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ISSUE 853

MARCH 1978 · VOLUME 53 · NUMBER 11

BRITAIN'S LEADING JOURNAL FOR THE RADIO & ELECTRONIC CONSTRUCTOR

Published by IPC Magazines Ltd., Westover House, West Quay Rd., POOLE, Dorset BH15 1JG

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Free This Month

‘GUIDE TO AERIALS’—A special supplement

An Apology

To all who bought our February issue. We are sorry that, due to an oversight, the Active Tone Control which was mentioned on the front cover, did not appear in the magazine. The article appears instead on page 814 of this issue.

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The C15/15 is a unique Power Amplifier providing Stereo 15 watts per channel or 30 watts Mono and can be used with any car radio/tape unit. It is simply wired in series with the existing speaker leads and in conjunction with our speakers S15 produces a system of incredible performance.

A novel feature is that the amplifier is automatically switched on or off by sensing the power line of the radio/tape unit hence alleviating the need for an on/off switch.

The amplifier is sealed into an integral heatsink and is terminated by screw connectors making installation a very easy process.

The S15 has been specially designed for car use and produces performance equal to domestic speakers yet retaining high power handling and compact size.

**C15/15**
- 15 Watts per channel into 4Ω
- Distortion 0.2% at 1KHz at 15 watts
- Frequency response 50Hz - 30KHz
- Input Impedance 8Ω nominal
- Input sensitivity 2 volts R.M.S. for 15 watts output
- Power line 10 - 18 volts
- Open and Short Circuit protection
- Thermal protection
- Size 4 x 4 x 1 inches

**Data on S15**
- 6" Diameter
- 5" Air Suspension
- 2" Active Tweeter
- 20oz Ceramic magnet
- 15 watts R.M.S. handling
- 50 Hz - 15KHz frequency response
- 4Ω Impedance

**C15/15 Price £17.74 + £2.21 VAT P & P free**

**TWO YEARS' GUARANTEE ON ALL OF OUR PRODUCTS**

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Crossland House,
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Tel. (0227) 63218.
A. P. ELECTRONICS
Manufacturer and Distributor of Electronic Components
3 MILDMAY ROAD, ROMFORD, ESSEX
RM7 7DA
Telephone: ROMFORD 28882

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1000 WATTS PER CHANNEL
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(Nov. 75 article by A. C. Ainslie)

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Practical Wireless, March 1978
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FEATURES

- 4 LED digits 1½ high. Red.
- 12 hour display with AM/PM indication
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Practical Wireless, March 1978
Vero Electronics Limited, Industrial Estate, Chamberlain Road, Earlsdon, Coventry CV4 6BP

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2003 190 x 110 x 60mm £3.72
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100 polyester, ±0.1-2uF £1.50
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100 off £18.50
25 off £5.50
The Chroma-Chime is the world's first electronic musical door chime to use a pre-programmed microcomputer chip to generate tunes. Now you can replace your old boring buzz, zing or ding with the sound of this remarkable feat of British engineering capable of playing 24 well known melodies.

Really enjoyable to build, this kit will give you the satisfaction of assembling a first class professional product for yourself and give you and your callers entertainment for years to come as well as enhancing your home.

Buy your Chroma-Chime Kit now and get a free large poster (size approx. 23½" x 16½") of the original circuit diagram as above, which incidentally measures 36-24-36. *This one was not done by our bird-brained designer on the back of a cigarette packet, as you can see!

The CHROMA-CHIME is exclusively designed by CHROMATRONICS, River Way, Harlow, Essex.

Practical Wireless, March 1978
Yes, they have got a funny name: Blob Boards.
And if you've never heard of them, you might wonder what on earth they're for. After all they sound more like sci fi than practical electronics.
But in fact there is a good reason for the name.
It actually describes the way these printed circuit boards work. You just put a tiny blob of solder onto circuit board and component and you've made a perfect contact.
Every time.
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These Blob Boards are about half the price of the few comparable alternatives.
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The roller tinned copper on Blob Board makes soldering easy, and it won't corrode, so they'll work for as long as you want them to.
You'll find a Bandridge Blob Board for every circuit you'll ever want to make, from the simplest to the most complex.
And if you're using Bandridge solderless DEC's for your prototypes you'll be pleased to learn that there's a Blob Board that exactly matches every DEC.
So when you're looking for a circuit board it'll be worth your while remembering Blob Boards.
As if you'd ever forget a name like that.

For your nearest stockist contact Bandridge Ltd., 80a Battersea Rise, London SW11 1EH. Tel: 01-228 9227.

Practical Wireless, March 1978
### THYRISTORS

<table>
<thead>
<tr>
<th>No.</th>
<th>Thyristor Type</th>
<th>Amp.</th>
<th>Volts</th>
<th>TOS</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>THY1/50</td>
<td>1 Amp.</td>
<td>30 Volts</td>
<td>TO5</td>
<td>18p</td>
<td></td>
</tr>
<tr>
<td>THY2/50</td>
<td>2 Amp.</td>
<td>30 Volts</td>
<td>TO5</td>
<td>24p</td>
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<td>THY3/50</td>
<td>3 Amp.</td>
<td>30 Volts</td>
<td>TO5</td>
<td>25p</td>
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<td>THY4/50</td>
<td>4 Amp.</td>
<td>30 Volts</td>
<td>TO5</td>
<td>30p</td>
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<td>THY5/50</td>
<td>5 Amp.</td>
<td>30 Volts</td>
<td>TO5</td>
<td>40p</td>
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<td>6 Amp.</td>
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<td>TO5</td>
<td>50p</td>
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<td>60p</td>
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<td>THY8/50</td>
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<td>70p</td>
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<td>THY9/50</td>
<td>9 Amp.</td>
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<td>80p</td>
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<td>THY10/50</td>
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<td>30 Volts</td>
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<td>THY11/50</td>
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<td>THY12/50</td>
<td>12 Amp.</td>
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<td>TO5</td>
<td>1.25</td>
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<tr>
<td>THY13/50</td>
<td>13 Amp.</td>
<td>30 Volts</td>
<td>TO5</td>
<td>1.50</td>
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<td>THY14/50</td>
<td>14 Amp.</td>
<td>30 Volts</td>
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<tr>
<td>THY15/50</td>
<td>15 Amp.</td>
<td>30 Volts</td>
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<td>2.00</td>
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<td>THY16/50</td>
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<td>THY18/50</td>
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<td>2.75</td>
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<td>THY19/50</td>
<td>19 Amp.</td>
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<td>3.00</td>
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<td>THY20/50</td>
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<td>3.25</td>
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<td>THY21/50</td>
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<td>30 Volts</td>
<td>TO5</td>
<td>3.50</td>
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<td>THY22/50</td>
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<td>TO5</td>
<td>3.75</td>
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<td>THY23/50</td>
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<td>30 Volts</td>
<td>TO5</td>
<td>4.00</td>
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<td>THY24/50</td>
<td>24 Amp.</td>
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<td>TO5</td>
<td>4.25</td>
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### TRIC AS

<table>
<thead>
<tr>
<th>No.</th>
<th>Amp.</th>
<th>Volts</th>
<th>TO202 (Plastic) 80p</th>
</tr>
</thead>
<tbody>
<tr>
<td>584</td>
<td>8 Amp.</td>
<td>400 Volts</td>
<td>TO202 Plastic 80p</td>
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### SWITCHES

<table>
<thead>
<tr>
<th>No.</th>
<th>Type</th>
<th>Price</th>
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<tbody>
<tr>
<td>517</td>
<td>5 x Mains Slide Switches</td>
<td>40p</td>
</tr>
<tr>
<td>518</td>
<td>4 x Standard Slide Switches</td>
<td>40p</td>
</tr>
<tr>
<td>519</td>
<td>4 x Momentary Push To Make</td>
<td>40p</td>
</tr>
<tr>
<td>520</td>
<td>2 x Miniature Push To Break</td>
<td>40p</td>
</tr>
<tr>
<td>521</td>
<td>4 x Assorted types Multi</td>
<td>1.00</td>
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### CAPACITOR PAKS

<table>
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<tr>
<th>No.</th>
<th>Value</th>
<th>Price</th>
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<tr>
<td>16201</td>
<td>10 pF to 10 nF</td>
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<tr>
<td>16202</td>
<td>10 pF to 10 nF</td>
<td>1.00</td>
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</table>

### RESISTOR PAKS

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<thead>
<tr>
<th>Order No.</th>
<th>Power</th>
<th>Resistance</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>16213</td>
<td>60 W</td>
<td>1000 Ohm - 330 Ohm</td>
<td>1.00</td>
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<tr>
<td>16214</td>
<td>60 W</td>
<td>1000 Ohm - 330 Ohm</td>
<td>1.00</td>
</tr>
<tr>
<td>16215</td>
<td>60 W</td>
<td>1000 Ohm - 330 Ohm</td>
<td>1.00</td>
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### DIODES

<table>
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<tr>
<th>No.</th>
<th>Type</th>
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</tr>
</thead>
<tbody>
<tr>
<td>102</td>
<td>Rectifier</td>
<td>6p</td>
</tr>
<tr>
<td>103</td>
<td>Rectifier</td>
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### MATCHED PAIRS OF GERMANIUM PNP, PNP TRANSISTERS

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### CABLE CLIPS

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**BI-Pak Brand New—Fully Guaranteed**

**Unstated Semiconductor Paks**

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**Resistors**

**Diodes**

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**Look at Our Books**

Practical Wireless, March 1978
Are you guilty?

1. Cord grip not in use, earth conductor detached from terminal as a result—the two most common faults pinpointed in the survey.

3. Reversed polarity, cord grip discarded by householder.

2. Broken plug body, possibly through being dropped onto hard floor, has exposed live and earth terminals. Use of resilient-clad plugs in areas where there is a risk of breakage (e.g., Kitchens) could minimise this problem.

4. Reversed polarity, cord grip discarded by householder.

**PLEASE NOTE**

We do not operate a Technical Query Service except on matters concerning constructional articles published in PW. We do not supply service sheets or information on commercial radios, TV’s or electronic equipment.

All queries must be accompanied by a stamped self-addressed envelope otherwise a reply cannot be guaranteed.
More than 70 million electric plugs used in British homes could be potentially dangerous according to a report published last November by the Electrical Research Association.

Britain's largest manufacturer of plugs and other electrical wiring accessories, MK Electric Ltd, commissioned ERA to carry out the survey and isolate the most common faults present in plugs used in the home.

The four pictures reproduced on the opposite page show some of the most common faults, we at Practical Wireless hope that you are not guilty of using plugs in these sort of conditions! The survey found that just over 18 per cent of the sample had inefficient cord grips. The grip, which prevents strain on the terminal connections was in many cases found to be loose, not in use, missing or to have lost one screw. 7-4 per cent of the terminals had faulty connections, largely as a result of inefficient cord grips.

Many people were still using plugs which had been damaged, probably as a result of being dropped onto hard floors. Some of these were in a very dangerous condition because damage had left live terminals exposed. The moral here is to throw away any broken plugs and to use a resilient clad plug in areas where the floor is hard such as the kitchen.

1-5 per cent of householders had reversed the live and neutral connections. Frightening isn't it? Get to know the colour code, brown is live, blue is neutral and green/yellow is earth.

The survey states that most of the faults are due to lack of consumer education although manufacturers could be more helpful in the design of cord grips and clearer wiring instructions.

MK reckon that a conservative estimate of the number of plugs in use in this country is 400 million, which means that, if the results of the ERA survey hold good for the country as a whole, over 73 million plugs could be in a dangerous condition through inefficient cord grips alone, another 12 million because of physical damage and 6 million with incorrect connections.

If that doesn't frighten you then we don't know what will!

Practical Wireless, March 1978

**'Pianocorder'**

An intriguing invention, which is in essence an extension of the early work by Edward Welte in 1904, is the 'Pianocorder'. Manufactured and developed by Superscope, the unit "plays" a piano by interpreting pulses recovered from magnetic tape. Welte produced what could only be described as a 'machine' which used a paper roll as the storage medium. Each note on the keyboard was fitted with a small carbon-tipped prong which made contact with a tray of mercury when depressed, and a similar arrangement was fitted to the pedals. When the circuit was made, the initial transients and durations were recorded on the paper in a manner similar to that of a pen recorder. The resulting traces were then punched out by hand.

The player mechanism itself consisted of a wooden box fitted with eighty felt-tipped fingers and two actuators for the pedals. The entire unit was placed in front of the piano in the normal playing position and operated by vacuum, the punched paper providing the keying sequences, timing and pedalwork.

Superscope have collected thousands of these original paper rolls and transcribed the information on to magnetic tape, employing a digital process. The cassettes are fed into a controller, located at the front of the instrument, and operate solenoids and relays within the piano.

In addition to the playback of pre-recorded cassettes, the device will also initiate its own recording. Thus it could be regarded as an extremely useful teaching tool for the pianoforte student, as well as an entertainment medium—if the f.o.b. price of around £600 dollars can be accommodated, that is!

With right and left channel sideband pairs being transmitted at ±15° from the carrier. There is absolutely no increase in occupied bandwidth or spectral density and no loss of mono coverage. Modulation of +125% and -100% is maintained.

The public can expect economical and stable receiver implementation with CPM. Tests conducted by the designers have shown that existing integrated circuits can be used for the AM/CPM receiver.

Because the CPM bandwidth is no greater than that of mono AM, there is good envelope detector compatibility, even with narrow-band receivers. As it is a linear additive system, stereo receivers will not generate distortion in any case—even under skywave conditions. Unlike non-linear systems, Harris CPM does not require flat receiver response and complex correction functions. Loudness is equal to the mono signal, unlike VHF/FM which has a loudness reduction when changing from mono to stereo. A conventional pilot indicator can be used, similar to that fitted to most VHF/FM tuners, and no stereo breakup with high modulation occurs.

Existing transmitting equipment may be used for CPM with only minor modification and the addition of a stereo exciter. Although listeners would need re-designed receivers for AM stereo in their homes or cars, costs are expected to be fairly economical and a vast consumer market is envisaged when the system is introduced and gains popularity.

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**Good News**

We are pleased to announce the reintroduction of the published subscription service for Practical Wireless. The annual cost to either UK or overseas addresses is £10.60.

Application may be made to:

IPC Services, Subscriptions Department, Oakfield House, Perrymount Road, Haywards Heath, Sussex.

Remittances should be made payable to IPC Services.
This article describes an active tone control for general use in audio amplifiers, having a good performance which is largely unaffected by the input and output characteristics of the associated pre-amplifier and power amplifier stages. The permissible output of 0.84 volt r.m.s. (1.17 V peak) at 1kHz, with both controls in the "flat" position, will be sufficient to load the input stage of most power amplifiers, while still permitting use of the maximum bass boost of 17dB at 30Hz without exceeding the output limit of 6 volts for 1 per cent total distortion at that frequency. The required input from the pre-amplifier under these conditions is 0.14 volt r.m.s. (0.2 volt peak). With both controls centred, the response is linear within 0·15dB from 30Hz to 20kHz.

The Circuit

The circuit (Fig. 1) is a feedback tone control based on P. J. Baxandall’s circuit, first published in the 1850s, which with various detail modifications has become something of a world standard, largely displacing the loss-type controls previously used. The present design uses linear potentiometers with Tappings, and achieves almost ideal control characteristics. A brief look at the design philosophy follows.

The basic control stage comprises Tr2 and the network connected between its base and the emitter or Tr1, with negative feedback from Tr2 output to the network. This stage provides the whole of the available gain and it is possible, as in the present case, to obtain sufficient open-loop gain (i.e. with feedback disconnected) to provide for the full range of boost and cut—about 20dB plus or minus—and still leave a useful positive gain over the mid-range of around 17dB. Thus, the tone-control is far from being a mere passenger, much less a "loser".

Circuits of this type work best when fed from a low impedance source, which is not normally available from a practical pre-amplifier having gain; furthermore the operation of the tone controls is liable to affect adversely the output characteristics of such a

![Fig. 1: Complete circuit diagram of the Active Tone Control.](image-url)

---

**Specification**

- **Input voltage:** 140mV r.m.s.
- **Input resistance at 1kHz:** 1 megohm approx.
- **Voltage gain:**
  - (controls flat): 8000
  - (controls at -6dB): X8 5 (10-83dB)
- **Maximum output voltage:** 8 volts r.m.s.
- **Maximum output distortion:** 0.1% of 1kHz
- **Effective noise voltage:** 5 microvolts
- **Range of tone controls:**
  - Bass (at 30Hz): ±17dB (relative to Treble at 20kHz)
  - Treble (at 20kHz): ±80dB (relative to 1kHz)
- **Distortion (over range):**
  - Bass (0.1%): 0.25%
  - Bass (1kHz): 0.35%
  - Treble (0.05%): 0.4%
- **Supply:** 24V ±2V 6V 0.25%
  - 0.4% 0.025%

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* Practical Wireless, March 1978
Pre-amplifier. Accordingly the present design employs Tr1 in an emitter-follower (common collector) circuit as an impedance transformer, to isolate the pre-amplifier from the effects of the tone controls and to provide them with the desired low-impedance source. Additionally, Tr1 input circuit is bootstrapped via capacitor C5 and its input resistance is thus raised to over a megohm, which is high enough to leave unaffected any normal pre-amplifier output circuit.

In the same way the feedback to the tone-control network is best derived from a low-impedance source, since operation of the controls causes the effective impedance of the network to vary markedly, which tends to spoil the desired uniform gain of Tr2 and also to limit its undistorted output. Therefore a second emitter-follower (Tr3), is used, DC coupled to Tr2 collector, and the feedback connection is taken from a tapping on its emitter load. This is as recommended as there is no phase-reversal in an emitter-follower.

In this way the tone control stage gets its feedback from the desired low impedance and Tr2 works unhindered into a very high impedance which imposes very little loading on it and has a flat frequency response over the desired range. At the same time a low-impedance output is provided whose operation will be largely independent of the load presented by the input of the following power amplifier, unless this is very low indeed. The complete tone control unit should therefore be usable without modification between a wide variety of pre-amplifiers and power amplifiers, regardless of their input and output impedances. The two emitter-followers together reduce the effective gain to around 16dB.

The circuit of Fig. 1 of course shows a single channel only; two are needed for a stereo installation, with twin bass and treble potentiometers ganged together.

Overload

The question of possible overload and consequent distortion when using the maximum available boost is a point not always clearly brought out in connection with such tone controls. A published circuit may be accompanied by a claim that the total distortion is less than, say, 0.1 per cent at an input not exceeding a given figure. However, closer study may show that this statement is true only while the bass and treble controls are at or near the "flat" position. In such cases distortion in the bass or treble regions may rise rapidly with an increase of bass or treble boost and can reach an unacceptable figure, or even the limiting point, before maximum boost has been obtained. The input signal must then be reduced substantially if full boost is required without excessive distortion. This assumes, of course, that the signal up to the tone control input is substantially level at all frequencies concerned.

In the present design the maximum available output swing at low distortion (1 per cent) is 6 volts r.m.s. (8-4 volts peak). The maximum bass boost available is +17dB at 30Hz relative to 1kHz (0dB). Therefore the maximum permissible output swing at 1kHz, if the boosted bass is not to be badly distorted, is 17dB down from 6 volts, namely 0-84 volt r.m.s. or 1-17, volt peak, and this should be the maximum designed mid-band input voltage required by the driver stage of the power amplifier to give an acceptable output volume around 1kHz, while still having enough power in reserve to accept a 17dB increase of signal input without overloading in any part of the power amplifier. This is not always easy to achieve economically. Overload due to maximum treble boost is not, perhaps, so serious for the resulting distortion products will mostly be outside the audible range, though some purists would probably dispute this.

Assuming, therefore, a permissible mid-range output from the tone control of 0-84 volt r.m.s. and an effective gain conservatively stated as 6 times (15-5 dB), the required input to the tone control unit from the pre-amplifier will be 0-84/6, or 0.14 volt r.m.s. = 0.2 volt peak. At these levels the total harmonic distortion will be less than 0.1 per cent at any frequency within the range, with both controls in the "flat" position, and should not exceed 1 per cent at any frequency when maximum boost is in use.

Components

None of the component tolerances is very critical and 10 per cent will generally be good enough. One of the advantages of using linear potentiometers is that they are generally better matched than the logarithmic type. Layout is not very important apart from guarding against stray hum fields, and there should be no stability problems.

Other transistors of roughly similar type can be used without much change in performance, e.g., BC107, BC109, or their plastic-cased counterparts, but they must be able to accept the 25 volt supply without risk of failure. A practical point concerns the setting of the control knobs on their shafts; the mid-point of the resistance range may or may not be the mid-point of shaft rotation (speaking now of conventional carbon-type controls) and the actual total resistance is unlikely to be exactly 100,000 ohms. Use an ohmmeter to measure the actual total resistance of the potentiometer concerned, rotate its spindle to give half the measured total from either end, and then secure the knob to the spindle to indicate 0dB at that setting.

Practical Wireless, March 1978
The passing of the Radio Amateurs' Examination, set by the City and Guilds, requires a certain level of theoretical technical knowledge. Whether one considers that this level is too high or too low is beside the point. The course that follows is intended, with the help of certain external aids, to prepare the reader to pass the examination. It will not teach him all about electronics!

**Transistors**

The diagram in Fig. 47 shows an npn transistor. Note that the base-emitter junction (a) is forward biased whilst the base-collector junction (b) is reverse biased.

The base region in a transistor is made very thin so that current carriers, entering from the emitter, experience the attraction of the collector voltage and are able to pass right through the base region and cross the base-collector junction, to the collector. A small proportion of current carriers from the emitter will recombine in the base region and these form the base current.

These currents can be expressed simply as,

\[ I_e = I_c + I_b \]

For example, typical values might be:

1mA (I_e) = 0.98mA (I_c) + 0.02mA (I_b)

The actual ratio of the emitter, base and collector currents depends on the type and construction of the transistor.

The ratio of the collector to emitter current is known as the DC alpha.

\[ \text{DC alpha} (\alpha) = \frac{I_c}{I_e} \text{ e.g. } \frac{0.98\text{mA}}{1.00\text{mA}} = 0.98 \]

and the ratio of collector to base current is known as the DC beta or \( h_{fe} \)

DC beta or \( h_{fe} = \frac{I_c}{I_b} \text{ e.g. } \frac{0.98\text{mA}}{0.02\text{mA}} = 49 \)

The DC beta or \( h_{fe} \) is the usual method of quoting the DC current gain of a transistor.

As you can see, there is a fixed relationship between the currents in a particular transistor, if you vary one then the other two will also vary by the same proportion.

In transistor amplifiers, input signals may be applied to the emitter or the base and the output taken from the collector or emitter. The general characteristics of each type of circuit configuration is shown in Fig. 48. The circuits have the biasing and supplies omitted for the sake of clarity.

In the common base arrangement (where the input signal is applied to the emitter), the emitter and collector currents are almost equal but, because the input impedance is low (forward-biased junction) and the output impedance is high (reverse-biased junction), there is a power gain. The signal power, (PR) in the collector is higher than the power (IR) in the emitter.

In the common emitter arrangement not only is there some power gain due to the output impedance being higher than the input, but there is also current gain (beta) from the base to the collector, giving the highest power gain of all the configurations. It is also the circuit which inverts the signal (positive-going signal in produces a negative-going signal out).

![Fig. 47: Construction of an NPN Transistor.](image)

![Fig. 48: General characteristics of circuit configurations.](image)
common collector circuit, or emitter follower as it is popularly known, has less power gain but its useful features are a high input impedance and a low output impedance.

**Practical transistor circuits**

In general, valve circuits have a high input impedance and are fed with an input signal voltage. Transistor circuits, on the other hand, have a medium to low input impedance (except for the emitter follower) and are usually fed with an input signal current.

The biasing of a transistor common emitter amplifier stage has already been discussed in some detail in section No. 3, page 501. These conditions apply to most small signal AF, IF and RF amplifiers, although in some instances the input and output signals may be coupled through suitable transformers or tuned circuits.

**Transmitters**

To state the obvious, the purpose of the transmitter is to generate a radio frequency signal for transmission to a distant receiving station. In addition, the transmitted signal must conform to the Amateur Sound Licence requirements in terms of power, frequency band, frequency accuracy and stability, absence of spurious emissions, etc., particularly when keyed or modulated by the information to be sent. Full details of these requirements are given in "How to become a Radio Amateur" Appendix B, published by the Home Office.

A block diagram of a simple CW transmitter (Emission Type A1) for 100 metres, 1-8-2-0 MHz, is shown in Fig. 49. It consists of a Variable Frequency Oscillator followed by a Buffer Amplifier and a Power Amplifier.

![Fig. 49: Block diagram of a CW transmitter.](image)

It is usual for the Oscillator to be operated in Class A or B, the Buffer Amplifier in Class B and the Power Amplifier in Class C. The various classes of operation refer to the condition under which the valve or transistor operates and these are summarised below and shown graphically in Fig. 50.

**Classes of amplifier operation**

**Class A**

In Class A, the transistor or valve is biased to near the centre of its linear operating range and the signal amplitude is insufficient to cause operation outside this range. A Class A amplifier has a low efficiency typically 50% or less (less than half of the input power is converted into useful output) but it does not distort the signal or generate harmonics.

Class B

In Class B, the valve or transistor is biased to the cut-off point and the input signal drives the device into full conduction for one half of the cycle of input signal (180°) and beyond cut-off during the other half. The efficiency is higher than Class A, being 60%-65% for CW (continuous radio frequency wave) operation.

A Class B amplifier stage with a single valve or transistor distorts the signal passing through it, producing mainly second harmonic distortion. In a Class B audio frequency amplifier, two valves or transistors are required. These operate in push-pull, one handling one half cycle and its partner the other, so eliminating the distortion.

A single valve or transistor Class B amplifier can be used for RF purposes in a transmitter because of the "flywheel" effect of the output tuned circuit. This type of amplifier has a reasonably linear transfer characteristic (the output signal is proportional to the input signal) and therefore an amplitude modulated RF signal can be amplified with little distortion, an important property which is essential in single sideband transmitters, as we shall see later.

**Class C**

In a Class C amplifier, the valve or transistor is biased well beyond cut-off and the input signal is required to have a larger amplitude in order to drive the device into conduction. Conduction only occurs for about one-third of a cycle of the input signal (120°) and the efficiency can be in the region of 70%.

The output of the device contains a high proportion of harmonics and the output circuit must be correctly tuned to the fundamental frequency to reduce the possibility of harmonics being radiated.

The Class C amplifier has a non-linear transfer characteristic and is therefore unsuitable for amplifying an amplitude modulated input signal although, as we will see later, it can be used to amplitude modulate a carrier wave.

---

Practical Wireless, March 1978
A Class C amplifier can be employed intentionally as a harmonic generator or frequency multiplier by increasing the bias still further so that the device is only conducting for a quarter of a cycle (90°) of the input signal.

In this condition, the output is rich in harmonics and by making the output circuit resonant at the desired harmonic, power can be obtained at this frequency. For example, the input could be at 7MHz and the output tuned to the second harmonic (14MHz) and then further amplified for transmitting on the 14MHz band or the third harmonic selected for transmitting on the 21MHz band.

In Fig. 50 the bias conditions are shown in relation to a valve anode current (Ia)/grid voltage (Vg) characteristic, although they could apply, similarly, to a transistor characteristic.

**Simple CW Transmitter 160 metres (1.8-2.0MHz)**

The circuit of the transmitter, illustrated in block diagram form in Fig. 49, is given in Fig. 51.

The VFO is a series-tuned Colpitts Oscillator. The oscillator feedback is obtained from a capacitive tap (the junction of C3 and C4). Memory aid: “C” is for Colpitts and Capacitive tap. (When the feedback tap is an inductive one, on the coil, then the circuit becomes a Hartley oscillator.) The frequency stability of the oscillator depends mainly on the coil and tuning capacitor VC1 having good mechanical stability, and on Tr1 being coupled in such a way that any change in its internal capacitance has little effect on the frequency. This is done by arranging that C3 and C4 are effectively across Tr1 and are large enough to swamp any small changes that might occur.

The output from Tr1 is fed to the tuned circuit L2, C5 which has a coupling winding L3 feeding Tr2. The bias for Tr2 is provided by R5 and R6 with decoupling by C6. The output from Tr2 is fed to the tuned circuit L4 C7 with a coupling winding L5 feeding the base of Tr3. Note that Tr3 is normally cut-off and only conducts when driven with an input signal. The emitter biasing resistor R8 provides extra biasing voltage when the stage is operating giving the correct Class C conditions. The output is fed to a suitable impedance matching point on L6 which, with VC2, resonates at the output frequency. Output coupling to the aerial tuning unit is provided by an adjustable coupling coil L7.

**Keying and the Keying Filter**

The transmitter is keyed on and off by connecting the morse key in the emitter circuit of Tr2. When the key is “up” no current will flow through Tr2 and there is no output. With the key “down” normal output is obtained.

Keying a transmitter by abruptly starting and stopping the carrier wave results in spurious signals being radiated and these are received as “key clicks” over a wide range of frequencies. To overcome this problem the transmitter must turn on and off less quickly and a key click filter L8, C9, R9 is included for this purpose. L6 restricts the rate of rise of current through Tr2 when the transmitter is keyed on and C9, the fall of current when keyed off, as shown in Fig. 52. The values of L8, C9 and R9 are often chosen experimentally, but the values given are typical.

**Modulation**

To transmit voice information by radio wave it is necessary for the microphone output signal to vary or modulate the RF carrier wave in a way that will allow the AF signal to be extracted at the receiver. The two basic methods are amplitude modulation and frequency modulation, each method having its particular advantages and disadvantages.

---

**Fig. 51**: The circuit diagram of the CW transmitter shown in Fig. 49.
Amplitude Modulation

Amplitude Modulation is produced by mixing the modulating signal with the carrier wave in a non-linear device or amplifier. Modulation can be carried out at high power level in the output stage of the transmitter or at low power in an earlier stage providing the subsequent amplifiers are linear (Class A or B).

Amplitude Modulation is shown in two ways in Fig. 53 a, b and c. On the left is a representation of the carrier wave, the modulating signal and the resultant modulation envelope as would be seen on a conventional oscilloscope. The graphs on the right show the same conditions but with frequency along the baseline. When two frequencies are fed into a non-linear stage, the output will contain a number of signals in addition to the original input signals. The main ones being the “sum” and “difference” frequencies, as shown below.

Input signals \( f_1 \) and \( f_2 \).
Output signals \( f_s, f_s + f_1, f_s - f_1, f_s + f_2, f_s - f_2 \).

If the carrier frequency is 1000kHz \( (f_c) \) and the modulating frequency is 1kHz \( (f_m) \) then two side frequencies are generated, the higher one at 1001kHz \( (f_s + f_m) \) and the lower one at 999kHz \( (f_s - f_m) \). It is the sum of the carrier and the two side frequencies which forms the “modulation envelope” shown in Fig. 53b.

The speech signal from a microphone consists of a band of frequencies between about 300Hz and 3-3kHz varying in frequency and amplitude with the voice patterns. Modulation by a speech signal results in two sidebands, the upper sideband and the lower sideband. These sidebands, which carry the AF modulation information, are mirror images of each other. The carrier wave remains constant irrespective of whether modulation is present or not and although it carries no information its presence is required at the receiver for the demodulation process.

Since the carrier wave conveys no intelligence it is possible to dispense with it altogether as shown in Fig. 53d (thus saving a great deal of transmitter power), provided it is generated again, locally, at the receiver for demodulation purposes. Unfortunately this carrier must be in the correct phase relationship with the sidebands or serious distortion will result. A double sideband suppressed carrier transmission is very difficult to tune in and requires a sophisticated receiver for satisfactory reception. However, if the carrier and one of the sidebands are removed and the remaining sideband transmitted then this exact phase relationship is no longer essential and the carrier can readily be inserted at the receiver.

As the two sidebands contain identical modulation, removing one of them does not result in any loss of information and effects a further saving of transmitter power. This type of transmission, shown in Fig. 53e, is known as single sideband suppressed carrier or Emission type A3J and commonly abbreviated to just SSB.

Single Sideband

SSB has several advantages for the Radio Amateur. 1. Saving in transmitter power or the ability to run the equivalent of higher power for the same rating of output amplifier. 2. No carrier radiated so it does not cause the usual heterodyne interference. 3. Requires only half the usual bandwidth. 4. Less affected by transmission path disturbances.
Amplitude Modulation Transmitter

Amplitude Modulation, (A3) can be performed at high signal level in the output stage of the transmitter by applying the modulating audio voltage to the bias or to the HT supply voltage as shown in Fig. 54. In a transistorised transmitter it is usually necessary to modulate the driver or buffer stage as well as the power amplifier. High level amplitude modulation requires appreciable power from the modulator output stage. For example, a transmitter PA drawing 150 watts would require at least 75 watts of modulation power for full modulation.

SSB Transmitters

The SSB signal is usually generated either by a phasing method, shown in Fig. 55a or by the use of a balanced modulator and filter, shown in Fig. 55b.

In the phasing method, the AF signal is processed in a phase shifting circuit which generates two signals having a 90° phase relationship over the audio frequency band, 300Hz to 3.3kHz. The RF signal is also phase shifted by 90° and fed with the AF signals, to two balanced modulators with a common output. The result is that the carrier is removed and one sideband is cancelled out. Upper or lower sideband can be selected by reversing the AF or RF inputs to the modulators.

In the filter method, the RF signal is modulated in a balanced modulator to provide a double sideband suppressed carrier signal and then one of the sidebands is selected by a high grade crystal filter to produce an SSB signal. The filter method is the simpler of the two, but requires an expensive, or very carefully home-made crystal filter.

Balanced Modulator or Mixer

The balanced modulator can take many forms but in essence it is a balanced circuit in which the RF input signal is cancelled or "nullled" out. The simplest form is a diode bridge arrangement shown in Fig. 56. Here the RF input is fed to a bridge circuit where the centre of the diodes is a null point. RV1 and TCI enable the bridge to be accurately balanced to provide adequate suppression of the carrier. An AF signal input causes D1 and D2 to conduct alternately, on each half cycle, unbalancing the bridge and producing a double sideband suppressed carrier signal at the output.

Simple SSB Transmitter

The block diagram in Fig. 57 shows a simple SSB transmitter for use on one band 14.00-14.35MHz. In this transmitter the SSB signal originates from a 9MHz crystal oscillator feeding into a balanced modulator and then to a crystal filter. The 9MHz SSB signal is mixed with a VFO, tuning 5-00 to 5-35MHz. The sum of the two frequencies 14.00 to 14.35MHz is selected at the output. This signal is amplified in a
linear buffer amplifier and then a linear power amplifier to give the required SSB power output. Operation on other bands would be possible by changing the VFO frequency.

It is essential that, once the amplitude modulated SSB signal is generated, subsequent amplification must be linear or severe distortion will result. Class C amplifiers are unsuitable for this purpose.

**Linear Power Amplifier**

A typical linear power amplifier, for use on one HF band is shown in Fig. 58a. The valve is biased to operate in Class B for good linearity combined with high efficiency.

The SSB signal is applied to the input tuned circuit and the control grid. The output signal, at the anode, is developed across the RF choke, L2 and fed via C5 to the output tuned circuit, L3, VC3, VC4. This output circuit is called a “pi” network (similar in shape to the greek letter pi, \( \pi \)). In operation, VC3 tunes the output circuit to resonance and VC4 effectively provides a variable capacitive tapping point on the tuned circuit and enables the output of the transmitter to be correctly matched to the load.

**Neutralisation**

There is usually some stray capacitance existing between the anode and grid of the valve both in the valve itself and in the wiring. Signal feedback through this capacitance affects the grid and anode tuning and may cause self oscillation. A neutralising capacitor VC2 feeds a small amount of RF signal from the anode to the opposite end of the grid tuned circuit and neutralises the effect of the anode-grid capacitance. The circuit is rearranged in Fig. 58b to show that the neutralising capacitor forms part of a “bridge” circuit. To set VC2, the HT is temporarily disconnected, an input signal is applied and VC1 adjusted for maximum drive indicated on M1. With VC4 at maximum VC3 is rotated and any variation on M1 noted. VC2 is then adjusted for negligible variation of M1, indicating correct neutralisation.

In the next section we will finish looking at Linear Amplifiers and cover Frequency Modulation and FM Transmitters, Receivers and Converters.

There is an excellent new book available, “Radio Amateurs’ Examination Questions and Answers”, compiled by the RSGB Education Committee and available from the Radio Society of Great Britain, RSGB Publications (Sales), 35 Doughty Street, London WCIN 2AE. Price £2 inc. postage.
Introduction

Most clubs, churches and societies have fund raising ventures such as bazaars, cheese and wine parties and the like. These usually have side shows and competitions, one of the most popular being the "spin the arrow" game.

This article describes a similar game using a model railway train. A simple model railway layout has four stations (in the prototype named Euston, Crewe, Carlisle and Glasgow). A button is pressed and the train runs for about 30 seconds then stops at one of the stations. Players put money on the stations getting their money back, with a bonus, if the train stops at their station.

Circuit Description and Track Wiring

Before describing the circuit it is necessary to describe the railway layout and how it is split into sections. If the track circuit was continuous and power was simply removed, it is most unlikely that the train would stop exactly at a station. For four stations it is therefore necessary to split the track into eight sections. Four longer running sections all wired together, and four short station sections which can be isolated individually (see Fig. 1).

Originally it was thought that the running sections would be permanently energised, and all the stations sections commoned and driven off a 555 timer. The train would then run for 30 seconds, and stop in the next station section. However the period of the 555 was found to be predictable, and it was possible to guess the station with a fair degree of accuracy.

The final circuit, Fig. 2, was therefore developed. On this the running sections are again permanently energised, but at the end of the 30 seconds one station section is randomly de-energised. The train keeps running until it reaches the de-energised section when it stops.

The run time and the random stops are controlled by a 556 dual timer IC1. The 'a' section is connected as a monostable (period 30 seconds) and the 'b' section as an oscillator (frequency about 50 kHz) gated by the 'a' section so that it only runs during the 30 second period. This gating is carried out by pins 5 and 8.

The pulses from the 50kHz oscillator which appear on pin 9 of IC1 go to a two bit counter made from two D type flip flops (IC2). At the end of the thirty second period this will contain a "random" number from 0 to 5 inclusive. This is decoded by IC3 and used to turn off one of the four transistors TR1 to TR4, de-energising one of the station sections. The high frequency of the oscillator and long period for which it runs gives a sufficiently random count.

The positive supply for the track is derived from a very simple series regulator TR7, allowing the train speeds to be controlled by RV2. Players can be allowed to drive the train as it does not affect the station the train ultimately stops at.

Fig. 1: The track circuit layout.

Practical Wireless, March 1978
Fig. 2: The complete circuit diagram.
When the monostable times out, TR5 turns off and TR6 emitter rises to about 9V. This brings the loco supply up to 9V when the 30 second period is over, taking control away from the players.

Whilst IC2 is counting, the transistors TR1-TR4 are being briefly turned off at regular intervals. The effect of pulsing a small motor at 50kHz was not known, so diodes D5, 6, 7 and 8 are used to hold the negative supply to the track during the 30 seconds that IC2 is counting. TR5 is turned on when the monostable is running and off when it times out.

The period of IC1a can be varied by RV1, and the running period can be terminated prematurely by pressing the stop button. If it is wanted to make this a game of ‘skill’ the stop button could be operated by the player.

The probability of stopping at station is varied by RV1, and the running period can be terminated prematurely by pressing the stop button. If it is wanted to make this a game of ‘skill’ the stop button could be operated by the player.

The power supply is straightforward, the 5V supply being derived from an IC2 regulator. Good decoupling is essential on the 12V supply to prevent noise spikes from the locomotive motor getting into the logic.

With a 7490 and a 7445 connected as shown in Fig. 3 a “loading” can be introduced, and the train will stop on average four times at station A, three times at station B, twice at station C and once at station D in ten runs. The returns to the players should be varied accordingly so as to make an overall profit on the game.

It is recommended that the trains be run in one direction only, as it is not possible to position the stations so that the train will stop at the station from each direction (remember that the loco has to stop past the station for the coaches to be at the platform).

**Components**

<table>
<thead>
<tr>
<th>Resistors</th>
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<tbody>
<tr>
<td>R1, R6</td>
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<tr>
<td>R2-R5</td>
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<td>R7-R9</td>
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<td>R10</td>
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<td>R11</td>
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<td>R12</td>
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<th>Variable Resistors</th>
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<td>RV2</td>
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<tr>
<td>C5</td>
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<tr>
<td>C7, C8, C9</td>
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<tbody>
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<td>IC2</td>
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<td>IC3</td>
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<td>IC4</td>
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<tr>
<td>TR1-TR5</td>
</tr>
<tr>
<td>TR6</td>
</tr>
<tr>
<td>D1-D6</td>
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<tr>
<td>BR1</td>
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<tr>
<th>Switches</th>
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<tr>
<td>S1, S2</td>
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<table>
<thead>
<tr>
<th>Miscellaneous</th>
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<tbody>
<tr>
<td>RV 1A transformer</td>
</tr>
<tr>
<td>Veroboard 0.1 inch pitch</td>
</tr>
<tr>
<td>5A overload cut-out (as sold by model railway shops)</td>
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</tbody>
</table>

**Construction**

The prototype was constructed on 0.1 inch pitch Veroboard with the layout shown in Fig. 4. No particular difficulty should be encountered in the construction. IC4 (the 5V regulator) and TR7 are mounted on the unit case.
Warning

The laws of this country regarding games of chance are somewhat complex, and are often overlooked by function organisers. Many premises and societies are licensed for gaming, but many are not. If it is decided to use this for some fund raising venture and other games of chance (as opposed to games of skill) are being used then the venture is licensed (or the club is already taking a risk).

If there any doubt, the local police should be consulted.

The layout was built on a 3ft x 4ft base board to a design as shown on Fig. 1. This gives a lot of track in a small area.

N gauge was used, and 6 inches was found to be a reasonable length for the station sections. The actual stations should be placed just before the station section and positioned so the coaches will be at the platform when the train stops.

The whole layout was landscaped with fields, cuttings, a waterfall and a tunnel, so the simple track layout was not immediately apparent.

There is actually more work in building the layout than in the electronics. The electronics were built in one evening, but laying the track and building the scenery took nearly a fortnight!
This new series of simple projects continues where the previous S-DeCnology articles left off. The S-DeC projects all used discrete components, but the new series will feature circuits which employ one IC.

All projects will be built on a µDeCB. Like the S-DeC it has lettered and numbered holes into which the components are plugged using their lead wires. Beneath the holes in the plastic top, tiny retaining clips/sockets (connected electrically) connect up the individual components. Their connection patterns are shown as raised lines on the plastic top surface of the DeC.

Whereas the S-DeC had but 70 holes, the µDeCB has 208. It will accept discrete components, but also has provision for taking two ICs. Special IC carriers are employed to avoid damaging the IC pins by repeatedly plugging them in and out. Two types of IC carriers are available but we will use the one which accepts standard 16-pin DIL flat packages (the other carrier accepts round ICs in TO-5 packages).

Wherever possible, the circuits to be described will use the same component values. Thus once a circuit is built, the components may be simply unplugged and used again for future projects. Circuits which are required in permanent form can either be transferred directly onto Blob Board, or a small PCB may be designed, drawn and etched.

The circuits have been designed with cost in mind, and to this end the first IC chosen was the ubiquitous 741 operational amplifier—advertised in Practical Wireless for as little as 24p including VAT.

Let us get to know our new friend, the 741 IC. The pin connections are shown in Fig. 1. The transistors we used in the last series each had three leads. The IC isn’t really so complex (connectionwise) since we are only going to use 5 leads. And because pins 7 and 4 got to the positive and negative battery terminals respectively, then we have, like the transistor, just three wires or leads. See how easy these ICs really are!

There is just one odd thing to resolve: we have one output (pin 9) but two inputs—pins 2 and 3. We’ll talk about those later, but first let’s look at some of the figures or specs for our 741 op amp.

It has low frequency gain, between input and output, of some 100,000. Each of its inputs has an input impedance of about 1MΩ while the output impedance at pin 6 is of the order of a few hundred ohms.

The positive (pin 7) and negative (pin 4) power connections are straightforward, and all amplifiers have an output (pin 6 in our case). So let’s look at those two inputs.

The input at pin 2 marked with a negative or minus sign gives an “inverted output” at pin 6. Alternatively, pin 3 (marked with a plus or positive sign) will give a “non-inverted output” at pin 6.

### components

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>100kΩ</td>
</tr>
<tr>
<td>R2</td>
<td>100kΩ</td>
</tr>
<tr>
<td>R3</td>
<td>100kΩ</td>
</tr>
<tr>
<td>R4</td>
<td>1kΩ</td>
</tr>
<tr>
<td>IC1</td>
<td>741 op amp (8-pin DIL)</td>
</tr>
<tr>
<td>LED</td>
<td>almost any LED</td>
</tr>
<tr>
<td>B</td>
<td>µDeC B</td>
</tr>
<tr>
<td>BC</td>
<td>µDeC B carrier</td>
</tr>
<tr>
<td>9V battery</td>
<td>solid cored wire, or DeC jumper leads</td>
</tr>
</tbody>
</table>

Fig. 1: The 741 op. amp. pin connections.
This merely means that if we apply a positive voltage to the negative input (pin 2) with pin 3 grounded, then the output will swing negative. In other words: positive input = negative output: inverted.

Conversely, if we applied our positive voltage to pin 3 (with pin 2 connected to ground this time) the output would swing positive. So: positive input = positive output: non-inverted.

Now let us examine two preliminary circuits to get the feel of the 741 op amp, and to actually see what we mean by inverting and non-inverting. You can easily build these on your µDeC if you wish.

Figure 4 has a 741 op amp, 6 resistors and an LED. The circuit is powered from a single 9V battery. Pin 3 is held at half the battery voltage (4.5V) by the potential divider R1/R4. We can vary the voltage applied to the negative input (pin 2) from negative ground (zero volts, or “low”) up to positive 9V or positive or “high”, and extinguish when it is low. If you wanted to be absolutely sure what the input was, then you could ignore the potentiometer and take a wire from point X connecting it in turn first to the positive battery terminal and then to the negative one. It can then be seen that when the connection is made to the negative or “low” terminal, the output at pin 6 is “high” and the LED lights. Connecting the wire to the positive terminal extinguishes the LED showing the inverting action of the circuit.

To see the effect of the non-inverting circuit, look at Fig. 5. Again we have a potentiometer and series resistor (R1). The LED and its limiting resistor also remain. Connecting the 100kΩ resistor R2 directly between output and the negative input (pins 6 and 2) means that the voltage at pin 2 is the same as the output voltage at pin 6. One can again turn the potentiometer from negative ground (zero volts, or “low”) up to +9V or “high”. Here it will be seen that when the input to pin 3 is high (+9V) the output is also high (LED lights). When pin 3 is “low” the LED does not light. Thus we have a non-inverting situation.

The above simplified theory is important and we will return to it when building other projects in this series.

Our first suggested project makes use of the very high gain and input resistance mentioned earlier. Figure 6 shows the circuit. Because of the high gain and high input impedance, pin 3 is easily affected by surrounding conditions.
The inverting input (pin 2) is fixed at 4.5V by the potential divider R1/R2. Pin 3 is also taken to the potential divider via R3. Pin 3 is now extremely sensitive to changes. So much so that if the end of the probe wire from µDeC hole B13 is merely touched the LED will immediately light up. In the prototype, just gripping the insulation of the probe wire caused the LED to illuminate.

On test, the circuit was found to function at 5V. Voltages above 9V are not recommended.

The project can be used for numerous things. For example, it could be useful to send visual morse by 'tapping' the probe wire. Hams might consider using the circuit as a noiseless morse key. The input or probe wire could be connected to a small (say 15mm²) aluminum plate. The c.w. could be sent with one finger touching out the morse characters. The 741 might be used to drive a transistor or thyristor to affect actual keying of the rig. With the touch wire connected to a metal door knob the circuit could be used as some form of alarm—how about trying it on the metalwork of your car?

By connecting a crystal microphone between pin 3 and earth (unplug the probe and connect the mike to µDeC holes B13 and D23) the LED can be modulated by speech and/or music. The circuit can thus be used as a simple light modulator.

When building µDeC projects watch out for jumper or shorting wires—they are easy to forget because they are not actual electronic components. There are two in this month's project; between holes H1/H12, and B15/C15.

The IC carrier will only fit one way round into the µDeC so there is no danger of error here. Note that our 741 is the 8-pin DIL type (because it was the cheapest!). This is plugged into the middle eight sockets in the carrier, and it is helpful to label the different pin numbers on the DIL carrier with a felt pen (or whatever). This makes wiring easier and helps enormously when checking out a circuit.

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TV AERIAL MASTS
As recent high winds have shown, the aerial mast is a vital but vulnerable part of a TV installation where reception from alternative transmitters is required. To buy and have erected a professional lattice mast is an expensive business — too expensive for most enthusiasts. There are alternative ways of going about raising the aerial(s) to a good height however, as Garry Smith and Keith Harmer show. Detailed guidance is given on the hardware required and safety precautions.

RECONDITIONING SETS
Many service engineers make a worthwhile sideline out of reconditioning and selling old TV sets. There are enough of them around, at bargain prices, but care is required in selecting suitable candidates. Steven Knowles advises on what to look for and the repairs it's worth making.

MONITOR CONVERSION
Sets designed as video monitors tend to be expensive. It's cheaper to adapt an off-air receiver for the purpose. This can be done without too much difficulty, as David Matthews explains.

SERVICING FEATURES
John Law on the Pye 67 chassis, a recommended set for renovation, while the second Saba article deals with the line timebase — of particular interest in being of the thyristor variety.

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Practical Wireless, March 1978
Charging meters
Having made use of rechargeable batteries I know how long it takes to fully recharge them. There have been some achievements in this area and at least one manufacturer had cells which could be recharged in just four hours.

Now I read with great joy about a sealed lead-acid battery which can be recharged to its full capacity in exactly 60 minutes if one follows the manufacturer's special recharging procedure. Perhaps, instead of parking meters of the future we will have charging meters for the electric car— it charges your battery while you shop, and charges you when you return!

Electronic au-pairs

 Doubtless everyone is all for labour saving devices— things which make life easier in the home (apart from one au-pair française!) are naturally popular. One manufacturer has given thought to a number of things and has sought to combine all the answers in one unit.

The original item of manufacture was an environmental chamber into which various pieces of electronics were put. These were then subjected to anything from freezing cold to tropical heat, salt spray, high humidity, etc., etc.

The makers then had a brilliant idea— why not make an environmental chamber for the home. A combined sauna, cold water bath, tropical sunshine sun-tanner, you name it— we do it chamber.

It seems that they've hit onto a winning idea, too. Orders are flooding in from health hydros, hotels and motels all over the place.

Needless to say the whole thing is electronically controlled and each sequence of whatever you've dialled in is electronically timed. Instead of having a sauna and then having to rush out and hurl yourself into a freezing puddle, you can climb into your environmental chamber, press a button, and immediately after your carefully timed sauna is over—a freezing puddle will rush in and hurl itself all over you!

And just for the record; the same company is manufacturing things called "whirlpool tubs". One's imagination could run riot here, thinking of things like automatic brushes which pop up to scrub your back— although faulty body positioning could prove fatal!

Radio Sundial

With electronic watches ever keeping up with the times I often wonder if there is any real limit to it all. At a recent electronics show at Basel, a famous watch manufacturer hung up an electronic watch with a conventional face. It was powered by its own solar cells and contained a radio receiver which was tuned to time signals broadcast from Switzerland. The result was that the clock maintained an accuracy of ±0.1 second per day. When the time signal went off the air, the watch went on ticking away to a frequency set by its own internal quartz crystal. Immediately the Swiss time signal came back on the air, the clock would synchronise and automatically correct any error which had crept in. We've come a long way since sundials.

Phonemes

Chatting to a computer is a common enough happening in television science fiction, but it isn't quite so far away as one might think. If you haven't already— meet the Phononic Mirror Handivoice. Don't shake hands with it too eagerly; it costs around £111:00 excluding VAT!

So, what do you get for the money? Well, all the device makes up of sounds. These basic sounds (which make up everything we say) are called phonemes. The device above has a memory which accepts up to 40 commands from a small keyboard (the whole unit is a little larger than a calculator). Inside is an electronic analogue of the human voice— a thing called a phonetic synthesiser. It produces all these basic sounds or phonemes. When the 'talk' button is depressed, the memory sends the commands to the phonetic synthesiser which then emits all the right squeaks and moans in the right sequence and the result is 'human' recognisable words.

Perhaps the most obvious question is how limited is the vocabulary. In theory, since it produces all the necessary phonemes, the vocabulary is virtually limitless. Surprisingly there aren't all that many phonemes required— about 45 or 90% of our normal usage. By making different sensor inputs, it is envisaged that even severely handicapped people could 'talk'. A sensor might sense breath, or perhaps muscle movement etc. Needless to say, the unit boasts a microprocessor in addition to its read-only memory and synthesiser.

Oh for my PL81

I can remember when a large semiconductor manufacturer claimed to have reduced the colour television receiver to just five integrated circuits. "Wonderful" mumbled an awed Press gathering. An even more "awed Ginsberg" heard recently that a German manufacturer had succeeded in reducing the number of ICs required to process colour TV signals down to three little chips. Apparently this current video miracle has been achieved by putting both luminance and chrominance amplifiers onto a single chip. While I bow my head to such great technical achievements I believe that it is sometimes a double-edged weapon. Think; as more and more is crammed onto a single chip— how much more complex and expensive that chip becomes. How very much more difficult it is to service— to check that chip as it comes off the production line.

Sad, sad, I still hold fond memories of my local TV service man assuring me, "it's yer PL81 mate— they always go about this time of year".

Goodbye pot!

If you have a light dimmer it's certain that you're using a potentiometer, with a knob on the end, as the control. Well, a manufacturer has come up with a touch plate plus complementary IC to change all this to touch control. Just touch the plate and the light will brighten or dim automatically. The punch line is that the cost of the IC and touch plate will be less than the cost of a potentiometer and knob! Look out knob twiddlers— this is your life!

Ginsberg
Following the great success of the Crystal Palace tests it was decided to attempt further experiments with aircraft and on June 18th, 1935 two De Havilland Dragon-Moth aeroplanes were fitted with transmitters and receivers for 56 Mc/s. One aircraft was again chartered by the Daily Herald and the other by Popular Wireless. Douglas Walter's gear was installed in the Herald's plane and George Jessop fitted his sets into the Popular Wireless plane. The Dragon-Moth was chosen because of its large cabin which normally held six passengers. Several seats were removed in order to provide space for the radio equipment and the associated power supply.

Ordinary 2V valves were used as oscillators (Osram P2's) and modulators (Osram PT2's in parallel). The power supply consisted of 200V from Hellesen super-capacity batteries, specially supplied for the occasion. The aerials were half-wave and slung inside the cabin and a transmitter power of about 5W was used. The receivers were conventional 3-valve super-regens as used before. When both planes were airborne, two-way radio communication was established between them. Owing to thick mist and heavy rain, the two aircraft lost sight of each other but met again over Harrow. At this time, Doug could hear George Jessop working dials hone with G2JV of Harrow and shortly after, Doug did the same. Later they worked G6KY and G6NF with absolute ease and when both planes landed at Romford Aerodrome they talked about the running commentary given by G5CV as he was landing.

Radio in Gliders

After spending an afternoon on Dunstable Downs watching the London Gliding Club's flying activities, Doug Walters decided that radio could really assist gliding. Pilots attempting long distance flights could obtain the latest information from ground stations and instructors correct faults and give advice to their pupils. Once more here was an opportunity to prove again the efficiency of 56Mc/s for reliable "local" communication.

One fine Sunday in 1934, "the old firm" of Walters and Jessop arrived on Dunstable Downs with a car load of 56Mc/s apparatus including a midget 5m receiver specially made by George. It had three valves housed in an aluminium case and measured 6 x 5 x 2½in. A 60V HT battery and a small unsippable accumulator were contained in a small suitcase which was placed in a recess behind the seat of the glider. The aerial was a 5ft length of wire inside the suitcase!

While the glider was being towed up the hill, Doug tested out his transmitter which was totally enclosed in an aluminium cabinet and mounted immediately below the feeder of their wire dipole, which was suspended between two 6ft rods supported at each end by the car. When the glider was airborne, Doug told the pilot that he was the first person to "listen-in" while gliding, and then asked him to "bank" to the left, which he did, as if to salute the expertise of G5CV and G6JP!

56 Mc/s Field Days

Field days have always brought out the best in both operators and equipment and records have often been established and broken and new ideas tested out. During a local 56Mc/s Field Day in 1934, BRS157 took his receiver to the top of Chanctonbury Ring in Sussex and heard G6CJ (50 miles), G2YL and G6NF (both 27 miles) and G5NF (50 miles). These listener reports were valuable in those early days because they could evaluate the differences between several stations.

The first 56Mc/s National Field Day was held in July 1937 and certificates of merit were awarded by the RSCB to T. P. Allen G12YW and W. Jones GW60K in recognition of the first 56Mc/s contact between Northern Ireland and Wales. Good distances were covered from various locations in the UK. For instance, G2DC/P located in Buxton, Derbyshire worked G6OK/P (85m), G6MX/P (77m) and G5MQ (40m), while down in Sussex at Kithurst Hill, near Storrington, G5MA/P worked G2NH/P, G5CM/P, G6RD, G5JW/P, G2MV, G6GR and G6IX/P. Up in Cumberland G6JZ using a QRP rig heard no signals all day, but over in Bristol G5JU/P contacted G6FV (14m) and heard G5BK/P at 60 miles.

One of the highlights of the second 56Mc/s NFD, held in 1938, was the contact between GW6AA/P on Snowdon and EI2J (68 miles) running 0.5W input to a type 30 valve from his car on a hill behind Dublin. Although the official report shows that the number of transmitting logs was down from 19 (1937) to 15 the prize for enthusiasm must go to G2NM/P operated by the West Sussex SW and TV Club situated in Bury Hill, in Sussex. Their transmitter was a 6L6 Trité ECO, 6L6 PA, modulated with a 6N7 in Class B and was powered from a rotary converter giving 110V AC. Many receivers were used besides the receiver associated with the field day transmitter. There was quite a gathering on the site with 35 members and visitors being present. They had a good log to show for their day's work: 11 contacts made and six stations heard, compared with G2JK/P on Epsom Downs, Surrey, who worked 14 and heard eight, and G5MA at Holybourne Down, Hants, who made 13 contacts and heard 10, while up on Snowdon, GW6AA/P worked 11 and heard one plus very strong signals from 5m police stations.

Thirteen listener logs were submitted compared with nine for the 1937 field day, and, apart from 2CIL's record entry, the leading stations were BRS2601 (Ewell, Surrey 21 stations), 2AAH (Chichester Sx 12), and 2DFG accompanied by BRS3322, each with their
own receiver, situated on Ditchling Beacon, Sx. Between them they heard 15 different stations, eight were on phone and 11 on CW.

1939

While researching this story, the author realised that the report of the 56Mc/s NFD held in July 1939 was published in the September issue of the *T & R Bulletin*, several days after the outbreak of World War 2, and the withdrawal of the amateur radio transmitting licence. The RSGB estimated that about 100 amateurs took part in the portable operations during this event, in addition to the large number of fixed stations who joined in from home. During this event, BRS1173 heard three European stations, F8AA, F8NW and ON4DJ, but unfortunately none of the portable stations was able to work them.

The RSGB was pleased to see that their policy of encouraging the use of crystal-controlled transmitters and modern types of receiver was bearing fruit. Of the 16 portable transmitting stations who entered logs no less than 11 employed crystal control and many of them used Acorn valves as IF amplifiers in their receivers.

The adjudicators decided that C. J. Rockall G2VZ and his partner E. Cosh 2DDD were the joint winners of the RSGB’s Mitchell-Milling Trophy, not so much on the actual performance of their station or the number of contacts made, but for the clear, concise, and extremely interesting log which they submitted. After the war Eric Cosh became 2DDDD and was one of the pioneers of both the 70cm and 23cm bands.

He spent the summer of 1975 going through the author’s collection of *T & R Bulletins* (1930-1940) marking all the references to the 5m band. This work was of great value to the author when writing this story. Eric died in 1976 having devoted his life to the experimental side of amateur radio.

Miss Constance Hall G8LY also qualified for a transmitting award of merit, again not so much for the number of contacts made but for the interesting report which accompanied her entry, including a plan showing the direction and distance of each station that she heard or worked. The equipment used by G8LY was housed in one cabinet and operated from the rear seat of her car and she could rotate her beam aerial through the window.

The third transmitting award went to Ernie Dedman G2NH, partly for his interesting report but more particularly for the consistency with which contacts were made during the whole event; 21 QSOs were made in 10 hours.

In the receiving section two awards of merit were made; one to G. F. Keen 2BIL and the other to J. Cymerman BRS301 because of the general excellence of their results and well written reports. 2BIL proved the value of CW for making DX contacts, hearing three CW stations over 100 miles away, 11 over 50 miles, but none over 50 miles were received on telephony.

The Trail Blazers

A small group of experimenters known as the "Folksome Radio Amateurs" established the first 56Mc/s link between England and the Continent in March 1936. This was arranged through correspondence between the group’s chairman G2IC and F8WY. On 29th March the operators at G2FA heard F8NW working F8AA. They gave F8NW a short call and to their great joy he came back, giving them R7 QSA5. Mutual congratulations were exchanged, and it must have been amusing to hear each of the 10 club members present take the microphone in turn and try his hand at French. Later they made contact with F8WY, F8ZF and F8AA.

The apparatus used at G2FA was a long-lines oscillator with a couple of Tungsram 15/400 valves in push-pull and an input of 8W at 250V. The aerial was a vertical dipole, Windom fed, with a reflector spaced at a quarter wave. The receiver was a two-valve self-quenching super-regen with a vertical doublet aerial.

TO BE CONTINUED
This is a general-purpose quality amplifier which has been specially designed with the amateur constructor in mind. Virtually all the components are mounted on a single printed circuit board, greatly simplifying assembly and eradicating the intangible problems of earth loops and hum pick-up from the power supply section. A simple, but very effective, method of heat sinking the output stage is used which, again, avoids a bugbear for the home constructor. Even though construction is simple the circuit is fairly sophisticated and it is imperative that there is no variance from the specified component values. Equally, because of the large number of components, care must be taken to insert them in the right places on the p.c.b.

The design provides push-button input switching and equalisation for a magnetic pick-up cartridge, a tape recorder playback head, a tuner and one auxiliary channel. The output stage provides maximum power into a 4 ohm loudspeaker; however, it is permissible to use 8 or 16 ohm loads provided the reduction in output power is acceptable. Controls are quite conventional utilising ganged potentiometers for Volume, Treble and Bass together with a Balance control. A simple switchable rumble filter can be introduced when required.

A nominal 56V power rail supplies the power amplifiers without stabilisation and has proved to be more than adequate. Nevertheless to avoid damage to speakers from switch-on surges a slow turn-on circuit has been incorporated. This will be described later. The supply to the pre-amplifier is 30V; obtained from a conventional series stabiliser circuit.

**Pre-amplifier**

The circuit of one pre-amplifier channel is shown in Fig. 1. The heart is an LM381AN integrated circuit which contains two ultra-low-noise amplifiers. They are completely independent and draw their power from an internal power supply decoupler-regulator that provides better than 120dB supply rejection and 60dB channel separation.

The alternative pin numbers shown on IC1 refer to the second channel connections.

Gain, and equalisation, options for the various inputs are selected by switching components into the feedback circuit for IC1. For example, when S4 is depressed the magnetic cartridge input is selected. Resistors R11, 12 and 13 together with C4 and C5 are switched into the feedback loop. R11 and R13 in conjunction with R4 set the d.c. working point of the amplifier and the frequency dependent components — C4, C5 and R12 shunted across R11 determine the compensatory roll-off for the RIAA recording characteristics.

Switch S3 selects the tape-head input. Note that this is designed to accept a signal direct from a tape recorder head and NOT after a tape pre-amplifier stage! NAB playback equalisation is provided by C2 and R7 shunted across R9 in similar manner to that for the magnetic cartridge.

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**Author’s specification**

<table>
<thead>
<tr>
<th>INPUT</th>
<th>Mag. PU 5mV RIAA equalised</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tape head</td>
<td>5mV NAB equalised</td>
</tr>
<tr>
<td>Tuner</td>
<td>350 to 500mV Low Impedance 'Flat'</td>
</tr>
<tr>
<td>Auxiliary</td>
<td>sensitivity 100 to 180mV. Low impedance, 'flat', suitable for:</td>
</tr>
<tr>
<td>Transistor radio or tape recorder earpiece</td>
<td>Or, medium output crystal cartridge with 470kΩ series resistor</td>
</tr>
<tr>
<td></td>
<td>Or, ceramic cartridge using 100kΩ series resistor</td>
</tr>
</tbody>
</table>

**POWER OUTPUT** Continuous, both channels driven, 30 - 30 watts into 4Ω load

**TOTAL HARMONIC DISTORTION** (75dB gain at 1kHz) Better than 0.05 to 0.1%

**CROSSOVER DISTORTION** at 1W into 16Ω-nil

**HUM AND NOISE** 115dB below 50W

**RUMBLE FILTER** — 7dB at 100Hz

**CHANNEL SEPARATION** 45dB at 1kHz

**FREQUENCY RESPONSE** 10Hz to 18kHz

**TREBLE/BASS CONTROLS** — 20dB to +20dB

**OUTPUT IMPEDANCE** Minimum 1Ω, maximum to infinity

**OPEN and short circuit protected**

**STABILITY** Unconditionally stable

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*Practical Wireless, March 1978*
Fig. 1: Circuit diagram of one channel of the pre-amplifier section. The alternative pin numbers given against the inputs and output of IC1 are for the other channel. Note that C8 should (of course) be drawn as a capacitor.
The remaining two inputs, selected by S2 and S1, are very similar to each other. Neither is provided with equalisation networks so when these are selected it can be assumed that the amplifier exhibits a flat response. They are therefore suitable to match the outputs of tuners, transistor radios, tape recorder preamplifiers and, provided a suitable series input resistor is incorporated, crystal or ceramic cartridges.

An equalised output is provided to feed an external tape recorder via R15 if required and this, of course, is not affected by the pre-amplifier tone, balance or volume controls.

### Semiconductors
- **Tr1** BC147
- **Tr2** BC147
- **Tr3** BC456
- **Tr4** BC109c
- **Tr5** BC109c
- **Tr6** BC109c
- **Tr7** TIP31A
- **Tr8** BFY56
- **Tr9** BC461
- **Tr10** TIP3055
- **Tr11** TIP3055
- **Tr12** BFY50

**IC1** LM381AN
**D1** 3A 200V bridge
**D2** BU2S2 C30V 400mW 30V Zener

Two off each transistor Tr1-Tr11 required.

### Transformer
- **T1** Low profile, low flux leakage transformer
- **Pri:** 240V 50Hz
- **Sec:** 45V off load
- **38V at 2A r.m.s.**

### Fuses
- **FS1** 2A 20mm
- **FS2** 500mA 20mm
- **FS3** 2A 20mm

Two off fuses FS3 required.

### Connectors
- **PL1 3-pole, chassis-mounting mains plug**
- **SK1** 5-pole DIN (180°)
- **SK2** 5-pole DIN (180°)
- **SK3** 5-pole DIN (180°)
- **SK4** 5-pole DIN (180°)
- **SK5** 5-pole DIN (180°)
- **SK8** 2-pole DIN speaker socket
- **SK7** 3-pole, chassis-mounting mains socket

Two off sockets SK6 required.

### Miscellaneous
- Insulating mounting kits for Tr7, Tr10, Tr11 (two off each)
- Heat-sinks for Tr2, Tr5, Tr9 (two off each)
- Horizontal mounting clip for C21
- Printed circuit board, (available from Reader's PCB Service)
- Materials for chassis, heat-sink and case.
- Knobs for VR1-VR4. Fuse holders for FS1-FS3 (4 off)

### Tone controls

Due to the high gain of IC1 and its large output signal it becomes possible to use a passive tone control system. This obviates the need for further feedback loops and reduces the chances of introducing instability or noise from an extra stage. The circuit is very similar to that which is normally incorporated in a feedback loop and provides bass and treble boost or cut from a centrally flat characteristic.

Potentiometer VR1 is the Bass control and when its wiper is nearest R16 maximum bass is obtained.

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**Practical Wireless, March 1978**

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### Components

<table>
<thead>
<tr>
<th>Resistors (all 1/2W unless otherwise stated)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1  47kΩ</td>
</tr>
<tr>
<td>R2  22kΩ</td>
</tr>
<tr>
<td>R3  47kΩ</td>
</tr>
<tr>
<td>R4  120kΩ</td>
</tr>
<tr>
<td>R5  470kΩ</td>
</tr>
<tr>
<td>R6  10kΩ</td>
</tr>
<tr>
<td>R7  56kΩ</td>
</tr>
<tr>
<td>R8  56kΩ</td>
</tr>
<tr>
<td>R9  2.2kΩ</td>
</tr>
<tr>
<td>R10 470Ω</td>
</tr>
<tr>
<td>R11 1MΩ</td>
</tr>
<tr>
<td>R12 100kΩ</td>
</tr>
<tr>
<td>R13 3.9kΩ</td>
</tr>
<tr>
<td>R14 27kΩ</td>
</tr>
<tr>
<td>R15 220kΩ</td>
</tr>
<tr>
<td>R16 5-6kΩ</td>
</tr>
<tr>
<td>R17 560Ω</td>
</tr>
<tr>
<td>R18 10kΩ</td>
</tr>
<tr>
<td>R19 82kΩ</td>
</tr>
<tr>
<td>R20 8-2kΩ</td>
</tr>
<tr>
<td>R21 18Ω</td>
</tr>
<tr>
<td>R43 100Ω</td>
</tr>
</tbody>
</table>

Two off each resistor required, except R39 and R40.

<table>
<thead>
<tr>
<th>Potentiometers</th>
</tr>
</thead>
<tbody>
<tr>
<td>VR1 100kΩ + 100kΩ ganged lin.</td>
</tr>
<tr>
<td>VR2 100kΩ + 100kΩ ganged lin.</td>
</tr>
<tr>
<td>VR3 100kΩ + 100kΩ ganged lin.</td>
</tr>
<tr>
<td>VR4 100kΩ lin.</td>
</tr>
<tr>
<td>VR5 100kΩ min. horizontal preset</td>
</tr>
<tr>
<td>VR6 1kΩ min. horizontal preset</td>
</tr>
</tbody>
</table>

Two off each preset VR5 and VR6 required.

<table>
<thead>
<tr>
<th>Capacitors</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1 0-1µF poly.</td>
</tr>
<tr>
<td>C2 1-5µF poly.</td>
</tr>
<tr>
<td>C3 22µF 25V elect.</td>
</tr>
<tr>
<td>C4 3-3nF ceramic</td>
</tr>
<tr>
<td>C5 1nF ceramic</td>
</tr>
<tr>
<td>C6 1µF 25V elect.</td>
</tr>
<tr>
<td>C7 0-1µF poly.</td>
</tr>
<tr>
<td>C8 88nF poly.</td>
</tr>
<tr>
<td>C9 0-47µF poly.</td>
</tr>
<tr>
<td>C10 2-2nF poly.</td>
</tr>
<tr>
<td>C11 22nF poly.</td>
</tr>
</tbody>
</table>

Two off each capacitor required, except C21 and C22.

<table>
<thead>
<tr>
<th>Switches</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1 6 p.c.o. push button</td>
</tr>
<tr>
<td>S2 6 p.c.o. push-button</td>
</tr>
<tr>
<td>S3 6 p.c.o. push-button</td>
</tr>
<tr>
<td>S4 6 p.c.o. push-button</td>
</tr>
<tr>
<td>S5 4 p.c.o. latching push-button</td>
</tr>
<tr>
<td>S6 2 p.c.o. latching push-button</td>
</tr>
<tr>
<td>S7 S.P.S.T. mains on/off</td>
</tr>
</tbody>
</table>

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The mains transformer T1 and switch assembly comprising S1-S6 are available from WKF Electronics, 60 Welbeck Street, Whitwell, Worksop, Notts.
This d.c. feedback and the state of balance of the long-tailed pair input stage. The latter can be adjusted by means of VR5 and this control is used during the setting-up procedure to make sure that the quiescent voltage at the positive end of the output capacitor C19 is mid rail. The two transistors Tr1 and 2 are not in the main audio route but serve as a slow turn-on circuit which prevents a surge of power from damaging the loudspeakers. Rate of application of power to the input and driver stages is determined by the charging curve of C14 on the base of Tr1.

Biasing of the output stage is controlled by Tr7 and can be adjusted by VR6 to set the standing output stage current and minimise cross-over distortion.

**Power amplifier**

The circuit of one channel's power amplifier is shown in Fig. 2. Transistors Tr4, 5 and 6 make up a differential input stage. The base of Tr6 is the inverting input which is used for main feedback stabilisation. Naturally the centre voltage of the quasi-complementary class B output is going to depend on this d.c. feedback and the state of balance of the long-tailed pair input stage. The latter can be adjusted by means of VR5 and this control is used during the setting-up procedure to make sure that the quiescent voltage at the positive end of the output capacitor C19 is mid rail.

The two transistors Tr1 and 2 are not in the main audio route but serve as a slow turn-on circuit which prevents a surge of power from damaging the loudspeakers. Rate of application of power to the input and driver stages is determined by the charging curve of C14 on the base of Tr1.

Biasing of the output stage is controlled by Tr7 and can be adjusted by VR6 to set the standing output stage current and minimise cross-over distortion.
Internal view of one of the prototype amplifiers. There are minor differences in layout compared with the final version of the p.c.b., which will be shown next month.

Fig. 3: Circuit diagram of the power supply, which is common to both channels.

Power supply

The circuit of the power supply is shown in Fig. 3. A low-profile, twin-bobbin transformer is used which gives extremely low flux leakage and it is precisely located on the printed circuit layout to minimise any flux linkage with the pre-amplifiers and input switching. The transformer delivers 40V a.c. to a conventional bridge rectifier and thence to the smoothing capacitor C21 which is specified to have a high ripple rating. No regulation is provided for the power amplifier supply; however the pre-amplifier supply is taken from a small stabiliser based on Tr12, R40 and D2.
**Versatile clock module**

The LT601 red LED display electronic clock module can function as both a 12 or 24hr display system and operates at 50 or 60Hz.

The series provides four basic selectable display modes; time, seconds, alarm and sleep display, and is a 4-digit, 0-9in LED display complete in itself apart from the mains transformer and function switches.

Featuring power failure indication the module includes brightness control capability, ‘sleep’ and snooze times, alarm ‘on’ and PM indicators, direct drive—no r.f. interference, fast/slow time setting control, pre-settable 59min sleep timer, 9min snooze alarm and lead zero blanking.

For the 12hr display modules the colon flashes at one hertz rate and for 24hr displays it is fixed.

The module finds application as a clock radio timer, desk clock, alarm clock, television-stereo clock and instrument panel clock.

At £6·00 plus VAT and 30p P&P, the module type LT601, manufactured by Litron Electronics is available with full specification and application information from:

Bywood Electronics Ltd., 68, Ebborns Road, Hemel Hempstead, Herts, HP3 9QR.

**New ABS boxes**

A new range of ABS boxes, manufactured in four colours (orange, blue, black and grey) is now available. Each incorporates slots on all four sides for holding 1-5mm (0·062in) thick P.C.B’s. The 1-5mm thick front covers sit recessed into the front of the boxes and are held by four fixing screws, running into thread brass inserts. Available in three sizes measuring from 56 x 85 x 28-5mm to 96 x 161 x 52-5mm, BIM4000 BIMBOXES have excellent electrical insulation properties, rated at 85°C (185°F) and are supplied with four self-adhesive rubber feet. Prices range from 80p to £1·49 plus VAT and P&P each.

**BOSS Industrial Mouldings Ltd.,**

Higgs Industrial Estate, 2, Herne Hill Rd., London SE24 0AU. Tel: 01-737 2383

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**Scrub up**

We have recently received a handy little tool for cleaning electrical contacts and surfaces.

The cleaning tool consists of a plastic body in which is mounted a stiff spun glass insert. The tool works on the same principle as a propelling pencil, as the exposed end of the insert wears, its length may be adjusted by a screw at the top of the tool.

The E105 contact cleaner is suitable for a variety of cleaning applications especially the cleaning of contacts, joints and PCB tracks prior to soldering.

The E105 costs 0·98p inclusive of VAT and P&P from:

Eraser International Ltd., 2/3, Hampton Court Parade, East Molesey, Surrey KT8 9HB. Tel: 01-979 8141/2.

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**Proportional Power Controller,**

January 1978 PW

C5 voltage rating was omitted; this should be 600V DC working (300V AC). If single polystyrene types are not available, one 10nF and one 22nF in parallel will suit. The jack socket should be a fully insulated type (for TH1) and care must be taken to ensure correct polarity of connection to the mains. IC1 is basic type L121 (Doram order code 65-600-9).

**RAE No. 5, January 1978 PW**

We regret that two errors occurred in formulae on page 662.

For the Parallel Impedance case, left-hand column, line 6, please read:

\[
Z = \frac{R \cdot X}{\sqrt{R^2 + X^2}}
\]

For the current flowing in a Series Resonant Circuit, right-hand column, line 14, please read:

\[
I = \frac{V}{Z} = \frac{V}{\sqrt{R^2 + (X_L - X_C)^2}}
\]
The small savings made in building a multi-range meter, rather than purchasing a commercially-produced model, do not as a rule justify the decision. The commercially assembled product is more often than not of greater accuracy and reliability. However, were it possible to build such a device at a considerable saving whilst maintaining a high degree of precision, then the project must surely be considered worthwhile.

This article covers the theory which will enable readers to produce an accurate instrument at favourable cost. It can be applied to movements of any FSD or coil resistance.

Ammeter Formulae
In order for a meter to read higher than its basic movement will allow, it is necessary to divert a proportion of the current away from it. This is achieved with a by-pass resistance—known as a “shunt”—which is placed across (or “in parallel with”) the movement. Fig. 1 shows this in circuit form. The shunt $R_p$ is of a precisely-calculated value and diverts a finite proportion of the total current away from the movement.

Thus the meter will pass a percentage of the total current in the circuit, the remainder being carried by $R_p$, whose value may be determined from the formula:

$$R_p \, (\text{ohms}) = \frac{\text{Required FSD - Meter FSD \, (ampères)}}{\text{amps}}$$

The FSD Voltage of the meter coil ($V_{\text{FSD}}$) can be obtained from:

$$V_{\text{FSD}} = \text{FSD \, (amps)} \times \text{meter resistance \, (ohms)}$$

Problems are likely to occur when shunt resistances become very small and attention has to be directed to difficulties arising from manufacturing techniques; even the contact resistance of range switches must be taken into account. Accurate resistors below a few ohms in value are difficult to obtain and will probably have to be made from resistance wire.

Voltmeter Formulae
The principle in the voltmeter is to measure the amount of current produced by applying a voltage across a fixed resistance. If the meter itself does not present a high enough resistance to the circuit, excessive current will be drawn and the meter will swing hard over or even burn out. In this case a series resistor will have to be inserted “in line” with the meter to reduce the current to a value within the range of the movement. This is illustrated in Fig. 2.

The series resistor $R_s$ can be calculated from:

$$R_s \, (\text{ohms}) = \frac{\text{FS reading required \, (volts)}}{\text{Current for FSD \, (amps)}} - R_m$$

Again, this formula holds good for all values, but in practice, problems are likely to be met. If the combined meter and series resistance is too low it will load the circuit under test, producing inaccuracies. Likewise, if high voltages (in the order of hundreds of volts) are to be measured, the resistors will have to be adequate if breakdown is to be avoided.

Ohmmeters
With an ohmmeter the idea is to monitor the current passed through a resistor when a known voltage is applied, and this is demonstrated in Fig. 3. Assuming the movement to have little or no internal resistance compared to the device under test, a simple application of Ohm's Law produces the result:

$$\text{Resistance to be tested \, (ohms)} = \frac{V_{\text{supply}}}{I_{\text{meter}}}$$

Fig. 3 in fact constitutes the simplest form of ohmmeter. Usually a multi-range meter will be used, with a resistor for current-limiting. Several test voltages are often provided and a potentiometer enables the pointer to be set at zero. Fig. 4 is a more likely basic design, providing switched ranges, but here the series resistors for each range may have such widely-differing values that the zero adjustment is inadequate. A more satisfactory solution is to select different current-limiting resistors, and Fig. 5(a) illustrates the technique. A three-gang switch is used to obtain four ranges.

Using the lowest value current-limiting resistor and

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*Practical Wireless, March 1978*
adding a high and low value potentiometer offers an overall solution and this is the popular method of achieving switched ranges. Fig. 5(b) shows the final progression.

The scale calibration of an ohmmeter is not linear, see Fig. 6, and this can be explained using Ohm’s Law. Doubling the resistance halves the current, so as the needle deflection doubles, the resistance halves. Consider a resistance which will permit 1mA to flow from a 1·5 volt battery (assuming a meter of 1mA FSD), then from Ohm’s Law

\[
\frac{V}{I} = R
\]

Where \( V = \) test voltage, \( I = \) current, \( R = \) resistance

\[
\frac{1·5}{0·001} = 1500 \text{ ohms}
\]

The minimum measurable resistance is therefore 1,500 ohms.

Considering the centre point (0·5mA) of the scale:

\[
R = \frac{V}{I} = \frac{1·5}{0·0005} = 3000 \text{ ohms}
\]

If the scale were linear we would expect its resistance at half-scale to be twice that at full scale and half that at the beginning. However, 3000 is not half of infinity but is twice 1500. Now the peculiarity will be apparent, and the scale will resemble Fig. 6.

Movements in excess of 1mA are rare in ohmmeters and 50µA is sometimes used. Parallel resistances increase the FSD if required.

**Ammeter Shunt Switching**

The correct approach for selecting current ranges using a double-pole switch is shown in Fig. 7. Note that any resistance introduced by the contacts is applied to the entire circuit, thus the resistor-to-meter ratio is maintained. The two poles of the selector switch are ganged together to reduce contact resistance to a level negligible with meters having a resistance greater than a few ohms.

**Voltmeter Switching**

Range selection in voltimeters is quite simple and if only voltage is required single pole switching as in Fig. 8 can be employed. Contact resistance in this case can be ignored.

Series resistances will be fairly high and values of at least 1000 ohms should be used in order to provide a reasonable accuracy. Sensitivities are usually quoted in “ohms per volt” and this is the resistance of the voltmeter on the 1 volt range. Switching to a higher voltage range will increase the internal resistance by a similar factor. Thus, switching from the 1 volt range to the 5 volt range multiplies the resistance by a factor of 5; e.g. 5000 ohms on a 1000 ohms-per-volt instrument. Note that this is not expressed as 5000 ohms-per-volt, because it is not the resistance of the meter on the 1 volt range. The sensitivity of a meter provides a guide to its accuracy, since the higher the resistance the less loading of the circuit under test. Commonly, meters of 20,000 ohms-per-volt are found and even 100,000 ohms-per-volt is not uncommon. Nowadays most quoted measurements are made using a 20,000 ohms-per-volt standard (i.e. AVO 8 or 9).

Combining a voltmeter with an ammeter requires only the techniques as applied to the ammeter, and Fig. 9 gives a practical circuit for this.

*Practical Wireless, March 1978*
Adding an Ohmmeter

Two methods of including an ohmmeter can be utilised; direct wiring into the switch or by using a separate terminal on the instrument. The first of these options is obviously the simpler but reduces the number of ranges available for current and voltage measurement. A basic wiring diagram is shown in Fig. 10. The latter of the choices offers many advantages: principally, though, it does not use valuable range-space on the function switch. A disadvantage, however, is the requirement for a third terminal on the multimeter, which may be considered to be confusing. Careful layout should avoid ambiguity in this instance, and a typical circuit is shown in Fig. 11. The separate terminal enables current ranges to be used for extending the lower end of resistance ranges.

Another idea for altering the ranges is to change the test voltage. If this voltage is increased, the lower and upper measuring ranges will decrease and increase respectively.

Some Notes on General Construction

In most cases, the precise value of resistor will not be obtainable and the solution here is to combine two or more resistors, of one or two per cent tolerance, to achieve the desired value.

Scale calibration is best performed by removing the meter covers and possibly the face as well. This is not always practical, so choose a meter which can be dismantled. The scale as supplied can be copied onto a piece of white card or stiff paper and other ranges calibrated against it.

Resistance ranges can be a little tricky as they are non-linear. The resistance of the current-limiting resistor and that of the meter must be considered, and the following expression is helpful in determining the resistance under test at any given point on the scale.

\[ R_D = \frac{V_T}{I_C} - (R_M + R_L) \]

Where
- \( R_D \) = Resistance indicated meter
- \( R_M \) = Meter resistance
- \( I_C \) = Current through circuit
- \( R_L \) = Limit resistance
- \( V_T \) = Test voltage

A more elaborate method is to use close-tolerance resistors of known value, "zero" being obtained by shorting the test terminals. Precision resistors of low value can be cut from "resistance wire" using the formula: Resistance = Length x ohms/metre. Typical examples of ohms-per-metre against gauge are shown below for "Eureka" wire.

<table>
<thead>
<tr>
<th>Gauge</th>
<th>Ohms/metre</th>
<th>Gauge</th>
<th>Ohms/metre</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>5-235</td>
<td>20</td>
<td>8-41</td>
</tr>
<tr>
<td>18</td>
<td>6-426</td>
<td>22</td>
<td>0-740</td>
</tr>
<tr>
<td>20</td>
<td>0-740</td>
<td>24</td>
<td>1-109</td>
</tr>
<tr>
<td>22</td>
<td>1-109</td>
<td>26</td>
<td>16-78</td>
</tr>
<tr>
<td>24</td>
<td>2-090</td>
<td>28</td>
<td>26-99</td>
</tr>
</tbody>
</table>

It is important that these resistors should, when made, be less than 75mm long.

When not in use, it will be noted that sharp movement of the instrument causes a violent swing of the meter needle. This is due to 'eddy currents' being induced into the coil. It is therefore good practice to arrange for the meter terminals to be 'shorted' during transportation.

Finally, it will be found that 1000 ohms/volt and 20,000 ohms/volt meters require movements with FSDs of 1 milliamp and 50 microamps respectively. The 50 microamp movement is a good one to use and will cost only a little more than one of 1 milliamp.
Construct the 'Purbeck'

The oscilloscope is probably the most useful instrument in the workshop, enabling as it does the constructor to look at the waveforms occurring in his equipment. The 'Purbeck' is a 5MHz single beam scope especially designed for easy building by the home constructor yet providing him with a professional piece of equipment.

also:

'Slim Jim'—an omni-directional free-space two-metre aerial featuring a radiation efficiency 50% better than a ground plane. It is slender, offering low wind resistance, and will operate with equal facility on lower or higher frequencies, with only minor modification of dimensions.

and

VHF Wavemeter

This is an attractively simple design for checking that the operating frequency of VHF transceivers is within the authorised band, and is cheap to construct, using only ten basic components.
PHILIP BOND

Introduction
Over the past decade the digital electronics scene has passed through several phases. In this time, the amateur electronics market has seen the popularity of digital ICs rapidly increase. At the moment there are two main logic families used in amateur electronics and radio, these are called TTL and CMOS. TTL (which means Transistor-Transistor Logic) was developed in the late 1960s and uses bi-polar transistors to perform the logical operations. CMOS (sometimes called COSMOS which means Complementary symmetry Metal Oxide Semiconductor) uses FETs to perform the operations. Each family has its various advantages, so they will both be in use for some time yet.

This project leads on to construct a logic probe which will aid fault finding and testing on equipment which has either of these families in its design. The display is given by LEDs and an audible output is also given, a low pitched tone for low logic level and a high pitched tone for the high logic level. This is particularly useful when the user does not wish to keep turning to look at the visual display.

In order to enable the device to be used on either logic family, certain design parameters were necessary. These are:
1. High input impedance to minimise circuit loading
2. Wide supply voltage (5-15 volts)

It must also be:
1. Relatively inexpensive
2. Compact

The device is powered from the logic supply rails of the equipment under test and current consumption is only about 15 mA enabling testing to be carried out on battery powered equipment.

Circuit description
Let us assume that we have connected the logic probe to the supply rails of the device under test and switched S1 into the “tone on” position. Under idle conditions the potential divider formed by R2, R3, R4 and R5 puts a bias on the inputs of the inverters. The inputs of IC1 (a) and (b) are biased such that they have a logic HIGH on their inputs. Their inverting action causes their outputs to be a logic LOW level. Hence, LED1 is not lit and D1 is reverse biased which prevents the astable from oscillating. Likewise, the bias on the inputs of IC1 (c) and (d) cause LED2 to be off and the output of IC1 (e) is low which reverse biases D2 and similarly stops the astable from oscillating.
Let us now assume that we connect the probe to a HIGH logic level. The inputs of IC1 (a) and (b) are not altered but the inputs of IC1 (c) and (d) are now such that they are almost at the logic HIGH rail voltage. Consequently they invert and their outputs swing LOW. Pin 6 is now low so that LED2 illuminates and pin 10 of IC1 goes HIGH, D2 is forward biased and R9 is effectively connected to the positive (HIGH) supply rail. The astable oscillates at a frequency of about 600 Hz. This is reproduced in the loudspeaker.

Now when the probe is applied to a LOW logic level the inputs of inverters IC1 (a) and (b) are pulled LOW and their outputs swing towards the positive (HIGH) rail. LED 1 is now lit and D1 pulls R8 to the positive rail. Once again the astable action takes place but since the value of R8 is larger than that of R9 the frequency of oscillation is lower. In fact the oscillator (IC2) now operates at about 500Hz, an octave below the HIGH tone.

If the probe is applied to a point in a circuit which is half the supply voltage then no LED will light or tone be heard. Normally these results occur if a point is disconnected, and the fault would soon be isolated. If the tone is not required the oscillator can be disabled by switching S1 to the mute position.

**components**

- **Resistors**
  - R1 100kΩ
  - R2 1MΩ
  - R3 470kΩ
  - R4 470kΩ
  - R5 1MΩ
  - R6 560Ω
  - R7 560Ω
  - R8 27kΩ
  - R9 3.9kΩ
  - R10 10kΩ
  - R11 100Ω

- **Capacitors**
  - C1 0.1μF (Mylar)
  - C2 4.7μF 16V (Electrolytic)

- **Semiconductors**
  - D1 and D2 1N914
  - LED1 T/L 209 Green (or T/L 211) with bezel
  - LED2 T/L 209 Red with bezel
  - IC1 CD 4069 AE or E (See text)
  - IC2 NE 555 V timer

- **Miscellaneous**
  - Small (3") loudspeaker 8 or 16Ω impedance, Verocase (153mm x 84mm x 79mm) Part no. 75-1239-K. SPST Miniature toggle switch, 2mm Plugs and sockets (Red, black and white). Ball point pen case, paper clip, wire, 6BA nuts and bolts.
Construction

The neatest way to mount the components is to use a small printed circuit board, and the design for such a board is shown in Fig. 2. The component layout is shown in Fig. 3.

The CMOS IC listed in the table of components for IC1 shows that a CD 4069 AE or E is required. However, there is the possibility that readers may be given a device which does not comply with this number. The different manufacturers use different codes to identify their devices and this takes the form of a prefix group of letters. CD is used by RCA, but you may see ICs with the letters SLC or MC1 printed on them. The important parts are the four-figure number code and the suffix, i.e. the “4069 AE or E”. The AE is one of many suffix codes used to show the range of characteristics which the device will possess. AE means the device is in a plastic DIL encapsulation, with a voltage range of 5 to 15 volts. There is also an indication of the temperature range of the device within this code too, but that does not matter in this application. The “E” device will operate over a slightly wider voltage range than the “AE” device, but this wider range is not necessary.

CMOS ICs are prone to damage if subjected to large static charges, so the CMOS IC, (IC1) should be the last component to be put in the circuit. Do not remove it from its special conductive packing until you are ready to use it. Damage may also arise if the pins are heated for too long, when soldering the device into the circuit. So if the constructor does solder the device directly in, then make sure the iron is not held at the individual pins for more than 5 or 6 seconds. Alternatively, the problem can be removed by using holders for the ICs.

The board and its subsidiary components were mounted in a plastic box, which was available commercially. This had the advantage that the top could be easily removed if any repair was necessary. Also, the box seemed to be tough enough to withstand a fair deal of knocking about, so it was an obvious choice for a test instrument case.

The loudspeaker and LEDs were mounted in the lid of the case; holes for the loudspeaker and the LED bezels were drilled plus two small holes for accommodating the 6BA bolts which were used to secure the loudspeaker.

The wiring layout is shown in Fig. 4. The LEDs have an anode and cathode like any other diode and the correct polarity must be observed. The longer lead of the two is the anode (positive) and it is best to wire these leads in one at a time so that errors cannot occur when the lead is trimmed short. Also note that S1 must be closed when it is in the lower position. This is the “tone on” state and since down for on is widely used in electronics, this was chosen here. The panel lettering was done with dry rub-down transfers: Vcc + marks the logic 1 rail, GND (Ground) marks the logic low rail and “probe” indicates the probe terminal.

The probe itself I claim no originality for whatsoever, since the method of making one has bedecked the pages of PW on a number of occasions. A ball point pen case was used as the tube, and the tip was made from a re-shaped paper clip. The clip was partly opened out and tinned (See Fig. 5). A small hole was made in the cap of the pen and the probe lead was passed through the hole and soldered to the paper clip. The clip was then pushed down the tube with a piece of stiff wire until 1 cm protruded through the end. The cap was put on again and the probe lead was terminated on a small plug, which, of course matched the socket on the front panel of the main unit. Two other leads were made but instead of probes they had small crocodile clips on their ends to connect to supply points in the circuit, under test. These leads were also connected to some small plugs which matched the sockets on the front panel. In fact two sets of test leads were made: one set for use where the probe is in close vicinity to the work being done, and a much longer set of leads for when the probe is located some few feet away.

Testing the unit

With all components mounted and the wiring checked the device can be tested. The device detects whether the probe is at a voltage nearer to the positive rail (Logic HIGH) or negative, in other words at the LOW rail. By connecting the leads of the device to the positive and negative terminals of a PP9 battery, the action of the logic probe can be checked. The probe should then be put to the appropriate connection on the box, and S1 can be switched to the “tone on” state. When the probe is not connected to either terminal, the LEDs should be off (or very dim) and the tone should be non-existent. If the probe is touched to the positive terminal the “HIGH” LED should now light up and the tone will be relatively high in pitch. And conversely when the probe tip is touched to the negative terminal the “LOW” LED will come on and the tone should be about one octave (which is “half” for all readers who are not musicians) below the first tone.

If these results are obtained the device is ready for use. There are many instances when a straightforward logic state display is useful; slow speed logic circuits and combinational logic elements can be checked. It also provides a very powerful teaching aid for those who are teaching or indeed learning the rudiments of digital electronics.
This month we will review one of the rather less well known devices, namely a Hall Effect switch. This is a miniature device in a plastic transistor type package which produces a sudden large change in its output voltage when the magnetic field exceeds a certain level.

There are many possible applications of such magnetic switching devices. For example, if a magnet is fixed to a revolving shaft (such as the propeller shaft of a car) and a stationary Hall Effect device is fixed close to it so that the magnet passes near to the device each time the shaft revolves, the pulse rate will be equal to the rate of revolution of the shaft. One can therefore use the pulse rate to measure the rate of rotation of the shaft or, in the case of a vehicle, its speed.

Applications

The Hall Effect device can also be employed to generate the pulses required for electronic ignition systems by employing a rotation magnet fixed to the camshaft. Similarly, it can be used to detect when the wheels of a vehicle lock on braking and an electronic system can be made which will keep releasing the locked brakes for a small fraction of a second whenever the locking occurs; skidding can then be greatly reduced, if not eliminated.

In general, the ULN-3006T can be used whenever one wishes to detect the close proximity of a magnet to the device, actual contact being unnecessary. For example, it can be used to generate the pulses required when the magnetic keys of a keyboard are depressed.

The Hall Effect

In order to understand how the ULN-3006T operates, we must first mention the basis of the Hall Effect. Let us consider a thin slice of silicon of rectangular shape, as shown in Fig. 1. A current flows from the upper to the lower edge and the whole slice is placed in a strong magnetic field which is perpendicular to the plane of the silicon.

The current carriers in the silicon (electrons or holes) are deflected to opposite sides of the semiconductor material, just as an electron beam is deflected to one side in a television tube or oscilloscope tube by the magnetic field generated by the scan coils or by any small magnet brought near to the tube. The deflection of holes is indicated in Fig. 1 although in actual practice the movement would be far less than that indicated.

If the electrodes A and B on each side of the silicon slice are connected to a sensitive voltmeter, a small potential difference will be detected across the slice. This is known as the Hall Effect voltage and is due to the deflection of the current carriers.

Hall Effect voltages have been used to measure magnetic fields and to measure currents. Hall Effect devices have also been used as analogue multipliers, since the Hall Effect voltage is proportional to the magnetic field intensity multiplied by the current passing through the device.
The ULN-3006T

In the ULN-3006T, the Hall Effect is used as the basis of a simple digital switch which will detect the presence of a magnetic field exceeding a certain intensity. The Hall Effect voltage is applied to the inputs of a differential amplifier, the output from this amplifier being applied to a trigger circuit. The trigger circuit switches suddenly when the input voltage exceeds a certain value and drives an output stage. The Hall Effect cell, the differential amplifier, the trigger circuit, and the output stage are all integrated on a single silicon chip inside the device; the internal circuit contains 36 components, including 14 transistors.

Package

The miniature ULN-3006T package is shown in Fig. 2, the Hall Effect silicon chip being placed in the centre of the body of the device. There are only three connections and, as shown in Fig. 3, the circuit is extremely simple. In the absence of a magnetic field, the internal output transistor is cut off and passes little current (about 15nA). The full supply voltage therefore appears at the output of the device. When a magnetic field perpendicular to the body of the device is applied to it, the internal output transistor is driven to saturation and the output voltage falls to about +150mV (the maximum for any device is +400mV).

![Fig. 3: A typical circuit used with the ULN-3006T. The transistor shown is one of the internal components of the device.](image)

Power Supply

The absolute maximum permissible power supply voltage for the ULN-3006T is 20V. However, the device characteristics are specified over the range 5V to 16V and it is wise to operate it within these limits. The writer found that satisfactory operation occurred when the supply voltage was as low as 3.4V.

When a small, but fairly strong, bar magnet was brought up to the device as shown in Fig. 4, switching to the low voltage state occurred at a distance of about 2.5mm. The magnet had to be moved back to a distance of about 8mm from the device before the circuit switched back to its high voltage state. Thus there is a built-in hysteresis effect in this type of circuit; that is, the switching to the low and high output voltage states occurs at two different magnetic field intensities.

The current passing to pin 1 of the device increases from about 7mA to about 12mA (with a maximum of 16mA) as the supply voltage is increased from +5V to +12V. The current passing through the load resistor R of Fig. 3 when the output voltage is low is additional to the current passing to pin 1. The output transistor is capable of sinking (or accepting) currents of up to 15mA, so the load resistor R can have any value exceeding 1kΩ with a 15V supply.

Smaller values of load resistor can be used with lower supply voltages provided that the 15mA limit is not exceeded.

![Fig. 4: The use of a magnet in switching the ULN-3006T.](image)

Magnetic Field

If the magnetic field is applied with incorrect polarity, no switching will occur. In other words, only one end of the bar magnet will be effective when brought up to one particular face of the device. The other end of the same magnet will cause switching when brought up to the other face of the device. Weak magnetic fields will not cause switching. The magnet must produce a field of not less than 0.075 Weber/sq. meter (750 Gauss) for certain operation. The device is immune to stray magnetic fields from transformers, relays, etc., since such fields are normally too small in value.

![Fig. 5: Arrangement permitting the use of weaker magnets.](image)

If two magnets with unlike poles towards each other are placed on each side of the device (as shown in Fig. 5), the switching will occur with much weaker magnets, since the two fields reinforce one another. Alternatively, a piece of soft iron or other magnetic material placed behind the device on the opposite side from the magnet will concentrate the flux and reduce the strength of the magnet required to produce switching.

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Practical Wireless, March 1978
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HOME OF BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY
If the magnet is not on the centre line of the body of the ULN-3006T, the maximum distance at which it will cause the circuit to switch to the low output voltage state becomes smaller. This effect is shown in Fig. 7 for distances of 1/10 to 1/100 of an inch between the magnet and the device.

The output from the ULN-3006T can be used to drive COS/MOS logic gates, transistors, thyristors, triacs and other devices. Some typical basic circuits are shown in Fig. 6.

The ULN-3006T is available from Phoenix Electronics (Solent) Ltd., 46 Osborne Road, Southsea, Portsmouth, Hants PO5 3LT at £2.50; this price includes VAT, but 20p must be added for post and packing to UK addresses.

**Fig. 6:** Suitable circuits in which the ULN-3006T is used to drive (a) a CMOS gate, (b) an NPN transistor, (c) a thyristor, and (d) a triac.

**Fig. 7:** Variation of magnetic field required for switching with distance from magnet, and with distance from the centre line.
When equipment is supplied from an internal battery its performance, calibration and output level are often unsatisfactory below a certain supply voltage. Some form of battery condition indicator can therefore help. The indicator described here consists of a small Veroboard circuit driving a panel mounted LED whose state reflects the battery condition. The LED has three possible states as follows:—(1) LED on, indicating an adequate supply voltage, (2) LED flashing at 2Hz, indicating that supply has dropped to a pre-set critical range, and (3) LED off, indicating that the supply voltage is too low for satisfactory operation.

All this information can be gleaned from a single panel mounted LED and this is driven by an operational amplifier.

The circuit takes up little space and can be added to almost any piece of equipment, where the LED will probably replace an existing indicator, or if not a suitable hole can be drilled. Two small board mounted pre-sets are used to make adjustments up to 12 volts, the current requirement being about 5mA.

### The Circuit

Several discrete circuits which would give the required action were considered, however these had unpredictable change-over levels or were too costly using many transistors and lacked "style". The use of a moving coil meter for this application is electrically the easiest solution. Unfortunately, such meters are very expensive and must be designed into the equipment taking up considerable panel space, a valuable commodity on modern equipment. The 741 op-amp circuit shown in Fig. 1 was eventually chosen.

Power for the circuit is supplied from the equipment being monitored, and the indicator will normally be wired between the circuit side of the on/off switch and the common supply line. Positive or negative earth circuits can be accommodated by wiring up the indicator as appropriate. Both inputs to the op-amp are used. The potential of the non-inverting input is held steady at the stabilising voltage of the Zener diode D1. The resistor R2 has practically no effect on the DC conditions due to the high input impedance; the non-inverting input will therefore be the reference voltage across D1, i.e. 3-5V. The inverting input is supplied from the pre-set potential divider VR1 and the circuit DC gain is set by VR2 and R3. The indicator LED is driven by the ICI output at pin 6, R4 limiting the current drawn for LED protection and current economy. Since the 741 IC output can fall to about 2-5V min. but will rise to almost the supply voltage, the LED must be connected to the positive supply line as shown in Fig. 1 rather than to the negative otherwise it will still glow slightly when a low output (LED off) condition is required.

Normally the voltage of the inverting input at pin 2, will be higher than that on the non-inverting input and thus the output, pin 6, will be at its lowest possible level with the LED alight. As the supply voltage drops, a voltage range will be reached when the potential of the inverting input will approach, reach parity, and finally become lower than the reference voltage on the non-inverting input. Over this range the IC will sweep through its transfer characteristic and the output will finally limit at its highest value causing the LED to extinguish.

Whilst the IC is between its upper and lower saturation limits, the circuit will act as a high gain amplifier and will oscillate at a frequency primarily governed by the values of C2 and R2. The output is a square wave and the LED will flash on and off. The range of supply voltage over which the circuit is in the oscillating mode is governed by the gain and hence the flashing range is set by VR2. With VR2 at its minimum resistance setting the gain is at a maximum.

---

**Fig. 1 : Circuit diagram of the Battery State Indicator.**

**Components**

<table>
<thead>
<tr>
<th>Resistors</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1 4.7kΩ</td>
</tr>
<tr>
<td>All ½ or ½W carbon film</td>
</tr>
<tr>
<td>VR1 10kΩ</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Capacitors</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1 1000pF disc ceramic</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Semiconductors</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1 Zener diode 3 to 5V 400mW</td>
</tr>
<tr>
<td>ICI 741</td>
</tr>
</tbody>
</table>

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*continued on page 866*
by Eric Dowdeswell G4AR

I must begin with an apology for not having wished all my contributors and readers a VERY HAPPY NEW YEAR which I should have done in the last issue! Only excuse is the lead time required for copy and the fact that the "January" issue comes out at the beginning of December! Anyway, have a successful year, with plenty of DX. There certainly shouldn't be any dearth of it on the 10m and 15m bands according to the reports coming in and it can only get better as we climb the somewhat unpredictable curve of the new sunspot cycle.

As I have said before, the newcomers to these two bands just don't know what they are in for! 10m especially will be a knockout and even the worst of receivers will be copying the DX! Apart from sensitivity the most important characteristic of a 10m set will be selectivity!

So far this month there is more news from the clubs than from individuals, so let's press on with that. New Secretary of the Edinburgh DARC is Tom Melvin GM8MJV of 17 Dundas Crescent, Eskbank, Dalkeith, Midlothian. Coming events run from Slow-scan to RTTY, not to mention skittles, so write to Tom for more info. Incidentally, Tom, tell the Editor of your Newsletter that info on your meeting place and addresses of Committee members would not be out of place in following issues!

The AGM of the Wessex AR Group revealed a membership of 82 plus 12 postal members, which sounds pretty healthy to me! A suggestion that membership should be limited was not the view of the majority of members present, however. Geoff Cole G4EMN of 6 St. Anthony's Road, Bournemouth remains Secretary and meetings take place in the Club room at the Dolphin Hotel, Holdenhurst Road, at 8 pm. You might read this in time to get to a talk on RTTY by G3VPC on February 3rd and you shouldn't miss H. H. Journeaux on Vintage Radio Equipment on February 17th.

D. Lively GSKII will be glad to meet newcomers to the Cheltenham AR Association at The Old Bakery, Chester Walk, off Clarence Street, at 8 pm on the first Thursday of any month, plus the third Friday, a New Year innovation. On to Wales where the Blackwood DARS has elected Steve Cole GW4GLE "Entertainments Secretary". From 10 Llanthewy Road, Newport, he tells me that club night is on Fridays at Oakdale Community, Near Blackwood, Gwent, with GW8LJJ presenting "Construction Techniques" on 10 February. A "special" will be G510R on "Oscar 7" on the 24th with part two of this tape/slide show on March 3rd. The club is well-equipped with gear for the HF and VHF bands and if you feel like having a go at the RAE there is a class running now. GW5KYA on Blackwood 225 825 can give up-to-the-minute info on club activities.

From Leamington Spa, Nick Smith A9050 reports buying a Codar CR70A, which, with a 120ft wire, has been mainly operational on 15m, 20m and 80m so far. Neil Braeman G4FUP took time off from operating to tell me how much he enjoys being on the air. He has a Panda Cub plus a Collins TCS12 receiver on the HF bands on CW, "I'm proud to say", but admits to using "fone on 2m with someone else's rig!" He comments on the "rubbish and pointless QSO's" on this band but I wonder if it is any different on the HF bands. Next project is an RTTY set-up and already bits and pieces are littered around the shack!

Steve Roberts writes from Mississauga in Ontario, Canada concerning my remarks on "strange calls", in the November issue, inferring that they came from the Citizens Band. He points out that the introduction of 40 channels this year to the band only has caused the price of the old 23-channel transceivers to drop to around $50! Then he remarks, most strangely that "the serious SSB operator had to go to the illegal use of a linear amplifier!" Not to mention the illegal "sliders", presumably meaning VFO's. Steve cites cases where he has found his CB gear of real use but as I have pointed out before, over here a licence is required and available for use that has a genuine need. Steve says he is not electrically minded so does not feel able to take an amateur licence exam. It would be worth making the effort OM!

D. W. Waddell in Herne Bay, Kent, tried a pre-selector in front of his lovely FRG7! I don't know what Yaesu would say, if they knew! Fortunately the p-s has now been dumped in favour of a pre-selector which is much more worthwhile. D.W.W. wonders when the "experts" get their DX on the 80m and 160m bands. Very briefly, between dusk and dawn! But listen an hour or so before and after this period if only to get the feel of the bands.

More club news! The Silverthorn RC has its HQ and club stations G5SRA and G6CSA at Friday Hill House, Simmons Lane, Chingford, London E4 and Hon. Sec. is Chris Hoare G4JFA of 41 Lynton Road, South Chingford, London E4 9EA. Chris together with Colin G4EZQ and Ted G8NP have been /P on 160m recently, usually on Saturday or Sunday evenings, with a TX using the SL600 series of ICs feeding into a 2N5591 PA, mainly on SSB. Long wires have been slung up with the help of a crossbow! Oh, yes, club meetings are at 7.30 on Fridays do go along if you live around that part of London.

Well, that is the sum total of information to hand and I can only presume that there is more knocking around the system somewhere. I'm sure that all you chaps and girls haven't stopped listening! Let's hope that all the radios that Father Christmas will have been distributing will soon increase the flow of reports!

Log extracts

D. W. Waddell:— 80m EP2TY JY9DJ UBKAG UL7KBN
20m FP6DG TU2EF 15m G5AAD KG6RT PJ9CG 5T5JD
7PRAI 9LISL/A 10m G5AT CE6EZ CW0A FG7BA FM0FC
HH2MC TU2GM
N. Smith:— 20m VR2XL 15m SV1DH

Practical Wireless, March 1978
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- TERMINATIONS—Five 2 jack sockets—input, 2 output, headphones.
- SIZE—32½ x 35 x 35½ max. depth to rear (plus separate power unit). Panel in matt black with controls sensibly grouped for easy handling.

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- INPUT IMPEDANCE—47k ohms

**POWER SOURCE**

- 220-240V. A.C. Mains

**CONTROLS**

- Mains on/off, master volume, bass ±15db, treble ±15db, L and R mixing, L and R motor switches, selector switch for P.F.L. (Pre-Fade Listening), headphone volume, mic. vol., aux. vol., LED indicators on mains and decks on/off switches.

**HEADPHONE AMPLIFIER**

- Powerful 2 watts into 8 ohms: separate volume control.

**TERMINATIONS**

- Five 2 jack sockets—input, 2 output, headphones.

**SIZE**

- 32½ x 35 x 35½ max. depth to rear (plus separate power unit). Panel in matt black with controls sensibly grouped for easy handling.

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Practical Wireless, March 1978

851
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SHORT WAVE BROADCASTS
by Charles Molloy G8BUS

The Austrian Short Wave "Panorama", which can be heard on 6155kHz, 9725, 15555 and 17770 at 1805 on Sundays, is holding a DX Trophy competition during the first three months of 1978. The idea is to log broadcasting stations in half-hour blocks. Every contestant will receive a diploma stating his score and the highest scorer will receive a DX Trophy, suitably engraved. Full details can be obtained by sending a SAE (in the UK) to Jonathan Marks, 12 South Bailey, Durham DH1 3EE or direct to DX Trophy, Austrian SW Panorama, Austrian SW Service, A-1136 Vienna, Austria.

"Now is the time of year when one can start looking for rare birds from the other side of the world. One of the most elusive is Radio New Zealand, which I have managed to hear during the past four winters" writes John R. Bedall from Rugeley in Staffordshire. John recommends the 25m band transmission of the Pacific Islands service which is on 11780kHz from 0530 until 0715 and on 11820 from 0730 until 1030, up to March 5th, 1978. The power is 7.5kW. Radio New Zealand is also on 11860 and 15130 from 1800 to 2215, on 17710 from 2250 to 0520, on 15530 from 2200 to 0540 and on 15130 from 0400 to 0715. DX reports, which should be accompanied by two International Reply Coupons, should go to Radio New Zealand, PO Box 2092, Wellington, NZ.

A 1957 Ferguson 59T receiver and 40ft long wire were used by thirteen-year-old Andrew Brade of Stone (Staffs) to pull in an interesting log of DX. Radio Uganda was heard signing-off in English on 9515kHz at 2105, Radio Cyprus on 7195 signing-on in Greek to the UK at 2215, Sri Lanka in English on 11795 at 1500 and the Voice of Greece on 11730 starting a programme in Greek at 1230. Andrew has been looking for Radio Veritas, Phillipines on 11725 between 1400 and 1500 and he would like if the station has changed frequency. Radio Veritas (PO Box 939, Manila, Phillipines) has been logged on 11855kHz at 1425 by Philip Grainger of South Shields using a Trio SR59DS reception and long wire antenna. Philip would be interested in hearing from anyone who would be prepared to help him start a DX club in his area. Letters should go direct to 26 Beattie St, South Shields, Tyne and Wear.

"Please recommend an International SW Broadcasting frequency book that gives the stations, frequencies, transmission times, etc", asks Van Ommen Kloce (E3SCM) from Arklow in Ireland. A similar request comes from R. J. Bedall of Chesham in Surrey who has a Sony ICF-S900 which pulls in plenty of stations. He wants to know who they are and where to write for a QSL. The World Radio and TV Handbook, published annually in Denmark, lists all known broadcasting stations on the long, medium, short and FM bands with the exception of some low power locals on the MWs. TV stations are also listed. There is a section for each country which gives the hours of transmission, addresses and QSL information and AM broadcasting stations are listed separately in frequency order. The 1977 edition cost £5. The 1978 edition is expected out in February and it can be ordered through booksellers or by post from the Modern Book Company, 25-27 Praed St, London W2 1NP, who advertise in FW.

Reader Bill Ball, who has been an SWL since the mid 1960s, now has a Yaesu MFJ-397 communications receiver and he would like to compare notes on aerials and the general performance of this receiver with other DXers. Write to Bill at "Garswood", 53 Winstanley Rd, Billinge, Wigan WN5 7XE. Stations heard with the FRG7 and end-fed at arial were Radio Globo, Brazil 1895kHz, Radio Club, Peruamambu, Brazil 11865, Radio Australia on 4865, Radio South Africa on 4810, USSR (Kalinin listed) on 4860, Benin Republic on 4870, Conakry, Guinea on 4910 and Radio Malaysia, Sarawak on 5005. No times are given but the 60m logging would be after dark and Brazil on the 25m band probably around 2100.

"Not a regular DXer but I do enjoy a bit of knob twiddling between listening to the amateurs" says Christopher Silk who lives at Leigh-on-Sea in Essex. Using an Eddystone 740 and a 20ft vertical aerial with 60ft of co-ax feeder he pulled in Radio Australia on 7240kHz at 1500. Reception continued until 1555 when an intermittent signal damaged reception. The transmission on 7240 is beamed on 525° to the Pacific Islands but he is also bearing across Europe on DX short route across Asia.

Twelve-year-old Chris Howleis who is a regular reader of PW recently took up SW DXing as a hobby and he bought a Vega 206 receiver. He added a 30ft long wire to an old VHF TV aerial and with this set-up heard Radio Australia at 0800 on 21570kHz in the 15m band, Radio Canada International at 1855 on 15325, All-India Radio at 2020 on 8590, Baghdad at 2010 on 9635 and the Voice of Turkey at 2200 on 9515. Chris is puzzled why the 15m, 16m and 19m bands go blank after about 1830 hours. The reason is that signals on these bands pass through the ionosphere after dark instead of returning to earth. The ionosphere is maintained by ultra violet radiation from the sun and its strength and hence the ability to receive signals is at a maximum on the sunlit side of the earth. On any particular path the frequencies in use will be higher during the day than at night.

Frequencies will also be higher for long distance (low angle) than short distance (high angle) communication. From the DXer's point of view this means that during the day, the highest frequencies will be in use for long distance and lower frequencies for short distance reception. After dark, the higher frequency bands are dead; long range reception is now found on lower frequencies while short range reception moves to the Tropical Bands (the 75m band in Europe) or to the medium waves.

A Trio SR39DS receiver and long wire aerial are in use at Braintree in Essex by R. Guest who heard Radio Australia on 11740kHz at 0640, on 21570 at 0800 and on 6035 at 2100, KWTR Guam on 8940 at 1330, Havana, Cuba on 17885 at 2055, Nigeria on 15120 at 0800 and Spain on 6100 at 2050 (there is a DX programme in English on this frequency at 2213 on Sundays). From the International Short Wave Club comes news of programmes in English from Radio 4VHE Cap Haitien on 9770kHz and 11835 between 2230 and 0030, Sri Lanka over 11955, 15120 and 17850 between 1845 and 1940, from Taiwan on 9600 from 2130 to 2230 (reports to 53 Jen A Rd, Sec 3, Taipei, Taiwan) and from Benin on 4970 (60m) from 2015 to 2030 (reports to PP 365, Cotonou, Benin). An old Ever-Ready radio of uncertain age works "incredibly well" for P. Gatehouse of Buckingham. All-India Radio came in on 8525kHz at 2230, Radio Canada on 11945 at 2038, Radio Israel on 7412 in English at 2350. On Sundays there is a DX programme from 2000 to 2050 and the station address is PO Box 1092, Jerusalem, Israel.

Reports on the various bands are welcome and should be sent direct, by the 15th of the month, to:

**AMATEUR BANDS** Eric Dowden 644AR, Silver Firs, Leatherhead Road, Ashtead, Surrey KT20 2TW. Log by bands, each in alphabetical order.

**MEDIUM and SW BANDS** Charles Molloy G8BUS, 192 Segars Lane, Southport, PR8 3JS. Reports for both bands must be kept separate.

**VHF BANDS** Ron Ham B8S17M4, Farnaby, Grayfriars, Storrington, Sussex RH20 3HE.
The mystery surrounding the CJON Radio Network has now been cleared up by Ian Rennison of Horsham in Sussex. CJON on 930 is no more. It has a new callsign (CHYQ), the address of the station is PO Box 6180, St John's, Newfoundland and the slogan used over the air is "Q Radio." The callsigns of the rest of the network have also been changed. CJFOX on 610kHz is now CKQY South Coast, CJNH 670 is now CHYQ Bonavista Estuary, CJCN 680 is now CIQY Central Newfoundland and CJCR 1350 is now CFYQ Gander, Ian, who uses a MW loop, differential amplifier, Trio 9R59D receiver, audio notch filter and the PW CMOS crystal calibrator, reports hearing a new CBC outlet on 750kHz relaying CBN (640) and that CFBC Saint John N.B. on 930 has now become prominent on this channel in place of CJYQ. All very confusing!

A Trio 9R59DS and a 56in loop are in use at Steyning, Sussex by Alf Cosham who reports hearing CKVO Clarenceville Newfoundland on 710kHz at 2350, WINS New York on 1010 at 0710 and WNEW also in New York on 1150 at 0705. The CJYQ frequency (930) seems dead at Alf's QTH and reports from other DXers suggest that CJYQ (ex CJON) may no longer be the strongest, most consistent and earliest North American to be heard in the UK. Stations seem to come and go on the medium waves. CBA Moncton N.B. at one time was a solid signal every night on 1070 after Paris closed down, while others, such as CBH in Halifax at 860, WMEX Boston on 1510 and WKBW Buffalo 1520 which used to be reported regularly are now inconspicuous. It is interesting to speculate why this should be.

Interference is probably one cause but the explanation that appeals most to the writer is the thought of the Chief Engineer, tired of answering reports from DXers, who adjusts his aerial system so that more signal goes into the service area and less goes out to distant lands and to eavesdropping DXers!

At the moment CKVO on 710kHz and WINS on 1010 are the stations to look for around midnight, if you have never heard North America on the medium waves. WINS has its studios in New York City but the transmitter is in New Jersey and the directional aerials boost the signal to the north east, towards New York and also to the DXer in Europe.

More North American DX from David Sidebottom who lives in Fleetwood and uses a Realistic DX160 receiver with an 80ft longwire aerial. Some of the stations heard by him between 0030 and 0200 are VOCM St John's on 590kHz, WHDH Boston on 850, CJCH Halifax on 920, CHER in Sydney on 850, CHNS Halifax on 930, CBP on 930, Corn Brook 990, WHN New York on 1050, CBA Moncton 1070, WCAU Philadelphia 1210 and WVJO Jacksonvile in Florida on 1520. "Q Radio" on 930 was also heard mixed with CFBC. Robin Harvey writes again from Halesworth to say that he now has a Trio 9R59DS communications receiver and he is set to do some serious DXing. He has been unable to hear MBC1 which has not been transmitting on 773kHz recently nor has he been able to locate the Voice of Peace on 1540. The latter has changed frequency to 1558 which is occupied also by the 700KW outlet at Mainflingen in West Germany and it will be very difficult to hear the "V of P" on this channel in the UK.

"I would like to know if readers ever write to you about hearing DX on the long waves" asks Peter Ramsey of Stevenson in Ayrshire. Occasionally, is the answer, and it is a pity that more DXers do not try this band. The main obstacle to DXing on the LWs is interference from the line timebase of TV receivers which appears as a buzz at intervals of about 15kHz. This trouble disappears after midnight, when it is worth tuning around the band for weak signals. Asiatic Russia, Turkey, Iceland, Algeria, Morocco, Romania, Sweden, Norway, Finland and Mongolia are to be found on the long waves. A good outdoor aerial is an advantage but a transistor portable with internal aerial can perform very well as its directional aerial will cut down static and QRM.

A report of Asiatic DX on the medium waves comes from our regular reporter Harold Embury who DXes in Mirfield with an Edystone 750 receiver and loop. Radio Pakistan's outlet at Quetta was heard on 750kHz, Astra-khan USSR on 791, Novosibirsk in Siberia on 1025, Saransk on 1061 with local identification. Also logged were Conakry, Guinea on 1403 which is on the air all night and EAJZ8 Radio Tarasa in Spain on 1412.

"What kind of ATU (Aerial Tuning Unit) must I use with a loop"? asks Raphael M. de Witte who lives at Whitley Bay. An ATU is used to match a long wire to a receiver and it is not suitable for use with a loop as it would act as an aerial itself, pick up signals and therefore mask the loop's null. Even if it were placed inside a screened box it would still give trouble as the type in general use is electrically unbalanced and would upset the operation of the loop.

"Is it possible to receive local radio stations from other parts of the UK"? enquires C. J. Roe of Warwick who says he is something of a novice regarding radio. The best type of receiver for this sort of DXing is the ordinary transistor portable with its internal directional aerial. Tune in a station on a portable, rotate the receiver without filtering it and two positions will be found where the station disappears or drops to a very weak signal. This ability to null-out stations can be put to good use when searching for local radio stations as most of the channels in use are shared. Try after dark on 755kHz, 854, 998, 1054, 1106, 1115, 1457, 1484, 1502, 1520, 1546 and 1594 for BBC locals and on 989kHz, 996, 1025, 1151, 1169, 1277 and 1546 for IBA outlets.

"Long time no hear" writes Ralph Newman from Reading who has not been idle, though. He has been doing "few mods" to his homebrew receiver and he now has a really good 8-element ceramic IF filter to sort out the QRM. Highlights from his log are Nigeria on 945kHz with identification at 2357, CBM Montreal on 940, WHN New York on 1205 at 0900, WCAU Philadelphia on 1210, WVOJ New York on 1304 at 0024, WOKO Albany NY (5KW) on 1460 at 0025 and WQXR in New York City on 1560 at 0030. WINS was heard at 0745 in the morning until its carrier finally went out as a heterodyne with 1070kHz at 0810. The fadeout of the sky wave from WINS would be caused by the reforming of the "D" layer in the ionosphere due to the action of ultra violet radiation from the rising sun. The "D" layer absorbs MW signals, but Lopik in Holland on 1070kHz would still be heard via the ground wave.
Gordon Goodyer BRS 37545 of Petworth, has purchased an Eagle SR550 amateur bands receiver and finds it very good on both the 20m and 10m bands and the long scale between 28 and 50MHz makes it an ideal tunable IF amplifier for his 2m converter. Around midday on December 4th Gordon heard an EI on 2m SSB during the RSGB Fixed Station contest and, according to the grapevine, a GM was also heard in the south, which is not surprising because conditions were right for a tropospheric opening. The atmospheric pressure rose sharply from 50-11m at midday on December 1st to 50-4in by midday on the 3rd and was falling rapidly throughout the 4th. The first sign of a lift came at 0248 on the 5th when signals from GW mobiles, through the Bristol Channel repeater, were opening the squelch on my receiver.

At 1454 I received a 53 signal from GB5SUT on 70cm, and a picture from the IBA transmitter at Lichfield on Ch.8, 180MHz. A dipole aerial was used to feed each receiver. By 1504 on the 4th, repeater signals were strong and I heard GW8MVA working a French station through GB3BC. The AP continued to fail for the next few days reaching a low of 29-2in at 0400 on the 8th which meant very bad weather over much of the UK and very poor VHF conditions. Later in the day the AP began to rise and by midday on the 12th it was back above 30-0in rising to 30-5in on the 14th bringing back good VHF conditions. At 2020 on the 12th Dave Butler G4ASR London, worked F6DFF Paris, on 2m SSB and was called by an HB9 whose signal suddenly disappeared into the noise; one of those VHF annoyances! Dave has an excellent VHF record; recently, while staying at the Lizard, he worked more than 1300 stations from 16 countries on 2m and 9 on 70cm. His best DX on 2m is Liechtenstein and Switzerland on 70cm. During the opening last September, Dave noticed that many south coast amateurs were able to work into Holland yet he could not hear the Dutch stations although he could easily work to Spain from his location at the Lizard. From his many aerial experiments Dave has found that his VHF Quad is by far the best of his equipment.

Alan Baker G4GNX Newhaven, noticed a lift during the evening of the 15th when he heard GSZIG Norfolk, work a GM on 2m SSB and on the 14th he heard signals from GB3DC right along the south coast to Rottingdean. Also on the 14th Lee Reynolds GELCK London, worked stations via the 2m repeaters in Birmingham, Bristol, Buxton, Dover, Four Marks, Martlesham Heath and Belgium, ON00V, all with 2-5W. Roy Bannister G8LXR Lancashire, heard French stations on 2m CW on both the 14th and 15th several of those repeater signals were operating the squelch on my receiver and during the early evening of the 15th, Alf Lee G4DQS Brighton, worked a French station via the Normandy repeater F237TF on R4. Frequently on these two days signals were heard from both GB3SUT and GB3EM on 70cm.

Congratulations are due to our readers Roy Bannister G8LXR and Barry Ainsworth G8HYN who went together to North Foreland and passed their morse tests. Roy now has the call sign G4GFX and Barry is G4GPW.

Brian Oddy G5FXE Storrington and J. A. Tipping G8XE Brighton, have been carrying out tests between Devils Dyke, a high spot Nr Brighton, and Storrington on 25cm. Both stations are using Microwave Modules converters into their respective receivers and they have been experimenting with a variety of aerials, including a 4ft home-brew dish, a J-Beams 15/15 slot and Brian's 16in dish which he used back in 1962 when he held a record for a 104 mile QSO on 1296MHz. Readers wishing to take part in these tests, which take place on most Saturday mornings, should write to G5FXE, QTHR.

The Haywards Heath ARC held its inaugural meeting on November 17th which was attended by 12 people including two, in an advisory capacity, from the Crawley ARC. The meeting elected Alec Parsons GB8MDP chairman, Andy Mepham G4CBZ secretary, and Chris Stagg G8MZO treasurer. At present the club is very much VHF orientated and future meetings, where new members are welcome, will be held monthly at the Liverpool Hotel, opposite Haywards Heath Station; for further information phone Andy Mepham, H.H. 57609.

A period of solar activity began on December 1st and was dying down on the 16th, during which time Cmdr Henry Hatfield, Sevenoaks, John Smith, Rudgwick, and myself recorded many individual bursts of solar radio noise and noise storm conditions prevailed on the 10th, 11th and 12th. On the 4th, Henry, using his spectroheliograph, located the cause of the noise when he identified two sunspot groups, 16 filaments and 4 plages on the sun's disc. As usual this solar activity disturbed the normal path of VHF radio signals.

Between 1720 and 1920 on the 2nd, John Braangan, Saline, Fife, observed an aurora borealis both optically and by radio. John sent me a fine drawing of the event, which I will pass on to G2FKZ, and he described it as pale pearly grey and white and the pattern was fluctuating in a few seconds. While this natural phenomenon continued, John received signals from five Continental FM stations, between 88 and 92MHz; 6 GMs, 1 GI, and a PA0 on 2m and several beacons including DL0PR, LA4VHF, GB3AN, GI, NEE, VHF and UTC, all being reflected from the changing auroral display. The BBC World Service reported ionospheric disturbances on December 1, 2, 6, 12 and 13 and during the evening of the 12th, Alan Baker reported that the VHF bands were unusually noisy.

No doubt this solar activity was responsible for the variable conditions on 10m. I heard signals from the Bahrain beacon A9XC on the 12th, the Mauritius beacon 3B8MS on the 1st and 11th, the Cyprus beacon 5B4CY on November 22, 24, 29, December 9, 11, 12, 15 and 17 while Nigel Golds BRS 36810 West Chiltington, Sussex, received a 559 signal from the German beacon DL0IGF at 0600 on the 10th and Ralph Cathies G5NDF Great Bookham, heard DL0IGI during the morning of the 13th in addition to signals from the Bermuda beacon VP0BA 28-165MHz. Both Nigel and myself heard signals from Europe, Italy, Russia and north and south America during the 10m contest on the 10th and 11th.

Anthony Mann, Applecross, Australia, says that there was “a most intense opening” during the evening of November 13th when he heard signals on 10m from A9XC, 5B4CY, 3B8MS and from amateurs in Europe and the UK as far north as Scotland. Anthony noted a lot of sporadic-E activity between November 6th and 20th.

From his DX TV observations he reports Malaysia’s Network 1, Ch.E2, which is in West Malaysia, came in on three occasions and during one of these he also received East Malaysia’s Network 3 on Ch.E2. On November 13th and 18th he received pictures from New Zealand on 45-25MHz and says “November 17th was a very good day for all of us”. At the time Malaysia was being received in Peru 4000 miles east by Sydney, Band 1 and 2 stations in the far north of Queensland were being received by friend Robert Copeman.

Thank you all for your interesting reports. Don’t forget the RSGB 144/432MHz Open and SWL contest on March 4th/5th and the 70MHz Open contest on March 19th; good luck if you compete and I will look forward to hearing from you after the events.

Practical Wireless, March 1978
and hence the supply voltage range over which oscillation takes place is very narrow, about 0.1V.

Construction and Component Selection

The Zener diode D1 should ideally give good stabilisation at a low current and can be simply checked by connection to a variable voltage supply with a 4.7kohms series resistor whilst monitoring its voltage with a multimeter. Selection of the Zener in this way is merely a refinement however, as in several indicator circuits lashed up so far all diodes were off the shelf and worked well. The actual Zener voltage is not critical, so a device anywhere between 3V and 5V will be suitable. The LED type is also non-critical except that it should have a suitable mounting clip.

The circuit is best fabricated on a small piece of Veroboard which can be located inside equipment where space permits. A suitable layout is shown in Fig. 2. Four Veropins are soldered in place at the board edge for connection to equipment being monitored.

Setting Up

This is a simple matter and is best carried out as follows. Connect the circuit to a variable voltage supply, monitoring the current drain, which should be about 5mA at 9V. Set the supply voltage to the value at which you want the LED to start flashing, say 7V, and adjust VR1 until oscillation begins. With VR2 in its minimum resistance position, the LED will flash between 7V and 6.9V.

This small range will be adequate for low current equipment when the battery voltage drops slowly e.g. a low distortion oscillator taking about 15mA from a PP9 battery, where it is convenient to take the onset of flashing as the "change battery" point. The flashing LED will attract attention if the equipment is being used when the battery voltage drops.

If when switched on after a period of little use the LED does not light, the battery voltage is too low, probably due to normal deterioration. Increasing the value of VR2 will increase the flashing range over wide limits. A small degree of interaction between the two presets is inevitable. For monitoring higher supply voltages than 12V the LED series resistor will need to be increased in order to keep the current at a safe and economic level.

Alan Baker G8LGQ an electronics engineer from Newhaven, Sussex, is a familiar name to the readers of my VHF column in this journal. According to his father, Alan showed signs of becoming an engineer at the age of three when he played with a pair of pliers and eventually put them across the mains! At the age of six his favourite toy was a crystal set, with the headphones in a pudding basin to increase the audio gain. On leaving Redhill Technical College at 16, Alan began work as a telephone engineer with the GPO and later became a TV service engineer with a private firm in the Kingston area. He was married in 1969 and in 1968 his technical ability took him into the field of public address and the specialised recording of folk music.

In 1975 Ralph Cathles G3NDF loaned him a Hallicrafters Super Skyrider receiver and it was hearing the W's on 20m that convinced him that it was time to take up amateur radio and by February 1976 he was sporting the call sign G8LGQ. Immediately he began exploring the 2m band with a Pye Cambridge which was later replaced with a Yaesu rig.

As a committee member of the Sussex repeater group Alan was involved with the installation of GB3BR, the Brighton repeater on 70cm, and as an enthusiastic mobile operator with an IC22A in his car, he has worked much DX through many of the British Isles and Continental repeaters. His constructional projects include a VHF linear, a frequency counter and a 5-manual theatre organ complete with pit and lift! Alan is a member of the Mid-Sussex Amateur Radio Society and the RSGB, and in May 1977 at the age of 30, he was elected chairman of the newly-formed Brighton and District Radio Society.

In the latter half of 1977 he polished up his morse code and passed the test at North Foreland in November. In just less than two years Alan Baker mastered the art of working DX on the 2m band and now intends to do the same on the HF bands with his new call sign G4GNX.
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857
### SEMICONDUCTORS

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HI-FI TYPES

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<table>
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<th>Valve</th>
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Practical Wireless, March 1978
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- **Cable Kit**: Includes all necessary cables for connecting the speakers to the amplifiers.
- **Remote Control Unit**: Offers easy and convenient operation.

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Rated at 35 amps 250 volts, ideal to make your own high current relay and for dozens of other applications. £1.99 each in packs of 10.

**Applications**: The micro switches can be used in various applications, such as controlling appliances, switches for security systems, and more.

**Price**: The price is subject to change, but is generally affordable and competitive within the market.

MULTISPEED MOTORS
Suitable for 240v mains and 110v/230v p.m., and 7,000, 9,000, and 11,000 rpm. 380W. £29.99 each.

**Features**: The motors are designed to handle high loads and are suitable for a wide range of applications, from industrial to household use.

**Price**: The price is generally competitive and reasonable, making it an affordable option for users.

RECTANGULAR HOT PLATE
Aluminium panel with plastic top and angled edge for undermounting. It is 20 x 20 inches. £39.99 each.

**Specifications**: The hot plate is designed to be used under sinks, tabletops, and in other confined spaces. It is ideal for kitchens and bathrooms.

**Price**: The price is generally competitive and affordable for such a versatile product.

HUMIDITY SWITCH
Amateurish and looks as though the pot No. 211. The action of this device is as follows: Upon the depressed, the two mercury-contaminated electrodes are moved, allowing a path to be formed which triggers a sensitive microswitch adjustable by a screw. Quite sensitive to the humidity, the switch is ideal for the control of air conditioning, boilers, etc. Price: £1.99 each.

8 POWERFUL BATTERY MOTORS
For models, Meccano, drills, remote control planes, etc. £2.99 each.

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Japanese made plastic container for lead acid batteries. Size: 15 x 15 x 15 cm. £4.99 each.

**Specifications**: The unit is durable and long-lasting, suitable for use in various applications such as remote control systems, toys, and more.

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Wiring diagram, supplied for complete house protection. Keep this diagram handy! £3.99 for a set of 10.

**Specifications**: The mats are designed to protect against electrical surges, ensuring safety in your home.

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MAINS TRANSISTOR PACK
Designed to operate transistor sets and amplifiers. A mains operated relay which will operate on 240v and stop at 220v. £4.99 each.

**Specifications**: The pack is ideal for use in conjunction with other electrical devices, providing a convenient and effective solution.

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Adapt colour or white light to your own requirements. 240v maximum (450W). Unit in box all ready to work. £9.99.

**Specifications**: The sound to light unit is ideal for use in creating a unique lighting effect based on the sounds in your environment.

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MICRO SWITCH
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Miniature mains transformers, fully stripped. 240V £5.95 each. Includes new equipment, complete with mains cable, plug and user guide.

BARGAIN PACKS
4 aluminium boxes 12" x 4 x 38 mm Ideal for signal injectors, etc. £9.95
Self filling enclosures complete with cable £2.95 30 each, £2.65 each
100 miniature rod switches ideal for burglar alarms, model making, Ubbink etc...
200 resistors 10 K ohm's on board operation at 15 volts £4.45
2 x 12 volt relay leads on board £4.45
High quality computer parts unboxed in best grade components 5 lbs £4.75, 10 lbs £8.95

DE LUXE FIBRE GLASS PRINTED CIRCUIT EYING KITS
Includes 150 sq. in. copper clad fp board, 1 lb terro chloride, 1 data etch resist pen, abrasive cloth, 2 mini drills, 10 drill and instructions £3.95

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STANDARD PROFILE DOUBLE SIDED DIL SOCKETS.
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40 Pin 45 60 80 80

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20 Pin 25 40 60 80
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