements mounted in front and behind. Often, only one element mounted behind is used and this is known as a reflector, although the trend is to use a multi-element reflector on the more elaborate arrays to achieve a good front-to-back ratio. The reflector is usually 5% longer than the dipole.
Parasitic elements mounted progressively in front of the dipole are known as directors. Increasing their number will increase the gain of the system and enhance its directional properties. The Yagi array is an inherently narrow-band system and attempts to broaden the bandwidth will result in a lowering of gain throughout its operating range. Consequently a wideband system will be a compromise in terms of gain and bandwidth for a given number of elements, when compared with an array cut to one specific frequency. As a rule-of-thumb guide, the reflector is cut to the lowest required frequency and the dipole cut approximately to mid-band. The directors are often cut to the higher end of the spectrum and where several are used the gain at the upper end becomes higher than at the lower end. This arrangement is often beneficial since signal losses increase with frequency.

The log-periodic design is an inherently wideband array, but unlike the Yagi, all the elements are dipoles, cut to respond to different frequencies. This type of array is more complex structurally than the Yagi, and at a given frequency only part of the array contributes to the gain, making it lower in relation to the number of elements when compared to the Yagi design. On the credit side, it has an exceptional front-to-back ratio and a very clean polar response with few side-lobes. In the past the log-periodic array has only been commercially available in the UK for UHF, and used in primary signal areas where ghosting is a problem. In the USA, rotatable log-periodic systems have been popular at VHF television frequencies (55-220MHz), where several local TV channels are available. The excellent polar characteristics help to discriminate against unwanted transmissions which could be a problem if a standard Yagi design was used.

### Bands I, II and III

VHF television Bands I and III are, at present, the domain of the DX-TV enthusiasts, apart from a few itinerants such as colleges' TV users. For Band I frequencies, commercially produced arrays are available, but only in channelised form. Wideband systems covering this band are obtainable from specialist manufacturers, albeit a compromise in terms of gain and bandwidth. Where space permits, it may be worth investing in channelised arrays for this band to help discriminate between unwanted transmissions, such as 6-metre amateur activity and the promised PMRs.

It is possible to make one's own array for Band I using ½-inch diameter alloy tubing. It is usually cheaper too, but hardware such as element-to-boom clamps and dipole boxes may be difficult to acquire. Some enthusiasts have opted for an inconspicuous system based on crossed dipoles where a large Yagi array is impractical. The dipoles are cut to the centre of the band, at approximately 55MHz, with each element 50 inches in length. The dipoles are mounted horizontally and at tight-angles to each other. The output of each dipole can be selected independently by means of a switch, or phased together to provide omni-directional coverage. The system has zero gain, but fortunately Sporadic-E signals frequently attain extremely high field strengths. The system is also ideal when used as a search array.

Commercially manufactured Band III aerials are generally the wideband multi-element Yagi type, although one UK company produces a log-periodic array. Needless to say, these are intended for the export market and channelised Yagis are cut to the CCIR channels E5 to E11. Combined Band I/III arrays are available — the main attraction being the single boom structure. Unfortunately, the outputs are combined to form a...


Table 3: Technical characteristics of the Jaybeam STEREOBEAM VHF FM radio aerials covering 88 to 102 MHz.

<table>
<thead>
<tr>
<th>Model</th>
<th>Number of Elements</th>
<th>Peak Gain (dBi)</th>
<th>Horizontal Acceptance Angle</th>
<th>Front to Back Ratio (typical)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBM 2</td>
<td>2</td>
<td>3.0</td>
<td>70°</td>
<td>12:1</td>
</tr>
<tr>
<td>SBM 3</td>
<td>3</td>
<td>6.0</td>
<td>60°</td>
<td>15:1</td>
</tr>
<tr>
<td>SBM 4</td>
<td>4</td>
<td>7.0</td>
<td>58°</td>
<td>16:1</td>
</tr>
<tr>
<td>SBM 6</td>
<td>5</td>
<td>8.5</td>
<td>56°</td>
<td>21:1</td>
</tr>
<tr>
<td>FM 95</td>
<td>9</td>
<td>9.5</td>
<td>40°</td>
<td></td>
</tr>
</tbody>
</table>

* The Jaybeam SUPERFRINGE FM 9S VHF FM array comprises folded dipole, triple reflector assembly and five directors. Single one which can prove to be a disadvantage for the DX-TV enthusiast wishing to include various filter/amplification options for each band.

Out-of-Band Transmissions

The OIRT FM radio band used by Eastern European countries, such as Russia, Poland, Bulgaria, Czechoslovakia, etc occupies the 64 to 73 MHz spectrum. Commercially available arrays are unobtainable in the UK specifically for this band although specialist manufacturers may oblige. The same remarks apply to certain OIRT television channels in use between 77 and 92 MHz.

FM Radio

For long-range reception, or where several local stations are available, the use of an array with a multi-element reflector is recommended. The high front-to-back ratio offered will minimise problems caused by unwanted signals arriving from the rear.

Bands IV & V

For long-distance reception at UHF there is more diversity in receiving-aerial design, than for any other band. Most DX-TV enthusiasts prefer to use a wideband array at UHF mainly for operational ease, despite its reduced gain. Cost effectiveness is

Figure 8: The AntifERENCE EXTRAGAIN XG14 array. This is available in grouped or wideband versions. The array features a unique quad dipole and director design.

Table 4: A selection of Jaybeam UHF arrays comprising of the MULTIBEAM JBX "MBM" grouped series plus the LBM2 log-periodic array which features almost constant gain throughout the UHF spectrum.

<table>
<thead>
<tr>
<th>Model</th>
<th>Groups Available</th>
<th>Peak Gain (dBi)</th>
<th>Horizontal Acceptance Angle</th>
<th>Front to Back Ratio (typical)</th>
</tr>
</thead>
<tbody>
<tr>
<td>JBX 21</td>
<td>A, B, C, D</td>
<td>16.0</td>
<td>22°</td>
<td>22:1</td>
</tr>
<tr>
<td>MBM 66</td>
<td>A, B, C, D</td>
<td>15.0</td>
<td>29°</td>
<td>16:1</td>
</tr>
<tr>
<td>LBM 2</td>
<td>WIDEBAND Ch.21 to 68</td>
<td>8.0</td>
<td>44°</td>
<td>23:1</td>
</tr>
</tbody>
</table>

Another consideration, especially since tropospheric conditions rated as 'excellent' may be present for only a few days each year. Although grouped arrays are superior in terms of performance, it can be argued that this approach is only justified where reception of certain distant transmissions is possible on a regular, or even daily, basis.

Two forms of wideband aerial are popular; the Continental-styled Yagi (see Fig. 8) and the stacked "bowtie" (see Fig. 9). The Yagi is favoured by some enthusiasts because of its directional characteristics, but, inherent in its design, the highest gain occurs at the upper end of the UHF spectrum. The semi-sideband version has gained popularity since most UHF DX appears within Band IV. This type of aerial usually covers channels 21 to 50 and is sometimes designated Group "K". The AntifERENCE semi-wideband type carries this suffix, but other manufacturers often have different codings.

The stacked bowtie system offers a more uniform level of gain throughout all the UHF channels, but at a lower level than the Yagi. One of its main disadvantages is its very wide capture angle. This leads to greater co-channel reception problems than the Yagi, but in terms of cost it is cheaper and more compact.

Over the past two years, both types of system have been evaluated, resulting in the following observations using a Wolsey Colour King and an AntifERENCE XG21 array.

Table 5: UHF Receiving Aerial Channel Groups and Colour Codes.

<table>
<thead>
<tr>
<th>Channel Group</th>
<th>Colour Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>21–34</td>
<td>A RED</td>
</tr>
<tr>
<td>39–53</td>
<td>B YELLOW</td>
</tr>
<tr>
<td>48–68</td>
<td>C/D GREEN/BLUE</td>
</tr>
<tr>
<td>39–68</td>
<td>E BROWN</td>
</tr>
</tbody>
</table>

Stacked "Bowtie"

This was found to perform very well in terms of gain over the entire UHF spectrum. The acceptance angle was perhaps too wide and problems with co-channel reception did occur. This was very noticeable when compared with a Yagi. On the credit side, this disadvantage could be exploited as it made an ideal "search" array, where the operator would be more conscious of signals arriving from a wider area. The aerial provides a very inexpensive wideband UHF receiving system. Fortunately, the extremely wide acceptance angle can be reduced by using more than one array. A double or even a quad system can be utilised. This will also enhance the overall gain. Low-loss inductive combiners are available for this purpose.

Semi-Wideband Yagi

A group "K" version was used simply to maintain a reasonable gain over the channel range 21 to 50, whereas the 21 to 68 version exhibits a very low level of gain throughout the lower group "A" channels. The off-screen results, observed from fringe transmitters, suggested that the gain was no more impressive than for the stacked "bowtie" aerial. The narrower acceptance angle was impressive, however, and many of the co-channel problems associated with the bowtie array were not as prominent. Unfortunately, towards the lower Band IV channels, the acceptance angle became noticeably wider and rejection of semi-local relay transmitters seemed no more impressive than for the other type of system.

Having a group C/D local transmitter introduced problems with the semi-wideband array due to cross-modulation effects on some channels throughout its normal operating range, even with the array beamed in a different direction. This was due to
the unpredictable polar response on channels above its designed bandwidth and the use of a wideband amplifier (470-860MHz) only aggravated the problem. Under these circumstances, the use of stub filters cut to the offending transmission may offer a solution to the problem and should not be overlooked.

**Mast-Head Aerial Amplifiers**

Nowadays most commercially available pre-amplifiers use broadband techniques, which ensure reasonably constant gain throughout the operating bandwidth. Experience has shown that unless the amplifier used has a lower noise figure than the tuner in the receiver, it is unlikely to offer any viewable improvement in the signal unless it is used at mast-head to compensate for cable losses. For DX-TV work, the use of a mast-head aerial amplifier is recommended at UHF, but it should be borne in mind that overload can easily occur if operated close to a local transmitter. This may produce cross-modulation and other spurious effects. Amplifiers for UHF reception are available in wideband (470-860MHz) or grouped (A, B, and C/D) versions.

Some manufacturers produce amplifiers covering the 40 to 860MHz spectrum. The use of such amplifiers can be a problem when utilised for Band I or Band III frequencies due to overloading from out-of-band sources. For instance, when operating close to local UHF transmitters the local UHF group may appear in Band I or Band III. Also, FM radio break-through may occur on the lower channels of Band III (CCIR channels E5 and E6, even at a distance of 25 to 30 miles. To overcome these problems, various bandpass filtering techniques can be employed. In the case of FM breakthrough in Band III, the Band III section of a VHF TV diplexer can be connected to the input of the amplifier to act as a high-pass filter. The Band I input must be terminated with a 75-ohm resistor.

**Conclusions**

All the manufacturers featured in this article are able to supply aerial systems and accessories to fulfil most receiving requirements. However, it would be noted that their European counterparts tend to produce more elaborate and sophisticated arrays for television and FM radio.

The authors wish to thank the following manufacturers for supplying invaluable information about current aerials and amplifiers:-

- Labgear Limited, Abbey Walk, Cambridge CB1 2RQ
- Antiference Limited, Bicester Road, Aylesbury, Buckinghamshire
- Wolsey Electronics, Cymmer Road, Porth, Mid Glamorgan CF39 9BT
- Jaybeam Limited, Kettering Road North, Northampton NN3 1EZ

Our special thanks to Wolsey Electronics and Antiference Limited for supplying products for evaluation.
First there was the ZX80/1, then there was the Spectrum/BBC/Oric — and now popular personal computers take another bound ahead with the first personal portable computer that meets the needs of the communications user and enthusiast in one compact package.

William Poel had to send the R&EW spies to scour the arctic wastes of Canada to find a Tandy shop still left with a model of the machine that is currently sweeping the USA.

In a time of continued general industrial indifference (perhaps recession is becoming the accepted norm after 5 years or so!), the miraculous infallibility of the personal computer market is still hard to believe — even if you happen to be involved in the industry. Offerings launched amid a combination of extreme oversell and inadequacy of supply, still manage to make their promoters rich men and women.

It's hard to think of a similar industrial phenomenon in history, although maybe there's a clue in some of the recent national press advertising by Sinclair that has been alluding to Henry Ford's famous model T motor car.

Hardbitten observers have all but given up trying to predict the depth of the seemingly bottomless public appetite for new microcomputers and games programs. The fact that the industry revolves around hardware products that aren't yet on the market, and software that would benefit from the attentions of Rentokil, only compounds the seeming illogicity of the way the business operates — in the kingdom of the visually disabled, the partially sighted are making a lot of money.

The Model 100

The philosophy of what gives a PC appeal, is far from a precise science. The marketplace is so broad that almost anything will sell to persons who have suddenly got the idea that a computer is the thing to be acquired. Logical choice, and in particular selection of the best technology is one of the last considerations that applies — a fact often related by pioneer Adam Osborne, whose own concept of wrapping a known and relatively unexciting technology in a very convenient package, complete with software, display and the world's favourite operating system is still one of the best around for computer 'users'.

The Model 100 exploits this technique by using very conventional technologies and concepts. Like an 8085 CPU, 24K of usable RAM and a LCD display, yet it still manages to be an excellent device for the computer 'user'.

This is because the 8085 (like the rest of the system) is implemented in CMOS.

The LCD is 8 lines by 40 characters, and the system comes complete with a familiar version of Microsoft BASIC, a very friendly text processor, and a serial communications package that goes to the lengths of a built-in direct dialling telephone modem (though only for US customers, while BT and Tandy get their act together). Our model had the US standard modem built-in, and glancing inside reveals a familiar MC14412 MODEM device (it's not too tricky to apply CCIT filter frequency standards to the active filter section — not recommended, of course!).

Taking the lid off the Model 100 is a less painstaking feat than with many machines — you see so many old friends nestling inside — Hitachi for the RAM and LCD, OKI for the CPU, and no computer is complete these days without an ALPS full travel keyboard.

Without getting hands on the NEC 8201 personal computer, it seems like a
A reasonable guess that Tandy have commissioned the model 100 from the same stable, so if NEC get their computing marketing organised in the UK, we may yet see a second source available.

The real casualty of the portable war is Epson's HX20, which is knocked sideways by the Model 100. Perhaps the frenetic launch promotion, the enormous number of 'franchised' dealers and very hard sell at a time when there was next to no software available (not even a word processor) was indicative of some awareness that the HX20 might be rather short lived on the marketplace.

The Model 100 is not a cheap computer, but we're going to leave the price until later because we don't want readers to form any opinions just yet. It isn't an alternative to the ZX81, Spectrum or Dragon for example. In fact it even gives the BBC model B (with disk) a run for its money. The model 100 is, however, a computer that you will never tire of. The communications capability permits it to swap files with most computers that have anything like an RS232 facility, so you can use it as a portable companion for when you can't get near the main system — or more usually, you can't be bothered to heave the computer, a cassette or disk drive, a monitor and all the leads to the nearest available power point. This is not to say that the model 100 is to computing what a music centre is to hi-fi, only that it operates on a totally new and exciting plane for most enthusiasts to explore.

The Hardware
The Model 100 is supplied in an A4 package, with a 'real' keyboard and an LCD that contains enough space for something really meaningful to take place. The 'mental buffer' seems to be ideally matched to the Model 100 display — in other words, by the time you get to the end of a screenful, the words written at the top of the screen are only of archival interest, as opposed to those influencing immediate writing.

The battery requirement is fulfilled by 4 AA pen cells. Tandy recommend Alkaline batteries, suggesting 20 hours average life expectancy. NiCads do not work, which must be one of the most negative aspects of the machine. There is a separate NiCad RAM support battery which charges from the main power source, so you don't lose data or programs when the batteries require charging.

The low battery warning LED is a useful indicator of impending closedown. If you forget to switch off, the Model 100 does it for you after 10 minutes of non-activity: the default setting of a user programmable function. An AC adaptor is available, although disappointing in this is an extra.

The superb keyboard includes 8 programmable function keys, plus 4 fixed functions and four cursor keys. Thank heavens you don't access half the cursor functions via the shift. There's a supershift function ('code'), and a graphics function, plus a keypad conversion key that allows rapid numeric data entry via a calculator style keypad at the right hand of the alphanumeric keyboard. The delightful display has a viewing angle adjustment control, and the I/O is via a real D-type RS232 connector. Two 8 pin DIN sockets (of different configuration) provide for the telephone line connection and the cassette interface. There's a mini-D for a bar code reader (when is someone actually going to do something with this frequently threatened facility?), and switching for power, modem type and configuration.

The Software
Tandy include several ROM-based bits of software that really make the machine work from the first switch on. The text processor is reminiscent of "Wordstar", using similar control code cursor commands, which are also duplicated via the cursor keys. It does everything required of it, except transmit text files to the printer using linefeed/ carriage return (more of this later).

There are two sub-functions within the text processor, named "ADDRESS" and "SCHEDL", which create files of names, addresses and telephone numbers (that can be used to set up the autodial feature), and a scheduler for creating an electronic diary/memopad. Both these facilities make use of the text processor's 'FIND' function to search out phone numbers by simply entering the name — or the day's events by searching for the date.

Since the files thus created are standard text (DOcument) files, they are word processable, transmittable and printable. A top flight executive can leave his model 100 connected to the phone line, with the modem (30 baud duplex) switched to "Answer", whilst his secretary phones in details of his schedule for the next day, together with any other messages, electronic mail etc.

The BASIC is compatible with most other implementations of Microsoft BASIC, but
Communications

The communications facilities (like all the other Main Menu functions) are accessed by placing the cursor over the TELCOM title on the main menu and pressing ENTER. The Model 100 then prompts the user with details of the current status of the serial communications port, and the dialling pulse format (default to 10 pps) - which is prefixed by an "M" if the Modem is invoked, which automatically enforces a 300 baud format.

If the user defines another set of values for the baud rate, word length, parity etc., the MODEM is disabled, and the D connector takes over. In this mode, files can be set up to receive and transmit data for application like RTTY and ASCII data reception.

The direct dialling facilities also allow details of system logon procedures to be stored away in the address file, so that you can autodial REWTEL (and other fine databases), "logon" with passwords etc., and get straight into the session without further ado. When Tandy and BT get their act together for approval of the Modem system,

UPLOADING files from the Model 100 to the serial output is simply a matter of setting the communication protocols, pressing the UP function key, entering the filename and line width, and pressing return. As at the time of writing, the system doesn't offer the option of line feeds with the carriage returns, nor does it offer a page length setting feature. We're looking into this, since although uploading a file to a CP/M system then permits the file to be manipulated by a word processing programme for subsequent printing and page formatting, this isn't exactly ideal for many users who would like to use the Model 100 as a complete system in itself.

The parallel printer port is the very common Centronics format, and no problems were experienced getting it going. We used the very natty colour graphics plotter made by ALPS for Tandy, and this provided a simple (if slow) listing facility, and all the delights of the four colour graphic functions available from BASIC. Just the thing for logging a panoramic view of band conditions and labelling the signals with their frequencies?

Early Days

We haven't had the Model 100 long enough to get deeply inside its capabilities, other than to discover that it's the first computer that is going to provide the communications enthusiast with a "packaged" approach that means that the applications and not the programming is the "thing".

We hope to have an AMTOR package before long, and work is proceeding with the RTTY system. On a more general note, we would like to start to build a library of communications and RF design programs from readers, especially now there's a medium for running them that doesn't need to be hidden inside a lead lined box. We will pay for publication in the first place, plus you will receive a further royalty every time a copy is downloaded via REWTEL's program distribution system REWSOFT.

Anything You Can Do

One rather revealing aspect of recent Tandy products like the superb colour printer/plotter and the Model 100 is the fact that neither of these products is actually manufactured by Tandy. Uncle Clive has the clout (and might have had the sense) to knock on ALPS and NEC's door to get the machinery into the UK under the Sinclair name. And at least he would have been able to deliver the goods in this instance.

The dangerously amateur marketing policies of the UK computer industry have already succeeded in sinking in one of the early producers of a very good machine (the original NASCOM). The equally dangerous and imperious "Not invented here" syndrome could well be the undoing of one or two more. Especially if they persistently fail to deliver the much vaunted and promoted goods.

Watch out for Tandy's carefully orchestrated Model 100 press launch on July 3rd, 1983 - and marvel at the fact that everything they'll be talking about might actually be available at their stores the next day. Are you receiving us up there in The Fens?

Will this machine (and those that are bound to follow it) change the attitudes of that vociferous band of radio amateurs who are passionately opposed to anything family to do with computing? There could be some lively correspondence in the next few issues.

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BLOCK CAPS PLEASE
A wideband RF amplifier can be a very useful piece of test equipment for the experimenter or radio enthusiast. The two extremely simple designs given here are housed in screened boxes, which have connectors that allow them to be easily inserted in-line. The total frequency coverage of the two amplifiers is from below 10MHz to 900MHz.

**LF Amplifier**

The SL560 IC, which is described by Plessey as a 300 MHz gain programmable amplifier, has been configured here to give a gain of about 14dB up to 100MHz.

**VHF-UHF Amplifier**

This is based on a NEC thin film hybrid which was designed for use as a TV preamplifier. The specifications of the MC5229 are given in Table 1. The noise figure of this amplifier is low enough to make it usable as a general purpose RF preamp (this being its original application) as well as for use as a piece of test equipment. Although the input and output impedances are nominally 75R, in practice the increase in VSWR should not cause many problems. The original

---

**Circuit Description**

The transistors used in the SL560 have a low noise figure and a transition frequency (fr) in excess of 1GHz. Q1 is normally operated in common base, which gives a well defined low input impedance. Full voltage gain is produced by this transistor and the output is buffered by two emitter followers Q2 and Q3. The collector load resistance of Q1 is split, the junction being brought out to pin 5. An external capacitor may be used at this point to provide roll-off. The input transistor may also be used in common emitter mode by decoupling pin 7 and using pin 6 as input. This gives a low noise figure of 2dB (source resistance = 200Ω) and a gain of up to 35dB.

---

**Figure 1:** Pin designations(a) and internal schematic(b) of the SL560.

**Figure 2:** Circuit of the 100MHz LF amplifier.
Table 1: Specifications of the MC5229.

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>PARAMETERS AND CONDITIONS</th>
<th>UNITS</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Icc</td>
<td>Operating Current at VCC = +17V</td>
<td>mA</td>
<td>36</td>
<td>41</td>
<td>46</td>
</tr>
<tr>
<td>G</td>
<td>Gain at f = 30~900MHz, Zout = 75R</td>
<td>dB</td>
<td>17</td>
<td>17.5</td>
<td>18</td>
</tr>
<tr>
<td>dG</td>
<td>Gain Flatness at f = 30~900MHz, Zout = 75R</td>
<td>dB</td>
<td>±0.8</td>
<td>±1.2</td>
<td></td>
</tr>
<tr>
<td>RLin</td>
<td>Input Return Loss at f = 30~900MHz, Zout = 75R</td>
<td>dB</td>
<td>7.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RLout</td>
<td>Output Return Loss at f = 30~900MHz, Zout = 75R</td>
<td>dB</td>
<td>7.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>iso</td>
<td>Isolation, f = 30~900MHz</td>
<td>dB</td>
<td>25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NF</td>
<td>Noise Figure, f = 30~900MHz</td>
<td>dB</td>
<td>5.0</td>
<td>6.5</td>
<td></td>
</tr>
<tr>
<td>IM2</td>
<td>2nd Order Intermodulation Distortion at f1 = 900MHz, f2 = 100MHz, f = f1 + f2, Vout = 100dBµV</td>
<td>dB</td>
<td>-50</td>
<td>-55</td>
<td></td>
</tr>
<tr>
<td>IM3</td>
<td>3rd Order Intermodulation Distortion at f1 = 200MHz, f2 = 210MHz, f = 2f2 – f1, Vout = 100dBµV</td>
<td>dB</td>
<td>-60</td>
<td>-65</td>
<td></td>
</tr>
<tr>
<td>Pout</td>
<td>Output Power at 1dB Compression, f = 500MHz, Zout = 50R</td>
<td>dBm</td>
<td>10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Prototype was made for use with a spectrum analyser and noise generator for noise figure measurements. The thin film circuit was simply ‘rested’ on a brass strap soldered between two tags inside the box. If this method is used, great care must be taken not to break the pins when forming them.

Construction
Both amplifiers use a double sided PCB, one side being the earth plane. Any earth connections should be made directly to the top of the PCB. The connector-box has two earth tags which are used to support the board and make an earth connection. When fitting the board, make sure that the track on the underside cannot short out to the case. In order to minimise stray pickup and to prevent supply borne interference, it is best to use feedthrough capacitors on the supply input.

Testing
There really isn’t much to test with these designs. Just check the supply current (typically 41mA for the MC5229 and 20mA for the SL560, at supplies of 17V and 6V respectively). Using a receiver, check that there is an increase in signal, noise and signal/noise ratio when the amplifier is in-line with the aerial or other signal source.

References
Plessey Semiconductors, Broadband Amplifier Applications.
Plessey Linear IC Databook
NEC MC5229 Data

PARTS LIST – SL560

- **Capacitors**
  - C1: 22u 35V tantalum
  - C2: 100n monolithic

- **Miscellaneous**
  - Case (RS), Power connector, PCB etc.

PARTS LIST – MC5229

- **Capacitors**
  - C1: 10n monolithic
  - C2: 4u735V tantalum

- **Semiconductors**
  - C1: MC5229

- **Miscellaneous**
  - Case (RS), Power connector, PCB etc.
WEATHER SATELLITE RECEPTION
Part II
William Poel follows up our introduction to Meteosat reception with a look at baseband considerations.

There are two readily available converters for 1.8GHz Meteosat applications, one from Microwave Modules and the other described by UY3UMV from VHF Communications. The R&EW Meteosat station uses the latter version, which produces the right results to obtain clear pictures from its 1.2m dish.

The 137.5MHz “IF” can be either the DC3NT receiver (described in the 4/79 and 1/80 editions of VHF Communications), an adapted R&EW UOSAT receiver, or any of the various 2m converters that have appeared from time to time.

We do not intend to get deeply into the RF intricacies in this series, since much already exists on these subjects covered in the references at the end of the previous instalment.

Recent work has shown that the fax demodulation and display section of this system works with a variety of other HF weather information services, and also appears to be suitable for modification of the UOSAT CCD image format, and general SSTV applications.

From The Detector

The block diagram of this module (ref YU3UMV/001) is shown in Fig. 1. The APT WEFAX signal is firstly filtered in a bandpass filter and demodulated. The analogue video signal is sampled and converted in an 8-bit A/D converter. Only 6 bits are required for 64 grey levels, which are then converted into a serial format. Synchronization is obtained from the 2.4kHz APT/WEFAX sub-carrier and all clock signals are obtained from a PLL, which is synchronized to the 2.4kHz sub-carrier. This is followed by a chain of dividers. Additional circuits provide the initial synchronization (initial phasing) of the image. These circuits recognize the synchronizing sequences present in the video signal and reset the line-frequencyDivider. It is possible for the image to be manually synchronized if these circuits are not able to recover the synchronizing pulses from the signal due to a poor signal-to-noise ratio.

The power supply provides all the required positive and negative supply voltages from a 12V6 external supply (negative ground), which need not be stabilised. This means the unit is portable and can be driven from a car battery if required. The board also includes a 1MHz clock oscillator, which is used to drive the TV sync generator on the storage module.

In order to describe the complex circuit more easily, we’ll divide it into six parts. Each part corresponds to one block in Fig. 1. All external connection points for input and output signals, potentiometer switches, etc, are prefixed with Pt.1 for module 001.

Filter And Demodulator

The filter and demodulator block is shown in Fig. 2. The level potentiometer, R 101, is accommodated on the front panel, and is followed by a bandpass filter for the APT/WEFAX signal. This is followed by the second amplifier for the LM 324, which drives an AM-demodulator with D 101 and D 102, followed by a lowpass filter for the video signal.

Figure 1: Block diagram of an APT/WEFAX/HRPT station.
The circuit was designed to accept the APT signals provided by a typical FM demodulator (TVA 120 or similar). Since the APT signal only contains useful information between 800Hz and 4000Hz, the S/N ratio can be considerably improved by filtering out-of-band noise. Also the FM-modulators on board the satellites do not employ pre-emphasis, thus the demodulated S/N will deteriorate with the square of the modulation frequency, which means that it is particularly important to filter out noise components above 4kHz and to use a good lowpass filter in conjunction with an operational amplifier. The filtering below 800Hz is less demanding, and it is only necessary to efficiently suppress any 50Hz power-line frequency interference. This can be obtained by correct selection of the coupling capacitors.

The second operational amplifier drives a full-wave rectifier AM demodulator. Experiments have shown that it is not necessary to have a very good balance of the demodulator, and a simple inverter is satisfactory (using the third section of the op-amp). In addition to the required video signal, a very strong component at twice the sub-carrier frequency (4.8kHz) is present at the output of the rectifier. This should not be fed to the sample-and-hold circuit and is therefore filtered out in an active lowpass filter using the remaining of the op-amp.

**Synchronizing Chain**

Fig. 3 shows the 2.4kHz synchronizing chain, which comprises a two-stage, narrow-band 2.4kHz filter and a PLL circuit with subsequent divider that generates all required frequencies for the clock generator. All these are phase-locked to the subcarrier signal.

CMOS inverters are used as active components in the 2.4kHz filter since they have a smooth, well defined symmetrical limiting characteristic. This is not true for all conventional, operational amplifiers, which are subject to saturation, ringing, unbalanced limits, and similar problems when operated with high-level signals. The circuit used here allows wide tolerances of both active and passive components of the filter, and the high input impedance of the CMOS inverters allows a wide choice of R and C values. It is only important that CMOS gates of the A or UB series are used, since the B series has too high a non-compensated gain and usually oscillates in feedback circuits.

The output of the filter is capacitively coupled to the self-biasing input of a CD 4046 PLL. Two components require noting: the 68k resistor, at pin 12, is not really necessary for operation, but ensures a good start-up for the VCO under any switch-on conditions. Wide tolerances are allowed for the VCO of the CD 4046 and it may be necessary to modify the value of the VCO capacitor between connections 6 and 7.

Phase comparator 1 (EX-OR gate) is used, since some input pulses might be missing due to noise and/or deep
modulation of the 2.4kHz sub-carrier. The VCO oscillates nominally at 38.4kHz, which is 16 times the sub-carrier reference frequency.

The VCO frequency is divided by 16 in the CD 4024 binary counter. Frequencies of 19.2kHz, 9.6kHz, 4.8kHz, and 2.4kHz are present at the outputs of the CD 4024. These frequencies drive the clock generator via a selector switch on the front panel and result in the pixel sampling frequency when divided by 8.

The choice of the sampling frequency is not trivial, and several factors have to be considered. The data rate of an APT signal is approximately 3200 words per second. Since this is limited by the transmission channel bandwidth, there is no point having a higher sampling frequency. Furthermore, the sampling frequency must also be adapted to the size and format of the frame memory available. Since that memory (256 x 256 pixels) is smaller than the APT image format (800 x 800 pixels), it should be possible to display the complete image at reduced resolution, or to use various enlargements or zoomed sections of the image at higher resolution, or even original spatial resolution - made possible by changing the pixel sampling frequency.

In theory, there is no relationship between the sampling frequency and the APT/WEFAX sub-carrier frequency. In practice, however, the residual sub-carrier frequency or its harmonics have to be filtered out carefully from the video signal. If these components reach the sample-and-hold circuit, they will heterodyne with the sampling frequency (or its harmonics) and will be visible as vertical bars in the image. (diagonal bars, if the two frequencies do not have a constant phase relationship to one another). In the case of 64K (256 x 256) memory, it is possible to select 2400Hz or sub-harmonics as sampling frequency.

Since no heterodyne products, except a DC component, will be produced below the sampling frequency, less filtering of the video signal will be required. However, it is important that the sampling frequency is phase-locked to the sub-carrier frequency, which also results in other advantages (eg,
providing an excellent tracking of tape-speed variations when displaying recorded images.

Table 1 gives the possible display formats on selecting the sampling frequencies: 2400Hz, 1200Hz, 600Hz, and 300Hz.

A/D Converter
And Clock Generator
As can be seen in Fig. 4, a CMOS transmission gate (CD4007) is used as a sampling switch. The input impedance of the A/D converter, ADC 0804 (National Semiconductor), is sufficiently high so that no additional amplifier is required for the hold function (100nF capacitor). The 68k7 resistor, from pin 9 (Vref) to ground, defines the dynamic range of the A/D converter from 0V to approximately 2V.

The ADC 0804 has an internal clock oscillator (Schmitt-trigger gate), which is provided with external components connected to pins 19 and 4. R106 is aligned to 800kHz. A clock frequency of 800kHz provides a conversion time of approximately 100 us. The conversion is started at the leading edge of the conversion-command signal (see Fig. 5), and when conversion is completed the data is transferred to the output storage of the ADC 0804. An 8-input NAND gate detects the over-range, which is displayed by a LED on the front panel. This indicator is very useful for adjusting the signal level at the input of the video demodulator correct — the appropriate potentiometer is adjusted when the LED just starts blinking, which indicates that the dynamic range of the A/D converter is being fully utilized without excessive clipping.

The parallel data at the outputs of the ADV 0804 is serialized in the multiplexer (CD4051) where the two lowest-valency bits are suppressed. The radiometric resolution of 6 bits for 64 gray levels is determined at this point.

The multiplexer, CD 4051, is driven by divider, CD 4024, and this converts the parallel data into serial form being fed to pin 3 of one of the buffer amplifiers, from where it is fed via Pt 113 to the digital memory module (YU3UMV/2) for storage.

The clock generator also includes decoder logic to generate the conversion command and pixel clock. Serial data, coherent bit-clock, pixel-clock, and line clock are fed via tri-state buffer amplifiers (CD4503) switched on when the enable input, Pt 116, is grounded (if, however, Pt 116 is connected to +5V, this will disable the tristate buffers so that the signals from another source, such as a frame synchronizer used in the high resolution system outlined in the last article, can be fed to the store).

The line sampling clock is derived from the pixel sampling clock. It is important here to know that the line sampling clock is only equal to the image line frequency when the maximum geometrical resolution is to be retained. If an image is to be displayed at reduced resolution, it is not
only necessary to reduce the pixel sampling clock to lower the horizontal resolution, but it is also necessary to reduce the line sampling clock to reduce the vertical resolution. This avoids geometrical distortion (wrong aspect ratio). For example, if the image is to be displayed at half of the original resolution, then the pixel sampling gate should be lowered to half of the maximum sampling rate, and only every second line of the image should be written into the memory. This means that the ratio between the pixel sampling frequency and the line sampling frequency remains constant for a fixed image format and memory size. In the case of a 256 x 256 memory displayed on a TV-screen having a 4:3 aspect ratio, the ratio between the two sampling frequencies is 600 for geostationary satellites such as METEOSAT and both METEOR standards, and 1200 for NOAA satellites.

Half the pixel sampling frequency is available at the outputs of divider IC109 (pin 6). A further division by 300 is performed by the line clock divider (IC118 and IC119 in Fig. 7) which provides the required ratios of 600 or 1200 between the two sampling frequencies. Auxiliary outputs are provided for other satellite
Synchronizing Logic

The initial synchronizing logic (see Fig. 6) can operate automatically by decoding the start and stop tones of the geostationary WEFAX transmission, or manually by decoding the synchronizing pulses of METEOSAT, NOAA, or METEOR.

Three PLL tone decoders of the LM567 series are aligned to 300Hz, 450Hz and 840Hz. Since very high capacitance values would be required in the output-filters (pin 1) of the first two decoders (IC 112 and IC113), external delay gates are connected to their outputs (pin 8). The 300Hz and 450Hz decoders control an RS flip-flop to implement the automatic start-stop function.

A delayed 300Hz pulse connects the highest-valency bit (MSB) from the A/D converter to the reset of the line clock divider. The synchronizing pulses which immediately follow the 300Hz start tone, synchronize the line divider automatically. The LM567 is a narrow-band tone decoder and it is not very suitable to detect very short tone bursts such as the horizontal synchronizing pulses of the NOAA and METEOSAT images (7 cycles). The operation of the 840Hz detector is not very reliable since it is also sensitive to image patterns, similar to synchronizing pulses, and to noise. So it is sometimes necessary to repeat the manual synchronizing process. On the other hand, METEOR satellites with 120 line/min, have far longer synchronizing bursts (16 cycles) but, unfortunately, the frequency of these bursts is not exactly 300Hz and a separate tone decoder would be required to obtain better results.

However, the S/N ratio is usually very poor at the beginning of signal acquisition when receiving polar orbiting satellites, especially when using simple omni-directional antennas.

Line Clock Divider

The line clock divider (Fig. 7) comprises two dividers. The first is a divide-by-three (IC118 and two NAND-gates [IC117]), which is followed by a divide-by-100 (IC 119). The divide-by-three divider can also be preset to divide by two or by four, using two push buttons. In this manner, a slightly higher or lower line clock frequency can be generated to manually shift the image in either (horizontal) direction.

The amount of shift is proportional to the time the pushbuttons are depressed. The diodes at the output to the CD4518 (IC114) are connected as an AND gate to narrow the output pulse. This is required for some satellite standards — for instance, to receive the METEOR IR-images (20 lines/min).

PSU And 1 MHz Oscillator

The power supply (see Fig. 8) also supplies the stabilised voltages for module 002. The nominal value for the external voltage at Pt 125 is 12V6. However, the whole unit will operate between 10 and 15V5 at normal ambient temperatures. The overall current drain is in the order of 400 to 450mA. Diode D110 protects the circuits against incorrect polarity and the RF choke suppresses the pulses from the digital circuits in order to ensure that they are not fed to the receiver via the power supply line.

A three-terminal voltage regulator supplies a voltage of ±5V; it should be mounted on a suitable heatsink (or cabinet). No insulation is required since the heatsink of the 7805 is grounded. A clock generator based on NE 555 is connected as a multivibrator and its output (AC) voltage is fullwave rectified in order to obtain approximately −8V. The −5V supply voltage required is obtained using a simple Zener diode/transistor regulator. This same module is also equipped with a 1MHz LC-oscillator, from which the horizontal and vertical TV-frequencies on the memory module are derived. Since the format of the TV-signal generated on the store module does not correspond exactly to CCIR (320 lines instead of 312.5 lines per frame), a variable oscillator is preferable to a crystal oscillator. Practical experiments have shown that some TV monitors (or modified TV receivers) are more sensitive to variations of the line frequency (loss of horizontal synchronization), whereas others are more sensitive to fluctuations of the frame frequency (interference with the 50Hz power lines). This can be compensated for, by careful alignment of L101.

Figure 9: Output data format (generated on PC-board YU3UMV001).
To newcomers, working foreign ATV stations seems more than a little exotic. To seasoned ATVers, it comes as a welcome bonus now and again. You don’t have to live in the South of England to work the Continent (though it can help) and, in fact, the skill of working far-off stations is more down to interpreting propagation conditions than where you live. All that follows is written with 70cm in mind, but most applies to the higher frequencies as well.

Getting a Lift

Unless you live in Dover or Folkestone you probably won’t be able to work The Continent under flat conditions, so you’ll need a “lift”. Enhanced tropospheric propagation, as it is more properly called, occurs mainly in late spring and early autumn but can happen at any time of the year, even in deepest winter. The mechanism of lifts is well described in books like the RSGB VHF/UHF Manual, so it only remains to recognise an opening when it occurs. Usually things are pretty lively on two metres, though not always so, and unusual stations coming in off the back of the beam on your broadcast TV reception may be a better guide. Falling atmospheric pressure after steady, warm weather is a good sign. Practical experience points to from 4 to 6 pm being a good time, and then late evening, say 8 to 9 pm. Sometimes things fade out after this, at other times they improve until conditions are wide open around 1 am. The next morning things are usually as good (but everybody is in bed, unless it’s Sunday).

Openings tend to favour one direction — possibly France, but not Germany or the Netherlands, or vice versa. Long water paths are useful: stations on the East Coast always do well, but many inland stations work long distances too. There seems to be a “clan” of regulars who watch for openings, both on this side of the water and on the other side and you tend to see these folk again and again.

Strange effects occur during openings, and two stations just twenty miles apart may be beaming in the same direction and see completely different signals, as their transmissions get trapped in ducts. What’s more, they can send each other pictures without causing mutual interference. If QRM does become a nuisance, shifting a couple of megahertz up the band usually solves the problem. I have crystals for both 435 and 438.5 in my transmitter for this reason.

Standards And Introductions

For coordinating things on two metres, the most obvious channel is the international TV calling frequency of 144.75MHz, though in the South of England you may well find it cluttered with ‘amateurs’ trying to work the French repeater. For this reason the French also use 144.17 (FM as well as SSB), and this is catching on elsewhere. As soon as you have made contact, you move off the calling frequency. Vision frequencies are not entirely standardised — most Continental stations tend to use 434.25 (with 5.5MHz intercarrier sound), but you will encounter Dutch stations with vision on 439.25 as well. All French ATVers use 438.5 with positive modulation, which may cause you problems if you don’t have a dual standard receiver, but more and more stations there have an auxiliary negative modulation transmitter. You may well encounter SECAM colour from France as well, so if you are into broadcast TV-DX with a multistandard receiver as well, you will be at an advantage.

Since the opening is doing the work for you, high power is not essential, though it does help if there is a lot of QRM or conditions are only slightly up. With ten watts it is quite feasible to work 200 miles or more, and fifty watts will easily get P5 pictures to Holland or Belgium. Reports on picture quality are normally given in the universal P1 — P5 scale which we know, though the French tend to say B1 — B5. The older German system on a scale of 9 points from B1 — B9 is also in use and some stations will give you a percentage report, so 80% is equivalent to P4. For some obscure reason ATVers seem to be poor QSLers, so remember to have a camera ready. If you have
a video recorder you can make a permanent record of contacts — if you remember to switch it on. It’s so easy to get carried away in the excitement.

When establishing contact and giving reports, English tends to be the ‘lingua franca’, which makes things easier for us. Dutch and Belgian stations in particular put us to shame with their excellent English, though some Germans and French tend to know only their own language. Then it’s all down to pigeon English or recollections of what you learned — or didn’t learn — at school. Sometimes, of course, you cannot speak anyway — ducting conditions may well favour 70cm but not two metres, or else your QSO partner may have a deaf two metre rig, or perhaps the QRM may just be too bad on two metres. Then it’s all down to felt pens and messages scribbled hurriedly on the back of a testcard. An electronic callsign inlay to your picture or a TV typewriter with large letters is a great help too.

Sometimes the reason why you cannot raise the station is because it is a repeater. The Germans have a system of repeaters with input on 24cm and output on 434.25MHz; being well sited, these repeaters propagate well during liftts and DBOTW is quite often seen.

Long Distance

In case you are wondering what the record distance is for an ATV contact I am not quite sure, since nobody seems to be keeping official scores. In October 1981, Phil Johnson GJ8KNV is believed to have worked some OK1 (Czechoslovak) stations and in October 1975 Ray Mohamed G8EGC worked 835 km to DK3NZ in Germany. Other long distance contacts have been EA1CR in Spain to F3YX near Paris (November 1979) and F1AID who was seen in Holland at the same time (1000km). Any claims to beat these will be most welcome!

That’s it for this month! I hope it has given some inspiration and food for thought. If you have any comments, questions or perhaps you would like to suggest a topic for coverage in this column I’ll be delighted to hear from you via the Editor. Feedback is always welcome, so why not drop me a line?

R&EW

Pictures by Ryn Muntjewerff.

Laurent, F1BJB, in Amiens is one of the “regulars” and pops up whenever conditions are up. Like F8MM he is also active on 1255MHz.

Jean-Marie, F1FKP, in Lens is another old stager. His testcard is distinctive enough to be recognisable even with the ‘wrong’ modulation.

EVENTS: MOBILE RALLIES

AUGUST 1983

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<td>BAE 18th Annual Exhibition</td>
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<td>July 24th</td>
<td>McMichael/Burnham Beeches ARS Maidenhead &amp; Dist. ARC Rally</td>
<td>McMichael Sports Club, Bell Hill, Stoke Poges</td>
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<td>August 28th</td>
<td>BARTG Rally</td>
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<td>Edward Batts G8LWY</td>
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AUGUST 1983
DESIGNER'S UPDATE

Our new series of Designer's Update will, each month, feature a range of circuits and ideas within one or two specific areas of electronics. Some of the devices featured will be recently introduced types, while others will fall into the class of 'old-favourites'. Not all of the applications mentioned will be fully developed as the aim of the series is to stimulate readers into undertaking their own design work.

Michael Graham begins the series with a look at graphic equalisers and fluorescent displays.

Many of you will be familiar with the uses to which spectrum analysers and graphic equalisers are put, but for those of you less familiar with the equipment, we'll briefly describe them.

A graphic equaliser is used to compensate for poor listening-room acoustics and to make allowance for the differing responses of cartridges, amplifiers and speakers etc. The graphic equaliser is probably best thought of as a sophisticated tone control, in place of the two familiar tone controls (bass and treble). A typical graphic equaliser will have ten 'tone controls'. Each channel, instead of being a simple low or high pass filter, will be bandpass design. The centres of the filters' pass bands will be chosen to span the entire audio frequency. A suitable series of centre frequencies for a ten band design would be 16kHz, 8kHz, 4kHz, 2kHz, 1kHz, 500Hz, 250Hz, 125Hz, 62.5Hz and 31.25Hz.

The above frequencies are chosen to give a spacing of one octave between each band centre. The Q of each filter block will normally be about three, which means that there will be some interaction between the various filters but that the whole of the audio band can be adequately covered with only the ten filters. Each band filter should offer at least a ±10dB control range, but ±15dB is a better design aim.

Figure 1 shows the filter characteristics of a typical graphic equaliser, while Fig. 2 shows it in a reproduction chain along with some additional components.

In The Pink

A pink noise generator is used to generate noise that has equal energy content in each octave of the audio range (a design for a white/pink noise generator appeared in March's R&EW). This is fed, via the graphic equaliser, to the amplifier/speaker combination to be 'equalised'. If the speaker and the listening-room's acoustics were ideal, a measurement of the noise level at any part of the spectrum would be no different to a reading at any other part of the audio frequency range. It's probably not too surprising to find that, in general, the absolute level of noise throughout the band, will vary and the graphic equaliser's job is to boost or cut the frequencies to compensate for these variations.

Graphic Design

Construction of graphic equalisers has changed with the times. Ten years or so ago, a graphic equaliser would have consisted of a series of LC filters — the resulting equipment being large, heavy and expensive.

About five years ago, the 'approved' method of realising an equaliser was to use a series of IC gyrators — this design approach is still very much used today. Fig. 3 shows the design of one section of a gyration-based graphic equaliser with Table 1 giving the capacitor values to provide the centre frequencies shown above. The highest band (16kHz) is still best implemented by an LC filter as a gyrator would be rather prone to noise.

Figure 1: Filter characteristics for a typical graphic equaliser.
Figure 5: Input buffer and output line driver circuits.

and hum pick-up at this frequency (Fig. 4 shows the circuit of this section).

The filters form the major part of a gyrator. The only other circuitry required is an input buffer and output line driver. Fig. 5 shows the design for these stages.

Graphic equalisers are usually constructed with a set of slide switches along the front panel in order that the exact status of the filter can be readily ascertained. Some of today's equalisers have replaced the sliders by two touch buttons per channel and a LED display. Implementing this with discrete components would be very costly. However, ALPS manufacture a pot that is operated by touch buttons and contains the LED display — exactly what is required.

Techniques On Display.

In many applications, LEDs either in the form of seven segment displays or as dot matrices of individual diodes, are an acceptable choice for a display system. Where 'high resolution' or a large amount of alpha numeric data is to be displayed at once, LEDs are not suitable. The major factor in this case is the high current requirement of each light emitting element. A matrix of 10 x 10 LEDs, with each running at a modest 10mA, would require 1 amp if all were illuminated — clearly not suitable if portable use is envisaged.

CRT displays are certainly capable of providing even the highest resolution, but suffer from similar power supply problems. In addition they are too fragile for use in many applications.

LCD displays largely overcome the disadvantages of the displays mentioned above, but again have a minus point against them in that they do not emit light — a problem in many applications. They also feature a rather sluggish response that is too slow for information displays in many real time applications.

Flourescent displays overcome most of the disadvantages of the other displays but, in fairness, we'll start by mentioning the aspects that may mitigate against their use. The first is that they are fragile. That does not mean that they have to be treated with 'kid gloves', but it does mean that they will not take too kindly to being dropped either. The other slight disadvantage is that they require multiple power supplies and that one of these must be AC.

What's On Offer

Futaba are probably the leading supplier of fluorescent displays with a range of devices for almost every application. Fig. 6 shows the basic building blocks of the displays while Fig. 7 shows just some of the range of displays (Fig 8 shows a typical display schematic).
Power Supplies
As mentioned earlier, the displays demand a number of supplies which has in the past limited their use. Recent developments in semiconductor design have meant that converter units capable of producing the necessary supplies from a single 5V rail have become available. Fig. 8 shows the way in which such a unit is used in a typical application. C1 and C2 are storage capacitors, while the Zener diode and resistor are required in order that the correct cathode voltage is produced.

Figure 8: A voltage converter operating from a 5V rail (Futaba).

Figure 9: Application circuit using the converter of figure 10.

Figure 10: Block diagram of the dot matrix controller.

Display Controllers
If a bar-graph readout is to be realised with a fluorescent display, the techniques are very similar to those used with LED displays and devices such as the LM3915 can be used. If, however, a dot matrix or alpha numeric display is required, the logistics of control can be rather too much for discrete circuits. Fortunately, Rockwell produce a series of display controllers that overcome any difficulties in this area.

Figure 10 shows the block diagram of their 10938 and 10939 controller for dot matrix displays. It can cope with a 20 character display and is cascadeable to 80 or more characters. The font is a standard 5x7 matrix and a separate cursor driver output is available. Data can be entered in either parallel or serial form making the controller an extremely versatile device.

Figure 11 shows the block diagram of the 10937 alpha numeric controller. This is a 16 character display driver with a serial input capability. It is suitable for use with 14 or 16 segment displays.

Using a suitable display, PSU converter and controller IC, an RS232, 16 character alphanumeric display could be designed with the minimum of external components. It would run from a single supply rail (5V), and thus be used in portable equipment.

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More from the World of Video, by Peter Luke, including the latest news on half speed recorders.

A year or so ago, the pages of video trade and consumer magazines were full of articles regarding the so-called war between the formats. The importance of the rivalry between the two major systems, VHS and Beta, was blown up out of all proportion by the media and today such items rarely make an appearance. What was a war, has become a happy co-existence. Things are now cozy enough for some manufacturers to produce both types of machine.

Ferguson led the way in the ‘each-way-but’ approach when they took on board, badge engineering, JVC machines to complement their relabeled Philips V200 models. Sanyo have recently gone down the same road by purchasing the Fisher Group. Sanyo are Beta backers in their UK guise, while Fisher are VHS in this country. With these two formats representing around 80-90% of the market, it means Sanyo, with a machine for each format across a large range of prices, are well positioned to secure a large slice of the market.

Spot The Changes
JVC’s portable, the HR-C3, is due to appear in a number of slightly different forms in the next few months. This VHS-C recorder will appear under both the Ferguson and Nordmende logos, when it will respectively be known as the VideoStar C3V40 and the V150.

Ferguson are putting the recorder, together with a small, new — JVC camera, in a £1000 package that also includes a battery, charger, leads etc.

Nordmende are to offer the recorder at £599 while their compatible C150 camera will set you back £519.

Slow Pace Quickens
Half speed video recorders are the flavour of the month at the moment with two new machines available from dealers now.

Hitachi’s VT-17 is, as well as being their first half speed recorder, also the first front loader from the company. At £599, the recorder features a 5 event, 14 day timer and Dolby noise reduction. The machine uses a four head system to implement the half speed facility and, like Toshiba’s Beta machine, this has the added benefit of making the recorder’s still frame performance impeccable.

Picture quality is said to be degraded by only 6% and this, say Hitachi, should go unnoticed by the majority of people. The same is not true of the audio performance, however, as the slow linear tape speed, less than half that of an audio cassette player, means that even with noise reduction techniques, sound is only just acceptable. The half-speed facility is well worth having though, especially at the very reasonable price of the VT-17.

JVC have entered the half speed stakes with the HR7655 — a modified version of their established 7650. Not surprisingly, Ferguson are offering the 3V32 half speed recorder at the same time.

New Chassis
Ferguson have moved into the cut throat end of the Colour TV market with a new chassis designated the TX90. Two new models based on this design are to be known as the 37104A and 27104C — the difference between models being restricted to the colour of the cabinet.

The sets are 14” colour portables and are priced at £169. At this level they are aimed very much at the cheap far eastern sets which have been selling rather well of late.

Levy Questions
The question of whether or not a levy will be raised on all blank tapes in the future, has once again raised its head. This time, it’s the Association of Independent Producers who are claiming that they are losing out on royalty payments as a consequence of tape piracy.

Most people — apart from bodies like the AIP — agree that a blank tape levy is a far from ideal, indeed some would say unfair, way of compensating copyright owners for lost revenue. When this sort of topic comes up in the popular press, it’s odd on that some pundit will be quoted as saying that if only the tape recorder manufacturers would offer some cooperation, the problem could be solved with some modifications to a recorder’s hardware.

Leaving aside the fact that there would seem to be very little to motivate the likes of Sony, JVC etc, into any such moves, think of the technical issues. The problem is that a video recorder playing back a recording through an unmodified TV must produce a standard modulated vision signal. A standard modulated video signal can be recorded by a second recorder.

In the States, distortion of the sync pulses was seen as a way of preventing copies. This relied on the fact that a TV set’s flywheel sync circuits would cope with sync pulses that would cause trouble to a recorder’s servo circuitry.

Very soon after the first tapes, ‘copyrighted’ in this fashion were available, things called sync stabilisers came onto the market. Of course these devices were not designed to permit copyrighted tapes to be duplicated but, by pure chance, they happened to do just that.

The fact is that while the requirements of a TV’s RF input are almost identical to that of a recorder’s there is very little that can be done to prevent duplication. Any simple form of protection — possibly inventing the video signal on the tape and selling an adapter to re-invent the signal — could be simply countered by the pirates.

If various interest groups insist on having their slice of the cake, it looks like a tape levy is the only workable solution.
A true RMS-to-DC converter

The AD536A is a complete monolithic IC, performing true RMS-to-DC conversion with a performance comparable or superior to discrete or hybrid circuits costing far more. A very useful feature is the auxiliary logarithmic output giving the added facility (after conversion) of a decibel reading with a dynamic range of 60dB. Using an externally supplied reference current, the 0dB level may be set to correspond to any input from 0.1 to 2 volts RMS. The input circuitry will withstand overloads well in excess of supply voltages, the output is short-circuit protected and loss of supply voltage(s) with signal present will not cause failure.

- True RMS-to-DC conversion
- Laser trimmed to high accuracy
- <0.2% error (AD536AK)
- <0.5% error (AD536AJ)
- Wide Response:
  - computes RMS of AC and DC signals
  - 300kHz bandwidth: VRMS > 100mV
  - 2MHz bandwidth: VRMS > 1V
- Signal crest factor of 7 for 1% error
- dB output with 60dB range
- Low power: 1mA quiescent current
- Single or dual supply operation

Graph 1: Values of CAV for % reading error and settling times.  Figure 2: Optional external gain and output offset trimming

Figure 1: Pin designations and internal block.

Figure 3: dB connection
The only external components required to perform measurements to the specified accuracy is the averaging capacitor, the value of which determines the low frequency AC accuracy, ripple level and settling time. The low Iq makes battery operation quite feasible from single or dual supplies between 5 and 36 volts total.

For use on the low signal ranges, the measurement accuracy may be further improved by using the Fig. 2 layout. R4 trims the output offset, but puts 249R in series with a 25K internal resistor (RI) increasing the scale factor by 1%. This is trimmed out by R1.

The device employs one solution of the RMS equation that overcomes the dynamic range limitations inherent in a straightforward computation of RMS. The actual computation performed follows the equation:

$$V_{rms} = \sqrt{\frac{1}{N} \sum_{i=1}^{N} V_i^2} \cdot \frac{1}{V_{in}}$$

The output current, I_{out}, of the squarer/divider drives a current mirror through a low pass filter formed by an internal resistor and the external capacitor CAV. If the time constant is much longer than the longest period of the input signal, then I_{out} is effectively averaged. The current mirror returns a current I_{in} which is equal to AV_{out}I_{in} back to the squarer/divider to complete the RMS equation thus:

$$I_{in} = I_{out} \cdot \frac{1}{V_{in}} \cdot V_{rms}$$

Figure 3 shows a circuit for dB measurements. OdB is set by R1. The op-amp provides a more convenient scale and allows compensation of the 0.3%/°C temperature drift of the dB circuit. Calibration is as follows:

1. Set Vin = 1.00V DC
2. Adjust R1 for dB out = 0.00V
3. Set Vin = 0.10V DC
4. Adjust R2 for dB out = -2.00V

Any other dB reference level can be used by setting Vin and adjusting R1 accordingly. Adjusting R2 for the correct gain automatically gives the correct temperature compensation. (R3 should be 1k 1% +3500 pF PTC resistor for most accurate Ts)

Table 1: Electrical characteristics (Tamb = 25°C unless specified).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conversion accuracy</td>
<td>Total error Internal trim</td>
<td>5 (±0.5% of reading) max</td>
</tr>
<tr>
<td></td>
<td>Temp coefficient</td>
<td>0 (±0.1% of reading) max</td>
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<td></td>
<td>Supply voltage error</td>
<td>0 (±0.1% of reading) max</td>
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<td></td>
<td>External trim error</td>
<td>±3 (±0.3% of reading)</td>
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<td>Error vs crest factor</td>
<td>CF = 1 to 2</td>
<td>Specified Accuracy</td>
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<tr>
<td></td>
<td>CF = 3</td>
<td>-0.1% of reading</td>
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<tr>
<td></td>
<td>CF = 7</td>
<td>-1% of reading</td>
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</table>

**Frequency response**

Bandwidth for 1% additional distortion (0 dB)

- 10mV < V_{in} < 100mV
- 100mV < V_{in} < 1V
- IV < V_{in} < 7V
- 10mV < V_{in} < 100mV
- 100mV < V_{in} < 1V
- IV < V_{in} < 7V

Ave time const CAV

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>Value</th>
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<tr>
<td>Input characteristics</td>
<td>Signal range</td>
<td>V_{s} = ±5V</td>
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<tr>
<td></td>
<td>Safe input, all supplies</td>
<td>±0.5</td>
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<tr>
<td></td>
<td>Input resistance</td>
<td>16.7 ± 25%</td>
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<tr>
<td></td>
<td>Input offset voltage</td>
<td>±0.5</td>
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<tr>
<td>Output characteristics</td>
<td>Offset voltage vs temperature</td>
<td>±0.2 max</td>
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<tr>
<td></td>
<td>vs supply voltage</td>
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<td>Voltage swing</td>
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<td></td>
<td>Output current</td>
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<td></td>
<td>Short circuit current</td>
<td>+5000, -130 min</td>
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<td>±Vs to (+Vs - 2.5V) min</td>
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**Notes:**

1. Accuracy is specified for 0 to 7V rms dc or 1kHz sine wave input.
2. Error vs crest factor is specified as an additional error for IV rms (200mV) rectangular pulse input, pulse width = 200us.
3. Input voltages are expressed in volts rms and error is percent of readings.
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Our regular DX-TV authors, Keith Hamer and Garry Smith, describe a special tuning system for DX reception on a domestic TV.

For over a decade, the dual-standard television receiver has enjoyed popularity amongst DX-TV (long-distance television) enthusiasts because of its dual-bandwidth IF strip. This can be exploited to give a choice of wideband (5.5MHz) or a more selective narrowband (3MHz) IF on any of the TV bands once the system switching has been suitably modified. Acquiring and modifying such a receiver today quickly loses its appeal when factors such as spares availability, the amount of renovation necessary before modification and age are taken into consideration hardly an easy job for anyone not engaged in television servicing.

There are several manufacturers (for example, Grundig, Sony, Plustron and JVC) who are able to supply multi-band monochrome or colour receivers, some of which cater for more than one sound standard. The 5-inch JVC CX610 G8 is such an example and will resolve the UK 6.0MHz, Western European 5.5MHz and Eastern-block 6.5MHz sound. It also resolves PAL and SECAM transmissions.

Such receivers are capable of excellent results, especially when a strong signal is present, but their main disadvantage is inadequate selectivity. The effects are only too apparent during a Sporadic-E opening in Band I or a tropospheric lift in Band III where non-standard channel...
allocations exist. The overlapping of channels is an unavoidable consequence (see Table 1). If strong signals are present on channels IA and E3, for example, the result will be two pictures floating until the stronger one prevails. The presence of a strong local 405-line transmission may also present problems if its sound or vision carrier lies close to the required DX channel (incidentally, the 405-line video appears as a mass of unlocked white line syncs because positive video modulation is used for system 'A').

All television transmission standards currently in use throughout the world, dictate a relatively wide IF bandwidth in the order of 5 to 6 MHz, whereas the obsolete 405-line standard requires a mere 3MHz. The exception is America and dependent countries, where 4.2MHz bandwidth is required. Ideally, for DX-TV, where crowded VHF bands exist, particular attention must be paid to receiver selectivity. A reduced IF bandwidth improves selectivity and also the gain over a given number of IF stages, but at the expense of picture definition. On weaker signals definition is inevitably lost and so an improvement in gain and selectivity is desirable. On stronger signals a wider bandwidth may be preferred since it will enhance the quality of the picture.

**Design**

Two years ago, we investigated the possibility of an experimental DX-TV tuning system which could be connected to the aerial socket of any modern single-standard receiver. Such a system has many advantages over the traditional practice of receiver modification. For instance, it solves the problem of mains isolation which is always present when adding extra switches and controls. A further advantage is the ease with which video recordings of DX reception can be made — the output signal will be at UHF. The system makes use of up-converter techniques, in which the IF output of a multi-band tuner is converted to a spare UHF channel.

Video modulators are available cheaply. One provides the basis of the IF to UHF converter; the section consisting of two stages of amplification preceding a passive diode mixer stage. This was found to be quite adequate in practice.

The varicap tuner unit chosen for the system was the inexpensive ELC 2060. Band I coverage extends well into the FM radio spectrum to approximately 100MHz while the lower end of Band III extends to well below the 2-metre band. On two tuner unit samples the amateur television band below channel 21 could be resolved without difficulty, although a third unit would not cover this band. The ELC2000 could be used as an alternative unit, but the Band I coverage does not extend as far. The connections are identical for both types of tuner.

Tuning is effected by means of two rotary controls, one for main tuning and the other for fine tuning. Calibrations were applied directly to the front panel and this has proved to be both adequate and functional, especially on the VHF bands. For UHF however, we prefer to use local and semi-local transmitters as markers, thus avoiding cluttered channel designations.

Due to the large frequency range of the 'Band I' coverage of the tuner, it was decided to split this into two ranges: 45 to 70MHz (Band I) and 70 to 100MHz (Band II). This allows easier tuning. The lower limit of Band III was fixed at approximately 160MHz.

A bandpass circuit (comprising L1 and C5) was included to reduce the IF

Table 1: VHF TV channel allocations and transmission standards.
Circuit Description

The complete circuit diagram of the DX-TV converter is shown in Fig. 2. The stabilised 12 volt supply feeding the tuner, selectivity modules and IF-UHF converter, is derived via a 7812 IC regulator fed from a full-wave rectifier circuit. The 30V tuning voltage supply rail is perhaps a little unconventional because it is fed from one half of the centre-tapped transformer secondary winding via a voltage trippler circuit. This consists of D10, D11, D12, C9, C10 and C11. The supply is stabilised by I1. Tuning is effected by the MAIN tuning control Rv2 and the FINE tuning control Rv1. SW1a and SW1b were included to limit the tuning range with each band by bringing into circuit R4, Rb and Tc for Bands I, II and III respectively. The values should be determined experimentally, since the tuning range may vary between different tuners. Resistor values used in the prototype are: R4=47k, Rb=15k and Rc=10k. It wasn't necessary to include limiting resistors for the UHF band.

RF gain adjustment is provided by RV3 and applied to pins 1 and 13 of the varicap tuner via isolation diodes D1 and D2. Diodes D4 and D8 take the appropriate AGC input pin high, to reduce gain depending whether UHF or VHF is selected. Diodes D3 to D8 supply the appropriate tuner pins with 7V volts via the BANDSWITCH control, SW1c.

When the full IF bandwidth is required, filter I1 and the selectivity modules are switched out of circuit by SW2 and SW3ab respectively. The tuner IF output is then passed via C3 and C4 directly to the input of the IF-UHF converter.

The bandpass filter (consisting of the L1 and C5) is brought into circuit by forward biasing D9, which is connected between the earthy end of L1 and chassis. Bias is applied via SW2, R6 and choke, CK 1.

Wideband amplifiers IC3 and IC4 amplify the IF signal prior to mixing. The RF output of the oscillator in the original modulator circuitry is coupled to the mixer diode D15 via C9 which consists of two 35-40mm lengths of insulated tinned copper wire twisted together. Two output frequencies are produced: one at the oscillator frequency plus IF and the other at minus the IF. Both outputs appear within the UHF Band IV.

bandwidth, but a dramatic improvement in selectivity was obtained by fitting a couple of selectivity modules. These are often fitted in colour TV front-ends in which IF response shaping takes place prior to feeding a wideband IF amplifier. We adopted a similar approach and were fortunate in obtaining modules from an early type of receiver - the Philips G8 colour chassis, circa 1970-76. The Philips type seemed ideal because of a stage of IF amplification is also provided within the module. By peaking the module, a more dramatic reduction in bandwidth was obtained compared to the sample circuit of L1 and C5. The increase in gain was, of course, an added feature.

Adjustment of one of the centre cores (Lc) provided a very sharp notch, and we were able to completely reject a strong channel B4 vision carrier from channel E4, 500kHz. The other cores were adjusted for optimum results. A second filter was added to remove B4 sound splatter from channel R2. This arrangement provides a very narrow IF bandwidth and excellent selectivity which is ideal for meteor-shower and weak signal work, but picture degradation is noticeable on strong signals.

Construction

The prototype DX unit is of semi-modular construction and a specially prepared PCB isn't required. However, the various modules and sub-assemblies are attached by means of 4BA solder tags soldered to a copper laminate board which acts as a chassis. It should be noted that the
selectivity module cans were removed to preserve space and no instability or interaction problems were encountered.

The prototype was housed in a plastic case. We should point out that the layout is very compact (experience in cramming a quart into a pint pot may be called far!) Fortunately, the layout isn’t too critical and a larger case could be used.

The various band-switching diodes are best connected directly to the tuning pins before attempting to secure the tuning to the rear plate of the case and the copper board.

It may be advisable to experimentally position the components, if the suggested layout is used, before getting too carried away drilling holes in the wrong places! The bandpass coil L1 consists of 6 to 7 turns of a low-loss coax inner tapped at 2 turns and spaced over 7/8” on a 3/8” former.

Modulator Modifications

Remove the small PCB sub-panel and disconnect the GREEN supply wire. The video input components (shown with an asterisk on Fig. 3), consisting of a 0.08 and a 12p capacitor, 4k7 resistor and the link with the ferrite bead, should then be removed. The video input connection pins may also be removed. A small portion of the internal screening is removed and holes are then drilled in order to mount the three feed-through capacitors and the phono input socket. To attach the module to the PCB chassis, fit a couple of 4BA solder tags at each end of the casing as shown. Pins 1 and 4 of the SL 521c are removed and suitable holes are then drilled in the modulator PCB to mount the ICs. Solder a 0.08 capacitor (Cb – the one removed from the video input circuit will suffice) on the underside of the modulator’s PCB to the points shown in Fig. 3.

Alignment

Before aligning the unit, ensure that the 12V and 30V supplies are present and that the RF gain voltage range is 2V4 to 7V5 measured on the appropriate tuner pins. The values of R4 and R5 can be altered if necessary to achieve this. IF alignment is possible without the aid of a signal generator, although one is useful for confirming the tuning ranges and to calibrate the DX channels. Alternatively, the DX channels may be calculated by referring to any known local or semi-local 405-line channels which may be present.

Set the RF gain to maximum, switch L1 out of circuit, bring the selectivity filters into circuit and unscrew their cores until they protrude approximately 2mm above the former. Set the tuning to the upper portion of Band III or UHF and tune through the lower UHF channels of the television receiver until a noise ‘peak’ is observed. This should occur 4 to 5 channels above and below the blip caused by the IF-UHF converter oscillator. If not, set the DX unit to another band or the tuning to a different part of the band; repeat the tuning operation of the receiver. Once the noise peak is located, adjust the IF coil of the multiband tuner for maximum noise on the screen. The noise should dramatically decrease with the selectivity filters switched out. Feed in a UHF signal, switch L1 into circuit and adjust for maximum gain. Adjust the IF output coil to broaden the response on ‘wideband’ if necessary (that is, with L1 and the selectivity modules switched out of circuit). The selectivity filters can be peaked for best results if required and just a single filter may suffice. On the prototype the first filter was used as a notch to remove B4 vision from channel E4 by adjusting Lc and setting the other cores for maximum rejection consistent with maximum gain. Similarly the second filter was adjusted to remove B4 sound splatter from channel R2. Repeat the alignment procedure until optimum results are obtained. On a received signal, further improvement in gain and selectivity could sometimes be obtained by adjusting the fine tuning of the television receiver. On the prototype, the converter output appeared around

Figure 3: Internal layout of the modulator.

Figure 4: G8 selectivity filter connections (viewed from component side).

Figure 5: Pin-outs for IC1-4.

Figure 6: Connections for the ELC 2060/ELC 2000.
channels 21 and 30 and despite the presence of strong semi-local transmissions no particular problems were experienced. The converter oscillator output frequency may be shifted slightly by adjusting the trimmer.

In Use
Several units based on this particular up-conversion principle have been constructed over the past two years. They have performed well during Sporadic-E and tropospheric openings. On very strong signals, picture degradation does tend to occur where on extremely narrow bandwidth is used. Fortunately, this is where the alternative IF response settings come into their own.

During the 1982 Sporadic-E season, broadcast television signals were received from virtually every European country including Morocco. As for ariels, a simple dipole mounted horizontally and clear of obstructions may be adequate for Sporadic-E reception. Each element should be cut to approximately 50 inches, that is, around channel E3.
Due to the popularity of this series, we asked the author — Jon Dyer — to update the latest part.

The following text has been re-arranged from the original article (July '83). Also the various corrections have been added.

**In-Band Intermodulation**

This is where two signals within the IF passband intermodulate to produce extra products. It is normally of little significance in HF communications except where multi-channel 'Voice Frequency Telegraphy (VFT)' systems, such as 'Piccolo', are in use. A typical level of performance for a good receiver is for a product of -40dB with reference to two in-band signals.

**Cross Modulation**

When modulation from an unwanted signal transfers itself across and 'modulates' the wanted signal, the effect is called cross modulation. It is due to non-linearities in the early receiver stages, and sometimes the same modulation will re-appear on each adjacent signal tuned in. Cross modulation is a third order effect, so good third order IMP performance will tend to mean good cross modulation performance. Looking at Fig. 7, the cross modulation may be specified as the level required (in dBu) for a 30% modulated carrier greater than (say) 20kHz off-tune to cause 3% cross modulation. A level of 70 to 90dBU can be considered good.

**Blocking**

Blocking, or de-sensitising, is similar to cross modulation, but in this case the large off-tune signal causes a reduction in wanted signal output. It is specified as the signal required to reduce wanted output by 3dB. It can often be caused by a strong CW signal, causing gain to go up and down with the keying. Figure of 90 to 110dBU can be considered a good performance, for a wanted 1mV(EMF) signal.

**Causes And Cures**

As previously mentioned, dynamic effects are caused by large off-tune signals driving the receiver into non-linearity. There are three ways of improving performance: preventing the off-tune signals getting in, improving the linearity of the early stages of the receiver (prior to and including the roofing filter) and reducing the level of all signals. This latter method works because the response to unwanted (dynamic) signals falls off at a faster rate than for wanted signals (Fig. 4).

The third approach is implemented by means of a front-end attenuator or by a wideband AGC loop (separate from the main AGC loop), which operates on the RF amplifier on large signals only and can be thought of as being an automatic attenuator. Both methods have the disadvantage of reducing receiver sensitivity, so other solutions must be found. The first method involves the use of sub-octave filters or some sort of pre-selector tuning. It can be very effective in reducing second order effects, but third order products can be too close for any sort of tuning to have an effect. The only real solution is to improve linearity, using the second method. Bipolar transistors are particularly poor in this respect, but FETs are approximately square-law devices and are therefore very good in terms of third order effects, though not so good for second order products. Linearity can be improved by using high voltage supply rails and keeping pre-roofing filter gain down to a minimum — consistent with required sensitivity — therefore keeping noise levels down.

The mixer may be a double balanced, switching-type, diode mixer, with volts of local injection to switch hard and thus improve linearity. Components normally considered to be linear, passive, and reciprocal must be carefully checked to ensure that they are. This especially applies to ferrite cores, used for RF coils and transformers, and crystal filters, which are often non-linear and non-reciprocal (ie, of different characteristics if connected the 'wrong' way round).

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**Figure 10: Relationships between levels specified in V(EMF), V(PO), dBU and dBm (50Ω).** Also shown in S-meter response (ARU), which specifies that S9 is at 100uV(EMF) with S-point spacing at 6dB intervals.

The practice of fitting protection diodes at the receiver input (often found on marine main-receivers), will also cause non-linearity, as will diodes used to switch filters etc. If all these points are carefully watched, linearity can be made very good — the intercept at ≥140dBu. This sort of performance should ensure that IMPs and cross modulation products are below atmospheric noise on HF.

Finally, there was a small misprint in Table 1. Under the 'Blocking' sidehead, the last line should read "...EMF (60dBU) signal".
REWTEL operates on the standard BT DATEL 200 service. This service provides a data transmission medium of up to 300 baud over the public switched telephone network. Data is converted into tones, which are in turn decoded at the far end back into data. Since we may wish to have a simultaneous two-way conversation (or operation in full duplex to use the technical jargon), four distinct tones are used. Two are for data transmission from the ‘originate’ end (the person who dialled the call) and two are for data transmission back from the ‘answer’ end (the person who answered the ringing phone). The tones are handled by a piece of equipment called a MODEM. Some have a switch on them so that they can be used at either end of a call, but others are fixed. In particular, acoustically coupled modems are often originate only, as they are mainly used with some sort of terminal at the originating end and there are legal difficulties about using such a modem into a computer at the answer end. Directly connected modems often have an auto-answer feature which allows an incoming call to be accepted and routed to a computer without human intervention.

As well as an originate modem, the REWTEL user requires a terminal, VDU or personal computer programmed to operate as a dumb terminal. The data format is 8 data bits with 1 stop bit; although the eighth data bit will be ignored when received at the computer and transmitted as a zero from the computer. Pages are 16 lines of 64 characters. Various personal computers make good dumb terminals (Epson HX20, Tandy TRS80 and TRS80 Model 100, Nascom, Apple IIE, Sirius and the BBC Model B have all been demonstrated or reported as operating satisfactorily). To access REWTEL the user must dial the number (0277 232628) and wait for the REWTEL computer to automatically answer the telephone. This will take at most three rings. The user should then attach his originate modem and wait to be asked for a subscription number. If the user is not a subscriber then merely ‘return’ will suffice. The sign-on message will follow.

After The Sign-on
The REWTEL database, like Gaul, is divided into three parts. Initially the user is logged into the ‘INFO’ section but can swap into the ‘BULLETIN’ or ‘UPDATE’ sections (or back to ‘INFO’) by mentioning these words as keywords at the prompt. Pages of information are retrieved by nominating a number of keywords. The REWTEL program first looks for occurrences of the words BULLETIN, UPDATE or INFO in case a switch to a different database is required. It then looks for pages in the database which contain all the (remaining) keywords. The titles of these pages are displayed along with the page numbers. If there is only one page which contains (within the title and the text) all the keywords, then that page is immediately displayed. If there are more than five titles, then the opportunity is given every five titles to abort the search or look at a particular page.

One particular page is displayed by typing the page number (eg "6607") or by specifying enough keywords to uniquely define it. To abort a page in full flow type ‘return’ and it will abort at the next line end. At the end of the page, REWTEL will transmit a bell character and pause. The pause is to avoid losing the top of the page on 16 line displays. To continue, type ‘return’.

Bulletin Board Facility
One of the joys of REWTEL is the bulletin board, where users and subscribers leave one another and the operator messages and sometimes see a reply. Anyone can leave a message — use the single keyword CHALK (it writes on blackboards!). The message can then be entered followed by a suggested title. At some stage the system operator will read out the accumulated
input and edit them. This process involves tidying up the acceptable bulletins, correcting spelling etc and censoring any bulletins intended for the operator only. In this way, in particular requests for subscriptions are not broadcast.

**Subscriber Specials**
REWTEL knows what the time is and tells you at every prompt to help you gauge the phone bill. If you are not a subscriber, it also 'times-out' after eight minutes. This gives users a chance to access the system—subscribers are allowed unlimited time.

A number of outside organisations contribute to the information and services available via R.E.WTEL. Computer Answers magazine will accept questions left as Bulletins on R.E.WTEL and soon an index of ACC/PCW clubs will be added. Ambit International offers a component price/delivery and ordering service to R.E.WTEL subscribers, which is entered by using the keyword 'SHOP'. R.E.WTEL is interested in increasing the number and variety of such contributions and welcomes advances from commercial organisations who feel R.E.WTEL has something to offer them.

**Version 2 Features**

New to version 2 are a number of features requested by users. The most important is that all titles appear in reverse chronological order, that is, the newest one is shown first. The Bulletin database particularly benefits from this innovation. Searches can be resumed after a page has been displayed at an

'every fifth page' prompt.

The whole way in which pages are selected from the database has been changed. The main effect is to speed up searches that previously took a very long time, at the expense of short searches. Up to eight keywords can be specified and the search takes longer as more keywords are used. Searches will be faster if uncommon words are used. Try not to use very common words that will appear on vast numbers of pages and which therefore will not concentrate the search very effectively anyway.

Most of the keyword editor has been withdrawn leaving only the 'slash-feature'. This allows the user to append a temporary set of keywords to the end of the last set used, in order to concentrate the search. The new set is added for only one search and should be typed in after a / character at the start of the line. Most often this allows selection of /PAGE1 /PAGE2 etc when a search has revealed a set of pages which the user requires to scan, without having to remember all the page numbers.

Finally there is now a two-way conversation facility whereby the operator can see what the user is typing and send him messages. If you see one of these messages then there really is a person at the R.E.WTEL end who might like a chat. The user should reply by using a single quotation mark at the start of the line which will then send the message to the operator rather than initiitiatixing a search.

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**R&EW**
Compiled by Keith Hamer & Garry Smith

April showed an improvement in meteor shower activity due to the Lyrids around the middle of the month. Sporadic-E propagation usually appears towards the end of April, but only a couple of small, insignificant openings were noted this time. Reception, via SpE, lasted only a matter of a few minutes. However, at the time of writing SpE activity has at last been forthcoming, albeit down on other years. An intense opening to Central Europe occurred on May 2nd when the MUF reached 80MHz.

April 1st saw the reception of five countries including the Netherlands (NOS) on channel E4 via a marginal improvement in tropospheric conditions. Czechoslovakia (CST) were noted on R1 with the EZO-type test card (see R & EW April 1983) at 1213 BST and later with the electronic test card carrying the identification “CST01”. The blank PM5544 pattern from TVP-Poland was seen at 1216 on channel R1 and at 1304, also on R1, the Hungarian interlude caption “SZUNET” appeared. Austria made a brief entry with the SpE at 1305 BST with the “ORF FS1 PM5544.

On the 6th, East Germany was present via meteor shower (MS) reflection at 1231 on E4 (62.25MHz vision). Also noted via MS was Austria with a Telefunken TDS monoscopic test card on channel E20 (49.75MHz). It should be noted that ORF-Austria occasionally display important announcements across the PM5544 which obliterate the central area. Such an event was noted on the 7th.

Signals from Hungary (Magyar Televízió) were observed on the 10th with the “MTV-1 BUDAPEST” PM5544 test card on R1 at 0807. At around lunchtime, the multi-burst electronic pattern was received. This test signal precedes the PM5544 prior to programme commencement.

The colour test card from TSS (Russia) made a brief entrance on April 20th at 1229BST. This pattern was featured in the November 1982 edition of R & EW. Also noted on the same frequency (49.75MHz) were signals from Czechoslovakia, Austria and Hungary.

A short Sporadic-E opening consisting of programme material was seen on the 23rd from 1355BST on channels R2 and E4. On April 30th, another SpE opening occurred with reception of the colour test from TVE-Spain on E2 and E4 with the aerials directed towards the south.

Identifying Signals

Further difficulties with station identification can arise during programme hours. Fortunately, there are many signals from new imported material which, in many cases, contain subtitles. The DX-TV enthusiast needs to be fairly conversant with foreign languages to take advantage of this. Clock captions and news programmes seem to be the main methods of identifying signals, but beware, it is sometimes easy to make a mistake with the identity of a programme source as the names of countries appearing on captions during a news bulletin can be misleading.

Possibly, one of the greatest identifying stations during programme hours is to watch weather forecasts. The signal will usually be emanating from the country most under scrutiny by the forecaster. Local weather charts are particularly useful in this respect.

The general direction in which a signal is being received may also give a clue to its origin. For instance, a signal arriving from the southeast on channel E3 would possibly be Yugoslavia. We say possibly because the typical skip distance via SpE is about 800 miles and Yugoslavia is the only country using channel E3 at this distance from the UK. However, the signal may be short-skip and may prove to be West Germany or Switzerland. If the signal is only present on E2, then it is unlikely to be Yugoslavia since there is only a very low-power relay station operating on this channel. Conversely, in West Germany and Switzerland the E2 transmitters have ERP of 100kW. Therefore by a process of elimination it is usually

**Around the Dial**

**Senegal**

Dokan on 4890 at 2309, OM in vernacular, presumably a newcast in the Domestic Service (Chain Nationale) which is on this channel from 0600 through to 0900, from 1155 to 1600 and from 1715 to 0100. Most programmes are in the French language with some short periods in various local vernaculars.

**Libya**

SPLABC (Socialist People’s Libyan Jamahiriya Broadcasting Corporation) Tripoli, ‘Radio Voice of the Arab Homeland’ on 11815 at 0017, OM with a newscast in Arabic in the External Service which operates on this frequency from 1745 to 0400.

Tripoli on 17930 at 1002, OM with a newscast mainly with local affairs. This is the Domestic Service in Arabic operating here from 1100 to 1745. At the end of the news there followed some militaristic marching songs.

**Qatar**

Doha on 21525 at 1015, OM with quotations from the Holy Qur’an in the Domestic Service which is on this channel from 0900 through to 1300.

**Algeria**

Alger on 17885 at 0952, YL with songs in Arabic complete with local-style musical backing in a Domestic Service programme. The Domestic Service is on this frequency from 0000 to 2310.

Alger on a measured 7246 at 0646, OM with announcer in Kabyle together with a programme of typical Arabic-style music. This is the National Network 2 on this frequency from 0500 through to 2200.

**Iraq**

Baghdad on 21585 at 0943, YL (Young Lady) with several songs in Arabic, complete with music, in a transmission of the Domestic Service which may be heard on this part of the dial from 0000 to 2305.

**Tunisia**

Sfax on 7225 at 0456, OM with quotations from the Holy Qur’an in a programme of the Domestic Service which is on this channel from 0430 to 2330.

**Nigeria**

Lagos on 7255 at 0450, interval signal of a series of rapid drum beats, the National Anthem at 0456 followed by YL with station identification in English, a short religious service, an English language newscast of world events, a commentary on the news, a local newscast and press review. Announced as the “West African Service”, Drums, identification and the news in French at 0600.

**Saudi Arabia**

Riyad on 7920 at 0417, OM with announcements in Arabic interspersed with a few bars of a military march – all in the Domestic Service which is on this channel from 0300 to 2300.

**South Africa**

Johannesburg on 7270 at 0420, OM with a programme all about current affairs in African in an English transmission for South, Central and East Africa and the Middle East, scheduled from 0300 to 0430. Station identification and programme details at 0425, interval signal and then into a French newscast at

**Romania**

Romania’s daily News programme radiated from studios at Bucharest. Photo courtesy of Televiziunea Romana.
Equatorial Guinea
Radio Nacional, Bata on 4925 at 1858, OM with a song in vernacular backed by the typical fast rhythmic music of the locality — once heard never forgotten. This one operates to the schedule 0430 to 0700 and from 1000 to 2200, the power being 100kW. If you could log on 4925 then tune to 5064, at which point on the dial it appears to operate alternately for short periods of some days.

Clandestine
"Voice of the Resistance of the Black Continents" on 4950 at 1905, OM with a heated speech in a vernacular. This station supports the UNITA cause and is hostile to the Angolan government.

Zaire
"Radio Cabindin", Bunia on 5066 at 0428, OM with a talk in vernacular ending with a military march. Programmes are of an educational nature and are broadcast from 0400 to 0730 and from 1500 to 2000 (Saturday from 0400 to 0730 and from 1230 to 1730, Sunday 1230 to 1830). The power is 1kW.

India
AIR (All India Radio) Delhi on 7280 at 1520, OM with a news-cast in Hindi followed by YL with station identification and the news in English from 1530 to 1545, OM with a news-cast after 1545, all in the Domestic Service which is on this frequency from 1235 to 1545.

ARL Delhi on 11620 at 1815, OM with station identification followed by a programme of Indian music in an English transmission of the General Services. This particular programme is aimed at the UK and West Europe from 1745 to 1830 and from 1845 to 1945 on this channel.

Pakistan
Isbarkaud on 21802 at 0955, OM's with songs, Urdu, local-style music in a World Service presentation to the UK. And timed from 0715 to 1100.

Karachi on 21485 at 1250, OM with a news commentary in Urdu in a programme that language directed to the Persian Gulf and the Middle East and timed from 1330 to 1600.

North Korea
Pyongyang on 11660 at 1942, YL with a news commentary in the German programme for Europe, scheduled from 1900 to 1950. Also logged in parallel on 9260 and 6576. The English programme for Europe is timed to commence at 2030.

Now Hear These

Bolivia
Radio Illimani, Lo Paz on 4925 at 0323, local pops, OM with station identification at 0325, the signal riding over Radio Caracol (identification at 0327) on the same channel. What a mix!

Clandestine
Voice of the Iraqi People on 7860 at 1655, OM with the Kurdish programme, timed from 1630 to 1700. At 1700 a marching song, OM with announcements and off after some military music at 1705. It was jammed — of course.

La Voz de Cuba Independiente Democritica on 5106 at 0325, OM with identification in Spanish, OM with a folk song and some local-style music. Thought to be Granada based.

Peru
Radio Huancavelica on 4885 at 0331, OM with a political talk in Spanish, it was anti-Shining Path, the local guerrilla organisation noted for lightning raids on local stations, broadcasting a manifesto and then just as rapidly vanishing into the night.

Antarctica
To end on a chilly note — Radio Nacional Arcangel, San Gabriel on 15474 at 0035, OM with a talk in Spanish after identification. It is manned by Argentinians!

Australia
Melbourne on 19570 at 0810, OM announcer presenting a programme of U.K. made pop records in an English programme for Europe, scheduled from 0700 to 0900 on this frequency.

Melbourne on 9760 at 0820, OM with a programme of recorded conversation to the Pacific Islands and Papua/New Guinea, scheduled from 0700 to 0845.

Melbourne on 17795 at 1130, OM with station identification and "Sporting Roundup" in an English programme for the Pacific, timed from 1100 to 1200 with this transmission.

Turkey
Ankara on 7105 at 0432, OM with music and songs in the Turkish programme directed at Turks abroad, to be heard on this channel from 0555 to 0605.

News programme from YLE-Finland called "TV UUTISET". Photo by courtesy of Petri Poppoopenen, Finland.

 Pirates clutter the FM band while on the Dutch ATV band (430-440MHz) pirate stations play stereo music and video films. Between UHF channels 30 and 40 many pirate television stations are in operation, some with exceptional picture quality. Obviously the Dutch version of our Home Office is just as helpless and inefficient in dealing with such illegal transmissions!

While on the subject of amateur television stations, Andrew Webster of Billinge near Wigan has obtained an ATV converter. Then he discovered that his Panasonic VCR would already tune down to the required channel! He has received several amateurs in North Wales and Cheshire and would like to know if there are any call-sign location lists available.

Finally, according to Robert Copeman in Australia, the Spe season in The Antipodes has been very disappointing. On the other hand transoceanic DX has excelled itself but he hopes that F2 conditions will return to provide some really long-distance reception.
The complete W&D kit consists of: synthesiser, VCO and modulator, receiver, shortened transmitter strip and solid state relay. The first thing to do is carefully read all the documentation before constructing anything. Not only does this give a greater understanding, but it gets the reader familiar with the W&D style and ensures that any modifications are noted. Parts check lists are included, which show any changes to the specified components. The circuit diagrams are a bit daunting at first, but it soon makes sense.

The digital board was built first, with a double sided through plated, PCB, of excellent quality. However the through-plating does entail the constructor in some checking that the right component is being inserted. The overlay diagram was inadequate here, because it only shows the value, not the circuit identification. Apart from this, no problems were encountered, and the six-section testing procedure was accomplished easily.

Opined Oscillations

The VCO also uses a double-sided fibre-glass board, but not plated through, and, like the digital board, care is needed because the component density is higher than normal. A frequency meter (or receiver) is needed to set up the VCO, and this should not be rushed as the range and sensitivity need careful attention. The text is easy to follow and proved to be trouble-free.

The two boards are connected together then as shown in a clear diagram. Once done, the unit locked up and delivered the correct frequencies. Then you can start on the receiver. Clearly design improvements have been made concerning the ceramic filters, and the CFSH M3 is now supplied. Unfortunately, the two filters would not fit the holes drilled. Redrilling was conceivable, but the ground plane was a problem, so I tried bending the legs... two days later replacement filters arrived!

The diagrams supplied with the kit.

---

**SPECIFICATIONS**

- **Coverage**: 144-146MHz
- **Output freq.**: 24MHz Tx, 45MHz Rx
- **Channel spacing**: 25kHz @ 144MHz
- **Offset**: 600kHz repeater
- **Toneburst**: crystal controlled
- **Power**: 12V @ 100mA
- **Out of lock inhibit**: CMOS, LS TTL Technology
- **2 d/s fibre-glass PCBs.**
- **Size**: digital board 4" by 3.5"; VCO + Modulator 2" by 3.5"

The best method is soldering in short lengths of tinned wire and attaching the filters to these – but clearly the board needs to be changed. (W&D inform us that a new PCB design has been completed and will soon be available).

Joining the receiver to the synthesiser was very easy and a noise was heard in the speaker. A nice feature about the receiver and transmitter boards is that initial settings for the trimmers are given. This not only aids alignment but, particularly with the transmitter, gives a good indication of a fault if the trimmers are way off the recommended settings. There was a lot of noise coming out of the speaker until the thumbwheels were set. Changing to a simplex channel produced a sensible contact with which I could peak up the trimmers. Notes are added in the literature about improving the receiver's performance involving the purchase of a BF900 and constructing some coils.

After the receiver was checked to be working, these coils were formed and inserted, and there was a definite
improvement in the front-end performance. I would have preferred to see them in the original kit, nevertheless it is good to see W&D updating their designs to improve the performance. The modulator was tested and found to be working satisfactorily.

Turning to Transmit

Compared to the receiver, the 2Y2T transmitter strip was simplicity itself, and apart from the supply and aerial, requires only one coax connection to the synthesiser. Tuning up is done either with a 50R power meter or a dummy load with reflectometer. A current meter in the supply line will also peak nicely. Between 1½-2 watts can be expected and if all is well the output coax is connected to the appropriate terminal on the receiver board.

The rig was mounted in a Centurion DX4 case, and everything needs bolting down firmly to avoid microphony problems, particularly the synthesiser and VCO which should be in screened die-cast boxes for best performance. Thumbwheel switches were used for our unit, but a neater solution would perhaps be to use the recently introduced SRH202U rotary switch. This has a decoded output for a digital readout, the only disadvantage being that ‘0’ will read ‘40’. However it is simple to build a small inhibiting network, decoding the necessary data lines to blank off the ‘4’.

A Big Performer

The rig performs well, was easy to construct and align with the minimum of test equipment, and is recommended for anybody who has some building experience. W&D offer a range of pre-amps and PAs, and I have just completed the 10 watt FM10B and the 144PA4/S preamp to go with the rig, and they perform very well. The synthesiser can be modified for use with Storno, Pye 2200s etc, and has an auxiliary Tx output at 6MHz or 12MHz. W&D provide ready-built modules, pretested and aligned, and this can represent a saving in time and money if constructors are unsure about their building abilities. A full back up servicing facility is also available, and local amateurs who have taken advantage of this service tell me that they are well satisfied.

Figure 1: Control circuitry block diagram.
NOTES FROM THE PAST

The debate over what constitutes ‘hi-fi’ has gained new significance with the introduction of compact disc systems. Such developments were also a talking point 25 years ago — Centre Tap elucidates.

Last month I felt it necessary to apologise for giving over much of the column to gramophones and records. Apparently I need not have worried. Rarely has the postbag been so full. Many readers wrote asking for the catalogue number of the Popular Science magazine Test Disc which I mentioned was now available in the UK. Fortunately I was able to find time to reply to them all, but for the benefit of others who might have wondered, it is simply known as Test Disc No 1 and is issued by Allied Records Ltd (London). I was surprised that so many record dealers did not seem to know of the existence of this record — apparently they only sell them and would seem to have little interest in the contents.

Thinking of record dealers reminds me of their being bypassed as the result of the direct sale of records in a similar manner to that popularised by the various Book Clubs. I have had quite a few requests for my opinion on the quality of the recording of various “Club Records” — some of which sell for little more than a third of the price of records sold through the normal channels. As the choice of titles selected are those which would chiefly appeal to the serious music listener, the question of recording quality is obviously of considerable importance. I have heard one which sells for under 15 shillings, but as it was played on very indifferent equipment I must reserve judgement. The quality, however, was about the same as that of standard records played under the same conditions. I hope soon to have an opportunity of making a comparative check on real hi-fi equipment. I would put the emphasis on the word “real” — lately I seem to have been running into stuff which is hi-fi in name only! In the meantime, the views of any readers who have made comparative tests will be welcome.

The only “Club Record” I have heard played on a true hi-fi system was one (of a set of ten with monthly additions) sponsored by a record manufacturer. These 12in long plays cost a little over a pound, and the one I checked on seemed equal in all respects to the better standard recordings.

I have also heard a brief demonstration of the first stereo disc records (double sound track), recently issued by Pye. Properly used, they certainly give 3-D sound. By the phrase “properly used” I don’t simply mean with the special equipment — that is obviously necessary. There is, however, an additional control, to give a balance between the two speakers. This and other incorrect adjustments can quickly falsify musical values, and I hate to think of what sort of sound people with more money than musical taste might adjust them to give. Apart from this danger, it represents a considerable technical advance and will keep the keen constructor on his toes as soon as he realises his present hi-fi may soon be considered old-fashioned.

A Job for Idle Hands

Among the letters received this month was one from a Luton reader. I rarely quote the nice things that readers, on occasions, say about this column; but this one is a little unusual, as it was written by a non-regular. He writes: “Like yourself, I have had a longish spell in hospital, and while there a friend brought me a bundle of old Radio Constructors to read. I haven’t done any radio for years, although at one time I was a keen experimenter. The magazines certainly re-vitalised my former interest. I went more or less straight through the bundle reading all your Radio Miscellany articles which I enjoyed — especially the parts about Old Timers. I think it must have been the revival of old memories and a certain hint you dropped that rekindled my old enthusiasm”.

“In one of your earlier articles you wrote at some length on rebuilding and modernising old receivers. Like most other families we had an old broadcast set at home, stuck away in the attic. So in the long weeks of post-hospitalisation at home I got busy with a new all-wave coil pack, miniature valves, a new dial and sundry modern components, all bought by post. I completely rebuilt the set, trying to keep it as much as possible like an exhibition piece. It works perfectly and I have now started to modernise another — a long-discarded portable”.

“I am convinced the idea, which came about as the result of reading your articles, materially assisted me in speeding up my recovery and made the long weeks of enforced idleness a pleasure instead of a period of boredom. Thank you for both the enjoyment and the idea I derived from your column, and I hope that you are now, like myself, fully recovered”.

Thank you too. J.S. for a most encouraging letter received just as I was about to again put my nose to the grindstone. Come to think of it, redesigning old sets must be an ideal way of pursuing constructional interests for armchair-ridden enthusiasts. No chassis bashing, octal-sized valveholder holes blanked off with miniature adaptors, doubtful components stripped out and modern parts fitted. No heavy benchwork, and it can all be completed with a few simple tools and a soldering iron — plus a couple of cushions in the back of the armchair to prop you up! I gladly pass the suggestion on for other readers to try out on their convalescent friends.

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**NEW PRODUCTS**

**IMF Speakers**

Making their debut at CES Chicago '83 are two new models from IMF Electronics. The CM2a is a Compact Monitor of acoustic suspension design with ferro-fluid damped tweeter for increased power handling. It is the lowest priced IMF Electronics model for five years at £169.00 (inc VAT) per pair.

The CM3a is also of acoustic suspension design. It features both ferro-fluid damped midrange unit and tweeter for increased power handling. This advanced specification offers superb value and performance at £298.00 (inc) per pair.

Both models represent the latest developments in relatively small loudspeakers, capable of monitor standards. The enclosures are rigidly constructed and internally braced to ensure that spurious resonances are avoided. Additionally the bass and ferro-fluid damped midrange units of the CM3a have their rear radiation absorbed in separate and tapered cabinet sections. Flat baffles and frameless foam grilles eliminate image smear caused by unwanted diffraction. Good crossover design ensures smooth impedance curves, efficient transfer functions and minimal inter-driver modulation.

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HIGH WYCOMBE,
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HP11 2SB

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**SPECSIFICATION**

<table>
<thead>
<tr>
<th>Model</th>
<th>Dimensions: 402 x 295 x 271 mm wide</th>
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<tbody>
<tr>
<td>CM2a</td>
<td>200 mm Bass/Mid - laminated cone.</td>
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<tr>
<td></td>
<td>25 mm Tweeter - soft dome.</td>
</tr>
<tr>
<td></td>
<td>ferro-fluid</td>
</tr>
<tr>
<td>CM3a</td>
<td>725 x 591 x 302 mm wide</td>
</tr>
<tr>
<td></td>
<td>200 mm Bass Unit - plastic cone.</td>
</tr>
<tr>
<td></td>
<td>100 mm Midrange - plastic cone.</td>
</tr>
<tr>
<td></td>
<td>25 mm Tweeter - soft dome.</td>
</tr>
<tr>
<td></td>
<td>ferro-fluid</td>
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</tbody>
</table>

Crossover Frequencies: 3kHz

Efficacies: Silly to beyond audibility

Refrigerated Amplifiers: 8 ohms nominal

Recommended Amplifier Power: 10-30 watts per channel RMS

Net Weight: 13.4 Kilos (pair)

Cabinet Finish: Walnut veneer with brown foam fronts - optional black lacquer with black foam fronts.

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**Spark Quenchers**

A new range of high quality, competitively priced C-R Combination Spark Quenchers are now available from Roxburgh Suppressors Ltd.

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Archilffe Road,
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C117 9EN

Pack It Up
A new range of quick assembly, lightweight cushion packs called 'Shellpack', offering a high degree of protection for postage or shipment of vulnerable products, has been introduced by Abbott Packaging Ltd.

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The most important potential application for 'Shellpak' is seen in the electronics industry for a range of products, including printed circuit boards and semiconductors, although the excellent protective features of the pack are likely to make it of considerable interest to those despatching such delicate items as glassware, jewellery, photographic equipment, scientific instruments and precision engineering components.

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Abbott's Packaging Ltd.,
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London
N11 1HL

Further four models are planned to be introduced from Autumn 1983 onwards.

Further details about the Megger 1000 Series and the Avo 1001 analogue multimeter are available from:
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**Precision Speed Control**

Ferranti Electronics has recently introduced the ZN411E, which, with a minimum of external components, provides precise speed control for electric motors.

The ZN411 will operate from the AC mains or a suitable DC supply and has an on-chip shunt regulator. The circuit has a power-down reset facility and 'soft start', whereby the speed builds up smoothly to the set speed.

The circuit produces negative triac firing pulses and has a triac regenerative facility. It can operate in an open or closed loop mode and the tacho input is compatible with Hall Effect devices. Full drive is available with inductive loads and a current limit is also included. A reversing input on the chip (when operated) will stop the motor, which then goes through the soft start to reach the speed set for the reverse direction. The speed is limited in the reverse direction.

The device is available in an 18 lead plastic package. Full details are available from:

Ferranti Electronics Limited,
Fields New Road,
Chadderton,
OLDHAM,
Lancashire.

**Gang Of Eight**

A new Gang programming module is available from MSS (Microsystem Services), that will simultaneously program up to eight MOS PROMs, each with different data, in one operation.

Known as the DATA I/O GangPak, the module will accommodate word widths of up to 64 bits, using an interface technique which enables a single word to be spread across several PROMs.

The new gang module, which is compatible with DATA I/O 29A and 100A universal programmers, currently supports over forty industry standard 24 and 28-pin EPROMs and EEPROMs, using programming algorithms approved by each memory device manufacturer. Devices handled include the new single voltage EEPROMs, 16K x 8-bit EPROMs and 32K x 8-bit EPROMs. The machine will also read electronic signatures from JEDEC compatible 28-pin devices.

The ability to program a complete set of PROMs simultaneously, saves time by eliminating the need for separate
Some of the many features included as standard are: push button control of Ch 1, Ch 2, Add, Diff, Alternate and Chop MODES — front panel control of astig, trace rotate, scale illumination, focus, intensity and probe adjust — Ch 1 output and intensity modulation auto, normal, X-Y and ext trigger modes — switchable Ch 1, Ch 2, line and ext SOURCE modes plus V MODE, in which the sweep trigger source is automatically selected by the vertical axis mode, particularly useful in alternate mode, since each channel input becomes its own trigger source — trigger level and slope selection — AC and video coupling with a new video sync circuit providing video clamping to enable quick sync of both vertical and horizontal circuitry and provides an amazingly stable sync.

These full feature oscilloscopes measure 260(W) x 160(H) x 400(D)mm and weigh from 8.1 kg. They have all the performance and reliability you could expect from a high quality, professional oscilloscope. As is usual from House of Instruments, they are fully guaranteed for 2 full years including free pick up, repair and return. Models with a tilt stand/ carrying handle are available. Quixwood Ltd., 30 Lancaster Road, ST. ALBANS, Herts. AL1 4ET.

Pairs Of Trios

House of Instruments announce the first group in a brand new range of oscilloscopes from Trio. CS-1010, CS-1012, CS-1020 and CS-1022 are 10 MHz single and dual trace and 20MHz single and dual trace respectively.

The new range have large 6 inch rectangular CRTs with illuminated inner-face graticule and high accelerator potential. This ensures a bright display with high resolution, eliminating parallax reading errors, easing waveform observation and aiding photographic recording.

Each model has extremely high input sensitivity of 1mV/cm, continuously variable to 5V/cm. 1mV/cm is particularly valuable in conjunction with the 20 nsec/cm to 0.5 sec/cm sweep speed for observing, in detail, complex low level and fast changing waveforms including video, digital, pulse and audio signals.

out by the module, including identification of devices which have been plugged into the wrong socket, illegal bit checks, blank checks and two pass verification ensuring the device is correctly programmed.

Further information on the GangPak module and all other DATA I/O programmers and modules is available from: MSS, PO Box 37, Lincoln Road, Cresssey Industrial Estate, HIGH WYCOMBE, Bucks.

down-loading and programming operations. Data down-loaded from a host development system is automatically partitioned into the appropriate data blocks by the GangPak.

The GangPak further reduces programming time by employing the latest intelligent algorithms, which eliminate redundant programming pulses by checking memory cells after each pulse to see if they have been programmed. The GangPak is completely software controlled and is configured for a particular device by a four-digit code.

A comprehensive range of test procedures is automatically carried out by the module, including identification of devices which have been plugged into the wrong socket, illegal bit checks, blank checks and two pass verification ensuring the device is correctly programmed.

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**Concept** Audio

Panasonic is about to set a new trend in one-piece audio, with the launch of the new SG-X10, a three-in-one system (turntable, cassette deck and tuner) including speakers. Competitively priced at around £120, the SG-X10 is set to appeal to music enthusiasts of all ages.

The SG-X10 combines sound performance with futuristic styling. The turntable section features an unusual, recessed sloping observation window in the dustcover and a unique drawer-type, auto-stop cassette deck which slides in and out and can be played in either position.

It is not only design, however, which gives the Panasonic SG-X10 its universal appeal. It also offers impressive technical specifications for the price. Power output is 10 watts per channel and the amplifier section features slide controls (tone, volume and balance) and auto-source selection with five LED indicators for instant reference to audio function.

Compact in size (375W x 136H x 327Dmm), the SG-X10 comes in matt black finish and includes a pair of full range bass reflex speakers. It is available through Panasonic’s network of authorised dealers.

**BBI Micros**

Burr-Brown have enhanced their range of microterminals, all of which can now be supplied for operation over the extended temperature range of –25 to +85°C. In addition the TM71 and TM77 is now available with an RS422 serial interface.

The RS422 interface available on the TM71 and TM77 increases the number of applications for which the microterminals can be used. RS422, which is fast becoming the industry standard for serial digital communications, allows up to 99 microterminals to be multi-dropped on the same loop over distances of up to 1.5km. Communications between host computer and microterminal is in serial ASCII at baud rates selectable between 300 and 18,200 baud.

Burr-Brown’s microterminals are compact (216 x 114 x 15mm), can be easily mounted on any flat surface and provide a simple means of communicating with a computer or process control system. There is a choice of hexadecimal, decimal and alphanumeric keypads and 8, 12 or 16 character displays. One model even has a bar code reader. Most of the terminals also have LED status indicators which are controlled by the remote computer.

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**Take Your Pick**

Burr-Brown has introduced a new low-power monolithic operational amplifier that has a pair of independent differential inputs and a single output. Known as the OPA
Series Of Designs

Pye Telecom's newly launched range of frequency-synthesised mobile radios offers up to 250 channels. Designated the MX 290 series, Pye has developed a new generation of advanced multi-channel mobile radios with the widest choice of options and facilities which enable systems to be tailored to users' requirements from a range of standard products.

The series features a completely new concept in mobile communications - a direct dialing facility, in both directions, that provides fully automatic interconnection from mobile to mobile and from mobile to radio to PABX telephone subscribers. This facility is provided by Pye's E31 signalling module with its plug-in control panel that mounts on a standard variant of the mobile.

Microprocessor and CMOS circuits are used for optimum performance and high reliability and the series features keypad entry and the display of the selected subscriber's number. Optional features include mini-trunking with automatic vocalising, automatic paging and shortform dialling.

The heart of this new range of sophisticated transceivers is the frequency synthesiser, which eliminates the need for channel crystals. The only crystals in the set are the high stability reference and receiver's second oscillator crystals. Fast customer frequency programming is achieved by means of a plug-in programmable read-only memory (PROM).

Available in all standard AM and FM bands on VHF and UHF, the MX 290 series is constructed from a zinc alloy chassis which forms a rigid die-cast frame with a finned heatsink and die-cast covers. The choice of plug-in control panels means users can upgrade or modify their existing equipment to suit changing system requirements. A series of plug-in signalling modules is also available, offering tone-lock and 6-tone sequential or digital signalling.

The carrier level detector provides signal strength information to the signalling units, which enables them to execute the correct system response or to select the optimum base station when used in trunking applications. Broad band characteristics allow wide frequency separation in multi-channel systems. Transmitter power output is 10,15 or 25 watts depending on the frequency band or the type of modulation.

Pye Telecommunications Ltd.,
St. Andrews Road,
CAMBRIDGE
CB4 1DW

±18V power supply, the OPA 201 is ideally suited for use in battery powered equipment.

Both of the input stages have excellent characteristics, including a low offset voltage of 100μV maximum, a voltage drift against temperature of only 1μV/°C maximum and a low 25nA maximum bias current.

The combination of low power consumption and good performance suit this unusual operational amplifier for use in auto-zero systems, variable gain two-channel multiplexers, switchable input instrumentation amplifiers and other systems.

Burr-Brown International Limited,
Cassidy House,
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U.S. Project Pack Agents, Box 411, Grenville, New Hampshire, NH030408. U.S.A.
Comment

It's been a while since Jon Burchell and I had the opportunity to take as much part in the production of an issue of R&EW as we would have liked – there's been a lot going on in the 'background' which has taken most of our time over the past year or so. One of the ways we can help ourselves is to apply as much technology to the production of the magazine as possible, so that at least we are not going to get bogged down in the minutiae of things like actually getting the words stuck down once they're written.

Now we are pleased to say that we have assembled the ultimate system, where text written on portable editing terminals can be 'delivered' and turned into made-up pages within the space of about 5 minutes.

Since we have to suffer leadtimes of as much as 5 weeks when submitting adverts to other magazines, we are rather smug about the completion of this very long term plan to improve the production efficiency of R&EW to be the best in the business. We hope that we can also persuade our advertisers to take advantage of this remarkably short time from submission of price information to publication under the noses of the customers.

One Night Stands

We frequently get asked for some digestible features, without losing sight of the basic aim of R&EW to remain reasonably 'State of the Art'. We've been looking out for some concise communications oriented projects for a while, and so we kick off in this issue with the start of a series from Stephen Ibbbs.

Perhaps this will also help remind you that we are always keen to receive submissions of all types – not simply the 'big' projects, but plenty of the One Nighters as well, please.

This Issue

The personal computer phenomenon seems unstoppable. Every time anyone introduces a new personal computer, the trade gasps in astonishment that the market seems able to support an almost infinite number of mouths. The latest such blockbuster is the Oric, which neatly and roundly upstages the Spectrum and also gives the BBC micros a run for their money.

However, if you read our review of the Epson HX20 earlier this year, you may recall that R&EW is rather keen on the concept of total portability, and also freedom from RFI. A fully CMOS computer with LCD and battery supply has to be a great deal more useful than the most sophisticated multi colour games playing machinery.

The complete lack of information from Epson about software availability has yet to be rectified, but meantime Tandy have saved us the trouble of bothering Epson any further, since the Tandy model 100 knocks all else into a reasonably cocked hat. At last we have the ideal 'users' computer, with enough of a display to be useful, and a range of built-in facilities that no longer insult the intelligence of the user.

It seems very likely that the Model 100 will actually overcome the legendary disinclination of the bulk of the amateur radio fraternity in computing matters, since here is a computer that provides completely portable RTTY, CW, AMTOR etc. facilities, can control transceiver functions, can help design your next homebrew project and can communicate with standard information services (like REWTTEL, of course).

We'd like to think that the price tag won't be too much of a trauma. After all, it's the price of a good transceiver, and a great deal less weighty on the conscience if the 'welfare' of the wife and kids is likely to become a contentious point where pursuit of a hobby is concerned.

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