GERMANIUM TRANSISTORS
Type  Vce  Vce  Ic  hFE  ft  fT  MHz
              max  max  max  hfe  MHz
                   R.F. APPLICATIONS (PNP)
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**PS12 Transformer T358 £2.30**

- **Component Shop:** 10 Baldock Street, Ware

Practical Wireless, May 1977
YES, dear reader, if you have just paid your 40p for this copy of PW then you have really got your money's worth this month! Apart from the free information card contained in this issue you will also find a free copy of the index for Volume 52 of PW which finished with the April issue. 'Fine' you may say, 'So what'? Well, it is something new for PW because in the past the index was produced some time after the end of the volume had been reached and if you wanted to get a copy of it you had to pay 45p! Plus all the bother of finding writing paper, envelope, stamp and postal order or cheque!

One would need to go back into the past quite a bit to discover how this practise arose in the first place, and more to the point, why it has persisted. Anyway, that's all history now and, hopefully, you'll get your free index on time in future.

Another relic of the past also needs to be dealt with and that is to make our volume of twelve issues coincide with the calendar year! I have no intention of wading through early volumes of PW to discover just when this discrepancy occurred but in the early days of PW in 1932 it was a weekly publication and the subsequent change to a monthly appearance probably explains the mystery.

I have often wondered whether those conscientious readers of PW who bind their copies do so by the volume or by the year. Personally, mine go into binders by the year but the office copies are very neatly bound by the volume! Ah, well, perhaps we will get it all together 'ere long. I don't suppose these little matters bother our average reader in the slightest, but it was something to talk about!

Eric Dowdeswell Assistant Editor

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More outlets for trio

UP to the present time, Trio High Fidelity equipment has only been obtainable from selected dealers within the UK. A move has now been successfully made to enable all Trio equipment to be available from Comet Discount Warehouses. Of course the same equipment will still be available from the selected dealers, but as from 1st February of this year, they have been redesignated as 'Trio Specialists'. B. H. Morris and Co (Radio) Ltd., Precision Centre, Heather Park Drive, Wembley, Middx HA0 1SU.

Bib book

PLANNED, and written for beginners by Clement Brown, the Bib Book Of Hi-Fi explains in laymen's terms the basics of Hi-Fi, stereo principles and the source of high quality programmes, and offers hints and tips to those planning new systems. Installation and adjustments are explained in a practical form, and emphasis is placed on good modern practice in equipment maintenance and record and cassette care. A glossary of Hi-Fi terms and an index conclude this latest offering from BIB. Priced at £1.98, it can be obtained from Hi-Fi dealers, bookshops, and audio components specialists.

Bib Hi-Fi Accessories Ltd, Kelsey House, Wood Lane End, Hemel Hempstead, Herts.

The author of the Gas/Smoke Sensor Alarm—April '77, acknowledges the help of WKF Electronics Ltd., Welbeck St., Whitwell, Worksop, Notts., in the construction of the Alarm. WKF can supply all components for this project.

VACANCY ON PW

Applications are invited for the post of TECHNICAL EDITOR on P.W. which will become vacant shortly.

Apply, with brief details of career, to Eric Dowdeswell, Assistant Editor.
HiFi '77

ALREADY 74 exhibitors have booked space for the fourth annual HIGH FIDELITY exhibition, which is to be held at the Heathrow Hotel, London Airport, from the 19th April to the 24th April, 1977.

Special events taking place during the exhibition will include a series of lectures and demonstrations in the Hotel's York Video Theatre, while facilities are being claimed to be 'second to none'. These will include air-conditioned and soundproofed exhibition rooms; free car parking; free exhibition catalogue and video transport between the Heathrow Hotel and London Airport terminals and Hatton Cross Underground Station.

Opening times for High Fidelity '77 will be as follows:
Trade and Press only—19th to 21st April inclusive, 10am to 8pm.
Public—22nd to 24th April inclusive, 11am to 9pm (with the exception of the 24th which closes 6pm.)

Admission for everyone is free. Further information from Emberworth Ltd., London House, Oxford Road, Stokenchurch, Bucks. Tel: 024026 2674/5.

Roll up, roll up...

NEW members are required for the Chester and District Amateur Radio Society, whose newly formed committee is formulating a new programme for the coming months. Meetings are held at the YMCA Chester on the 2nd, 3rd and 4th Tuesdays of each month at 8pm.

Any readers interested in joining the club should contact G. W. Chaliner G8DMR, 34 Chestnut Avenue, Summerhill, Wrexham, Clwyd.

Rally call

THE North Midlands Mobile Rally will take place on Sunday 17th April at Drayton Manor Park, near Tamworth, Staffordshire. This event is organised by the Midland and Stoke-on-Trent Amateur Radio Societies, and will include the usual exhibitions.

Further information, stickers, badges etc., from Barrie Willetts G8DEM, Alf Walton G3ZKQ or Max Gutteridge G8BHE at 68 Max Road, Quinton, Birmingham.

Aerial guides

FOR many years now the general public and electronic enthusiasts have realised the importance of a good aerial system, to utilise the full potential of modern tuners and radio receiving gear.

In the forefront of modern aerial development is Antifference, who have recently published a Wall Chart and FM Stereo guide. The Wall Chart measures 23\(\frac{3}{4}\)in x 16\(\frac{1}{4}\)in and is printed in bright yellow, red and black and gives a complete up-to-date guide to all UHF TV transmitters, together with all the main Antifference TV aerial products.

The FM Stereo Guide comprises a three colour pocket folder illustrating the complete range of "Mushkiller" VHF/FM aerials with individual polar diagrams and comparative gain graph. The FM Station guide gives a complete "run down" on BBC and IBA transmitters showing clearly the polarisation, ERP in kW and frequency of transmissions. A map of the UK is also incorporated to show the relative positions of the transmitters, together with detailed photographs of aerial accessories.

Further information from Antifference Ltd., Aylesbury, Bucks. Tel: 0296 82511.
The author required a two-way intercom for his workshop, which would also permit listening for the telephone, doorbell, burglars, etc, when no-one else was at home. Suitable amplifier designs which have been published all seem to have a high input impedance. Since it was intended to use the loudspeakers as microphones, this would have necessitated a transformer to match the loudspeakers to the amplifier input. The circuit described here eliminates this need.

**The Circuit**

The amplifier circuit is shown in Fig. 1. Tr2-5 form a conventional push-pull amplifier, with the quiescent current in the output transistors being set by D1 and D2. The input stage Tr1 however, is connected in the common base configuration, which gives the required low input impedance, with high voltage gain. Negative feedback is applied from the output to the base of Tr1.

The DC voltage at the emitters of Tr4 and 5 is set by R3, although for optimum performance this voltage should be half supply voltage, which could be obtained by substituting a 10kΩ preset and 12kΩ resistor in series for R3. This is not strictly necessary here, since HiFi is not really needed. The AC gain is set by the ratio of R5 and R4, and if a volume control is required, the circuit of Fig. 2 can be used, which simply varies the amount of AC feedback applied.

Capacitor C3 has been chosen to roll off amplifier response at low frequencies to reduce pickup of mains frequency. C2 rolls off response at high frequencies to eliminate RF pickup, which can be a problem when long lines are used. (Radio 2 on 1500m is the main offender.)

**Operation**

To communicate, S2 should be in the “ON” position, Fig. 3, while the direction of communication is
Components List

<table>
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<th>Resistor Values</th>
<th>Capacitor Values</th>
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<td><strong>Resistors</strong></td>
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<tr>
<td>C2 470µF 15V</td>
<td>R2 3.3kΩ</td>
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<tr>
<td></td>
<td>C5 1000µF 15V</td>
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Power Supply

The circuit can be operated off a 9V battery, but for prolonged or frequent use a mains supply is recommended. Any supply of 9-12V DC at 200mA minimum will suffice. The prototype used a small 8V bell transformer T1, with rectification and smoothing as shown in Fig. 5. Note that if a mains supply is used any exposed metalwork should be earthed, and the live line fused at a maximum of 2A, either in the plug or in the unit itself.

Construction and Installation

No problems should be experienced with construction, as all components are housed on a single PCB as shown in Fig. 6. The cases were standard aluminium boxes, 101×132×38mm for the slave, and 177×127×63 for the master.

*General interior photograph of the master unit. As this is the prototype, construction was on Veroboard and not a PCB as described in the text.*
Switch S1 should be biased, and may be difficult to obtain, although such switches are often available on the surplus market. Alternatively, it is possible to "doctor" a bank of push buttons to provide S1 and S2, as in the prototype (note that one of the banks does nothing, so three would suffice).

Once made, the units should be mounted on a convenient wall, and joined with two-core cable (screened cable could be used, but is unnecessary). Take care to get the polarity right, otherwise C3 might suffer. It is advisable to route the cable away from mains as far as possible, to prevent undue pickup, since the hum level in the amplifier itself is very low.

Practical Wireless, May 1977
To: READERS PCB SERVICES LTD, PO BOX 11, WORKSOP, NOTTS

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A LARGE number of integrated circuit voltage regulator devices are now available which enable very stable, high performance power supplies to be constructed very easily with the simplest possible circuitry. Such regulators are extremely valuable when one requires a very stable output voltage as the load current or as the input supply voltage varies. They are equally useful when the hum level from a mains power supply unit must be kept to a very low level. For example, a few mV of hum on the tuning voltage feeding a varicap front end will produce hum at the FM detector output, but a small monolithic regulator in the varicap supply can be used to prevent this.

This article has been written to guide readers on the general principles of operation of regulator devices and to provide information on the types readily available for the home constructor and the basic circuits in which they can be used.

DEVICES CLASSIFICATION

Monolithic regulator devices can be divided into two main classes, namely fixed and variable output types. The former is basically designed to give a certain specified output voltage, although it is possible to increase this voltage somewhat whilst keeping a very simple circuit, whilst the latter gives an output voltage which can be varied by means of a potentiometer in the external circuit. Regulators can also be classified according to whether they are designed to provide a positive or a negative output voltage. However, these types are to some extent interchangeable.

Classification can be according to the maximum rated output current. The maximum current from the low current devices is about 100 to 200mA; such devices are normally mounted in a transistor type package and seldom require a heat sink. Medium current devices provide maximum outputs of 200mA to 1.5A and will usually be used with a heat sink, whilst devices delivering still higher currents are always used with a substantial heat sink.

Low current regulators can be used in more complex circuits with external power transistors to provide quite high output currents. This approach is often more economical than the use of high current monolithic or hybrid devices which are normally far more expensive than the low or medium current devices.

PACKAGES

The low current regulators are normally supplied in transistor or dual-in-line packages. Many medium current devices are in plastic packages with a tab or metal insert for mounting the device on a heat sink, whilst high current devices are often encapsulated in the diamond shaped TO-3 metal package used for power transistors. The recent trend is for the use of low current "on card" devices, the regulator being on the same PCB as the devices to which it supplies power and this greatly reduces unwanted coupling due to the line impedance.

The general principles of operation of a voltage regulator are shown in Fig. 1 which uses a 741 op-amp as a comparator. The zener diode D1 provides a reference voltage V\text{ref} and the 741 compares this with the voltage tapped off by VR1. If the value of V\text{ref} is the greater of the two, the 741 output will be high and Tr1 will conduct so that the output voltage, V_o, rises towards the input voltage, V_i. As soon as V_o rises to a value which brings the potential of the slider of VR1 to V\text{ref} the output of the 741 falls and Tr1 presents a higher impedance. Thus the output voltage is stabilised at a value higher than that of V\text{ref} the value being determined by the setting of VR1.

![Fig. 1: A voltage regulator using a 741 operational amplifier.](image)

The 741 input requires little current and therefore does not affect the stability of the \text{Vref} voltage. Most voltage regulators operate on this principle, with all the components fabricated on a single chip and usually including protective circuits. The maximum output current is determined partly by the ratings of the series transistor Tr1.

![Fig. 2: Regulator currents and voltages. I_o is the quiescent current which flows even when the output current is zero.](image)
POWER DISSIPATION

The power dissipated internally in a regulator may be estimated using the circuit of Fig. 2. A quiescent current $I_q$ flows through the device at all times to enable it to operate correctly, usually of the order of 10mA. If no output current is taken, the internal power dissipation is $V_i I_q$ and is quite small owing to the low value of $I_q$. When an output current is taken there is an additional internal dissipation of $(V_i - V_o) I_o$ since $(V_i - V_o)$ is the potential difference through which $I_o$ flows as it flows through the device. Thus the total dissipation is $(V_i - V_o) I_o + V_i I_q$.

INPUT VOLTAGE

What input voltage should one apply to a regulator? The maximum value is quoted on the data sheet and damage may occur if it is exceeded even for a millisecond! The minimum input voltage should always be a few volts above the output voltage, since this additional small voltage is required to enable the device to operate correctly. The minimum value of $(V_i - V_o)$ is known as the "drop out" voltage, since at lower voltages the regulator "drops out" and ceases to provide regulation.

![Diagram](image)

Lambda Electronics supply the LAS7000 series of regulators. That shown here has a rating of 400W.

As the internal power dissipation is $(V_i - V_o) I_o + V_i I_q$, it is very desirable to keep $V_i$ as low as possible in order to minimise the dissipation. This is especially important in the case of high current regulators where $I_o$, and therefore the internal dissipation, is large. In the case of variable regulator circuits which provide a wide range of output voltages, $V_i$ must exceed the maximum value of $V_o$ so the value of $(V_i - V_o)$ and the dissipation can be large when the output voltage is set to a low value. If the output current is moderately high, it is advisable to consider the use of a switching regulator circuit which can offer higher power efficiency at the expense of circuit complexity.

PROTECTION CIRCUITS

Most modern regulator devices incorporate circuits to protect them from damage if the output is shorted or if the device becomes too hot, the former by a circuit which limits the maximum value of the output current to a safe value. Thermal protection can take two possible forms. In one type an increase of the chip temperature will cause the output current to be reduced so that the temperature cannot increase further and cause damage to the device. Nevertheless, it is bad practice to operate a regulator for a considerable time at such a high temperature that this current limiting circuit operates; such high temperatures tend to reduce device reliability.

Another form of protective circuit used in low to medium current devices is that of foldback current limiting. If a low resistance is connected across the output or if the output is shorted, the current "folds back" to a much smaller value than the maximum output. Thus the internal power dissipation is kept relatively small.

BASIC CIRCUIT

The basic circuit used with simple three terminal voltage regulator devices is shown in Fig. 3. The input voltage is developed across the reservoir capacitor $C_1$ and the regulator provides a constant output voltage. In addition, the hum level at the output is far less than that across $C_1$.

If a slightly increased output voltage is required, a resistor may be included between the 'earth' terminal and the zero voltage line. For example, if this resistor has a value of 270Ω and the quiescent current is 10mA, the output voltage will be raised by the voltage across this resistor, namely 2.7V. Alternatively a zener diode may be used instead of a resistor.

LOW CURRENT DEVICES

One of the best known series of fixed output low current regulators is the TBA625A (5V), the TBA435 (8.5V), the TBA625B (12V) and the TBA625C (15V) series produced by SGS-ATES Ltd. (available from Chromasonic Electronics). They can be used in the very simple circuit of Fig. 3 to provide output currents of up to about 120mA. The devices incorporate foldback current limiting; if the output is shorted, the current falls to between 30 and 45mA. In addition, the short circuit current falls with increasing chip temperature, to provide further protection.

These regulators reduce the hum level across $C_1$ by a factor of about 400 times (52dB). The larger the value of $C_1$ the smaller the hum voltage across it and the lower the output hum level. If $C_1$ is about 250µF the output hum level will be of the order of 1mV. $C_2$ may be required with some devices to prevent instability and should be close to the device. The dropout voltage is about 2.5V at the maximum current, whilst the output impedance is of the order of 0.1Ω.

This series of regulator devices is available in the
type of transistor package shown in Fig. 4(a). The devices may be used in the type of circuit shown in Fig. 5 to provide a small range of output voltage variation. In this circuit the output voltage is equal to \( V(1 + R2/R1) + I_A R_2 \) where \( V \) is the voltage of the regulator itself. The circuit of Fig. 3 can also be used to provide a negative supply if the positive line is earthed instead of the negative line.

**THERMAL LIMITING**

Another type of 100mA regulator is made by Fairchild as the \( \mu \)A78L00 series, by Motorola as the MC78L00C series and by National Semiconductor as the LM78LXX series, but the latter has been replaced by the improved LM340L-XX devices. When referring to a specific device in the series, the '00' or 'XX' is replaced by the voltage of that device. For example, the \( \mu \)A78L05, the MC78L05C and the LM340L05 are 5V devices, whilst the LM340L-24 is a 24V device.

These devices are available in TO-5 metal cans, but the connections, Fig. 4(b) are different from those of the TBA625 series; they are also available in TO-92 plastic packages. Some types are stocked by Chromasonic Electronics Ltd., whilst National Semiconductor devices are available from DTV Group Ltd., 126 Hamilton Rd., London S.E.27.

These devices can be used in the same circuits as those already discussed. The output current on short circuit does not fold back, but is limited in value and a thermal limiting circuit operates at high chip temperatures. The performance is similar to that of the TBA625 series, but the dropout voltage (1.7V) is rather less.

Voltage regulators of almost any type can be used as a current regulator, in the circuit of Fig. 6. The output current is held constant at a value of \( V/R1 + I_A \) where \( V \) is the output voltage of the device concerned.

**MEDIUM CURRENT DEVICES**

The National Semiconductor LM342-XX series has similar internal circuitry to the LM340L-XX series, but can supply in excess of 200mA. The SGS-ATES TDA1405 (5V), TDA1412 (12V) and TDA1415 (15V) are available from Doram Electronics Ltd, and have a similar internal circuit to the TBA625 series, but can deliver output currents of up to 500mA. They are encapsulated in a 3-lead plastic package with a hole for bolting the metal insert to a heat sink. The foldback limiting causes the current to fall to between 80 and 180mA on short circuiting the output. However, thermal damage can be caused if the device is not mounted on a heat sink. The L129 (5V), L130 (12V) and L131 (15V) are similar to the TDA1405 devices, but have a wider operating temperature range. All these devices can be used in the type of circuit already discussed.

![Fig. 7: A circuit for increasing the output current from a LM340T-15 device by a factor of five.](image)

Another series of medium current devices has been adopted by many manufacturers, thermal limiting being employed rather than foldback limiting. The internal circuitry is similar to that of the LM342-XX series but the output current can be up to 500mA in some types and up to 1A in others. These standard types are available with nominal outputs of 5V, 6V, 8V, 12V, 15V, 18V and 24V. For example, the 1A range includes the LM340T-XX in a TO-220 plastic package, the LM340K-XX in a TO-3 package, the Motorola MC7800 series, the Fairchild \( \mu \)A7800 devices and the Texas Instruments SN72900 series. The 500mA devices include the National Semiconductor LM341P-XX plastic types with a tab for bolting to a heat sink and the Fairchild \( \mu \)A78M00C. Other devices available from Doram Electronics Ltd include the LM309K 5V regulator in a TO-3 package which can give over 1A and the LM323K in the same package for 5V at up to 3A.

**HIGHER CURRENTS**

All these devices can be used in the circuits discussed, but the type of circuit shown in Fig. 7 can be used to obtain more output current. In the particular circuit shown, a LM340T-15 device is used, the maximum current being 5A instead of the 1A of the device itself.

If the voltage across D1 is equal to the base-emitter voltage of Tr1, the current flowing through R1 is about four times that through R2. This current boosting circuit takes advantage of the internal current...
limiting properties of the regulator to provide short-circuit protection of the booster section. The short circuit is limited to R2/R1 times the output limiting current of the regulator device itself. If the heat sink fitted to Tr1 has at least four times the capacity of the sink fitted to the LM340T-15 device, the thermal overload protection of the latter will be extended to Tr1. As the load current increases from 0 to 5A, there is a change of about 1% in the output voltage.

HIGH OUTPUT VOLTAGE

The circuit of Fig. 8 shows how the LM340T-24 can be used to provide an output of 48V. Under short-circuit conditions the voltage at the input side of the regulator falls to 35V, D3 aids the start-up of the circuit and protects the regulator from high input-to-output voltage differentials during short circuits.

DUAL TRACKING REGULATORS

Work with operational amplifiers normally requires dual power supplies of about ±15V and the supplies should be regulated to prevent the output voltage of the operational amplifiers from drifting. Further, it is desirable for accurate work that the drift in the voltage of one of the pair of lines should be matched by a proportional drift in the voltage of the other line; that is, the two voltages must track one another.

One of the simplest ways of constructing a dual tracking power supply unit with ±15V outputs involves the use of the Raytheon RC4195 device in the circuit of Fig. 9. This device is available from Doram Electronics Ltd (order code 303-636) as an 8-pin dual-in-line package which can deliver over 100mA from each output with short circuit currents of about 220mA. The input voltages should be in the range ±18V up to the maximum of ±30V. The frequency compensating capacitors C3 and C4 increase stability, but can often be omitted.

The RC4195 device incorporates thermal shut down and short circuit protection for both outputs. It replaces two separate regulator devices. The balance connection to pin 6 can be taken to a variable voltage so that the two output voltages can be accurately balanced. The RC4195 can also be used to provide a single regulated output of +50V at 100mA, whilst in another circuit with external power transistors it will provide a dual tracking supply of ±15V at 2.5A each.

Next month, in Part 2, we shall deal with Fixed Regulators.
Radio . . . what?

Next time you are in the company of people who delight in using long words, get your own back; say radioimmunoassay! If they call your bluff and ask what it means, the following explanation might help.

The word radioimmunoassay (RIA for short) comes from the medical profession, well known for its love of technical tongue twisters. RIA is a technique used to measure very very tiny amounts of things in the blood such as hormones etc. The medical minions often do this by putting in some minute but radio active tracer elements and following their path around the body. These tracers are often measured while still in the body.

A rather bright medical instrument manufacturer has now gone one better. The antigens (these are the minute traces you want to measure) are bound to microscopic flecks of iron. It is then, in crude lay terms, simply a matter of going fishing with a magnet! The fluid is passed by a magnet and the iron particles are separated leaving only the elements in the sample which are required for measurement. In practical terms this means that the manual separation part of RIA can be fully automated.

Micro speaker

Beepers for use as alarms have been marketed for some time and are available in this country from various electronics stockists. However, although their idea is not new I am very taken with the very latest one just launched in America.

The beeper measures only 0.64in cube and weighs just 6 grams. Despite its very small size, the device has a free field output of 105dB at 1in. The secret of this great output compared to size is in the cunning construction of the inside of the cube which houses the device. This internal structure is fashioned like a miniature folded horn which is tuned to 2.1kHz. An advantage of a tuned horn as opposed to a resonant cavity is that the horn tunes very broadly and so is not critical. Yet another advantage is that the beeper, because of its broader bandwidth, can be used as a truly miniature loudspeaker. It is offered in a variety of impedances from 2Ω to 2kΩ and it even has little solder tabs for ease of mounting onto a PCB. One can imagine a very small radio set for, say, the bedroom using a ZN414, LM380 and one of these tiny speakers. Alas—they’ve only just been released onto the market in America and are not obtainable in this country as yet.

Expensive games

With television games gaining greater popularity one would think that this was a real growth area for electronics and without too many problems. Sad to tell this is not the case. I hear of a report which indicates that the grid or pattern projected onto the CRT of a television (i.e. the goals for football or the walls for squash etc) is “burning” a permanent image onto the TV tube and, as such, will eventually ruin it for normal TV watching. The time taken for this effect to become noticeable is, so I’m told, about 2,000 hours of use. However, with different games, different intensity settings and, indeed, different tubes, this time is by no means a standard to judge the situation by.

Now, a group has been set up to study this effect and to report its findings to the authorities. I will mention this again as and when more news comes in. However, the thought of ruining a colour television tube is a little frightening when one thinks of the cost. Perhaps, if you play TV games, it might be prudent to keep the brightness turned down just a little?

Straight tape

If you drill a hole how do you know if it’s straight? Probably this is unimportant for your ordinary average hole, but if your drilling real big deep ones, like oil people do, then it becomes very important. A British company has manufactured what is called an inertial navigation unit (more long words). In use, this unit is lowered down the hole. On its journey it keeps careful records; it has a cassette recorder to monitor and log the distance it has travelled and deviation in terms of lateral movements. When the unit is hoisted up the tape is played to an analyser unit which in turn feeds out printed data on the accuracy of the hole at different depths.

Before you decide to use one for the precision drilling of this years potato crop, the price for one such installation is quoted as around £91,000—and that’s a ‘hole’ lot of money.

Hot news

If you wanted to take the temperature of something it’s almost certain that you’d use some kind of thermometer. I see that the market has just been invaded by another non-contact thermometer and it struck me that some readers may not have heard of these intriguing devices.

This latest one is a small hand-held unit which is simply pointed at the target. It will then, within one second, show the true temperature of that target in degrees C. The target can be up to 20 feet away and this particular “thermometer” has a measurement range from 10°C right up to 1,000°C. It occurs to me that if I was only 20 feet from 1,000°C I would become medium rare in about 20 seconds!

More expensive?

When hire transport in London changed from handsome cab to motor taxi there must have been some regretful sighs. I wonder if there will be any sighs for taxi meters. A problem is that a cab may be laid up for a matter of days while its electromechanical meter is adjusted. Owners of a few of the larger fleets of cabs have got together and formed a company to manufacturer an electronic taxi meter. Readout of the fare cost is, of course, digital while changing the meter is just a matter of unplugging one and plugging in another.

Watch out for the new best seller folks, “Electronic Taxi Meters—Are They Really Fare?”
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P. W. MARCH '77

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improved etching of PCB's

ANY chemicals and combinations of chemicals are suitable for etching copper but by far the most common, due to its cheapness and ease of use, is ferric chloride, either by itself or mixed with various additives. In solution ferric chloride reacts with the water to form a small amount of the insoluble salt ferric hydroxide, together with hydrochloric acid (HCl). This reaction is easily prevented by adding up to 5% HCl. In either case HCl is present and available for reaction with both ferrous chloride and cuprous chloride, converting them back to ferric chloride and cupric chloride respectively if free oxygen is present.

\[
\text{FeCl}_3 + 3\text{H}_2\text{O} \rightarrow \text{Fe(OH)}_3 + 3\text{HCl} \quad \text{Hydrolysis.}
\]

\[
\text{FeCl}_3 + \text{Cu} \rightarrow \text{FeCl}_2 + \text{CuCl} \quad \text{At copper surface.}
\]

\[
\text{FeCl}_3 + \text{CuCl} \rightarrow \text{FeCl}_2 + \text{CuCl}_2 \quad \text{In body of solution.}
\]

\[
\text{CuCl}_2 + \text{Cu} \rightarrow 2\text{CuCl} \quad \text{At high copper levels.}
\]

If oxygen is present:

\[
4\text{FeCl}_2 + \text{O}_2 + 4\text{HCl} \rightarrow 4\text{FeCl}_3 + 2\text{H}_2\text{O}
\]

\[
2\text{CuCl} + \text{O}_2 + 2\text{HCl} \rightarrow 2\text{CuCl}_2 + 2\text{H}_2\text{O}
\]

From the above it can be seen that it is advantageous to have an oxygenated solution. The two commonest methods of oxygenating a solution (spraying it through air or bubbling air through it) also provide mechanical agitation at the copper surface thus removing the ferrous and cuprous chlorides as they are formed and supplying fresh etchant to the surface.

Spray etching produces better results than bubble etching but the problems involved in producing a uniform spray pattern and obtaining pumps manufactured in materials that are inert to the etchant tend to cancel any advantages to the amateur. In comparison, bubble etching is very simple to implement.

Photograph A shows the plastic tube suitably bent and fixed to a heavier plastic base. In B the tube has been fitted to the air pump. Photograph C shows the complete set-up with the tube in the bottom of a plastic bowl. Finally in D the solution is seen bubbling with the PCB floating on the surface with the aid of a cork in each corner.
THE SGS-ATES TBA820 device is not designed to give a very high output power but is very suitable for use in portable equipment where the battery voltage may be as low as 3V. The typical quiescent current consumption is only 4mA at 9V, so one can obtain a long battery life at low output power.

The TBA820 is very suitable for use in small portable radio receivers, small record players and tape recorders, etc. It enables much simpler audio power amplifiers to be constructed compared to those where only discrete components are used.

The TBA820 is encapsulated in a quad-in-line package with the connections shown in Fig. 1. In this type of device alternate pins on each side of the plastic body are bent so that they protrude to different distances at their lower ends. This configuration provides more space between adjacent pins for ease of soldering than in dual-in-line devices, but quad-in-line sockets are more difficult to obtain.

![Circuit Diagram](image)

**CIRCUITS**

A typical circuit for the TBA820 is shown in Fig. 2. If the input signal has any DC superimposed on it, a capacitor of value about 0·22µF must be placed in series with the input connection. R1 may be replaced with a 100kΩ volume control, if desired, but a resistor of value not exceeding a few hundred kΩ must be present from pin 7 to earth to achieve correct biasing.

The capacitor C6 prevents a steady current flowing from the output (pin 12) through the loudspeaker speech coil. A somewhat smaller value can be used, but this will result in a reduction in the bass response. The power supply decoupling capacitor, C4, should be soldered fairly close to pin 14 to prevent spurious RF oscillation. C7 is an electrolytic capacitor in parallel with C4 which provides decoupling at lower frequencies.

The gain of the circuit is determined by the value of R2. An internal feedback resistor of value 6kΩ is connected from pin 12 to pin 5, so the smaller the value of R2, the greater the gain. The gain is approximately equal to 6000/R2; thus voltage gains of 30, 60 and 120 may be obtained by using values of R2 of 200Ω, 100Ω and 50Ω respectively. The maximum value of R2 is about 390Ω if a 9V supply is employed or 270Ω with a 12V supply, since saturation of the input circuit may occur with higher values.

The value of C5 determines the high frequency response of the circuit, but the value required for any specified frequency response is affected by the value of R2. The value of C5 required for various upper cut-off frequencies is plotted against R2 in Fig. 3.

The optional capacitor C3 provides a reduction of about 42dB of any hum on the power supply line. It is not required if a well stabilised supply is employed. However, if a battery is used as a source of power, this capacitor should always be included, since it will prevent 'motor boating' when the internal resistance of the battery rises with age.

The maximum output power which can be obtained from TBA820 depends on the impedance of the loudspeaker and on the power supply voltage. For example, one can obtain 2W with an 8Ω speaker.
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Forgive the terrible puns. If you don’t quite twig ’em just have a word with your opera-going friends and they will reveal all! Frankly, we’ve used the characters above simply to catch your attention and to lead you on to the more interesting point that Home Radio Components Ltd. are the people to deal with when you need component for the projects in this magazine, or for any other electronic gadget you may be creating. Thousands of constructors have proved that they get good advice, good components, good value, good service from Home Radio. Many buy over the counter at Mitcham, many purchase by Mail Order sending a cheque or P.O. each time they need something, and a growing number of customers are proving the advantages of joining the Home Radio Credit Account Scheme. Whichever method you opt for you’ll need a Home Radio catalogue. Read all about it in the paragraph below.
and a 12V supply. The absolute maximum power supply voltage is 16V which will enable 2W to be obtained from a 16Ω speaker. However, it is wise to regard 14V as the maximum to allow a reasonable margin of safety. If a 4Ω speaker is employed, the power supply voltage should not exceed 9V to prevent overloading of the device. An output of up to 1.6W can then be obtained. If the circuit is operated from a 9V supply when using an 8Ω speaker, the maximum output is about 1.2W, Fig. 4.

If the supply voltage is only 3.5V, the maximum output power is about 0.2W. Although this may seem very small, the ear has a logarithmic response and this power level is quite adequate for a portable receiver; indeed, many small speakers cannot handle more. The writer found that the circuit shown will operate satisfactorily with power supply voltages down to 5V but at still lower voltages the distortion increases rapidly and the gain falls. At low supply voltages a relatively low impedance loudspeaker of 4Ω may be chosen so as to provide a reasonable output power.

Cross-over distortion is not present in the TBA820. As the power output increases, the distortion remains almost constant at a low value of about 0.2 per cent until clipping of the waveform begins. The distortion then rises very rapidly with increasing output power.

The TBA820 can dissipate up to 1.25W. In practice this means that no heat sink is required when the device is used with power supplies of up to 16V with a 16Ω loudspeaker, up to 12V with an 8Ω loudspeaker or up to 9V with a 4Ω loudspeaker.

RADIO RECEIVERS

The writer has used a TBA651 AM radio circuit (see Practical Wireless July 1974) which fed a signal into a TBA820 power amplifier. This circuit used an 11V supply but a different integrated circuit must be employed in the radio section in receivers using a low power supply voltage.

A simple low voltage radio is shown in Fig. 5; only medium wave coverage is provided by the circuit shown, but a long wave coil could be switched into
the circuit if desired. About 220 turns of 40 SWG insulated wire is suitable for a long wave coil. The two silicon diodes D1 and D2 keep the supply voltage to the ZN414 fairly constant as the power supply voltage falls with an ageing battery. Low voltage capacitors are used in the circuit of Fig. 6, since they are smaller and cheaper than higher voltage types. However, the power supply voltage must not exceed 6V when these capacitors are used.

**Fig. 6: A circuit in which one side of the speaker can be earthed.**

**IN USE**

The TBA820 may be soldered in position on a piece of matrix board with 0.1in hole spacing. However, a neater amplifier can be made by using a printed circuit board. It should be noted that the input earth connection should be separate from the output earth connection, to minimise unwanted coupling.

If the constructor wishes to employ a circuit in which the loudspeaker is earthed on one side, the circuit shown in Fig. 6 may be used. This does require an additional electrolytic capacitor C8 to provide the bootstrap signal to pin 1. The component values not marked should be selected in the same way as the corresponding components of Fig. 2. If a hum rejection or "anti-motorboating" capacitor is employed in this circuit, it should be connected between pin 2 and earth and not as in Fig. 2.

**IMPROVED ETCHING OF PCB's—contd from page 33**

![Diagram showing improved etching of PCB's](image)

Illustration of the plastic tube showing how the holes in the tube are drilled.

Comment, as it increases the useful life of the etchant and can reduce etching time to less than five minutes thus minimising any tendency for the resist to deteriorate. All that is required in addition to the etching tank is a high capacity air pump as used for aquariums and a length of 1/2in dia. PVC tubing. The pump should be capable of maintaining a pressure of 2lb/sq.in.

**CONSTRUCTION**

The tube is mounted close to the bottom of the tank as shown in the diagram with 0.5mm holes spaced about 1cm apart on the underside of the tube offset alternately by about 45°. The end of the tube in the tank is sealed with a rubber bung and the other end attached to the pump, the pump being mounted above the level of the etchant.

The etch rate is greatest near the surface of the etchant therefore the best results are obtained by floating the board copper side down on the surface of the etchant. This is most easily achieved by cutting the board slightly oversized and inserting the corners into small corks. Double sided boards should be etched vertically. If it is desired to increase the etch rate still further an aquarium heater set to about 30°C can be used to heat the etchant.

A suitable etching solution would be:

- Ferric Chloride (FeCl₃) 500 gm.
- 35% Hydrochloric Acid (HCl) 50ml.
- Water (H₂O) 1 litre.

**NOTES**

Up to 1ml of photographic wetting agent may be added but this may cause foaming which could prove troublesome. When in use adequate ventilation must be provided and the solution should not be left in an open tank any longer than necessary as it will promote oxidation of any metal in the room.

The most suitable method of disposing of the ferric chloride is to neutralise it with calcium carbonate (limestone) and then bury it. (N.B. Hard water should not be used for making the solution.)

The success or failure of PCB production depends to a great extent on the cleanliness of the copper being maintained at all times. An economical medium for mechanically cleaning the board is a 'Scotchbrite' pan scouring pad followed by a wipe with a tissue wetted with acetone in order to remove any grease present. Acetone is also suitable for removing 'Dalo' type resists.

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**KINDLY NOTE!**

*TUG 'O WAR — APRIL 77*

Main PCB, page 1052. Track from pins 13/14 IC5 should join adjacent track going to +9V. PCBs from Readers PCB Service are correct.

---

*Practical Wireless, May 1977*
Many of the previous circuits in this series have found major applications in novelty. The project described here has a more serious role.

Basically it is a device for indicating the value of “unknown” resistors. To this end it employs rather novel principles—and no expensive meter. In use, the resistor whose value is unknown (or in doubt) is plugged into S-DeC holes 55 and 60. The potentiometer, VR1, is rotated until the bulb lights. The pot is then rotated slowly in the opposite direction until the lamp goes out, and the value of resistance is then read or interpolated from the calibrated dial.

Circuit ideas
The most immediate thought in designing such a circuit would be to use a simple bridge of some sort, you will need . . . .

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<td>330Ω</td>
</tr>
<tr>
<td>R2</td>
<td>4.7kΩ</td>
</tr>
<tr>
<td>R3</td>
<td>4.7kΩ</td>
</tr>
<tr>
<td>R4</td>
<td>12kΩ</td>
</tr>
<tr>
<td>R5</td>
<td>5.6kΩ</td>
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<tr>
<td>R6</td>
<td>4.7kΩ</td>
</tr>
<tr>
<td>VR1</td>
<td>10kΩ</td>
</tr>
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Tr1 BC109
Tr2 BC109
Tr3 AC128
B1 12V battery
One S-DeC
One Blob Board ZB-5D

Full circuit diagram of the 'Ohm Gnome' resistance checker. If power is applied continuously, it's a good idea to keep some sort of resistance in the Rx position to prevent Tr3 from getting overheated.
and indeed circuitry exists which advocates this. However, despite the most careful tests this idea was rejected. To turn the potentiometer until the lamp was extinguished was almost impossible without using a magnifying glass to be really sure that the bulb was out or at least at "minimum red glow".

In the circuit diagram, transistor Tr3 drives LP1 upon receipt of a suitable signal from Tr2 and so the Tr3 part of the circuit is quite straightforward. Let's look at the role played by Tr1 and Tr2. These transistors are connected as a Schmitt trigger circuit. This useful arrangement can be used for our purpose because it triggers at a reasonably precise level/value of input signal.

**Potential divider**

In the circuit we are varying the input by rotating the potentiometer. The latter, together with R1 and the unknown value of resistor under measurement forms a potential divider. The setting of VR1 at which the circuit triggers will vary depending upon the value of the unknown resistor. Thus by calibrating the potentiometer dial using known values, the unknown ones can be read directly or interpolated.

The circuit will work well by simply "tuning" for the bulb to switch on, but it seemed easier on test to set the pot more precisely by "tuning" for bulb-off. The only real difference in practical terms is that the dial readings are slightly displaced between the two sets of readings. Providing, when calibrating, the constructor settles for one method or the other and sticks to it (i.e. the bulb-on or-off giving indication) then either method is entirely satisfactory. Using a 10kΩ potentiometer for VR1 gave a measurement range from 33Ω to just over 33kΩ. The useful measurement range was found to extend from 1kΩ to 33kΩ because the lower end of the range (below 1kΩ) tended to be very cramped and difficult to read with any degree of accuracy. Substituting a 1MΩ potentiometer for VR1 gave a measurement range from about 33Ω to 2.2MΩ but the dial was rather cramped.

**Just plug-in**

Assembling the circuit on the S-DeC is extremely simple and easy. Just plug in the components via their own leads. Push the leads into the S-DeC hole number(s) given in the circuit and check again, against the full size S-DeC layout drawing. Using the little jumper leads with plugs on each end is helpful when links are required.

For those constructors who would like to make a permanent unit of the Ohm Gnome the following suggestions are offered. The simplest method of construction, once the circuit has been "proved" on the S-DeC, is to transfer the components directly onto a piece of BloB Board. Because all the components are soldered and fitted on one side of the board only, the BloB Board may be stuck (with any good adhesive) directly to the inside of a suitable case.

A push button should be inserted between the negative terminal of the battery and the negative line of the circuit (point X in the circuit). In operation, press the push button and hold it down. Rotate the pot until LP1 lights, then release the push button (if tuning for lamp-off, hold push button until you've "tuned" back to extinguish the light). In this way the battery life will be considerably extended since the circuit will only draw current when actually measuring.

**Dial construction**

With a reasonable size case, a useful size of dial can be employed, and it is suggested that the constructor consider making the dial with the aid of a protractor. Mark the dial around the potentiometer pointer accurately, in degrees. Then, using a piece of graph paper mark degrees along the X axis, and the known resistance values along the Y axis. Plug in, say, a 1kΩ resistor, 2.2kΩ, 4.7kΩ, 10kΩ, 12kΩ, 22kΩ, 27kΩ, 33kΩ. These will give you all the points you need to draw a graph. You will find most of these resistors from previous projects in this series.
It's the new TV

In next month's Practical Wireless

Tennis
Football
Squash
Pelota

Plus:
On-screen scoring & sound effects

CW filter unit
Versatile AF generator

On sale 6th May
TRUE Beat Frequency Oscillator detectors operate on the principle that the outputs of two separate oscillators are combined to produce an audio tone although the oscillators may be at non-audible frequencies.

The metal locator uses the search coil as the tuned circuit of one oscillator so the presence of metal objects modify the resonant circuit causing a change in the beat note. Fig. 1 shows the block diagram of a typical detector.

Although this type of detector is easy to construct it does have drawbacks, namely:

1. Metering facilities are ineffective and insensitive.
2. The two oscillators may drift in different directions and make operation tedious.
3. It is difficult to obtain high detection sensitivity combined with stable (drift free) operation.
4. In general the battery life is proportional to the output volume and, since the output is usually a sine wave, high outputs are required.
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Vaughan E. .................................. Vaughan E.
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The service offered enables any reader to purchase a glass-fibre, ready drilled and roller-tinned board, that has been fully tested and approved by PW staff.

Each month PW carries a price list of all boards that are currently available, together with reference numbers and date of publication of the project.

READERS PCB SERVICES LTD, PO BOX 11, WORKSOP, NOTTS

ELECTRONIC CLOCK

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CIRCUIT OPERATION

This new unit overcomes the first two of these problems by using a single search oscillator whose output is fed into a discriminator coil and the frequency changes are converted to voltage variations in a similar manner to an FM tuner. Fig. 2 is the block diagram of this unit and Fig. 3 is the full circuit diagram.

Since only one oscillator is employed it becomes that much more effective to apply AFC to the oscillator to cure drift and improve the long term tuning stability. To accomplish this effectively, the small voltage differential at the detector output is amplified in a Norton Amplifier (an LM3900) and fed to the oscillator, via a variable time constant (R17 and C15), and applied to D2. Provision is made to switch C15 in or out in order to give two sensitivity settings.

With C15 in circuit the high output at pin 10 of IC1, resulting from the presence of a metallic object entering the field of the search coil, takes an appreciable time to effect the oscillator and the detector is at maximum sensitivity to varying frequency fluctuations.

With C15 switched out the output of IC1a is fed direct to the oscillator and input variations produce virtually instantaneous AFC correction. In this mode the range is effectively halved.

The output of IC1a is sufficient to drive a sensitive meter. This meter provides an earlier warning of the presence of metal objects since the eye can detect smaller changes than the ear.

IC1a also drives the audio amplifier circuit, based on IC1c and d, when the unit is switched to BFO. The output is available either through a speaker or plug-in earphones. This audio is in the form of a square wave and produces a higher audibility than a sine wave consuming the same power thus prolonging battery life.

The main tuning of the unit is performed by the varicap diode D1 with resolution afforded by VR1, a 22 turn preset potentiometer. Because the oscillator utilises a very high L/C ratio it is important to use a heavy gauge wire for the search coil (the prototype used 22 SWG) to maintain the "Q". This also means that the large amount of capacity used to tune the circuit results in relatively small frequency variations, even with the abrupt type of varactor used.

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With the unit switched to "Pulse" it is possible to adjust VR4 such that IC1b is just below the threshold of conduction. Under this condition the output of IC1a is fed to one input of IC1b but, because of the setting on the other input, the audio amplifier is off. When a signal is present at the search coil it results in a change at pin 10 of IC1 and ICb switches to the on state. Its output is fed to the input of the audio stages and the treasure is advertised. This mode has the advantage that the detector can be used on the speaker output without annoying others present.

In conjunction with the pulse operation is switching for Ferrous or Non-Ferrous detection. The presence of ferrous (iron based) objects will lower the frequency of the tuned circuit whilst non-ferrous will increase it. In the Seekit type of detection this will result in deviations in opposite directions, see Fig. 4, and by switching from ferrous to non-ferrous, whilst in the pulse mode, it is possible to decide if the object is what we are looking for. Unfortunately, at the frequencies used, large pieces of ferrous material can cause the detector to react as if it had located something non-ferrous due to HF eddycurrents set up within the material. Although a sweep of the area will indicate whether the find is large or small it could still be a large non-ferrous item.

![Fig. 4. The changes in output voltage resulting from frequency changes. Use is made of the positive and negative changes to identify ferrous or non-ferrous materials.](image)

**THE SEARCH HEAD**

The capability of the unit is largely a function of the search coil. Small coils are best for detecting small objects fairly near the surface whilst large diameter coils will sweep a large area and detect objects at a greater depth. Thus the coil used will depend to a large extent on the type of hunt.

Whatever size of coil is used it is essential to exercise care in its construction, details of a satisfactory method are given later. The varying numbers of turns for various diameter coils are given as Table 1. These coils have been calculated to give an operating frequency of about 90kHz since this is within the approved range of the Home Office and has advantages over lower frequencies in the band.

- **Table 1. The approximate resonant frequencies for coils of varying diameter and number of turns.**

<table>
<thead>
<tr>
<th>Coil diameter</th>
<th>Number of turns</th>
<th>Inductance</th>
<th>Frequency with 0.1µF Capacitor</th>
</tr>
</thead>
<tbody>
<tr>
<td>7&quot; (175 mm)</td>
<td>25</td>
<td>243µH</td>
<td>102kHz</td>
</tr>
<tr>
<td>8&quot; (200 mm)</td>
<td>24</td>
<td>224µH</td>
<td>106kHz</td>
</tr>
<tr>
<td>9&quot; (225 mm)</td>
<td>23</td>
<td>235µH</td>
<td>104kHz</td>
</tr>
<tr>
<td>10&quot; (250 mm)</td>
<td>22</td>
<td>215µH</td>
<td>108kHz</td>
</tr>
<tr>
<td>10&quot; (250 mm)</td>
<td>22</td>
<td>242µH</td>
<td>102kHz</td>
</tr>
<tr>
<td>10&quot; (250 mm)</td>
<td>21</td>
<td>245µH</td>
<td>101kHz</td>
</tr>
<tr>
<td>10&quot; (250 mm)</td>
<td>20</td>
<td>222µH</td>
<td>107kHz</td>
</tr>
</tbody>
</table>

**components list**

- **Resistors**
  - R1 33kΩ
  - R2 68kΩ
  - R3 22kΩ
  - R6 680Ω
  - R5 1MΩ
  - R7 22kΩ
  - R8 22kΩ
  - R9 68kΩ
  - R10 68kΩ
  - R11 1MΩ
  - R12 1MΩ
  - R13 10kΩ
  - R14 100kΩ
  - R15 10MΩ
  - R16 100kΩ
  - R17 100kΩ
  - R18 1kΩ
  - R19 1MΩ
  - R20 1MΩ
  - R21 2.2MΩ
  - R22 1MΩ
  - R23 470kΩ
  - R24 33kΩ
  - R25 4.7MΩ
  - R26 390kΩ
  - R27 100kΩ
  - R28 100kΩ
  - R29 3300Ω
  - VR1 10kΩ preset type PT10V
  - VR2 10kΩ preset type PT10V
  - VR3 10kΩ preset type PT10V
  - VR4 10kΩ preset type PT10V

- **Semiconductors**
  - IC1 LM3900
  - Tr1 BF256 (FET)
  - Tr2 BC108 or similar
  - Tr3 BC108 or similar
  - Tr4 BC108 or similar
  - D1 MVAM2, MVAM115
  - D2 MVAM2, MVAM115
  - D3 1N914, 1N4148
  - D4 1N914, 1N4148
  - D5 1N914, 1N4148
  - D6 0A91, 0A90
  - D7 0A91, 0A90

- **Capacitors**
  - C1 0.01µF ceramic
  - C2 0.01µF ceramic
  - C3 0.02µF poly-carbonate/Mylar
  - C4 0.02µF poly-carbonate/Mylar
  - C5 0.02µF poly-carbonate/Mylar
  - C6 470pF ceramic/ polystyrene
  - C7 470pF ceramic/ polystyrene
  - C8 270pF ceramic/ polystyrene
  - C9 0.01µF ceramic/ polystyrene

- **Inductors**
  - L1 search coil, see text
  - L2 20 to 43 mH screened choke, Toko type 10RA/RB
  - L3 Detector assembly, high Q, Toko type ST3/D2

- **Miscellaneous**
  - Speaker, 35 to 80Ω. Crystal earpiece with plug and socket. 4 way change-over switch, push button, non-interlocking. Meter, edge reading, 400mA or better. Case, moulded or suitable box to hold components. Detector head, moulded or home made. Plastic tubing and joints if required. Coax plug and socket. Coax cable, approx 1 metre (3ft).
Fig. 5. The wiring pattern of the electronics board, shown full size to enable direct copying for the 'Do-It-Yourselfer'.

Fig. 6. The component positions and orientations. Note that provision is made for the stabiliser required if standard batteries are to be used over long periods.

Note: On Fig. 3, the polarity of D7 is incorrectly shown reversed.
If searching for a particular object recently lost (e.g. coins on the beach or a ring in the garden) a small coil is required but if combing an old battle field looking for swords etc., then the large coil is the answer, see Fig. 7. The 8 inch (200mm) coil on the prototypes was able to detect a 2 pence piece at between 8 and 10 inches in free air and, with a well shielded coil, in most other non-metallic materials.

CONSTRUCTION

Apart from the speaker, the phone socket, the meter, the batteries and the search coil all the components are mounted on a single printed circuit board. Fig. 5 shows the wiring pattern of the board whilst Fig. 6 shows the component location and orientation on the board.

The meter and an output socket are mounted on the case of the unit and, if the moulded case is used, the mounting positions are cast in during manufacture.

The batteries are fixed into standard holders and the holders themselves are bolted to the case.

The electronic items do not present any problems in their assembly since it is largely a matter of wiring-up a printed circuit board. The coil, on the other hand, does require very careful construction. The details of a suitable former etc., can be left to the individual constructor but the following points must be observed.

1. The wire should be 20 or 22 SWG.
2. The windings must be wound tight and held tight after winding.
3. A Faraday electrostatic shield should be fitted but remember that the shield must not be a complete short circuit around the coil.

The prototypes were constructed as follows and took care of the above conditions.

Firstly several strips of adhesive tape were fastened to a saucepan of about 7 inches diameter such that a portion of the sticky side faced outwards. Next, 25 turns of 20 SWG enamelled copper wire, with a quality lacquer coating rather than a polyurethane finish, were wound tightly around the former and on the tape. When the winding was completed the ends were held tightly whilst the tape was folded over the turns. The winding was slid off the former and the tapes bound tightly around the turns, covering as much of the winding as possible. Extra tape should be wound over the wire to cover it completely. The tape should be wound as tight as possible and if heat shrink tape is available it could be used with advantage.

This article will be completed next month.


**COMPLEMENTARY SYMMETRICAL OUTPUT**

Fig. 17 is a more convenient circuit, using a single battery. The speaker is coupled by C3. Each output transistor has its own emitter resistor, to help to stabilise working conditions. Overall stabilisation is obtained by R1 from the output emitter circuit back to Tr1 base. DC feedback of a similar type is found in many driver/output circuits of this kind. It is necessary to use the transistors shown (or near equivalents) or the value of R3, in particular, may need changing.

![Fig. 17 Circuit Diagram](image)

With circuits of this kind, best results are obtained with the correct speaker impedance. Somewhat higher impedances may be used with a loss of volume. Lower impedances should not be used, as this may damage the output stage transistors.

**SPEAKER IMPEDANCE**

The speaker impedance specified for a circuit should be used, depending as it does on operating conditions and power output expected. A lower impedance may cause peak currents to be exceeded or result in too high a dissipation in output devices. A higher impedance than specified usually causes reduced power output and possibly other troubles. Changes to output load can upset feedback circuits and the correct load is particularly necessary with high fidelity equipment.

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**THERMISTOR COMPENSATION**

It was seen that acceptable working conditions are easily maintained over a range of temperatures and voltages in the case of low power amplifiers where emitter stabilisation was possible. In other circumstances additional means of stabilisation are needed, and Fig.12 included a thermistor in a Class A stage.

Fig.18 is a 1W transformerless amplifier in which the VA1040 thermistor stabilises the operating current of the output pair Tr3 and Tr4. The resistance of the VA1040 falls as temperature rises, thus reducing the base/emitter bias voltage of the pair. This effect is the opposite of that arising in the transistors themselves.

Quiescent (no signal) current is set by VR1 to between 12 and 15mA. The emitter of Tr1 samples the DC voltage at the emitters of Tr3/Tr4, and by DC coupling through Tr2, maintains DC operating conditions. Tr3 and Tr4 require heat sinks about 4x4cm of 16SWG aluminium, or larger. DC operating conditions of all stages are related, so values should be as shown.

**QUIESCENT CURRENT**

The "silent" or quiescent current of an output stage is very easily adjusted with circuits such as Fig.19, as DC operating conditions are isolated from other stages. R1 and R2 set the base bias point and their relative values control the collector current of Tr1 and Tr2. Reducing the value of R1, or increasing the value of R2, moves the base bias negative and increases collector current (with PNP devices). Reducing R2 or increasing R1 has the opposite effect.

If the quiescent current is low, objectionable crossover distortion arises, especially with falling supply voltage or reduced temperature. If current is high,
dissipation in the transistors rises, so close-tolerance resistors are often necessary for R1 and R2. An alternative is to use a pre-set resistor, such as 100Ω for R2. The total collector current can then be set to 8 to 10mA, for the transistors shown.

INTEGRATED CIRCUITS

Numerous ICs suitable for audio applications are available and they can be used in a wide range of circuits. They may be obtained with gain, power-handling and other ratings suitable for pre-amplifier, output and other purposes. Some require relatively few extra discrete components (resistors and capacitors) and they are available for a considerable range of operating voltages. Some have integral overload protection. These devices may be used alone or in conjunction with transistors and can often offer advantages compared with the use of individual transistors for all stages.

Amplifiers using ICs may be assembled on perforated board or PCBs prepared for the purpose. Some ICs have tabs which must be soldered to areas of the board, for heat sinking. This in turn, may depend on the operating voltage, or power required. For example, the TBA800 audio IC requires no heat sink provision, other than the tabs provided on it, for up to 1W but for higher outputs the tabs are soldered to copper areas of the PC board. Other ICs rely on the use of certain pins, or alternative methods, of carrying heat away from the interior of the device.

With many ICs there are optional speaker loads, depending on the operating voltage and power dissipation. The TBA800 is also an example of this and can be expected to deliver up to about 1.8W with a 16Ω speaker but about 3W with an 8Ω speaker, when using 14V. Apart from the obvious advantage of using a pair of ICs for stereo, ICs may be combined in arrangements similar to the push-pull output stage, allowing more power than would be available from a single IC of the same type.

THE MFC4000A

This is a simple, low-power audio IC having the configuration shown in Fig.20, employing stabilised driver and output stages. There are four external connections only, as shown. Fig. 21 is an operating circuit for this IC the extra components consisting of an input coupling capacitor C1, by-pass capacitor C2, speaker coupling capacitor C3, and feedback resistor R1.

The more important ratings for an audio IC are similar to those which would apply to an amplifier constructed from discrete components. These characteristics allow an IC to be chosen to suit the

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purpose in view. For the MFC4000A typical ratings are:
- Operating voltage: 9V
- No signal current: 3.5mA
- Maximum output: 350mW
- Sensitivity (50mW output): 15mV
- Harmonic distortion (50mW): 0.7%

If complete details of an IC are required, or an internal circuit (such as that in Fig.20) these are often available from the maker or supplier. Otherwise it is more general to show only the external circuit (Fig.21) as this is all that is required to build an amplifier. In Fig.21, the top of the device is shown, with pins in their actual locations. With other circuits, pins are numbered, and do not usually appear in their actual locations. The latter are found by reference to a diagram of the device.

**VOLTAGE/POWER**

With an IC amplifier there is a range of possible operating voltages. The lower limit is set by the device ceasing to give an adequate performance (or to operate at all) while the upper limit depends on the device itself, heat sink and speaker impedance. With many circuits less than maximum operating voltage is used, but the voltage should only be increased when it has been checked that operating conditions are still suitable.

In Fig.22 the dissipation expected in the LM380 IC is shown for 12, 14 and 16V, with an 8Ω speaker. When no heat sink is fitted, dissipation should be kept under 1.25W. This sets 14V as a maximum safe voltage with an output of a little over 2W. With 12V about 1.5W output would be expected. With 16V a heat sink is necessary.

Fig.23 is a circuit for the LM380 and it also shows the pins. When a heat sink is necessary, pins marked HS are soldered to it and it may be a foil area of the PCB. If high frequency oscillation arises, a 1000nF capacitor with a 2.7Ω resistor in series may be connected from pin 8 to negative line. The 1000nF capacitor should have short leads to pin 14 and the negative line. Top-cut tone controls may be connected from pin 2 to 6.

**SL414A/SL415A**

These IC’s provide 3W or 5W, with 18V or 24V using an 8Ω speaker, the power dropping to approximately 2-2W and 3-8W with a 16Ω speaker. The IC includes a pre-amplifier (24dB) and main amplifier (26dB) sections and automatic overload protection. Fig.24 is a simple circuit for these ICs with input for the main amplifier (4) taken from the volume control VR1. Satisfactory working, with reduced output, is possible down to 9V.

Fig.25 is also suitable for the SL414A or SL415A. More components are required but the pre-amplifier output (5) is taken to the main amplifier input (4) and gain is increased. A high-frequency by-pass capacitor may be required from pin 9 to pin 1 near the IC (as in Fig.24). In some cases a 22Ω resistor and 47nF capacitor in series may also be required from pin 10 to pin 1.

**TO BE CONTINUED**
THIS battery charger offers several features which are usually omitted on the general run of charger circuits.

In particular, it protects itself and the battery from damage in the event of the charging leads being connected the wrong way round, it protects itself against damage from the charging leads shorting together, its charging rate and the end voltage of the battery are easily adjusted during manufacture or subsequently and the components are relatively easy to obtain.

DESIGN IDEA

To provide the above features the author chose a circuit using a constant current generator and a variable on/off period of charging. The switching for the on/off is a mixture of electronics and electromechanics since the charging current is switched by a thyristor whilst the thyristor itself is switched by a pair of contacts on a relay.

Fig. 1. The complete circuit diagram of the charger. Although a single PCB is used the components mounted on it have been split to enable normal progression through the circuit.
Having determined the charging rate and the end voltage the unit will regulate its on/off cycle quite automatically, providing a rapid charge initially but not tailing off quickly (as a normal charger) when the battery voltage approaches its charged state.

CIRCUIT OPERATION

Fig. 1 shows the complete circuit for the charger. The mains are stepped down by the transformer T1 and the low voltage output is bridge rectified by diodes D1 to D4 to provide the pulsing DC required for charging.

The additional circuitry of D5 and C1 provides a smoothed DC supply for the base of Tr1. This potential, and the base current, of Tr1 is controlled by R1, R2, D6, D7 and D8.

The charging current has to flow through Tr1 and, with its base stabilised, the current is limited by the emitter resistor R4. The charging current must also flow through the thyristor Th1 and it is this device which switches the charging current on and off.

**Components List**

<table>
<thead>
<tr>
<th>Resistors</th>
<th>Capacitors</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1, R2</td>
<td>C1</td>
</tr>
<tr>
<td>R3</td>
<td>C2, C3</td>
</tr>
<tr>
<td>R4</td>
<td></td>
</tr>
<tr>
<td>R5</td>
<td>680μF or 1000μF, 35V</td>
</tr>
<tr>
<td>R6</td>
<td></td>
</tr>
<tr>
<td>R7</td>
<td>2,200μF, 16V</td>
</tr>
<tr>
<td>R8</td>
<td></td>
</tr>
<tr>
<td>R9, R10</td>
<td></td>
</tr>
<tr>
<td>R11</td>
<td></td>
</tr>
<tr>
<td>R12, R13, R14</td>
<td>1kΩ 5% 1W</td>
</tr>
<tr>
<td>VR1</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semiconductors</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1–D4</td>
</tr>
<tr>
<td>D5–D9, D11</td>
</tr>
<tr>
<td>D10</td>
</tr>
<tr>
<td>LED1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Miscellaneous</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1, transformer, 16V and 18V tapped secondary at 4A. PCB, Readers PCB Service. RL1, relay, 12V coil, 2 N/O contact sets. S1, switch, S.P.S.T. 5A rated. Ammeter, 0–5A. Box (size will depend on meter and transformer used). Double tag strip, 10 tags each side. DIL socket, 8 pin. Terminals. Battery clips. Grommets.</td>
</tr>
</tbody>
</table>

Note 1

Most of the components used can be obtained from local sources. Minimum requirements have been given and devices better than these can be used. Most mail order companies will supply against the specifications given.

Note 2

Suitable transformers are available from Everest Instruments Ltd., 34 Shakespeare Street, Nottingham and Barrie Electronics, 3 The Minories, London EC3N 1BJ

<table>
<thead>
<tr>
<th>Time (mins)</th>
<th>Battery Voltage</th>
<th>Current (amps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>start</td>
<td>9</td>
<td>3–4</td>
</tr>
<tr>
<td>5</td>
<td>11</td>
<td>3–1</td>
</tr>
<tr>
<td>30</td>
<td>12</td>
<td>3–0</td>
</tr>
<tr>
<td>110</td>
<td>12</td>
<td>2–9</td>
</tr>
<tr>
<td>140</td>
<td>12</td>
<td>2–8</td>
</tr>
<tr>
<td>200</td>
<td>12</td>
<td>2–8</td>
</tr>
<tr>
<td>440</td>
<td>12</td>
<td>2–8</td>
</tr>
<tr>
<td>530</td>
<td>14</td>
<td>2–7</td>
</tr>
<tr>
<td>590</td>
<td>14</td>
<td>2–8</td>
</tr>
</tbody>
</table>

Table 1. The charging rate and time to bring a flat battery to fully charged. The current and voltage figures have been rounded off. Note that although the charging rate does fall-off it is effectively level over a significant portion of the charging time.

The heart of the thyristor charging circuit is the operational amplifier ICl, which is acting as an under voltage switch. The negative input, pin 2 of ICl, is fixed by tapping across VR1 which is, in turn, regulated against supply variations by zener diode D10. The sampling voltage on pin 3 of ICl is a fixed percentage of the battery voltage and is determined by the potential divider R6, R7 and R8. Capacitors C2 and C3 slow down the "hunting" action of ICl when the battery is in the fully charged state.

With a discharged battery connected the sampling voltage will be below the reference voltage and ICl will cause Tr2 to conduct. The supply for the circuit is obtained from the battery itself when first switched on. When Tr2 conducts, the relay RL1 is energised and a DC current is fed to the gate of the thyristor. The anode of the thyristor is connected to the negative side of the bridge rectifier and the cathode is fed, via the battery, with the pulsating DC from the positive of the bridge. Therefore the thyristor can pass the charging current. Transistor Tr1 already has base current and now has a collector voltage so it too can conduct. The battery is therefore being charged.

When the battery reaches its fully charged voltage, usually set at about 14-15V, the positive input at pin 3 of ICl exceeds that at pin 2 and ICl switches off transistor Tr2. In turn, Tr2 de-energises the relay which removes the gate supply to TH1. With no gate current, TH1 will switch off at the next half cycle through and will not switch on again.

The removal of the charging voltage permits the battery to drop from its "voltage on charge" to its "voltage off charge" and the cycle is repeated. Without the capacitors C2 and C3 the cycle is governed by the relay energise and de-energise times and the relay chatters.

PRACTICAL CONSIDERATIONS

Before obtaining any components it is necessary to decide on the charging current required. For most home garages about 3A is sufficient. Table 1 shows the time taken for a nominal 3A unit to bring a very flat battery up to its fully charged condition. Although the unit is a constant current design the current does decrease as the battery voltage increases but not by a significant amount. The author settled for 3A and the components list is based on that current.

Having chosen the charging current the choice of components can be made bearing the following points in mind.
The transformer should be double wound and have a secondary of 16V to 18V, if higher currents are required then voltages above 18 may be required. Since the secondary is bridge rectified it doesn't require a centre tap.

The rectifier bridge can be an encapsulated unit or separate diodes. Silicon rectifiers are preferred because of space and reliability but it may be possible to pick up a suitable selenium stack at a local shop. Although in a bridge circuit each diode supplies only half the rectified current it is better to use devices with a generous safety margin, say a 5A device for a 3A or 4A charger.

Tri can be a 2N3055 for currents up to 15A but will need a heat sink, (if a metal box is being used, bolt it onto the side). By earthing the collector, as in Fig. 1, there is no need to use insulating washers.

R4 may be dissipating several watts at the higher charging currents and voltages. To assist in setting and adjusting the current several resistors in parallel have been used. The values and numbers will depend on what is available locally. Table 2 gives the currents obtained against various values of emitter resistance. Since the prototype used 2Ω units the table is based on numbers of these in parallel.

<table>
<thead>
<tr>
<th>Number of 1Ω resistors in parallel (R4)</th>
<th>Charging current at 16V setting (amps)</th>
<th>Charging current at 18V setting (amps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>2.8</td>
<td>3.0</td>
</tr>
<tr>
<td>8</td>
<td>2.5</td>
<td>2.8</td>
</tr>
<tr>
<td>5</td>
<td>1.7</td>
<td>2.0</td>
</tr>
<tr>
<td>2</td>
<td>not measured</td>
<td>1.1</td>
</tr>
</tbody>
</table>

Table 2. The charging rates against Tri emitter resistance and supply voltage. Note that the charging current does not have a linear relationship with the supply voltage. Higher voltages were not tried on the prototype and the requirements for higher currents cannot be specified.

Current setting can be achieved by adding or removing resistors and, subject to the ratings of the rectifiers, transformer and thyristor not being exceeded, no components need to be changed.

Current levels could be changed by switching the resistors in or out but the switch must be rated at several amps. No details of switching are given nor is a switch called for in the components list.

The thyristor passes the full charging current and for a 3 to 4A charger should be rated at 5A minimum. The applied voltage is low and the lowest standard working voltage of 50V is ample. Similarly there is a large gate current available and the device doesn't need to be a sensitive one.

The relay needs two pairs of contacts, both normally open, one pair for the thyristor gate and the other pair for the indicator. When an open relay is used together with a large metal box for the unit it will probably make a sufficiently loud noise to enable the indicator to be dispensed with. In this instance, of course, a single pole relay will suffice.

The relay noise and/or the indicator lamp coupled with the reverse polarity protection built into the unit makes it possible to connect the battery to the charger in complete darkness. If the polarity is wrong nothing happens. No noise, no light and, more importantly, no damage. On reversing the connections at the battery or at the charger the system should operate correctly.

The relay resistance should be at least 100 ohms and the transistor Tr2 should be capable of passing at least 200mA collector current.

**CONSTRUCTION**

The small electronic components, which will be common irrespective of the charging current selected, are mounted on a single P.C.B. The wiring pattern for this board is shown as Fig. 2 whilst the component positions and orientations are shown as Fig. 3.

The only large component common to all charging currents is the relay. This is also mounted on the P.C.B. but, to leave the choice of type as great as possible, provision is made to make connections between it and the board by flying leads. Some form of mechanical fixing will be required but the type and location will depend on the relay selected.

Although a metal box is not essential for containing the circuitry it has many advantages, both mechanical and electrical.

The power transistor, Tr1, will require a heat sink approximately 3½ inches square for a 3 or 4A charger but could be bolted directly onto the side of a metal box. Since the design earths the collector of this transistor there is no need to use insulating washers.

Whether the box is metal or not, heat sinks will be required for the thyristor and the bridge rectifier. These can be of 16 gauge aluminium approximately 3½ inches square. To save space they can be folded into channel sections but must be mounted vertically to ensure an adequate air flow. The thyristor must be fitted with insulating washers and if individual stud mounting diodes are used they too must have insulating washers.

![A photograph of the inside of the prototype. This unit did not use a PCB and several of the components now mounted on the board were mounted on the tag strip.](image)

The resistors making up R4 were mounted on tagboard. This made changes easy and would assist switching if required. Although 2Ω units were used the individual components can be of any low value. Although the prototype didn't get more than just warm, holes were drilled in the ends of the case to enable an air flow when fixed to the wall. Several
small holes are better than a few larger ones unless a screen is used to prevent items falling in.

When the battery has reached its “fully-charged” state the relay will de-energise. Because of the differences in “on-charge” and “off-charge” voltages the relay will pull in and drop out all the while the charger is connected. The rate will depend on the charging current set but will be of the order of 10 seconds. The meter will try to follow this change from full charge to no charge and will seem to fluctuate. To minimise possible damage to the movement a switch has been incorporated and the meter can be short circuited. The relay noise and the indicator will show that the charger is still working.

Practical Wireless, May 1977
Order in comfort

Regular readers of PW, will I’m sure, have seen the Maplin advertisements regularly carried on the back cover of this magazine. Now, to make the job of ordering components an easy, accurate and enjoyable pastime, Maplin have come up with a brand new catalogue containing hundreds of photographs and illustrations. Measuring 285 x 205 x 10mm, this latest offering contains 216 pages packed with details of components, circuit ideas, diagrams & PCB’s, kits for synthesiser, organs, amplifiers, and sections containing tools, books and cabinet hardware. In fact just about everything the DIY electronics enthusiast requires.

The catalogue comes complete with up-to-date price list, order form, postage paid envelope, and money back guarantee if returned within 14 days of purchase. The price incidentally is 50p.

For those interested, contact:

Maplin Electronic Supplies, PO Box 3, Rayleigh, Essex. Tel.: 0702 715155 or call at Maplin’s shop 284, London Road, Westcliff-on-Sea, Essex. Tel.: 0702 47379.

Probe for faults

Electronic enthusiasts are well aware of the ever increasing use that is made of DTL, TTL/C-MOS devices in almost every type of circuit that not so very long ago would have necessitated the use of hundreds of transistors. Unlike transistors though, logic IC’s are generally more difficult to test in circuit, especially C-MOS devices which require extreme caution, if they are to survive the rigours of testing.

A logic test probe is the answer, and the latest to appear in the UK market is sold by Rastra Electronics Ltd, who have launched the LP-1 logic probe. A few of the parameters of this probe are a detectable pulse width of 50nS, a maximum input frequency of 10MHz and a power requirement of from 5 to 36V. LED’s are used to indicate logic ‘1’ (2.25V ± 0.015V 70%Vcc) or logic ‘0’ (0.8V ± 0.01V 30% Vcc) and pulse, which blinks on for 8s transients. Price is £28.60 plus VAT.

Rastra Electronics Ltd., 275-281 King Street, Hammersmith, London W6 Tel: 01-748 3143

I see new chips

Three new devices that have recently come onto the market are discussed below, and are available from Rastra Electronics, Distronic, and SGS-ATES, respectively:

The first is a precision waveform generator/voltage controlled oscillator, and designated the ICL8038-CGPD. The IC is said to be capable of producing sine, square, triangular, sawtooth and pulse waveforms at frequencies ranging from less than 1/1000Hz to more than 1MHz. FM and sweeping can be accomplished with an external voltage, and it is claimed to be highly stable over the temperature range of 0°C to 70°C. Package is a standard 14 pin DIL.

Further information from Rastra Electronics, 275-281 King Street, Hammersmith, London, W6. Tel: 01-748 3143.

Continuing with oscillators, Distronic have released details of their crystal controlled oscillators, which combine crystal technique with hybrid integrated circuit technology.

The units are claimed to have the high stability temperature and aging characteristics associated with AT-cut quartz crystals, and are available for driving multiple TTL or C-MOS loads. For TTL types, the available frequency range is from less than 0.25Hz up to 30MHz with an input voltage of 5V DC.

The frequency range of the C-MOS oscillators is from 300Hz up to 10MHz for TO-5 package types and from 0.002Hz up to 10MHz in 14 pin DIL packages. Distronic Limited, 50-51 Burnt Mill, Elizabeth Way, Harlow, Essex. Tel: Harlow 32947.

The new SGS-ATES chip is a 5 terminal voltage regulator—the L200. Output voltage is adjustable between 3 and 30V and output current adjustable from 0 to more than 1.8A. Thermal overload and short circuit protection are also incorporated, as is second breakdown and overload protection which enables the L200 to withstand spikes of up to 60V. Load regulation is said to be 0.1% of Vout, while ripple rejection is better than 70dB. Other applications for this device are precision current limitation and switching regulation in which neither external transistors nor additional protection circuitry is required.

Further information on this product from SGS-ATES (UK) Ltd., Walton Street, Aylesbury, Bucks. Tel: 0996 5977.
**Disco Separates**

Rather than 'Cart around' a heavy disco comprising of decks and amplifiers combined in a single cabinet, it is often advantageous to have separate units. The new RTVC 70W and 100W RMS mono disco amplifiers fit into this category, each providing a full range of mixing facilities and an input for a separate slave mixer amplifier. Both units are fully protected against speaker malfunction and against any short circuit conditions. Maximum power is developed into 40ohms.

Inputs 'Deck 1' and 'Deck 2' are for ceramic cartridges with outputs in the order of 200mV, while the 'Mic' input is a dual sensitivity type, accepting either 1mV or 10mV outputs. Microphones may be of either high or low impedance. Other inputs provided are 'Tape in' (300mV into 50k ohms), 'Tape out' (150mV at 100k ohm) and 'Slave in', 'Slave out', both at 150mV at 5k ohm.

PFL—pre-fade listening is also incorporated on each input regardless of the level, and is controlled by a separate rotary control.

Along with other RTVC products, these Disco Amplifiers are very competitively priced, with the 70W model selling for £49-00 plus £3-00 p&p and the higher powered 100W model carrying a price tag of £65-00 plus £4-00 p&p.—RTVC, (Dept. PW), 21 High Street, Acton, London, W3 6NG and 323 Edgware Road, London W2.

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**4-piece meter**

One of the most frustrating factors in owning any instrument is that of servicing and calibration. Alcon Instruments claim that they have solved this problem with the introduction of their new pocket-size range of multimeters from Miselco. These instruments have been designed for repair in a simple and easy manner using factory matched replacement modules which, by virtue of their design, obviate the need to recalibrate each time.

The Miselco Tester range of four Multimeters cover between them a high current model capable of measuring up to 30A; a model with a high sensitivity figure of 1MΩ/V; a general purpose model with a sensitivity of 20kΩ/V and finally one intended for electronic work with a sensitivity of 30kΩ/V The latter model has claimed accuracy figures of 2.5% on DC and 3.5% on AC, while all the other models claim 2% on DC and 2.5% on AC.

Each model comprises two case parts, a movement and a PCB. Any one module may therefore be replaced by the user, using only a screwdriver to complete the job.

Alcon Instruments Ltd, (Dept. PW) 19 Mulberry Walk, London SW3 6DZ.
Dear Sir,

Designers—please note

I am one of the unfortunates so roundly condemned by Paul Heath in his editorial on your letters page in the February issue. Unfortunately my QTH is quite useless for VHF transmitting, so my activity is therefore confined to low-power portable working using FM. If it were not for repeaters such as MP and RF, I would have no contacts at all. I rarely hear any signals on the simplex channels.

Working through repeaters is a great boon for mobiles also, handicapped by low power and whip aerials. And if we all incur the wrath of the critics for not listening on the input channels, that is because of a shortage of receiver designs. P.W. has published some splendid articles on 2-metre converters, and on hi-fi equipment for the FM broadcast bands. But never have I seen a design for a straightforward FM receiver for 2-metre work.

May I suggest a possible specification? (a) single conversion receiver with tunable front-end, using a variable capacitance diode; (b) integrated circuit (e.g. CA 3089E) for the complete IF strip, possibly including the cheap Toyocom crystal filter to avoid the headache of alignment problems; and (c) a small integrated circuit for the audio side, such as the LM 380. This receiver would work from the 12V vehicle battery or from a small mains power pack. I’m sure that there would be a great interest in it on the part of SWLs, many of whom enjoy listening to the repeaters but are handicapped through the use of the inefficient method of “slope detection”.

PW has many gifted contributors: surely one of them could come up with an effective design along the lines indicated. And then you could follow it up with a design for a converter for the 70cm band, to work into the PW FM receiver! F. Ness GD3ESV (Douglas, IoM).

Hot tip

Re the stripping of Litz wire (Letter H. Pruim) in the February issue. I am now retired after a lifetime in many branches of work using all sorts of wires, and for years I have used a simple method of stripping Litz that needs only a small meths lamp with wick and shallow tin lid.

Just put about a 1⁄4 in of meths in the lid and put it by the lamp. First hold the end to be stripped in meths flame till just red hot. Then quickly dip the hot end into the meths, presto—perfectly clean strands just right for soldering. Not much knack required, but a few trys will soon prove the idea. George Comber (Tadley).

High power interference

Democracy, according to the Radio Society of Great Britain requires that minority groups be given absolute priority over other amateurs—or so it seems on the 2m band. I will not challenge Dr. Allaway’s remarks in your February issue about minority groups having a right to exist, but they must not be allowed to take up unduly large portions of any band, in a way that absolutely prevents anyone else using that band segment.

I am referring to the Oscar command station which is located at Surrey and requires about 100 kHz of the 2m band. The power which is radiated (believed a few kW E.R.P.) completely obliterates any but the most local legal-limit transmissions. The transmission is in the “all-modes” part of the band, which should be shared by all and not monopolised by a minority service which already has its own “space” segment elsewhere.

The RSGB required the greatest persuasion even to publicise the source of the nuisance. They will now have nothing more to do with the matter—I cannot even get them to tell me when to avoid the frequency! The transmission begins without warning about once every two hours or so. It has caused interference as far north as Liverpool.

“RSGB represents all UK radio amateurs.” It says so on my membership card. The blatant white-wash over the mistake in licensing this wide-band transmission in an Amateur band seems to suggest that the statement is in some way at fault.

How can I trust a society that performs in this manner to safeguard my interests at WARC in 1979? It is the same society that had a 6-month option on a very costly investment, and although promising “informed discussion” on the wisdom of the purchase and suggesting that they would wait to hear any views that informed members may have on the subject, they abruptly bought the machine in question with most of the 6-month option period still left to run.

Yet the RSGB is probably the only body that can make representations to the delegation from this country that will vote at WARC.

RSGB, you are in a position of trust. You must be above suspicion, in all your claims. Please realise your responsibilities—G. L. Manning, G8JBH (Edgware).

More ’scope

Just a small but important observation I thought we ought to share. Many useful projects have been featured in PW associated with oscilloscopes including the “belt on” goodies and details on operation and fault-finding techniques. However, many of us, and specifically myself, haven’t got the basic and necessary item, i.e. an oscilloscope. The last featured scope, correct me if I’m wrong, was August 1973 “PW Student”.

Could it be that 1977 is going to give us a super new scope project? Well, that’s it, except one specification. Please! a minimum 4 inch tube. G. Starkey (Warwickshire).

The Editor will be pleased to hear from potential contributors on the above projects.

Practical Wireless, May 1977
THE previous article "Vertical Aerials for 144MHz" (Practical Wireless July 1976) dealt with omnidirectional types such as the ground plane and vertical colinear which are convenient for transmitting or receiving in any direction but have relatively little gain over a dipole. For example, a 4-element colinear has but 4-3dB gain and is a sizeable aerial, some 14ft or so long. Beams are the only way of obtaining relatively high directivity and gain and there are many to choose from with the Yagi or parasitic array being the most popular.

However, fairly small but efficient beam aerials for 144MHz are not difficult to make and gain as high as 10dB over a dipole is possible without resorting to large numbers of elements as are necessary for Yagi or colinear arrays. The corner reflector aerial, which employs only one driven element, may be an exception and although a high gain, around 12dB or more, is possible, the reflector itself is of somewhat unwieldy dimensions.

TWO DRIVEN ELEMENTS
Small beams with a useful degree of directivity and gain may be derived from "end-fire" or "broadside" arrays consisting of two driven radiators spaced a specific distance apart with the pattern in each phased according to the directivity required. In the case of the "end-fire" array the pattern has zero radiation broadside (at right angles) to the plane of the array and maximum end-fire radiation when the spacing between the elements is a half-wavelength or less and the currents in the elements are equal in amplitude but in opposite phase i.e. 180° phase difference.

The configuration of this array is shown in Fig. 1 in which the spacing "d" may be from \( \frac{1}{2} \lambda \) to \( \frac{3}{4} \lambda \) to obtain the requisite horizontal plane end-fire radiation pattern when the array is vertical as in Fig. 2(a) and looking down on the ends of the elements. Radiation in the vertical plane i.e., with reference to an angle to the ground, will be as shown in Fig. 2(b).

To obtain "broadside" radiation, at right angles to the array, the spacing between the elements is usually a half-wavelength and the elements fed in phase. The available directivity/gain is greatest when the elements are spaced \( \frac{1}{2} \lambda \) or \( \frac{3}{4} \lambda \) but not closer. The end-fire array is of greater interest since considerable gain can be obtained with closer spacing between the elements thus allowing for a more compact aerial plus uni-directional or bi-directional radiation pattern as required. Such an aerial may be operated horizontally (for horizontal polarization) or vertically (for vertical polarization).

Greatest bi-directional gain is obtained when two driven half-wave elements are spaced 0.125λ apart and fed out of phase as in Fig. 3. The gain is about 4dB with reference to a half-wave dipole. However, for 144MHz operation the high feed point impedance presents a problem as it is not suitable for direct connection to commonly used 50Ω coaxial cable although this can be overcome by the use of a matching stub.

Since beam aerials have to be rotated for maximum radiation in a desired direction there is little point in using a bi-directional array. Better to use a uni-directional system and obtain a little more gain. This can be achieved with a two-element close spaced array in which one element is fed 135° out of phase with respect to the other. The radiation pattern then becomes a cardioid as shown in Fig. 4 and remains virtually the same whether the aerial is used vertically or horizontally.

An aerial based on this arrangement, to provide even more gain, was designed by the writer some 26 years ago and is known as the "ZL Special" although it was originally intended for HF bands operation. It employs two driven elements fed 135° anti-phase but the element lengths are such that one operates as a driven element/director whilst the other behaves as a driven element/reflectors. The radiation pattern is cardioid as in Fig. 4 and the gain a little over 6dB with reference to a half-wave dipole.
"ZL SPECIAL" FOR 2M

This beam is identical to the original model except that an alternative feed method to suit 50Ω coaxial cable was necessary and the element lengths are appropriate for 2m band operation. It is easy to construct and the elements and phasing line may be made from copper wire, copper tube or even 300Ω ribbon feeder. Quite a large number of this 2m version have been constructed and tested and being a very compact aerial it has proved ideal for use indoors since it is not generally affected by the proximity of walls and even conductive structures, providing these are not too close.

This beam has a broadband characteristic and properly constructed and adjusted should exhibit around a 1:1 SWR over the whole 2m band. Constructional details are shown in Fig. 5 and providing the phasing line length and the element spacing and lengths are adhered to, the materials for these may be as mentioned above. If 300Ω ribbon feeder is used the distance between conductors will of course be that of the feeder itself.

The small air-spaced 20pF variable capacitor is necessary to achieve a correct match to 50Ω coaxial cable and is adjusted for minimum SWR at 145 MHz. Not more than about 10pF of this capacitance should be necessary to achieve this. Do not use mica or ceramic type trimmer capacitors. It is important to curve the feed line away and down as shown in the inset in Fig. 5 when the aerial is operated vertically.

---

Practical Wireless, May 1977
### XEROZA RADIO

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PHONE 01-226 1489

### SEMICONDUCTORS

by MULLARD, TEXAS, MOTOROLA, SIEMENS, I.T.T., R.C.A.

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### SPECIAL OFFERS

- **47K**: 35p
- **33K**: 35p
- **22K**: 35p
- **10K**: 35p

### RESISTORS

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### MULLARD POT CORES

- **LA3**: 100-500 kHz, 75p
- **LA4**: 10-30 kHz, 100p
- **LA5**: 30-100 kHz, 100p

### SKELETON PRE-SET POTENTIOMETERS

- **1W**: 35p
- **2.2KW**: 35p

### TANTALUM CAPACITORS

- **330uF**: 15p
- **33uF**: 15p
- **10uF**: 15p
- **1uF**: 15p

### CMOS

- **4000**: 10p
- **4001**: 10p
- **4002**: 10p
- **4003**: 10p
- **4004**: 10p
- **4005**: 10p
- **4006**: 10p

### Diode SOCKETS

- **8 Pin**: 10p
- **14 Pin**: 15p

### REED INSERTS

- **Lamp**: 15p

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The RSGB is the national society representing all UK radio amateurs. Membership is open to all interested in the hobby; write to the membership section and ask for full details.
Fig. 5: Details for the construction of a ZL Special aerial for 2 metres.

Fig. 6: Construction of a three element ZL Special beam.

Fig. 7: Details for the director lengths and spacing for a five element ZL Special. Other constructional details as in Fig. 6.

and the matching capacitor should be adjusted only when the feeder has been secured. The short stub mast used to support the aerial must be of insulating material, wood or plastic tube and extended to a few inches below the bottom ends of the elements when it may be coupled to a metal mast. The gain remains the same when the aerial is used horizontally but the cardioid pattern becomes a little narrower to the sides. Note the unbalance-to-balanced co-axial connection using a ¼λ sleeve which is bonded to the main co-axial braid only where shown, at point X in Fig. 5. The end near the feed point is not connected to anything. For use outdoors the feed connections and tuning capacitor must of course be protected from weather as must the elements and for this a small plastic electrical junction box could be used. The elements and supporting frame (this must be wood or plastic tube) can be given two or three coats of polyurethane varnish.

This aerial is used by the writer on a cabin cruiser (G2BCX/MM) at a height of only 9 feet above the water and so far 10 European countries as well as many UK DX stations have been worked. The photo shows the aerial enclosed entirely in plastic “plumbing” tube for complete protection from weather and salt water. The aerial is also ideal for portable work as it will fit comfortably in the boot of a car.

Since the basic ZL is a driven array and the radiation pattern uni-directional it has been found possible to add parasitic director elements to obtain an increase in forward gain. One director mounted...
0.12a in front of the main driven element (B in Fig. 5), increases the forward gain by slightly over 2dB thus providing a total gain of 8dB which is quite considerable for a beam measuring only about 50cm (20in.) from front to rear. The addition of three directors, still making the beam only about 1.2m (40in.) high, yields a forward gain of a little over 10dB which is comparable with that of an 8-element Yagi having a physical length of about 2.8m (110in.), or twice the length.

The construction of a ZL with directors is much the same as for the basic aerial shown in Fig. 5 except that the element support is extended for mounting the directors. This must be insulating material, such as wood or plastic tube, and one suggested method of construction, particularly suitable for outdoor use, is given in Fig. 6. The main support which consists of the boom and stub mast is made of plastic pipe. The stub mast is fitted into the boom either by cutting a hole in the boom and gluing the mast in with Araldite, or by using a pipe “T” piece to make the join. The copper tube elements are fitted tightly into holes through the boom section and secured by screws through the side of the pipe. The phasing line which may be two copper wires (12 to 16 SWG) are inside the tube as is the small capacitor. To ensure that the phasing lines do not touch, they may be insulated with sleeving.

This 3-element ZL Special has been tested over a long period and operated both vertically and horizontally with considerable Continental DX worked. The half-power beamwidth (5dB) is about 80° and radiation directly from the rear is about 25dB down although the overall radiation pattern is still cardiod but narrower than that from the 2-element ZL Special.

The addition of two more directors, making a total of three, and the aerial therefore a 5-element version, will provide a gain of about 10dB. The aerial is still not very large and may of course be operated vertically or horizontally. Construction is the same as for the 3-element version except for the three extra directors cut to length and spaced as shown in Fig. 7. Note that the amount of capacitance required across the 50Ω feed to effect a good match may be much less or even nil with the directors in use.

**VERTICAL END-FIRE ARRAY**

This is relatively easy to construct and will provide about 4dB gain over a dipole and is bi-directional. It needs only to be turned through 90° to achieve all round coverage and being compact could prove useful to flat dwellers unable to put up an aerial outside. It consists of two half-wave radiators fed 180° anti-phase to produce the radiation pattern as in Fig. 2a. It may be assembled on a wooden frame and the elements and stubs can be made from copper wire as shown in Fig. 8. It could also be set up to rotate on a floor stand, as the extension of the diagram illustrates, making it suitable for indoor use. Details of the matching stub and feed are shown with more detail in Fig. 9. Adjustment for minimum SWR is carried out by sliding the shorting bar along the stub in conjunction with moving the tapping point of the 50Ω coax feeder. The approximate positions for these are given in Fig. 9 and very little further adjustment should be needed to obtain an SWR approaching 1:1 over the whole 2m band. Used in the writer’s workshop at about 10ft above the ground, this aerial could receive a substantial signal from the GBSPI repeater nearly 40 miles away.

---

**Fig. 8:** Details for the construction of a bi-directional end-fire array with about 4dB gain.

**Fig. 9:** Details of the feed system for the end-fire beam shown in Fig. 8.
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HAPPY man this month is Neil Braeman of Southwater, near Horsham, and regular contributor to this column. He has passed his RAE and he is now G4FUP. Congratulations Neil, I know the bit of effort required to get down to the necessary studying will be found to have been worthwhile, for very many years to come. He has sold his bike to get funds to buy a better receiver and intends to make his own transmitter, a policy which I heartily endorse!

When John Taylor of Cheadle Hulme found the cost of a decent receiver a bit beyond his means he dragged out an old R107 that hadn't worked since 1953! A simple signal generator and multimeter and it was soon going again. John is thinking of building a converter for the higher frequency bands which is a very sound arrangement. In Stockfield, Northumberland Simon Robinson is just starting to listen to the SW bands and is thinking of getting a surplus CR100 and 'hotting it up'. Well, Simon, unless you have the requisite test gear and a bit of experience I should tread warily. Make one change at a time, re-aligning if necessary, before doing anything else. Personally speaking, I would get it going properly on the LF ranges and use a converter, as previously mentioned.

A note from Jim Martin A7089, Secretary of the newly-formed Edinburgh and District ARC, tells me that a group of about 20 members meets every Tuesday at 1930 at the club's rooms situated at the City Observatory, Catton Hill, Edinburgh. One could say that things are looking up! The club is active from 2m to 160m with calls GM4AJV/A and GM4BWT/A until they get their own call. Interested? then write to Jim Martin at 22 Ross Gardens, Edinburgh EH9 3BR. Still in GM-land, the Aberdeen ARS got all excited recently with a visit from the BBC involving interviews with several members, later broadcast on Radio Aberdeen. The producer is interested enough to suggest a monthly spot on Radio Scotland dedicated to amateur matters. In the meantime more mundane meetings take place at the hall to the rear of 91 Crown Street, Aberdeen. On 8 April there's a demonstration of an automatic CW reader and a try out of a new Jap receiver that covers LW to 500MHz! On 15 April an RSGB Tape Lecture will be illustrated with slides while 22 April sees RSGB Council member GM3ZBE visiting the club to talk of Society affairs. Secretary Stan Sutherland awaits your enquiries at 67 Greenfern Road, Aberdeen or ring 691716.

Back to regular correspondent Robin Bayley A9203 who is now settled at Kenberton, near Shifnal, Shropshire. He has been assessing his new QTH from the DX aspect from 15 to 80m with the aid of his EC10. With HKO's on 80, 40 and 15m and KH6 on 20m things look promising. Andrew Work A9091 in Beverley E. Yorks, changed his 66ft wire round the loft to a straight wire outside and naturally found a big improvement in results including VP2 and VP5 on 80m. In Wallasey E. J. Shaspe has progressed through a couple of receiver kits to an Eddystone 670A which he found going cheap. He's anxious to beg or borrow a handbook on the same so if you can help write to 36 Warren Drive, Wallasey, Merseyside L45 0JS.

Zone 23 is a very rare place and many aspirants for the Worked All Zones award have had long waits for a QSL from there. B. Harrison in Hastings heard JTIKAA from Mongolia which is a good start to getting a card. KC6 was another good catch in the East Caroline Islands in the Pacific. Steve Budd A8713 also on the sunny south coast, in Worthing, has been logging stuff on the downlink from Oscar 6 10m and the 2m downlink from Oscar 7. However he still did not desert the HF bands. Steve Cottis A8961 seeks the DX from Harrogate and has QSL's from HP7, VQ9 and VR8 to prove he has been successful. I'd hesitate to attribute the improved conditions on 15m to a general rise in sunspot activity, Steve. Rather it is the usual improvement as we move towards the summer in the northern hemisphere.

David Peck BR57621 has done us proud this month from Cambridge with logs for SSB and RTTY somewhat restricted by a move with all the gear from the house to a shed in the garden!! David started with a Creed 7B printer plus 'RTTY the Easy Way' built the terminal unit and he was away! The receiver is a Yaesu FRG7 fed from a 135ft wire.

D. Anderson BR56591 has not written for a while from Brookwood, Surrey, but makes up this month with a good log. Normally he tapes his DX but at the moment the recorder is u/s. Dennis takes the RAE next December and in the meantime G8LVB is helping him with the necessary studies.

Now a note for all! The Annual Convention and Exhibition of the Northern Radio Societies will take place at Belle Vue, Manchester on Sunday 24 April. See the box in the News feature of this issue for further information.

Log Extracts

J. Taylor:— 20m KG4DHE VE8SO 7X2LTA

R. Bayley:— 80m AP2AD EA9CR FP8DX HK0COP JA1JRK KH6PP PY7PO 40m CT2ZP EA9CF HK0CAT 20m FP8DH KH6PA TG9TL VP8AA 15m EA6DA FP8DA HK0KCOT TG9TY ZL5AK

A. Work:— 80m VP2PK TL2FM VP2EEQ (QSL WA6AHF) ZD7SD 40m HCN1DK VP2KP ZS3AW 20m VP29SN ZSP (Seychelles) 7P8AC 7Z1AB

D. Anderson:— 80m VS6DO 7Y4MD 20m C2IPS (Nauru) CP5GR HM0SM KC6KO P29BS VP2AG ZP6KR

J. Taylor:— 20m KC4AAA KC4USD KL7IEU 15m JR6HIJ WB2CJF/HZ1 20m RTTY IC8POF K9KHI OH0NI UK3ACRA WA0YDJ/4 YU2CE 9K2EP
A report from Ralph Newman in Reading mentions an unidentified station on 945kHz between 2300 and midnight which created a 1kHz heterodyne with the Russian on 944kHz. The writer has made a tape of the closedown announcement, which is in English, and although no location was obtained, two frequencies on the medium waves were referred, to 602kHz and 945kHz. The transmission ended with the Nigerian national anthem at 0002. The Western Nigeria Radioservice Division has a 10kW outlet on 602kHz located at Abaflon and it seems likely that they now have another on 945kHz. Although the signal is quite strong at times interference makes reception difficult. DXers who use communications receivers and a loop might like to take up the challenge offered by this new broadcaster and try to obtain a more definite identification.

In a letter from Horsham in Sussex, Kes Olley reports hearing CKVO Clarenville in Newfoundland on 710kHz using his Roberts portable radio connected to a long wire aerial and earth. He asks how to use a loop with this receiver. From St. James in Barbados, Paul Griffith poses a similar question when he asks how can he connect a loop to a portable receiver which has no external jacks for earth or aerial. A number of DXers have written on similar lines and the short answer is that a loop is really unsuitable for use with a receiver that has an internal aerial. Even if aerial and earth sockets are fitted to the portable, they are intended for use with a wire aerial and if a loop is connected to them then poor results will be obtained.

The internal aerial in a transistor portable is wound on a ferrite rod or slab and this type of aerial is directional. There are two positions of maximum pick-up at right angles to the rod and two other directions of minimum pick-up which lie along the length of the rod. A loop aerial which is based on the frame aerial used in the early days of radio, has similar properties and if an attempt is made to use both aerials at once then problems will arise. The loop may detune the receiver input causing poor selectivity. If the null (direction of minimum pick-up) of the loop is pointed at an interfering station, there may still be pick-up from that station via the internal aerial, the overall effect being to reduce the directional properties of the loop.

One method of overcoming this problem is to attach the receiver to the centre of the loop in such a way that the nulls of loop and receiver coincide. In most cases this will mean that the receiver will be at right angles to the plane of the loop windings. Coupling between loop and receiver is inductive, so no direct connection should be made between them. The loop and receiver are rotated together to null out interference. This method should provide an interesting field of experiment but at best it is only a makeshift.

The most effective DX tool on the medium waves is a communications receiver and readers will note that most of the DX reported in this column comes from users of this type of equipment. Newcomers to the hobby who are thinking of investing in a receiver should think along the lines of a realistic DX160, Trio 9R59D/E or the Heathkit or Edystone range, rather than of portables or hi-fi tuners which do not possess the selectivity or sensitivity required by the serious DXer.

Robin Bayley has moved to a new QTH at Kember- ton in Salop and is now the owner of a Edystone EC10. He reports on receiving a DX programme from Thames Valley Radio on 1450kHz during the Golden Days programme which is on the air on Sundays between 2200 and 2300. Another programme of interest to the DXer is the weekly ‘Sweden Calling DXers’ which is on the air on Tuesdays at 2315.

Latin American medium wave stations come in well in the UK, the long sea path across the Atlantic favouring propagation from this area. Reception from South America is often at its best when DX from North America is poor so it is worthwhile investigating Spanish and Portuguese speaking stations when DX from North America is absent. It is unusual if there is no DX at all on the medium waves! John Wilday who uses a Grundig Satellite 2000 in Doncaster says he has positively identified Radio Margarita on 1020kHz but he finds that the fast tuning style of South Americans makes identification difficult. He has heard a number in the 800 to 1000kHz and 1200 to 14000kHz areas.

Latin American countries most frequently heard are Colombia, Venezuela, Argentina and Uruguay where Spanish is the language and Brazil where Portuguese is spoken. Although callsigns are allocated they are seldom used but most broadcasters have names such as Radio Globo, R. Nacional followed by the location, such as Radio el Mundo Buenos Aires (which is on 1070kHz). The ‘World Radio and TV Handbook’ gives a comprehensive listing of LA stations both by frequency and country together with station addresses. In answer to J. Williams of Frome in Somerset, the WRH is distributed in the UK by Fountain Press and it can be ordered through bookshops.

“Wonders never cease, I got a verification yesterday from Radio Suat Entza, Magangue, in Colombia, HJHN on 960kHz” writes Harold Embles in Mirfield in Yorkshire. Latin American stations are notoriously difficult to verify. Receiving a station is only the first and usually the easiest part of the exercise. They are unpredictable too. The DXer can plug away for years with reports that are unanswered and then suddenly receive a cordial letter with pennant, QSL card and detailed information about the station and its locality. This appears to have happened to Harold who now has details of

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by Charles Molloy
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APPLICATIONS: Hi-Fi—Hi-fi quality disco—Public address—Monitor amplifier—Guitar and organ

SPECIFICATIONS:

INPUT SENSITIVITY 500mV.

OUTPUT POWER 65W R.M.S. INTO 8Ω; LOAD IMPEDANCE 4-16Ω; DISTORTION 0.04% at 80W at 1kHz.

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APPLICATIONS: Hi-Fi—Disco—Monitor—Power slave—Industrial—Public Address

SPECIFICATIONS:

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OUTPUT POWER 100W R.M.S. INTO 8Ω; LOAD IMPEDANCE 4-16Ω; DISTORTION 0.05% at 100W at 1kHz.

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FEATURES: Thermal shutdown—Very low distortion—Load line protection—No external components

APPLICATIONS: Public address—Disco—Power slave—Industrial

SPECIFICATIONS:

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W5CJY—"Do I like the JOYSTICK? I guess so! I took five antenna down and now use the Joystick alone!"

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G3CED G3VFA
the Radio Satatenza network in Colombia. Each station calls itself Radio Satatenza following this with the name of the town. HJCJ Medellin is on 590kHz with 100kW, HJGX in Cali is on 700 with 120kW, HJCY in Bogota on 810 with 250kW, HJHN in Magangué on 960 with 120kW and HJGL in Barranquilla on 1010 with 10kW. HJHN in 960 is often logged by DXers in the UK.

More LA DX comes from Ralph Newman in Reading with his homebrew receiver and loop which pulled-in Radio Margarita on 1020 and Radio Vision, the 50kW outlet in Maracay, Venezuela on 650kHz. Roy Patrick who DX’es in Derby with a Trio 9RS9D and loop reports hearing Trans-World Radio Bonaire on 800kHz at 0200. This station is on the island of Bonaire which is part of the Netherlands Antilles which lie off the northern coast of South America. Multi-lingual programming, which includes English is radiated from a 500kW transmitter and is mainly of a religious nature.

**SHORT WAVE BROADCASTS**

by Derek Bell

First we must tie up a loose end from a month or so back. Tony Cook had an HAC set that was giving trouble on its band spread section and thus thought it wise to ask, via this column, if his confrères in the DX world could assist. As a result a letter is before me from Joe Owens of Dolgellau, North Wales who describes himself as “an old time PWER from the nineteen thirties”. He suggests that it might be worth trying to connect the BS capacitor to the main tuning capacitor via a small series fixed capacitor. If Tony has not got one of these he can twist two equal lengths of thin wire together. Well there seems to be enough there to pass a few happy hours tinkering! I hope that it achieves the required result.

As a footnote Joe says that he has six redundant loudspeakers that need good homes and for the price of the return postage he will pass them on. If I may inject a personal note here it might be nice if they went to school clubs or disabled or pensioner DX’ers.

For once in my life, as the song says, I can be in the forefront and let you have advance news of a station. This rare event is due to the good offices of Robin Bayley from Kemerton, Salop. Robin has sent several items of station news the high spot of which is that the Red Cross organisation is to run one of its periodic station tests on 26, 28 and 30 July at 0600 to 0700, 1130 to 1230, 1700 to 1800 and 2200 to 2300 on 7210. These test transmissions are to ensure that in the event of an emergency the Red Cross has a viable means of world-wide communication from Geneva. They will QSL if you report to 7 Ave. de la Paix 1211 Geneva 8. Robin also reports that the BBC is to supply Marconi SW transmitters and aerials to Masirah Island station by December and that Russia is supplying four


Our newcomers take the floor now led by Jeffrey Raynor from Prestwich who runs a domestic radio/cassette recorder. Despite the fact that this is hardly a communications set Jeffrey says that he has loads of fun listening to “the affairs of distant nations”. He has connected a 25ft long wire and pulled in the following:

- Radio Pekin on 6100 at 0215
- Radio Norway on 6050 at 0030
- Radio Sweden on 6850 at 0030
- Voice of Turkey on 9550 at 2300

I can assure Jeffrey that he has not as he suspects moved the cursor needle, the fact that his frequencies are not spot on are a result of the crude calibration of domestic receivers. This extra aerial, in my experience, can throw the calibration by affecting the oscillator. Lock on to a station of known frequency and then add the aerial. When this is done one finds the station again and notes the difference remembering to take this difference into consideration when logging in that band.

Marcus Duncan from Thornaby also notices this phenomena of calibration movement on his Alba and seventy-foot long wire. He has made a start on the PW General Coverage set with which project your column wishes him the best of luck. He logs as follows:

- Israel Radio on 7412 at 2250
- Voice of Iran on 9005 at 2015
- Radio Cairo on 9700 at 2210
- WYFR on 11645 at 1810

Two rarely reported stations come from our old friend Roy Patrick of Derby with his Trio 9RS9 and JoyStick. In this lean spell Roy cheers us all up by proving that some DX is still running by logging Emissor Regional Dos Acores (Azores) on 4865 and Radio Omdurman (Sudan) on 5039 at 1645. Coupled with this may I include another old friend Bob Burgess who writes but once a year but when he does he brings good cheer. From his Chelwood Gate QTH Bob and his Satellit 2000 bring a list ‘as long as yer arm’ of Latin Americans and Africans. While I admit that a Satellit is not a run-of-the-mill set it is still a portable and Bob uses it as a bedside set with all the hazards that local QRM can throw at him. I wish that I could list all of the loggings but space does not permit; however here is a handful:

- Radio Nacional Argentina on 11710 at 1900
- Radio Nacional Brasilia on 11780 at 2300
- Radio Nacional Chile on 9566 at 2300
- Radio Rumbos Venezuela on 4970 at 2315
- Conakry, Guinea on 4910 at 2245
- Pointe Noire, Congo on 4843 at 2240

Bob mentions that Radio Nacional Chile is heavily jammed from Eastern Europe. Bob is hoping to retire shortly so we wish him well and wonder what sort of a logbook he will have, with more time to spend DXing.

We end this month on the subject of the Voice of America. J. H. Collick of Erdington would like to get in touch with VOA regarding their Big Band shows run by the veteran Willis Conover. The address to write to is VOA US Information Agency, Washington DC 20547 USA. This address also covers QSLs. With that I will wish you best 73s and all the best.
WE start 'down-under' with another interesting letter from Anthony Mann, Western Australia, who tells of some mouth-watering DX on February 11 and 12, almost at the end of their sporadic-E "season". The 12th was most unusual, says Anthony, video signals on Ch 0 (46.25MHz) from eastern Australia (1900 miles) was received as early as 0800, local time. Later, between 1240 and 1400 video was received from New Zealand on 45.25MHz (3400 miles). Prior to this a strong signal from an Hawaiian amateur was heard on 10m (KH6AHL working VK8AC). Around 1800 (1000 GMT) the 10m band opened toward Europe, with both UK and French amateurs dominating the band. At 1037 GMT the German beacon DL01GI (28.15MHz) was heard for less than a minute, Anthony uses a Barlow-Wadley XCR-30 with a folded dipole on 10m. While listening to an amateur broadcast he heard that, on January 24 and 25, the Great Australian Bight between Adelaide in VK5 and Albany in VK6 (1200 miles over water) had been bridged on 1296MHz. Our congratulations to the stations concerned.

In 14 years of routine observations the writer has never known a month like February when the VHF bands were so quiet. From the 1st to the 24th the atmospheric pressure did not rise above 30-0", in fact for 10 of those days it was nearer 29-5", so, at no time was there any 'life' in the troposphere for our radio signals. However, this has not daunted our readers. George Zitterstein, G8ITS, City of London, has now installed a barograph at his station, he was lucky to find one with an electric motor to drive the drum, to try and find out why the changing AP can become frequency critical within the VHF/UHF part of the spectrum.

Alan Baker, G8LQG, our watchdog in Newhaven, noticed a 'lift' on 2m around 1500 on the 12th when he heard signals from PA0, but this did not last long and dashed the hopes of both Alan and Ernie Hoare, G8BDJ, Southwick, Sussex, of some good dx.

During the 500th edition of World Radio Club, broadcast by the BBC World Service on February 16th, the team was asked, "When is sunspot minimum?" and this prompted your scribe to examine his records and put you all in the picture. After all, we are at the beginning of a new cycle and as it develops over the next few years, the increased solar activity will affect our mutual interests with DX again on the 10m band and more auroral activity to upset our VHF's. The following figures show the number of days each year that the writer's telescope recorded solar radio noise during the old sunspot cycle:— 1969—101, 1970—176, 1971—203, 1972—160, 1973—118, 1974—140, 1975—65, 1976—72. The peak activity was in 1971, followed by a downward trend until the end of 75 and the slight increase shown in 1976 may well be the start of the new cycle. Nigel Fisher, Co-ordinator of the Radio Astronomy Group of the South East Essex Astronomical Society, says that they have now completed their solar radio telescope and made satisfactory tests.

The solar radio waves will be collected on a Yagi aerial and fed to a Microwave Modules 136MHz converter; an Eddystone communications receiver is used as the IF amplifier and detector and an integrated circuit DC amplifier drives an Evershed and Vignoles pen recorder. Nigel's group will be observing between 1000 and 1400 hrs daily and will be supplying both the British Astronomical Association and ourselves with information as soon as they are properly organised.

Cmdr. Henry Hatfield, Sevenoaks, reports seeing a tiny solar flare and a plage through his spectrohelioscope on the 8th and on the 13th he saw a group of several sunspots. This accounts for the solar radio noise recorded by your scribe at 136MHz from the 10th to 13th inc. John Smith, Cranleigh, Surrey, noted that the mean solar noise level had increased at 140MHz over that period. John has been making radio observations of the sun for more than 12 years.

No doubt some form of solar activity was responsible for the ionospheric disturbance reported by the BBC World Service during the early hours of the 1st; this sort of information from the BBC is most useful to those readers who use the DX bands. Apart from a couple of short bursts of signals from the Cyprus beacon, 5B4C, (28.-180MHz) at 0630 on the 16th and 0905 on the 19th, the 10m band has been dead.

Did you know that the "hissing" which you can hear above the background noise of your receiver when the sun is "active", was first discovered in 1955 by Denis Heightman, G6DH, on the 10m band? Our readers are active in many fields. On February 18th Flt./Lt. John Keegan, CO 2464 (Storrington) Squadron, ATC, used 5 vehicles, each equipped with a Pye Cambridge, during a night exercise. These mobile units were spread over a 10 mile area of hills, vales, and woodland, not ideal for VHF communication with the short aerials attached to the cars. In addition the AP was low and falling and a moderate gale was blowing, but, despite this, and the undulating terrain, good communications were maintained throughout. On board each vehicle was a cadet wireless operator, and each one a keen radio enthusiast. After the exercise they were convinced that the "low-band" frequency was much better than the "high-band" frequency for reliable communications when conditions are bad.

The writer plans to be at the RSGB Convention at Alexandra Palace on May 7th and will be pleased to meet any of our readers who may be there. Thanks again to all who have sent in reports.

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<th>BROADCAST BANDS</th>
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<td><strong>Short Wave</strong> Reports by the 15th of the month to Derek Bell, 169 Max Rd., Chaddeston, Derby.</td>
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<td><strong>Medium Wave</strong> Logs to Charles Molloy, 132 Segars Lane, Southport, PR8 3JG.</td>
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<th>AMATEUR BANDS</th>
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<tr>
<td>Logs covering any amateur band/s in band/alphabetical order by the 25th of the month to Eric Dowdeswell G4AR, Silver Firs, Leatherhead Road, Ashtead, Surrey, KT21 2TW.</td>
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<tr>
<td>VHF Reports on VHF matters to Ron Ham, Faraday, Greyfriars, Storrington, Sussex RH20 4HE.</td>
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Adapted for reception of switch up to 3000 hours, and switch up to 5000 hours. Price 3/6d. VAT & posting.

RELAY BARGAIN

Type 600 relay with twin 500 ohm coils which may be joined or operated separately.寺 can be operated off voltages between 6 and 30 volts D.C. Price 6d each.

MULTISPEED MOTORS

Six speeds are available 500, 800, 1100, and 1400 rpm at 9 volt and 11000 rpm. Shaft is 1 inch diameter and is approximately 1 inch long. 250/360 volt. Its speed may be further controlled with the use of our Thyristor controller. Very popular computer, radio aerials, tape recorders, etc. 10c/approx. 2, dia x 1 x 1. In. Post & VAT.

SWITCH TRIGGER MATE

So this is undetectable under carry-type radios with slighter weight. For burglar alarm, 40 cents each. Post a box all ready to work. 7d-8s. 8p. VAT & posting.

SPIT MOTOR WITH CARTER

Gearbox Probably one of the best epil motors made. Originally intended to be used in very high priced cookies however this can be put to plenty of other uses, for use in your barbeque or to drive a tumbler for stone polishing. These drivers are no code to its uses. Normal motors operation. $2.00 omitting VAT & posting.

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Inverse power transformer used for many purposes. At 250 volts it is very well built with six secondarys and is quite expensive. $30 per 100-18 volt at up to 12 amps, 20-50 volt at up to 6 amps: single 10v at 12 amp; single 18 volt at 5 amp; single 24 volt at 3 amp. Transformer can be used for power circuits, lighting (and for switches) or for amplifiers, these being more than enough between the mains and the transformer. A transformer like this today would cost at least $25 from the makers, however we are able to offer a special offer at $9.95 Post & VAT paid. Grab some while you can, this stock may not last long.

8 POWERFUL BATTERY MOTORS

For models, Meccano, drills, remote control toys, boats, etc., £2.00.

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TECHNICAL: Where order is under $5 and 25¢ surcharge to offset packing expenses.

ITS FREE

Our monthly Advance Advertising is free to the public. If you are not yet receiving or have just arrived—often bargains with all sorts of special offers. It can appear—an interesting list and may even be the start of a recent list.

If you are interested, you may have a look at "The Transformer", 240 volts primary with 20 volt secondary, partial screen. This transformer has a set of 0.2mH inductors for special purposes. It is tapped to 90v. Any one of these secondaries may be tapped to 30v or 10v, and of course be spread over to all the secondaries. Use a bright metal base plate. Size 4" x 3" x 2". Price $2.95 & 9p. Post 40¢.

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Main Motor—double ended with normal mounting feet. Ideal for fan, box etc. Price 7s 6d. Post 7p. VAT 10¢.

Motorised Transformer, American RCA, their 12v-75W transformer, 360° 450° wattage for much more or under one £15.00. Price £3.95 & 9p. Post 40¢.

Push Button Double Changeover Switch. Hysteria, 10 amp for mains operation £2.95 & 9p. £5 15s. £7.95 & 9p. Price 3" £1.95 & 9p. Post 40¢.

Photo Multiplier Tube. American RCA, their 12v-125W transformer, 360° 450° wattage for much more or under one £15.00. Price £3.95 & 9p. Post 40¢.

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- A CMOS Day-of-the-Week Indicator that functions for one year on a battery of manganese cells
- A transient generator which produces keyboard triggered envelope profiles, for use with synthesiser VCAs and VCFs
- A mains-powered 3½-digit voltmeter based on the Ferranti ZNA116 dual-slope integration DVM chip
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`Practical Wireless, May 1977`
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<td>FANE 70</td>
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<tr>
<td>A.C. Current</td>
<td>1-5 μA</td>
<td>5 μA-2 5 A</td>
<td>5 μA-2 5 A</td>
</tr>
<tr>
<td>D.C. Volts</td>
<td>75V-800V</td>
<td>75V-600V</td>
<td>75V-1000V</td>
</tr>
<tr>
<td>A.C. Volts</td>
<td>300V-900V</td>
<td>15V-900V</td>
<td>1V-1000V</td>
</tr>
<tr>
<td>Resistance</td>
<td>0-225Ω</td>
<td>1K-1M</td>
<td>300-500Ω</td>
</tr>
<tr>
<td>Capacitance</td>
<td>0-5 μF</td>
<td>0-5 μF</td>
<td>0-5 μF</td>
</tr>
<tr>
<td>Accuracy</td>
<td>1-5 % D.C., 1-5 % A.C.</td>
<td>2-5 % D.C., 2-5 % A.C.</td>
<td>4-5 % A.C.</td>
</tr>
</tbody>
</table>

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