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Input sensitivity 600mV. Aux. input sensitivity 120mV. Power output 2.7 watts per channel. Output impedance 6.8 ohms Stereo headphone socket with automatic speaker cutout. Provision for auxiliary inputs - radio, tape, etc., and outputs for tape decks. Overall dimensions. Speakers approx 15½" x 6" x 4". Complete deck and cover in closed position approx. 15¼" x 12½" x 6¾

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Console size: Unit Closed — 17¼" x 11½" x 8½" (app.)

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This disco console is ideally matched for the Reliant IV and Diasonic 50 or any other quality amplifier. The unit is finished in black PVC with contrasting simulated real edges, diamond spin control knobs with matching control panel.

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The use of frequency modulation by radio amateurs as a communication system has generally been confined to the VHF and UHF bands. When used for this purpose it is essentially a narrow band mode radically different from that used for high fidelity broadcasting. Until now, narrow band frequency modulation equipment has been confined to articles appearing in various journals, but this manual is intended to present complete coverage of the subject from one source.

It is hoped that it will encourage the home construction of equipment which is truly narrow band, using the frequency or phase methods of modulation and taking full advantage of the mode by the use of the correct demodulator.

The relative freedom from interference to television, radio and audio equipment, and the excellent rejection of impulse noise, makes the mode attractive and economic for both fixed and mobile operation.

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1/8"
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50% 47% 6p
68% 8 ohm ceramic 8p
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**LEGISLATION**

Following our recent comments on the reception of privileged transmissions and the illegal use and sale of walkie-talkie type radios, we have, as a result, acquired quite a postbag from many of our readers. We apologise for the fact that we may have been unable to answer all your individual comments, but we are publishing a small selection of them in our Letters pages.

Comments have been wide and varied and much controversy has been aroused. Readers may judge for themselves whether or not our comments were justified. One particular point has arisen over the sale of “non UK licensable walkie-talkies” and this also applies to the sale of equipment that is licensable. This is the ease by which transmitting/receiving equipment, portable or otherwise, may be quite openly acquired. Anyone may purchase a transmitter/receiver without any formality whatsoever, simply by passing the cash over the counter, or ordering by post from a multitude of sources.

A considerable amount of radio interference, much of which is deliberate, is being caused to licensed users by other “sources”. There is no evidence, so far, to support some views that deliberate interference is being caused by licensed stations.

It is the unlicensed operator and the indiscriminate sales of transmitters/receivers to these persons that must be checked. It is essential that a measure of control be introduced to stop sales to non licence holders.

One suggestion that certainly meets with our approval, is that it should be a legal requirement that intending purchasers should produce the necessary licence before equipment of this nature is sold, and that the sale be recorded and registered. Of course, this will raise the battle-cry, “shades of 1984” but what is the alternative? After all, purchasers of TV receivers, firearms etc have their purchases recorded and the details are passed to the appropriate government licensing dept. It is quite clear that appropriate legislation is long overdue.

**LIONEL E. HOWES—Editor**

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**THE NEW TELEVISION**

Next month we have a surprise for you! A new, bigger and better Television magazine, starting with the July issue. The page size will be larger, and there will also be more pages. We have been experiencing increasing difficulty in getting all we want into each month’s issue of the magazine in its present form. Colour servicing, for example, calls for the inclusion of more and more complicated circuitry. This has been tending to squeeze out some of the other features we feel should be included. But with larger and more pages we consider we will be able to provide the service we aim to give.

---

**NEWS...**

**18th Longleat Mobile Rally**

This annual event, organised by the City of Bristol Group of the R.S.G.B., will take place at Longleat House, Longleat Park, near Warminster, Wiltshire, on Sunday, June 29th, 1975.

As in previous years the trade stands will be housed in spacious marquees. The rally starts at 10 a.m. and talk-in stations will be operational. 160 metres (G6YB/P) 1920kHz, 80 metres (G3JMY/P) 3755kHz, 2 metres (G3TAD/P) 145-00, 145-50MHz plus VFO.

There will be a walking DF hunt starting at 5 p.m. on 160 metres. Bring your DF equipment or your transistor radio converted to top band and join in the fun. All members of the family can take part in this.

As well as the trade stands there will be the grand raffle, RSGB book stand, bring and buy stand (no rubbish please), all goods to be marked with the price and name and call sign of the person selling the article. Refreshments will be available on site.

There is something for everyone in the grounds. The wild life park, the stately house, the gardens, children’s zoo and pet corner with plenty of space to picnic, park the car or just “rag-chew.”

Overnight camping as from 6 p.m., Saturday, June 28th, 1975.

Details from Brian Croker G3ULJ, 36 Portland Street, Staple Hill, Bristol, BS16 4PT.

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July-November 74

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NEWS...  NEWS...  NEWS...

Plessey distributor

PLESSEY Semiconductors have recently appointed Semiconductor Specialists as distributors for the Plessey range of IC's in the UK and North America.

Semiconductor Specialists are situated at Premier House, Fairfield Road, Yiewsley, West Drayton, Middx., and state that they will hold stocks in the UK, so that buyers can obtain their supplies of both Plessey and U.S. components from a single source.

Although large stocks of UK franchised products are held at the West Drayton depot, the firm further states that U.S. franchised products in stock at the company's Chicago warehouse are shipped to the UK every weekend and can be delivered in four working days.

New book

THE new book is written by Robert Brown and Mark Olsen entitled 'Experimenting with Electronic Music'. It's contents cover exactly what the title suggests and includes details on the construction of tone generators, a small electronic organ and a series of electronic modifiers such as tremolo, reverberation, and a chime device. Price is £1·50.

Other useful publications to help the novice understand the various aspects of electronics, comprise: 'Basic Maths Course' by Henry Jacobwitz, 'The oscilloscope' by George Zwick, and 'TV Tough Dog Problems Solved' by Art Margolis. Price for these books is £1·40, £1·75 and £1·75 respectively and are all available from the publishers Foulsham-Tab Ltd., Yevol Road, Slough, SL1 4JH.

Pyser look-out for antiques

PYSER LIMITED, sole UK distributors of Marantz high fidelity equipment, are in the market for "antiques". The company wishes to purchase certain "classic" high fidelity units in first-class condition, and at present the limit (with prices offered) is: Marantz 7C £100; McIntosh MC-275, £100; McIntosh MC-75, £90; JBL SA660, £90; JBL SA600, £60.

In addition, Pyser would like to hear from audiophiles who would like to sell other "classic" Marantz units in good condition. Contact Malcolm Blockley, Electronics Division, Pyser Limited, Fircroft Way, Edenbridge, Kent.

BREMA news

NEWS now from BREMA (British Radio Equipment Manufacturers Association) which must surely emphasise the economic climate that envelopes us all. They state that deliveries of colour TV's, whether UK-made or imported, dropped in Dec. '74 by 23% over the same period in '73. This brought the total for the year to 2·2 million, a fall of 20% compared with 1973. This may all sound pretty bad, but for the monochrome TV it's even worse! A total fall of 42% for the year's deliveries, resulting in a mere 810,000 sets being delivered.

This dramatic fall, however, is not limited to TV's; audio systems fell by 17% and radio receivers by 28%. It must be seen that if this trend continues, many people in the TV/radio industries will be redundant. This not only hits these people hard but, indirectly, thousands of others.

The MC 14435

THE MC 14455 3½ digit DVM i.e. the latest addition to the rapidly growing Semiconps Ltd. McMOS family and contains the logic for use in a dual slope integration A/D converter system. The device consists of 3½ digits of BCD counters, 13 memory latches and multiplexed BCD outputs. An internal clock oscillator is provided which needs only a single external capacitor.

In order to complete the system use is made of the MC 1505L dual-ramp generator and comparator. Only one external capacitor and two calibration potentiometers are required. Further gen from Semiconps Ltd., Northfield Industrial Estate, Beresford Avenue, Wembley, Middx. HAO 1SD.

Books received

Use of Microphones
By A. Nishida
Shows one how to choose microphones to suit various jobs, how to position them, move them, balance and control them etc. Price: £1·75

Focal Press Limited, 31 Fitzroy Square, London WIP 6BH

Dictionary of Data Processing
By Jeff Maynard
A dictionary for those wishing to keep abreast of current data processing terminology. More than 4,000 terms are defined. Price: £3·90

Newnes Butterworths Limited, 88 Kingsway, London WC2B 6AB

Television
By Heinz Kurth
The author takes the whole concept of television to pieces and shows how a TV camera takes pictures, how the image is broadcast, how the receiver works, how colour TV works, what goes on in the studio etc. Price: £5·50

World's Work Limited, The Press, Kingswood, Tadworth, Surrey

Colour Television Servicing (2nd edition)
By Gordon J. King
Deals with the servicing of PAL receivers in a down-to-earth manner and with a minimum of mathematics. It is divided into three sections the first looking at colour TV systems as a whole, the second studies the elements involved such as picture tubes, conversion systems, channels etc. The third section is devoted exclusively to matters of servicing.

Newnes Butterworths Limited, Borough Green, Sevenoaks, Kent TN15 6PH

Principles and Calculations for Radio Mechanics (Part 2)
By R. A. Bravery & A. P. Gilbert
The second of two volumes designed to meet the needs of students studying principles and calculations as part of the City & Guilds Radio Mechanics' Course 222.

Price: £1·90

Newnes Butterworths, 88 Kingsway, London, WC2B 6AB
MOST licensed amateurs began their specialised amateur activities by listening to some of the amateur bands. These bands are frequencies in the short wave range used by amateurs licensed to operate transmitting equipment. Once it was easy for anyone to listen to amateur transmissions, because general purpose all-wave and short wave receivers cover some of the amateur bands.

Due to the very greatly increased use of single sideband (SSB) transmission by amateurs, this is no longer so, since the carrier has been removed and as a result, their transmissions cannot be resolved by general purpose all-wave or short wave receivers. In addition, such receivers cannot be used for CW (Morse). This is a severe limitation to the interested listener who may wish to take advantage of the RSGB Slow Morse transmissions which are available in some areas, or who wish to gain speed in Morse reception.

Such limitations do not apply to a communications type receiver as this will be equipped to deal with AM, SSB and CW signals. On the other hand, such receivers require quite complicated circuits. An answer to the problem of receiving amateur SSB and...
Inside the receiver with the oscillator/mixer board to the right with input coils at extreme right. Oscillator coils L3/4 are positioned near the main tuning capacitor. The audio amplifier board is on the left.

CW signals can be found in the direct conversion receiver. This omits the frequency changer, intermediate frequency amplifier, product detector and carrier or heterodyne oscillator of the communications superhet. Instead, conversion of the incoming signal to an audio signal takes place directly.

**components list**

<table>
<thead>
<tr>
<th>Resistors</th>
<th>Capacitors</th>
<th>Semiconductors</th>
<th>Miscellaneous</th>
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<tbody>
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<td>C1 50pF SM</td>
<td>Tr1 40673</td>
<td>Coilmformers 10mm (7/8 in.) diameter, with cores (4).</td>
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<tr>
<td>R2 27kΩ</td>
<td>C2 100pF SM</td>
<td>Tr2 BC108</td>
<td>Ferrite beads FX115 (2). Ball slow motion drive (Jackson 4511/DRF). Knobs (4). S1 2-pole 2-way wafer switch. Jack socket, insulated. Case, flanged members 203 x 101mm (8 x 4 in.) (2), 127 x 101mm (5 x 4 in.) (2). 203 x 76 (8 x 3 in.) (2), flat plates 203 x 127 (8 x 5 in.) (2) (Home Radio). Aerial and earth sockets. Rubber feet</td>
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<tr>
<td>R3 4.7kΩ</td>
<td>C3 20µF 6V</td>
<td>Tr3 BC107</td>
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<td>R4 220Ω</td>
<td>C4 0.047µF</td>
<td>Tr4 BC109</td>
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<td>All 5% ± or ±4W</td>
<td>C5 220 µF 12V</td>
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<td>VR1 10kΩ log-pot with switch S2</td>
<td>C6 0.01µF</td>
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<td>VR1 10kΩ log-pot with switch S2</td>
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<td>C8 100µF 12V</td>
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<td>VC1 25pF variable (Jackson C804)</td>
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<td>VC2 100pF variable (Jackson C804)</td>
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**BANDS USED**

Of the amateur bands available, the 80 metre band (3.5 to 3.8MHz), will probably be of most interest for general reception of amateur signals, likely to be available at any time, while at weekends and evenings there is usually a great deal of activity. So the receiver is primarily intended for this band. However, Top Band, 160m (1.8 to 2MHz) coverage is also included, as this band carries Slow Morse, local and other transmissions.

Both these bands are influenced by seasonal, daily and other propagation changes, but it is unusual for 80m, in particular, to lack all amateur signals as this band is much used for regular Nets and other contacts.

**RECEIVER CIRCUITS**

In the circuit in Fig. 1. L1 tunes 160m and L2 tunes 80m, VCl with C1 in parallel providing suitable coverage. VC1 is panel operated and is peaked for best reception. Aerial coupling is via TC1, which can be set to suit long or short aerials. Pole SM1 of the switch selects either L1 or L2 as required. Tr1 is the converter stage signal passing to gate 1 of the 40675 which is internally diode protected, and thus much less liable to damage than an unprotected insulated gate transistor. For the reception of CW, Tr4 acts as a heterodyne oscillator, with injection to gate 2 of Tr1 via C15. When receiving CW, the pitch of the audio tone depends on the difference in frequency between the received signal and oscillator Tr4.

During SSB reception, Tr4 performs as the conversion oscillator, resulting in an audio signal appearing at the drain of Tr1. This audio is resolved into intelligible speech when Tr4 is so tuned that it is able to replace the carrier suppressed during transmission. If Tr4 is tuned to the wrong side of the SSB signal, the speech is inverted and unintelligible.
The second section of the switch, S1b, selects L3 for 160m, and L4 for 80m with VC2 giving approximately correct coverage. C12 and C13 are 1% or 2% silver mica capacitors and no adjustment is required, except to the coil cores, to bring the oscillator into the band.

Ferrite beads FB1 and FB2 are to avoid VHF parasitics, although this oscillator circuit was found to be very stable and reliable.

Audio signals from Tr1 are taken to a simple two-stage audio amplifier Tr2/3. Capacitors C3 and C4 by-pass the source of Tr1 at audio frequencies. VR1 is the audio volume control the output from the final audio amplifier Tr3 going to a jack socket.

**INDUCTORS**

The coils are all wound on 10mm (\(\frac{1}{4}\)in.) diameter formers with adjustable cores. L1, L2 and L3 are wound with 32SWG enameled wire, L4 is wound with 24SWG enameled wire.

L1 has 70 turns, wound in a compact pile. L2 has 40 turns, L3 has 32 turns and L4 has 20 turns, all close wound.
View from the rear of the completed receiver. If the potentiometer VR1 has a metal spindle it is important to check that it is isolated from the track, see Fig.1. If not, insulating panel bushes must be used. Leads between the coils and their respective tuning capacitors should be rigid and as short as possible.

Each winding is begun as near to the top of the coil former as possible. The wire can be secured with a little quick-setting adhesive, or with a turn or two of cotton or thread to which a little adhesive has been applied. After winding, the end of the coil is secured in the same way. A few touches of an adhesive, such as Bostick, can be applied to keep turns in place, but the whole windings should not be painted, varnished or waxed.

The bottom end of each winding is soldered to a tag. This will be held by one of the fixing bolts in contact with the metal chassis. The top end of each winding is cut to a suitable length to reach SI.

The cores of L3 and L4, in particular, should be fixed against further movement after adjusting them, by wax or thin elastic placed between core and former.

OSCILLATOR MIXER BOARD

The board is approximately 75 x 50mm (3 x 2in) and components are positioned as in Fig. 2. Begin by drilling holes for two 6BA bolts, which secure the tags MC. Later, additional nuts on these bolts will allow the board to be secured to the metal chassis, with a little clearance for underside wiring.

In most places the wire ends of components will be long enough to reach the various connecting points. Elsewhere, 22SWG tinned copper or other connecting wire can be used, with insulated sleeving where necessary.

No special care is necessary when fitting Tr1, except to avoid lengthy heating of the leads, as with any transistor. Other dual-gate FET's may be used in this circuit, but if they are not gate-protected it is
absolutely essential that the shorting wire supplied round the leads is not removed until R1, R2 and R5 are connected, at least.

When fitting Tr4, take the collector lead to R10 and the emitter lead to R11, as in Fig. 2. A piece of insulated sleeving slightly longer than the ferrite bead is put on the base lead, and bead FB1 is added. R8 and R9 are then soldered in place, with very short leads at the base. Bead FB2 is then fitted in the same way, and the base lead is taken through the board to C14.

Some flying leads are provided, for connecting later. One runs from C2, to C1, VC1 and S1a. A short projecting wire passes from the junction of C12 and C14, for VC2 and S1b. A connection is also provided from the drain of Tr1, R3 and C5, to go through the chassis to the audio amplifier. A red lead from R4 and R12 is the positive connection. The negative circuit is completed by the bolts MC.

![Fig.5: If a separate audio module is available stages Tr2 and Tr3 can be omitted. Connections for the Sinclair IC2 are shown here.](image)

**AUDIO AMPLIFIER**

The board 65 x 32mm (2 3/4 x 1 1/4in.) is assembled in a similar way, as in Fig. 3, with bolts MC again providing a connection to the metal chassis. The wire end of C7 can be taken through the board, then bent up to provide a connecting point for the lead from Tr1 drain circuit. A pin is inserted for the positive connecting point. Leads from here run to R4/R12, output jack and battery positive, the latter going through a hole in the board, with a clip soldered to the end of the flex.

Three leads run to VR1. That from C10 positive goes to the centre tap of VR1, while the outer taps go to Tr2 collector and positive line. Switch S2 is connected to the chassis and to a flexible lead with a negative battery connector.

Leads from Tr3 collector and positive run to the output jack. This must be an insulated type, giving complete isolation from the metal.

**CONSTRUCTION**

The flanged members form a rigid assembly and make a good case for the receiver when top and bottom are closed with flat plates. The general layout of items will be seen from Fig. 4.

The internal 205 x 75mm (8 x 3in.) member is raised about 52mm (2 1/4in.), and is set back about 40mm (1 1/2in.) to clear the drive, VR1 and other panel controls. It is necessary to place the member forming the panel inside the flanges of the sides.

Front, back and sides are secured together with the 4BA bolts provided, using the holes already punched for this purpose. Holes are drilled to take bolts to secure the internal member.

Fit VC1, S1 and VC1 about 40mm (1 1/2in.) from the bottom of the panel. The drive for VC2 is 50mm (2in.) from the bottom edge, so that VC2 clears the chassis. A clearance hole is punched for the drive, which is fixed with spacing sleeves and long bolts. VC2 is attached to a bracket, or to a piece of scrap metal, which is bolted to the front flange of the chassis. The drive and VC2 should be lined up correctly, so that tuning is smooth and easy. If needed, large or elongated holes can be provided on the bracket, to allow a little adjustment for this purpose.

If a different drive is employed, it should have a fairly high ratio, or tuning will be rather critical. The cursor is attached by two small screws.

Fix the two circuit boards in the way described, taking care that no short circuits can arise to the metal. Leads can then be taken to the two sections of the bandswitch, etc., as shown in Fig. 4. C1 is soldered directly across VC1. Insulated sockets provide for aerial and earth connections, the earth socket being connected to the metal.

**ALIGNMENT**

The cores can be provisionally located with each about 4 or 5 turns down from the top of the former, but this will have to be adjusted to secure band coverage.

If no other means of adjustment is available, each band can probably be located fairly readily at a time when there is plenty of amateur activity, such as on a Sunday morning. With the receiver switched to 80m, set the core of L4 so that amateur signals are heard throughout almost the whole swing of VC2. Tuning from the maximum capacitance position for VC2, CW signals should be heard for about the first one-third of rotation, and SSB signals for about the other two-thirds.

![Fig.6: A bandpass input can be formed by adding the above circuit but TC1 must be reduced in value, see text.](image)

Should it be possible to borrow a communications-type receiver, place a temporary wire from its aerial socket to near VC2 and adjust L4 so that the carrier picked up by the receiver can be tuned from about 5·5 to 5·8MHz. In the same way, adjust L3 for about 1·8-2·0MHz. Otherwise adjust L3 to bring amateur activity within the range tuned by VC2.

Subsequently, it is only necessary to adjust L1 on the 160m band, and L2 on the 80m band, so that VC1 can be peaked for best volume, throughout both bands. Here, TC1 will have some influence on tuning. With other than short aerials, TC1 should be unscrewed to quite a low value.

Should a signal generator be available, it can of course provide a means of adjusting the circuits for correct coverage.

---

*continued on page 158*
Already we know of 22,000 people who like our ideas.

In October of last year we ran several ads announcing a brand-new service for amateur electronics enthusiasts.

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THE Texas Instruments SN76013N and SN76023N IC audio amplifiers can provide a continuous output power of typically 5W RMS into an 8Ω loudspeaker when it is driven from a 24V power supply. The minimum output power before clipping obtainable from any device of either type is 4W into an 8Ω load or 3W into a 16Ω load using a 24V supply.

The absolute maximum permissible power supply voltage is 28V, but it is wise to regard the upper limit as about 24V so as to allow a suitable margin of safety.

The minimum recommended load impedance is 8Ω. Both ICs incorporate a finned heat sink made of extruded aluminium providing a total effective area of about 75 square centimetres in a small space. Its efficiency can be appreciated by the fact that the absolute maximum continuous output power rating into an 8Ω load is 8W RMS at 25°C, or 6W at 70°C.

The quiescent power supply current at zero signal is about 10mA at a power supply voltage of 24V.

AVAILABLE TYPES

The only difference between the SN76013N and the SN76023N is in the feedback circuit. No internal feedback components are included in the SN76023 device and suitable external components must therefore be employed. This increases the versatility of the device, since tone controls can be used as part of the feedback circuit.

The SN76013 contains two internal feedback resistors which minimise the number of external components required. The gain of this device can be reduced of necessary.

The SN76013 and SN76023 are each available in either a dual-in-line package which has a gap in the centre of each line of pins or a quad-in-line encapsulation in which alternate pins on each side are bent so that one can see four lines of pins when the device is viewed from one end. The same gap is present at the centre of each line of pins.

The SN76013ND is electrically identical to the SN76013N but has no metal fins, possessing instead a metal tab at the centre of each of the two lines of pins. It provides a minimum output power of 3W into a 15Ω load, but the use of a load of smaller impedance may result in the device overheating owing to the absence of cooling fins. It can be used in the same circuits as the SN76013N, but will not be discussed further here.

SN76023N AMPLIFIER CIRCUIT

A typical circuit for the use of the SN76023N as a power amplifier is shown in Fig. 1.

The bias voltage at pin 2 is smoothed by R2 and C2 to remove mains hum or any other signals on the power supply line which reach pin 2. The bias is then applied via R1 to the input pin 1. The value of this bias voltage determines the mean output potential at pin 6.
If a well-smoothed power supply is employed, C2 may be reduced to 0·1µF. There is no point in increasing its value above about 10µF, especially as the use of a large value will result in a short time delay at switch-on whilst this capacitor charges.

The input impedance of the circuit is approximately equal to R1, since the input impedance of the integrated circuit itself is well over one megohm.

The optimum value of C5 depends on the type of power supply employed. If a well-regulated mains power pack is used, C5 may be as low as 0·1µF, but for the other types of supply it should have a value of at least 100µF—preferably considerably more when batteries are used. C5 should be soldered as close to the integrated circuit as possible. Alternatively a 0·1µF capacitor may be soldered directly between pin 10 and ground and a larger electrolytic capacitor in parallel with it at a more convenient point.

Frequency compensation is provided by C4. The value shown will provide low distortion at frequencies approaching 100kHz. Instability may occur if the value of this component is made too small in an attempt to raise the upper frequency limit for non-audio applications.

The value of C6 is not at all critical; this component maintains high frequency stability on negative going half cycles by compensating for the difference between two internal complementary transistors.

The low frequency response is mainly determined by the value of C8. This component prevents the loudspeaker from taking a steady current from the output of the amplifier. The filter C7-R6 compensates for the inductance of the speaker.

VOLTAGE GAIN

The voltage gain of the circuit is equal to (R4+R5)/R3. If the values shown are used, the gain is about 270 or about 46dB. If R5 is increased to 4700, the voltage gain falls to about 57 or about 35dB. R3 should not be increased above about 1kΩ (at which value the gain is 28 or about 29dB) unless an additional capacitor is connected between pins 1 and 16 to reduce the gain at very high frequencies and thereby maintain stability.

The value of the feedback resistor R4 can be increased to give a very high gain, but this will result in increased distortion and the circuit will be more prone to instability. In addition, there will be a delay at switch-on as C3 charges through R4.

THE SN76013N CIRCUIT

The SN76013N may be used in the same type of circuit, but the following modifications must be made to the circuit of Fig. 1.

(a) The feedback resistor R4 is omitted, since an internal 25kΩ resistor is connected between pins 6 and 16 of the SN76013N device.

(b) The SN76013N contains an internal 100kΩ resistor which functions as R3 of Fig. 1. The inverting input is not connected directly to pin 16, but via the 1000Ω resistor. If a voltage gain of 250 (about 46dB) is required, C5 is connected directly between pin 16 and ground. If a lower gain is required, an additional resistor is connected between pin 16 and the upper end of C3. This additional resistor will be in series with the internal 100kΩ resistor.

PERFORMANCE

The output power from these devices is plotted against the supply voltage for distortion levels of one and ten per cent in Figs. 2 and 3 respectively.

The minimum supply voltage at which the devices will function satisfactorily at low power is about 8V. Although a speaker of impedance greater than 8Ω may be used, the power delivered to the speaker at any given value of the supply voltage will be reduced as shown in the graphs.

The power dissipated in these devices can reach about 3·8W with a 24V supply or 5·4W with a 28V supply when an 8Ω loudspeaker is used. The corresponding figures for a 15Ω speaker are about 2·1W and 2·6W.

RADIO RECEIVERS

The writer has used the SN76023N in the circuit of Fig. 1 with an input from a t.r.f. radio receiver using the ZN414 device. The supply voltage was 9 to 12V.

It was found that the gain was rather too high and therefore the value of R3 of Fig. 1 was increased to 3300Ω. This comment will probably apply to the use of the Fig. 1 circuit with most radio tuners. It would have been necessary to increase the power supply voltage if the output of 5W had been required.

These audio amplifiers can also be used with superheterodyne IC radio receivers such as the TBA 651, LM1820, µA720, etc.

USE IN RECORD PLAYERS

The circuit of Fig. 4 shows how the SN76023N can be used with a record player employing a ceramic cartridge. This relatively simple circuit includes separate bass and treble controls and a volume control.
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If a stereo system is required, the additional components shown dotted may be employed to provide a channel balancing control. The lower end of VR4 would be connected to the slider of the volume control in the other identical channel.

The 27kΩ resistor R9 is the main feedback resistor which passes the feedback current to the tone control network.

A power supply unit is shown in Fig. 4 which is also suitable for use with the circuit of Fig. 1. If the lead to pin 10 is not short, an additional 0.1µF capacitor should be soldered close to the integrated circuit between pin 10 and ground. It will provide a low impedance at high frequencies and will thus preserve stability.

**AVAILABILITY**

The SN76013N and the SN76023N are available from S.D.S. Components Ltd., Hilsea Industrial Estate, Portsmouth, PO3 5JW at £1.57 each plus V.A.T. plus 20p packing and postage.

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**ACROSS**

3 The airman's voice in stereo? (5, 4)
8 A tester set this short one ... (4)
9 ... and essences to test this mike distortion! (9)
10 Cable erosion joints don't look straight (4)
12 Put unclean material on the air? (4)
14 Echo irking the group inside (5)
15 Box handled only with gloves on? (4)
17 Stationary selector? (5)
19 The law for resistance units? (4)
21 Non-transmitters (5)
22 Six to one it's such a triode! (4)
26 Head of a solid state for oiling? (4)
27 Solar orbit makes speakers hum? (5, 4)
28 Shorten aerial for a bit of opera? (4)
29 Annoyed about such a network? (9)

**DOWN**

1 Quite a dish with open-air Mike! (9)
2 A graphic account of a signal success (8)
4 One girl got me to switch up, boss ... (4)
5 ... and another's ring is radioactive! (5)
6 Rough ways to make L.P.'s? (6)
7 Component between arm and head (4)
11 Painting transistors back and front only! (3)
12 It's groovy before you hear a sound! (3, 2)
13 Tape device to rub out the chief! (5, 4)
16 Modulators containing liquid? (8)
18 Short value with ship-to-shore link? (3)
20 America is solid with them (6)
23 Reception's not so hot in this house? (5)
24 Den a beginner on this broadcasting? (4)
25 The magnetism of that Rod! (4)

FOR AMUSEMENT ONLY

ANSWERS NEXT MONTH
This, the fourth and final part of the PW Easybuild Organ, covers in detail the construction of the cabinet, the dimensions required to cut out the aluminium cover plate, and the final wiring of the keyboard and pitch switches.

As with the rest of this project, follow the details of the cabinet very carefully to prevent any problems which might arise with parts not fitting exactly. The cabinet design has been kept as simple as possible avoiding any fancy carpentry. Most of the structure is held together with butt joints, pins and resin glue. Chipboard, plywood and softwood battens are the basic materials required but the final attractive appearance is obtained with iron-on wood veneer which also covers the less attractive details of the assembly!

CABINET CONSTRUCTION

Stage one is to make the basic structure which is, in effect, a shallow tray comprising a base made from 6mm (1/4in) plywood with 12.5mm (1/2in) chipboard ends and back, Fig. 14. An elliptical aperture for the speaker is cut at one end of the back, using a coping saw, while a recess can be cut in the outer surface if one wishes to use an inlaid loudspeaker grill which will give the back surface of the finished organ a nice flush appearance. No details of this grill are shown because it is felt that readers can use their own initiative here. The prototype used a commercial grill made from thin strips of wood glued to hessian.

The two sides and back are glued and pinned into position and a strip of softwood is similarly fixed along the front edge, giving extra strength to the edge and finishing off the gap which would otherwise be under the keys. A notch has to be cut in one end of this batten for the aluminium cover which is fitted later.

A long batten is fixed towards the rear of the tray to which the keyboard hinge is screwed, likewise two short blocks are required at either end of the keyboard so that it can be firmly screwed down into place. Make sure that these pieces are accurately located otherwise the keyboard will not fit properly.

Stage two is to make and fit the supporting battens for the two printed circuit boards. These are glued and pinned into position as shown in Fig. 14. The main printed board should fit snugly into the back left hand corner of the cabinet and be supported on all edges. The power supply need only be supported along its two longer edges. Make sure that the battens are not too high otherwise the top of the transformer might protrude.

FITTING INTERNAL COMPONENTS

The third stage is to fit the internal component parts into place. Start with the keyboard. The hinge should be opened up horizontally, and when resting on the long batten, the two side support blocks should just fit under the end flanges of the keyboard sub frame. Ensure that the busbars are short enough at the ends not to foul on these blocks! The front edge of the keys should be just about flush with the front edge of the cabinet; they should be inset rather than proud. Screw the hinge firmly to the long batten but do not, at this stage, screw the end flanges down to the support blocks.

Place the main PCB in position and when satisfied that it is seated correctly, screw it down on all four sides. Hinge the keyboard up and carefully lay the bunch of wires, that will form the loom, under the keyboard and then shut the keyboard down on them for the time being. There should be sufficient clearance for the wires to run between the hinge batten and the left-hand end support block.

Next screw the power supply PCB and loudspeaker...
into position. Cut to shape, but do not fix, the two keyboard cheeks. These are made from softwood and veneered to match the cabinet Fig. 15. Note that the left-hand cheek has a recess along two edges to match the recess in the end of the front strip, for locating and fixing the aluminium cover plate. The cheeks will ultimately be fixed into position from the underside of the cabinet with long thin screws. They take very little strain and really only serve to finish off the appearance.

At this stage, cut, bend and grain (with wire wool) the aluminium cover plate, shown in Fig. 16. Fix the three switches and two jack sockets into position and make any adjustments so that it will fit over the slider controls of the main PCB, without fouling. This can now be put to one side because the connections to it will be made later. Finally assemble the lid which is designed to fit on to the top of the cabinet and be fixed with three screws, one in each end and one in the centre of the back. To finish the cabinet, veneer all visible exterior surfaces, not forgetting the inside surfaces of the two ends.

LOOM CONNECTIONS

First connect the three leads from the power supply board to the three corresponding terminals on the main PCB. Run leads from the OV and LS1 pins of the main board to the loudspeaker and mains leads to S1 and the power supply board. Now complete the loom wiring by hinging up the keyboard.

Take a piece of twine about 1.85m (6ft) long and gently bundle the 60 wires together about 50mm (2in) away from the main PCB. Do not put too much strain on them and make sure there are no kinks. They should give the appearance of long hair converging to the top end of a plait. Instead of plaiting the wires they should be kept as straight and as parallel as possible once they have been formed into the bunch. Use the twine to tie the bunch securely and then tie a tight loop of twine round the wires approximately every 25mm down their length while forming the loom round and under the keyboard.

When the corner has been negotiated and the loom is close to the tags for bottom “C”, locate the wire which carries the flag number 31 and cut it to length so that it can be neatly soldered to the tag which carries RK2. After soldering into position tie another loop around the loom and then cut and solder wire

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Fig. 14: The complete cabinet, showing internal construction and the veneer on exposed surfaces. Sizes for the individual sections are obtained by noting the relevant letter on the section and referring to the table immediately above this figure.
56 to the next tag; tie another loop and then work steadily down the keyboard referring all the time to the wiring schedule, connecting one wire at a time and carefully and neatly tying the loom tightly after each soldering operation.

After the first two or three connections it will be found to be quite a simple operation and it has the distinct advantage that it gets easier as the loom gets thinner. If this step is done neatly, a great deal of satisfaction will be gained from the end result. It will look neat and professional, but more importantly, will give a strong, reliable job.

BUSBAR CONNECTIONS

The next stage in the construction is to connect the busbars via the switches to the main PCB, Fig. 17. Use screened pick-up lead for this and make sure the screen is earthed exactly as shown. Two of the connections go straight to the board while two go via S2 and S3. A little loose cable can be left under the aluminium cover plate so that it can be readily lifted out of position without the leads restraining its movement (do not forget the solder tag under one of the switch fixing screws). The screened leads should roughly follow the same routing as the loom and, if wished, could be anchored to the loom with twine to stop them flopping about under the keyboard.

TESTING

The organ can now be tried out properly and final tests and adjustments carried out as follows:

Assuming that the main PCB is exactly as it was left after the initial tests it should be possible to apply power, and with the vibrato at minimum and volume at maximum, be able to advance each “voice” for each of the two pitches in turn and get a sound from the loudspeaker for every note on the keyboard as the keys are depressed. There will be much less volume than previously because the keyboard series resistors have been introduced which reduce the output level to about 1/50 of the original. It is possible to compensate for this by increasing the gain of the busbar pre-amplifiers and, if that is not enough, by means of VR15.

Check that every note sounds correct at each pitch. If not, check for bad connections in the line for that note. Try playing several notes at the same time and then a tune. It may be that you will hear a
sort of click as you play some notes. This is to be expected and is most likely caused by the key contacts making before they break from the earth busbar. For a fraction of a second the whole busbar will be shorted to earth as the offending keys are pressed.

To correct this, methodically go through every 'b' wire of the contact while listening to sounds at 8ft pitch only. Press bottom "C" and keep it pressed; very slowly depress C
d next to it, and if the sound of bottom 'C' disappears at a certain depression of C
d then it means that the 'b' wire of the C
d contact block furthest away from the 'a' wire must be moved. A pair of forceps helps make this a very simple operation.

Having cured C
d, move on to 'D' while listening to C
d, and adjust the 'b' wire for note 'D'. Carry on like this for every note on the keyboard and then start again by adjusting the 'c' wire while listening to notes at 16ft pitch. It sounds a formidable job but in actual fact is very quick and quite interesting and curiously relaxing!

OUTPUT MATCHING

The keyboard can now be screwed down via its end flanges and the end cheeks fixed into position which hide the flanges from view. It is now necessary to break the shorting links at A/A1 and B/B1 on the main circuit board and connect the output jack sockets as shown in Fig. 17. Before fixing the cover plate into position permanently, test the phono output by feeding from the correct jack socket to a radio tuner or ceramic cartridge input of a hi-fi system. Set the volume control of the main amplifier to the level normally used and try playing a tune. The output may be lower or higher than expected, in which case use VR15 in the organ to set the output to match the levels normally associated with the volume setting of the hi-fi system. This action however, may cause the loudspeaker inside the organ to be either overloaded or too weak. In order to overcome this problem leave all the preset controls as they are and change the value of R29.

This can be done by reducing its value (to prevent the loudspeaker overloading when the volume control is set to maximum) by shunting it with another similar value resistor and keep reducing the value of this shunt resistor until a satisfactory state of affairs is reached. If however the output from the internal loudspeaker is too weak after all the adjustments to match the hi-fi system have been made, the value for R29 should be increased. This is achieved by carefully cutting one of R29's leads on the top side of the board and inserting another similar value resistor in series with it.

COMPLETION

The organ is now complete and the aluminium cover plate can be screwed into position; fix the top and give the veneer a polish with good quality wax. Finally check that everything is working satisfactorily, the fine tuning, the vibrato, the keyboard splitting switches and then, if you are anything like the author, get some lessons on how to play it! Or start on another one for your neighbour!

Notes

It has been brought to our attention that the connections of certain manufacturer's 747 IC's (IC14 & IC15) do not conform to those used by the author. We therefore advise all constructors to check the positive supply to pins 9 and 13. The IC's used by the author, and the subsequent circuit board published, assumed that all 747's had pins 9 and 13 internally shorted. This is not always the case. Link pins if necessary.

H. L. Smith, 287 Edgeware Road, London, W2 have agreed to supply the cover plate. Material used will be 16SWG aluminium and it will be bent and cut to size with the control slots machined out. Price is 75p or £1·06 by post. Both prices are inclusive of VAT.

Studio Electronics, PO Box 18, Harlow, Essex. Tel: 0279 416771 have informed us that they will be able to supply ready-built cabinets and all components including the keyboard, IC's and PCB's. Prices on request.

Integrated circuits, transistors and diodes are also available from Marshalls, 42 Cricklewood Broadway, London, NW2. Tel: 01-482 0161.

Another manufacturer who is willing to supply both main and power supply printed circuit boards for the Easybuild Organ is WKF Electronics, Welbeck Street, Whittall, Worksop, Notts. Price for both boards, which are constructed from fibre glass and roller tinned is £5·50 plus 25p p & p.

For the more adventurous constructor, PW is offering a full-size paper drawing of the main PCB, showing track layout. For those who require one of these, please write, marking envelope 'Easybuild Organ' to Practical Wireless, Fleetway House, Farrington Street, London EC3A 4AD enclosing a PO or cheque for 25p and a 10 x 8in S.A.E.
TAKE NOTE
It's getting harder and harder these days to make a dishonest living. Take forgery of banknotes as an example. In this field, electronics is making it really difficult. Onto the US scene has come a midget bank note forgery detector—and it's hand held, too.

Far from being a leg pull, the device is quite ingenious and has certain patented ideas within it. Basically, all US notes are printed in an ink which contains certain ferrous oxides. What the detector does is to magnetize these inks as its read/write head (rather like a tape recorder's) is passed over the note. On striking the detector back across the note again, it will immediately flash a light if the note is genuine. On its return path, the read/write head is detecting the residual magnetic field on the finel engraved lines of the money. If the light fails to flash, it's a forged note. The unit itself is less than half the size of a one dollar note, requires only a single activating button to be depressed to operate it, and it runs from a 9V battery.

ORGANITIS
Exponents and enthusiasts of the electronic organ will delight in hearing about a new IC from SGS Ates, the Italian semi-conductor manufacturer. The new chip, called an arpeggio/chord generator makes even the beginner sound like an accomplished organ player. For while he plays a simple one note melody on the top keyboard, the new IC will produce the correct chord for accompaniment and the bass notes also. So with a single note playing, you get the correct chord accompaniment and bass—all from a single chip.

Also from SGS Ates come two new rhythm generator chips. Eight instruments and twelve rhythms are offered but two of these rhythms can be used at the same time thus offering a wide variety—again from a single chip. I suppose the ultimate will be when some semiconductor manufacturer brings out a complete electronic organ on a chip; all you'll have to connect will be a keyboard and a set of tabs switches to select voices and rhythms.

“KEEPING CHEQUE"
Talking about money (Ginsberg's favourite topic) I note with interest the launch of a "computer check book". It's not available in the UK yet but it seems a very good idea. The entire unit is about the size of a cheque book case and it quite simply keeps the balance of your bank account continually in its mind—figuratively speaking. It'll do this for about a year. The device utilises a shift register type of memory and requires very little current indeed. What a wonderful idea—just have a super overdraft and let a shift register worry about it! (Dare I suggest that this might register a shift in responsibility?)

LASER LINK
I see that yet another application has arrived for the laser. This time it's Xerox who is using in its latest facsimilie (fax) machine. This is a unit which can be connected to the telephone, and documents, letters or photographs etc. can be transmitted to one of the terminal stations at the other end of the telephone line. What is remarkable is that the new copier takes only 120 seconds of line time to transmit the document. Besides employing a helium-neon laser and being very fast it has another interesting "plus". Most copiers need special paper, but this telecopier uses plain, unsensitised paper.

At the 120 second speed, resolution is around 6,200 picture elements to the square inch, but if you run at 180 seconds this can be improved on. Don't bank on having one as a toy—the price stands at around the equivalent of £3,400 although leasing one works out at £78/month plus extra charges per document sent over a certain number.

VIDEO DISC
A German manufacturer has launched a TV video disc system, which is compatible with US, French and Japanese standards. The system is currently offered for sale in West German radio and TV stores for around the £250 mark. At present there are around 50 different records to choose from but this should increase to about 300 plus by the end of this year. Titles include, children's programmes, education and entertainment. The records last for about 10 minutes (in colour) and cost something like £1-60p each. Perhaps, in the near future, you'll be able to see as well as hear a performance when you buy a record?

BUG FINDER
Are there bugs in your house? Not the hairy, creepy kind, the electronic sort? If there is a bug about, the new development from Britain's EMI will sniff it out. Designated Bloodhound, the device is a wideband receiver. Most of the listening bugs around consist of an F.M. solid state transmitter with a range of a few hundred yards at best. The microphones in these devices can normally detect conversation at anything up to about 30ft.

Unfortunately for this type of bug Bloodhound's sensitive little earholes can listen over a very wide band—300MHz and it can soon ferret out listening devices, even those attached to telephones or mains wiring. So if something's bugging you, this could be the answer.

FOURIER CHIPS
The quest to pack more and more on a single IC chip continues. The latest to catch my eye has been one which carries out things called Fourier transformations. This is a method of analysing a signal into its many component parts and is very useful in military/security applications where one can identify a wanted signal from a masking signal etc. The new chip will perform fast Fourier transforms in a few milliseconds—something that normally takes a digital computer. Perhaps the most impressive thing is the density of packing on the device. The chip size is only a meagre 270 thou. by 350 thou. and the manufacturers have managed to pack what amounts to a 13,000 transistor capability in this tiny area. Makes that tiny transistor portable of yours that you thought was small look a bit silly doesn't it?
UPDATE your

PRACTICAL WIRELESS

TEXAN stereo amplifier...

...with the

TEXAN II

Improve the performance with a few simple modifications. New toroidal-wound mains transformer gives higher power output per channel. Reduced susceptibility to mains-borne interference. Plusoptional tape monitoring facility.

VARI-CAP AM/FM STEREO TUNER

All electric tuner using varicaps... double linear phase filter IF strip... stereo decoder with lowpass filter and stereo beacon. Modular construction allows choice of FM or AM facilities, or both.

DON'T MISS THIS EXCITING ISSUE!

ON SALE IN JUNE
To anyone possessing an oscilloscope, a waveform or function generator is a very useful but expensive item of test gear. There are a number of excellent commercial instruments available, the least expensive of these being in the Heathkit range of generators. The instrument described in this article is cheaper than any of the commercially available units and gives a very useful performance. Some sacrifices have of course been necessary, but in general these do not detract from the instruments’ usefulness for the majority of applications.

PERFORMANCE

The generator provides selected sine, sawtooth or square waveforms having a maximum peak amplitude of 10 volts. The calibrated frequency range is 0.1Hz to 100kHz with an additional “high” range giving useful signals up to 1MHz. An unusual feature of the instrument is the decade switching giving “period” or time, instead of frequency. If for example, the decade switches were set to a “period” of 10^-5Sec, this represents the time interval between the signal peaks. Frequency is given by the reciprocal of this period i.e. 1/10^-5 = 1/10^-1 = 100kHz. A period-to-frequency conversion chart will be given later. This form of presentation together with a “decimal point” using light emitting diodes (LED) makes the instrument particularly useful when employed with a modern oscilloscope. A DC shift control is also provided, capable of shifting the signal ±5 volts. By this means the signal may be either positive going 10 volts, negative going 10 volts or symmetrical about earth ±5 volts. An attenuator is also provided so that the signal and DC shift may be used at low levels.

Unloaded, the attenuator gives the following approximate peak voltages 10V, 2V, 1V, 200mV, 100mV, 20mV, 2mV and 1mV. Loads as low as 600 ohms can be driven with reasonable accuracy on the 1 to 20mV ranges. On the higher ranges loads must be greater than 100kΩ in order to maintain attenuator accuracy. If accuracy is unimportant the instrument will drive 2kΩ on the higher ranges and even smaller loads, less than 600 ohms, on the low ranges.

Fig. 1: Block diagram of the Intersil 8038 waveform generator IC. The lower diagram shows the pin designations.
CIRCUIT DESIGN

The generator design is based on the Intersil 8038 IC waveform generator (see Fig. 1) capable of producing sine, square or triangular waveforms. Two types are available, the 8038CC, which is the cheaper version, and the 8038BC, which has a superior performance; another model the 8038AC has a military specification, but is rather expensive for use in this application. The 8038BC has been selected for this instrument. However, some users may be able to make do with the cheaper unit. A certain amount of component selection is necessary to achieve the best from the circuits.

The constructor has a number of options open to him with regard to performance and simplicity thus:—

1. 8038 BC with component selection (gives maximum performance)
2. 8038 BC with components as designed (gives a reduced performance)
3. 8038 CC with component selection
4. 8038 CC without component selection
5. 8038 BC with a simplified circuit
6. 8038 CC with a simplified circuit.

The performance gets worse as one approaches option Number 6, but for those people who want waveforms, but are not particularly concerned about accuracy, then option 6 is the cheapest. Options 5 and 6 use a simplified circuit which will be dealt with in a later article.
The circuit diagram is given in Figs. 2 to 5. Frequency or period range is controlled by capacitors C1 to C7 selected by switch S1a. Switch S1b operates the LED decimal point indicator. Position 1 is the seconds range where the first LED (D3) is lit. The maximum period which may be set on this range is 9.99 seconds (0.1Hz). Position 2 is calibrated in milliseconds and the last LED (D1) is lit. This means that the switches can be set to 999 milliseconds, i.e. 1Hz approximately but 1Hz can be obtained precisely on range 1 by setting the switches to 1.00 seconds. However, in practice this fine distinction is outside the capability of the instrument. The period adjustment is carried out on switches S2 to S4 connected to pins 4 and 5 of the 8038 (Fig. 5).

Capacitors C8 and C9 are decoupling components which must be mounted close to the IC for optimum performance. R1 is a current limit resistor for the light emitting diodes and may be reduced in value to give more current in the diodes if necessary. R2 is a load for the 8038 whilst R3 to R5 set the voltage levels for each of the output waveforms. VR1 and VR2 are used to adjust the purity of the sine wave output. C10 is a decoupling capacitor.

---

Fig. 2: Circuit diagram of the main generator section of the waveform generator. The light emitting diodes D1-D3 are the decimal point indicators on the front panel. The capacitors C1-C7 are nominal values and must be adjusted for required accuracy.

Fig. 3: Wiring of the three period select switches. These allow period to be varied over a range of 1000 to 1.
**components list**

<table>
<thead>
<tr>
<th>Resistors</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1 1kΩ</td>
<td>R65 1kΩ</td>
</tr>
<tr>
<td>R2 2kΩ</td>
<td>R66 6.4kΩ</td>
</tr>
<tr>
<td>R3 20kΩ</td>
<td>R67 2.4kΩ</td>
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<td>R4 68kΩ</td>
<td>R68 2.4kΩ trim</td>
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<td>R5 3.9kΩ</td>
<td>R69 2kΩ</td>
</tr>
<tr>
<td>R6 10kΩ</td>
<td>R70 200Ω</td>
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<tr>
<td>R7-R14 10kΩ</td>
<td>R71 8kΩ (4.7k + 3.3k)</td>
</tr>
<tr>
<td>R15 10kΩ</td>
<td>R72 1kΩ</td>
</tr>
<tr>
<td>R16-R20 10kΩ</td>
<td>R73 800Ω (470 + 330)</td>
</tr>
<tr>
<td>R24-R32 1kΩ</td>
<td>R74 1kΩ</td>
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<tr>
<td>R33-R41 1kΩ</td>
<td>R75 80Ω (47 + 33)</td>
</tr>
<tr>
<td>R42-R50 100Ω</td>
<td>R76 10Ω</td>
</tr>
<tr>
<td>R51-R59 100Ω</td>
<td>R77 8Ω (4.7 + 3.3)</td>
</tr>
<tr>
<td>R60 6.8kΩ</td>
<td>R78 1Ω</td>
</tr>
<tr>
<td>R61 10kΩ</td>
<td>R79 1Ω</td>
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<tr>
<td>R62 4.7kΩ</td>
<td>R80 1.2Ω 2.5W wire-</td>
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<td>R63 56kΩ</td>
<td>R81 1.2Ω wound</td>
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<tr>
<td>R64 110Ω</td>
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All ± 5% ±W unless otherwise stated

<table>
<thead>
<tr>
<th>Capacitors</th>
<th>Values</th>
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<tr>
<td>C1 30μF 25V</td>
<td>C10 1μF</td>
</tr>
<tr>
<td>C2 3μF</td>
<td>C11 10μF</td>
</tr>
<tr>
<td>C3 0.3μF</td>
<td>C12 1000μF</td>
</tr>
<tr>
<td>C4 0.03μF trim</td>
<td>C13 1000μF 50V elect.</td>
</tr>
<tr>
<td>C5 300μF</td>
<td>C14 0-22μF 50V</td>
</tr>
<tr>
<td>C6 300μF</td>
<td>C15 100μF 25V elect.</td>
</tr>
<tr>
<td>C7 30μF</td>
<td>C16 1000μF 50V elect.</td>
</tr>
<tr>
<td>C8 1μF</td>
<td>C17 0-22μF 50V</td>
</tr>
<tr>
<td>C9 0.33μF</td>
<td>C18 0-22μF 25V elect.</td>
</tr>
</tbody>
</table>

Capacitors and resistors marked “trim” are nominal values and should be trimmed to working values using the method to be described in the text.

**Semiconductors**

- IC1 8038BC (see text)
- IC2, IC3 MVR15V (RS)
- D1-D3 TIL209 light emitting diode (3 off)
- D4, D5 REC76 (RS) or similar 200V, 2A bridge rectifier (2 off)
- Tr1-Tr3 BC184 (3 off)
- Tr4 BC214

**Switches**

- S1 2 pole 7 way
- S5 2 pole 3 way
- S2 2 pole 9 way
- S6 1 pole 9 way
- S3 2 pole 10 way
- S7 Double pole mains
- S4 2 pole 10 way

**Miscellaneous**

- T1 Mains primary, 0-20V 0-20V 30mA secondary
- LP1 Main neon indicator
- Sk1 BNC socket
- Instrument case 432 x 200 x 88mm (RS type 4) with tilt bail (RS type D), knobs 28mm (4 off), Knobs 14.5 mm (3 off), Veroboard 0-1in matrix 330 x 70mm (13 x 21in), 80mm 4BA studding (4 off), 25mm stand-off (4 off), finned heat sink 50 x 50 mm (2 x 2in) (2 off), capacitor clips, 14 pins DIL socket.

**Note**

Please note that RS Components will not supply direct to the public, but components can be ordered from them through a retailer. The MVR15V, case, REC76 and transformer are available from Doram, PO Box TR8, Wellington Road Industrial Estate Wellington Bridge, Leeds LS12 2UF.

Order numbers are 305-399, 509-920, 281-592, 196-319 respectively (see catalogue).

Switches S1 to S6 can be made from RS Makaswitch components.

The 8038 is available from Ambit, Technomatic or Trampus.

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**Fig. 4**: Circuit diagram of the differential amplifier used in the waveform generator to give up to 10V peak output.
which must also be mounted close to the 8038. C1 to C7, R3 to R5, R6 to R25 are marked for selection. These are the components which must be adjusted to obtain the highest accuracy of options 1 and 3.

The three output waveforms from the 8038 function generator are fed via S5 to a differential amplifier (Fig. 4). S5b is necessary to short the pulse waveform to earth when the sine or triangular waveform is selected. This prevents the pulse interfering with these two functions through the switch stray capacitance. If possible, a large, low capacity switch should be employed in this position together with another pole to short the triangle waveform to earth when the generator is switched to sine operation.

The differential amplifier Tr1, Tr2, Tr3 couples the selected waveform to Tr4, an emitter follower output stage. Tr1 and Tr2 form the differential amplifier proper with feedback in the emitter and a constant current “tail” formed by Tr3. VR3 is used to adjust the calibration of the DC shift potentiometer VR4 at zero. A small portion of the output signal is fed back to the input of Tr1 via R60. C11 is a stabilising capacitor. Emitter follower Tr4 is coupled to a simple output attenuator which is capable of driving the loads already specified.

POWER SUPPLY

The power supply (Fig. 5) uses a transformer having two 20 volt windings. DC is obtained from bridge rectifiers D4 and D5 smoothed by 1000µF capacitors C13 and C16. The DC voltage from the two capacitors is applied to voltage regulators contained in a T05 package IC2 and IC3. C14, C15, C17, C18, R80 and R81 are stabilising components which prevent the regulators from oscillating.

To be continued
HAVING introduced the two new Motorola diodes for AM tuning in Part 1, this month’s feature examines and explores the possibilities and potential that this breakthrough in price represents for the art of radio and electronics in general.

BIASING TECHNIQUES

Both the new diodes, the MVAM1 and MVAM2, employ a negative voltage to perform the tuning function, so with the almost universal adoption of negative earth circuitry techniques, this presents a few problems.

A solution is proposed in Fig. 2.1 which shows how a 27V bias can be used to keep the varicap reverse biased as the tuning voltage is varied from 0V to 25V. Until such time as the manufacture of a diode for direct negative earth applications is completed, this method is the best compromise.

The +27 volts still have to be found from somewhere in the circuit. In mains equipment, this will be another tapping on the transformer—or possibly a simpler arrangement via a voltage doubler from the main winding. In battery portable equipment, the only solution is a separate battery supply, or a DC to DC converter.

* Ambit International
A general circuit is shown in Fig. 2-2, employing just a single transistor and inverter inductor. The turns ratio of the primary to secondary will determine the voltage step up—so from 12V to 36V, 1 to 3 is necessary.

The output from this inverter is carefully decoupled and filtered to prevent any residual remains of the AC signal being present by the time the voltage gets to the tuning diodes.

The inductor used can be of the bobbin, pot core or iron cored variety, but should be suitable for operation at the selected frequency of the inverter. Iron cored inductors may not be suited to frequencies above 20kHz.

The current that can be taken from the circuit will depend on the rating of the inductor—the overall efficiency for such a configuration is in the region of 40 to 50 per cent, given the correct components.

For simplicity, the method of voltage stabilisation is the three terminal 7924 (24V fixed negative regulator). A cheaper alternative can no doubt be devised using a Zener diode and a resistor, but the 7924 maintains better stability and has a far greater degree of supply rejection.

**SQUARE LAW**

When biasing any single varicap in the radio frequency circuit, remember that the law of the tuned circuit scale will be the “square law”, so to obtain a scale of uniform linearity, the potentiometer should have an inverse square law.

Such a potentiometer is not presently widely available, but it is anticipated that a special long slider will be available with this feature designed specifically for radio tuning applications.

The two trimmers at the extremities of the main tuning pot are an important feature when aligning the scale. Although the various tuning diodes in the same package are matched to one another to a close degree of tolerance, this is not necessarily so between different samples.

It is also wise to remember that the lowest value of the tuning voltage should not be permitted to fall below two or three volts. This is because there is a chance that the oscillator circuit in the receiver will have an RF voltage that could exceed the total reverse bias on the diode tuning it. The result is that the oscillator RF gets rectified, and ceases to function at low frequencies with various audible manifestations of the instability. This can also be the case with an RF stage that is handling a very high level signal—this may become rectified, and will then modulate the supply to the other diodes on the same tuning bias supply.

**OTHER APPLICATIONS AND FACILITIES**

Anywhere that one uses a conventional variable capacitor of the mechanical variety, the varicap can be used for greater layout flexibility.

There are a couple of qualifications, based on the effect of strong signals becoming rectified by the diodes; so the devices would not, for instance, be suited to transmitter power circuitry; but in test gear, they certainly have many applications.
As an audio oscillator, the 8038 can be swept by up to 1000:1 by the application of a suitable sweep voltage at pin 8. However, the sweep voltage is basically a low duty cycle triangle wave—or ramp voltage and the amplitude of this, direct from the chip is approximately one third of the supply voltage.

With a 30V supply, this gives 10 volts, so to increase this, an operational amplifier is employed to amplify to around 28V peak to peak.

The values shown on the circuit allow the frequency of sweep to be varied from 20Hz to 20kHz. By switching additional capacitance across the timing capacitor at pin 10 the frequency can be lowered, though to fully appreciate the capability of the 8038, reference should be made to the very comprehensive manufacturer's data sheet.

The square wave output from the 8038 can then be employed as the trigger for the oscilloscope timebase, to ensure that the sweep voltage and the trace start simultaneously.

**SCAN WIDTH SELECTION**

Applying the whole voltage to the varicap diodes will result in a very large sweep being achieved—but this is not the only factor, since it is desirable to be able to select a specific area of the spectrum for examination. Fig. 2.6 shows how this is accomplished by simply adding the sweep voltage into the main tuning voltage. This technique is often employed in VHF varicap tuners, where it is desirable to be able to control all the tuned circuits at once, rather than just the local oscillator.

Adjusting the amplitude of the sweep voltage will vary the width of the scan. Remember that the sense (polarity) of the tuning voltage for the single ended MVAM diodes should be considered when testing equipment, as separate power supplies may need to be employed.

**EXISTING RECEIVERS**

It is a relatively simple matter to append the spectrum analyser feature to an existing receiver design by simply adding the MVAM diodes across the various sections of the tuning capacitor. The scale linearity of the main receiver will suffer—but if used in conjunction with a signal generator to provide marker reference points, the result will be fascinating at least, and probably very useful as well.

By monitoring the diode voltage at the detector, one will obtain a frequency/amplitude plot on the oscilloscope trace—giving a visible display of signals present within the swept part of the band, as shown in Fig. 2.7.

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**SWEEP OSCILLATORS**

Sweep oscillators are used extensively for radio tuned circuit alignment, and are known under various guises as panoramic adapters, wobbulators, spectrum analysers, etc. They all employ the same basic principle, namely that an RF oscillator is varied in frequency in synchronism with an oscilloscope trace.

The circuit under test is fed with the output of the oscillator and the performance of the tuned circuit is then assessed by the visible display of the amplitude response. Fig. 2.3 details a simple form of sweep voltage generator, and in conjunction with the oscillator of Fig. 2.4 a basic wobbulator is formed. Fig. 2.5 shows how this combination is used in conjunction with an oscilloscope for displaying the response characteristics of a tuned circuit.

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**SWEEP GENERATOR**

The 8038 function generator IC is used to provide the basic waveform generation. It is a fascinating device in its own right, in that the single chip provides triangle, square and sine wave outputs simultaneously with a fixed phase relationship.

The duty cycle (Fig. 2.3b) can be simply adjusted with the potentiometers on pins four and five, and the actual frequency of the sweep is again set by a potentiometer.
RADIO CONTROL COMPONENTS
Home Radio inform us that they can supply the following components for the Radio Control Monitor: VC1 (Cat. No. VC26D); TC1 (Cat. No. VC52); PHF3 coil (Cat. No. CO84C); OA90 (Cat. No. OA90); C1-0·047µF (Cat. No. 2CN155); 3·5mm jack socket (Cat. No. JH18) and 100 Microamp meter (Cat. No. TG76). Total price including post, packing and VAT is £5·88 — Home Radio (Components) Ltd., 234-240 London Road, Mitcham, Surrey.

INSTRUMENT CASES
Arbour Electronics Limited have sent us details of their 'Centurion' instrument cases. The two shown in our picture are the 222F and 321F.
Model 222F (left) comes packed flat. The front and rear panels are of aluminium and the case of mild steel. The front panel is finished in white gloss and the other sections in blue hammer stove enamel. Price of the 222F (197 x 254 x 159mm) is £3·40 plus VAT (postage paid).
Model 321F (203 x 406 x 165mm) has an aluminium front panel. The case and rear panel are of mild steel. The front panel is finished in white gloss and the other sections are a black 'crackle' finish. This cabinet is finished with top and bottom aluminium trim. Price of the 321F is £5·80 plus VAT post paid.

Further information on these instrument cases or the sheet metal work service run by Arbour, contact them at Unit 13, East Hanningfield Industrial Estate, Nr. Chelmsford, Essex. Tel. Chelmsford (0245) 400700.

TRIMMER POTS
The Allen Bradley single trim type Z trimmer potentiometer is ideal for use in miniature equipment for it only measures a 6·35mm cube.

Power rating is 0·5W at 70°C and terminations are by pins with the option of vertical or horizontal mounting. High power rating is achieved by cermet technology in the 50Ω to 1MΩ range.

Both vertical and horizontal types are available in 10% tolerance (price 95p each for 25 off) ex-stock from Jermy Industries, 74 Vestry Estate, Sevenoaks, Kent.

TELE-TENNIS REPRINTS
These are still available from:
Chief Cashier (P.W. Tele-Tennis)
IPC Magazines, Tower House, Southampton St., WC2E 9QX. Price is 75p + 7p postage.

THE DANAMETER
Dana Electronics have developed a "personal" volt-ohmmeter which features a 3½-digit liquid crystal display. A single 9V transistor radio battery will last a year with normal use.

Sixteen ranges are available on the switch: four each of d.c. volts, a.c. volts, d.c. current and ohms. Both a.c. and d.c. volts scales are 2, 20, 200 and 1kV; d.c. current is measured from 20µA through 2mA, 200mA to 2A, and ohms from 200 through 20kΩ, 2MΩ to 200MΩ. Reading accuracies vary from ±(0·5% of range) to ±(8% of reading + 0·05% of range) (2V d.c. range) to ±(6% of reading + 0·05% of range) (200MΩ range). When 'd.c. volts' is selected the input resistance is 10MΩ, and the impedance for a.c. volts is 2MΩ. Switch position 17 is for internal battery checks, and position 18 is 'Off'.

The Danameter costs £99·50. Further information may be obtained from Dana Electronics Ltd., Collingdon Street, Luton, Beds.
LARSHOLT VHF TUNERSET
The constructor who feels that making a VHF receiver is a bit too complicated a venture will welcome the Larsholt “Tuneret” made by Larsen and Hoedholt in Denmark. It will also appeal to the experienced constructor who may not have too much spare time on his hands.

This elegant and well-constructed unit is only 168 x 65 x 25mm (6½ x 2½ x 1in) with clearly numbered pins for connecting to the external circuitry. The input accommodates 75 or 300Ω feeders and provides around 330mV of audio at medium impedance at the output with signals greater than 2μV. Gate-protected 4082 and 4083 MOSFET’S are used in the RF and mixer stages and a BF244 in the local oscillator. All three stages are varicap tuned by an external stabilised voltage which can be fed into the unit by the conventional push-button panel. A voltage from 2-3 to 12 volts will provide a frequency range from 87.5 to 104.5 MHz. The recommended stabilised main supply is 20 volts, taking 65mA.

The signal at the usual IF of 10.7MHz passes through a double ceramic filter to a CA3088E limiting stage and an LM3900 IC. Quadrature detection, muting and AFC facilities are provided. Two sections of the LM3900 are unused and their input and output connections brought out to pins so that they can be used as additional audio amplifiers. With stereo, the audio output signal can be routed via an external decoder IC, such as the CA3090A or MC1310 or KB4400, the two channels then being fed back to the two spare sections of the LM3900 for further amplification.

Simple external circuits connected to the appropriate pins will provide a signal strength meter, centre-zero tuning meter as well as muting and AFC switching. A frequency scaled meter can be linked to the varicap tuning voltage if desired.

The technical specification adequately meets today’s requirements and a first-class receiver can be quickly built around the Tuneret. The accompanying technical literature is clear and provides all the necessary information to accomplish this. Indeed, the frills can be left to later and the tuner made to work initially with just the 20V power supply and a couple of PP3 batteries across a potentiometer for the tuning voltage, the output being fed into some audio amplifier such as a Hi-fi set-up. All necessary tuning and alignment points are clearly marked but it is suggested that these be left alone until the final alignment when the finished receiver is working properly.

Full information on the Tuneret can be had from Ambit International, 37a High Street, Brentwood, Essex.

RIVLIN POT.
Rivlin for many years have been known for their quality precision wirewound resistors and resistive standards.

The new Rivlin Type WS150 potentiometer is developed from experience gained during the last 2 years of producing a 60mm Carbon Slide Potentiometer, which has been much praised for its price and technical merit.

This latest pot is the first of their WS range and features a wirewound 50kΩ, 150mm track, of near professional standards. It is being used in our P.W. “Apollo” m.w. tuner/receiver featured in P.W. This component is intended to satisfy a need in the Audio and lighting industry where a linearity of 0-1% and resolution of 0-03% are required. Further developments in the range will incorporate varying track lengths as market dictates. For further information, please send a stamped addressed envelope to: Rivlin Instruments Ltd., Dept. P.W., Doman Road, Camberley, Surrey GU15 3DJ.

HAVE TOOLS—WILL TRAVEL
The Link - MK service engineer’s cabinet and tool case is a neatly adapted standard small parts cabinet. It comprises a Link - MK cabinet containing four sizes of transparent drawer in various combinations, together with a wooden tray for larger tools, all housed in a lockable simulated leather carrying case.

When open, the rigid front of the case folds down to make a convenient platform for tools. All the drawers can be subdivided to hold large or small items (an assortment of dividers is supplied) and each drawer has a label slot.

The cabinet, measuring 15in x 12½in x 8in, is intended to meet the needs of both professional service engineers and hobbyists of all sorts, from DIY enthusiasts to modellers and photographers. It is obtainable from storage specialists at a recommended price of £14-80 plus VAT. Names of local stockists will be provided by the manufacturers on request. Link-Hampson Ltd., Bone Lane, Newbury, Berkshire.

The one shown in our photograph is the SR-3A de-luxe kit from which one can build 105 projects including things like a solar-battery-operated transistor radio, three - transistor intercom, amplifiers, electronic sirens metronomes, organs, etc., etc.

These kits are very good for youngsters to learn the basic elements of radio and electronics for all components plug into a circuit board. No soldering is needed. For further information and prices write to Electroni-kit, 408 St. John’s Street, London EC1B 1JL.
In the “good old days” of valve equipment it was quite surprising what one could get away with, and many engineers who really hadn’t much idea what was going on, managed to execute quite successful repairs by trial and error. As we shall see, this kind of approach with directly-coupled transistorised equipment can do far more harm than good, and it is hoped that this article will, at the very least, indicate to readers how not to repair equipment! Let us imagine that an amplifier has blown its fuse and has come in for service. How does Fred, the bodger, tackle the job?

First, Fred replaces the fuse which immediately blows again, to give himself a chance to find the fault he fits a larger fuse! Noting that this also blows he decides to check the output transistors on a tester and sure enough, one of them seems faulty. Fred swops the transistor, switches on, and blows another fuse! Fred next decides to isolate the two channels, and so disconnects the supply voltage from the left hand one, and sure enough the right hand channel functions satisfactorily without the destruction of any more fuses. Fred is now convinced that one of the output transistors is still faulty, but just to prove the point he decides to swop over the power amplifier boards which, fortunately, plug in. Soon the amplifier works on neither channel, blows mains as well as low voltage fuses, and so, in desperation, Fred sends the amplifier back to the manufacturers.

When the bill arrives, Fred’s customer finds that he has to pay for eight transistors, four rectifier diodes, a mains transformer and several sundry parts which, together with Fred’s time, and carriage amounts to over £30. Fred assures the customer that it wasn’t his fault as the amplifier had so many faulty components that he just hadn’t a chance! What went wrong?

**WRONG APPROACH**

In the first place Fred made a totally wrong approach to the job. Transistorised amplifiers, unlike their valve counterparts, are invariably directly-coupled devices, and this really does throw a spanner in the “lucky dip” type of approach to servicing, as faults in one stage can often damage components, as well as affecting voltages, in other stages. In the case in question, the only original fault could well have been incorrect quiescent current brought about by the setting of VR1 in Fig. 1 or that one of the transistors was faulty. The fuse had blown to protect the equipment, and the real trouble did not start until a larger fuse was fitted. With Tr8 and Tr9 incorrectly biased the supply current surged up blowing all the output and driver transistors.

As the circuit boards do not include the output transistors, swopping the boards around connected a good board to a faulty pair of output transistors and a faulty board to a good pair of output transistors. This resulted in another collection of blown components. In the end, so much current was drawn that the rectifier went short-circuit taking the mains transformer with it. We might well laugh at Fred’s approach, but how does one go about tracing faults in transistorised equipment?

**REGAINING SUPPLY VOLTAGE**

With a transistorised amplifier that blows fuses, one has a real problem, as, without power, not many meaningful tests can be made. Simple faults, such as the mains rectifier or smoothing capacitor being short circuited will blow the mains fuse and can be found by ohmeter tests. But faults causing excessive current to be drawn in the amplifier section do not usually respond to such a simple approach. The first problems when dealing with a case of a blown LT fuse, is to get the amplifier into some kind of working order without destroying more components in the process. There are two possible answers here.

1. Restrict the voltage applied to the equipment.
2. Restrict the maximum LT current possible.

In the first approach the amplifier is connected to a supply derived from a variable voltage transformer or Variac with a milliammeter connected in place of the LT fuse. The amplifier is switched on with the applied volts at zero, this is then gradually increased until the meter measures, say, 100mA. This method works quite well, but does not protect the amplifier or the test meter against any sudden avalanche of current, should the amplifier suddenly break down at some particular applied voltage. This method also ties up a valuable meter and necessitates the use of a variable AC supply which might not always be available.

The second approach, shown in Fig. 1 is the best one. Here a resistor RX is used to replace the LT fuse, its value being calculated so that under short-circuit conditions the possible current is limited to
a safe value. The value of the resistor is not particularly critical and if a resistor of around 2500Ω is fitted this will ensure that under conditions of even a dead short, the current will not exceed a few hundred milliamps. Note that under short-circuit conditions the resistor could get hot so it should be rated at 10 or 20W depending upon the supply voltage. Having connected the resistor, the amplifier can be switched on safely and under fault conditions, only a small voltage will appear at point Y (if the amplifier was not faulty the voltage at point Y, with the amplifier drawing only its standing current, would only be a few volts below normal). Having got a small voltage at point Y it is now possible to do a little fault tracing, and to find out just where the excessive current is going.

The first point to ascertain is which channel is the faulty one, and under low voltage conditions this might not be at all obvious, as sometimes the channel which appears to have the clearest voltages turns out to be the good one! The certain way to tell whether the current is going, is to disconnect the LT supply separately from each channel; but sometimes a quick dodge is to feel the temperature of the transistors, as the warmest ones will usually be those which are passing most current.

**FAULT TRACING**

Having got the amplifier into some sort of operating condition and established which channel is faulty we are ready to apply some logical fault tracing techniques—or are we? Practice shows that the slowest way to trace faults in a transistorised directly-coupled power amplifier is to try and trace them logically! A few shots in the dark are very well worthwhile.

The first items to test are the output transistors and, if in doubt, checks on these made by an ohmmeter or a simple transistor tester should be compared against tests made on known good samples. Silicon output transistors should show no noticeable leakage, but often good germanium transistors will register quite high leakage. With amplifiers where it is possible to swap over the circuit boards, it is very simple to tell whether the fault is in the board or the output transistors by swopping them over, but in this case ensure that RX is fitted and not a fuse. One point to note here is that confusion can be caused if, as quite frequently happens, in addition to there being a faulty output transistor there is also a fault on the driver board.

Presuming that the output transistors are found to be in good condition, or are made so, but that the amplifier still tries to draw excessive current, the next components in order of their likelihood of being faulty are; Tr8, Tr9, Tr6, Tr7 and C34. This order seems to apply to all of the many transistorised amplifiers which use circuit arrangements similar to that shown in Fig. 1 and in 95% of cases the fault will lie in one of these components. If the fault does not appear to be due to a transistor or an output capacitor, a considerable amount of time may have to be spent tracking it down, remembering all the time to try and separate cause from effect. In the case of amplifiers where the driver boards containing all the power amplifier components, with the exception of the output transistors, are removable, it might be advisable to swap the whole board. If it is necessary to trace the trouble without outside help, here are a few tips which may be of use:

1. When things are working correctly, the output stage current is determined by the difference between the base voltages of Tr8 and Tr9. This, in turn, is controlled by the voltage drop across D1, D2 and VR5. D1/D2 stabilize the voltage, whilst VR5 adjusts it to the correct value depending upon the current through Tr7. If any fault occurs which tends to increase the voltage between the bases of Tr8, Tr9; such as an open-circuit diode or potentiometer, this will result in excessive current.

2. In a correctly functioning stage using NPN silicon transistors, the base will always be about 0-6V more positive than the emitter (using PNP transistors the voltage will be about the same but negative, whilst germanium transistors will be found to have about 0-1V between base and emitter). More voltage than this indicates that the transistors base/emitter junction is open circuit, whilst less voltage indicates that there is insufficient bias.

3. The amplifier's DC stabilization will be completely upset by the low supply voltage which is applied under test conditions. In these circumstances it is no use at all trying to scale down voltage readings from those given in the service manual, and any voltage checks in a stereo amplifier should be made by comparison with the known good channel.
LOW OUTPUT AND DISTORTION

Having discussed the faults which can cause excessive current to flow let us now have a look at other troubles which can occur. In a normally operating amplifier point X should be at about half the LT supply voltage, and any departure by more than, say, 10% from this indicates trouble. Such a departure from the correct voltage would usually result in low output or audible distortion, and when trying to track down such troubles, checking the centre voltage between the output transistors is one of the first tests that should be made. In many amplifiers this voltage is adjusted by a pre-set potentiometer in the base circuit of Tr6, while others use self-stabilising circuits. In either case, the trouble can be caused by almost any component and checking through from the output transistors backwards, as previously suggested, is as good an approach as any.

If low output or excessive distortion in the power amplifier section occurs without any apparent centre voltage deviation, it is quite possible that there is a lack of quiescent current and this should be checked and re-set if necessary by adjusting VR5, or its equivalent, according to the makers' instructions. When checking quiescent current it is wise to solder a resistor of about ten times the milliammeter's internal resistance across the measurement point; otherwise, should the test leads drop off, or the meter cut-out blow, Tr6 will be destroyed as it will try to take over the work of the output transistor.

If, upon checking, the standing current is found to be too low or non-existent but is not adjustable, the fault will possibly lie in either D1 or D2 being short-circuit, as, whilst there are exceptions, a faulty transistor will usually upset the centre voltage reading.

OTHER FAULTS

Up to now we have confined ourselves to looking at DC faults in the directly-coupled power amplifier section, as this type of trouble is exclusive to transistorised equipment. More normal "valve type" faults occur however, and there is no reason why some unwanted effect should not turn out to be an open circuit capacitor or a resistor "gone high". To be fair, such faults are rare and 95% of troubles in the power amplifier section are of such a nature that they affect the DC operating conditions.

"What is the trouble with my amplifier?" asked our customers. "Oh, it will be either the output transistors, the input transistor, or somewhere in between," replied our service engineer, and believe it or not, he was right! This may sound a little facetious, but just as the output transistors are the most failure-prone devices in the power amplifier section, so the input transistors are the most troublesome component in the pre-amplifier section. Lack of gain, or distortion, in the input stage can usually be traced by simple voltage checks, once again noting the magic figure of 0-6V which should appear between base and emitter on any amplifier using modern silicon devices. Whilst measuring this voltage do not forget to allow for the loading effect of the test meter, as the base voltage of an input transistor, which should be 4V for instance, would be wildly out if an attempt was made to measure it using the 5V range of a 10000/V test meter.

Hissing or spluttering is invariably caused by noisy transistors and the offender can often be found by the application of a little heat or cold, and a marked change in the level of the noise will normally result if the offending transistor is approached with the tip of a soldering iron or is squirted with aerosol freezing fluid. In any case, if in doubt about the goodness of a transistor, substitution is the final test.

REPLACEMENT TRANSISTORS

Many transistors are basically very similar, different types being picked out by a selection process during production. The BC109 for instance, is guaranteed to have high gain and low noise, but the makers do not guarantee a very high voltage rating. The BC107 however has a guaranteed higher voltage rating but does not claim as good a noise or gain performance. These characteristics are guaranteed for the sake of users who want a transistor which they know will work without the need for further tests.

In workshop practice for instance, by carrying only the BC109 in stock, it is quite possible to select individual transistors that will replace the BC107, the BC108 or the BC109, or for that matter nearly any other NPN small signal transistor. The gain of transistors can be checked to sufficient accuracy with quite cheap transistor checkers. As well as voltage and gain ratings the power rating of transistors also has to be taken into account, but to some extent this can be judged from physical size. In a service department almost all faulty small-signal silicon audio transistors end up being replaced by a BC109!!

Output and driver transistors come in a multitude of shapes, and sizes but many are interchangeable. If an NPN silicon output transistor is required for an amplifier which is rated at 30W and which has a 60V supply rail, it is almost certain that another NPN output transistor which is the same physical size, and which is used in another makers' 45W amplifier with a 70V rail, will be a more than adequate replacement. Likewise the driver transistors of the larger amplifier can more than likely be used quite successfully with the smaller amplifier.

This approach of using transistors which exceed the specification of the original items fitted might seem extravagant, but entails fitting a more expensive replacement. It does, however, much reduce delay and the number of parts carried in stock, and in the end it makes sound economics, even where it is felt desirable to replace both output or driver transistors to ensure a matched pair, instead of waiting weeks or months whilst a reluctant maker deems to deliver replacements.

FINAL TESTS

As a final check, all amplifiers should preferably be checked to their original specification for power output and distortion and should also be checked with an oscilloscope for performance on square waves. If, due to lack of the requisite test equipment, this is not possible, a fairly reliable comparison test can be made using a mono signal. This is fed into both channels of the amplifier and set to balance each other out by carefully adjusting the balance and tone controls. Any distortion existing in one channel alone will not balance out, and, if excessive, will indicate that further attention is required.
The Fultograph

ANGUS Kennedy, who is aged 12½ and lives in Ludlow, Shropshire, recently sent me a cutting from a 1928 newspaper and asks if anyone can advise on a machine called the “Fultograph”.

If any other readers can help us out on this one—information, a picture of a built unit or anything, we shall be pleased to mention it in “Going Back”.

The newspaper item is entitled “Forecasting the Fultograph—Pictures to be broadcast” and is described as the “wonderful new feature of the BBC transmissions”.

Readers were told that extraordinary interest was attached to the then recent announcement by the British Broadcasting Corporation of their plans for the prospective broadcasting of pictures. A new and more entertaining type of programme was to be expected and wireless would be afforded a fresh and entirely new dimension. News pictures of events within a few hours of their happening, illustrations of children’s stories, latest Paris fashions, winning race horses, football favourites, weather charts, portraits of missing people—these were but a few of the possible subjects that could be transmitted—not only from English stations but some of the more powerful continental stations.

The Fultograph was described as being “not only for the wealthy few”. By the cheapness of the apparatus, pictures by wireless would be at the disposal of a vast majority of wireless owners in England to whom its utter simplicity would appeal. It had to be connected to any ordinary wireless set capable of working a loudspeaker and it operated automatically, requiring no tuning, no additional batteries and no more current than for one ordinary valve. In roughly three minutes the complete picture would be reproduced on specially-prepared paper and just to watch it evolve would be not the least fascinating feature of the device. On the paper’s removal from the instrument no fixing or developing by photographic means would be required.

The Fultograph system was described as being used by the British Broadcasting Corporation and was an invention perfected only after years of research and experiment. Long before 1928 a less-effective instrument could have been put on the market but it was decided to wait until the device described had been fully perfected.

The apparatus was to have been marketed by Wireless Pictures (1928) Limited. It was obviously some form of facsimile machine which would have been available to everyone and was, basically an exceedingly good idea. It was probably dropped because of the development of the television receiver but—does anyone know the inside story on the “Fultograph”? We would be very pleased to hear from you if you do.

Wireless Museum

THE Vintage Wireless Museum of the Wireless Preservation Society has been transferred from South Lincolnshire to the Isle of Wight, and is to be established in Arreton Manor, which is open to visitors throughout the year. It is the Home of Count and Countess Slade de Pomeroy, and already houses a folk museum and exhibition of domestic and agricultural bygones, many of which were collected on the Island. There is also a superb collection of dolls, dolls’ houses and toys of past ages.

The Wireless Preservation Society was established some three years ago, and is exclusively devoted to the collection, preservation and restoration of wireless, electronic and sound reproducing equipment, including television receivers, for purely cultural, educational and historical purposes. It is an entirely non-profit-making organisation, and all its officers are honorary.

The Hon/secy and curator, Mr. Douglas Byrne, G5KPO, is now living at No. 32 Luccombe Road, Shanklin, IOW (Tel. 098-386 2586), from whom further information can be obtained.

Revolution?

GOING back through my photographic files the other week I came across this Mullard photograph, released back in the ’60’s. Its caption reads: “The Trons are forced to retreat as they are overwhelmed by armies of Semics”. It is very interesting to see how their photographer envisaged the transistor “revolution”. I am sure however, that amongst our Going Back readers there are many thousands that feel the valve will live for ever!
Dear Sir,

Dear Sir,

The Law is an Ass!
The law which states that the public must not listen to certain wavelengths or use the dial pointer over certain parts of the radio scale is as ridiculous as it is archaic; and is typical of the backward thinking of British politicians as was the law requiring a man carrying a red flag to walk in front of every motor car. Further to your Editorials in the March and April issues, I feel it is not the public nor the small print that needs to be looked at, but the Law; this unrealistic aspect of it should be rescinded and the sooner the better!

I draw the distinction, however, between the use of the air and the use of on-the-spot “bugging” devices for the surreptitious eavesdroppings of private conversations. This is quite a different matter and should be prohibited out of common respect and decency, backed (so far as necessary) by law.

But the air should be free whether we breathe it or listen to it (at any frequency).

Those who are brave enough to preach democracy should be brave enough to practise it.—Peter W. Feesey (London)

Designers—take note
As a reader of PW for the past 25 years, I would like to say how excellent your magazine is, and to further state how pleased I am that you have kept to the sensible “zig-zag” sign for resistors instead of the “oblong box” symbol of foreign origins. In particular I’m grateful for new equipment designs using ICs and varicap tuning.

May I however, make a plea, and beg for an article which deals with a varicap-tuned, digital frequency readout communication receiver, covering frequencies from 10kHz to 30MHz. Also a digital readout frequency meter, covering the range 10kHz to 30MHz and 30MHz to 100MHz.

Preferably the RF, Osc., and IF stages of the 10kHz to 30MHz communications receiver should have FET’s of MOS FET’s, and should be able to receive NBFM, SSB and CW. Sensitivity should be at least 1µV for 50mW output on all ranges. Power should be derived from a 12V source to enable the set to be completely portable.

The equipment that I have just described costs “a bomb” if bought commercially, so surely PW could publish a design that would enable the home constructor to build one, at a fraction of the cost of the ready-made article.—G. B. Corry (West London)

Whose kidding who!
We at the Gullibavsky Institute of Leggapullov are dismayed at the pirating of our research work, as described in your April issue. The device was invented by us and we called it a “Bogatron”. It was not envisaged by us to be used at radio frequency, (which is testimony to its versatility), but at extremely low frequencies, barely above D.C.

At these frequencies of about 5 cycles per day, it was enormously successful in flushing out phonies. (Would you like to buy a couple?)—George W. Spray (Isle of Wight)

From the many enquiries on the Unitron article (April issue), it would appear that many readers enjoyed the joke—Ed.

PW in Parliament?
In a recent letter to my MP (Neil Macfarlane—Sutton and Cheam) regarding the continual erosion of individual liberty, I cited the Home Office’s deplorable behaviour in sending letters to editors as reported in your March editorial. My MP, in reply, said he had not seen a copy of the letters sent, and asked for a sight of one if I wished him to take the matter up with the Home Secretary.

As this is a clear case of a Govt. Dept. misusing an Act of Parliament and trying to limit individual rights I would ask if you are prepared to supply a copy of the letter in question for me to pass on to my MP.

I have already put it to him that the Home Office is a totally unsuitable Dept. to overlook communications and that in any event the Act in question should be repealed or amended as if it attempts to deny an undeniable human right to receive magnetic waves—radio frequencies being no different from light and heat from the sun.

It is up to those who desire secrecy to apply that little extra to obtain it by coding or scrambling.—SM Sudden (Surrey)

Problem solved!
I was interested to read in the March 1975 issue of your magazine an article on building a Sinclair Scientific Calculator. In the last paragraph the author says “On the other hand the most annoying operation is a “clear last entry” key. Having to repeat a lengthy calculation because you push a wrong button can be very frustrating.” Well, fret no more! I bought one of these calculators, ready-built, I am ashamed to say, and have also found the lack of this particular key annoying. So I worked out this key sequence to effect the same operation.

Example Say we wish to multiply 1.2345 by 6.7890 and we accidentally key in 6.7890 then we can clear this number by keying -9, 9, + this has the effect of adding 6.7890X10^-99 to 1.2345 which gives 1.2354, then key in the correct value and continue the calculation.

I hope you, and all other Sinclair Scientific users will find this useful.—W. S. Mcbrair (Cambridge)
Illegal sales

Having read your magazine for many years, I can't recall anyone writing to you regarding "public enemy No 1"—the imported walkie-talkie. I'm sure every reader knows that these sets are illegal, yet a walk up the Edgware Road will show a selection of these sets on display to the general public. Granted most have written in the sales literature, in small print, "not licensable in the UK", but I was horrified when I visited a well known shop and overheard the sales chat of one of the salesmen.

He was telling a potential customer of a walkie-talkie set, costing in excess of £50, that it would be virtually impossible to trace the signal due to the high density of buildings in London. This is utter rubbish, as with today's sophisticated tracking equipment, it wouldn't pose much of a problem for the GPO. The salesman further went on to explain, that in the event of a "10,000 to one" chance of being traced he would probably be ticketed off or suffer a maximum £5 fine. Unfortunately the salesman neglected to say that his £50 worth of equipment would also be confiscated.

In my opinion the law should be changed, so that it would be illegal to sell any transmitting device, without first obtaining proof that the buyer has a licence to use the set in question, and that the set conforms with the regulations.—D. Lane (London)

Think negatively

Having constructed the PW electronic ignition circuit, published June 1971, and successfully used it on two Ford Escort cars in the last 21/2 years, I've found one fault in the system—and this is due to the car manufacturers! What happens if a positively earthed vehicle is changed for a negatively earthed one? Is the ignition circuit obsolete?

In my particular case, the vehicle earthing did change, as above, which necessitated only four alterations to the circuitry. These were to remove the supply from the transformer centre tap, and transfer it to the link connecting the collectors of Tr1 & 2 to R2/R3. An earth was then placed on the transformer centre tap; D5 was removed altogether, and D4 reversed, so that its anode was connected to R7/R6. Finally, Tr1 and Tr2 were insulated from the chassis.—C. A. Emms (Suffolk).

Attention Holders!

We are trying to assemble a small collection of old electrical equipment, mainly radios, record players, etc. As we rely on donations, we have so far been limited to equipment no more than 40 years old. If anyone in the Belfast area has any old, unused, or damaged equipment (the condition is immaterial) we would be very glad to hear from him.

There are two particular items for which we are looking: an old valve portable radio (with DF91 and similar valves), and an old "Cat's Whisker" crystal set.—C. J. Steensson (Annedale Grammar School, Belfast).

Wake-up, Home Office

Having been a reader of P.W. for over 20 years I have gained a lot of knowledge and enjoyment from it. But the time has come when I can no longer restrain myself from writing to your columns for the very first time.

Your editorial article in the March '75 issue really makes one wonder. When will the powers that be, i.e., the Home Office, wake up from their 1900 era of thinking and acting? Where, might I ask them, can the public obtain a copy of the Terms, Provisions and Limitations, that we must abide by since a licence to use a radio receiver for the reception of Wireless Telegraphy is no longer required?

No doubt the Home Office would point out, if a situation arose that required taking a person to court for breach of Section 5 of the "Wireless Telegraphy Act, 1949", that ignorance of the law does not exempt a person from being prosecuted under it! Even if, and it is a big IF, the public had access to the aforesaid mentioned Act, etc., how many would actually read it, and further, how many would really digest it or understand it?

Like most small print in any document it is written in a pedantic style of wording, appropriate to the year 1900. Again, I wonder how many people have read Clause 4 of the Television Broadcast Receiving Licence, and of those who have read it, how many have understood it? Especially as it refers to "messages" unintentionally received. What about "visual images"?

With reference to no licence being required for a radio receiver, again I think the powers that be are doing the BBC a grave injustice in taking money away from them; they say that more money is lost collecting a licence fee than is gained. What a ridiculous statement, have they not got any brains, or are they just too lazy to use them?—H. H. Berry (Cheshire).

Unavailable licence?

Your editorials on walkie-talkies etc were long overdue. For years this equipment has been sold without restraint, aided and abetted more recently by the Home Office who seem to have insisted that advertisers add a note that such equipment needs a licence for use in the UK or, even more ludicrous, that a licence is required but is not generally available to the public!

The advertisers must be laughing their heads off! Tell everyone that it will be illegal to listen to such-and-such transmissions on their XYY Superset and they'll rush round in their hundreds to buy one! Surely the answer is simple, no licence, no sale!—A. Smith (Romford, Essex).

Modified or not?

I am writing in response to your editorial in the March edition—regarding the Home Office claim that it is illegal to listen to private communication channels under Section 5 of the Wireless Telegraphy Act.

I am quite sure that this Act was modified at the time FM broadcasting by the BBC was introduced on VHF; purely because breakthrough was inevitable and it was not possible not to hear Public Service Transmissions.

I think Barlow on TV was correct in his statement that it was not illegal to listen to Public Service Broadcasts because I am sure the modified section of the Wireless Telegraphy Act made it, not illegal to listen, but illegal to act on, or pass on any information received in this way.

Unfortunately, I cannot put a date on this modification but I am sure it happened and I would welcome any comment from legal advisers.—D. H. Myers G8AYG (Cheshire).
by Eric Dowdeswell G4AR

LET'S give a big cheer this month to regular correspondent Tim Charles (Colchester) who has heard New Zealand on Top Band! That's just about the ultimate in DX'ing, combining maximum distance with the lowest of our HF band allocations. Tim was aroused by the activity of many G stations around the DX 'window' of 1825 to 1855kHz at 0647 on 9 March last. He tuned up to 1872, the usual frequency for ZL's, and heard ZL3RB calling CQ DX although he was only RST 349 and disappeared in a couple of minutes. It is not known if any positive QSO's resulted but now is the time to try, as we approach the bottom of the sunspot cycle.

Tim suggests, and I think correctly, that G2PU worked a ZL about 12 years ago when we were around the bottom of the last cycle. With the improvements in technique which have been made by Top Band enthusiasts over the last few seasons I should not be surprised to hear of several QSO's being made with ZL in the near future. Let's hope that Tim can now get a QSL from ZL3RB. That would be something really worth having on the wall of the shack!

While in the southern hemisphere I should mention an interesting letter received from David Down in Christies Beach, South Australia. An ex-Royal Australian Navy operator David sticks to CW. He has taken his examination for a licence so he ought to be on the air very soon now. His list of stations heard on 7, 14 and 21MHz does not contain any G's, unfortunately, seemingly due to the unfavourable times that he has been listening, as far as G operation is concerned. I have asked him to keep a lookout for Europeans on 160m!

John Porter (Baslow Derbys) and family got a bit fed up with tripping over radio equipment scattered around the house so he moved it into an outside shack where I am sure he will be very happy! He was able to get his 10, 15 and 20m dipoles connected to his FR30B without any difficulties. He was pleased to copy KC4USG/MM2 on 14MHz SSB. This is the US icebreaker Glacier which itself was trapped in thick ice in the Antarctic, after damaging a propeller. On 10 March the Daily Express reported that the scientists and crew aboard the Glacier had been flown out. Andrew Swiffin (Cheddle) was kind enough to send me details of his crystal-controlled converter mentioned last month. It first appeared in QST and uses a 6AK5 RF stage with another 6AK5 as mixer. A 6J6 double triode uses a single crystal on 6-2 or 8-5MHz, or thereabouts, harmonics being selected according to the band required. It is very versatile when used in front of a general coverage receiver.

A brief letter from Tom Proctor, aged 16, who lives in Bristol and uses a No. 19 set on which he copies SSB signals. No mean achievement with that equipment! Michael Connolly (Yeovil) joins the column for the first time, using a CR70A and PR40 and a dipole on 80m. He can also copy on 2m with a Sentinel converter fed from a halo aerial in the loft. Gary Edge (Culcheth, Warrington) stuck to 80m SSB like so many others, using his 9R35DS and 150ft wire plus a whip aerial. A PS says 'have sold my 9B5 and bought an HA500'. We all hope you will both be very happy!

Paul Barker (Sunderland) comes up with yet another VE oddity! CY6GQ special event station in Calgary, work ten CY6's for an award. Well, don't just sit there, go and get those CY6's! Ian Moore aged 14 has got a head start on most of you. His Dad is G3QJJ ex-DL2WM and he allows Ian to use the receiver part of his treasured FT200 provided Ian learns the Morse Code. What a clever Dad! But watch out Dad, once Ian has his ticket you won't be able to get near your FT200!

Old friend David Saul A8723 hopes to leave us by the end of the year! He takes his RA in May and looks forward to a nice new G4+5 callsign. We hate to lose you OM but sincerely hope you make it. David Coupe (Nr Middlesborough) joins us and says his main interest is 2m using a Microwave Modules converter into an Eddystone 888A at 28-30MHz. Input comes from a six element Yagi at about 22ft. A good clear path to the north has enabled him to hear many GM's on SSB with the odd ON and PA9 to the south. He has also logged many stations through Oscar 7.

Malcolm Sole (Lancaster) reports a quiet month but still managed good catches like ST2AY and KG4F0 Guantanamo Bay on 80m SSB. Ron Newall (Richmond Sy) joins the column with a first log of GM on 160 and 80m, presumably SSB. There can't be that number of stations still using double sideband and carrier! I deliberately omitted to say 'AM' because the statement would have been incorrect! It is quite surprising how many amateurs, and others, who talk and write about SSB and AM as if they were two completely different methods of modulation. They are both amplitude modulation or AM! It's just that SSB is the result of conventional 'AM' losing one sideband and its carrier. The methods of generation are quite different of course but that is another matter. I am surprised that those who still use the old style of AM do not incorporate all the refinements which have developed around SSB such as VOX, restricted audio bandwidth etc. There is no reason why they should be thought of as being peculiar to SSB.

Stephen Terry BR535669 (Banbury) kept his log to the real goodies and a nice lot they are too, from 15 to 80m using his FR50B and a dipole fed 'off-centre'. Watch your matching OM, the impedance rises rapidly away from the centre and if you are using low impedance cable you could be losing some of the signal voltage developed on the aerial. Stephen doesn't say which band the dipole is cut for so it is probably rather ineffective on the other bands anyway. Alan Doherty (Portrush Co Antrim) just beat the deadline with a log that concentrates on his favourite band, 20m, again with an FR50B fed from a 132ft aerial. One early morning stunt was rewarded with KC6PS, quite a rare prefix.
Log extracts

J. Porter:— 80m HP4HCU TG6AU 20m CE8AA KC4USG/MM2 (see text) KV4AA ZD8TM ZS2PR (Marion Is) 15m 5L2JJR (Liberia)

A. Swifin:— 80m FG7AO PZ1AP UIJMV VP2DM 20m KL7IEU TA2SC VS5LH ZS3TP 15m CE6EZ OA4O VP2A (Antigua) VP2EE (Anguilla)

T. Charles:— 160m VE1BCZ ZL3RB (see text) 80m HP1CWP VP2DAJ YB2AU ZL1AH ZL5FZ ZL4FB 40m CO2SM VK7CH ZL1RN ZL2AGY 20m CR4BS TR8VE VP2LAW ZS3DO 2m via Oscar 7 from 70cm DJ2IE DJ2RE DL1JV ON4DY

M. Bennet:— 20m CP10Y CR3AH P29MI 15m JY9CR VS0MB ZS4MZ

M. Connolly:— 80m CT2AE PI1VKL 20m CR4BS TU2FG ZD7SD 8P6BU

G. Edge:— 80m EP2VJ MI1 TZA1AC YB0ABV ZSSLB 7X5AH

S. Budd:— 20m CS6U (Gambia) TA1BW VQ9MC 15m VQ9HCS (Astown Is).

SHORT WAVE BROADCASTS

by Derek Bell

SEVERAL letters recently reproved me for referring to a megahertz when I should have said kilohertz. This was in the item on using 300,000 to find wavelength or frequency. The answer I offer is that MHz has long been preferred to describe frequencies, so that instead of saying “five thousand kilohertz” we say “five megahertz” while for values under one megahertz the frequency is referred to in kilohertz.

Recently I asked for info on DX shows, in order to compile a list for you. I am glad to say that shoals of letters arrived giving not only days and times but four or five frequencies for each station. This is because of the practice of many stations of putting out signals on several frequencies at the same time. This posed an insoluble problem, namely which frequency would be audible here on any given day? Last year was, it is agreed, one of the worst years in memory for the short wave DXer, due to solar storms. So which frequency do I select when there is every chance that it may be blotted out by noise or that it may not be carrying DX at all?

In order to get round this I selected one frequency and one alternate and the list is as follows:

<table>
<thead>
<tr>
<th>Days</th>
<th>Stations</th>
<th>Frequency</th>
</tr>
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<tbody>
<tr>
<td>Mondays</td>
<td>Japan 1640</td>
<td>11815</td>
</tr>
<tr>
<td></td>
<td>Norway 0810</td>
<td>11850</td>
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<tr>
<td></td>
<td>Finland 1800</td>
<td>9550</td>
</tr>
<tr>
<td></td>
<td>Hungary 1615</td>
<td>21505</td>
</tr>
<tr>
<td></td>
<td>Prague 1900</td>
<td>7245</td>
</tr>
<tr>
<td></td>
<td>Africa 2226</td>
<td>11970</td>
</tr>
<tr>
<td></td>
<td>Holland 1842</td>
<td>6085</td>
</tr>
<tr>
<td></td>
<td>Bonaire 0045</td>
<td>11815</td>
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<td></td>
<td>Bulgaria 1950</td>
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<td>Rumania 1950</td>
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<td>Israel 2050</td>
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<td></td>
<td>Monaco 0920</td>
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<td></td>
<td>Lisbon 0955</td>
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<td>Austria 0915</td>
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<tr>
<td>Thursdays</td>
<td>Japan 1842</td>
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<td>Norway 0810</td>
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<td></td>
<td>Austria 0915</td>
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</tbody>
</table>

The first set of figures, that is the time, is the advertised start of transmission and you will realise that the DX shows are slotted into the session for a particular target area and that this session may be of an hour or so duration. The second set, the frequencies, are those in English, since some stations repeat the show in more than one language. My thanks go to among others, Messrs Mead, Chowanietz, James and Forkin for taking the trouble to help me compile the list. There are of course other stations that do DX shows, for instance BBCS World Service, that are crowded out through space problems, but your World Radio and TV Handbook will give more information on these.

John Godwin of Rugeley sends some detailed information for the new European service of Radio Sri Lanka. This starts every evening at 1900 on 15120 and 11800 and comprises talks, requests and news and John says that for a QSL the DXer should write to:

English Services
Sri Lanka Broadcasting Corp.
PO Box 1510
Colombo, Sri Lanka

We have at last lured into the column one of the licensed amateur operators. Part of the condition of the amateur ticket is the right to listen to time-signal stations and G. F. Painter G3CFO sends a comprehensive list of unusual stations that he has heard. One in particular, LOL Buenos Aires, “popped up”, as Mr. Painter puts it, on 5MHz while he was doing something irrelevant to the rig, at his house in Chipping Norton.

John Haines has his rig in the living room with his aerial made of five feet of cable suspended from the curtain rail. This and the Heathkit SW717G he runs brought in Radio Nacional de Brazil on 11780 at 2135, John Higginbothom of Holyhead, however, goes in for a fifty foot long wire in the loft and has an ITT Euromarine dangling on the end of it. John has been fortunate enough to pull in the Voice of Nigeria on 7275 at 1530 Radio Norway on 9590 at 1300 RSA on 11900 at 2100

John hopes to take possession shortly of an ex-RAF 1132A. This is a fine example of the full coverage ex-service set that can be bought very reasonably, if you are lucky. The trouble is that there are so very few

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of them ever come on the market! From the charming town of High Wycombe Terry Gilbert sends a logging of a very rarely reported station, Radio Afghanistan on 15195 at 1130. This goodie was pulled in via a Codar CR70A and Joystick, coupled to a Hamgear preselector ATU. Terry very kindly says that this column gets read first in PW and wonders if anyone can fill him in on the Heathkit GR78, as he is looking for a set to take on holiday (We shall be reviewing this kit in the July PW-Ed).

The other month I featured a set bought in a jumble sale, but this month one that was actually given away because it apparently did not work! This happy event happened to J. Shurman of London who was given a Pye five band set by his grandmother. He does not tell us the aerial type but he has managed to log:

- Radio Peace and Progress on 9800 at 1415
- Vatican Radio on 9645 at 1500
- Radio Cairo on 9455 at 2315

We will all, I am sure, want to wish Alan Crookes of Deepcar, Sheffield a "get well soon". He had an accident at work which will, as he says, put him "out of circulation" for a spell. Nothing daunted he turned to his Murphy B40 and hooked this on to the PW aerial tuner unit which sucks the signals from a redundant TV aerial. This set up brought in, among others, Radio Australia on 11840 at the unusual time of 1710 along with another rarity the Gospel station ETLF Ethiopia on 11830 at 2215.

To wind up this month's items a quick look around the stations. WDXC report that Adventist World Radio plan to broadcast from the Deutsche Welle Malta relay by the summer, while FEBA plan to put into action a 100kW transmitter which they test on 15325 from 1250 to 1500.

MEDIUM WAVE DX
by CHARLES MOLLOY

F. WILDMAN (Bournemouth) has been trying the medium waves with his Codar CR70 and 75ft outdoor aerial. He reports excellent reception of WINS New York City on 1010kHz at 2345 on the 4th March, both Hilversum on 1007kHz and Mainz/Wolfsheim on 1016kHz having signed-off at 2300 to leave a clear space for the North American. Another outlet in NYC—WNEW on 1130 kHz—was logged on the 7th March at 0620. Reception was very good with occasional interference from Brussels on 1124kHz, and lasted until 0650 which was well past daybreak.

Fred Dinning pulled-in a good bag of Canadians at his QTH at Dunlop in Scotland using a Hammerlund SP600 and medium wave loop. DX logged includes VOCM St John's Newfoundland on 590kHz; CKCM Grand Falls, Nfld 620kHz; CFY Charlotte-town, Prince Edward Island 650kHz; CBN St John's 640kHz; CJJC Grand Falls 680kHz; CBNM Marys-town, Nfld 740kHz; CBH Halifax, Nova Scotia 860kHz; CJIC Halifax 920kHz; CJON St John's 930kHz; CHER Sydney, N.S. 950kHz; CHNS Halifax 960kHz; CKBW Bridgewater, N.S. 1000kHz; CBA Monotom, New Brunswick 1070kHz; CBD Saint John N.B. 1110kHz; CKEC New Glasgow, N.S. 1320kHz. Newfoundland, which is located approx. 2,200 miles west of the U.K. and 3½ hours behind GMT in time is the first part of North America to fade-in (some 4 to 5 hours after sunset in the U.K.), followed shortly afterwards by the eastern seaboard states of Canada (GMT−4) and the United States (GMT−5). Even in midsummer the outlets logged by Fred can be heard in the U.K. for an hour before sunrise. Reception is often very good as dawn approaches—a reward for the keen DXer who tunes round the band at this hour.

Harold Emblem reports again from Mirfield in Yorkshire. Using an Eddystone 730 and medium wave loop he logged Kabul, Afghanistan on 1280kHz with sign-on at 0200; CKVO the new outlet at Clareville, Newfoundland on 710kHz and Radio Caribbean on 840kHz. (Radio Caribbean transmits with a power of 10kW from Castries on the island of St. Lucia). Listen for medium wave broadcasts from the Caribbean between 0100 and sunrise during the summer. Stations to search for that are logged regularly in the U.K. are Radio Surinam, Paramaribo on 725kHz; Point Galina, Jamaica 750kHz; Radio Demerara, Guyana 760kHz; Trans World Radio, Bonaire 800kHz; Radio Antilles, Montserrat 930kHz; Radio Victoria, Aruba now on 960kHz; Radio Paradise, St. Kitts 1265kHz; Radio Bahamas in Nassau on 1540kHz.

A. J. Fenton (Warley) has heard a Russian station on 254kHz after the close down of Lahti, Finland at 2130. Yerevan, Armenia is on this frequency until 2200 while Dushanbe, Tadzhikistan signs-on at 2300. Either of these is capable of being logged in the U.K. David Blair (Airdrie, Scotland) asks if an Aerial Tuning Unit would improve reception on the medium waves. An ATU is inserted between the aerial and receiver and is adjusted to give a good match between the two. In many cases this will bring a considerable increase in signal strength. Partridge Electronics, who advertise in Practical Wireless, can supply a Joymatch ATU suitable for use on the medium waves.

BROADCAST BANDS

Short Wave Reports by the 15th of the month to Derek Bell, c/o Practical Wireless, Fleetway House, Farrington Street, London, EC4A 4AD.

Medium Wave Logs to Charles Molloy, 132 Segars Lane, Southport, PR8 3JG.

AMATEUR BANDS

Logs covering any amateur band/s in band/alphabetical order by the middle of the month to Eric Dowdeswell GIAR, Silver Firs, Leatherhead Road, Ash- stead, Surrey, KT22 7TW.
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One of the most common LC oscillators is the Hartley oscillator which we shall be describing and using this month. The basic circuit is shown in Fig. 108a. To prevent experimental problems we shall be making this circuit oscillate with frequencies in the range of 500kHz to about 1MHz, i.e. over the medium wave band. This allows us to use any conventional transistor radio, having a medium wave tuning range, to detect oscillation and, at the same time, the frequencies are not so high to give us problems with parasitic capacitance and layout.

Tr1 is operated in a very similar mode to the simple feedback biased audio amplifier stages described previously, but note that its emitter is not returned direct to the earth rail. Imagine that L1 and C1 had been left out of the circuit as we have drawn it; L2 would act as an emitter load to the transistor. Any signal that we applied through C2 to the base of the transistor would cause collector current to vary through R2 and L2. This gives rise to voltage variations at the collector of the transistor. There will be pretty insignificant voltage variations at its emitter but there will be reasonable levels of current flowing through the windings of L2. These currents cause varying magnetic fields within the windings and these magnetic variations are used to generate our feedback to make the circuit provide self-sustained oscillation.

Now let's see what happens when we introduce L1 to the circuit. This winding is coupled electrically to the top end of L2 and is wound on the same magnetic axis. We shall be using a ferrite rod on
which to wind the coils as this helps increase the magnetic coupling between the two coils. By adding the extra turns for L1 on the same core that we are using for L2 gives us the equivalent of an Auto-transformer. If an AC signal was applied between the top end of L2 and earth it would induce a signal across the top of L1 and earth having a higher voltage. The voltage increase would be proportional to the ratio of turns.

\[ V_{\text{out}} = V_{\text{in}} \times \frac{\text{Turns on } L1 + \text{Turns on } L2}{\text{Turns on } L2} \]

This simple turns ratio expression does not make allowances for losses but is sufficiently accurate to give an indication of what is happening. In our case we get voltages at the top end of L1 that are approximately 20 times greater than are applied across L2. We must, however, remember that something has to go to allow this voltage magnification and, of course the current is reduced by a factor of 20. In other words we can say that the impedance across L1 and L2 in series is higher than that across L2 on its own.

\[ \text{Capacitive reactance} = \text{Inductive reactance} \]

\[ \frac{1}{2\pi f C} = 2\pi f L \]

where \( f \) is in hertz, \( L \) in henrys and \( C \) in farads.

Remember, in our circuit, the value for inductance is obtained from the total inductance of L1 and L2 together!

It is a feature of a parallel tuned circuit that when the two reactances are equal the impedance of the parallel circuit becomes extremely high, the limiting value of this impedance being set by the Q factor of the coil. This means, in real terms, that at resonance we shall see the highest values of AC voltage appearing across the tuned circuit. At all other frequencies, whether higher or lower, the voltage across C1 will be less. It should, therefore, be quite obvious that we shall get higher values of feedback voltage at the resonant frequency than at any other and the circuit will prefer to oscillate at the resonant frequency.

By making C1 a variable component we can alter the frequency of oscillation to suit ourselves. The inductor we shall use is identical to the ferrite aerial coil one would use for a simple transistor radio set. After all, the input stages of a medium wave radio have to tune to the same frequencies we are hoping to generate so it should seem only right that the inductance and capacitance values should be the same. Wind L1 and L2 with 22SWG enamelled copper wire on about a 6in length of 3in diameter ferrite aerial rod. They should be close wound and there should not be more than about 1in gap between L1 and L2, Fig. 106b. Make sure that you start each winding at the right place and keep the same winding sense.

Now wire up the circuit of Fig. 108a according to the given layout, Fig. 109, and apply power from a 4.5V battery. Lay (do not connect) a piece of insulated wire close to Tr1 and connect the other end of the wire to the aerial input socket of a medium wave radio. If there is no aerial socket the chances are that there is a ferrite rod inside the radio; if so it should be sufficient, for our experiment, to continue on page 157.
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place the radio close to the ferrite rod of our oscillator. Tune in a broadcast station on the radio and then adjust C1 of our oscillator. At one setting you should hear a very loud whistle changing in pitch as you adjust C1. This is heterodyning or beating of the signal we are generating and the signal coming in from the distant station.

Try different positions on the tuning scale of the radio and you should be able to check the range of frequencies our oscillator generates. It is easiest to beat this signal against incoming signals otherwise you will hear no noise from the loudspeaker when in tune, apart, perhaps, from a slight reduction in background hiss as the AGC circuits of the radio come into operation.

If the level of positive feedback is too great Tr1 might be driven into saturation and instead of getting a pure sinewave signal we will get a clipped signal. This clipping introduces high order harmonics and you might find in the case of excessive feedback, spurious signals occurring all over the tuning range of the radio. You can increase the level of feedback by increasing the value of C2 and vice versa. With too little feedback the circuit will, of course, not oscillate. Ideally the value for C2 should be selected to enable the circuit to just oscillate. Try altering the number of turns for L1. Reducing the turns makes the circuit operate at higher frequencies, shorter wavelengths, because we are reducing its inductance, and vice versa.

The circuit we have just made produces what is called an RF carrier signal. It is a pure, constant amplitude sinewave and, as such, carries no intelligible information. However, in the case of broadcasting we need just such a signal but need to impress audio information upon it so that we can get an intelligible signal from the loudspeaker of our radio. The simplest way of doing this is by a process known as amplitude modulation, AM. This entails altering the level of signal our oscillator produces in proportion to the amplitude of audio signal we wish to transmit.

Fig. 110 shows a simple modification that allows us to modulate our carrier signal with a square wave produced by the multivibrator, Tr2 and Tr3. Resistors R3 and R4 form the collector load for Tr2 and we use the junction of these two components to provide the power rail voltage to our RF oscillator. As the waveform at the collector of Tr2 rises and falls so does the voltage driving the oscillator and the amplitude of the resulting carrier will be amplitude modulated at the frequency of the multivibrator. A clear tone should be detectable over the medium wave range of the radio as Cl is adjusted. Such a circuit can form the basis of a test signal generator. The layout is shown in Fig. 111.

**Fig. 110:** An audio tone is generated by multivibrator Tr2/3, modulating the carrier produced by oscillator Tr1.

**Fig. 111:** Layout of components used in Fig. 110.

**Next month:** Simple radio receiver circuits.
IN USE
When receiving SSB signals, accurate tuning is absolutely necessary, since small errors will influence the quality of the signal. No resolution of speech is possible if the oscillator is on the wrong side of the signal. This will soon become apparent in use.

For CW reception, the oscillator may be either side the signal, as is found to give best reception. Tuning slightly one way will change the pitch or audio tone.

The receiver is not intended for conventional AM reception as AM signals produce a continuous heterodyne except when tuning of the oscillator agrees exactly with the carrier frequency.

The output stage is suitable for headphones of medium or high impedance type with a resistance of about 100Ω to 1.5kΩ. Battery current is about 7mA with 1.5kΩ phones and 20mA with 100Ω phones, the latter providing greater volume.

MODIFICATIONS
Other audio amplifiers could be used, omitting Tr2 and Tr3. An example is the Sinclair IC-2, which can be connected as in Fig. 5.
C7 and VR1 are already present. The additional resistor and capacitor are a high frequency filter, to help produce a frequency response more suitable for the purpose. The amplifier is operated from its own 9V battery and a 3 to 15Ω speaker can be used.

When using this or other Class B amplifiers it is essential to prevent frequency modulation of Tr4 at syllabic rate from a common battery supply. The simplest method is to use separate batteries, as mentioned. The alternative is a decoupled and regulated supply for Tr1 and Tr4. The amplifier in Fig. 1 gives excellent head phone volume with many signals, but it is not really intended for a loudspeaker.

BANDPASS INPUT
If a resonant aerial or tuning unit is not available, the coil and capacitor in Fig. 6 may be added near the receiver aerial socket.
VC3 can be 100pF or larger, if one coil is to cover both bands. The tuned winding resembling L1 or L2 in the receiver. For the aerial coupling winding, use about one-third as many turns as the tuned winding. TC1 is almost fully opened providing top-capacitance coupling between the tuned circuits.

DIRECT CONVERSION RECEIVER—contd from page 118

TELEVISION

IN THE JUNE ISSUE

THYRISTOR TESTER
Thyrists are now commonly used in solid-state receiver stabilised power supplies. Unfortunately they are inclined to be troublesome. Other applications are in the line output stage of many imported colour receivers and as over-voltage protection crowbar trips. So there is increasing need to be able to test them. Simple checks are not reliable: the only satisfactory method of testing involves the use of high voltages and currents. This is the basis of Alan Wilcox's useful tester, which complements his recent transistor tester.

FAULT-FINDING: GEC SERIES 1 AND 2
John Law's latest fault-finding guide deals with the timebase sections of the GEC Series 1 and 2 chassis.

RANK'S REMOTE CONTROL SYSTEM
Channel changing techniques have altered a great deal in recent times. The latest approach is to use touch tuning in conjunction with a varicap tuner unit, with an integrated circuit to switch between the tuning potentiometers. This arrangement lends itself readily to remote control and Rank have exploited the possibilities to produce an ingenious low-cost cordless remote control system which is a standard feature of the latest range of Bush colour receivers. A detailed description of the system will be given.

APOLLO—continued from page 139

Fig. 2.7: Using this set-up one may obtain a visible display of signals present within the swept part of the band.

If in any doubt about one's proficiency to undertake such a modification to an existing set, take great care to become accustomed to using the vari caps, and the techniques necessary to avoid damaging them through over-voltage when coupling to an existing circuit.

NEXT MONTH: A VARICAP AM/FM STEREO TUNER

Television

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SPECIFICATION OF UNITS

Recommended retail price

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- 40N2
- 40P1
- 40P2
- 90N3
- 90N4
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- 90P4

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90 WATT SILICON

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AUTO TRANSFORMERS

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MINIATURE TRANSFORMERS WITH SCREENS P & P

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**Sliders**

<table>
<thead>
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<th>Value</th>
<th>Description</th>
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<tr>
<td>50K</td>
<td>Triplet</td>
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<tr>
<td>100K</td>
<td>Quadruplet</td>
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</table>

**Pre-Set**

- Vertical or Horizontal

### CAPACITORS

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- Multilayer C220 Series 630 Volts W/kg, Metalized Polyphosphate Film

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- Metal Oxide Film, ±10% Tolerance
- Ceramic Composition, ±10% Tolerance

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<th>Value</th>
<th>Cost</th>
<th>Price</th>
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<td>100K &amp; 1M</td>
<td>2p</td>
<td>1.4p</td>
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<tr>
<td>3µF</td>
<td>5p</td>
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These two modules together form a high quality A/M/FM tuner covering the long, medium and shortwave broadcast bands, and the AM bands, and are available in kits or DIP sockets. £10.50 (Carriage 50p). Spec.

LP170
AM Bandwidth 5 - 6 kHz
FM Bandwidth 8.5 kHz
Builtin AGC LP171
Supply: 12V, 18V range or 12V or 18V and ±2V outputs and spec. data.

LP171I
AM Bandwidth 6.5 kHz
FM Bandwidth 9 kHz
Builtin AGC LP171I
Supply: 8 - 18V range or 8 - 18V and ±2V outputs and spec. data.

Suitable Ferrite coil: 0.5 - 75 µH each
£4.00 each or £7.50 pair

Multimeter Modules
LP170 170 7F - Type 50
LP170 8F - FM TUNER 50
Genua PERM. Tuner 50

Amplifiers with controls
BB210 12 volt 2.5 + 1.5 watts 550p
BAC18 Mono 7.5 + 7.5 watts 800p
BAC20 Mono 15 + 15 watts 800p
BAC90 Mono 15 + 15 watts 800p
BAC65 Mono 12 + 3 watts 600p
BAC54 Mono 10 + 10 watts 600p
BAC14 Mono 9 + 9 watts 600p
BAC51 Mono 9 + 9 watts 600p
BAC35 Mono 12 + 3 watts 600p
BAC25 Mono 10 + 10 watts 600p

Fm and AM Tuners and Decoders
FM525 (2x3) FM 8 volt Tuner 550p
FM808 (2x3) FM 8 volt Tuner 550p
FM102 (2x3) 12 volt Tuner 550p

MP335 12 volt transistor AM decoder 550p

SD6281 12 volt Stereo decoder for Tu 3-12 volt 550p
SD6421 8 - 12 volt stereo decoder for Tu 12 volt 550p
BAC90 9 volt stereo tuner in cabinet 550p
BAC92 9 volt stereo tuner 550p

50M (S) 9 volt stereo decoder 50M 550p

BAC62 12 volt stereo decoder general purpose 550p

Power Supplies Mains Input (plus-esti-case)
115V AC 670/ 240 MA with adaptors 3.50
90V 900 500 MA 3.50
90V 240/ 120/ 240 MA stabilized 5.70
90V 240/ 120/ 240 MA stabilized 7.50
90V 240/ 120/ 240 MA stabilized 9.60
90V 240/ 120/ 240 MA stabilized 11.70
90V 240/ 120/ 240 MA stabilized 15.00

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Compliment 4000 series' IC's from £2.00 each
Signetics Phase Low IC's: RCA Linear IC's: T03 Power Version (PNP and NPN from £1.50 each)
RC07 and "BC range" from £1.50 each
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DIL SOCKETS
6 pin 14p
8 pin 17p
16 pin 20p
24 pin 25p

NOMBER TEST EQUIPMENT
Model 35 Stabilised Power Supply
A short circuit proof power supply delivery up to 20 volts at 1 Amp. Built-in Volts and ammeters. £34.00

Model 40 Wide Range Audio Signal Generator
A high stability signal generator using the low distortion Wien bridge principle. £34.00

Model 41 RF Signal Generator
Covers 150 kHz to 200 MHz in 8 ranges. Built in AF output up to 50mW. £38.00

Model 42 Wide Range RF Signal Generator
Covers 150 kHz to 300 MHz in 8 ranges. Highest range on harmonic. £24.50

Model 43 RC Bridge
Null indicator bridge for resistors and capacitors. Resistance range 10k to 10m ±2% at 20°C. £23.50

Model 44 Inductance Bridge
Measurers leads from 10 Hz to 3 kHz ±5% accuracy. £34.00

Model 45 Direct Reading Frequency Meter
10Hz to 100kHz in 4 ranges. Input from 10mV to 5V £36.00

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