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THE FEBRUARY ISSUE WILL BE PUBLISHED ON 2nd JANUARY
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JANUARY 1978
Stereo FM Tuner
Fitted with Phase Lock-Loop Decoder

- **FET Input Stage**
- **VARI-CAP Diode Tuning**
- **Switched AFC**
- **Multi Turn Pre-sets**
- **LED Stereo Indicator**

Typical Specification:
- Sensitivity 3μV
- Stereo separation 30db
- Supply required 20-30V at 90mA max.

**STEREO FM TUNER**

A top quality stereo pre-amplifier and tone control unit. The six push-button switch provides a choice of inputs together with two really effective filters for high and low frequencies, plus tape output.

**Frequency response +1dB**
- 20Hz-20kHz

**Sensitivity of inputs:**
1. Tape input 100mV into 100K ohms
2. Radio Tuner 100mV into 100K ohms

**MK60 AUDIO KIT:** Comprising: 2 x AL60, 1 x SPM80, 1 x PA100, 1 front panel and knobs. Kit of parts to include on/off switch, neon indicator, stereo headphone sockets plus instruction booklet. COMPLETE PRICE £38.00 plus 62p postage

**TEAK 60 AUDIO KIT:** Comprising: Teak veneered cabinet size 18½" x 11½" x 3½", other parts include aluminium chassis, heatsink and front panel bracket plus back panel and appropriate sockets etc. KIT PRICE £13.25 plus 82p postage.

**STEREO 30 COMPLETE AUDIO CHASSIS**

The Stere 30 comprises a complete stereo pre-amplifier, power amplifiers and power supply. This, with only the addition of a transformer or overwind will produce a high quality audio unit suitable for use with a wide range of inputs, i.e. high quality ceramic pick-ups, stereo tuners, stereo tape deck, etc. Simple to install, capable of producing really first class results, this unit is supplied with full instructions, black front panel, knobs, mains switch, fuse and fuse holder and universal mounting brackets, enabling it to be installed in a record plinth, cabinets of your own construction or the cabinet available, ideal for the beginner or the advanced constructor who requires Hi-Fi performance with a minimum of installation difficulty (can be installed in 30 minutes).

**TRANSFORMER** £3.25

**TEAK CASE** £5.45

**TOTAL** £16.25

**STEREO 30 COMPLETE CHASSIS**

- **7 WATTS R.M.S.**
- **Dimensions:** 105mm x 63mm x 30mm
- **Transformer BMT80:** £5.40 + 86p postage
- **Pre-sets:**
  - **1.** Tape input 100mV into 100K ohms
  - **2.** Radio Tuner 100mV into 100K ohms

**AL 60**

- **25 Watts (RMS)**
- **VAT** 20%

**SPM80 Stabilised Power Supply**

SPM80 is especially designed to power 2 of the AL60 Amplifiers, up to 15 watts (r.m.s.) per channel simultaneously. With the addition of the Mains Transformer BMT80, the unit will provide outputs of up to 15A at 35V. Size: 63mm x 105mm x 30mm. Incorporating short circuit protection.

- **Input Voltage:** 33-40 V.A.C.
- **Output Voltage:** 33V D.C. Nominal
- **Output Current:** 10mA-1.5 amps
- **Overload Current:** 1.7 amps approx.
- **Dimensions:** 105mm x 63mm x 30mm

**Transformer BMT80:** £5.40 + 86p postage

**BI-PAK**

- **OUR PRICE** £20.45
- **Dimensions:** Overlead 10mA-1.5 amps 33V D.C. Nominal
- **Output Voltage:** 105mm x 63mm x 30mm

**S450**

- **Transformer BMT80:**
- **Output Voltage:** 105mm x 63mm x 30mm

**STereo 30 COMPLETE AUDIO ChASSIS**

- **7+7 WATTS R.M.S.**
- **Dimensions:** 105mm x 63mm x 30mm
- **Transformer BMT80:** £5.40 + 86p postage

**BIC**

- **Output Voltage:** 105mm x 63mm x 30mm
- **Transformer BMT80:** £5.40 + 86p postage

**BI-PAK**

- **OUR PRICE** £20.45
- **Dimensions:** Overlead 10mA-1.5 amps 33V D.C. Nominal
- **Output Voltage:** 105mm x 63mm x 30mm

**AL 60**

- **25 Watts (RMS)**
- **VAT** 20%

**SPM80 Stabilised Power Supply**

SPM80 is especially designed to power 2 of the AL60 Amplifiers, up to 15 watts (r.m.s.) per channel simultaneously. With the addition of the Mains Transformer BMT80, the unit will provide outputs of up to 15A at 35V. Size: 63mm x 105mm x 30mm. Incorporating short circuit protection.

- **Input Voltage:** 33-40 V.A.C.
- **Output Voltage:** 33V D.C. Nominal
- **Output Current:** 10mA-1.5 amps
- **Overload Current:** 1.7 amps approx.
- **Dimensions:** 105mm x 63mm x 30mm

**Transformer BMT80:** £5.40 + 86p postage

**STEREO FM TUNER**

Fitted with Phase Lock-Loop Decoder

- **FET Input Stage**
- **VARI-CAP Diode Tuning**
- **Switched AFC**
- **Multi Turn Pre-sets**
- **LED Stereo Indicator**

Typical Specification:
- Sensitivity 3μV
- Stereo separation 30db
- Supply required 20-30V at 90mA max.

**STEREO PRE-AMPLIFIER PA 100**

A top quality stereo pre-amplifier and tone control unit. The six push-button switch provides a choice of inputs together with two really effective filters for high and low frequencies, plus tape output.

**Frequency response +1dB**
- 20Hz-20kHz

**Sensitivity of inputs:**
1. Tape input 100mV into 100K ohms
2. Radio Tuner 100mV into 100K ohms

**MK60 AUDIO KIT:** Comprising: 2 x AL60, 1 x SPM80, 1 x PA100, 1 front panel and knobs. Kit of parts to include on/off switch, neon indicator, stereo headphone sockets plus instruction booklet. COMPLETE PRICE £38.00 plus 62p postage

**TEAK 60 AUDIO KIT:** Comprising: Teak veneered cabinet size 18½" x 11½" x 3½", other parts include aluminium chassis, heatsink and front panel bracket plus back panel and appropriate sockets etc. KIT PRICE £13.25 plus 82p postage.

**STEREO 30 COMPLETE AUDIO CHASSIS**

The Stere 30 comprises a complete stereo pre-amplifier, power amplifiers and power supply. This, with only the addition of a transformer or overwind will produce a high quality audio unit suitable for use with a wide range of inputs, i.e. high quality ceramic pick-up, stereo tuners, stereo tape deck, etc. Simple to install, capable of producing really first class results, this unit is supplied with full instructions, black front panel, knobs, mains switch, fuse and fuse holder and universal mounting brackets, enabling it to be installed in a record plinth, cabinets of your own construction or the cabinet available, ideal for the beginner or the advanced constructor who requires Hi-Fi performance with a minimum of installation difficulty (can be installed in 30 minutes).

**TRANSFORMER** £3.25

**TEAK CASE** £5.45

**TOTAL** £16.25

**STEREO 30 COMPLETE CHASSIS**

- **7 WATTS R.M.S.**
- **Dimensions:** 105mm x 63mm x 30mm
- **Transformer BMT80:** £5.40 + 86p postage

**STEREO FM TUNER**

Fitted with Phase Lock-Loop Decoder

- **FET Input Stage**
- **VARI-CAP Diode Tuning**
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**TRANSFORMER** £3.25

**TEAK CASE** £5.45

**TOTAL** £16.25
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**SPECIFICATION:**
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- **Harmonic distortion:** 0.1%
- **Load impedance:** 8-16 ohm
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- **Frequency response:** 20Hz-40KHz
- **Sensitivity for 25 watts O/P:** 280mV R.M.S.
- **Max. Heat sink temperature:** 90°C
- **Dimensions:** 102mm x 64mm x 15mm
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- **Fuse requirements:** 1-5A

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- Load Impedance: 8 to 16 ohms
- Sensitivity: 90mV for full output
- Frequency Response: 60Hz to 25KHz
- Max. Heat Sink Temp: 80°C
- Dimensions: 90 x 64 x 27mm

Only £3.65

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Stereo Power Supply designed for use with AL30A, PA12 etc. Input voltage 22-30v D.C. Output current 800mA

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Specially designed for use in Disco Units, P.A. Systems, high power Hi-Fi, Sound reinforcement systems

**SPECIFICATION:**
- **Input Power:** 125 watt RMS
- **Continuous:**
- **Operating voltage:** 50-80
- **Load:** 4-16 ohms
- **Frequency response:** 25Hz-20KHz Measured at 100 watts
- **Sensitivity for 100 watts output at 1kHz:** 450mV
- **Input impedance:** 33K ohms
- **Total harmonic distortion:**
  - 50 watts into 4 ohms: 0.1%
  - 50 watts into 8 ohms: 0.06%
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A common problem with photographs which have been taken with the aid of a single flash unit is that they have very sharp and rather unnatural shadows. The usual solution to this difficulty is to use a suitably positioned second electronic flashgun which is automatically fired by a slave unit. A photoflash slave unit is merely a device which fires the secondary flash when it picks up the pulse of light produced by the primary flashgun. Thus, it is really just a type of photosensitive switch.

It is obviously essential for the device to operate at very high speed so that the secondary flashgun fires while the camera shutter is open. This virtually instantaneous operation can be easily achieved with a solid state switching device, as opposed to a mechanical component such as a relay which would be too slow. It is also desirable for the unit to be very sensitive so that it does not have to be critically positioned in order to obtain correct slave firing.

The photoflash slave unit which is described in this article has been designed to use few components, but without sacrificing sensitivity and reliability of operation as a result.

THE CIRCUIT

The complete circuit diagram of the unit is provided in Fig. 1. There are basically three sections: the light detector circuit which utilises TR1, an amplifier incorporating IC1, and a solid state switching device which actually controls the second flashgun, SCR1.

TR1 is a photo-Darlington transistor with R2 as its emitter load. The current which is passed through R2 and the collector-emitter terminals of the phototransistor is largely determined by the light level which is incident on the device. The higher this light level, the higher the current which flows in this collector-emitter circuit, up to the point where the phototransistor becomes saturated. When TR1 is in this condition it exhibits a collector-emitter impedance of only a few ohms.

In normal operation TR1 conducts more heavily when it receives a pulse of light from the main flashgun. This generates a positive output voltage at the emitter which is fed via C2 to the amplifier section. If TR1 should become saturated then obviously the required positive voltage pulse cannot be generated and the unit would be rendered inoperative. A photo-Darlington transistor is a very sensitive device which can be readily saturated at ordinary light levels. R1 is therefore connected in the base circuit of the transistor, and this component reduces its sensitivity to a level at which saturation is unlikely to occur under normal circumstances.

The amplifier section incorporates a CA3130T operational amplifier used in the non-inverting mode. R3 sets the input impedance of the amplifier at 4.7k Ω, and feedback resistors R4 and R5 set the voltage gain of the circuit at approximately 1,200 times. The circuit may at first look perfectly conventional, but it is a little unusual in that the dual balanced positive and negative supply rails usually provided for an operational amplifier are not present. Instead, a single positive supply rail is used.

This arrangement would not be satisfactory for the majority of i.c. operational amplifiers as their outputs will not take up a voltage of less than about 2 volts relative to the negative rail, and the two inputs would need to be at a minimum potential of about this level if the amplifiers were to function correctly. The CA3130T i.c. does not suffer from these drawbacks, and it will operate perfectly well with either the inputs or the output at virtually the same potential as the negative supply rail. This ground referenced amplifier therefore works correctly, but of course it can only produce an output which is positive with respect to the negative supply rail. An i.c. such as the 748 cannot be substituted for the CA3130T in this application.

Coupling capacitor C2 has been given a relatively low value so that the circuit will only respond to fairly fast changes in light level (such as the flash from a flashgun), and will not be spuriously triggered by ordinary changes in ambient light level. C3 is the compensation capacitor for IC1, and with the specified value the i.c. has a typical slew rate of about 15 volts per microsecond and an fT of about 5MHz. Thus, it easily provides the required fast operating speed as also, of course, does
FLASH SLAVE UNIT

HIGH SENSITIVITY QUICK-ACTING UNIT WHICH CAUSES A SECOND ELECTRONIC FLASHGUN TO BE TRIGGERED BY A PRIMARY PHOTOFLASH.

COMPONENTS

Resistors
(All 1/4 watt 10%)
R1 5.6kΩ
R2 5.6kΩ
R3 4.7kΩ
R4 1kΩ
R5 1.2MΩ

Capacitors
C1 0.22µF type C280 (Mullard)
C2 0.047µF type C280 (Mullard)
C3 39pF ceramic plate

Semiconductors
TR1 2N5777
IC1 CA3130T
SCR1 1amp, 400 p.i.v. (see text)

Switch
S1 s.p.s.t., rotary or toggle

Miscellaneous
Plastic case
9 volt battery type PP3 (Ever Ready)
Battery connector
Veroboard, 0.1in. matrix
Control knob (if needed for S1)
Flash extension lead
Wire, solder, etc.

Fig. 1. The circuit diagram of the photoflash slave unit. Despite the small number of components, it has a high degree of sensitivity.
the phototransistor TR1.

The same is true of the switching device, SCR1, which has its gate terminal fed from the output of IC1. IC1 output is normally at nearly the negative supply rail voltage, but when the main flashgun fires and produces a positive voltage spike at TR1 emitter this spike is amplified by IC1 and fed to the gate of SCR1. This switches on SCR1, which is connected across the flash lead of the second flashgun, and so this flashgun is fired in sympathy with the main one. SCR1 automatically turns off after the secondary flashgun operates, and the slave unit is then ready for the next flash at TR1.

S1 is an ordinary on-off switch and can be rotary or toggle, as desired. A rotary switch was employed in the prototype. Power is obtained from a PP3 battery and, since the quiescent current consumption of the unit is only about 350 µA, this will have nearly its shelf life even if the unit is used frequently.

SCR1 is a silicon controlled rectifier, or thyristor, rated at 1 amp 400 p.i.v. and housed in a TO5 or TO39 case. A suitable type is the THY1A/400 available from Bi-Pak Semiconductors. The 2N5777 specified for TR1 can be obtained from several suppliers. The author's unit was housed in a plastic case, with aluminium front panel having nominal dimensions of 85mm by 37mm by 56mm. Any other plastic case of similar size which will take the Veroboard component panel, battery and switch could alternatively be used, if desired.
CONSTRUCTION

Apart from the on-off switch and battery, all the components are mounted on a 0.1in. matrix Veroboard panel which has 20 holes by 7 copper strips. Details of this panel are shown in Fig. 2.

There are six breaks in the copper strips which are made before the components are soldered into position. The lead-out wires of TR1 are left full length, and should not be trimmed at all. The curved surface of this transistor, which presents the light sensitive area, faces towards the outer edge of the Veroboard. Make sure that the two link wires are not accidentally omitted.

The prototype slave unit is housed in the plastic case just referred to. S1 is mounted in the centre of the front panel.

The most practical way of connecting the unit to the secondary flashgun is via a flash extension lead. The plug end of this lead connects to the flashgun, and the socket at the other end is cut off. A hole 4mm. in diameter is drilled in the left hand side of the case behind the Veroboard, and the free end of the flash lead is then threaded through this and around the Veroboard panel. Its wires are soldered to the appropriate points on the component panel.

An important point to note here is that the flash lead must be connected with the polarity shown in Fig. 2 as otherwise the silicon controlled rectifier will be unable to trigger the flashgun. The polarity of the voltage across the flash lead can be determined with the aid of a multimeter set to a high volts range, say 500 or 1,000 volts f.s.d. If a multimeter is not available then it is possible to find the correct polarity by trial and error, since no harm will come to the circuit if the flash lead is connected the wrong way round.

The case has mounting rails for printed circuit boards, and the component board is mounted vertically in the set of rails on the extreme left hand side of the case, with the component side of the board facing into the middle of the case.

A hole must be drilled in the top of the case adjacent to the phototransistor so that this can receive the light from the main flashgun. This hole is about 6mm. to 8mm. in diameter, and the phototransistor is pushed into it from the inside. Otherwise, the case will screen the phototransistor to some degree, and this would have the effect of making the unit more directional. In order to improve appearance a small piece of Sellophane, light diffusing material or thin Perspex is glued over the hole. A flat washer, which acts as an escutcheon, is then glued in place over this.

The battery fits neatly in place at the extreme right hand side of the case, and no form of mounting bracket is required.

USING THE UNIT

The slave unit is very sensitive. Within reason it does not matter in which direction the unit is aimed when it is used indoors. Light which is reflected from walls and ceilings is almost invariably adequate to trigger the device. Probably the best plan is to aim the unit at the ceiling when it is being used indoors, as ceilings are normally light in colour and therefore reflect light efficiently.

When used out of doors it is normally necessary to aim the slave unit direct at the main flashgun, as there is little in the way of reflected light. Even if the main flashgun is a low powered type, the unit should work satisfactorily up to a maximum range of at least 40 feet or so.
MINI CALCULATING WATCH

Earlier this year the zenith of electronic calculator/timepiece development seemed to be the Casio Crystal Quartz CQ-1 — a handy electronic calculator combining also the features of a digital watch with built-in calendar memory, stopwatch and alarm clock.

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It tells the time in hours, minutes and seconds (12 hour with am and pm, or 24 hour system). At the touch of a button its internal calendar shows the year, month, date and day of the week; and no fussing about at the end of a month that doesn’t have 31 days. Touch another button and it tells the time somewhere else!

The MQ-1 is small, under 4½ x 1½ x ¾ inches, and weighs only 1½ ounces. It has a liquid crystal display powered by two tiny silver oxide batteries, and has an amazing battery life of some 13,000 hours — or 18 months. All at a recommended retail price of only £39.95.

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THE COMPLIMENTS OF THE SEASON

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The Litesold wood burning tool electrically heats the specially shaped interchangeable brass tips to just the right temperature for the controlled burning of wood and leather surfaces to give beautifully artistic effects. By variation of speed and pressure, direction of movement and the shape of the tip, it is simple to produce markings in a variety of shades and widths, allowing designs, decorations and complete pictures to be applied to a variety of wooden and leather articles.

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The 24v version is particularly suitable for schools and may be operated from either an existing 24v supply or from the Litesold 2450 Power Unit.

The cost of the Litesold Poker Work Tool, complete with four bits and an allen key, is £9.67 each including postage, packing and 8% VAT.

Orders and the appropriate remittance should be sent direct to: Light Soldering Developments Limited, 97/99 Gloucester Road, Croydon, Surrey.
**COMMENT**

**FERROCHROM TAPE**

The accompanying photograph illustrates Ferrochrom tape cassettes manufactured by BASF. These dual oxide tapes were introduced in the beginning of 1976, and BASF have passed on some useful details concerning the manner in which they should be used. When they first appeared, few cassette machines were capable of realising the full capability of the tape but since then many more cassette machine manufacturers have produced models with Ferrochrom bias adjustment. BASF feel, therefore, that it is now appropriate to remind people of the advantages of Ferrochrom tape, especially its extremely high output which BASF considers exceeds all other commercially available cassettes.

Ferrochrom tape has a two-layer coating which starts with a polyester base coated with a relatively thick high density ferric oxide dispersion. On top of this is added a carefully controlled layer of chromium dioxide. The resultant composition exploits the simple theory that low frequencies are reproduced from the whole of the tape coating whilst high frequencies are reproduced from the top of the coating.

Because of its dual oxide, the optimum bias current for Ferrochrom is a value approximately half-way between the current for ferric oxide and that for chromium dioxide. Ferrochrom can still be used on a conventional ferric recorder where, at a VU setting of +2dB, it gives an overall output 4 to 5dB higher than BASF LH tape. On playback the higher frequencies are overpronounced, giving an effect similar to that of a Dolbyised cassette played back on a non-Dolby machine. The effect is easily remedied by a slight adjustment of the amplifier treble control. BASF state that the frequency response and dynamic range achieved using Ferrochrom in this way is equal to that of a chromium dioxide cassette played on a machine biased for chromium dioxide.

With recorders having a manual chrome switch it is possible to record Ferrochrom in either of the two ways to avoid the necessity of adjusting the treble control on playback. The first is to record on ferric setting with a VU level of +2dB, then play back on chrome setting. The second method is to record on chrome setting with a VU level of 0dB and play back on ferrite setting. Ferrochrom should not be recorded and played back on the chrome setting as this produces unpleasant high frequencies and requires an unsatisfactory recording level.

The best results are achieved on cassette recorders biased for Fe-Cr. On these the dynamic range from a VU setting of 0dB is 1.5dB greater than that possible from chromium dioxide.

BASF Ferrochrom is available in C60 and C90 lengths. Each cassette housing has a large window which enables the user to see the tape hubs and BASF's patented tape transport system: Special Mechanics (SM). The amount of tape on each hub is accurately shown and any disturbance of the tape can be seen before problems occur.

Amongst the many aspects of electronics featured in this issue are two concerned with TV. The TV Anti-Theft article is of course of much wider application and articles of this nature are, inevitably, widely read.

In the In Your Workshop feature Dick and Smithy delve into the intricacies of Vertical Time Base Synchronisation and convey to the reader, in an easy assimilated manner, much useful information.

Also concerned with TV is a new booklet, Objective TV Measurements, from Marconi Instruments Ltd., a GEC Marconi Electronics company. The text, accompanied by many illustrations, explains the various television measurement parameters and the use of Insertion Test Signals — ITS — to measure them. The booklet describes the range of MI instruments available to meet national and international ITS requirements and the ways in which systems can be tailored to meet individual requirements.

The booklet is available on request from the Publicity Department of Marconi Instruments, Longacres, St. Albans, Herts.

**BBC WAVELENGTH CHANGES IN 1978**

From 23 November 1978 a new international frequency agreement comes into effect. This provides for a considerable increase in the number and power of transmitters in Europe, and many of the frequencies used for BBC Radio will be changed.

We will give more details and background information next month.
No. 7

SEQUENCE GENERATOR
AN UNUSUAL DESIGN INCORPORATING 2 I.C.'s

By I. R. Sinclair

This interesting circuit generates a sequence of voltages on five output terminals, and the sequence starts to repeat only after 31 input pulses. It can be used as a frequency divider dividing by 31 or, more interestingly, as a generator of code signals or musical notes. The circuit shown here generates the sequence with the outputs monitored by l.e.d.'s, so that any use other than the random light display of the l.e.d.'s will require additional gating and other circuitry which can be added on another Blob Board.

SHIFT REGISTER

The heart of the circuit, which is shown in Fig. 1, is a shift register type 7496. This contains five flip-flops connected to each other in sequence. The outputs of two of these flip-flops, QC and QE, are taken to the two inputs of an exclusive-OR gate, and the gate output is taken to the serial input of the 7496 to be fed as an input to the shift register. For those who have not met the exclusive-OR gate before, details are given in Fig. 2 and Table 1. From these you will see that the output of the gate is a logic 1 only if one of the inputs is at logic 1. If both inputs are at logic 1 or both are at logic 0, the output of the gate is 0.

Fig. 1. The circuit diagram of the sequence generator. The circled numbers apply to the Blob Board tracks, the remaining numbers being i.c. pin numbers. The earth symbols indicate the negative supply.
TABLE 1

Exclusive-OR Truth Table

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<th>A</th>
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Now the principle of a shift register is that any logic digit, 1 or 0, that is present at the serial input when a clock pulse arrives at the clock pin will be transferred to the first stage of the register (A), and will appear at the output of this stage, QA. The next clock pulse will then transfer this signal to the next output, QB, and will enter a new signal into QA. This process continues at each clock pulse, with the digit present at the input being fed in, and each stored digit being moved one place to the right. See Table 2 and Fig. 3. Normally, when the QE output is reached the information is then lost at the next clock pulse. In our circuit, however, the exclusive-OR gate ensures that when there is a 1 at either QC or QE, a 1 will be fed in at the serial input; and that a zero will be fed in when there are logic 1 or logic 0 signals at both QC and QE. Because of this, the sequence of digits passing through the shift register is continually changing and is shown in Table 3, in which column F is the

TABLE 2

Serial Input-Clock Sequence

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TABLE 3

Sequential Generator Truth Table

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COMPONENTS

Resistors
(All 1/4 watt 10%)
R1 1kΩ
R2-R6 470Ω (see text)
Capacitor
C1 680µF electrolytic, 10V. Wkg.
Semiconductors
IC1 7476
IC2 7496
LED1-LED5 TIL 209
Switch
S1 miniature slide switch
Blob Board
Blob Board type ZB-2-IC
output of the exclusive-OR gate which feeds into the serial input. Table 3 starts with a set of 1's stored and goes through the whole sequence, with State 32 being the same as State 1. If i.e.d.'s are attached to each output terminal they will flash on and off in an apparently random fashion when the register is clocked slowly.

The exclusive-OR gate can be built up using NAND gates and inverters, but it is much simpler to employ a ready made exclusive-OR gate in i.c. form. The 7486 is a quad exclusive-OR gate (four separate gate circuits on one chip) which is relatively cheap at the moment. The only chance of interrupting the count occurs when all the register outputs should reach zero, since this prevents a 1 ever being fed into the serial entry pin. This can only occur if all the register outputs are at zero when the circuit is switched on, but we must be able to break this state if it should appear. To do so, we use the preset enable pin (pin 8) of the 7496 to enter a set of 1's if the register happens to start with a set of zeros. Normally, S1 in Fig. 1 is closed; it is momentarily opened to allow the preset enable input to go high and then closed again.

As an indication of some of the possibilities of this circuit, Fig. 4 shows the outline of a random harmony generator in which one of the outputs of the shift register is used to switch an oscillator on and off. The remaining four outputs are taken to a 74141 decoder, which gives an output on one of its ten output pins for each combination of four inputs (and some odd outputs, because four inputs can give sixteen combinations, and the 74141 can give only ten outputs). Each of these outputs can drive an oscillator at a different frequency, and the notes can be mixed to provide an output to an amplifier. The oscillators can be Schmitt trigger types, as were described in the third Blob-A-Job article, "12 Note Tone Generator", published in the last August issue, Note that the 74141 outputs are low when activated, so that an inverter must be interposed between each output and the oscillator gating input. I suspect that at times some modern composers are already using a system of this type.

The clock pulses for the circuit of Fig. 1 are generated by the remaining exclusive-OR gates using these as simple inverters, so that the circuit needs only two i.c.'s. This is a common type of t.t.l. oscillator, though it is unusual to employ exclusive-OR gates in it. Although C1 is a normal polarised electrolytic capacitor, it functions quite satisfactorily in the circuit in practice. The oscillator runs at approximately 1Hz.

BUILDING THE CIRCUIT

The circuit is constructed on a ZB-2-IC Blob Board. If extra gating is to be used for a note generator such as that just outlined the components required can be assembled on one or more further Blob Boards.

Start construction by soldering on the two i.c.'s in the usual way. Place the Blob Board on the bench correct way round so that the printing is right way up then tin each pin of the i.c.'s. Place IC1 on the Blob Board with pin 1 at pad 7 and pin 8 at pad 20. Solder pin 1 to its pad and check the i.c. positioning. If all is well, solder pin 8 and recheck. Remember that only a blob of solder is required for each connection, since the tinning on the Blob Board makes soldering a very quick operation. If IC1 is correctly positioned, solder all the remaining pins to their respective pads. The reason for this procedure is that it is easy to remove an incorrectly positioned i.c. if only two of its pins are soldered. If all are soldered it is necessary to use desoldering braid.

Repeat the process with IC2. This is a sixteen pin i.c., so pin 1 is first soldered to pad 26, and then pin 9 is soldered to pad 41, with the same checks being carried out after each step. If all is well the remaining pins are then soldered. The two i.c.'s are shown in position in Fig. 5.

Now connect the 5 volt positive and earth (negative supply) lines. With the ZB-2-IC board it is convenient to use track 1 for the positive supply and track 2 for the earth. Using insulated link wires, connect pin 7 of IC1 (pad 19) and pin 12 of IC2 (pad 35) to the earth line at track 2. Next, connect pin 14 of IC1 (pad 8) and pin 5 of IC2 (pad 34) to the positive supply at track 1. Connect another link wire between tracks 2 and 23, so that a second earth line is available at the bottom of the board. These links are all shown in Fig. 5.

Further wiring steps are given in Fig. 6. Connect

![Fig. 4. An experimental suggestion intended for the more experienced constructor. One Schmitt trigger oscillator is switched by output A, and the others, after inversion, by the ten outputs from the 74141 decoder.](image-url)
two tags of S1 to pads 40 and 42, and add a short link wire between pad 42 and track 23. This completes the switching circuit to the preset enable input at IC2 pin 8. If a third tag of the switch is above track 23 it may be soldered to that track for mounting stability. The switch will almost certainly be double pole and the remaining pole tags may also be soldered to the pads of 40 and 42, and to track 23, if it is felt that this causes the switch to be positioned more firmly.

The l.e.d. circuits are completed next. The series l.e.d. resistors, R2 to R6, are specified as 470 ohm in the Components List, but lower values, down to 330 ohm, can be employed if a brighter display is required. The output pins of IC2 are 15, 13, 14, 11 and 10, and each series resistor is blobbed from the appropriate pad to a spare pad, as in Fig. 6. Fit sleeving over the resistor lead-outs where there is a risk of short-circuits to other lead-outs or components. From each of these spare pads in turn, an l.e.d. is connected to earth. The lead of the l.e.d. is identified by a flat on the l.e.d. plastic body which connects to earth.

The exclusive-OR gates which control the register can now be wired in. Blob an insulated wire link from pin 11 of IC1 (pad 14) to pin 9 (pad 41) of IC2. Blob a further insulated link from pin 12 of IC1 (pad 12) to pin 10 of IC2 (pad 39), and another insulated link from pin 13 of IC1 (pad 10) to pin 13 of IC2 (pad 33). Then add an insulated link from pin 8 of IC1 (pad 20) to pin 1 of IC2 (pad...
26), so connecting the oscillator output to the shift register.

Two further insulated link wires connect inputs and outputs in the oscillator circuit. Connect pin 6 of IC1 (pad 17) to pin 10 of IC1 (pad 16), then connect pin 3 of IC1 (pad 11) to pin 5 of IC1 (pad 15). Pins 2, 4 and 9 of IC1 are left open-circuit, allowing these inputs to take up a high potential. Blob C1 between IC1 pin 10 (pad 7) and IC1 pin 6 (pad 17), with positive to pad 17. Finally, blob R1 between IC1 pin 1 (pad 7) and IC1 pin 3 (pad 11).

**OPERATION**

Check your connections and then apply a supply, taking great care to observe correct polarity. The circuit draws a fairly high current, of approximately 60mA, and as usual it may be powered directly by a 4.5 volt dry battery. It may also be powered by a 6 volt dry battery if a forward connected silicon rectifier is inserted in series in the positive supply lead to drop the voltage, or by a 6 volt accumulator with two forward connected silicon rectifiers in series in the positive line. See Fig. 7. A suitable rectifier type is the 1N4001. The circuit must **not** be supplied by a 6 volt accumulator which is on charge.

The l.e.d.'s should then flash in the sequence shown in Table 3. Check the order by resetting to 11111 (all l.e.d.'s lit) by opening and closing S1.

Note that if the sequence generator is to be used with gates, some care has to be taken over the gate outputs. Gates such as the 7400 must **never** have their output terminals directly connected together, because if one gate output is at 1 and the other is at 0 a very large current can pass, burning out the circuit. Some types of gate with open-collector outputs can, however, be wired in this way, as is illustrated in Fig. 8, so that the outputs of several gates can be combined. This is called a ‘wired-OR’ connection. Suitable open-collector gates are the 7401 and 7403 quad 2-input NAND gates.
There are quite a few applications in which a double period electronic timer can offer practical advantages when compared with a single timer. One particular instance is given when the first timing period is employed to control a process, such as a photographic enlargement exposure, after which the second period allows warning to be given for a limited time that the process has been completed. Two-step processes, in which a second process follows the first, may also be controlled.

The circuit to be described in this month's article in the "Suggested Circuit" series allows independent two-stage process timing to be achieved. The design is general in nature since it is assumed that the constructor will be able to choose his own timing components. It is also slightly experimental, as it may be necessary for the value of one capacitor to be determined empirically after the circuit has been assembled.

CIRCUIT DIAGRAM

The complete circuit of the two-step time switch is given in Fig. 1, and it incorporates two 555 i.c.'s, each of which operates a relay. The relay contacts switch on the processes concerned. It is assumed that each timing period will be at least several seconds long.

The unit is switched on by means of S2, whereupon the trigger pins 2 of each 555 are taken to the positive
rail via R1 and R3 respectively. Under this condition, both the i.c.'s are inhibited and their outputs, at pin 3, are low. The circuit remains in this condition until the "Start" push-button, S1, is pressed. The trigger pulse then taken from the output at pin 3 goes high, the discharge coupling at pin 7 is taken off C2, and the latter commences to charge via R2. Since pin 3 of IC1 has gone high an energising current passes via D1 through the coil (shown as a rectangle of relay RLA1), and this relay operates. Its normally-open contacts close and the first controlled process is switched on.

This situation is maintained until the voltage across C2 reaches two-thirds of its supply voltage. The threshold input at pin 6 then causes the internal flip-flop in the i.c. to change state and the output goes low again. Relay RLA2 releases and its contacts open. At the same time a negative-going trigger pulse is applied via C4 to pin 2 of IC2. This goes through the same timing process as did IC1, with C5 charging via R4, and it causes relay RLA2 to energise and its contacts to close. When the voltage across C5 reaches two-thirds of the supply voltage the second timing period ends, the output goes low again and relay RLA2 releases. The circuit is then ready for another cycle of operations, which can be initiated by pressing S1.

The current drawn from the 9 volt supply is approximately 10mA when the relay is de-energised, this increasing by the current in each relay coil as the relays operate.

**COMPONENT VALUES**

The length of the timing period given by IC1 is equal to 1.1 times the product of R2 and C2, where time is in seconds, resistance is in megohms and capacitance is in microfarads. Similarly, the timing period given by IC2 is equal to 1.1 times the product of R4 and C5. The values required in the two capacitors will almost certainly be such that they will need to be electrolytic, and they are shown as such in Fig. 1. Although not essential, it is desirable that the resistor values lie in the range of some 10KΩ to 300KΩ. These values will allow robust circuit conditions with charging currents which are not too high or too small. Since the capacitors are electrolytic components with typical tolerances on value of +50% and -10%, the resistors will need to be partly presettable so that precise timing periods may be achieved.

As an example, Fig. 2 illustrates suitable values for R2 and C2 when it is desired that the timing period for IC1 be 10 seconds. The product of R2 and C2 multiplied by 1.1 should be equal to 10 seconds, whereupon this product is approximately equal to 9. Suitable values would be 90kΩ (0.09MΩ) and 100μF. If C2 is on its highest tolerance R2 needs to be 50% down, at 60kΩ, and when C2 is at its lowest tolerance R2 needs to be 10% up, at 100kΩ. These requirements could, as a first step, be given by making R2 a 40kΩ pre-set potentiometer in series with a 60kΩ fixed resistor, as in Fig. 2(a). The pre-set potentiometer is then adjusted for a precise timing period of 10 seconds.

There are, however, tolerances in the potentiometer and the fixed resistance as well, the tolerance in the potentiometer being usually as high as 20%. To take these in, the potentiometer value should be greater than 40kΩ; the next preferred value of 47kΩ is just a little too low from upsetting circuit operation. The other two diodes, D2 and D4, damp any back-e.m.f. voltages across the coils after de-energising. D1 also enables the output of IC1 to fall rapidly to the low state and impart a suitable starting pulse to IC2.

If the circuit is powered by a 9 volt battery it should function as shown in Fig. 1. If, alternatively, a supply of around 9 volts is provided by a mains power unit, difficulties can arise if the supply voltage is not reasonably well stabilized and smoothed. With a poor supply it may be found that IC2, as well as IC1, is triggered when S1 is pressed. This effect can be cleared by adding a capacitor of around 100pF to 400pF across R3 in the CX position. The value required is found experimentally, and should be the smallest which allows reliable operation to occur. The mains power supply should be switched on first, at its mains input, before S2 is closed.

**TRIGGER INPUTS**

The only critical points in the circuit are at the i.c. pin 2 trigger inputs. These inputs have a very high impedance and can cause the i.c.'s to be triggered by very short negative-going spikes picked up from wiring or via the supply rails. The wiring to pin 2 of each i.c. should be kept reasonably short and clear of the wiring to pins 3 and 7 of the same 555. Capacitor C1 ensures that IC1 is not triggered when the circuit is switched on by S2.

The diodes D1 and D3 isolate the relay coils from the circuit when the output of the appropriate i.c. goes low at the end of a timing period, thereby preventing coil voltage changes as each coil field collapses.
TWO NEW SPEAKERS COMBINE EUROPEAN AND JAPANESE TECHNOLOGY

Two new speakers from Sansui are claimed to offer superb sound, particularly for their price category.

Known as the Sansui ES 203 and ES 205, the speakers handle maximum input powers of 30 and 50 watts, respectively. They are both two-way, two-speaker systems; the former a bass reflex type, the latter an acoustic air suspension type. Impedance is 8 ohms and sensitivity 90dB/watt. Woofers and tweeters are, respectively, 165mm and 65mm (ES 203) and 204mm and 80mm (ES 205).

Sansui are particularly proud of the medium-sized, ES 205. This has a crossover network — two-way, 12dB/oct. crossover frequency — 2500Hz. A new flat-baffle design eliminates speaker mounting frames, and provides greatly improved sound dispersion. Dimensions are 250mm wide, 480mm high and 241mm deep. Finish is in simulated walnut grain with detachable front grille in deep grey cloth.

MARCONI MK. VIII CAMERA

That world-beater, the Marconi Mk. VIII colour television camera, is in the news once more. The Kuwait Ministry of Information has again ordered television systems built around it in a contract worth over £1 million.

Under this contract, Marconi Communication Systems Limited, a GEC Marconi Electronics company, is to supply seven Mk. VIII cameras, vision and sound mixers, sync generators and an extensive range of ancillaries to complete the facilities at Kuwait's Radio and Television Centre. The equipment, which will be used in two new studios at the Centre, is scheduled to be "on air" in time for the celebrations marking Kuwait's National Day on February 25th, 1978.

The Marconi Mk. VIII is claimed to be the world's most advanced automatic colour television camera. It has achieved a global sales total which has now exceeded the 450 mark and is in use or on order in more than twenty countries throughout the world, including U.S.A. and the U.S.S.R. In the United Kingdom the camera is in use with Southern TV, Tyne Tees, Ulster, Anglia, Harlech, London Weekend Television, the BBC and the Churches Television Centre, as well as Scottish Television.

Marconi's have also been busy on the home front. By the Spring of 1979 many listeners to BBC medium wave radio will receive their programmes from an advanced type of high power transmitter developed by Marconi Communication Systems.

Under the terms of contracts worth nearly £2 million, Marconi's are to supply 24 of their new 50kW B6034 transmitters to the BBC. These will be used to update existing transmitting stations, some of which were equipped by Marconi's in the 1930s and have given excellent service ever since.

The transmitters will be used singly to provide 50kW, in pairs to provide 100kW or in groups of three to provide 150kW outputs, and they will be installed at many of the BBC's high powered medium wave stations. When the re-equipment programme has been completed, the BBC's medium frequency United Kingdom network will be capable of fully automatic and unattended operation.

VEROKOTE LACQUER COATING

Verospeed has now expanded its range of products and service aids, available by return, with the addition of the Verokote Circuit Lacquer Aerosol.

Veroskote is a one-component clear polyurethane lacquer coating, which cures on exposure to the air. It is a high performance coating, giving highly effective protection to circuit boards and electronic assemblies against adverse conditions of humidity and atmosphere pollution.

Veroskote is highly durable and abrasion resistant, with excellent adhesion, and is suitable for use with all types of wire. It is available immediately from Verospeed, at £1.95 per 16oz can. Address: Verospeed, 10 Barton Park Industrial Estate, Eastleigh, Hants. SO5 5RR.
The author was rather surprised recently to learn that amongst the more common items stolen from private houses are colour television receivers. His informant also asked him for advice on the protection of these items.

Seeing that most thieves are deterred by any loud sound giving evidence of their presence probably the best, and certainly the simplest, method of protection consists of installing an alarm circuit which causes a bell to ring if the television set is moved from its normal position. It is fairly easy to make up protection devices incorporating home-made contact sets which close when the television set is raised from the surface on which it is placed; but the most reliable approach consists of using a dry reed switch together with two permanent magnets.

**DRY REED SWITCH**

As most readers will be aware a dry reed switch consists, in its most common form, of two springy contacts in a cylindrical glass housing filled with an inert gas, as in Fig. 1(a). The contacts are made of a magnetic material and are normally open. If a bar magnet is brought up to the switch, as in Fig. 1(b), the contacts become magnetised. The outside contact end nearest the north pole of the magnet exhibits a south pole and the outside contact end nearest the south pole of the magnet exhibits a north pole. The inside end of each contact exhibits an opposite polarity to that at its outside end.

If the magnet is moved closer to the reed switch the intensity of the magnetic attraction between the two inside contact ends becomes sufficiently high for them to close, as in Fig. 1(c). The closure has a “snap” action: once the contact ends begin to move towards each other the magnetic attraction increases as the distance between them reduces. The contact ends are plated with a high conductivity metal, such as gold, allowing a low resistance circuit path to be provided when the switch closes.

When two magnets with opposing polarity are positioned on either side close to the reed switch, as in Fig. 2(a), their magnetic fields cancel out and the switch stays open. Taking away one of the magnets will cause the switch to be influenced by the remaining magnet only, and it will then close. This forms the basis of the television protection system.

Fig. 2(b) shows one bar magnet affixed to the base of a television receiver resting on a wooden table surface, with the reed switch and a second magnet of opposing polarity mounted under the table surface. If the television receiver is moved the second magnet takes control and causes the reed switch to close. Note that the two magnets do not have to be on opposite sides of the switch, as...
they were in Fig. 2(a). The system will work if one magnet is above and the other alongside the switch, provided they are both the same distance away. Should the wooden table surface be too thick for the magnet on the television receiver base to exert sufficient control, the underside of the surface may be recessed to take the reed switch closer, as illustrated in Fig. 2(c). It will probably be unnecessary to provide a recess for the magnet underneath unless the table surface is extremely thick.

The scheme may not function if the table is covered with Formica of a heat resistant grade. Such Formica sometimes incorporates a steel shim laminate, and this would prevent the magnet above the table surface affecting the reed switch below.

SWITCHING CIRCUITS

A glance through the mail-order catalogues will show the capabilities of reed switches currently available. For instance, the “Standard” reed switch available from Maplin Electronic Supplies will handle currents up to 2 amps and could control a bell directly, as in Fig. 3(a). The series 4.7Ω 3 watt resistor limits maximum bell current, which can be surprisingly high with some bells, to less than 1 amp. With this circuit the bell ceases to sound if the television receiver is replaced in the same position as it had before. If a relay is introduced, as in Fig. 3(b), the switching current requirements for the reed switch are considerably reduced. Also the relay, when energised, stays energised by way of its contact set 2, and the bell will not be silenced if the television receiver is replaced. Any standard relay having two contact sets which close when energised can be employed here. Catalogues listing relays normally indicate the coil energising voltages required.

In both the circuits of Fig. 3(a) and (b), the on-off switch, bell and other components are positioned in a safe location remote from the reed switch.

The system can also be used to guard other valuable items, provided these are not made of a ferrous metal and that it is possible to affix a magnet to the base in the required position. Before carrying out any installation, check experimentally the distances between the reed switch and the magnets which give the desired switch functioning. These distances can be relatively quite high: for instance a Maplin “Magnet Large” will just operate the “Standard” reed switch from a distance of 22mm. For reliable functioning the magnets should be closer to the switch than the “just operate” distance.
Continuing the 90 metre-band saga (see last issue), if you can dodge the QRM and avoid the noises, why not try —

- **TOGO**
  Lama Kara on a measured 3222 at 1912, light music European-style, OM with announcements in vernaculars.

- **SWAZILAND**
  Trans-World Radio, Manzini, OM with a religious programme in English on 3240 at 1916.

- **RWANDA**
  Radio Rwanda, Kigali, on 3330 at 1925, African music and folk songs.

- **LIBERIA**
  ELWA Monrovia on a measured 3227 at 2125, African drums, YL’s in chorus in the Home Service.

- **SOUTH AFRICA**
  SABC Meyerton on 3205 at 1920, OM in Afrikaans, piano and light orchestral music.

- **VENEZUELA**
  Radio Barcelona on 3385 at 0050, OM in Spanish, local-style music, all heard through the inevitable QRM!
  Radio Universidad on 3395 at 0058, local-style dance music, OM with announcements in Spanish.
  Radio Libertador on 3245 at 0338, choir with a local ballad after announcements in Spanish.

**CURRENT SCHEDULES**

- **UGANDA**
  “Radio Uganda”, Kampala, operates a Domestic Service in which the news in English may be heard from 1900 to 1915 and news headlines in English from 2100 to 2105 on 3340, 4976, 7195 (Red Channel) and on 5026 and 7110 (Blue Channel), Sign-off on both channels at 2110.

- **ALGERIA**
  “Radio of the Democratic People’s Republic of Algeria”, Algiers, has an External Service in which the English programme is radiated from 1800 to 1900 on 11910.

- **SOMALI REPUBLIC**
  A programme from Mogadishu is on the air daily from 1100 to 1130 on 9585.
  Dxers may care to listen from 1430 to 1530 when a programme in Amharic is being broadcast from Mogadishu on 9585 and from Hargeisa on 7120 and on 11645.

- **NORTH KOREA**
  “Radio Pyongyang” currently lists two programmes in English intended for listeners in Europe, the first being from 0600 to 0750 on 9420 and 11531 and the second from 2000 to 2150 on 3560, 6575 and on 9420.

- **ZAMBIA**
  “Radio Zambia”, Lusaka, in the latest schedule lists several programmes in English. For listeners here in the U.K. try from 1800 to 1815 and from 2000 to 2055 when a newscast and a news summary respectively may be heard on 6060, 7235 and on 9580.
  The Home Service (Domestic) from Lusaka features a newscast in English from 1800 to 1810 on 3295 and 4911.
  The General Service (Domestic), also from Lusaka, has a newscast in English from 1800 to 1815 on 6165.

- **FINLAND**
  “Yleisradio” — The Finnish Broadcasting Company, Helsinki, provides English programmes for listeners in Europe as follows: from 0930 to 0955 (Saturdays and Sundays only) on 9550, 11755 and on 15270; from 1300 to 1325 on 11755, 15105 and on 15260; from 1900 to 1925 on 11755 and 15265 and from 2030 to 2055 on 9550 and on 11755.

- **MONGOLIA**
  Ulan Bator has an External Service in which programmes in English are radiated to South East Asia and the Far East (except Sundays) from 1220 to 1250 on 9575 and 11860 and from 1715 to 1745 on 8890.

- **CLANDESTINE**
  The “Voice of the People of Malaya” (in Malay “Suara Rakyat Malaya”) has programmes in Cantonese, Malay and Standard Chinese from 2130 to 0015 and from 1130 to 1530 on 7020 variable. The station is pro-Peking, anti-Malaysian Government.
  The “Voice of Lebanon” (in Arabic “Huna Sawt Lebanon, Sawt al-Hurriyah wa al-Karamah” which translates as “This is the Voice of Lebanon, the Voice of Freedom and Dignity”) operates to the following schedule — from 0455 to 0930 in Arabic, from 1100 to 1300 in Arabic, from 1430 to 1745 in Arabic, from 1830 to 1900 in Armenian and from 1900 to 2105 in Arabic. Of interest to Dxers in the U.K. however would be the following — from 1300 to 1430 and from 1745 to 1830 there is a Western Programme, described as mostly music but with a newscast in French at 1800 and one in English.
from 1745 to 1755. All this on 6500, the station being pro-Phalangist. Both these Clandestine items are according to the BBC Monitoring Service to which due acknowledgement is made.

AROUND THE DIAL

- **ECUADOR**
  HNJQ Quito on 17865 at 1935, OM with the world news in English after station identification.

- **CUBA**
  Havana on 17885 at 2054, Cuban songs and music YL announcer in the English programme directed to Europe, scheduled from 2010 to 2140. Also logged in parallel on 17750 at 2105 with a newscast in English and identification.
  Havana on 17705 at 2036, YL with identification in the Spanish programme for the Mediterranean area, scheduled from 1840 to 2040.

- **NETHERLANDS ANTILLES**
  Bonaire (Radio Nederland Relay) on 17810 at 1835, OM with the news in French in a programme for North and Central Africa, scheduled from 1830 to 1950 on this channel and in parallel on 15220 and 17740.

- **CYPRUS**
  Limassol (BBC Relay) on 17885 at 0700, identification and a newscast in English.

- **PAKISTAN**
  Karachi on 17830 at 0705, YL with song in Urdu in the World Service programme directed to South Asia, the Middle East and East Africa, scheduled from 0500 to 0815.

- **NETHERLANDS**
  Hilversum on 17700 at 1830, OM with identification and a newscast in English to Europe and Africa which is scheduled from 1830 to 1950 and also in parallel on 0620 and on 11730.

- **U.S.A.** — 2
  WIFR Family Radio, Oakland, on 17845 at 2050, OM with identification and sign-off after the programme in English to West Africa.

- **CHINA**
  Lanzhou on 4865 at 2131, YL with songs in Chinese, followed by orchestral music in the local style.
  Radio Peking on 4800 at 2108, OM in Chinese in the Domestic 1st programme scheduled here from 1103 to 1735 and from 2000 to 0100.
  Radio Peking on 4850, YL in Chinese, local music in the Domestic 2nd programme scheduled here from 1403 to 1700 and from 2100 to 2400.

- **NOW HEAR THIS**
  Radio Rwanda, Kigali, on 3330 at 0514, interval signal rendered on xylophone-sounding instrument (actually an Inanga — local harp) the theme being repeated, OM with announcements in vernacular.

### Obituary

**Sylvia Margolis — A Personal Tribute**

Very occasionally in life one meets people of such a dynamic personality that they leave an indelible impression; such a person was Sylvia Margolis. The writer of this note had the pleasure of being one of her friends and knew something of the courage and motivation which urged her on although she knew that her life would be a short one — she died in her 50th year, on 23rd September 1977.

When, through her late husband, she first came into contact with Amateur Radio she soon realised its potential for fostering friendship, crossing barriers of race and culture, and her home became renowned for the hospitality extended to visiting amateurs from home and abroad.

She and her husband, G3NMR, worked very hard for the Amateur Radio Mobile Society and together for a number of years they produced the Society's Newsletter. For a time she was Public Relations Officer of the Radio Society of Great Britain.

Her radio amateur journalistic activities spread into other media where she popularised the hobby. Subsequently she moved into broadcasting, producing and presenting features for BBC's Radio London.

Despite her exceptionally busy life she was active in the British Red Cross and at Christmas time she would often help out at local hospitals so that her Christian friends could spend more time with their families.

We extend to her two sons our deep sympathy.

A.C.G.

JANUARY 1978
CHECKING ELECTROLYTIC

How to obtain approximate indications of the values of electrolytic capacitors.

We take a known capacitor, C1, and charge it to a voltage, V1. The capacitor now holds a charge, Q, which is equal to C1V1, where Q is in coulombs, C is in farads and V is in volts.

We next connect an unknown capacitor, C2, across C1, whereupon the charge spreads between the two capacitors and the voltage across them falls to a level, V2. We have a new capacitance, (C1 + C2), and since the charge remains unaltered (C1 + C2) V2 is equal to C1V1. We now take a few simple steps in algebra.

\[
\begin{align*}
(C1 + C2) V2 &= C1V1 \\
C1V2 + C2V2 &= C1V1 \\
C2V2 &= C1V1 - C1V2 \\
C2 &= C1 \frac{V1 - V2}{V2}
\end{align*}
\]

In other words, C2 is equal to C1 multiplied by the drop in voltage and divided by V2.

MEASURING CAPACITANCE

This exercise provides a very simple method of finding the approximate value of an electrolytic capacitor whose markings have become obliterated or defaced. The test equipment required is an electronic or valve voltmeter, which must have a very high input resistance, and a 4.5 volt battery.

It is found in practice that a surprisingly high proportion of modern electrolytic capacitors have such low leakage current that they will retain a charge of around 5 volts for periods of time extending well beyond the 15 seconds or so required for the measurement to be described. Such capacitors may be selected by connecting them to the voltmeter, charging them to 4.5 volts by means of the battery and then disconnecting the battery. If the voltmeter reading remains steady at 4.5 volts for at least 15 seconds then the capacitor can be used as a known C1.

If the unknown capacitor to be checked has not been in use for a long period it is advisable to initially connect it across the 4.5 volt battery for some 5 seconds or so to allow its electrolyte to "form" fully. The capacitor is then discharged by short-circuiting its leads.

TESTING METHOD

The testing procedure is carried out as indicated in Figs. 1 (a) and (b). The voltmeter is connected permanently across the known capacitor, C1. The battery is next connected across it, whereupon the voltmeter indicates approximately 4.5 volts. The battery is removed, after which the leads of the unknown capacitor, C2, are touched across those of the known capacitor, causing the voltage to fall. There is no need for the two capacitors to be connected together more than momentarily. The value of the unknown capacitor can then be determined from the decreased voltage indicated by the voltmeter.

Fig. 2 gives a chart, made up from the formula for C2 found earlier, which enables the unknown capacitance to be determined in terms of V2 and C1. If, for instance, C1 is 100µF and the voltage falls to 1.5 volts, the unknown capacitance is 200µF. Should the voltage fall to 3.2 volts the unknown capacitance is 40µF. For ease of calculation it is preferable that C1 be a 10µF, a 100µF or a 1,000µF component.

Obviously, the readings obtained are very approximate because C1 is itself an electrolytic capacitor with its own wide tolerance on nominal.

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Fig. 1 (a). C1, whose capacitance is known, is connected to a very high resistance electronic voltmeter. It is charged to 4.5 volts by temporarily connecting a 4.5 volt battery (b). When an unknown capacitor, C2, is touched across C1, the voltage across the latter drops.

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RADIO AND ELECTRONICS CONSTRUCTOR
CAPACITORS

By R. V. Smithson

Fig. 2. This chart shows the value of C2 in terms of C1 and the final voltage across C1

Fig. 3. A very simple electronic voltmeter can be used as shown here. The multimeter reading is almost exactly equal to the voltage across the test terminals. S1(a)(b) is the on-off switch

value. But we are using one wide tolerance component to check another wide tolerance component, and the approximations are acceptable for most practical purposes. The working voltage of the capacitors being checked will in many instances be considerably higher than the 4.5 volt test voltage, but this fact will not invalidate measurements to any serious extent.

VOLTMETER

The capacitance test requires that the electronic voltmeter has a very high input resistance and such a voltmeter may not be readily available to many readers. Also, many electronic voltmeters which could offer a very high input resistance still have a resistive potential divider at the input which prevents their use in the present application.

A very simple electronic voltmeter which can be pressed into service is shown in Fig. 3. This basic circuit has appeared several times in previous projects in this journal and, with virtually all BC107 transistors likely to be encountered, offers an exceptionally high resistance across the test terminals. The meter in the emitter circuit of TR2 is a multimeter having a resistance of 10,000 ohms per volt or better which is switched, ideally, to a 0-10 volts range. The circuit is set up initially by connecting the two test terminals together and then adjusting R2 for a zero voltage reading in the meter. The meter then gives voltage readings which are almost exactly equal to the voltages applied to the test terminals.
Simple Circuitry incorporating LM377 I.C.

By R. A. Penfold

Although the stereo amplifier to be described uses fairly simple circuitry it is capable of producing a very high quality output. An unusual feature is the use of a single i.c. in the power amplifier stages of both channels, this being an LM377 dual power amplifier. This interesting device will provide an output of up to 2 watts r.m.s. per channel continuously at a total harmonic distortion level at 1kHz of typically only 0.1%. An intermittent output power of 3 watts r.m.s. per channel can be achieved, and there is no danger of damaging the device by overloading as it incorporates both thermal and output short-circuit protection circuitry.

The distortion level of the amplifier as a whole is quite low, and is typically only about 0.4% at an output level of 2 watts r.m.s. Three inputs are provided and these are for crystal or ceramic cartridge, for tuner and for tape deck. The approximate input sensitivities and impedances of these inputs are, respectively, 50mV into 1MΩ, 200mV into 100kΩ and 500mV into 100kΩ. These input sensitivities are all for an output power of 2 watts r.m.s. The output is for 8Ω impedance speakers and a socket for a pair of stereo headphones is also provided. The output noise level is extremely low, being -63dB in the tape and tuner modes and -60dB in the gram mode, with volume at maximum, tone controls adjusted for a flat response and input open-circuit. These figures are unweighted and referred to a 2 watt r.m.s. output level.

POWER AMPLIFIERS

The circuit of the power amplifier section of the unit is shown in Fig. 1. Here R1, R2 and VR1 form a conventional balance control circuit from which the input signals are applied to the dual volume control, VR2(a) (b). Capacitors C2 and C3 provide d.c. blocking between the sliders of VR2(a) (b) and the non-inverting inputs of the amplifiers contained in the LM377.
These amplifiers are rather like operational amplifiers in that they have both inverting and non-inverting inputs. The amplifiers are intended to be used in the non-inverting mode, which is the case here. The input impedance at each input is very high and virtually 100% negative feedback at d.c. is applied over the amplifiers by R7 and R8. This means that the d.c. voltage gain of the circuit is almost exactly unity, and that the non-inverting input and output voltages will be virtually identical. The quiescent output voltage of each amplifier needs to be about half the supply rail voltage, and this can be achieved by connecting the non-inverting inputs to a potential divider which provides a suitable voltage. Such a circuit is contained within the i.c., and its output is available at pin 1. This bias voltage is coupled to the amplifiers by R3 and R4; although these resistors have quite high values very little voltage is dropped across each of them due to the very high input impedances of the amplifiers. The input impedance of each power amplifier circuit is approximately equal to the value given to the input bias resistor. C1 is needed to prevent cross-talk between the channels due to coupling through R3 and R4, and it also smooths out any hum or noise which would otherwise be transmitted from the supply lines to the inputs via the bias circuitry.

Whilst unity gain at d.c. through each amplifier is convenient from the biasing point of view, it is of course totally inadequate for signal amplification. Therefore, at a.c. some of the feedback must be decoupled in order to provide a reasonable level of signal voltage amplification. This is the purpose of C4 and R5, and of C5 and R6. The capacitors provide d.c. blocking and the resistors limit the amount of a.c. feedback which is decoupled. The signal voltage gain of each amplifier is equal to the value of the feedback resistor divided by the value of the feedback limiting resistor, and is approximately 45 times.

C6 and C7 are the output d.c. blocking capacitors, and S2(a) (b) enables the output to the
speakers to be cut. The speakers may then be muted when headphones are being used. R23 and R24 are connected between the output of the amplifier and the headphone jack, and they attenuate the output to a level which is suitable to drive any normal stereo headphones. Without these resistors there would be the possibility of the headphones being damaged by an excessive output level, and under normal operating conditions the volume control would have to be turned almost to minimum. This last point is important because the output noise level does not alter much with changes in volume control setting and so on, with the volume control set towards minimum, only a comparatively poor signal-to-noise ratio would be produced for headphone listening. Attenuating the headphone output makes it necessary to considerably advance the volume control in order to obtain an adequate volume level, and thus the problem is eliminated.

**PRE-AMPLIFIER**

The circuit of the pre-amplifier and tone control network for one channel is given in Fig. 2. The tone control network is a passive circuit of quite conventional design. With reference to 1kHz it provides about 12dB of boost and cut at 100Hz and 10kHz. VR3 is the treble control and VR4 is the bass control. When the tone controls are adjusted for a flat response the -3dB points are at approximately 50Hz and 30kHz.

About 88mV r.m.s. is needed at the input of the power amplifiers in order to produce an output level of 2 watts, but losses in the tone controls reduce the sensitivity of the circuit by almost 10 times. The pre-amplifier must, therefore, provide an output level of about 50mV r.m.s., and it must have a high input impedance if it is to provide satisfactory results when used with a crystal or ceramic cartridge. These usually require a load impedance of about 1MΩ, as a significantly lower load impedance would result in a loss of bass response.

The high input impedance and modest voltage gain which are needed can be obtained by using a JFET common source amplifier, and TR1 forms the basis of such a stage. Two good features of an f.e.t. amplifier such as this are that it provides a low noise level and good linearity.

Offset gate biasing is used, and the required gate bias voltage is produced by the potential divider consisting of R9 and R10. This voltage is fed to the gate of TR1 through R11. The input impedance of TR1 is very high but R11 shunts this and reduces the input impedance of the circuit to about 1MΩ. R13 is the source bias resistor and C11 its bypass capacitor. R12 is the drain load resistor. Input and output d.c. blocking is provided by C10 and C12 respectively. R17 and C9 give supply decoupling. Although quite a high peak-to-peak output level is produced by the pre-amplifier, it is powered by a comparatively high supply voltage, and it has an overload margin of about 18dB.

Fig. 3 shows the input selector circuitry for one channel. The circuit for the other channel is, of course, identical to this. In the 'Gram' position the selector switch, S1, connects SK3 direct to the input of the pre-amplifier. In the other two positions the input signal is attenuated prior to being fed to the pre-amplifier. R18 and R19 form the attenuator for the tuner input, and R20 and R21 form the attenuator for the tape input.

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**Fig. 2. Pre-amplifier circuit for one channel, the other channel being identical. The decoupling components, R17 and C9, are common to both channels.**

**Fig. 3. The input switching circuit for one channel. Again, the other channel is identical.**
POWER SUPPLY

The circuit of the power supply section is given in Fig. 4. S3(a) (b) is the on-off switch and LP1 is the mains indicator. This is a panel mounting neon assembly which must have an integral series resistor for mains operation. T1 is a mains transformer with a 9-0-9 volt secondary, but in this application the secondary centre-tap is ignored and the full secondary winding feeds a bridge rectifier via fuse FS1. C17 smooths the output of the rectifiers, and under quiescent conditions about 28 volts appears across this component. This is too high to connect direct to the power amplifier circuit as the LM377 has an absolute maximum supply voltage rating of 26 volts.

A simple regulator circuit is used to reduce the output voltage to about 20 volts. The circuit also provides electronic smoothing of the supply voltage, and it helps to give the unit a negligible level of hum at the output. A conventional series regulator circuit is employed, with R22, D5 and C18 producing a stabilised potential of 22 volts which is fed to the base of TR2. TR2 and TR3 are connected as a Darlington pair emitter follower, and they therefore provide unity voltage gain between the input base and output emitter. The output at TR3 emitter is at a low impedance and can supply the fairly high currents required by the power amplifiers. Approximately 1.6 volts is dropped across the base-emitter junctions of TR2 and TR3, and so an output potential of a little over 20 volts is produced. C19 provides final smoothing of the output.

COMPONENTS

Some comments need to be made concerning components. S1 is a 4-pole 3-way miniature rotary switch, of which only two poles are employed. S2 and S3 are d.p.d.t. rotary switches intended for mains switching. These are available rated at 4 amps at 250 volts a.c. The mains transformer is an Osmabet type MT9V, and this is listed by Home Radio.

The LM377 i.c. is available from several suppliers including Maplin Electronic Supplies. A special vaned T03 heat sink is required for TR3, and this can also be obtained from Maplin Electronic Supplies. The amplifier is assembled in a BEC case type GB1 which isretailed by H.M. Electronics, 275a Fulwood Road, Sheffield, S10 3BD. This has dimensions of 14in. by 6in. by 2in., and its general appearance can be judged from the
COMPONENTS

Resistors
(All fixed values ± watt 10%)

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>150kΩ</td>
</tr>
<tr>
<td>R2</td>
<td>150kΩ</td>
</tr>
<tr>
<td>R3</td>
<td>1MΩ</td>
</tr>
<tr>
<td>R4</td>
<td>1MΩ</td>
</tr>
<tr>
<td>R5</td>
<td>2.2kΩ</td>
</tr>
<tr>
<td>R6</td>
<td>2.2kΩ</td>
</tr>
<tr>
<td>R7</td>
<td>100kΩ</td>
</tr>
<tr>
<td>R8</td>
<td>100kΩ</td>
</tr>
<tr>
<td>R9,  R9(a)</td>
<td>33kΩ</td>
</tr>
<tr>
<td>R10, R10(a)</td>
<td>5.6kΩ</td>
</tr>
<tr>
<td>R11, R11(a)</td>
<td>1MΩ</td>
</tr>
<tr>
<td>R12, R12(a)</td>
<td>4.7kΩ</td>
</tr>
<tr>
<td>R13, R13(a)</td>
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</tr>
<tr>
<td>R14, R14(a)</td>
<td>39kΩ</td>
</tr>
<tr>
<td>R15, R15(a)</td>
<td>82kΩ</td>
</tr>
<tr>
<td>R16, R16(a)</td>
<td>8.2kΩ</td>
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<tr>
<td>R17</td>
<td>1kΩ</td>
</tr>
<tr>
<td>R18, R18(a)</td>
<td>27kΩ</td>
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<tr>
<td>R19, R19(a)</td>
<td>82kΩ</td>
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<tr>
<td>R20, R20(a)</td>
<td>10kΩ</td>
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<tr>
<td>R21, R21(a)</td>
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<tr>
<td>R22</td>
<td>820Ω</td>
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<td>R23</td>
<td>120Ω</td>
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<tr>
<td>R24</td>
<td>120Ω</td>
</tr>
<tr>
<td>VR1</td>
<td>2MΩ potentiometer, linear</td>
</tr>
<tr>
<td>VR2</td>
<td>1MΩ dual gang potentiometer, log</td>
</tr>
<tr>
<td>VR3</td>
<td>220kΩ dual gang potentiometer, linear</td>
</tr>
<tr>
<td>VR4</td>
<td>220kΩ dual gang potentiometer, linear</td>
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</table>

Capacitors

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>330µF electrolytic, 16 V. Wkg.</td>
</tr>
<tr>
<td>C2</td>
<td>0.1µF type C280 (Mullard)</td>
</tr>
<tr>
<td>C3</td>
<td>0.1µF type C280 (Mullard)</td>
</tr>
<tr>
<td>C4</td>
<td>6.8µF electrolytic, 16 V. Wkg.</td>
</tr>
<tr>
<td>C5</td>
<td>6.8µF electrolytic, 16 V. Wkg.</td>
</tr>
<tr>
<td>C6</td>
<td>680µF electrolytic, 16 V. Wkg.</td>
</tr>
<tr>
<td>C7</td>
<td>680µF electrolytic, 16 V. Wkg.</td>
</tr>
<tr>
<td>C8</td>
<td>100µF electrolytic, 40 V. Wkg.</td>
</tr>
<tr>
<td>C9</td>
<td>100µF electrolytic, 25 V. Wkg.</td>
</tr>
<tr>
<td>C10, C10(a)</td>
<td>0.1µF type C280 (Mullard)</td>
</tr>
<tr>
<td>C11, C11(a)</td>
<td>10µF electrolytic, 10 V Wkg.</td>
</tr>
<tr>
<td>C12, C12(a)</td>
<td>2.2µF electrolytic, 25 V. Wkg.</td>
</tr>
<tr>
<td>C13, C13(a)</td>
<td>470pF polystyrene</td>
</tr>
<tr>
<td>C14, C14(a)</td>
<td>0.0047µF polystyrene</td>
</tr>
<tr>
<td>C15, C15(a)</td>
<td>0.0022µF polystyrene</td>
</tr>
<tr>
<td>C16, C16(a)</td>
<td>0.022µF type C280 (Mullard)</td>
</tr>
<tr>
<td>C17</td>
<td>1,500µF electrolytic, 30 V. Wkg.</td>
</tr>
<tr>
<td>C18</td>
<td>47µF electrolytic, 40 V. Wkg.</td>
</tr>
<tr>
<td>C19</td>
<td>1,000µF electrolytic, 25 V. Wkg.</td>
</tr>
</tbody>
</table>

Transformer

T1 Mains transformer, secondary 9-0-9V at 1A, type MT9V (Osmabet)

Semiconductors

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>IC1</td>
<td>LM377</td>
</tr>
<tr>
<td>TR1, TR1(a)</td>
<td>2N3819</td>
</tr>
<tr>
<td>TR2</td>
<td>BFY51</td>
</tr>
<tr>
<td>TR3</td>
<td>2N3055</td>
</tr>
<tr>
<td>D1-D4</td>
<td>1N4002</td>
</tr>
<tr>
<td>D5</td>
<td>BZY88C22V</td>
</tr>
</tbody>
</table>

Neon Indicator

LP1 Panel mounting neon indicator with integral resistor, 250V a.c.

Fuse

1A 20mm.

Switches

S1 4-pole 3-way miniature rotary
S2 d.p.s.t. rotary, 4A at 250V a.c.
S3 d.p.s.t. rotary, 4A at 250V a.c.

Sockets

SK1 2-way speaker socket, DIN
SK2 2-way speaker socket, DIN
SK3 5-way 180 degree socket, DIN
SK4 5-way 180 degree socket, DIN
SK5 5-way 180 degree socket, DIN
JK1 3-pole stereo jack socket, jn. (see text)

Miscellaneous

BEC case type GB1 (see text)
4 large control knobs
3 small control knobs
Heat sink for TR3 (see text)
20mm. panel mounting fuse holder
Materials for printed boards
Twin stereo screened cable
3-core mains lead
Screws, nuts, solder tags, etc.
way 180 degree DIN types, and the output sockets are 2-way DIN speaker types. These sockets are all mounted by means of short 6BA bolts and nuts.

Reference to the accompanying photographs will show the general layout in the interior of the case. The mains transformer is mounted on the extreme left hand side of the case (as seen from the front) using two short 4BA bolts and nuts. A solder tag is secured under the front mounting nut and this provides the chassis connection for the mains earth lead. Most of the circuitry is assembled on three printed circuit boards. The one next to the mains transformer contains the power supply components, the one in the centre is for the power amplifiers, and the pre-amplifier circuitry is constructed on the third panel which is furthest away from the transformer. The mounting bolts for the transformer and boards have their heads on the underside of the chassis. The holes are marked out using the transformer and boards, after completion, as templates. The tone control and input selector circuits use point-to-point wiring on the control tags.

**POWER AMPLIFIER BOARD**

Details of the component layout and the copper pattern of the power amplifier circuit board are provided in Fig. 6. This diagram is reproduced actual size so that it can be easily copied. The board is prepared and wired up in the usual manner, and the three mounting holes are drilled for 6BA clearance.

The corresponding mounting holes in the chassis are then marked out with the aid of the board and are similarly drilled 6BA clearance. Spacers about 4in. long are used over the mounting bolts, between the panel and the chassis, so that the connections on the underside of the panel are clear of the metal case. The chassis connection to the panel is made via these spacers, which should be metal. The panel must be wired up to the rest of the unit before it is finally mounted.

Some of the point-to-point wiring associated with the power amplifier is shown in Fig. 6. In addition to this, the tags of SK1 and SK2 which do not connect to S2 are earthed at the appropriate tag of the headphone jack socket. It is worth noting
Fig. 6. The component and copper sides of the power amplifier board. This is reproduced full size.
Fig. 7. How the power supply board is constructed. TR3 collector connects to the copper print by way of one of its mounting bolts.
that the output sockets must be connected up with the same phasing, or the finished set-up will not provide a correct stereo image. Therefore, if the round connector of SK1 connects to chassis and the flat one connects to S2, then SK2 must be wired up in the same manner. R23 and R24 are mounted on the headphone socket.

Before wiring up S2 check its tag functions with the aid of a continuity tester to ensure that the switching agrees with the circuit of Fig. 1. This will obviate the risk of short-circuiting the two outputs together, should the switch have a different tag layout to that shown in Fig. 6.

A twin stereo screened cable is used between the panel and the volume control. The outer braiding of its leads connects to the two relevant tags of the volume control.

POWER SUPPLY BOARD

Details of the power supply circuit board and wiring are given in Fig. 7. Construction of the printed circuit board assembly is quite straightforward except that TR3 and the vaned TO3 heat sink are mounted on the panel. These components are bolted in position using short 4BA bolts and nuts with the bolt heads on the copper side, and it is by way of one of these bolts that the connection between TR3 collector and the printed board is made. The emitter and base pins of TR3 are cut short and soldered into circuit in the normal way. They must not be left long or they will short-circuit to the chassis when the board is mounted.

All the power supply wiring is shown in Fig. 7, and when this has been completed the panel is mounted in the same fashion as the power amplifier board, using ¥in. metal spacers which similarly take the chassis connection to the board.

There is only small spacing between the mains transformer tags and the underside of the case top. It is necessary, therefore, to have positive insulation here and this can be provided by wrapping several layers of insulating tape around and over the transformer tags, the solder joints at which should be smooth and without spikes.

As with S2, check the tag functions of S3 with a continuity tester before wiring up to this component.

NEXT MONTH

In next month's concluding article constructional details will be given for the assembly of the pre-amplifier board, which measures 3¥ in. by 2¥ in. This will be followed by a description of the input and tone control wiring and notes on the use of the amplifier with crystal or ceramic cartridges having a high output.

(To be concluded)
HISS FROM THE ACTIVE SUN
by Ron Ham

This article describes the activities of a small group of British amateurs who succeeded, in the later 1930's, in identifying radio signals emanating from the sun.

Soon after the war it became known that radio noise associated with sunspots had been detected by British radar receivers working between 60 and 80MHz in February 1942. Since 1946 consistent solar observation has proved that, when sunspots are present accompanied by strong metre wave radio noise, we can expect an aurora or an ionospheric disturbance or both to occur and upset the normal paths of our terrestrial radio signals.

RECEIVER NOISE

The background noise produced by a receiver when no signals are present is partly caused by the movement of electrons within the wiring and components of the set itself. In the days of the thermionic valve, which served radio for more than fifty years, a lot of noise, including shot noise and induced grid noise, was generated inside the valve itself and by the currents which flowed through its associated components. Now that semiconductors have replaced the valve, receivers are much quieter, because solid state devices are far less noisy themselves and require very little current to drive them. Unfortunately the noise produced by heavenly bodies is similar to receiver background noise therefore, in the case of a radio telescope, receiver noise must first be measured so that any incoming celestial noise can be identified and its amplitude estimated.

Although the wartime detection of solar radio waves was not made public until 1945 records exist to show that members of the RSGB's pre-war Radio and Experimental Section had known about their existence since 1935. Radio amateurs are always keen to investigate something new, and in those days they quickly learnt that short wave communication was exciting because it is so vulnerable to natural disturbances, and they wanted to know why.

THE DISCOVERY

Periodically during 1935 Denis Heightman, G6DH, the most prominent member of the 28MHz propagation group (a section of the RES) heard a strange hissing sound above the background noise of his 10 metre band receiver. Denis consistently observed that this sound only occurred during daylight hours and frequently preceded some form of radio disturbance, and he rightly concluded that the hissing noise was coming from a solar event.

On January 1st 1936 another experienced radio operator, Miss Nell Corry, G2YL, became author of the 28MHz reports published in The T & R Bulletin (then the monthly journal of the RSGB). These reports were backed up with diaries in which she kept a daily record of 28MHz happenings received from radio amateurs in many parts of the world. From the entries in Nell's diaries, which now form a part of the author's collection, and her journal reports during the period 1936 to 1939 inclusive, the author found that twenty-four radio amateurs had reported hearing the hissing noise and, furthermore, that it was not confined to 28MHz. The diaries also revealed that during this four year period hissing was reported on 107 days, signal fade-outs on 140 days, aurorae on 53 days and "echoing" on signals on 26 days.

Visual reports of solar activity were supplied to the group by Mr. Newbegin (an astronomer from Worthing, Sussex), Wireless World and amateur transmitter G5JH, but when the skies were overcast sunspots or prominences may have gone by unrecorded. However, in 1936 Denis Heightman, Nell Corry and their associates showed that radio (unaffected by cloudy skies) could observe the active sun.

In 1936 and 1937 Denis Heightman told the technical world about his important discovery, in a letter published in Wireless World for April 10, 1936, in a comprehensive article in The T & R Bulletin and in letters to Professor (later Sir) Edward Appleton, and in 1938 to Dr. J. R. Dellinger of the U.S. National Bureau of Standards and Dr. Richardson of Mt. Wilson Observatory.

IN THE 5 METRE BAND

An entry in Miss Corry's diary on July 31, 1938 revealed that Miss Barbara Dunn, G6YL, had heard the hissing sound in the 5 metre band at 56MHz and her valuable report was confirmed by 2BIL (AA Licence, no G), and published in an article written by E. J. Williams G2XC, for The T & R Bulletin of July 1939. Miss Dunn's report meant that radio amateurs were able to tell the astronomers that radio noise from the active sun could be heard as high as 56MHz.

Further evidence of hissing in the 5 metre band came from Denis Heightman, who observed it on June 25, 1939. Unfortunately, the war curtailed the work of most amateur radio observers and science temporarily lost a radio monitoring service. It was in February 1942 that solar noise, just above 56MHz, was observed again, but this time it was the sensitive receivers of British radar that detected it.

POWERFUL TRANSMITTER

The sun has been a powerful transmitter of radio waves for millions of years, but this fact was not discovered until man was clever enough to make a radio receiver and, then, not until this art was about thirty-five years old.

For more than forty years both Nell Corry and Denis Heightman devoted much of their lives to the study of radio communication. Amongst their many individual achievements the best ever must be their detection and identification of the hissing radio noise which came from the sun, 93 million miles away.
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Before undertaking any constructional project described in a back issue, it must be borne in mind that components readily available at the time of publication may no longer be so.
VOLTAGE CONTROLLED OSCILLATOR

By R. Webber

Multivibrator frequency can be directly controlled by voltage.

Voltage controlled a.f. oscillators have useful applications in electronic music and the like, and in themselves they represent interesting circuit developments. It is possible to voltage control the frequency of a multivibrator; very few components are required and circuit operation is readily understood.

MULTIVIBRATOR

The circuit of a voltage controlled multivibrator appears in Fig. 1, the control voltage being selected by adjusting VR1. As may be seen from the Components List, the multivibrator is symmetrical. A 6 volt supply is specified in order that the maximum reverse base-emitter voltage ratings of the BC107's used for TR2 and TR3 are not exceeded. Where gain selected transistors are available TR2 and TR3 can be BC107B, although their gain requirements are not at all critical in practice. The same comment applies to the emitter follower, TR1.

![Fig. 1. The voltage controlled oscillator. Multivibrator frequency varies as VR1 is adjusted.](image-url)
When the slider of VR1 is at the top end of its track the voltage available at the emitter of TR1 is about 5.4 volts with respect to the negative rail. The multivibrator then functions in virtually the same manner as it would if the base resistors R2 and R3 were returned to the positive rail, as in a conventional multivibrator. When, at a cycle changeover, TR2 turns on it causes the right hand terminal of the charged coupling capacitor C3 to go negative of the negative rail by a voltage about 0.7 volt less than the supply potential. C3 then starts to charge via R3 until the voltage on its right hand terminal is about 0.6 volt positive of the negative rail. TR3 turns on and the next part of the cycle proceeds, with the left hand terminal of C2 similarly going negative of the negative rail by about 0.7 volt less than the supply potential.

If VR1 slider is moved down its track the voltage at TR1 emitter decreases, with the result that, after TR2 turns on, C3 has available a lower charge current and consequently takes longer to reach the state where its right hand terminal rises to 0.6 volt. During the other half of the cycle C2 similarly takes a longer period to charge. Thus, adjusting VR1 so that its slider moves down the track causes the multivibrator frequency to decrease, and this is the voltage control of frequency which is exerted upon the multivibrator.

The multivibrator continues to run when VR1 has a setting which causes about 0.6 volt to appear at the emitter of TR1. The reason that it can do so is that the base resistors, R2 and R3, have values which are only twice those of the collector resistors, R3 and R4. Because of these low resistance values the multivibrator may continue to run if the voltage from VR1 slider is lower than that which produces 0.6 volt at TR1 emitter, and when there is nominally no base current available for TR2 and TR3. However, the relationship between voltage at VR1 slider and multivibrator frequency no longer holds good, and the multivibrator frequency may even increase. It is because of this effect that VR2 is inserted in series with the track of VR1. VR2 is set up such that the emitter of TR1 is taken to the limiting 0.6 volt level when VR1 slider is at the bottom end of its track.

EXTERNAL VOLTAGE

If desired an external control voltage can be applied to the base of TR1, the voltage lying in the range available from VR1 when VR2 is set up. The two potentiometers are then not needed. The input impedance at TR1 base is in the order of hundreds of kilohms.

An output is taken from the multivibrator via C4 at SK1, which can be a coaxial or jack socket. The peak-to-peak amplitude of the output is slightly less than the supply potential of 6 volts. The equipment coupled to the multivibrator should have an input resistance of, preferably, 47kΩ or more.

The frequency range is from about 1.25kHz to 400Hz and Fig. 2 shows the relationship between the voltage at TR1 emitter and multivibrator frequency. The curve is more linear than would at first sight be expected, although an increase of the rate of decrease of frequency with decrease of voltage is noticeable at the lower frequency end.

When the circuit has been assembled it is necessary to check performance and then adjust VR2. Initially, this potentiometer is set up to insert zero resistance into circuit. After switch-on, VR1 should be adjusted over its range whereupon the desired frequency-voltage relationship should be observed as its slider is taken down from the positive end of its track. When the slider approaches the negative end of its track the multivibrator may cease operation or give an oscillation which increases in frequency.

VR1 slider is then set fully at the negative end of its track. The resistance inserted by VR2 is next slowly increased until either the multivibrator starts or the tone it is producing is at its lowest frequency. VR2 is then left alone, and VR1 will provide control over the whole useful range of the circuit.

The current consumption is low, being approximately 1.6mA at the low frequency end of the range and about 2.8mA at the high frequency end. Four HP7 1.5 volt cells connected in series will form an adequate battery, and will have a relatively long life.
Scientists at Bell Laboratories in U.S.A. have made it possible, for the first time, to fabricate efficient light-carrying glass fibres from a single material only, as opposed to present-day fibres which are made from two different materials. The new, hair-thin, fibres are produced from the purest known commercially available glass. Future optical communications systems may use these new fibres in a manner similar to the way wires and cables do the job right now.

**LOW LIGHT LOSS**

The new fibre has exhibited light loss as low as 5dB per kilometre (about 50% in 2,000 feet). This low loss could allow signal amplifiers to be placed further apart than occurs in land cable systems now in service. Some day the fibres, packed into a cable a quarter of an inch in diameter, may carry thousands of communication signals. Thin fibre cables could be threaded through existing underground ducts already housing wire cables in metropolitan areas, thereby reducing the costs of communication signal expansion.

Today, signal carrying glass fibres are manufactured from two different materials. One of these forms a very narrow inner region or core, whilst the other gives a surrounding outer cladding. Light in transit through the fibre is kept in the core by the outer cladding. The use of different glass materials can allow the appearance of undesired impurities which interfere with the passage of light and cause transmission losses.

The glass chosen by the scientists for the new fibres had demonstrated a potential for very low transmission loss as an unclad fibre. By means of a unique design configuration the researchers have created a structure which permits the use of a single glass in the fibre with no additional materials.

In the design shown in the photograph there are three component parts; an outer tube, a solid inner rod and a flat supporting plate or platform which holds the rod central inside the tube. The configuration is preserved when the assembly is heated and drawn, being maintained even when the glass is drawn down to the diameter of a human hair.

The central solid glass rod becomes the light-carrying core of the new fibre, whilst the plate gives support without allowing the light to escape. And the outer tube provides overall strength, together with protection for the tiny central rod.
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VOLTAGE MULTIPLIER
by F. Bowden

ANOTHER USE FOR THE 555 TIMER I.C.

When a high degree of regulation is not required it is a relatively simple matter to obtain a higher voltage from a 12 volt supply.

The 555 timer i.c. offers many uses and in the present application it is employed in a d.c. voltage multiplying circuit which raises a 12 volt supply to a nominal level of 22 volts. The main advantages of the circuit are its simplicity and efficiency. The regulation of the output voltage is low but it should still be adequate for many purposes. A considerably more complex circuit would be required for a well regulated multiplied output voltage.

VOLTAGE DOUBLER

The circuit of the voltage multiplier is given in Fig. 1, in which the 555 is employed in a standard astable multivibrator configuration. The values of R1, R2 and C1 allow operation at approximately 500Hz, and R1 is given a value which is much lower than that of R2. During each cycle C1 charges via R1 and R2 in series and then discharges via R2 on its own. With the values chosen, the ratio of charge period to discharge period is 17:15, whereupon the 555 output, at pin 3, is fairly close to a 50:50 square wave.

During the charge period the output at pin 3 is high, and it goes low during the discharge period. When it is low C2 charges via D1 and, assuming no output load current, C3 acquires a charged voltage which is nearly equal to supply voltage less the forward voltage dropped in D1. When the output goes high the negative terminal of C2 is taken to a voltage close to that of the positive 12 volt supply rail, with the result that its positive terminal is higher than the rail by its charge voltage. It then discharges via D2 into C3. Again assuming no output load current, C3 acquires a charged voltage which is approximately double the charged voltage of C2 less the forward voltage in D2. The circuit incorporating C2, D1, D2 and C3 is, indeed, a voltage multiplier circuit.

COMPONENTS

Resistors
(Both 1/4 watt 5%)
R1 2k Ω
R2 15k Ω

Capacitors
C1 0.1μF polyester
C2 100μF electrolytic, 16 V. Wkg.
C3 100μF electrolytic, 25 V. Wkg.
C4 470μF electrolytic, 16 V. Wkg.

Semiconductors
IC1 555
D1 1N4002
D2 1N4002

Switch
S1 s.p.s.t., toggle

Fig. 1. The voltage multiplier requires only a 555 timer i.c. together with a few discrete components. In many cases C4 may be omitted.
doubling rectifier. The multiplied output voltage is that across C3.

If a load current is drawn from C3, this capacitor discharges during the period when the 555 output is low. When the 555 output goes high, the replenished C2 then discharges into C3 to raise the voltage across the latter.

Capacitor C4 is included to provide a low impedance across the 12 volt supply rails and to prevent 500Hz interference from the 555 being passed to any other circuits fed by the 12 volt supply. C4 may be omitted if the 12 volt supply has a low internal impedance, as would be given by a 12 volt accumulator. Since the maximum supply voltage rating for the 555 is 16 volts, the circuit should not be supplied by a 12 volt accumulator on charge, where the accumulator voltage could exceed the 16 volt level.

REGULATION

Two factors prevent the off load high voltage being double that of the 12 volt supply. The first of these is that, as already mentioned, a forward voltage is dropped across both D1 and D2. The second is that the output of the 555 does not rise fully to the voltage of the 12 volt positive rail when it is high. With the author’s circuit the measured off load output voltage was 22.5 volts, or 1.5 volts below the 24 volts which would be given by an ideal voltage doubler.

The regulation of the output voltage is shown in Fig. 2. The regulation is nearly linear and is shown as a straight line in the diagram. Output voltage is 17 volts at a load current of 40mA, whereupon the regulation resistance is 5.5 volts (22.5 minus 17) divided by 40mA, or about 140n. The supply is therefore equivalent to a fully regulated 22.5 volt supply with a series physical resistor of 140n.

Efficiency is quite high. The 555 draws a standing current of about 8mA. The current drawn from the 12 volt supply is slightly more than double the output current at any level up to 40mA plus the 8mA standing current.

Fig. 2. Regulation curve showing output voltage against output current

Here’s a mildly puzzling state of affairs.

In Fig. 1 we have an n.p.n. transistor connected in the grounded base mode, with its base bypassed to chassis by capacitor C1. If we inject a signal at the emitter the signal will appear as an output at the collector. When the signal causes the emitter to go positive the collector will go positive, too. This effect can be readily visualised: taking the emitter positive with respect to the base is similar to taking the base negative with respect to the emitter; the result is a reduction in collector current and a consequent rise in collector voltage. The same effect is given with negative signal excursions. If the emitter of the transistor is taken negative the collector goes negative as well.

To sum up, the emitter and collector of the transistor in Fig. 1 are in phase with each other.
To take the riddle one stage further, if instead of taking an output from the emitter in Fig. 2 we apply a signal input instead, as we do in Fig. 3, taking the emitter positive would again cause the collector to go positive, whereupon the emitter and collector are once more fully in phase!

CURRENTS

The answer to the puzzle is that we should start thinking in terms of current instead of voltage. The first thing to remember is that in a correctly biased bipolar transistor the collector and emitter currents are virtually the same. (Actually, the emitter current is equal to the collector current plus the much smaller base current which maintains the emitter and collector currents.) When, in Fig. 1 the input signal goes positive, extra current from the source of signal flows into R2. The actual voltage across R2 will rise only slightly, as otherwise the transistor would cut off, whereupon nearly the same voltage appears across it. The emitter now has to supply less current. A fall in emitter current gives a corresponding fall in collector current, and so the collector goes positive. In Fig. 1, when the emitter goes negative the source of signal is drawing extra current from the emitter and the collector current increases in sympathy.

In Fig. 2 the reverse is happening because the emitter is providing an output instead of receiving an input or, to use the jargon, it is driving instead of being driven. Signal currents then flow in the opposite direction. It is reversals of signal current flow which cause the apparent phase anomaly.

OUT OF PHASE

In Fig. 2 the base bypass capacitor is removed and a signal is fed into the transistor base. The signal will appear both at the emitter and at the collector. If the input signal goes positive the emitter, due to emitter follower action, will go positive too. Since the base-emitter current in the transistor then increases so does the collector current, and the collector voltage goes negative.

Thus, when in Fig. 2 the emitter goes positive, the collector goes negative. In other words, the emitter and collector are now directly out of phase with each other.

How is it that in one configuration the emitter and collector of the transistor are in phase whilst in the other they are out of phase?

RADIO & ELECTRONICS CONSTRUCTOR

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By Recorder

If you are to indulge seriously in the hobby of electronics what test equipment do you require? When faced with a question of this sort, I tend to fall into a deep reverie, conjuring up happy visions of a sparkling workshop stacked with r.f. and a.f. signal generators, oscilloscopes, transistor testers, a really top performance multimeter and all the other equipment which would be expected to exist in a sumptuously appointed laboratory.

In practice, so far as I'm concerned, such dreams have to remain dreams. Also in practice, I'm happy to say, it is possible to do nearly all one's constructional work armed with nothing more complex or expensive than a multimeter.

MULTIMETERS

A multimeter is, in fact, an essential for the more serious constructor. We cannot see what goes on in a circuit and the multimeter provides our electronic eyes, since it tells us what voltages exist and what currents flow. Those who have multimeters usually find that they use the voltage ranges much more frequently than the current ranges. It is far easier to measure the voltage across a resistor and then deduce from Ohm's Law the current which flows through it than it is to break the circuit to the resistor and insert the multimeter in series. Whilst on the subject of current readings, incidentally, there is one aspect of most multimeters, including in particular the more expensive ones, that should always be borne in mind. On their current ranges multimeters employ a "universal shunt" circuit which simplifies range switching but which causes the voltage drop across the meter to be quite high when a current flows through it. A quite typical voltage drop across a multimeter can be of the order of 1 volt when its needle is at full-scale deflection. Provided this fact is acknowledged it need not be a serious disadvantage. But it should always be remembered when measuring current in low voltage circuits, since the voltage drop across the meter may modify circuit functioning.

On the multimeter volts ranges, a sensitivity of 10,000Ω per volt is quite satisfactory for most normal work. A higher sensitivity is better, of course, but it usually has to be paid for.

A number of low cost imported multimeters were available some years ago but these do not appear to be so plentiful these days. Nevertheless, you may still be able to run down quite a good bargain if you hunt around a bit. As with most things, you pays your money and you takes your choice. A cheap multimeter is liable to be less accurate than a more expensive one of the same specification, and will almost certainly be more fragile and less able to withstand abuse. Nevertheless, provided you treat it with care, a cheap multimeter should prove quite adequate for most purposes.

A final hint: always leave a multimeter switched to a high voltage range when you put it away after use. There is then less chance of your absent-mindedly connecting it to a voltage which will cause it damage when next you use it.

UNUSUAL GEAR

Apart from the multimeter all sorts of unusual items of equipment can be pressed into service for testing purposes. As Smithy demonstrated in a recent "In Your Workshop" a transistor radio switched to long waves and tuned to a blank part of the band can be very useful for picking up static voltages. It will, for instance, nearly always tell you if an a.f. multivibrator is working. It will do the same for 555 oscillators, unijunction oscillators and most other relaxation (as opposed to sine wave) oscillators in which the circuit changes very rapidly from one state to the other. You simply hold the receiver so that its ferrite rod aerial is close to the oscillator wiring, whereupon it should pick up the oscillator harmonics modulated at oscillator frequency. I cannot guarantee that this dodge will work every time, but it always does for me when I've employed it.

The Fluke Model 1911A frequency counter. This has a range of 5Hz to 250MHz, and offers a 50Ω input impedance from 50MHz to 250MHz. Input sensitivity over most of the range is 15mV

www.americanradiohistory.com
A portable receiver switched to long waves can also be very useful when designing triac mains-switching circuits. If the triac does not switch on cleanly, or is insufficiently suppressed, the receiver will soon give evidence of this. It can, again, often indicate whether there is a faulty switching action in a switch which completes a circuit passing a fairly high current. It will even tell you whether there is any thunder in your district! Random crashes of static will soon be heard as an accompaniment to local flashes of lightning.

There aren't many devices which will take the place of an oscilloscope, but you can occasionally make a fairly accurate guess at a waveform by slowing things down a bit and using a multimeter. A 555 oscillator can be slowed down to, say, a cycle every two seconds or so, whereupon a multimeter switched to a volts range can be connected to its output. The slowing down process is achieved by temporarily connecting a large value capacitor across the existing charge/discharge capacitor in the oscillator. If two transistors are in a conventional symmetric multivibrator it is often possible to determine the duty cycle by measuring the voltages on the collectors. With a 50:50 duty cycle the voltages on the collectors, with respect to their emitters, will be about the same and will be approximately equal to half the supply voltage. If one transistor is turned on for a third of the cycle and the other for two thirds, the collector voltage of the first will be about two thirds of supply voltage and that of the second about one third of supply voltage. This assumes, of course, that connecting the meter does not upset multivibrator operation, but usually it is possible to employ the idea in sufficient instances for the test to have a significant value.

FREQUENCY COUNTER

The handsomely presented digital instrument in the accompanying photograph is the Fluke frequency counter Model 1911A. In company with a similar sister instrument having slightly less facilities, the Model 1910A, this counter has recently been introduced by Fluke International Corporation, Garrett Close, Watford, WD2 4TT.

These new portable counters have operational frequency ranges of 5Hz to 125MHz with the 1910A, and 5Hz to 250MHz with the 1911A. An additional feature of the 1911A is a 50 Ω input impedance from 50MHz to 250MHz to ensure correct matching in 50 Ω r.f. applications. Sensitivity over the major portion of the ranges is 15mV for both models. Readout is by way of 7-digit i.c.d. displays.

In addition to standard frequency measurement functions, both the 1910A and 1911A offer period average and totalisation capabilities. In the period average mode up to 10,000 periods may be averaged, giving a period resolution range from 0.1 microsecond to 10 picoseconds; and in the totalise mode 9,999,999 events may be counted at a rate of up to 125MHz.

To enable accurate measurements to be made in the presence of unwanted noise, signal conditioning can be effected by means of trigger level and attenuator controls situated on the instruments' front panels. An input for an external timebase is provided to allow the use of the counters with a 10MHz frequency standard.

Additional options include a basic serial data output module for data logging applications, and a rechargeable battery pack which provides up to 4 hours of continuous operation on a full charge.

Both models are designed for ease of operation by the user, including especially those inexperienced with digital counters. Auto-ranging with a hysteresis capability to prevent unwanted up and down ranging, in addition to auto-reset between ranges and functions, ensure consistently accurate and correctly displayed readings. Four manually selected gate times and a self-check function complete these new, versatile multi-counters.

I.C. TEST CLIP

In the second photograph can be seen a new test clip which is produced by Walmore Electronics Ltd. This can be slipped over the pins of a d.i.l. plastic i.c. mounted on a circuit board. The clip gives positive contact and a special "lock-on" feature eliminates the possibility of accidental disconnection. The contacts provide a wiping action with the i.c. pins, and end-contacts hook under the end pins of the i.c. to give the "lock-on" action.

The clip is profiled to the same dimensions as the i.c. to which it connects and it can easily be used in areas of high component packing density. 14 pin and 16 pin versions are available, both using 0.25in. square gold plated beryllium-copper contacts and colour coded high-strength glass filled nylon bodies.

Cable connections can be made quickly and easily and barrier strips between contacts prevent short-circuits between leads. The manufacturers are Walmore Electronics, Ltd., 11-15 Betterton Street, Drury Lane, London, WC2H 9BS.

MOCK-UP CIRCUITS

And, finally, here's a little dodge for those of you who like to make an experimental mock-up of a transistor circuit before conferring on it the permanence of a properly constructed unit. Provided that there aren't more than about four transistors in the circuit, a rough assembly of the "bird's nest" variety will often enable such things as resistor and capacitor values to be assessed.

The approach takes advantage of small tag strips which can be assembled on a piece of perforated metal such as a Lektrokit LK-111 Chassis Plate No.1. The transistors are wired to the tags with their bodies below the tags so that their lead-outs point towards you. A procedure not, perhaps, to be recommended for the beginner but one which the seasoned can handle without difficulty.

And that's all there is to it. When the transistor lead-outs are pointing towards you they take up the layout given in the data books and this saves you one mental step when dealing with an experimental circuit. With metal cased transistors, take care that the cases don't touch each other or the perforated metal base as they may be internally connected to one of the transistor electrodes.
Once again the season of Christmas overtakes Smithy and Dick, and this year it finds them engaged in the repair of a hybrid television receiver exhibiting poor vertical hold. Thenceforward, apparently no proportion to the time taken by Smithy to explain the vertical timebase circuit to his ever avid assistant.

VERTICAL TIMEBASE SYNCHRONISATION

At once the Workshop is fully illuminated, to reveal that the intruder is no less a personage than Smithy himself, and that his load is a large black and white television receiver.

Again there is a rattle at the door. Surprised, Smithy turns round to gape at the second person seeking entry.

"Ye gods," spluttered Smithy, "I thought I wouldn't be seeing you again until well after Christmas."

"I just happened to be passing by," replied Dick, "when I saw the lights come on. I thought you'd packed up for Christmas, too."

"So did I," said Smithy morosely, as he took off his raincoat and hung it behind the door. "But I went to my club last night and got conned into fixing this TV set by the steward. I don't know why I go into that place these days. Every time I do, someone shanghais me into doing a repair on the cheap."

By now, Dick had also taken off his raincoat and was looking with interest at the television receiver.

"What's wrong with it?"

"Poor vertical sync," replied Smithy. "The set has got good line sync but weak vertical sync."

"That shouldn't be too hard to clear up."

"I don't know so much," responded Smithy gloomily. "Unlike most faults in TV sets, weak vertical sync can be caused by a snag occurring in quite a few stages. The faulty area can extend all the way from the video amplifier to the vertical timebase itself."

(Fig. 1.)

"But," protested Dick, "if you've got good line sync and poor vertical sync then the fault can only lie between the sync separator stage and the vertical timebase."

"That's not necessarily true," stated Smithy. "Even in a fully serviceable set vertical sync locking is usually quite a lot looser than line sync locking. If there is a loss of sync pulse amplitude, anywhere from the video amplifier onwards, the effect normally shows up in the vertical sync first. At any rate let's hope you're right and that the snag is between the sync separator and the vertical timebase. I was a bit late getting to bed last night and I don't feel in the mood for tackling a difficult fault today."

"I'll give you a hand if you like," volunteered Dick.

"During your Christmas holiday?" Smithy sounded incredulous. "Why not?" Dick shrugged his shoulders. "I've got nothing else to do for the time being."

"Fair enough then," commented Smithy. "For a start you can get the service manual out."

As Dick walked towards the filling cabinet, Smithy took the back off the receiver then connected it to the mains supply and an aerial. He switched on. The set, a late hybrid model, sported five valves with all the rest of the circuit transistorised. Smithy waited whilst the valve and tube cathodes warmed up. First, the sound channel became audible, then, after the booster diode had warmed up, a picture appeared on the screen. Line hold was satisfactory but the picture rolled upwards. Smithy adjusted the vertical hold control, to find that it had a critical central setting at which a tenuous

ENTER SMITHY

But what is this?

There is the busy clutter of a key in the lock, the brisk opening of the door and the sudden bustling entrance of one clutching a large and bulky burden. Unerringly, the figure strides swiftly towards Smithy's bench and deposits his encumbrance on its surface, then hurries to the switches at the door.

The Workshop rested, this Christmas Eve, withdrawn, sequestered, untenanted. The weak late morning sun shone fitfully through its windows, decorated for Christmas yet again by Dick with evenly-spaced equally-sized clumps of cotton wool representing what was apparently the utmost in geometrically ordered snow storms. The signal generators were switched off, the soldering irons reposed coldly on their rests, and the needle of the millimetre on Smithy's bench stayed peacefully at zero whilst that on Dick's bench, following a recent unfortunate incident, indicated zero only on its inner scale and all of 5 volts on its outer scale.

Dick and Smithy had spent the previous day wrestling manfully with the multiplicity of sets which, perversely, chose to break down just before Christmas, and had finally succeeded in completing the last repair by early evening. Exhausted, they had then exchanged greetings appropriate to the season and had finally tottered off to their respective homes.

Thus the Workshop, this Christmas Eve morning, lay unoccupied and destitute.

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lock would hold for a short while before the picture rolled again. He switched off the set.

"I must confess I rather like playing around with these hybrid sets," he remarked to his assistant, who was returning now with the service manual. "It brings back the old days when everything was valves."

"That's quite a recent set," commented Dick, looking inside the cabinet.

"It is," agreed Smithy. "TV sets have changed over from valves to transistors at a far slower rate than did radio sets and audio amplifiers. In fact the rate has been so slow that you can bump into TV sets with valves and integrated circuits in them! The same thing seems to have happened in America, too. When I read the TV servicing articles in American electronics magazines I see that they're just as much preoccupied with valves as they are with transistors. The set we have here has a triode-pentode as a.f. amplifier and output, a triode-pentode as part of the line flywheel sync circuit and line oscillator, a pentode line output valve, a booster diode, and a triode-pentode vertical oscillator and vertical output valve. All the rest of the set is solid-state."

"Apart from the tube," Smithy turned a beady eye on his assistant.

"Apart, as you say, from the tube," he grunted. "Let's next have a quick look at the circuit around the last valve I mentioned. That is, the vertical oscillator and output circuit."

**VERTICAL SYNC**

Smithy opened out the service manual circuit diagram and indicated the vertical oscillator and output stages. (Fig. 2.)

"Blimey," gasped Dick. "There seem to be a lot of spare resistors and capacitors in this circuit."

"You tend to get that with valve vertical timebases," stated Smithy.

---

**Figure 1.** In a monochrome television receiver, signals from the video amplifier are passed to the cathode ray tube and the sync separator. The separated pulses are next fed to the line timebase via the line flywheel sync circuit, and to the vertical, or frame, timebase, via an integrating circuit which extracts the vertical sync pulses from the composite sync pulse signal.
They don't have things like emitter follower output stages to which a linear sawtooth waveform can be applied, and it's necessary to have quite complicated coupling and feedback circuits to produce a linear scan. Now, before I do anything else I'll try a new triode-pentode valve. It's most unlikely that the fault is causing the fault but, since it's so easy to change it, the sensible thing to do is to check out the circuit with a new valve. It's a PCL805 that's required here, and I should have a spare one knocking around for checking purposes.

Smithy reached up to the shelf over his bench and picked up a cardboard box with several valves in it. He selected one, removed the valve in the set, fitted the new one then switched on the receiver. After a period the set commenced operating once more, with precisely the same loss of vertical sync that it had before. Smithy evinced no surprise as he switched the set off again.

"That's carried out the first obvious check," he remarked, as he refitted the original valve. "Now we'll have a spot of fault-finding at rather more basic level."

"Where," asked Dick, "does the sync go into the vertical oscillator?"

"At the cathode of the triode," replied Smithy. "The set has a very simple sync separator consisting of a common emitter transistor which turns hard on at sync pulse tips from the video emitter follower which drives the video output transistor. In consequence there are nice clean negative-going sync pulses at the sync separator collector. These are fed direct to the line flywheel sync discriminator and also to the vertical timebase integrating circuit consisting of R1 and C1. This gives negative-going vertical sync pulses at field frequency which are passed to the cathodes of the triode via C2. Each pulse turns the triode on near the end of the vertical scan period and initiates vertical flyback." (Fig. 3.)

"I don't quite get this," stated Dick. "Are you saying that the triode is off during the vertical scan period?"

"Of course it is," said Smithy. "The triode and pentode form a multivibrator, so that when the triode is conducting the pentode is non-conducting, and vice versa. Now, the pentode has got to be on during the scan period or you wouldn't get a scan. That means the triode has got to be off."

"Another way of putting it," said Dick musingly, "is that the pentode has got to be off during flyback, or there wouldn't be a flyback. So the triode has to be on during flyback, and must therefore be off during the scan period."

"That's right," confirmed Smithy. "Hey, why on earth am I telling you all this? This is Christmas Eve and I want to get shot of this job as soon as I possibly can, not waste time answering your questions."

"The couplings between the triode and the pentode," continued Dick remorselessly, 'seem' to be pretty complicated. In an ordinary valve multivibrator you just have one capacitor coupling one anode to the opposite grid and a second one coupling the other anode to the grid of the first valve." (Fig. 4.)
Fig. 4. A basic valve multivibrator. One or both of the grid resistors may, alternatively, be returned to the positive rail

Smithy sighed helplessly.
"There's no stopping you," he grumbled, "once you get the bit between your teeth. As I said just now, the coupling and feedback arrangements in valve vertical timebases are complicated, and you have a lot of extra resistors and capacitors in the circuit to give waveform shaping. There are also resistors which reduce grid current when the opposite anode goes positive. Now the triode anode couples to the pentode grid by way of R3, C7, C10, R14, R15 and R17, and the pentode anode couples back to the triode grid via C11, R11, C8 and R9. There's another feedback network consisting of C13, R16, C12, R18 and R19 which also provides waveform shaping. Indeed, the two vertical linearity controls appear in this network. Okay?"

"There's one capacitor which isn't in any of the inter-coupling networks," remarked Dick. "That's C4, between the anode and cathode of the triode."

"Ah yes," said Smithy. "That's one of the most important waveform shaping components of the lot. Its function is to provide a basic sawtooth waveform at the anode of the triode in conjunction with R3, R4 and R5. If you didn't have C4 in the circuit the triode anode would go rapidly positive when the triode turned off at the start of the scan period. When C4 is in circuit the anode goes positive quite slowly, to give the rising section of a sawtooth as C4 charges. At the end of the scan period the triode turns on and discharges C4." (Fig. 5.)

**TIMEBASE FREQUENCY**

With a determined gesture, Smithy switched on his soldering iron.

"And that," he went on doggedly, "is the end of question-time! All I want to do is a quick servicing job here and get away again. Dash it all, it is Christmas Eve!"

"I know," said Dick. "And that's another reason why I popped in when I saw the lights come on. With all the bustle we had yesterday I completely forgot to give you your Christmas present."

"Smithy's jaw dropped. "Ye gods!" he exclaimed. "I forgot all about giving you yours, too! My boy, my boy, my apologies.

You can forget all I said just now about your asking me questions all the time. From now on we shall proceed with a proper regard for the courtesies of Christmas and all that they involve. Let me get out my present for you."

Smithy leaned forward and opened the cupboard under the bench. As he did so, Dick walked over to his own bench, to return with a rectangular package gaily wrapped with paper illustrating robins against a background of holly and snow. He handed it to Smithy who, in turn, presented him with another rectangular package. This was covered in paper bearing a motif of golden bells against a background of holly and snow.

"There you are, Smithy!"

"Thank you Dick. And here's yours."

"Thanks Smithy," Dick chuckled. "At least we've managed to choose different wrapping paper for our presents this year."

They proceeded to unwrap the parcels. Each yielded a green oblong cardboard box. Frowning, Smithy removed the lid from one end of the box then withdrew its contents. Dick's present to him was a 10 inch slide rule. Dick's forehead creased unhappily as he also took off the cover of his box. He pulled out a 10 inch slide rule.

"Well, well, well," said Smithy uncertainly. "This is what I've been wanting for ages."

"The same here," stated Dick, his voice betraying a certain level of incredulity, "I've always wanted a slide rule."

They gazed at each other for a moment, then looked down again at their presents. Dick made to place his on Smithy's bench.

"I think," said Smithy gently, "you'd better put it on your own bench. It would never do to get them muddled up, would it?"

"No, of course it wouldn't," replied Dick weakly. He took his slide rule to his bench, then returned to Smithy's side.

"Well, thanks anyway, Smithy."

"And thank you too, Dick. I must say that there's nothing like the giving of presents to create the selflessness that Christmas stands for. I suppose I'd better get on with this TV set now."

"Okeydoke," replied Dick, with an audible tone of relief at the change of subject. "Incidentally, how does the vertical hold control work?"

"D'you mean R6?"

Now that the strange episode of the slide rules had passed there was a note of relief in Smithy's accents, too. So much so, indeed, that he forebore to comment on his assistant's resumption of questions. "That's right, R6."

It works in the usual way for a vertical timebase," said Smithy.
“What you always have to remember with TV vertical timebases is that the length of the flyback period is fixed and that you vary timebase frequency by changing the length of the scan period. During the flyback period in the circuit we have here the pentode anode goes highly positive because of the collapse of the magnetic field in the primary of the vertical output transformer. Thereupon C11 and C8 become charged. At the end of the flyback the pentode becomes conductive again and the two charged capacitors take the grid of the triode well negative of the cathode so that the triode turns off. They then start to discharge via the resistors in the circuit, including R9, R7 and R6, and the scan period commences. This will come to an end when C11 and C8 are sufficiently discharged for the triode to start conducting again and initiate another flyback period. The rate at which the capacitors discharge is governed by the values of the resistors in the circuit and can be altered by the variable resistor, R6, which is the vertical hold control. This resistor is set up such that, without sync pulses, the scan period would be a little longer than that needed to resolve a picture. When sync pulses are applied the scan period becomes controlled, because the sync pulses initiate the flyback earlier than would otherwise occur.”

VOLTAGE DEPENDENT RESISTOR

“I’ve got it,” said Dick brightly. “Well, there’s only one other thing that’s puzzling me now.”

Smithy’s expression unaltered.

“And what?” he asked, “is that?”

“It’s that queer looking gubbins which is marked R21. It looks a funny sort of resistor to me.”

“It isn’t an ordinary resistor,” stated Smithy, “it’s a voltage dependent resistor.”

“Blimey, what’s that?”

“It’s a resistor whose resistance decreases dramatically as the voltage across it increases. The one in this diagram is an E298ED/A265 and…”

His voice trailed off, and he opened the drawer in his bench, taking out a notebook. He turned the pages slowly.

“Ah, here we are,” he resumed. “I’ve just recalled that I made some notes about these v.d.r.’s a year or so ago, including the one we’ve got here. This one passes a current of about 0.1mA when the voltage across it is 350 and it passes a current of 1mA when the voltage across it is 600 volts. In other words, the current increases 10 times for an increase of less than twice the voltage.”

“Well?”

“That means it acts as a sort of high voltage zener diode,” explained Smithy. “Not a very efficient one, admittedly, but good enough to provide fairly effective voltage stabilization at low currents.” (Fig. 6.)

“I still,” said Dick slowly, “don’t fully understand what it’s supposed to do here. And why is it coupled to the boosted h.t. supply?”

“In a valve vertical timebase,” explained Smithy, “it’s always a good idea to have the resistive part of the sawtooth generating circuit, which in this case is given by R3, R4 and R5, connect to a high supply voltage because this gives improved linearity. The higher the supply voltage the more the circuit approaches the ideal of a sawtooth circuit capacitor charging from a constant current generator. In this set there will be about 600 volts positive on the boosted h.t. line, which comes from the line timebase, of course, and the v.d.r. stabilizes at around 450 volts. This stabilized voltage is then applied to R3.”

“Fair enough,” said Dick. “I suppose that all that the height control does is to vary the charging current flowing into C4 during the scan period.”

“That’s exactly what it does do,” agreed Smithy. “When R4 is set to insert minimum resistance C4 charges to a higher voltage at the end of the scan period than it does when R4 is set to insert maximum resistance. So, R4 controls the voltage amplitude of the sawtooth waveform passed to the grid of the pentode and, hence, the amplitude of the sawtooth waveform at the pentode anode. In consequence, R4 controls the height of the reproduced picture. I thought you said you were only going to ask me one more question.”

“Well,” said Dick, “the other ones tended to follow on. There’s another voltage dependent resistor in the circuit, by the way. It’s R22, across the primary of the vertical output transformer.”

“Now look,” began the Serviceman belligerently.

“It’s Christmas, Smithy!”

Smithy drew a deep breath.

“That v.d.r.,” he said through gritted teeth, “comes into action during the flyback period. Like the other one it exhibits a continually decreasing resistance as the voltage across it goes up and, in this case, it limits the back-e.m.f. flyback voltage across the transformer primary. In practice it limits it to about 900 volts. Are you satisfied now?”

“Yes, Smithy.”

“Can I get on with fixing this set?”

“But, of course!”

FAULT-FINDING

“Thank you,” remarked Smithy with heavy irony. “Well, the first thing to do is to tackle the obvious thingie you’ve already swapped the valve and it isn’t that. If we’re very lucky, we may find that the sync pulses going to the sync separator transistor base have adequate amplitude, so that there are good strong separated pulses at its collector. Proceeding from that assumption our first suspicions fall upon the integrating circuit consisting of R1 and C1. Either R1 has gone high or C1 has gone leaky. Modern plastic foil capacitors don’t usually go leaky so we shall start by checking the value of R1. The milliampere, please!”

Engrossed in Smithy’s discourse, Dick hurried to pass the instrument over to the Serviceman. Smithy switched it to a resistance range, adjusted its set-zero control and applied the testmeter prods across R1. Fig. 6.

The meter indicated 400kΩ.

“This,” said Smithy, patently delighted, “is my first lucky break of the day. That resistor going high is a real present from Santa Claus!”

Fig. 6. Voltage-current curve for the E298ED/A265 voltage dependent resistor. (This is prepared from information published by Mullard Limited)
“Go on, there ain’t no Santa Claus!”

“There is, you know. As proof, he’s just presented me with this faulty resistor!”

Smithy made a gesture towards the set whereupon Dick, correctly interpreting his meaning, took over the repair of the television receiver. He quickly removed the offending 68kΩ resistor and, after a brief rummage in the spares cupboard, fitted a brand-new component in its place. He switched on the receiver and the pair waited expectantly.

The sound channel came to life and the strains of “I’m Dreaming of a White Christmas” sung by Bing Crosby issued from the speaker.

“Every year,” exclaimed Dick irritably, “every darned year he gets in with that song.”

The picture resolved on the screen of the cathode ray tube. It had rock-steady line hold. And it also had rock-steady vertical hold.

Smithy adjusted the hold control. The picture broke on either side of the lock-in range in just the manner that it should do in all well behaved television receivers.

“And that’s another job finished,” stated Smithy with immense satisfaction. “I’ll leave you to button it up.”

As Smithy sat comfortably watching his assistant screw on the back of the set, a thought struck him.

“Where,” he asked idly, “did you get that slide rule from?”

“My uncle,” replied Dick absentmindedly. “He seems to have rather a lot of them.”

“I got mine,” remarked Smithy thoughtfully, “from the steward at my club.”

There was an uneasy silence.

“The steward,” continued Smithy, “said that he’d obtained quite a few of them at low cost. Apparently, they don’t sell very well these days now that everybody’s got pocket calculators.”

“Er, my uncle said much the same thing, too.”

Suddenly, Smithy thumped his fist on the bench. Dick started at the sound.

“I’ve just remembered,” stated Smithy irritably, “that the club steward is your uncle! And it’s him that I’ve just fixed this set for! Could this be another reason why you decided to come in today?”

“Well, he did rather ring me earlier on this morning and ask me to keep an eye on things. Apparently, you were somewhat—what shall I say?—verse at your club last night.”

“Me? Verbose? Never!”

“He didn’t actually use the term ‘verbose’.”

“What term did he use?”

“Stoned!”

FESTIVE SPIRIT

“All I can say,” snorted Smithy, “is that it’s a good thing it’s Christmas. Not only am I conned into doing a set on the side but my name is blackened all over town as well.”

His expression brightened.

“Anyway,” he said more cheerfully, “this is the end of work now, and I can really start thinking of a holiday. Which reminds me that we forgot something else yesterday, too.”

He reached down into his cupboard and for several moments there was no sound save the musical clink of bottle against glass, Smithy handed a charged glass to his assistant.

“A Merry Christmas, Dick.”

“And a Merry Christmas to you too, Smithy,” responded Dick warmly.

They both stood.

“Let us,” said Smithy, “also wish a really Merry Christmas and a truly Happy New Year to all the readers who have put up with our antics over the last twelve months.”

They drank deeply.

“And God bless us,” concluded Dick, “God bless us, everyone!”
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