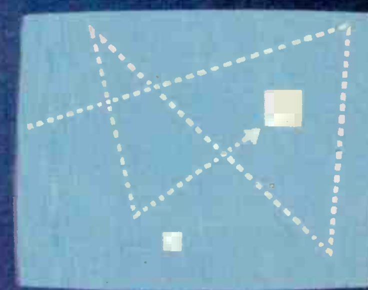
PRACTICAL WIRELESS

AUGUST 1977

40p

Shoot!



ADD-ON UNIT FOR THE PW TELE-GAMES

and

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ATOMIC TIME Receiver

Morse Tutor

PRACTICAL WIRELESS

VOL. 53 NO. 4
ISSUE 846
AUGUST 1977

BRITAIN'S PREMIER MAGAZINE FOR THE DO-IT-YOURSELF RADIO AND ELECTRONICS CONSTRUCTOR

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Due to an enlarged format, shortly to be announced, there will be a delay in supplying larger sized binders for Volume 53. See page 279.

● NEWS & COMMENT

● CONSTRUCTIONAL

● OTHER FEATURES

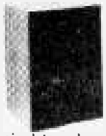
DIY SPEAKER KITS

15-WATT KIT IN CHASSIS FORM

When you are looking for a good speaker, why not build your own from this kit. It's the unit which we supply with the enclosures illustrated below Size 13" × 8" (approx.) woofer (EMI), tweeter, and matching crossover components. Power handling capacity 15 watts rms. 30 watts peak.

£17.00 PER STEREO PAIR + P & P £3.40

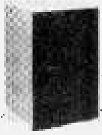
EASY-TO-BUILD WITH ENCLOSURE



Specially designed by RT-VC for cost-conscious hi-fi enthusiasts, these kits incorporate two teak-simulate enclosures, two EMI 13" × 8" (approx.) woofers, two tweeters and a pair of matching crossovers. Easily constructed, using a few basic tools. Supplied complete with an easy-to-follow circuit diagram, and crossover components. Input 15 watts rms. 30 watts peak, each unit. Cabinet size 20" × 11" × 9½" (approx.). £25.50 PER STEREO PAIR + p & p £5.50

COMPACT' FOR TOP VALUE

How about this for incredible bookshelf value from RT-VC! A pair of high efficiency units for only £7.50 – just what you need for low-power amplifiers. These infinite baffle enclosures come to you ready mitred and professionally finished. Each cabinet measures 12" × 9" × 5" (approx.) deep, and is in wood simulate. Complete with two 8" (approx.) speakers for max. power handling of 7 watts.



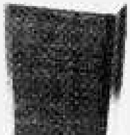
per stereo pair £7.50 + p & p £1.70

SPEAKERS Two models – Duo IIb, teak veneer, 12 watts rms, 24 watts peak, 18½" × 13½" × 7½" (approx.).

★ £34 PER PAIR + p & p £6.50

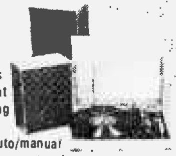
Duo III, 20 watts rms, 40 watts peak. 27" × 13" × 11½" (approx.)

★ £52 PER PAIR + p & p £7.50



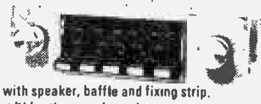
EASY TO BUILD RECORD PLAYER KIT

Ideally suited for the constructor who requires a complete stereo unit at a budget price, comprising ready assembled stereo amp. module, Garrard auto/manual deck with cueing device, pre-cut and finished cabinet work. Output 4 watts per channel, phones socket and record / replay socket



£26.95 + p & p £4.05

CAR RADIO KIT



Complete with speaker, baffle and fixing strip. The Tourist IV for the experienced constructor only. The Tourist IV has five push buttons, four medium band and one for long wave band. The tuning scale is illuminated and attractive small aluminium control knobs are used for manual tuning and volume control. The modern style fascia has been designed to blend with most car interiors and the finished radio will slot into a standard car radio aperture. Size approx. 7" × 2" × 4¼". Power Supply Nominal 12 volts positive or negative earth (altered internally) Power Output 4 watts into 4 ohms.

MOTOR TOP 10 AWARD

£12.50 + p & p £1.50

PERSONAL SHOPPERS ONLY

Viscount IV 20 x 20 Amplifier as illustrated plus 1 pair of speakers finished in teak with melamine panels 8" drive unit and 3½" approx tweeter. 22" × 13" × 10½" size approx.

£45.00

SPECIAL OFFER

illustrated **20 x 20 WATT STEREO AMPLIFIER** ★

Superb Viscount IV unit in teak-finished cabinet. Silver fascia with alimunium rotary controls and pushbuttons, red mains indicator and stereo jack socket. Function switch for mic. magnetic and crystal pick-ups, tape, tuner, and auxiliary Rear panel features two mains outlets. DIN speaker and input sockets, plus fuse. 20 + 20 watts rms, 40 + 40 watts peak. £29.90 + p & p £2.10

FREE 'Limited Period' A Free 4 Channel Stereo Adaptor to all purchasers of the Viscount Amplifier. Available separately. £3.95 + p & p £1.00

SPECIAL OFFERS

DEDUCT 10% Mail order only (not on postage) DEDUCT 15% Personal Shoppers only

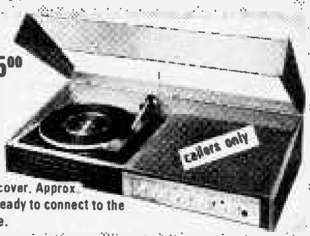
★ on complete stereo systems using starred Products ★

For example Duo speaker system II or III Viscount Amplifier, MP60 type turntable complete

PERSONAL SHOPPERS ONLY

DECCA DC1000 Stereo cassette, ready built tape deck, replay / record P.C.B. with pair record / replay heads	£3.95
AM. FM. TUNER P.C.B. with Mullard L.P. 1186, 1185 1181 modules	£9.50
CROWN 5 push button car radio, LW. MW. 12v Pos. neg. earth 5 watts output, tone control complete with speaker and fixing kit, in dash type	£15.95
STEREO CASSETTE TAPE PLAYER Negative earth only. 3 watts per channel output	£16.50
AM. FM. STEREO MULTIPLEX CAR RADIO/cassette player in dash fixing Negative earth 5 watts output	£36.00
I.C. Stereo 8 Track to Cassette adaptor converts, any 8 track player to cassette player.	£18.95
GLOBAL Spherical speaker 8 ohms. 5 watts	£3.50
100K Multiturn Varicap tuning pots 6 for	£1.00

VISCOUNT COMBI £65.00



For personal shoppers only, this unit comprises: The 20 × 20 Viscount amplifier BSR MP60 Type turntable housed in an attractive teak finished console with smoked acrylic cover. Approx. 30½" × 14½" × 7½" complete ready to connect to the speaker system of your choice.

BSR TURNTABLES

BSR MP60 TYPE Single play record player (Chassis form) £15.95 less cartridge. P & P £2.00

BSR automatic record player deck (Chassis form) with cueing device and stereo ceramic head. £9.95 P & P £2.00

Cartridges to suit above ACOS MAGNETIC STEREO ...... £4.95 CERAMIC STEREO £1.95

TURNTABLE illus. Popular BSR MP 60 type, complete with magnetic cartridge, diamond stylus, and de luxe plinth and cover. Ready wired ★ £29 + p & p £4.50

30 x 30 WATT AMPLIFIER KIT

Specially designed by RT-VC for the experienced constructor, this kit comes complete in every detail. Same facilities as Viscount IV amplifier. Chassis is ready punched, drilled and formed Cabinet is finished in teak veneer. Silver fascia and easy-to-handle aluminium knobs.

Output 30 + 30 watts rms, 60+60 peak. £29.00 + p & p £2.10

DECCA 20 WATTS STEREO SPEAKER

This matching loudspeaker system is hand made, kit comprises of two 8" diameter approx. base drive unit, with heavy die cast chassis laminated cones with rolled P.V.C. surrounds, two 3½" diameter approx. domed tweeters comp with crossover networks + £4.00 p & p stereo pair £20.00

PORTABLE MONO DISCO CONSOLE

with built-in pre-amplifiers

Here's the big-value portable disco console from RT-VC! It features a pair of BSR MP 60 type auto-return, single play professional series record decks. Plus all the controls and features you need to give fabulous disco performances. Simply connects into your existing slave or external amplifier. p & p £6.50 £64.00

35-WATT MONO DISCO AMP

£27.50 + p & p £2.50 Size approx 13¾" × 5¼" × 6¾"

Here's the mono unit you need to start off with. Gives you a good solid 35 watts rms, 70 watts peak output. Big features include two disc inputs, both for ceramic cartridges, tape input and microphone input. Level mixing controls fitted with integral push-pull switches. Independent bass and treble controls and master volume.

100 WATT MONO DISCO AMP

Size approx. 14" × 4" × 10¾". Sloping facia, you can use the controls without fuss or bother. Brushed alumimium fascia and rotary controls. Five smooth acting, vertically mounted slide controls – master volume, tape level, mic level, deck level, PLUS INTER-DECK FADER for perfect graduated change from record deck No. 1 to No. 2, or vice versa. Pre-fade level control (PFL) lets YOU hear next disc before fading it in. VU meter monitors output level. Output 100 watts RMS 200 watts peak. £65.00 p & p £4.00

PRACTICE GUITAR AMPLIFIER WITH BUILT-IN SPEAKER

This budget practice amplifier, has been specially designed for the amateur, who requires a quality self-contained unit with all facilities. 2 inputs – 1 for mic or guitar, the 2nd for record player or cassette deck, it also can be used for cine-sound amplification. 2 volume controls, 1 for each input, also base and treble controls. Power output with internal speaker, 10 watts RMS, with remote speaker (not supplied) 20 watts RMS. Size approx. 17" + 9" × 11". £32.50 + p & p £3.00

HOME 8 TRACK CARTRIDGE PLAYER

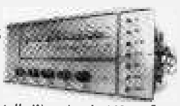
Automatically switches programmes monitored by indicators with manual override track selection. This unit will match with the Unisound modules and is compatable with the Viscount IV amplifier with Sim teak cabinet. approx. 9" · 8" · 3½" p & p £1.50 £14.60

4 x 4 STEREO AMP KIT £14.50 P & P £2.00

For the experienced constructor who wants to design his own stereo. Kit includes all necessary components including constructors manual. Plus Pair of easy to build 4 watt speakers in kit form, with teak simulate finish cabinets 12" x 9" x 5" approx.

PYE STEREO GRAM CHASSIS

(Complete with circuit-diagrams)



Complete ready to install—Wave bands LM, VHF STEREO, VHF MONO. Controls for tuning volume, balance, bass and treble. Power output 7 watts R.M.S per channel 14 watts peak 8 ohms 2" × 8" approx chassis speakers and BSR auto record player deck.

PERSONAL SHOPPERS ONLY £35.00

Ordergiving your credit card number ONLY

ALL PRICES INC. VAT AT 12½%

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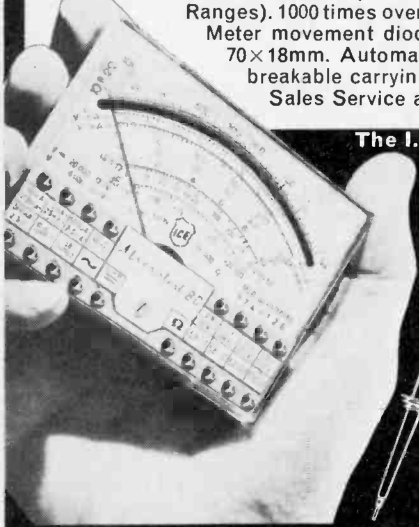
20,000 Ohms/Volt, (d.c.) 4,000 Ohms/Volt (a.c.) 2% accuracy. V d.c. 100mV to 1kV (6 Ranges). I d.c. 50μA to 5A (6 Ranges). V a.c. 1·5V to 1kV (5 Ranges) I a.c. 250μA to 2·5A (5 Ranges). Resistance, Low Ohms, Ohms×1, Ohms×10, Ohms×100. Output Level Measurements 1·5V to 1000V (5 Ranges) + 6dB to + 62dB (5 Ranges). Capacitance 25μF to 25,000 μF (4 Ranges). 1000 times overload protection (on Resistance ranges). Meter movement diode protection. Size (without case) 90×70×18mm. Automatic zero, non-parallax mirror scale. Unbreakable carrying case and probes supplied. Full After Sales Service available. **Price £16.15 inc. VAT**



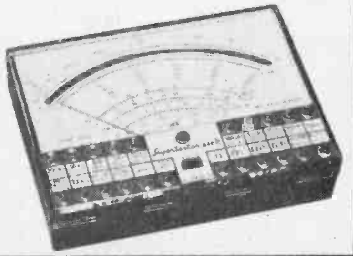
The I.C.E. Measurement System includes a comprehensive range of accessories: shunts, transformers, specialised probes, transistor-tester etc.
I.C.E. High-Voltage d.c. Probe, Model 18. Input Impedance: 500M Ohm, nominal (Other values available to order). The Model 18 d.c. Probe consists of a highly insulated moulded plastic body, fitted with a hand guard-ring, containing a stable, precision 500M Ohm resistor, which may be used to extend the d.c. voltage measuring capability of analogue multi-meters or electronic voltmeters, to a maximum value of 25kV. The probe is fitted with a prod-tip for connection to the voltage source to be measured and a connecting lead terminating in a 2mm plug for insertion into the measuring instrument's d.c. voltage input socket. (4mm plug available to order). **£6.42 inc. VAT**

SUPER TESTER 680R—I.C.E.

20,000 Ohms/Volt 80 RANGES

20,000 Ohms/Volt 1% d.c. 4,000 Ohms/Volt a.c. 2% V d.c. 100mV to 2kV (13 ranges). V a.c. 2V to 2kV (11 Ranges). I d.c. 50μA to 10A (12 Ranges). I a.c. 250μA to 5A (10 Ranges). Resistance Ohms × 1, × 100, × 1000, × 10,000 and Low Ohms. Reactance Detector 0-10M Ohms. Freq. Measurement 0-5000 Hz (2 Ranges). Output Level 10-2000V (9 Ranges). Decibels —24–+70dB (10 Ranges). Capacitance 0-500,000 pF (2 Ranges using mains supply) 0-20,000 μF (4 Ranges using internal 3 Volt battery). 1000 times overload protection on Resistance ranges and meter movement diode protection. 10 Measurement Functions and 80 Ranges. Size 128 × 95 × 32mm. Non-parallax mirror scale. Unbreakable carrying case supplied which contains probes, mains lead, crocodile clips and shorting link.

Price £27.27 inc. VAT



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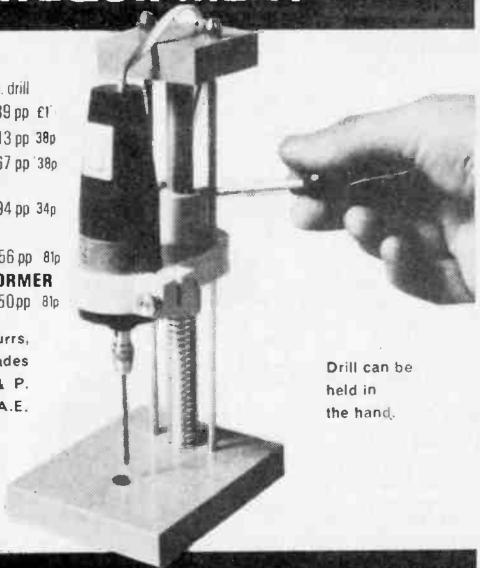

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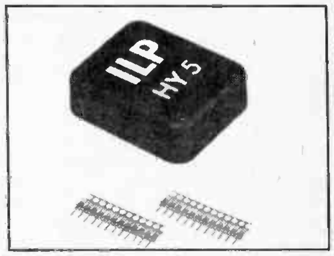
15—240 Watts!

HY5
Preamplifier



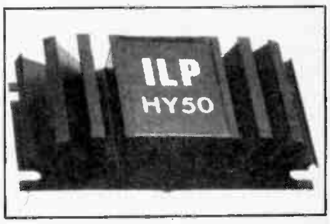
The HY5 is a mono hybrid amplifier ideally suited for all applications. All common input functions (mag Cartridge, tuner, etc) are catered for internally. The desired function is achieved either by a multi-way switch or direct connection to the appropriate pins. The internal volume and tone circuits merely require connecting to external potentiometers (not included). The HY5 is compatible with all I.L.P. power amplifiers and power supplies. To ease construction and mounting a P.C. connector is supplied with each pre-amplifier.
FEATURES: Complete pre-amplifier in single pack—Multi-function equalization—Low noise—Low distortion—High overload—Two simply combined for stereo.
APPLICATIONS: Hi-Fi—Mixers—Disco—Guitar and Organ—Public address
SPECIFICATIONS:
INPUTS. Magnetic Pick-up 3mV; Ceramic Pick-up 30mV; Tuner 100mV; Microphone 10mV; Auxiliary 3-100mV; Input impedance 4·7kΩ at 1kHz.
OUTPUTS. Tape 100mV; Main output 500mV R.M.S.
ACTIVE TONE CONTROLS. Treble ± 12dB at 10kHz; Bass ± at 100Hz.
DISTORTION. 0·1% at 1kHz. Signal/Noise Ratio 68dB.
OVERLOAD. 38dB on Magnetic Pick-up. SUPPLY VOLTAGE ± 16-50V.
Price £5·22 + 65p VAT P&P free.

HY30
15 Watts into 8Ω

Available June '76

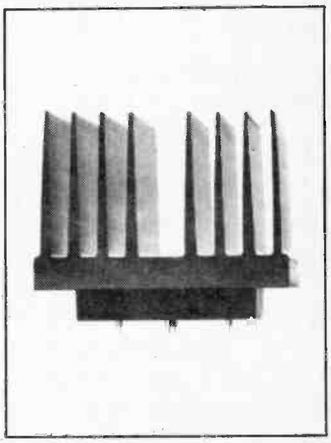
The HY30 is an exciting New kit from I.L.P. It features a virtually indestructible I.C. with short circuit and thermal protection. The kit consists of I.C., heatsink, P.C. board. 4 resistors, 6 capacitors, mounting kit, together with easy to follow construction and operating instructions. This amplifier is ideally suited to the beginner in audio who wishes to use the most up-to-date technology available.
FEATURES: Complete Kit—Low Distortion—Short, Open and Thermal Protection—Easy to Build.
APPLICATIONS: Updating audio equipment—Guitar practice amplifier—Test amplifier—audio oscillator.
SPECIFICATIONS:
OUTPUT POWER 15W R.M.S. into 8Ω: DISTORTION 0·1% at 1·5W.
INPUT SENSITIVITY 500mV. FREQUENCY RESPONSE 10Hz-16kHz—3dB.
SUPPLY VOLTAGE ± 18V.
Price £5·22 + 65p VAT P&P free.

HY50
25 Watts into 8Ω



The HY50 leads I.L.P.'s total integration approach to power amplifier design. The amplifier features an integral heatsink together with the simplicity of no external components. During the past three years the amplifier has been refined to the extent that it must be one of the most reliable and robust High Fidelity modules in the World.
FEATURES: Low Distortion—Integral Heatsink—Only five connections—7 amp output transistors—No external components
APPLICATIONS: Medium Power Hi-Fi systems—Low power disco—Guitar amplifier
SPECIFICATIONS: INPUT SENSITIVITY 500mV
OUTPUT POWER 25W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0·04% at 25W at 1kHz
SIGNAL/NOISE RATIO 75dB FREQUENCY RESPONSE 10Hz-45kHz—3dB.
SUPPLY VOLTAGE ± 25V SIZE 105 50 25mm
Price £6·82 + 85p VAT P&P free.

HY210
60 Watts into 8Ω

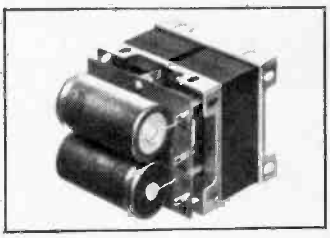


The HY120 is the baby of I.L.P.'s new high power range. Designed to meet the most exacting requirements including load line and thermal protection this amplifier sets a new standard in modular design.
FEATURES: Very low distortion—Integral heatsink—Load line protection—Thermal protection—Five connections—No external components
APPLICATIONS: Hi-Fi—High quality disco—Public address—Monitor amplifier—Guitar and organ
SPECIFICATIONS
INPUT SENSITIVITY 500mV.
OUTPUT POWER 60W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0·04% at 60W at 1kHz
SIGNAL/NOISE RATIO 90dB FREQUENCY RESPONSE 10Hz-45kHz—3dB SUPPLY VOLTAGE ±35V
SIZE 114 50 85mm
Price £15·84 + £1·27 VAT P&P free.

HY200
120 Watts into 8Ω

The HY200 now improved to give an output of 120 Watts has been designed to stand the most rugged conditions such as disco or group while still retaining true Hi-Fi performance.
FEATURES: Thermal shutdown—Very low distortion—Load line protection—Integral heatsink—No external components
APPLICATIONS: Hi-Fi—Disco—Monitor—Power slave—Industrial—Public Address
SPECIFICATIONS
INPUT SENSITIVITY 500mV
OUTPUT POWER 120W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0·05% at 100W at 1kHz.
SIGNAL/NOISE RATIO 96dB FREQUENCY RESPONSE 10Hz-45kHz—3dB SUPPLY VOLTAGE ±45V
SIZE 114 50 85mm
Price £23·32 + £1·87 VAT P&P free.

HY400
240 Watts into 4Ω



The HY400 is I.L.P.'s "Big Daddy" of the range producing 240W into 4Ω! It has been designed for high power disco address applications. If the amplifier is to be used at continuous high power levels a cooling fan is recommended. The amplifier includes all the qualities of the rest of the family to lead the market as a true high power hi-fidelity power module.
FEATURES: Thermal shutdown—Very low distortion—Load line protection—No external components.
APPLICATIONS: Public address—Disco—Power slave—Industrial
SPECIFICATIONS
OUTPUT POWER 240W RMS into 4Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0·1% at 240W at 1kHz
SIGNAL NOISE RATIO 94dB FREQUENCY RESPONSE 10Hz-45kHz—3dB SUPPLY VOLTAGE ±45V
INPUT SENSITIVITY 500mV SIZE 114 100 85mm
Price £32·17 + £2·57 VAT P&P free.

POWER SUPPLIES

PSU36 suitable for two HY30's **£5·22** plus **65p** VAT. P/P free.
PSU50 suitable for two HY50's **£6·82** plus **85p** VAT. P/P free.
PSU70 suitable for two HY120's **£13·75** plus **£1·10** VAT. P/P free.
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Typical Specification:
Sensitivity 3μ volts
Stereo separation 30db
Supply required 20–30v at 90 Ma max.

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£20.45

The 450 Tuner provides instant programme selection at the touch of a button ensuring accurate tuning of 4 pre-selected stations, any of which may be altered as often as you choose, by simply changing the settings of the pre-set controls.
Used with your existing audio equipment or with the BI-KITS **STEREO 30** or the **MK60** Kit etc. Alternatively the **PS12** can be used if no suitable supply is available, together with the Transformer **T461.**
The S450 is supplied fully built, tested and aligned.
The unit is easily installed using the simple instructions supplied.

STEREO PRE-AMPLIFIER PA 100

VAT ADD 12½%

A top quality stereo pre-amplifier and tone control unit. The six push-button selector 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
3. Magnetic P.U. 3mV into 50K ohms

P.U. Input equalises to R1AA curve within 1dB from 20Hz to 20KHz. Supply 20-35V at 20mA. Dimensions—299mm × 89mm × 35mm.

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Comprising: 2 x AL60's 1 x SPM80, 1 x BTM80, 1 x PA100, 1 front panel and knobs. 1 Kit of parts to include on/off switch, neon indicator, stereo headphone sockets plus Instruction booklet. **COMPLETE PRICE £29·55** *plus 62p postage.*
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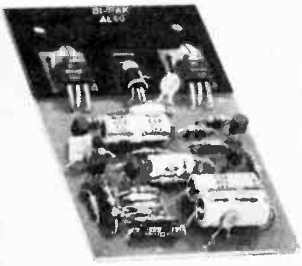
Comprising: Teak veneered cabinet size 16¾" x 11½" x 3¾", other parts include aluminium chassis, heatsink and front panel bracket plus back panel and appropriate sockets etc. **KIT PRICE £10·70** *plus 62p postage.*



AL 60

25 Watts (RMS)

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TRANSFORMER BMT80	£2·60 + 62p. postage

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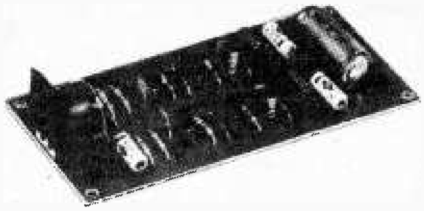
Mounting	2, 4BA fixing holes in heat sink
Fuse requirements	1·5A

MPA 30



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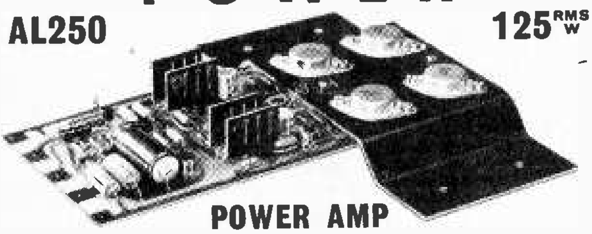
AL250 125 $^{RMS}_{W}$



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  - 50 watts into 4 ohms: 0·1%
  - 50 watts into 8 ohms: 0·06%
- S/N ratio: better than 80dBs
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- Semiconductor complement: 13 transistors 5 diodes
- Overall size: Heatsink width 190mm, length 205mm, height 40mm

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The AL30A is a high quality audio amplifier module replacing our AL20 & 30. The versatility of its design makes it ideal for use in record players, tape recorders, stereo amps, cassette & cartridge players. A power supply is available comprising of PS12 together with a transformer T538, also for stereo, the pre amp PA12.

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NEW PA12 Stereo Pre-Amplifier completely redesigned for use with AL-30A Amplifier Modules. Features include on/off volume. Balance, Bass and Treble controls. Complete with tape output.
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Morse Code ~ the PW Way

AMONG the offerings in this issue of *Practical Wireless* is a Morse Code Tutor, an excellent project that we are sure will be suitable for construction by amateur radio clubs and groups up and down the country as well as by many individual constructors. While clubs often have organised code practice classes under the eagle eye of a qualified instructor it is very convenient if the odd member or two can sit down with our Tutor and get it to send perfect code over a wide range of speeds, just for practice.

Whether we like it or not, passing the Morse proficiency test as set by the Home Office is a necessary requirement before the transmitting amateur can reach out on the HF bands. There is no other way out.

Many Class "B" licencees, restricted to 144MHz and above, are quite happy to leave it at that. However, there generally comes a time when a two-way link on one of the HF bands would be most useful in conjunction with some VHF activity or other. The Oscar amateur radio satellite programme is one case in point where a world-wide network is maintained by enthusiasts on the HF bands, passing a continuous stream of scientific information concerning the operation of the satellites and predictions for future orbits. Without that network the full potential of these satellites would never be realised.

While it is very easy to spurn the Morse code and to devise various reasons why one should not learn it, the fact remains that those who do take the trouble to pass the test are frequently delighted to discover that they have, without a great deal of trouble, acquired the ability to converse in a new language! However, that is only the beginning and after a few months of experience on the key the newly-acquired art of communication can easily supercede the rather artless operation of just talking into a microphone! If DX is the main interest it will be found that many countries around the world appear at the low frequency end of bands on CW, some of which seldom appear on telephony.

Unfortunately, old-fashioned methods of teaching the code are still persisted in, such as working up very slowly from a few characters a minute to 12 words a minute or so but always religiously maintaining the correct ratio of dots and dashes. This leads, almost inevitably, to the development in the pupil's mind of the well-known "speed barrier" around 7 or 8wpm when any further progress seems impossible regardless of the amount of practice indulged in. The only sensible method is to learn the sound of the whole letter or number sent at fairly high speed but with long gaps in between. Note that the sound is learned rather than the individual dots and dashes. Now when the gaps are gradually reduced in length, suddenly, hey presto, code at 12wpm without any "barrier"!

The *PW* Morse Code Tutor can do just that without the need for an experienced operator to be present at the time. Any letter or character can be repeated ad lib until it is known by heart or rather, by ear! Mix them up and send them at random thus avoiding any chance of self-deception which always occurs if the letters etc are sent in alphabetical order as is sometimes advocated.

Once confidence has been gained there is no reason why further practice should not be obtained with the help of another experienced operator but avoid other inexperienced operators like the plague! Otherwise you will both finish up with the same faults and these can be very difficult to eradicate.

Eric Dowdeswell *Assistant Editor*

NEWS...

Lionel Howes

WE are sorry to have to report that Lionel Howes G3AYA has had to relinquish the post of Editor because of continuing ill health. Lionel was previously Assistant Editor before being appointed Editor in October 1974.

We are sure that readers and the many friends of Lionel will want to wish him a very speedy recovery to good health and we look forward to his continued involvement with the magazine in the future.

Put a name to it

WE have been asked by A. Marshall (London) Ltd. to inform readers that this is their correct name, although from time to time a different name appears in the index to advertisers. The correct address for this company is 42 Cricklewood Broadway, London NW2 3ET. Tel: 01-452 0161.

Ten more to remember!

TEN new transistors to join the already bewildering choice available to the general public have recently been announced by Ferranti. They are complementary members of the E-Line series, rated at 500mW and designed for small and medium signal amplification from DC to RF.

The transistors in this new series are the BC546P and BC556P which are designed to withstand high breakdown voltages of V_{ceo} of 65V.

The BC547P and BC557P which can be used as driver stages for AF amplifiers and signal processing circuits functioning from a voltage of up to 45V, or should a lower voltage be acceptable

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

then the BC548P or BC558P may be selected.

The final two in this series are the BC549/550P and the BC559/560P and these are intended for low noise input stages in tape recorders and other good quality audio equipment.

Ferranti Ltd., Special Components Division, Gem Mill, Chadderton, Oldham. Tel.: 061-624 0515.

Weekend report

EIGHTEEN of their 25 members attended a weekend meeting of the St. Dunstan's Amateur Radio Society held in the Winter Garden at Ian Fraser House, Ovingdean, near Brighton, on May 20-22. Among those who had travelled some distance to be there were their Secretary/Treasurer Ted John G3SEJ, Merseyside, Jock Inness G4AJP, Yorkshire and SWL Tony Parkinson, Lancashire. The Society, open to St. Dunstaners, was inaugurated in January 1976 and is affiliated to the RAIBC, and RSGB, because of their military associations, to the RAFARS, RNARS and the Royal Signals ARS.

While using the call sign G4AFV/A, instead of their regular call GB3STD for such meetings, they worked several stations in the USA on 20m. Using a KW Atlanta feeding a Moseley Beam they also had a QSO with JA2GPR, despite heavy QRM. The operating of Bill Shea G4AUT impressed the visitors among whom were Louis Varney G5RV President of the Mid-Sussex ARS, Alan Baker G8LGQ Chairman of the Brighton And District Radio Society, and a party of cadets from the 2464 (Storrington) Squadron of the ATC. At the same time a 2m transceiver was being operated by Peter Bargen G3OTB, from Aylesbury.

The Saturday afternoon lecture was given by Ron Ham on 'Satellite Communication' and this was recorded by Ralph Cathles G3NDF for other members of the 'white stick' brigade. After the lecture Joan Ham showed the St. Dunstaners a selection of wartime morse keys including the Muirhead key made in 1915 and used by the late Nelly Corry G2YL when she worked all continents on 10m in October 1935. George Cole G4AWI a keen CW operator referred to the keys and to the value of CW operating when he moved the vote of thanks to the speaker. Looking to the future, Secretary Ted John said that it is proposed to set up a permanent amateur radio station at Ian Fraser House and to have it working by the end of the year.

Seaside amateurs

SOME 30 local radio enthusiasts were present at the inaugural meeting of the newly formed Brighton and District Radio Society, held at the St. John The Baptist Social Club Hall, Bristol Road, Brighton, on May 18th. The chairman, Alan Baker, G8LGQ, said that their aims are to further the well-being of amateur radio in all it's aspects, provide a technical advice service, help members with home construction, and promote good relations between people of similar interests.

They meet fortnightly at the Baptist Hall, where new members are welcome. Details of membership and their future programmes can be obtained from the secretary, *Nigel Hewitt, G8JFT, 74 Carlyle Street, Brighton.*

Welsh date

NOW established as the major amateur radio event in Wales the Welsh Amateur Radio Convention will again be held this year, on Sunday, 25th September, at the usual venue—Oakdale Community College, Oakdale, Blackwood, Gwent. The Convention will be opened by the Mayor of Islwyn Borough.

Apart from the usual Trade Exhibition, the programme will include an exhibition of early amateur radio equipment, an exhibition station, illustrated lectures on a visit to the Seychelles Islands by Roger Brown, G3LQP/VQ9RB, and the launching and post-launch control systems for AERIEL 5, one of the U.K. satellites, by John Wright, G3VPW, of the Appleton Research Laboratory, Slough.

There will be increased parking space this year and advice on obtaining overnight accommodation will be available upon request, from *R. B. Davies, GW3KYA, 16 Vancouver Drive, Penmain, Blackwood, Gwent.*

New WRC times

AS from Wednesday, 7th September, the transmissions of World Radio Club will be as follows:—

Wednesday — 0815 to 0830 GMT
Wednesday — 1330 to 1345 GMT
Wednesday — 2315 to 2330 GMT
Friday — 2100 to 2115 GMT

As can be seen the 0815 Sunday transmission has been cancelled.

University convention

THE Lancaster University Amateur Radio Society North West Amateur Radio Convention (must be the longest title of a convention yet) will be opening their doors to the general public at 2 p.m. on Saturday, 17th September, and again on Sunday 18th.

Lectures will cover many topics including repeaters, Oscar, TV, aerials, QRP, etc. There will be a supporting programme of films a raffle, constructors competition, and a coach tour of the lakes on Sunday. Full accommodation and all meals, including a dinner on Saturday are available. Optional lunch on Saturday will be available for those arriving early.

Further information concerning the convention and charges for the weekend can be obtained from *J. R. Morris, Dept. of Physics, Lancaster University, Lancaster.*

Handy-Mini POWER SUPPLY

I. HICKMAN

THIS power supply was designed to be easy to construct, with a very simple circuit, yet provide facilities and a standard of performance normally only associated with professional equipment. It is constructed in a diecast box which also acts as heat sink for the power transistor. The dimensions of the box used limit the size of mains transformer but this unit provides 0 to 12V at up to 500mA. However, with a larger box and heat sink, the same circuit can provide 1A with very minor modifications.

CIRCUIT

The circuit diagram is given in Fig. 1. Care has been taken to ensure that the circuit is stable under all conditions of use and some of the finer design points are explained below, along with the circuit description. The centre-tapped transformer and bridge rectifier provide both positive and negative rails, each of 15V nominal (18V off load). The negative rail provides the main current, the positive rail being used as an auxiliary supply for the reference zener D1. C2, C3 and the zener provide three stages of smoothing/filtering, reducing hum across D1 to a fraction of a millivolt. VR2 allows the range covered by the output voltage control VR3 to be set to 12V. The stabilised output voltage is less than the voltage at the slider of VR3 by the V_{BE} of Tr2, about 600mV. Tr2, 3 and 4 form a triple compound emitter follower, the large internal loop gain

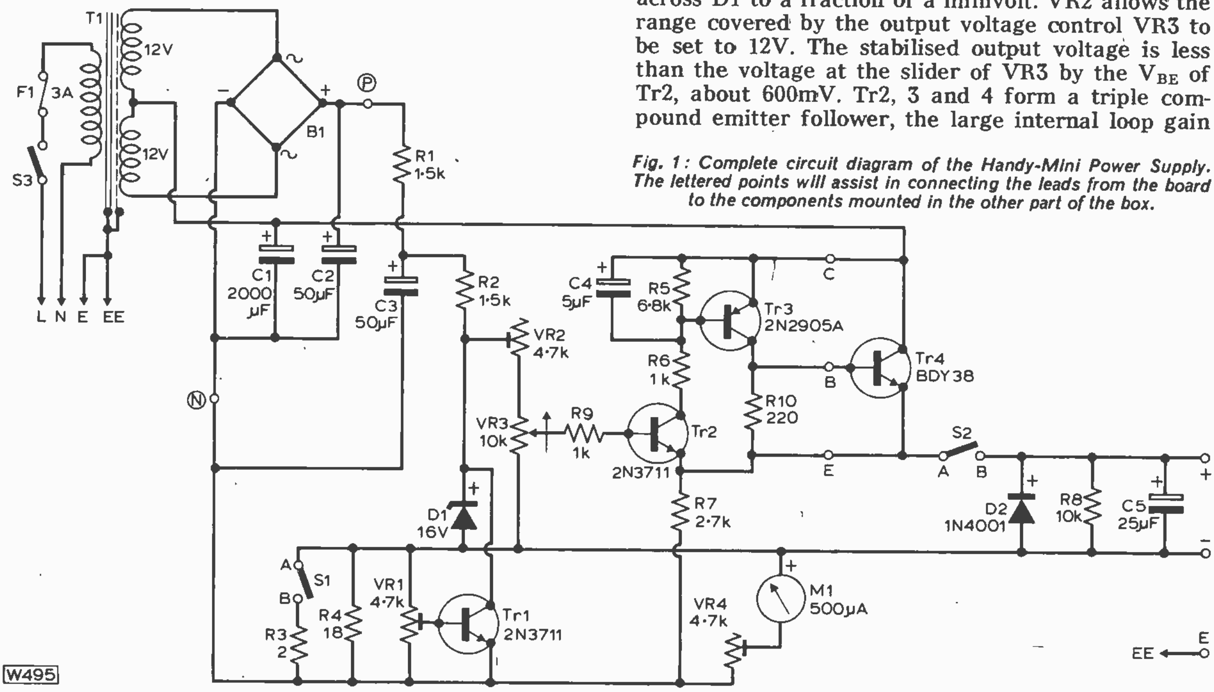


Fig. 1: Complete circuit diagram of the Handy-Mini Power Supply. The lettered points will assist in connecting the leads from the board to the components mounted in the other part of the box.

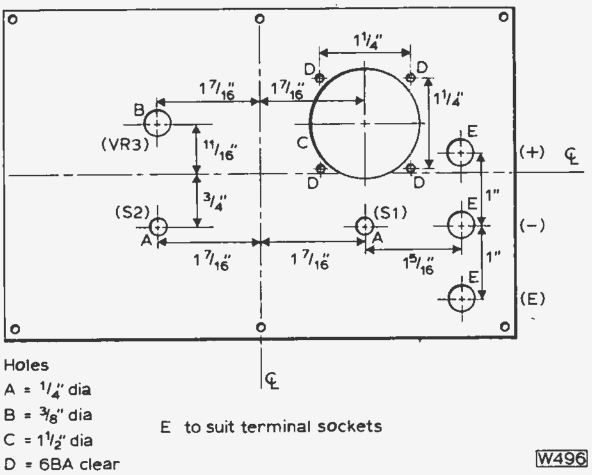


Fig. 2: above, gives details of the holes required in the lid of the box. The hole for the meter may need to be altered to suit the meter actually used.

Fig. 3: below, shows the wiring between components and the components layout. In many cases the wire ends of components are long enough to complete the wiring. Note that resistance R3 is wound in the form of a coil, for convenience only.

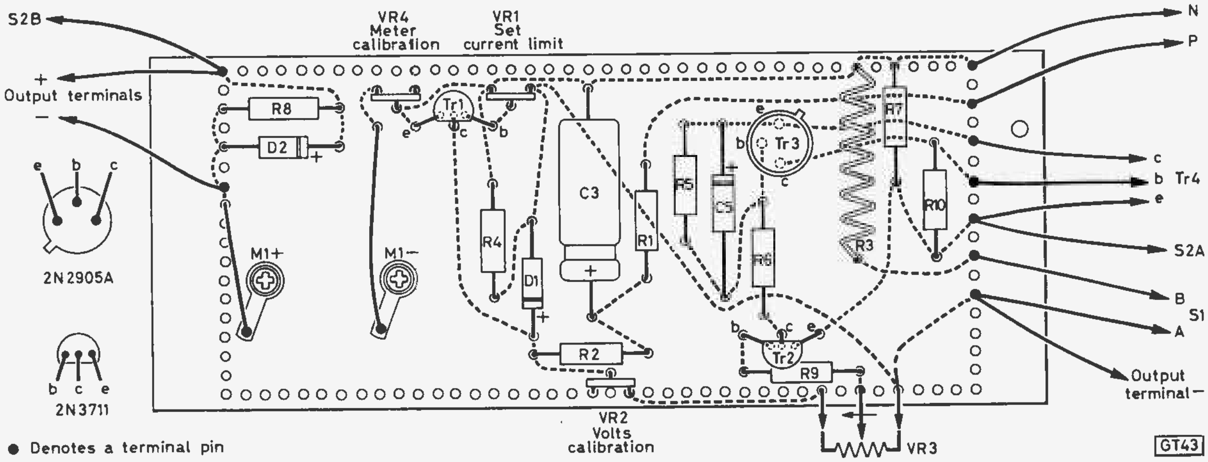
★ components list

Resistors
R1 1·5kΩ, R2 1·5kΩ, R3 see text, R4 18Ω, R5 6·8kΩ, R6 1kΩ, R7 2·7kΩ, R8 10kΩ, R9 1kΩ, R10 220Ω
VR1 4·7kΩ min vert., VR2 4·7kΩ min. vert., VR3 10kΩ linear, VR4 4·7kΩ min. vert.
All ½W 5% except R3

Capacitors
C1 2000μF 25V, C2 50μF 40V, C3 50μF 40V, C4 5μF 10V, C5 25μF 15V

Semiconductors
Tr1 2N3711, Tr2 2N3711, Tr3 2N2905A, Tr4 BDY38
B1 50V 1A bridge, D1 16V zener (BZY88C16), D2 1N4001

Miscellaneous
F1, 3A fuse and holder. T1, transformer 240V/12-0-12V 500mA. S1, 2, 3, single pole on-off switches. M1, meter 500μA type MR38P. Die cast box and lid, approx 6¾ × 4¾ × 2in. or similar. Pointer knob, terminal sockets (3) preferably green, red and black.



ensuring an output impedance of 0·1Ω typically.

A separate output switch S2 ensures that the voltage across the load collapses to zero in a second or so after switch-off. If, as with some power supplies, a mains switch only is provided, some output voltage can still be present seconds after switch-off. This can result in damage to circuitry fed from the power supply during subsequent soldering operations. C5 keeps the output impedance low at high frequencies. D2 catches voltage reversals on switch-off when feeding an inductive load and also prevents damage to the power supply should it be connected in series with another supply of higher current rating. D2 should therfore be rated at 1A, at least.

Tr1 protects the power supply in the event of an overload at the output, by reducing the output voltage. Should more than 50mA be drawn through R4, or more than 500mA through R4 and R3 in parallel, Tr1 turns on and reduces the reference voltage by shunting D1. The output voltage therefore falls just as far as is necessary to prevent the current exceeding 500mA on the high current range or 50mA on the low current range. The low current range is very useful when testing out a variety of low power circuits, since 50mA for a few seconds does not in practice damage any common semiconductor. Circuits can thus be switched on in safety without bothering to check them through too thoroughly! Meter M1 measures the voltage drop across the current sensing resistors R3 and R4 and thus indicates the current drawn by the load connected to the supply, except for the small amount of current through R8.

C4 starts to roll off the loop gain at around 100Hz. In normal operation (constant voltage mode) a much smaller capacitor could be used, as further gain roll off is provided by C5. However, in the constant-current mode with a short-circuit at the output terminals, C5 obviously can be ignored and there is the additional loop gain provided by Tr1 to cope with as well. Thus, it is the current limit condition which determines the loop shaping capacitor, but it has been possible to retain the full loop gain up to 100Hz and this together with the low ripple across D1 results in the output ripple at full load being only 200μV RMS.

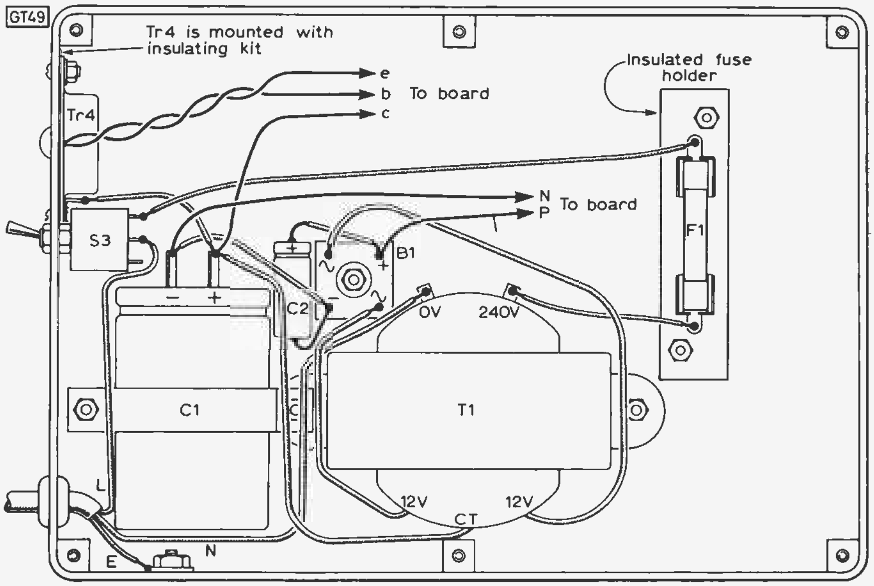
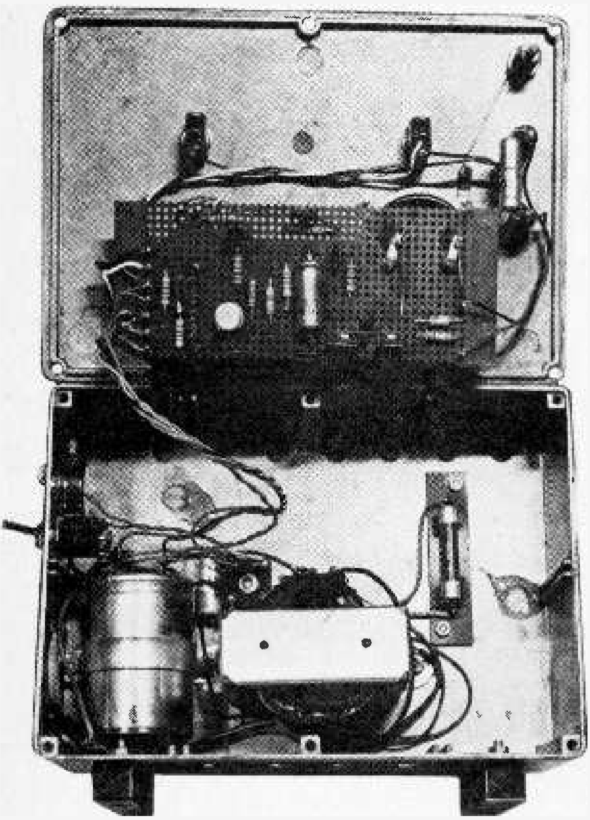


Fig. 4: Wiring of the mains supply components and Tr4 in the box. This may be compared with the photograph below. The leads of Tr4 are cut short and wire leads soldered on to reach to the board. Ensure that these leads are completely insulated to avoid contact with the case. Note that an insulation kit must be used with this transistor.



A view of the finished power supply. Note that capacitor C5 is mounted directly across the output terminals, observing the correct polarity of this electrolytic.

Front panel drillings are given in Fig. 2. The meter is the popular type MR38P and serves as one support for the circuit board, the other end being supported on a piece of studding, glued to the back of the front panel. The author made up the circuit on a piece of 0·1in pitch plain pin-board. Component leads were passed through holes and wired up on the back of the board. Crossovers were avoided so that the same layout can be used for a printed circuit. See Fig. 3 which shows the component side of the board with connections ghosted in. Fig. 4 shows the wiring in the box itself.

The following components mount in the box as shown in the photograph; fuse F1, mains switch S3, mains transformer T1, bridge rectifier B1, capacitors C1 and C2 and Tr4. The latter is mounted inside the box, with a mica washer insulating set and the base and collector pins are cropped fairly short, with the leads from them covered by an insulating channel.

Note that the transformer is mounted so as to fit between S1 and S2 when the lid is fitted.

CALIBRATION

When construction is complete, set VR1 and VR2 to mid travel and switch on. Check that Output Voltage control VR3 varies the output voltage and adjust VR2 so that with VR3 fully clockwise, the output voltage is 12V. Mark in calibrations 0 to 12V round the Output Voltage control VR3. Set Current Range Switch S1 to 50mA (up) and connect an AVO on its 100mA range across the output terminals. Adjust VR1 for 45mA short circuit current. Adjust VR4 for full scale reading on 500μA meter M1. With Current Range Switch S1 set to 500mA (down) check that M1 reads the same as the AVO, i.e. approx. 500mA. If not, adjust R3 which can conveniently be 5in of 36 SWG Eureka wire. Finally, re-adjust VR1 if necessary to set the short circuit current to exactly 500mA. This is important to avoid overrunning the transformer. Note that on the 50mA range, the short circuit current in the load will actually only be 45mA, the other 5mA represents the current through D1.

USES

In use, this power supply is practically indestructible. It may be connected in series with another supply to give a higher voltage but should not be connected in parallel with a supply which has a higher maximum output voltage. It may be connected in parallel with another 0 to 12V supply to give a higher current. The mains switch S3 should be left on and the output turned on and off with output switch S2.

morse tutor

A.– B–... C–.–.

D. J. EDWARDS

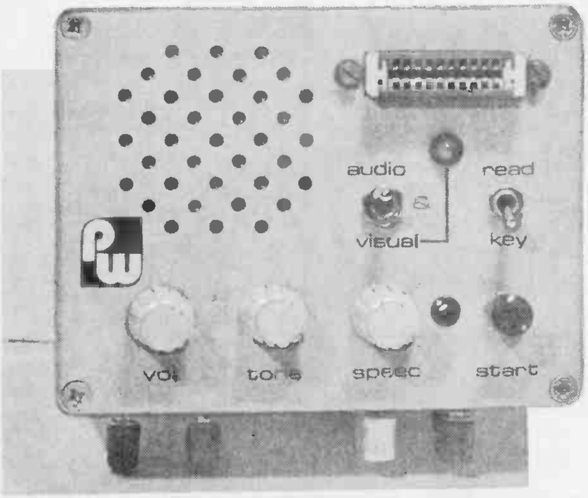
THIS unit is intended as a self-teaching aid for learning Morse by presenting the code as a series of sounds rather than dots and dashes.

The system uses a set of coded cards, each representing a Morse character which may be a letter, figure or standard phrase. When a character card is plugged into the unit, the appropriate code is reproduced as an audible and/or visual signal. A manual control alters the speed of the code as the user becomes more proficient at recognising the character; whatever speed is chosen, the relative spacing between elements of the character is maintained (see Fig. 6). This ensures that the user develops accurate timing. Controls are also provided to adjust the volume and tone of the Morse to the most natural sound.

The unit can also be used as a Morse practice oscillator when required, either for normal sending practice or to copy signals just produced by the Morse generator.

Principle of operation

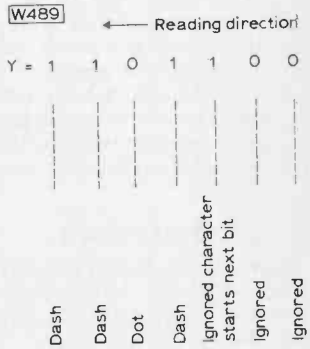
The system uses a seven bit binary code; the most significant bit(s) represent a binary equivalent of the Morse character where logic 1 is the equivalent of a 'dash', and logic 0 is a 'dot'. The least significant bit(s) identify the beginning of the character. Each bit is sampled in turn from right to left. If the first bit is a logic 0, it is ignored as are successive logic 0s. Once a logic 1 is encountered, this informs the circuit that all the remaining bits are binary Morse code.



The code cards slot into the front panel edge connector. Pressing the start button initiates the reading process.

Fig. 1 shows the seven bit binary code representing the letter Y. In this case, the first two bits are sampled, seen to be logic 0s and ignored. The next bit is also ignored, but as it is a logic 1, the system prepares to reproduce the remaining bits as Morse code elements. Thus the next logic 1 is produced as a 'dash', the logic 0 as a 'dot', and so on until all seven bits have been sampled.

Fig. 1: The code cards present a series of high and low states on to the terminals of the edge connector corresponding to the dots and dashes of the Morse character. The circuit 'reads' the character bits in succession. Following the first 1 (which sets the circuit up) all remaining bits are read as Morse; 1 produces a dash while a 0 produces a dot.



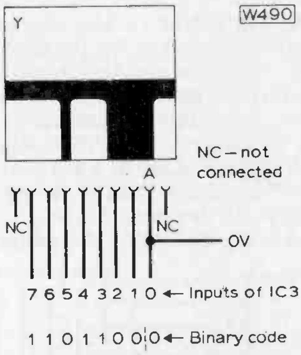
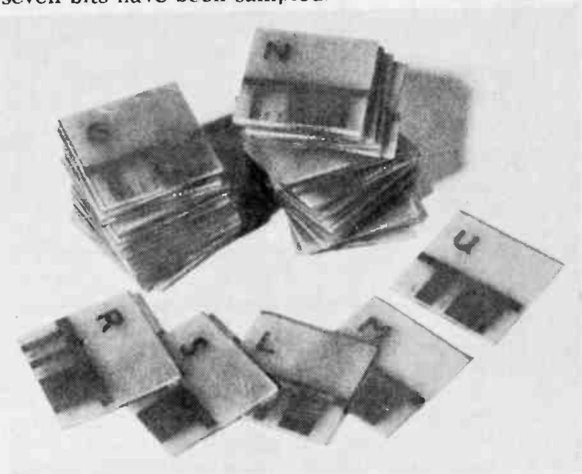


Fig. 2: Construction of the code cards. The artwork for the cards is shown on page 267. Alternatively, ready made cards may be obtained through the Readers' PCB service. Cards may be constructed from hard wired, suitably cut, verostrip. 0·1" matrix board should be used.

Since Morse characters contain up to six elements (except in one case which has been ignored to avoid unnecessary complication) then a maximum of seven bits is needed for binary encoding. Where a character has less bits, these are made up to seven by the inclusion of logic 0s as seen in the example above. In this way, the end of a code is easily recognised by preventing further operation of the system once seven bits have been sampled.

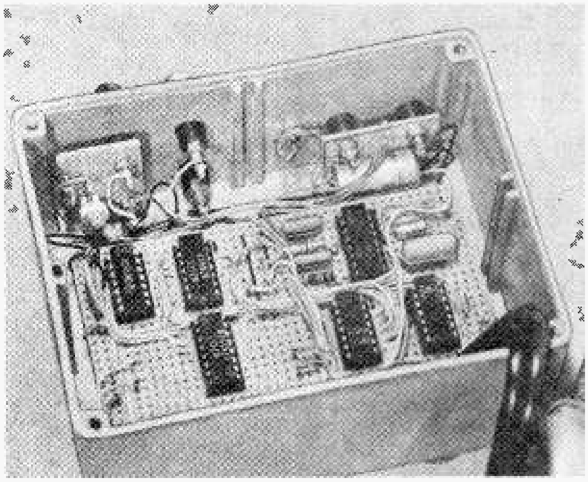


The code cards used with the prototype.

Code cards

The seven bit code is applied to the unit by using a patch card of copper laminate board etched to represent the code to be reproduced. Fig. 2 shows how the patch card, representing the letter 'Y', is used to apply the correct code to the data select inputs of IC3. With no card in position, inputs 1 to 7 of IC3 are held at logic 1 by 'pull-up' resistors. It can be seen that if the card is plugged into the connector, connection A applies 0V (i.e. logic 0) to the copper of the patch card, which in turn 'pulls' down inputs 1, 2 and 5 of IC3 to logic 0. Inputs 3, 4, 6 and 7 remain held at logic 1.

Since no code requires more than seven bits, input 0 is permanently wired to logic 0, obviating the need for this to be supplied by the patch card.

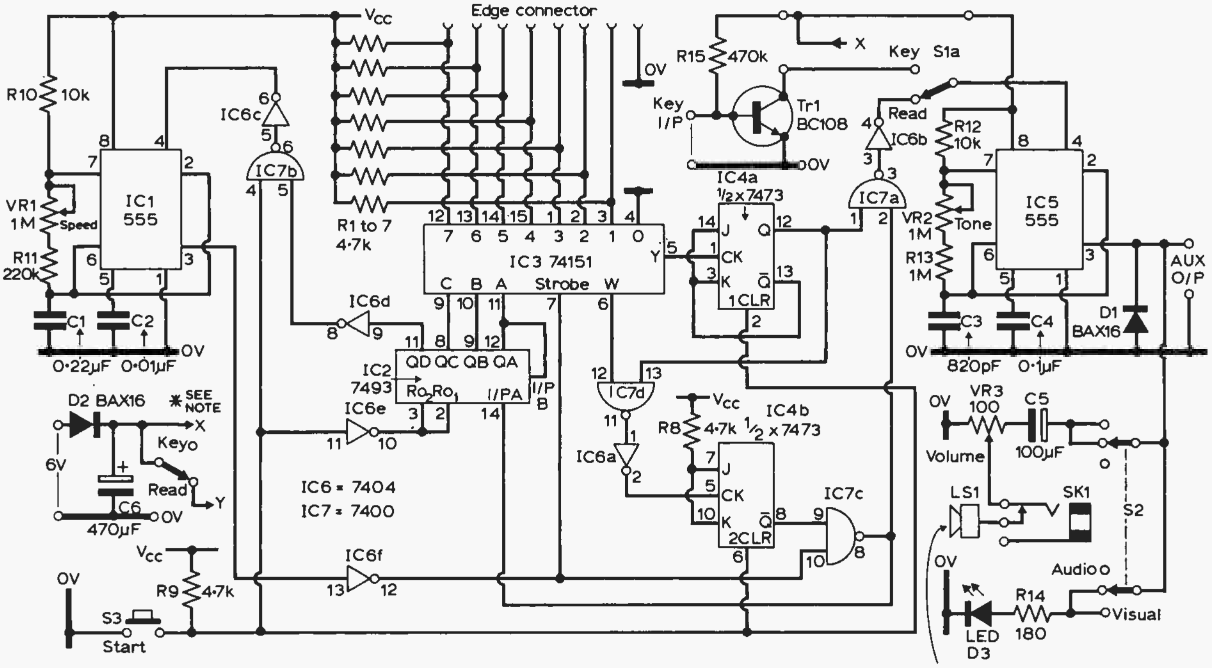


Circuit description

Looking at Fig. 3, the circuit comprises an astable clock oscillator (IC1) a four bit binary counter (IC2) a one of eight line data selector (IC3) controlled by the binary counter, a pair of J-K flip-flops, an audio oscillator and a series of gates.

A character card inserted in the edge connector provides a binary pattern equivalent to the Morse character on the data input lines of IC3. On pressing S3, the circuit clock IC1 increments the binary counter causing the data bits on the character card to be interrogated in turn. Ignoring all leading 0s, the circuit scans until it encounters a 1. This sets up the bistables which will change state in a manner dependent on subsequent high/low states which make up the character card. If the next bit is a 0, then flip-flop IC4a changes state and gates the audio oscillator for one clock cycle. If a 1 is encountered, the flip-flops act as a divide by 3 routine for a duration of three clock pulses; similarly, this gates the audio oscillator on for a period of three clock pulses. Since reset action requires a duration of one clock pulse, the 1:1:3 dot-space-dash relationship is absolutely textbook and immutable. Further replays of the Morse character can be made by depression of S3 to enable the master reset line.

VR1 and VR2 provide control of the clock and audio oscillator respectively; the first controls the speed of character transmission and the second adjustment changes the tone. IC5 provides enough signal to drive a high impedance loudspeaker directly. The prototype incorporates an LED which

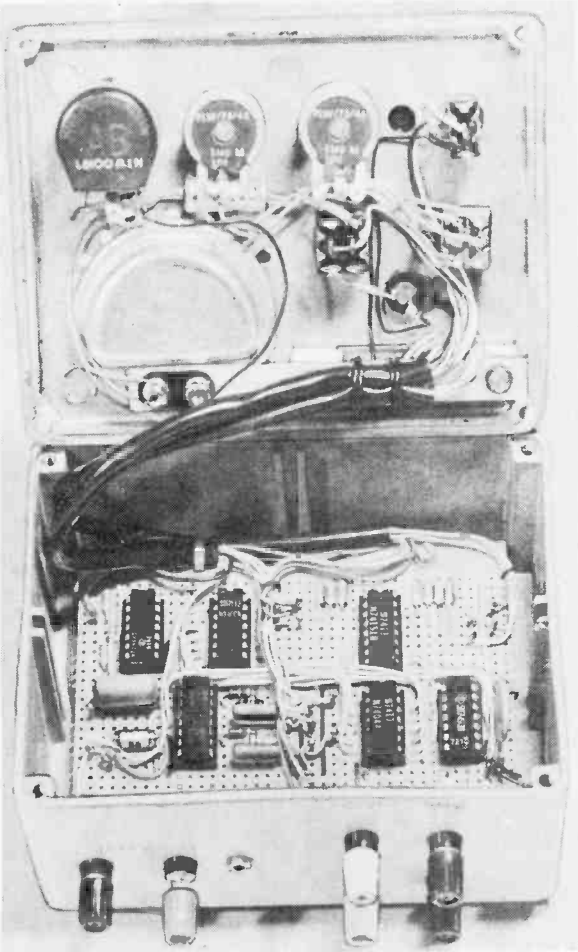


✱ X O/P from D2 connected to R15 and IC5 pin 8.
Y O/P from S1b connected to all points marked V_{cc}, and to IC2 pin 5, IC3 pin 16, IC4 pin 4, and ICs 6 & 7 pin 14.
OV buss to all points marked, and to IC2 pin 10, IC3 pin 8, IC4 pin 11, and ICs 6 & 7 pin 7.

W493

Fig. 3: Complete circuit diagram of the Morse Tutor. The switches are shown set to 'Read' mode and 'Audio/Visual', Pins 1 and 10 of the edge connector are not shown since these are not required for circuit operation. C7, not shown, is connected across V_{cc} and OV.

is also driven by the oscillator to give a visual Morse output. However, this is really just a gimmick. The prototype was powered by a 6V battery. Since the logic ICs require 5V, silicon diode D2 drops the positive rail voltage by about 0·7V.



Construction

The prototype was constructed in a diecast box drilled as in Fig. 4. If alternative components are used, care should be taken to ensure that they do not foul each other or the logic board before the mounting holes are drilled as there is not a great deal of space available in the size of box used.

The edge connector should be cut down in size so as to leave twelve contacts. The contacts at each end should then be removed to leave room for insertion of the mounting feet. This assembly is mounted through the panel aperture from the underside with its contacts nearest to the panel edge. The 'least significant bit' end of the connector will then be towards the centre of the panel. After wiring, the speaker bracket may be attached to the connector mounting screws using stand-off pillars. The speaker can be attached to this by means of its terminals.

Fig. 7 shows the board used to form 48 individual patch cards. The shaded areas represent copper, the remainder being etched away. These cards have been designed to fit in a ten-way edge connector with closed ends, and should be trimmed carefully for accurate positioning. If another make of edge connector is used, some modification to the cards may

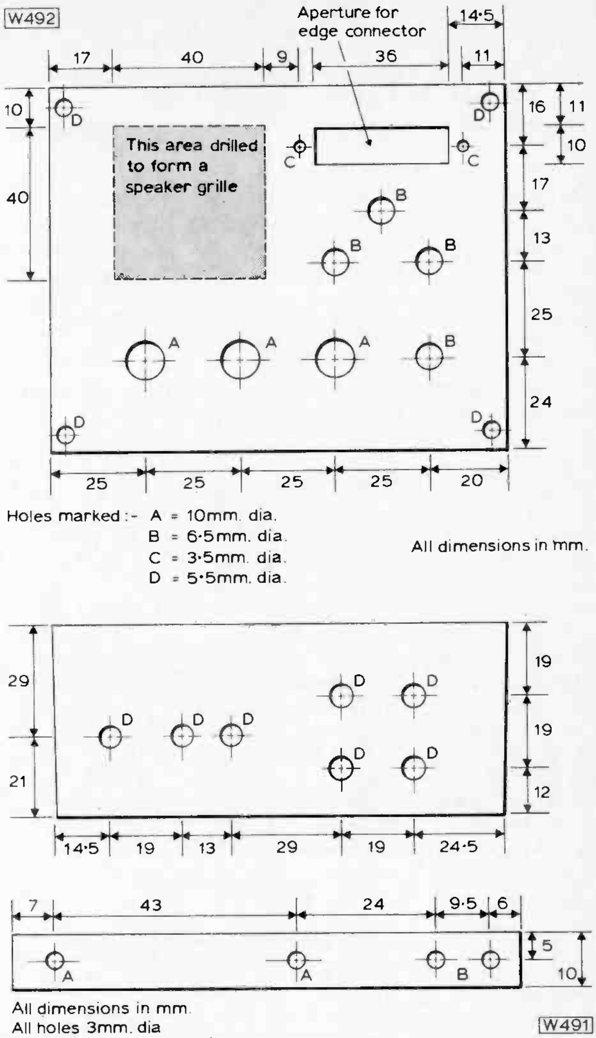
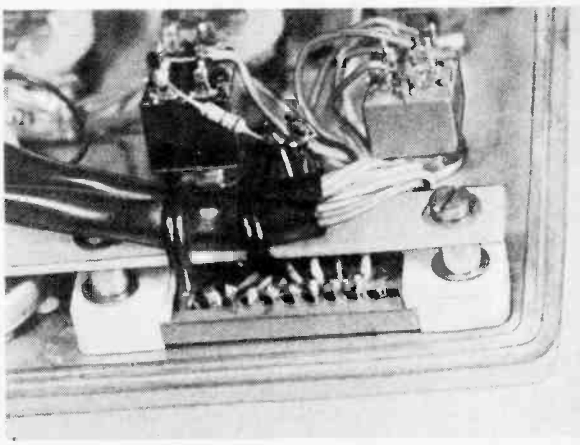


Fig. 4: Drilling details.

be necessary. Additional cards may be made in a similar fashion for those characters that have been omitted. If preferred, they may be made up from small pieces of 0·1in matrix veroboard by connecting the appropriate copper strips together with wire links.



Close up view of edge connector wiring and earpiece mounting bracket. Note details of edge connector truncation.

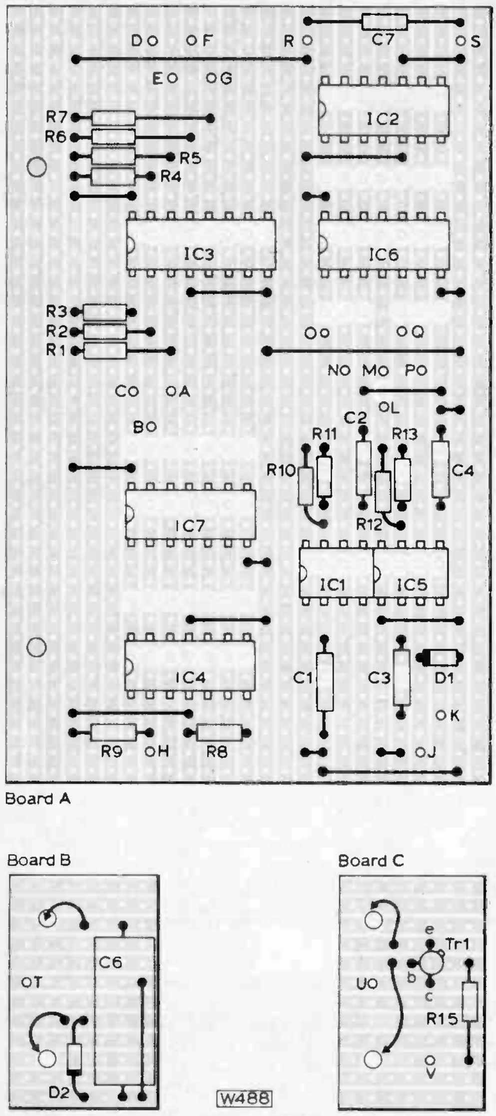


Fig. 5: Veroboard layout. Board A mounting holes are 3mm dia with 63mm spacing. They attach the board to diecast box using the rubber feet mounting screws with spacers.

Board B attaches to diecast box using the 6V power terminals. Board C is attached to the Key terminals. The flying leads shown on both boards connect with the appropriate terminals.

PIN CONNECTIONS

- A Edge Connector pin 3
- B „ „ „ 4
- C „ „ „ 5
- D „ „ „ 6
- E „ „ „ 7
- F „ „ „ 8
- G „ „ „ 9
- H S3
- J Aux output and S2
- K S1a
- L Board B pin T
- M S1a (read)
- N VR1
- O VR1
- P VR2
- Q VR2
- R OV terminal
- S S1b (Y Fig. 3)
- T Board A pin L, Board C pin V and S1b
- U S1a (Key)
- V Board B pin T

★ components list

Resistors
R1 to 9 4·7kΩ
R10 10kΩ
R11 220kΩ
R12 10kΩ
R13 1MΩ
R14 180Ω
R15 470kΩ
All ¼W 5%

Semiconductors
Tr1 BC108
IC1 555 (8 pin)
IC2 7493
IC3 74151
IC4 7473
IC5 555 (8 pin)
IC6 7404
IC7 7400
D1, D2 BAX16
D3 LED

Capacitors
C1 0·22μF Polyester
C2 0·01μF Polyester
C3 820pF Polystyrene
C4 0·1μF Polyester
C5 100μF 10V
C6 470μF 10V
C7 0·1μF Disc ceramic

Switches
S1 DPDT Centre off miniature toggle
S2 DPDT „ „
S3 SPDT push to make

Potentiometers
VR1 1MΩ Carbon linear ½W.
VR2 1MΩ Carbon linear ½W.
VR3 100Ω Wirewound 1W.

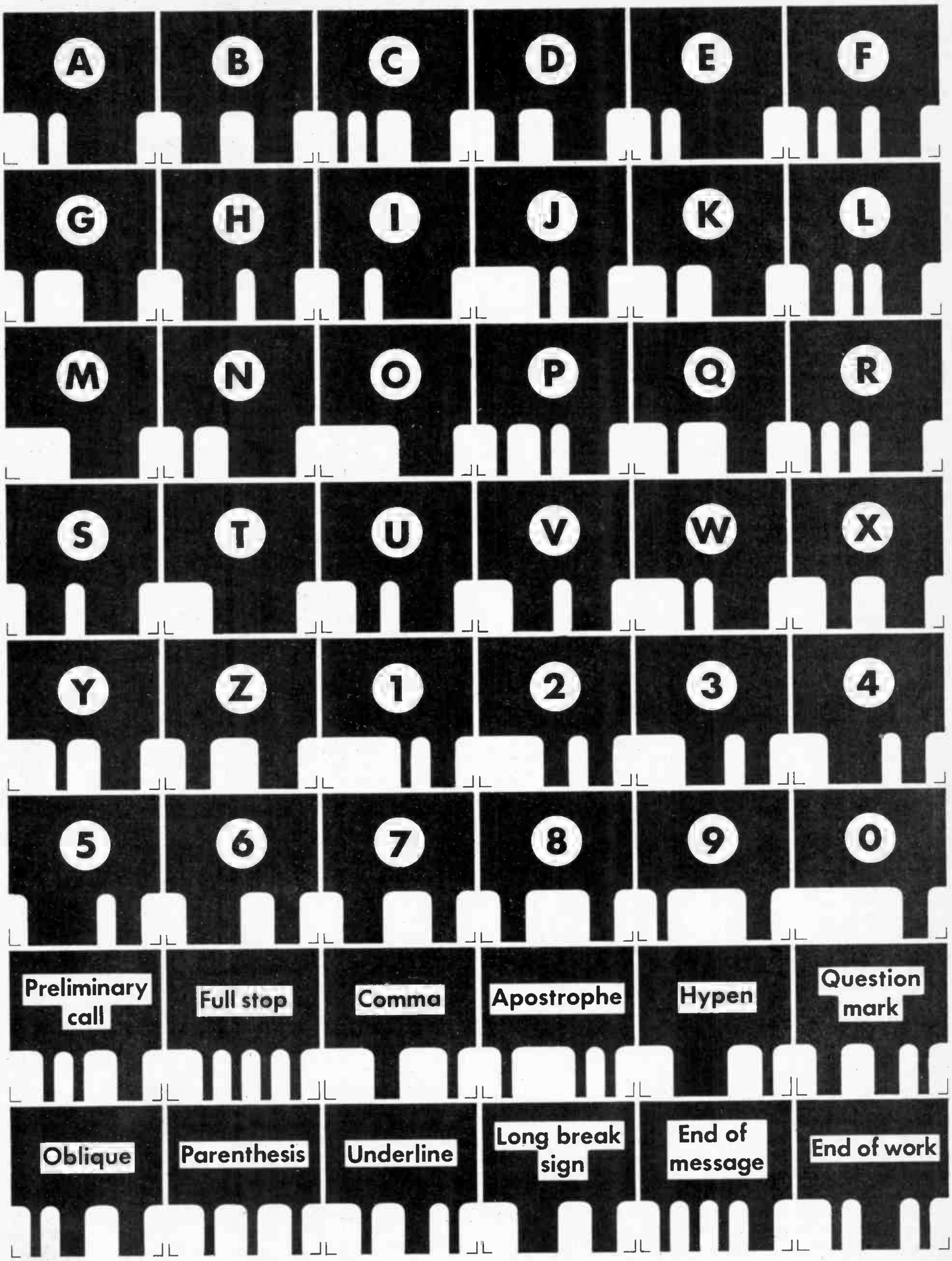
Miscellaneous
16 Way 0·1″ edge connector, 3·5mm earphone socket, IC sockets, 2mm terminals, rubber feet, diecast box 114 × 89 × 55mm, knobs, nuts and bolts, 6mm mounting pillars, veropins, veroboard, battery 6V, LS1 PO type receiver insert (30Ω).
Note that the edge connector and most other components are RS types available from Doram and other suppliers.

Testing

A 6V battery or suitable power supply should be connected to the unit. Turn SPEED control VR1 to minimum and VOLUME control VR3 to maximum. Set S2 to '&' position (i.e. VISUAL & AUDIO). If the START button is pressed and released, six long bursts of tone should be heard, along with a visual signal. This corresponds to six 'dashes' and is the signal produced when no patch card is in position.

A spare piece of unetched copper laminate board cut to the size of a patch card should now be inserted in the connector. Operation and release of S3 should not result in any output signal (allowing time for all inputs to be read) as no logic 1 will be encountered. These procedures ensure that the unit is sensing the condition on each edge connector input pin correctly.

Finally, the card representing 'underline' is recommended for use as a test card as it checks the unit



A 037

Fig. 7: Foil patterns, actual size, for the 48 patch cards.

for correct response to changes from dots to dashes and vice versa with a sequence of two dots and two dashes.

Check the remaining two positions of S2 for the appropriate output signal, and that the volume, tone, and speed controls are effective. It is wise to ensure that each patch card produces the desired code, and that the copper accurately covers the appropriate edge connector pins without any chance of contact with pins that should remain unconnected.

Whenever power is first applied to the unit, it is possible that an output signal will result. This can also occur if S1a is switched from KEY to READ. This can be cleared, either by holding down S3 until a card is inserted, or releasing it and waiting for the counter to complete a cycle. It was felt that this problem did not really justify the extra complication of some form of power-on reset.

The cards can be selected either according to some set learning system or at random and the character identified from the face of the card. Constant replay of the pattern become associated with the letter. The object of the learning exercise should always be to familiarise Morse characters in terms of a sound pattern rather than as discrete dots and dashes.

It is recommended that short groups of letters are familiarised at a time—perhaps about five—until the whole alphabet can be recognised from the dah-di-dah rhythm of the characters. Although the unit may be used as a practice oscillator, the beginner's studies should be concentrated on *receiving* Morse rather than sending. Once the former has been attained, the latter is easy. Although the Morse Tutor is very useful, it provides no substitute to reading Morse code from an experienced operator since sequential groups of letters cannot be generated—individual character recognition of the alphabet won't ensure a pass in the Morse test! However, using the unit in conjunction with records, tapes and RSGB Slow Morse transmissions in particular should result in a pass. PW

A	• —	N	— •	1	• — — — —
B	— • • •	O	— — —	2	• • — — —
C	— • — •	P	• — — •	3	• • • — —
D	— • •	Q	— — • —	4	• • • • —
E	•	R	• — •	5	• • • • •
F	• • — •	S	• • •	6	— • • • •
G	— — •	T	—	7	— — • • •
H	• • • •	U	• • —	8	— — — • •
I	• •	V	• • • —	9	— — — — •
J	• — — —	W	• — —	10	— — — — —
K	— • —	X	— • • —		
L	• — • •	Y	— • — —		
M	— —	Z	— — • •		

— • — • —	Preliminary call
• — • — • —	Full stop
— — • • — —	Comma
• — — — — •	Apostrophe
— • • • • —	Hyphen
• — • • — •	Inverted commas
• • — — • •	Question
— • • — •	Oblique stroke
— • — — • —	Brackets
• • — — • —	Underline
— • • • —	Long break sign
• • • • • • • •	Error
• — • — •	End of message
• • • — • —	End of work

Spacing and length of signal

(i) A dash equals 3 dots

(ii) The space between elements which form a character is equal to 1 dot

(iii) The space between 2 characters equals 3 dots

(iv) The space between 2 words is equal to 5 to 7 dots

W494

Fig. 6: The Morse code.

FM FRONT ENDS

Brian DANCE

SO! You have decided to construct an FM tuner. What problems are likely to cause you most difficulty?

Even if you have only a limited amount of experience, the construction of a good intermediate frequency amplifier should not be too difficult with the availability of modern integrated circuits and miniature 10·7MHz ceramic filters. If one of the normal quadrature detector circuits is employed with a suitable integrated circuit, there will be only one tuned circuit to be adjusted at 10·7MHz—IF alignment is very easy. It is also easy to add a stereo decoder circuit using one of the modern phase locked loop integrated circuits such as the LM1800.

Function

The front end accepts a signal from the aerial at a frequency in the range 88 to 100MHz. The signal is amplified and passed through a number of tuned circuits which attenuate unwanted signals. The amplified signal is then passed to the mixer stage where it is mixed with a locally generated signal; the latter is always kept 10·7MHz away from the signal frequency being received by the aerial.

The output from the mixer stage is a 10·7MHz difference signal frequency modulated with the audio signal. This is fed through a single or double tuned resonant circuit before being passed to the output part of the front end from where it is processed by the limiter/amplifier/demodulator.

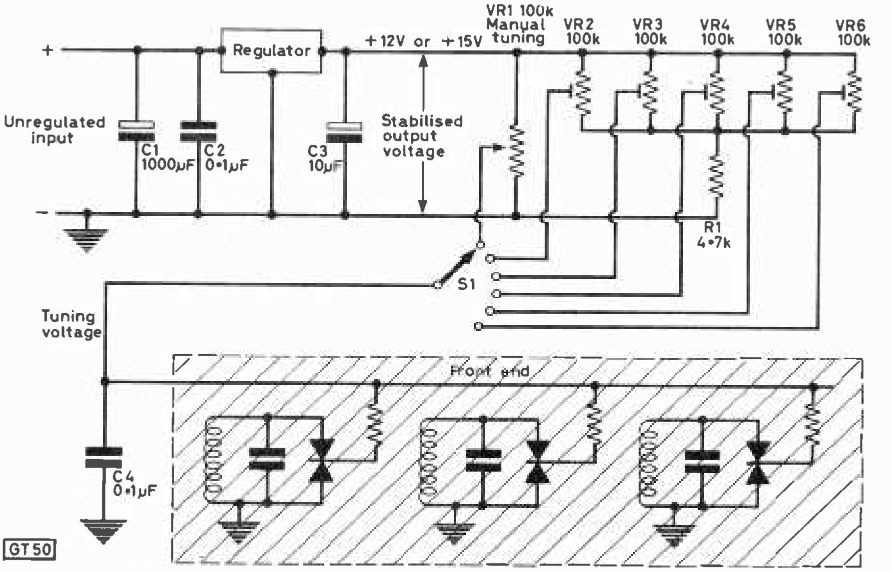
Ganged capacitor types

Some types of FM front ends employ conventional ganged capacitor tuning. The low capacity VHF ganged capacitor usually has another variable capacitor mounted on the same spindle for AM medium and long wave tuning. Such front ends incorporating an AM tuning section are convenient for obtaining FM and AM reception using a single tuning knob although there is no AM circuitry other than the variable capacitor itself in the front end.

Ganged capacitor tuned front ends are available with a spring loaded reduction drive fitted to the spindle. The tuning knob may be fitted directly to such a front end, but provision must be made for fitting a tuning scale and pointer. Some other types do not have a reduction drive and some form of slow motion drive must be designed; for example, a suitable arrangement of drive cords may be used to provide the required speed reduction.

Varicap tuning

This is the other tuning system widely used in modern front ends. Such front ends require a tuning voltage which may be obtained from a potentiometer. One of the advantages of using a varicap system is that the unit may be placed at any convenient point in a receiver, even if the tuning control must be placed at the opposite side of the cabinet. Capacitor tuned front end placement is



A practical circuit for an FM varicap front end tuning arrangement. Six-way switch S1 selects any of five pre-tuned stations; the sixth position offers manual tuning by a multi-turn potentiometer. With most units adequate frequency coverage can be obtained with a tuning supply voltage from the regulator of 12V.

usually governed by the requirement that the tuning spindle must be at a suitable place for the drive cords or tuning knobs to operate it.

High performance front ends require quite a number of signal tuned circuits, but the number of variable capacitor sections which it is convenient to fit on a single ganged capacitor spindle is limited to about 3 or 4. There is no such limitation with varicap diode tuning and therefore the most expensive, high performance front ends tend to employ this system.

Another advantage of varicap tuning is that it is quite easy to arrange for the switched tuning of a number of selected frequencies; this is very desirable in domestic receivers. The varicap system requires a regulated supply from which the tuning voltage is derived to prevent drift. Further, the regulator circuit must reduce the power frequency hum level to a very low value on the varicap tuning supply line; any residual hum manifests itself as hum in the audio output. A hum level in the order of 1mV or less is required.

Typical circuit

A typical varicap tuning circuit is shown in Fig. 1. The unregulated input voltage from the receiver supply may be fed to the input of a low output current voltage regulator integrated circuit (such as the μA78L15 or the TBA625C for a 15V output or the μA78L12 or the TBA625B for a 12V output). While discrete regulator circuits can be constructed, the use of a monolithic regulator simplifies the circuitry.

The hum level at the output of the regulator should be some 50 to 60dB lower than that at the input of the regulator. It is important that the reservoir capacitor C1 should have an adequate value or the hum level at the input to the regulator will be high leaving an undue level on the output. C2 is a small non-electrolytic capacitor in parallel with C1 to provide high frequency decoupling.

The stabilised output voltage from the regulator is applied to a number of potentiometers in series with the resistor R1; this resistor ensures that the tuning voltage never falls below about 2 to 3V since the front end unit does not operate at very small tuning voltages.

The potentiometer in use is selected by S1. The tuning potentiometer VR1, selected by S1, enables manual band coverage. The other positions of S1 are for the reception of switch tuned frequencies. VR2 to VR6 inclusive should be high quality trimmer potentiometers with about 15 or 22 turns each for ease of adjustment; single turn potentiometers are unsuitable. Similarly, VR1 may be a 10 turn potentiometer fitted with a 10 turn dial. Alternatively, a long slider potentiometer, such as the Rivlin WS 150 (Ambit International) may be suitable.

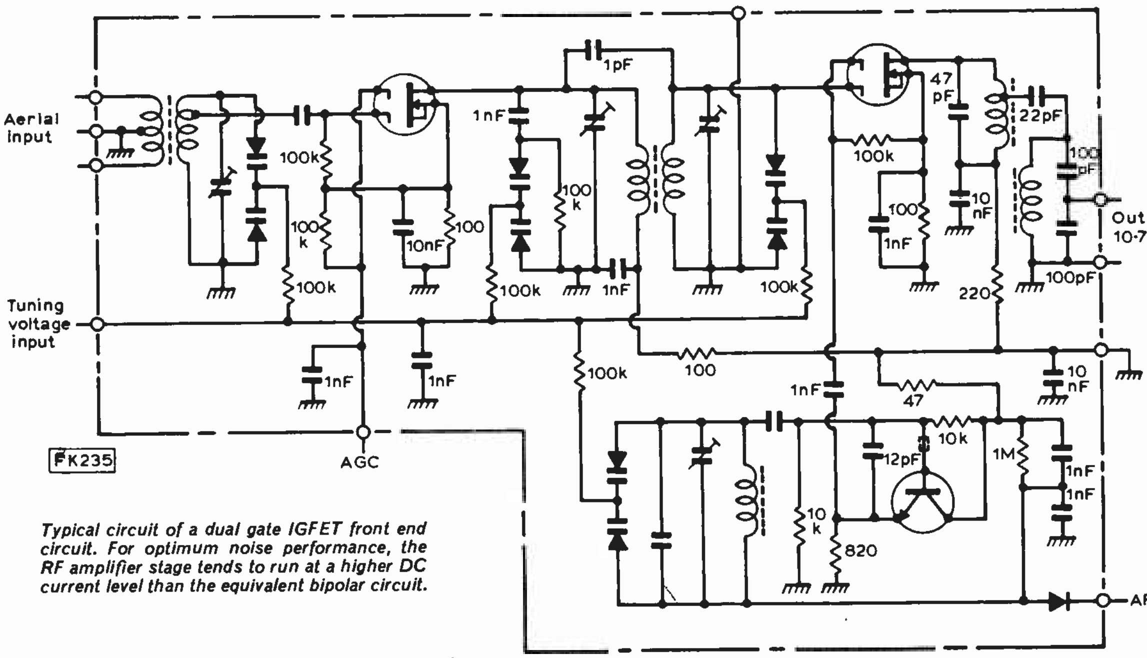
Another tuning system involves the use of the IMI varicap control unit type 9932 (from Ambit International). This unit has 6 push buttons, each of which has its own potentiometer. Fine adjustment of the tuning can be made by rotating one of the push buttons when it has been pressed in.

AM tuning facilities may be achieved using a varicap system. In this case, the tuner will incorporate suitable AM tuning diodes in the AM section of the receiver.

Image rejection

The main advantage of the more expensive front end units is the higher rejection of unwanted signals. This may be particularly important if one lives near to an ambulance, police or fire station which has an adjacent transmitter. The more expensive units (priced at around £12) can provide about 90dB rejection of all spurious signals, whereas cheaper front ends (priced at about £6) may provide some 40 to 50 dB rejection.

Most VHF front ends employ a MOSFET in the signal frequency RF stage for low cross modulation whereas a bipolar transistor operates as a mixer; a few use a MOSFET as a mixer to minimise inter-



Typical circuit of a dual gate IGFET front end circuit. For optimum noise performance, the RF amplifier stage tends to run at a higher DC current level than the equivalent bipolar circuit.

Safe, tough, efficient and versatile – that's our new miniature CX iron.

Safe because it is virtually leak-free (leakage current less than 1μA). Earth it if you like – three core lead. It is made to conform with B.S. 3456 and has a breakdown voltage of more than 4000V.

Tough because the handle is almost unbreakable and the ceramic shaft is covered by a stainless steel shaft.

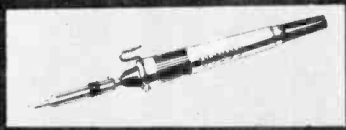
Efficient because the element is situated right inside the soldering bit and the heat generated by its 17 watts is not wasted.

Versatile because the iron can be used for a wide variety of soldering jobs; with six easily interchangeable, slide-on bits, ranging from ¼" right down to $\frac{1}{32}$" (1mm). It's suitable for small, miniature and micro miniature joints.

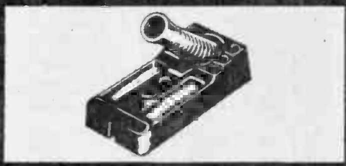
Available for 220-250 volts *or* 100-120 volts. *Weight* – 1½oz (40 gram). *Length* 7¾" (19cm). *Price* – £3·40 fitted with standard bit $\frac{3}{32}$" (2.3mm). *Spare bits* £0.45; £0.72; £0.84 exclusive of VAT.

Stocked by most of the well-known wholesalers and many retailers. Or direct from us if you are desperate.

Model X.25 is a general purpose soldering iron, also with two shafts for toughness and perfect insulation. Available for 220-250 volts *or* 100-120 volts at 25 watts and priced at **£3·40** exclusive of VAT.



Stand model S.T.3 has a chromium plated steel spring, two sponges for cleaning the bits and is priced at £1.40 exclusive of VAT.



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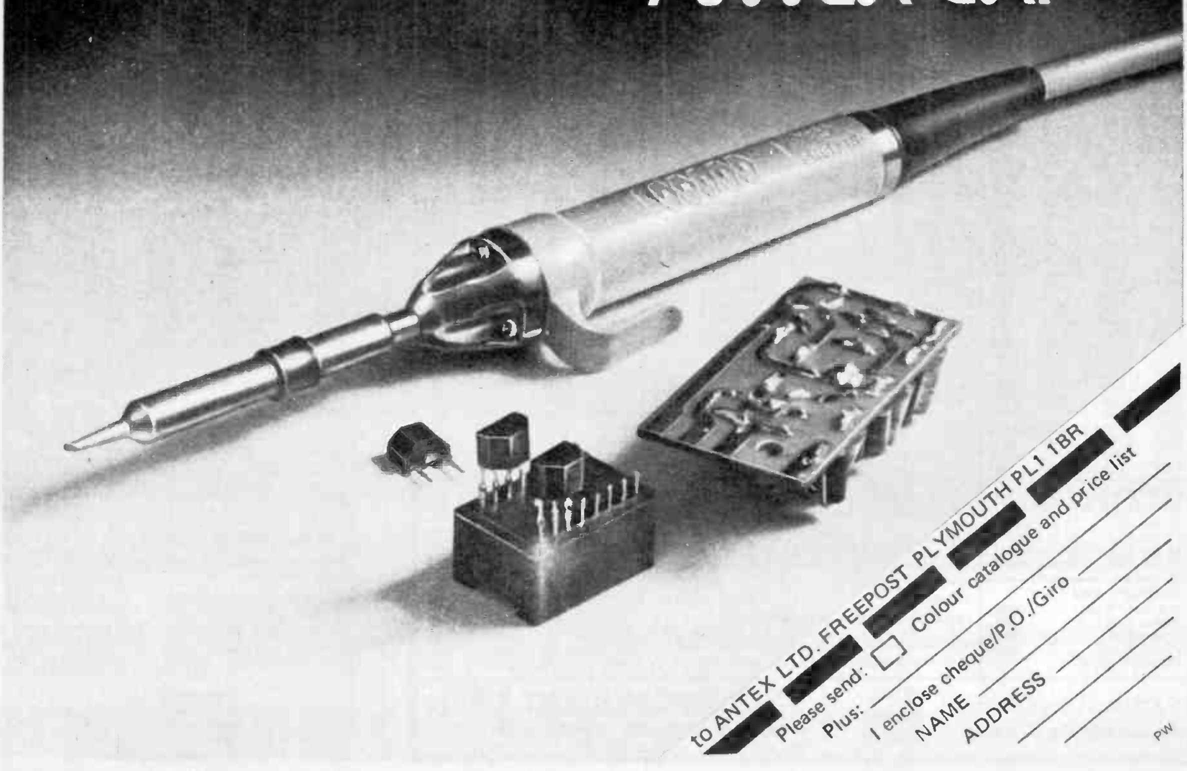
Forget all you've ever read about miniaturised soldering irons. This is the NEW ANTEX CX.



TTLs by TEXAS

7400	16p	74111	75p
7401	18p	74112	96p
7402	18p	74116	216p
7403	18p	74118	160p
7404	24p	74120	130p
7405	25p	74121	32p
7406	43p	74122	52p
7407	43p	74123	75p
7408	22p	74125	70p
7409	22p	74126	65p
7410	18p	74128	82p
7411	26p	74132	81p
7412	25p	74136	81p
7413	40p	74141	85p
7414	85p	74142	300p
7416	40p	74145	95p
7417	40p	74147	205p
7420	18p	74148	160p
7421	43p	74150	130p
7422	28p	74151	81p
7423	36p	74153	81p
7425	33p	74154	160p
7426	43p	74155	97p
7427	40p	74156	97p
7428	40p	74157	97p
7430	18p	74159	250p
7432	37p	74160	130p
7433	43p	74161	130p
7437	37p	74162	130p
7438	37p	74163	130p
7440	18p	74164	140p
7441	85p	74165	150p
7442	75p	74166	160p
7443	120p	74167	320p
7444	120p	74170	260p
7445	120p	74172	750p
7446	108p	74173	190p
7447	90p	74174	130p
7448	85p	74175	97p
7450	18p	74176	130p
7451	18p	74177	130p
7453	18p	74180	160p
7454	18p	74181	324p
7460	18p	74182	150p
7470	38p	74185	190p
7472	32p	74186	990p
7473	36p	74190	160p
7474	37p	74191	160p
7475	48p	74192	160p
7476	37p	74193	160p
7480	54p	74194	160p
7481	108p	74195	110p
7482	90p	74196	130p
7483	99p	74197	130p
7484	120p	74198	270p
7485	120p	74199	270p
7486	36p	74221	175p
7489	340p	74251	150p
7490	43p	74265	97p
7491	90p	74278	320p
7492	58p	74279	150p
7493	43p	74283	220p
7494	90p	74284	475p
7495	75p	74285	475p
7496	90p	74290	160p
7497	290p	74293	160p
74100	140p	74298	220p
74104	75p	74365	160p
74105	75p	74366	160p
74107	36p	74367	160p
74109	60p	74390	220p
74110	60p	74393	245p
		74490	250p

CMOS ICs

4000	21p	4040	150p
4001	21p	4042	97p
4002	21p	4043	100p
4006	127p	4046	150p
4007	21p	4047	150p
4009	67p	4049	64p
4011	21p	4050	58p
4012	23p	4054	120p
4013	55p	4055	140p
4014	90p	4056	145p
4015	90p	4060	130p
4016	54p	4069	30p
4017	120p	4071	30p
4018	110p	4072	30p
4019	57p	4081	30p
4020	140p	4082	30p
4021	120p	4093	104p
4022	140p	4510	140p
4023	23p	4511	140p
4024	90p	4516	130p
4025	23p	4518	140p
4026	200p	4528	140p
4027	64p	14433	£14
4028	110p	14533	540p
4029	120p	14583	£1
4030	67p		

LOW PROFILE DIL SOCKETS BY TEXAS

8 pin	12p	22 pin	36p
14 pin	13p	24 pin	40p
16 pin	14p	28 pin	60p
18 pin	30p	40 pin	75p

MEMORY I.Cs

1702A EPROM	1200p
2102-2 RAM	216p
2107 RAM	1080p
2112-2 RAM	470p
RO3-2513 ROM	850p

OP. AMPS

LM301A	40p	741	25p
LM318N	225p	747	76p
LM324N	120p	748	40p
LM339N	175p	776T	216p
NE531V	140p	MC1458	75p
709	38p	CA3130	108p
733	150p	CA3140	108p
		LM3900	70p

LINEAR I.Cs

AY-1-212	650p	NE555V	40p
CA3028A	112p	NE556	100p
CA3046	85p	NE561B	450p
CA3048	250p	NE562B	450p
CA3053	75p	NE565	200p
CA3065	200p	NE566V	200p
CA3080E	97p	NE567V	200p
CA3089E	250p	SN72710N	54p
CA3090AQ	425p	SN76003N	275p
ICL8038CC	400p	SN76008	280p
LM377N	200p	SN76013N	175p
LM380N	112p	SN76013ND	160p
LM381N	190p	SN76018	280p
LM389N	160p	SN76023N	175p
M252AA	850p	SN76023ND	160p
MC1310P	180p	SN76033N	275p
MC1351P	110p	TAA621A	310p
MC1495L	490p	TAA661B	150p
MC1496G/P	112p	TBA120	97p
MC3340P	180p	TBA641B	300p
MC3360P	160p	TBA651	225p
MFC4000B	97p	TBA800	112p
MFC6040	200p	TBA810S	125p
N5596	112p	TBA820	100p
NE540L	160p	TDA2020	405p
		ZN414	140p

VOLTAGE REGULATORS—Fixed

Plastic—TO220—3 Terminals

1 Amp	+ ve		— ve	
5V	7805	130p	7905	215p
8V	7808	130p	—	—
12V	7812	130p	7912	215p
15V	7815	130p	7975	215p
18V	7818	150p	7918	215p
24V	7824	150p	7924	215p
100mA — TO92				
5V	78LO5	70p	79LO5	80p
6V	78LO6	70p	—	—
12V	78L12	70p	79L12	80p
15V	78L15	70p	79L15	80p

LM309K (TO3) 1A 5V 150p
LM323K (TO3) 3A 5V 700p
LM327N (16 DIL) 100mA +5 —12V 275p
MC1468 (16 DIL) 100mA ±15V 300p
(Adj. by Rs from ±8V to ±20V)
TBA625B (TO5) 0·5A 12V 120p
7805 (TO3) 1A 5V 150p

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LM317T TO220 1A—2V-37V 340p
TL430 TO92 100mA 2V-30V 75p

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ORP 12	75p	TIL211	Green	36p
ORP 60	90p	TIL32	Infrared	81p
ORP 61	90p	0·2"	Red	16p
2N5777	48p		Green	20p
			Yellow	36p

DISPLAYS

3015F	Minitron	175p		
DL704	Red	160p	Green	160p
DL707	Red	160p	Green	160p
DL747	Red	250p	Green	250p

DRIVERS: 75491 84p, 75492 104p, 9368PC 216p

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1A 400V TO5	95p	2N3525	130p
3A 400V stud	120p	2N4444	200p
7A 400V TO5	120p		
12A 400V TO220	180p		
16A 400V TO220	220p		
16A 600V TO220	270p		
BT 106 stud	150p		

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15A 400V	200p
15A 500V	225p
40430	130p
40669	130p
T2 302D	130p
BR100	32p

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1A 100V	27p
1A 400V	31p
2A 50V	40p
2A 100V	45p
3A 200V	70p
3A 600V	80p
4A 100V	90p
4A 400V	90p
6A 50V	96p
6A 100V	108p
6A 400V	120p
10A 400V	270p

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OA47	9p
OA81	15p
OA85	15p
OA90	9p
OA91	9p
OA95	9p
OA200	9p
OA202	10p
1N914	4p
1N916	7p
1N4148	4p
1N4001/2	6p
1N4004/5	7p
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1N5404	20p
1N5407	25p

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AC188	20p	R2010B	225p
AD149	60p	TIP29A	50p
AD161	45p	TIP29C	62p
AD162	48p	TIP30A	60p
AF114	22p	TIP30C	72p
AF115	22p	TIP31A	56p
AF116	22p	TIP31C	68p
AF117	22p	TIP32A	63p
AF127	40p	TIP32C	85p
AF139	40p	TIP33A	97p
AF239	48p	TIP33C	120p
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BC109	10p	TIP35A	243p
BC109C	11p	TIP35C	290p
BC147	9p	TIP36A	297p
BC148	8p	TIP36C	360p
BC149	10p	TIP41A	70p
BC157	11p	TIP41C	84p
BC158	13p	TIP42A	78p
BC159	13p	TIP42C	96p
BC169C	15p	TIP2955	76p
BC171	12p	TIP3055	60p
BC172	11p	TIS43	40p
BC177	20p	TIS93	28p
BC178	17p	2N697	25p
BC179	20p	2N698	43p
BC182	12p	2N706	22p
BC183	12p	2N708	22p
BC184	14p	2N918	43p
BC187	32p	2N930	19p
BC212	14p	2N1131	25p
BC213	12p	2N1132	25p
BC214	17p	2N1304	70p
BC461	40p	2N1305	70p
BC478	32p	2N1306	70p
BCY70	20p	2N1307	70p
BCY71	24p	2N1613	22p
BD124	140p	2N1711	22p
BD131	63p	2N1893	32p
BD132	67p	2N2102	60p
BD135	54p	2N2160	120p
BD136	55p	2N2219	22p
BD139	56p	2N2222	22p
BD140	60p	2N2369	15p
BDY38	160p	2N2484	32p
BDY56	225p	2N2646	52p
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BF167	25p	2N2905/A	22p
BF170	25p	2N2906/A	22p
BF173	27p	2N2907A	25p
BF177	28p	2N2926RB	9p
BF178	30p	2N29260G	11p
BF179	35p	2N3053	22p
BF180	35p	2N3054	65p
BF181	35p	2N3055	65p
BF184	24p	2N3439	72p
BF185	24p	2N3442	151p
BF194	13p	2N3565	34p
BF195	11p	2N3702	14p
BF196	17p	2N3703	14p
BF197	19p	2N3704	14p
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BF244B	34p	2N3706	14p
BF256B	60p	2N3708	14p
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BF258	39p	2N3707	14p
BF259	48p	2N3711	14p
BF337	32p	2N3773	320p
BFR39	34p	2N3819	27p
BFR40	34p	2N3820	50p
BFR41	34p	2N3823	70p
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MPF104	40p	3N187	200p
MPF105	40p	40360	43p
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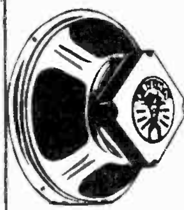

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Mail Orders & Export enquiries to Middlesbrough Branch. Add 55p carr. on Hi-Fi spkrs. or kits. Otherwise add 85p (12" spkr.) £1·25 (15") £2 (18") modulation. This does not imply that a front end using a MOSFET is necessarily better than one employing a conventional bipolar device since the one employing the bipolar type may contain several tuned circuits to increase the selectivity and therefore the rejection of spurious frequencies. The noise performance of a bipolar arrangement may be superior.

Aerial impedance

The input impedance is usually either about 75 ohms for use with an unbalanced signal from a coaxial cable or about 300 ohms for use with a flat twin balanced feeder. If an aerial with the incorrect impedance is employed, the signal to noise ratio will be reduced somewhat. In an area of high field strength, this is not likely to matter.

A signal to noise ratio is quoted for most front ends, as a figure expressed in dB. In an area of low signal strength, noise performance may be important. However, minor differences are relatively inaudible. For example, a noise level of 6dB is only just noticeably better than a 9dB noise figure.

Frequency coverage

Most units provide a frequency coverage of some 87 to 109MHz, but all will cover the complete broadcast band with room to spare, especially at the upper end. If one selects a varicap front end, the uppermost frequency of about 109MHz will not be attained unless the tuning voltage can provide perhaps 20V to 25V. An upper limit of not less than about 101MHz should be obtained with a 12V and not less than about 103MHz with a 15V tuning voltage. A supply of 10V or even less is adequate to cover the present broadcast band.

Various front ends require power supply voltages ranging from about 6V to 12V—no problems here. However, types requiring 12V may not be so convenient for use in portable receivers.

AGC/AFC

Most units do not have AGC facilities; they are generally unnecessary unless used very close to a transmitter. On the other hand, most have an AFC input and this can be most valuable if there is any tendency towards drift. Incorrect tuning results in increased distortion, especially at high modulation depth. Care must be taken to ensure that the AFC voltage from the receiver is suitable for the front end selected; some accept AFC voltages centred at 0V, while others require an input which has a mean positive potential relative to the negative line.

Commercial front ends

We will now comment fairly briefly on some front ends available from our advertisers. More formal specifications are given in Table 1.

	EF-5800HG	EF-5800HQ	EF-5600U EF-5602U EF-5603U	EC-3302U	8319	LP1186	NT3302
Tuning	varicap	varicap	varicap	varicap	varicap	varicap	ganged capacitor
Supply voltage	12V	12V	12V	9V	12V	8V	9V
Supply current (mA)	25–35	25–35	17 (max)	16 (max)	25	6·1	18 (max)
Gain (dB)	44	37	30	22	32	30	25
Noise figure (dB)	8·5	7·8	7	7	5	6·5	8
Tuning range (MHz) for tuning voltage	88 to 108 2·5–16V		87–109 3–25V	87–109 2–20V	87·5–108·5 2·3–18V	87·4–108 2–17V	87–109 —
Input impedance (ohms)	75	75	75	300 (bal.)	75 or 300 (bal.)	75	300 (bal.)
Output impedance (ohms)	300	300	75	300	recomm'd load 150	75	300
Image rejection (dB)	78	97	90 (min)	45 (min) 108MHz	56	40	45 (min) 108MHz
Thermal stability 25–55°C (kHz)	180	180	100	150	—	300	150
No of varicaps	6 back to back	6 back to back	5 back to back	3 single	4 back to back	3 single	—
No of transistors	4	4	4	3	3	3	3
No of 10·7MHz tuned circuits	2	2	2	1	2	2	1
IF bandwidth (kHz)	300	300	300	200 (min)	300	200 (min)	350
Approximate size (body only) (mm)	170 × 20 × 24		90×61×33	66×26×15		42×31×17	74×53×49

Table 1. Basic details of some front ends; full details should always be obtained from the data sheet before purchase

NT3302UG

The Toko NT3302UG (Ambit International and from Doram Electronics) employs a ganged capacitor and is low cost. It incorporates a double gang capacitor for AM tuning with a range of 8·5pF to 360pF each. A similar Toko unit, the MT3302, has an AM tuning gang with 160pF and 76pF capacitance per section. A similar type is also available with a 3:1 reduction drive. These units incorporate a MOSFET input stage with bipolar transistors as mixer and oscillator. A single 10·7MHz output tuned circuit is used. AFC facilities are provided.

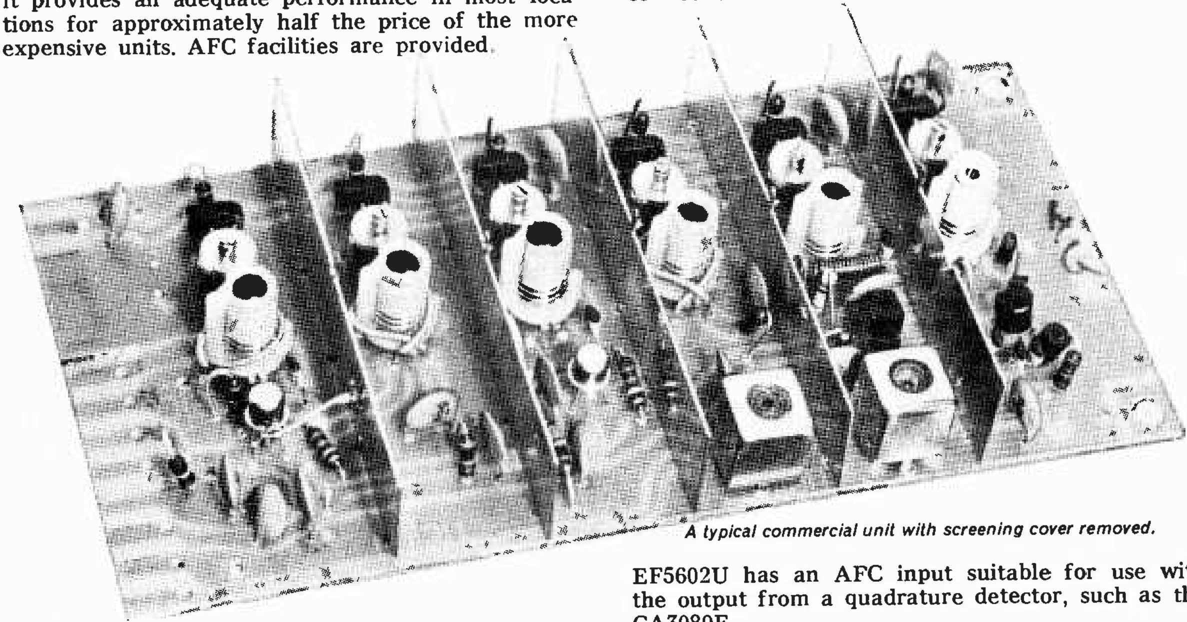
EC3302U

The Toko EC3302U (Ambit International) is an economical, compact varicap tuned front end. A MOSFET input stage is used with bipolar transistors as mixer and oscillator. As in the NT3302, the output is via the coupling winding of the 10·7MHz output transformer. Although the EC3302U has less rejection of spurious signals than other Toko front ends, it provides an adequate performance in most locations for approximately half the price of the more expensive units. AFC facilities are provided.

An EF5801 is also available with an FET buffered frequency counter output and is built on a double sided printed circuit board. The AGC range is also increased.

EF5600 series

The Toko EF5600 series are high performance front ends with an extremely high rejection of spurious frequencies (minimum 90dB). This high rejection is obtained by the use of three signal frequency tuned circuits between the RF stage and the bipolar mixer. Five back-to-back varicap diodes (type BB-104) are used. An emitter follower output stage follows the 10·7MHz double tuned circuits so the output impedance is low. A 0·01μF blocking capacitor is used in the output circuit so that the output can be directly connected to any other circuit. The EF5600U has AGC and AFC facilities, whereas the EF5603U has neither. The AFC of the EF5600U is designed for use with ratio detector circuits giving a voltage centred at zero; if the AFC is not used, the AFC connection to the front end must be earthed. The EF5602U has an AFC input suitable for use with the output from a quadrature detector, such as the CA3089E.



A typical commercial unit with screening cover removed.

EF5800 series

The EF5800 front ends have been introduced fairly recently by Ambit International. They are unusual in that two RF stages are employed (both using MOSFET devices) with bipolar transistors as the mixer and oscillator. There are six circuits tuned by varicap diodes: an aerial circuit, two tuned circuits between the two RF stages, two tuned circuits between the second RF stage and the mixer and oscillator stage. A double tuned 10·7MHz circuit is used in the output with a coupling winding providing the actual output.

The EF5800 units are available completely built and aligned, but are also available as a kit. While the kit is about £2 cheaper than the completely built and aligned unit, readers are strongly advised to ask themselves (more than once) whether they are equipped to construct this unit. If any doubt exists, it is well worth paying the extra. The EF5800 is available in two versions (see Table 1). The EF5800HG has a very high gain, but the EF5800HQ gives optimum rejection of spurious signals.

8319

The Larsholt 8318 (Ambit International) front end is manufactured in Denmark. It is a high performance unit with an especially good noise figure. There are two tuned circuits between the RF stage and the mixer. Both the RF stage and the mixer use MOSFET devices. Another unusual feature is the provision of separate inputs for 75 ohms (unbalanced) and 300 ohms (balanced). There is an AFC facility.

LP1186

The Mullard LP1186 (Doram Electronics) is one of a series of modules. Although designed to be used with the LP1185 10·7MHz IF module, the LP1186 can be used with any of the amplifier/demodulator integrated circuits. The AFC facility in this module is designed for use with ratio detector type equipment with an AFC input centred about 0V. The gain is higher than that of the EC3302U, but the latter has better frequency stability.

NARROW BAND FM Demodulator

Bill BOND G3XGP

MOST radio amateurs are aware of the advantages of narrow band frequency modulation (NBFM) transmitters in that little, if any, interference is caused to other services. Amplitude modulated transmissions, either AM or SSB, or CW can be picked up on a neighbour's television sets, a hearing aid or the Hi-Fi—the received RF overcomes the bias on the input transistors causing demodulation of your signal. Increasingly, new amateurs coming on the two metre band modify or purchase equipment for frequency or phase modulation (FM or PM) gaining the advantage of an audio modulator running microwatts instead of at least half the power of the RF output stage required by AM. To those capable of receiving NBFM, ignition interference is largely eliminated as is the characteristic QSB or flutter found on /M stations.

NBFM demodulation

Unfortunately not all amateurs receive NBFM under optimum conditions. With the average AM receiver, detection is done on the slope of the IF pass band (Fig. 1), the frequency of reception being offset from the centre of the carrier so that the signal moves in and out of the pass band of the IF and thus presents a variable voltage to the diode detector corresponding to the audio modulation. If the receiver has a fairly sharp edge to the pass band this method of reception can be very effective. However even the best of AM receivers fail where FM deviation is very small.

The solution is to employ a limiting amplifier with high gain to square the incoming wave. This eliminates audio modulation leaving only the frequency deviation which can be converted to an audio signal by a phase demodulator. In the past this has required a complex transformer to present a balanced input to a double diode detector such as the Foster Seeley or the ratio detector. Even a pulse counting demodulator gives poor recovered audio from NBFM. The phase locked loop is an excellent technique of recent development giving good AM rejection but expensive of space in isolated component form and expensive financially in integrated circuit form. Fortunately with the need to demodulate FM TV sound, cheaper, simple and very effective integrated circuits have appeared which combine a very high gain limiting amplifier with a double balanced demodulator. The latter is presented with a square wave, one side being at 90° nominal phase difference resulting in demodulation of NBFM with an efficiency seldom achieved by older methods.

The author's NBFM demodulator design uses a high gain amplifier and a double balanced demodulator in a single IC with a minimum of external components to give an audio output of up to 0·8 volt, but pursues the matter a little further. Not every amateur wishes to 'butcher' his equipment. The addition of accessory equipment should not alter the ability of the receiver to accept AM or SSB with equal facility. This discriminator includes an input stage which provides minimum loading on the output from the IF stages and, by including an audio stage, provides reception of NBFM through a separate loudspeaker. This enables both NBFM and AM stations to be received without adjustment of the receiver controls and also gives some indication of the amount of FM on an AM transmission. If the complete unit is made, only three connections are required: an input from the IF stage, and power supply take off. The unit has been designed for the two popular IFs of 455 kHz to 470 kHz, and 1·6 MHz.

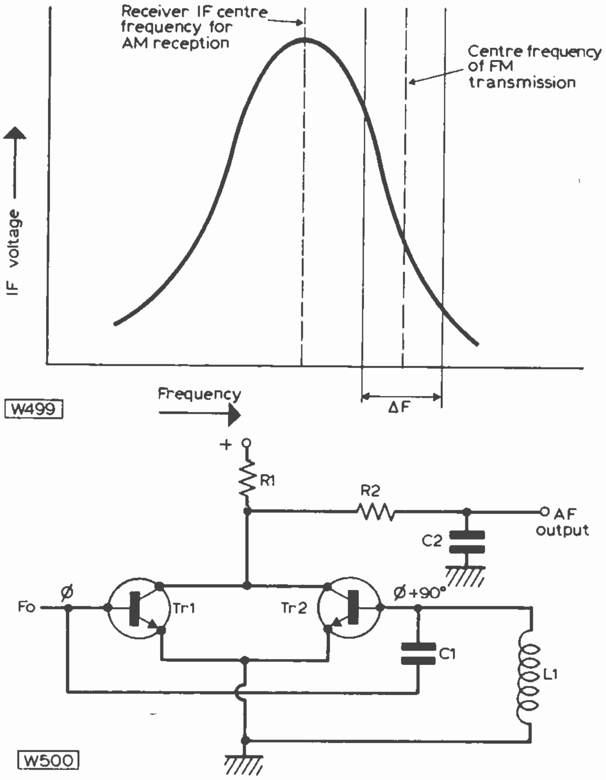


Fig. 1: The upper drawing shows a conventional AM receiver tuned for reception of signals. The FM is converted to AM using the receiver passband slope. The lower drawing shows a simplified quadrature detector. The relative phase between inputs of Tr1 and 2, a function of the input frequency when the combination of L1/C1 is near resonance, controls the current conduction angle through the common collector resistor R1. Recovered audio modulation appears across this resistor.

Circuit description

A very high input impedance stage is provided by an FET (Fig. 2) capacitatively coupled to the last IF

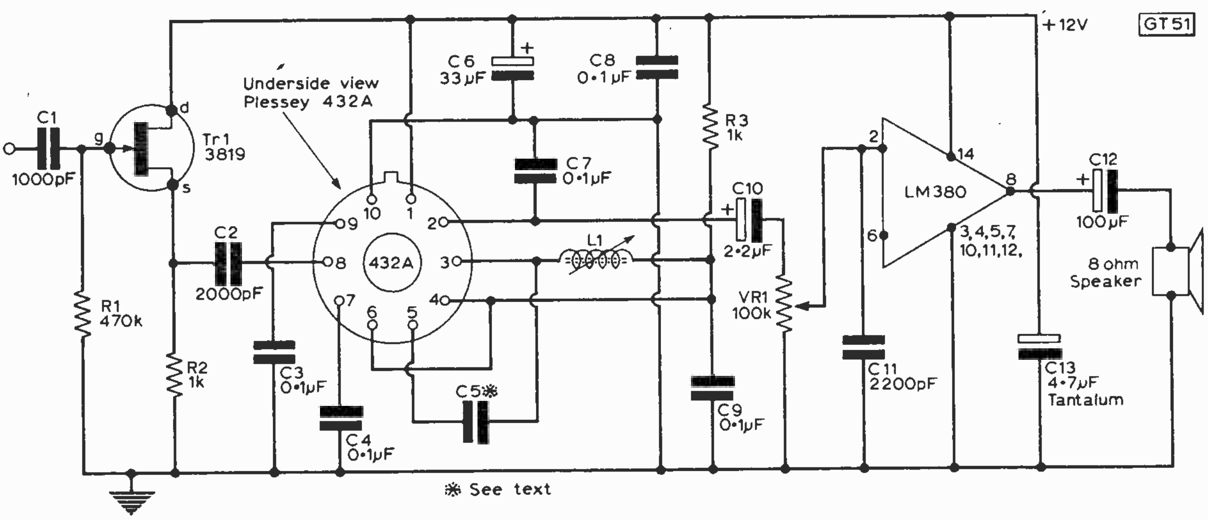


Fig. 2: Circuit diagram. The prototype was constructed on a small piece of etched circuit board. The layout needs considerable care to avoid instability. Keep the input and output wiring of IC1 separated; use a screen if necessary. L1 will require a screening can.

stage, the input being best connected to the anode or collector through a capacitor of suitable voltage tolerance. Some readjustment of the last IF transformer slug will be required which should be minimum when the link between IF stage and discriminator is as short as possible.

C1 links IF to the gate of Tr1 which is held at earth potential by R1. R2 is the source resistance and provides a low impedance input via C2 to the IC, a plessey 432A. This has an input impedance of 1·4kΩ and incorporates an amplifier with a gain of over 50dB followed by a balanced demodulator. Most of the capacitors surrounding the IC decouple the various stages. However, C5 and L1 provide a 90° phase shift between pin 3 and pin 5 at the IF, and both must be selected depending on the IF to be demodulated (see component list). The output from the balanced demodulator is fed via C10 to IC2.

Construction

Because of the high gain of the preceding receiver IF strip, particular attention must be paid to abolition of ground loops—these can occur while connecting the demodulator unit to the receiver as well as in the component board itself. All conductors surrounding the 432A must be kept as short as possible; this particularly applies to the circuit decoupling capacitors.

The circuit can be constructed on either veroboard or etched PCB. The author used the latter method for the prototype. Whichever method is employed the input circuitry (Tr1, etc) should be placed the opposite side to the output circuitry (L1, IC2, etc.).

L1 was wound on a standard 12 mm pot core as used in many IF transformers. For 455kHz wind 80 turns of 40 gauge enamel covered wire. C5 should be about 1000pF. For 1·6MHz, wind 50 turns of similar wire with C5 270pF. It is essential to screen L1 in a metal can to avoid instability. For those without 12 mm pot cores readily to hand, it might be worth experimenting with converted IF transformers. L1 and C5 should be series resonant at about the the receiver intermediate frequency. In operation, L1 is 'mistuned' so that the phase shift across C5, normally 180° at resonance, is reduced to 90°. With standard high Q IF transformers, this will occur within a few kHz of nominal resonance; the recovered audio depends on the Q of the LC combination. The higher the Q, the higher the output for a given deviation. Adequate results may be obtained by breaking open an old IF can, removing one winding and tuning capacitor, and using the remaining winding for L1 and the associated capacitor for C5. Slight adjustment may be necessary to compensate for the capacitative loading of IC1 in the 'new' application.

★ components list

Capacitors
- C1 1000pf
- C2 2000μF
- C3, 4, 7, 8, 9 0·1μF ceramic
- C5 1000pf for 455 kHz / 270pf for 1·6 MHz } See text
- C6 33μF
- C10 2·2μF
- C11 2200μF
- C13 4·7μF tantalum
- C12 100μF

Resistors
- R1 470kΩ
- R2 1kΩ
- R3 1kΩ
- VR1 100kΩ linear

Coils
- L1 Standard 12 mm pot core as used in many IF transformers. Wind 80 turns 40 gauge enamel covered or Litz wire for 455 kHz, or 50 turns similar wire for 1·6 MHz. Screening can essential. See text.

Semiconductors
- IC1 432A Plessey
- IC2 LM380

Setting up

Connect a 12V supply to the unit; the current drawn should total about 30mA. Feed an FM IF signal to the unit at the mean operating frequency and adjust L1 for maximum output. A fairly accurate adjustment may be made by disconnecting the aerial from the receiver and tuning L1 for maximum white noise in the loudspeaker. However, really accurate adjustment can only be made with a NBFM transmission.

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NOW S

THE General Instrument AY-3-8500 IC has two positions on the games switch that provide a square target for use in shooting games. In the first position the target bounces round the screen in an invisible box. In the second position the target crosses the screen from left to right. When the reset button is pressed the screen is blanked except for the target. After 15 shots the score appears to indicate the number of hits out of 15.

SHOOT is an add-on unit which allows an aiming mark to be placed on the screen and moved around by joystick control to chase the target. If the firing button is pressed when the aiming mark is on target a point is scored. A variable timer allows the aiming mark to be placed on the screen for preset times.

D.S.COUTTS

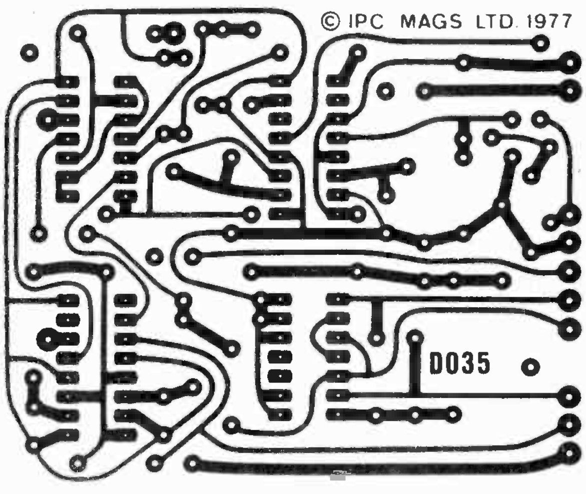
Circuit description

The circuit of the unit is shown in Fig. 1. The unit obtains its supplies from the main 8500 PCB. The sync from the 8500 is fed to pin 5 of IC1b and to Tr1. IC1b fires on each line sync and controls the horizontal position of the aiming mark, its range being approximately 15 to 55μs. The components C5, R5, D2 determine the width of the mark, the values on the circuit giving a width of 0·5μs. Tr1 is used to separate the frame sync from the line sync and provides a trigger pulse each frame to pin 12 of IC1a. IC1a controls the vertical portion of the aiming mark and is variable over the range approximately 5 to 18μs. Components C3, R4, D1 determine the height of the mark; the values shown give a height of 3 lines. S1 is the fire switch, debounced by IC3a and b. IC3 output from pin 10 is fed to the shot input of the AY-3-8500 incrementing the shot counter each time the trigger is pressed. C6, R8, D3 determine the width of the fire window. C6 can be increased to make the window wider which makes the game easier.

Gating

IC1a and b gate IC4a together with the output from IC2a. When S2 is pressed IC2a fires for a period determined by VR3 opening gate IC4a. The output of IC4a is inverted by IC4b, used to produce the spot on the screen, and also gates IC4c. The ball output from the AY-3-8500 and the fire window from C6 are also fed to IC4c. When a hit is detected by this gate, IC2b fires and outputs a pulse to the 8500 hit input. This increments the hit counter, outputs a tone and blanks the target for the duration of the hit pulse.

There are therefore seven connections between the 8500 main PCB and SHOOT: 0V, +8V, SYNC, BALL OUTPUT from the main PCB and shot, hit and AIMING MARK from SHOOT.



HOOT!

AN ADD-ON GAMES MODULE

★ components list

Resistors

R1	10kΩ
R2	2·2kΩ
R3	10kΩ
R4	27kΩ
R5	10kΩ
R6	15kΩ
R7	15kΩ
R8	1MΩ
R9	15kΩ
R10	470kΩ
R11	330kΩ
R12	47kΩ
VR1	25kΩ moulded track
VR2	50kΩ moulded track
VR3	500kΩ
VR4	22kΩ skeleton preset
VR5	22kΩ skeleton preset

Capacitors

C1	0·02μF
C2	10μF tantalum
C3	0·01μF
C4	0·01μF
C5	56pF
C6	0·1μF
C7	22μF
C8	2·2μF
C9	10μF tantalum
C10	0·01μF

Semiconductors

IC1	MC14528
IC2	MC14528
IC3	MC14011
IC4	MC14023
D1	1N914
D2	1N914
D3	1N914
Tr1	BC108

Miscellaneous

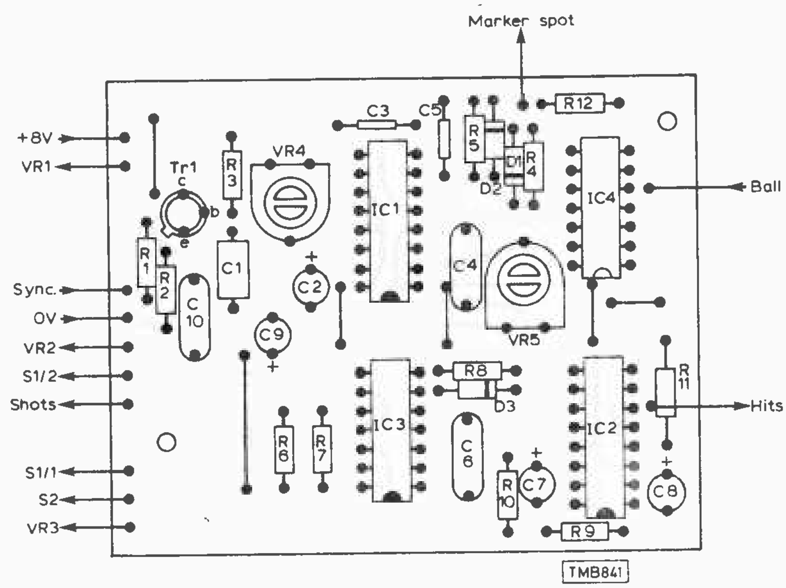
S1 1 pole change over; S2 push to make, hardware, box (14 x 5 x 8cm), plug and socket (see text), joystick mechanics. PCB from PW Readers' PCB Service

Construction

Actual mechanical construction will depend on the size of the joystick used; a typical layout is shown in Fig. 5. As standard joysticks used for radio control may have 5kΩ pots fitted, ensure that the type obtained can be modified to take a 25kΩ and a 50kΩ pot. If one is obtained with a tubular operating arm, S1 may be mounted in a piece of dowel and fitted on top of the operating arm.

Fig. 2 (left): PCB copper side shown actual size. The board is secured to the base of the plastic housing by two 6BA bolts inserted through the drillings indicated on the board. Circuit diagram (Fig. 1) is shown on page 283.

Fig. 3 (right): PCB component layout. DIL sockets should be used for all ICs unless the usual CMOS soldering procedures are followed. Devices should be left in the conductive foil or foam until ready for insertion; pins 2 and 14 of the MC14528 are especially susceptible to static damage since these do not have the normal input protection diodes.



When the mechanical parts have been mounted in a suitable box, begin assembly of the PCB. Fit the wire links as shown by the single lines on Fig. 3 and fit the other components. As CMOS devices are used in the system it is advisable to fit IC sockets and leave insertion of the ICs until construction is finished. If you do not use sockets then use an iron with an earthed tip for soldering. When the PCB is complete fit it into the box. Fig. 3 also shows the connections to the board.

Connection

A seven-pin plug should be fitted to the cable to join the unit to the TV games unit with a matching socket in the latter's box. The connection points on the 8500 PCB are shown in Fig. 4. The sync output is taken from pin 16 on the 8500 IC and the marker spot lead connects to the end of R9. The +8V output

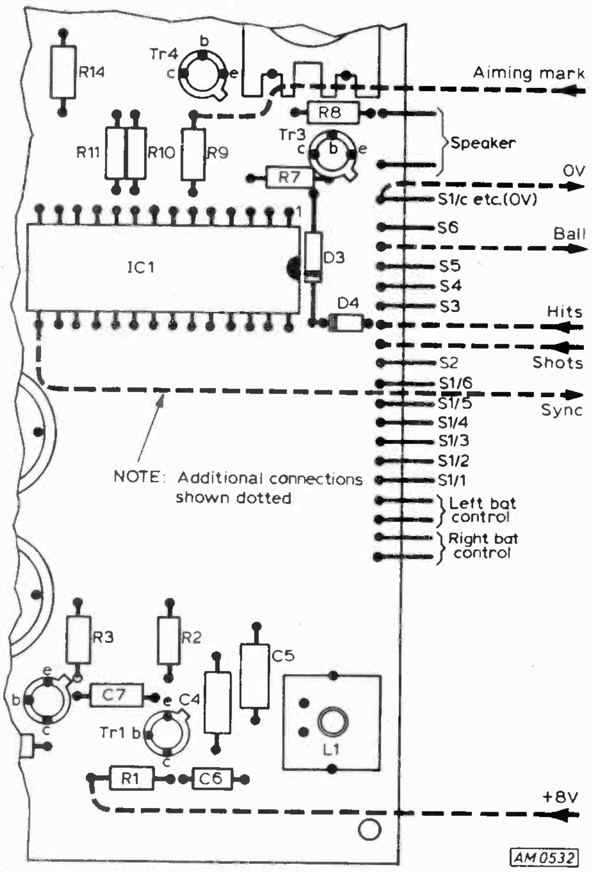


Fig. 4: Interconnection diagram for use with PCB featured in the June 1977 Telegames unit. Although the prototype SHOOT module was connected to the main unit by flying leads, readers are recommended to fit 7-pin DIN plugs or other multiway connectors to both master and slave games unit.

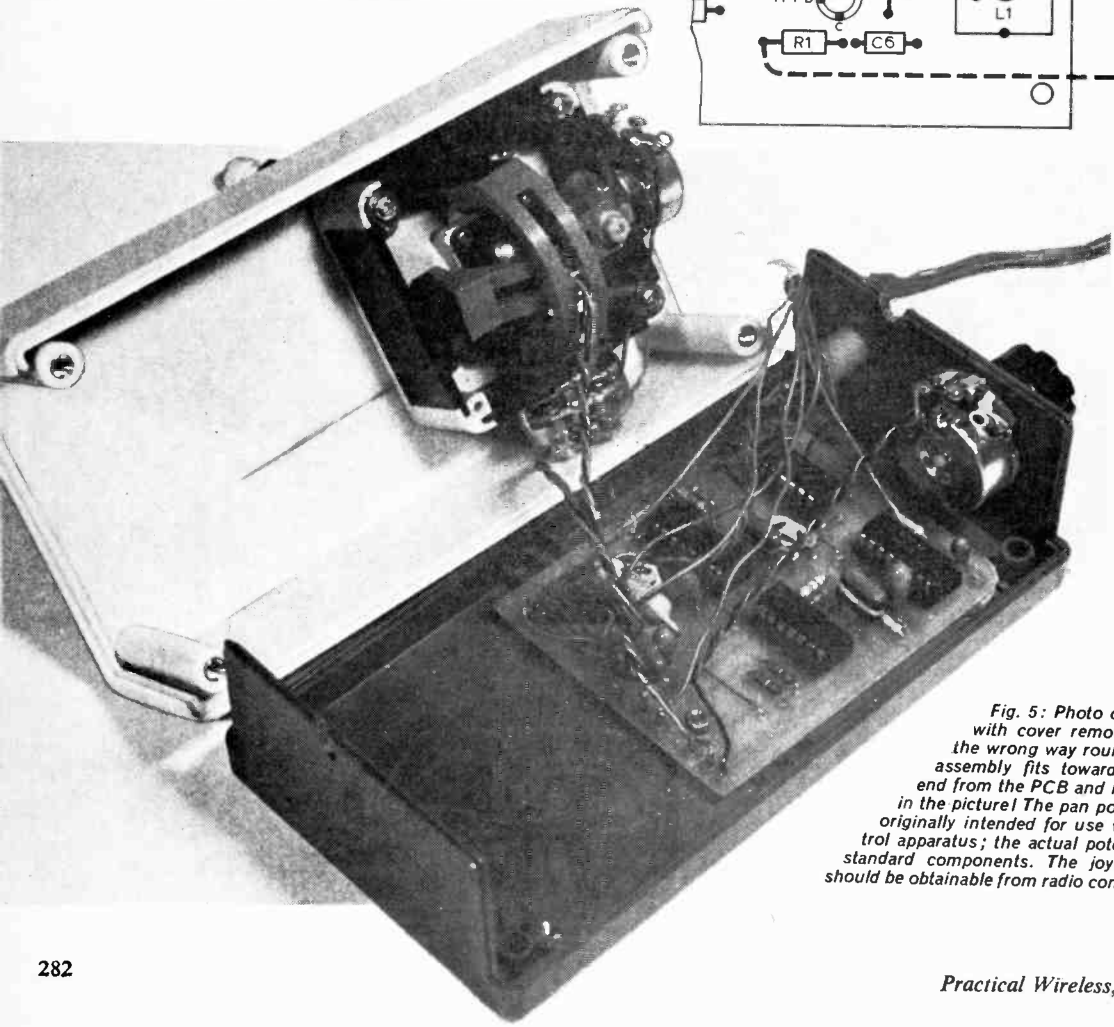


Fig. 5: Photo of the prototype with cover removed and shown the wrong way round. The pan pot assembly fits towards the opposite end from the PCB and not as indicated in the picture! The pan pot assembly was originally intended for use with radio control apparatus; the actual potentiometers are standard components. The joystick assembly should be obtainable from radio control specialists.

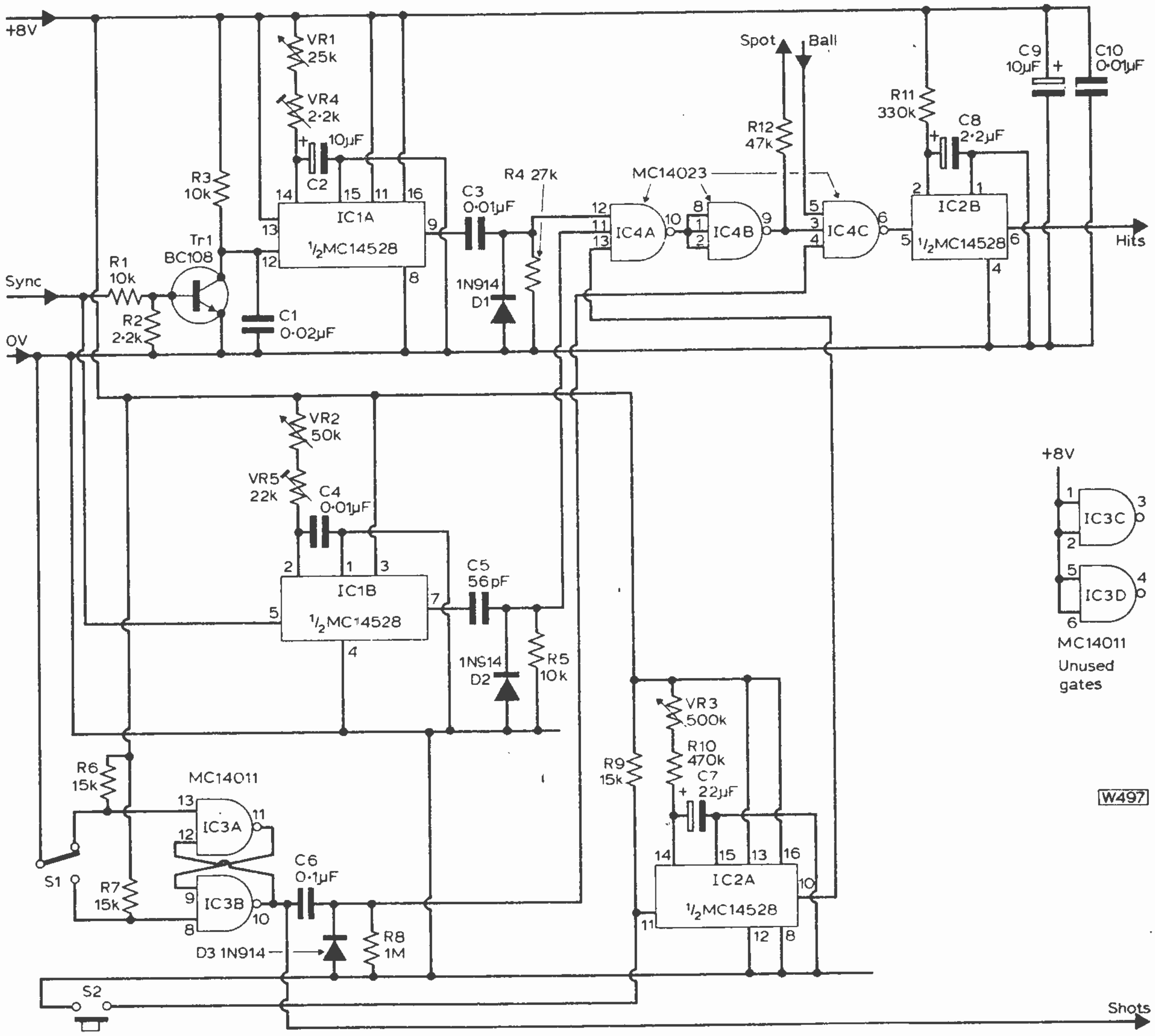


Fig. 1: Circuit diagram. The text referring to this occurs on page 280. IC3c and d are unused gates, the inputs of which must be grounded or tied to the Vcc line. They must never be left floating. The power supply to the SHOOT module PCB is taken from the parent board in the Telegames unit. Note: VR4 should be shown as 22kΩ as in components list.

comes from the regulated supply. The other connections are on pins at the edge of the PCB.

Setting up

After checking the unit carefully for shorts, etc, connect the SHOOT adaptor to the main unit. Set VR3 to maximum resistance. Select rifle game R1 and auto mode when the target should appear on the screen. Push S2 and adjust the position of VR1, VR2 and the presets VR4, VR5 to get the aiming mark on the screen. Remember that S2 has to be pressed occasionally to keep the mark visible. When the mark has appeared on the screen adjust the pots and presets until the mark can be swept over most of the screen by means of the joystick. When this is satisfactory try out the fire button when a tone should be obtained each time the target is hit (N.B.—when moving the stick with the target moving fast it is easy to think you have a hit which hasn't registered when in fact a slight delay in pressing the fire button has caused you to miss). It is advisable to use slow speed for testing; further, the fire window can be widened temporarily by connecting another capacitor across C6. PW

PRODUCTION LINES

bill tull

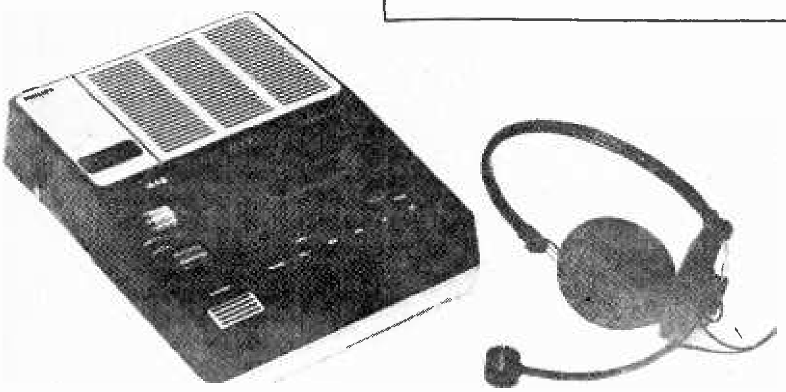
Mind your language

Right now it's holiday time—going abroad or maybe you are abroad? Bet you wished you could talk the local lingo and that you had paid more attention in those language classes when you were at school?

A method of language tuition that has been popular for some years now is the language laboratory which of course is hardly portable. But now Philips have introduced a new language trainer the AAC4000 based on their audio active comparative (AAC) system and it really can be carried on the shoulder. In laymen's terms, AAC means that the user listens to sentences of tuition pre-recorded on the lower half of the training compact cassette. There are long pauses between the sentences of tuition and during the pauses the student repeats the sentences, which are then recorded on the cassette's upper track. Subsequently the student can replay both tracks at the same time so that he can compare his own pronunciation with the teacher's. If he wishes to try again the student can erase his previous performance but the tuition track is automatically protected against erasure.

The separate tracks can also be used for other applications such as slide and sound synchronisation.

Philips Electrical Ltd., Century House, Shaftesbury Ave., London WC2. Tel: 01-437 7777.



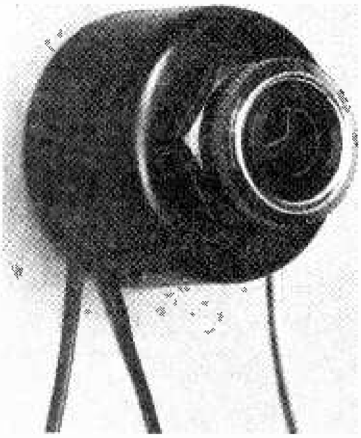
It's in the bag

It's not every reader who can make his own printed circuit board and make a good job of it—the usual trouble is the mess created by the etching solution, it seems to get just about everywhere except onto the board where it's needed. If the board and solution were contained in a special bag the major problem would

be overcome—no more mess. Verospeed have adopted this idea with their new Etching Kit which comprises all that is needed to remove copper in a clean, safe and simple way from ten Eurocard-size boards.

A special neutraliser is also included which ensures environmentally safe disposal once the kit is exhausted. An etch resist pen and transfers, together with a copper cleaning block completes the kit, which is guaranteed, says Verospeed, to be available by return post. Each kit is priced at £4·30 plus VAT and has code number of 22-4410G.

Are you the type that likes a bit of noise, especially when your car is about to be pinched or your house is being burgled? You are? Then how about a miniature audible warning device that takes very little current and can be satisfactorily operated from 5 to 30V DC or 20V AC. A



choice of two continuous signals, high or low frequency is available from the one unit, which is priced at £3·52 plus VAT. Verospeed order number is 41-4642J.

Verospeed Service, 10 Barton Park Industrial Estate, Eastleigh, Hants. SO5 5RR. Tel: 0703 618525.

Making waves

Time was, when, if you required a specifically shaped signal, the equipment you required tended to be a bit cumbersome. With the introduction of integrated circuits this exercise has now become a little mundane, and IC's can be obtained which give a sine, square and triangular waveform output over a fairly large frequency spectrum. Lascar Electronics now market a waveform generator module comprising IC, peripheral components all mounted on one board, and whose frequency on all three waveforms extends from 20Hz to 20kHz. Operating on a supply voltage of ±5 to ±15V, this CB-FG8038 generator has typically 1% distortion, duty cycle variations of 2% to 98% and power dissipation of 750mW.

Output frequency is set by an ex-

ternal 10k ohm pot, and by adjustment of the on-board duty cycle pre-set pot, sawtooth, ramp and pulse waveforms can also be obtained.

The Cirbloc module is assembled onto a PCB measuring 76 × 48mm and is priced at £7·16 + VAT.

Lascar Electronics Ltd., PO Box 12, Module House, Billericay, Essex. Tel: 02774 3394.

Take me to your leader

No it's not a copy of Penthouse or the latest fashion magazine for bathers at St Tropez — it's — wait for it, the latest catalogue from Eagle International. I can just read your minds now, what could that strange cover possibly have to do with Electronic components and HiFi gear? Well the answer is nothing, but never-the-less what it has got to do with is extremely interesting. The

picture, which incidentally is produced by NASA is supposed to convey to an alien being all that he needs to know about Homo Sapiens (Man). What do you mean you don't see it? Its quite simple really, the 'rays' represent our sun in respect to the closest radio-emitting stars (pulsars). Also shown are the relative positions of the planets in our system and the size of the vehicle (spacecraft) compared with its creators. Much more information is encoded using the binary system, all of which could be deciphered by any intelligent lifeform. So, if there are any readers who classify themselves as 'Intelligent Lifeform' please drop PW a line and explain it all to us!

Incidentally the Eagle Catalogue is pretty good too.

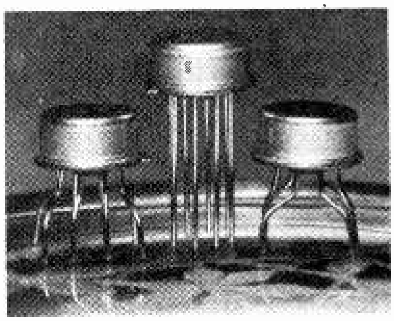
Eagle International, Precision Centre, Heather Park Drive, Wembley. Tel: 01-902 8832.

1½ billion ohms

A new range of BiMOS Op-Amps incorporating MOS/FET inputs, COS/MOS outputs, and having low drift figures of 6μV/°C have now been introduced by Mogul Electronics.

Notated the CA3160, output current is in the order of 20mA, bandwidth is 4MHz, input impedance is typically high, being in the order of $1{\cdot}5 \times 10^{12}$ ohms and the output voltage is capable of swinging to within 10mV of either supply rail.

The CA3160 family is said to be ideal for interfacing with COS/MOS, and all devices operate within the temperature range of −55°C to +125°C. Packages obtainable com-



prise a standard 8-pin TO99 package or a DIL can device with TO99 lead configuration preformed to 8-pin DIL layout.

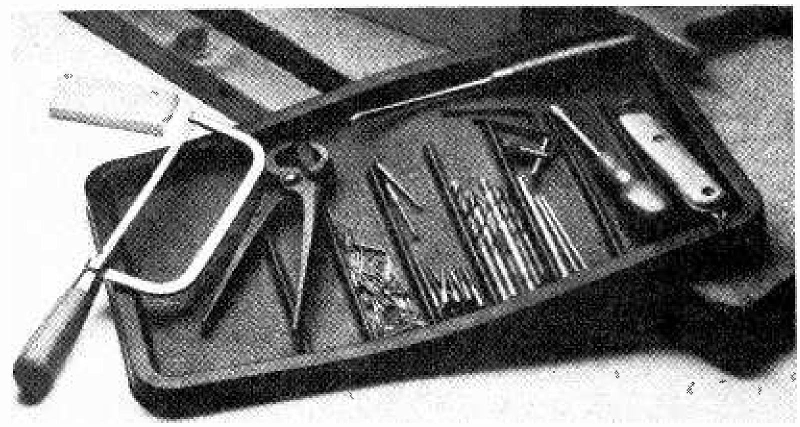
This device is manufactured under the *YES Electronics label which is part of Mogul Electronics Ltd., 273 High Street, Epping, Essex. Tel: 0378 77366.*

Tidytray

You know it always happens, you put down the screwdriver and five minutes later its gone—walked off. You swear and curse and accuse everyone around you and then look on the bench, and then, yes you've guessed it, the screwdriver has mysteriously returned. Well these things are sent to try us, but wouldn't it be nice if we could keep all our tools together, know where they are, and know that they won't walk off, or roll off or just plain dissappear.

Obviously a firm by the name of Cannon have had the same sort of problem that you and I suffer from, because they have recently introduced a rubber mat that's flexible, non-slip can be draped over an irregular surface or laid flat on a polished table top. It has internal dividers, and a 1inch lip around the tray provides for a variety of small tools.

Called the Autotidy, the price is £1·38 and can be obtained from most DIY stores.



HOTLINES ON RECENT DEVELOPMENTS

Citrus power

How about shoving an orange into your transistor radio next time the battery runs flat? Not quite a practical proposition, but lemons were used as a source of power at a recent electronics exhibition in London. This power was then stepped up to give a spectacular display.

The "secret" lies in the fact that if you unkindly stick two dissimilar metals into the acid contents of a citrus fruit, such as an orange or a lemon, a voltage and current are generated. The output is, of course, quite small, but your ageing scribe has had a CMOS oscillator running from a single lemon—quite an impressive demonstration for when friends call.

Perhaps, with power conservation presently in everyones' minds, farmers will be encouraged to grow special "electrical" varieties of fruit. Imagine scouring neighbourhood greengrocers in search of a 3 volt grapefruit!

You can't beat it

A chap called Khayyam wrote, "The moving writes and having writ . . ." etc. In modern times, however, the moving finger moves and rests lightly on top of a digital wrist watch. That's so that the owner can check his pulse rate—of course!

Just out in the States is a digital watch with a tiny two-sensor button on the top, just below the readout face. One little sensor is a light transmitter while the other is a light receiver. Resting the finger directly across the two, switches on the pulse counting sections of the watch. The tiny transmitter emits infrared light. This travels into the finger and is reflected back again to the receiver sensor. Blood in the capillaries of the finger expand and contract very slightly as blood is pumped through them. It is this tiny change which alters the amount of infrared light received by the receiving sensor. The result is a series of tiny infrared pulses triggered or caused by the actual body pulse itself.

Individual pulses are amplified and passed to a control counter then to a count-digit converter and so to the digital readout which shows the pulse rate directly. Since the digital watch has a very accurate seconds pulse (from the watch oscillator) the tiny microcomputer in the watch can accurately measure the pulse and give a direct readout in beats per minute. Sad to say you cannot buy one yet and the price in the US is around 500 dollars for a stainless steel case version. The watch may be accessed or interogated 25 times every day for a whole year before the batteries need changing. Presumably this watch is aimed at impulse buyers.

Light time piece

Talking electronic watches, I note that a German company is to market two quartz-driven clocks with accuracies of ± 30 seconds a year. The difference with these timepieces is that they have built in solar cells which keep the batteries charged. One is designed to function in daylight (not necessarily sunlight) which is interesting. Perhaps transistor radios will follow suit when these cells become cheaper and more efficient.

And talking about solar cells reminds me that President Carter's new energy programme has some support already. For example a knitwear factory is currently under construction in the US which will eventually employ some 300 people. Its power requirements are 1,400kW and this is to be provided entirely by the sun. At last solar power is really getting down to the knitty gritty.

Carrying on from a previous Ginsberg when I mentioned a professor who had an all-electric car, I see that a great deal of work is being done in this field. Two cars are under investigation by one company. One car has electronic controls while the other utilises a huge flywheel for better acceleration. These are both four-passenger models with a top speed of 55mph and a range, at present, of 75 miles. Some four million dollars is invested here in contracts which run for two years.

Hall marked display

Ever heard of LETI? No, not a little Yhetti but the laboratory for electronic and computer technology attached to the French atomic agency (yeah, I think it's easier to say LETI, too!). Apparently a group of researchers there have discovered that by taking an organic electrolyte, plus a drop of silver, they can make readout cells which, they claim, are better and cheaper than liquid crystal types. In their normal or "off" state, these cells are transparent. They change to opaque in some 50ms when a 1V pulse is applied across them. The application of this pulse causes a very thin layer (typically 50 Angstroms) of silver to "plate" the electrodes. This plating will stay in position for around 10 minutes before the cell begins to go transparent again so it might be argued that these devices have a ten minute memory. A pulse can be applied which will clear the cells immediately.

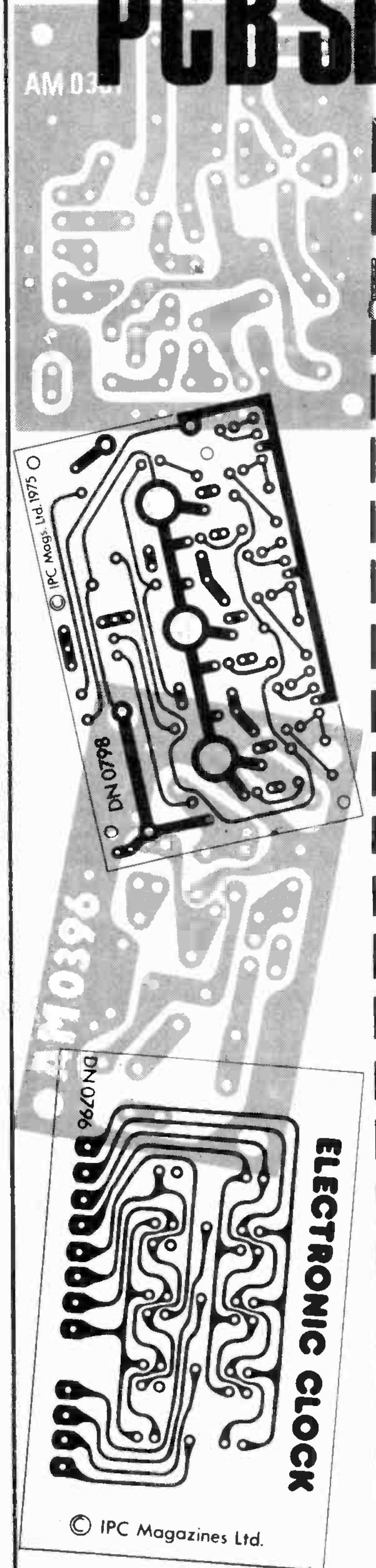
Cap that!

Discrete capacitors are still used by the millions in almost every conceivable electronics application. One company in the capacitor field has come up with a good idea. They manufacture foil and film capacitors and they've brought out some devices called Multipacitors. In a single unit package, this company houses a number of different capacitors offering a 30% saving in space compared with using separate discrete components. The trick is to take tapping points off the foil winding to offer different capacitance values within the same package. Instead of buying four components, you buy only one! One package offers, 0·47μF at 400V wkg plus 1μF 400V wkg plus 2μF at 200V plus 4μF at 200V wkg.

I note with interest that the latest digital display devices have drivers and decoders built in. All you need do is feed the beast direct from a four line BCD output. They're TTL compatible, too. Whatever will they integrate next?

Ginsberg

PCB SERVICE FOR READERS



All boards, except SRBP, are glassfibre, drilled and roller-tinned

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Oct 76	Hazard Flasher	D005	0·76+12	☐
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Nov 76	Electronic Thermostat	A017	1·30+12	☐
Nov 76	Cirtest Probe	A018	0·48+12	☐
Nov 76	Burglar Alarm	A019	0·50+12	☐
Dec 76	Chromachase	A021	5·70+22	☐
Jan 77	Oscilloscope Calibrator	A023	1·25+12	☐
Jan 77	Icelert	A020	1·45+12	☐
Jan 77	Polyphon, motor and main boards	A025/4	7·90+20	☐
	Polyphon, tune disc, blank, SRBP	A008*	0·90+15	☐
Feb 77	Transistor Checker	A026	1·18+12	☐
Mar 77	FM Stereo Touch Tuner	D023/4/5	7·50+20	☐
Apr 77	Tug 'o' War (set)	A029/030	2·88+12	☐
Apr 77	Gas/Smoke Sensor Alarm	A028	0·65+12	☐
May 77	2-Way Intercom	D019	1·28+12	☐
May 77	Protected Battery Charger	A027	2·38+12	☐
May 77	Seekit Metal Locator	A031	3·38+12	☐
June 77	Reverberation Amplifier	A032	2·38+12	☐
June 77	Versatile AF Generator	A033	2·38+12	☐
June 77	Tele-Games	D029	3·22+18	☐
July 77	20W IC Amplifier	A034	1·38+12	☐
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ATOMIC TIME RECEIVER

N.C.HELSBY, MA, MIEE

THE advent of quartz crystal oscillators in watches, and the regulation of conventional clocks and watches, poses a thorny question—how does one check their performance? Clocks driven by the mains supply, either digital or mechanical, indicate to a high accuracy only if viewed over a period of months or years, compared with a quartz watch, since they may be a number of seconds wrong at any particular moment—and by this time there may have been a power cut! The Post Office Speaking Clock could prove expensive to an enthusiast—and if the telephone is not next to your favourite grandfather clock how do you set the exact second? Greenwich time signals from the BBC can turn out to be very elusive just when you need them.

Standard time and frequency signals have been transmitted for many years on both short and very long waves. The most convenient of these for time checking purposes in this country is the 60kHz transmission of Rugby MSF. This station transmits seconds and minute markers as well as a call-sign which enables identification of the hour. Recently, at the end of each minute, a time code was introduced in which the hours and minutes are signalled in a binary code; it is possible to construct a digital clock which sets itself by means of this code. However for many purposes the seconds and minutes markers, which are easily recognized by ear, are all that is required for setting and checking clocks or watches.

Atomic transmission

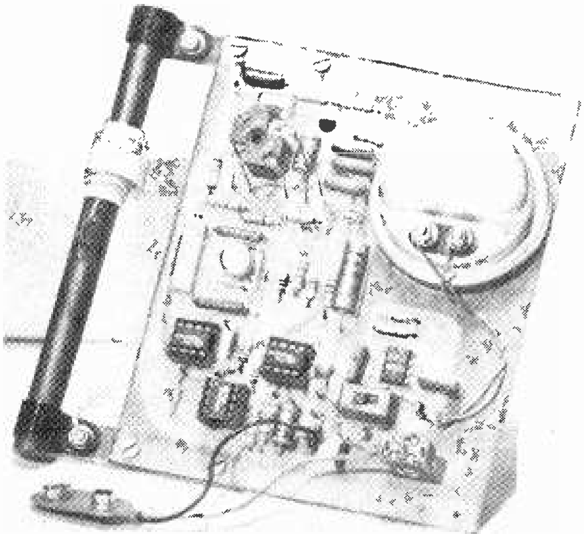
The time by which we live must clearly be related to the rotation of the Earth on its axis but, even when all possible corrections have been made, the rate of this rotation fluctuates unpredictably. Also the Earth is known to be slowing its angular rate due to tidal friction (admittedly amounting to only a millisecond a century), thus in principle to arrive at a standard invariable unit of time such as the second another definition is required. In 1964, at a meeting in Paris, the International Committee of Weights and Measures adopted as its tentative standard an atomic transition, specifically a hyperfine transition in the atom of caesium^{133}. To keep the time of day measured by atomic clocks using this definition of the second (the time for 9,192,631,770 transitions) in step with the time scale referenced to the rotation of the Earth about its axis corrections by means of the addition or subtraction of a complete second are occasionally carried out, usually on either June 30th or December 31st. Clearly whilst checking the performance of accurate clocks it is useful to know when these corrections have been made, as they will be applied to Greenwich time signals as well as the other accurate sources of time.

Rugby MSF

The Rugby transmission gives an indication of when such leap seconds (or the reverse) have been included. The normal seconds markers are formed by a complete 0·1s break in the 60kHz carrier. The minute marker is easily identified as it is a 0·5s break, apart from the first 0·2s or so which contains the time code. In each case the start of the break in the carrier represents the exact time, so that a receiver which "bleeps" when the break occurs sounds similar to Greenwich time signals as transmitted by the BBC, apart from a slight croak at the minute due to the presence of the time code: except for servicing periods (usually a few hours on the first Tuesday in the month) the signals are available 24 hours a day.

The difference between the time scale related to the rotation of the Earth and the atomic scale is given in units of 0·1s by means of an extra pulse (where a pulse is no carrier) following each second from second number 1 to, at most, second number 7, for the atomic scale lagging behind the rotation of the Earth. If the atomic scale is ahead similar pulses following seconds 9 to up to 15 are inserted.

Thus a sudden change from, say, an extra pulse after each second from 9 to 15 inclusive to an extra



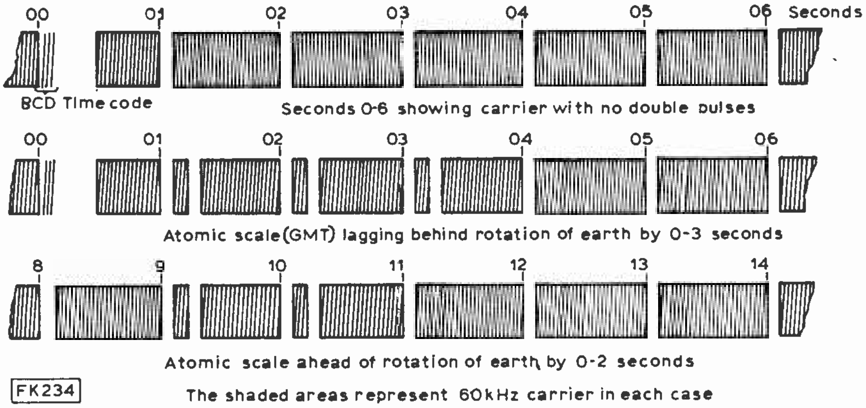
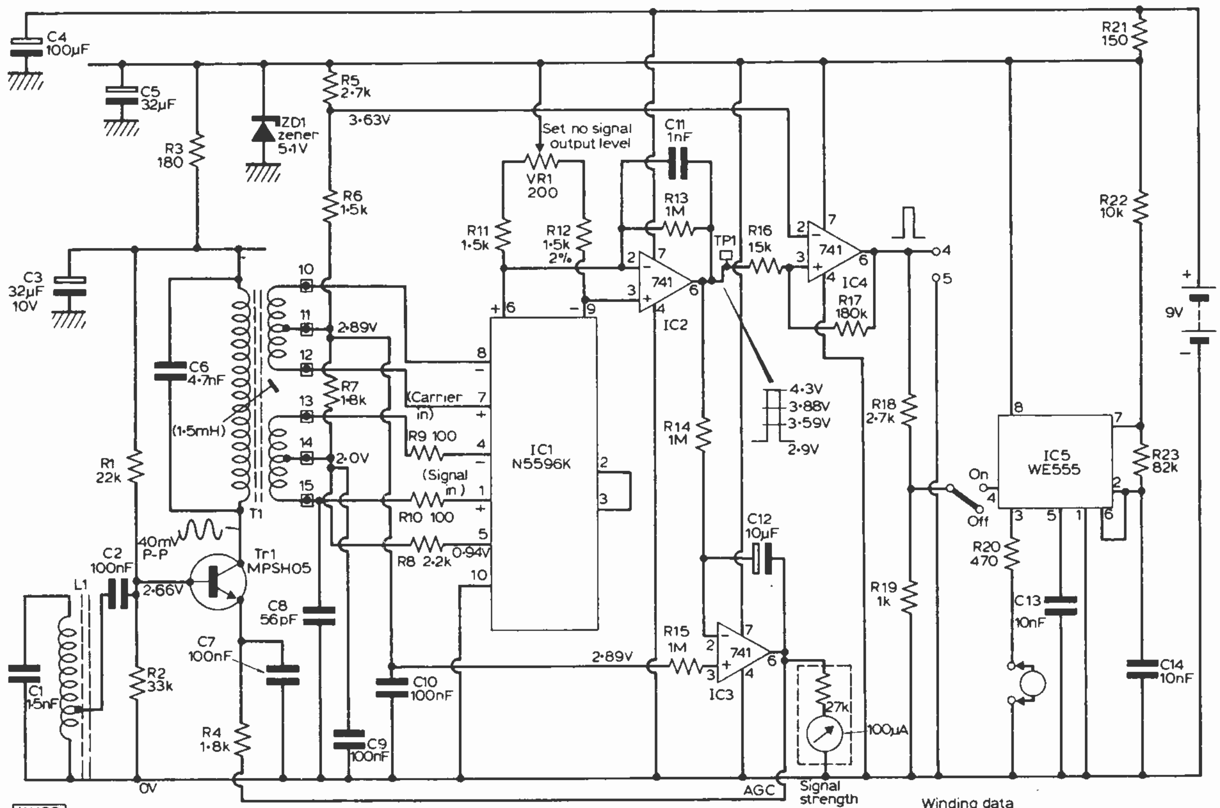


Fig. 1: The atomic time code as transmitted by Rugby MSF. The BCD time code occurs at the start of each minute pulse train. Relationships between atomic time and earth rotational time notated by appearance of double pulses in either seconds 1 to 6 (atomic time behind earth) or in seconds 9 to 15 (atomic time ahead of earth).

pulse after each of seconds 1, 2, and 3 would show that an extra second had been inserted into the atomic time scale, which has therefore jumped by this amount relative to all other clocks and watches; these, if their accuracy merits it, must be readjusted to follow suit. A change from, say, an extra pulse after each of seconds 1, 2 and 3 to one after 1 and 2 merely indicates how the rotation of the Earth is going relative to the atomic scale. In other words, the error does not concern us with regard to checking other clocks until the whole second correction is made, which is apparent from the sudden switch in positioning of the double pulses. See Fig. 1.

The receiver

The usual method of listening to a telegraphy signal, for example morse code transmitted by the keying on and off of a carrier, is to heterodyne or beat a local oscillator with the signal to produce an audible tone. This is one of the functions of the BFO (beat frequency oscillator) found on short wave receivers. However to make the *gaps* in a signal audible an audio oscillator is required to be switched off by the signal and turned on in its absence. This is slightly unusual, and, incidently renders, in the case of the Rugby signal, the morse code "MSF" sent



Winding data

Component	Core	Number of turns		Wire
		Primary	Secondary	
T1	RMG (U14145)	59	2 off 7-0-7	30SWG

Fig. 2: Circuit of the atomic time receiver.

twice just before each hour unreadable, but gives the short bleeps most convenient for setting clocks.

Starting from this end of the receiver (Fig. 2) any audio oscillator capable of being switched on and off will suffice—the one shown uses the familiar 555 timer, the output of which may connect to a small loudspeaker or earpiece such as the standard telephone type available from surplus suppliers. Note that a resistor is shown in series with the timer output to limit the current in the loudspeaker or earphone. It was found that 470 ohms was about the lowest value that could be used without endangering the normal operation of the 555 when feeding such loads. IC5 is turned on and off by the output of the receiver, therefore when no carrier is present the reset line (pin 4) is taken high by the output of IC4 and the output of the timer causes a "bleep" from the earpiece, Fig. 1.

The multiplier is used as a squaring circuit. The signal is multiplied by itself to produce a DC output, as well as a double frequency output which is removed by the following amplifier. The signal is fed into the two balanced inputs of the multiplier via the secondaries of a transformer T1. The bias point for each pair of inputs of the multiplier and the setting of the multiplier "tail" currents are obtained from a chain of resistors including R6, R7 and R8. The primary of T1 is tuned by means of C6 to 60kHz. This transformer is wound on a Mullard type RM6 core more details of which will be given later. Tr1 is a common emitter amplifier having T1 as its collector load and its input fed from the secondary of the ferrite rod aerial. The primary of the aerial is tuned by C1.

★ components list

Resistors

R1	22kΩ	R13	1MΩ
R2	33kΩ	R14	1MΩ
R3	180Ω	R15	1MΩ
R4	1·8kΩ	R16	15kΩ
R5	2·7kΩ	R17	180kΩ
R6	1·5kΩ	R18	2·7kΩ
R7	1·8kΩ	R19	1kΩ
R8	2·2kΩ	R20	470Ω
R9	100Ω	R21	150Ω
R10	100Ω	R22	10kΩ
R11	1·5kΩ ± 2% metal film	R23	82kΩ
R12	1·5kΩ ± 2% metal film		
VR1	200Ω cermet trimmer		

All resistors ¼W ± 5% carbon film (except R11 & 12)

Capacitors

C1	1·5nF Polystyrene	C8	56pF Polystyrene
C2	100nF Polycarb.	C9	100nF Polycarb.
C3	32μF or 47μF 10V	C10	100nF Polycarb.
C4	100μF 12V	C11	1nF Polystyrene
C5	32μF or 47μF 10V	C12	10μF 6·3V Tantalum
C6	4·7nF Polystyrene	C13	10nF Polycarb.
C7	100nF Polycarb.	C14	10nF Polycarb.

Semiconductors

Tr1	MPS-HO5 or BC183 or ZTX300	IC3	741
ZD1	BZY88C5V1 5·1V zener	IC4	741
IC1	N5596 or MC1496G or SG1496T	IC5	NE555
IC2	741		

Miscellaneous

Signal strength meter 100μA FSD. Ferrite rod aerial LW only, type LW5FR (Denco). T1, RM6 R Inductor core plus parts (Mullard)

Schmitt characteristic

Thus when a 60kHz signal is picked up and amplified by Tr1 it is applied to both inputs of the multiplier. This causes pin 6 of IC1 to go slightly positive and pin 9 slightly negative each with a 120kHz signal superimposed. IC2 then provides a great deal of amplification—about 625 times the differential input signal at DC. C11 and the amplifier's own frequency response ensure that the 120kHz component is removed. The stability of resistors R11 and R12 is important as any change in the value of one of these alone will cause a change in the output of IC2. Providing R11 and R12 change by the same amount there is no output change so they should preferably have matched temperature coefficients. The receiver will work with carbon film types here but if excessive drifting with wide temperature changes is experienced metal film type (not necessarily metal *oxide* types unless selected for matched coefficients) eliminate the drift.

DC level

VR1 is used to set the DC level at TP1 with no input signal at the aerial (i.e. aerial shorted). A 60kHz signal causes the level at TP1 to fall, while the following amplifier, IC4 has positive feedback to give it a Schmitt characteristic. A reference level for IC4's negative input is obtained from the bias chain that feeds the multiplier. The purpose of this stage is to make sure a definite change in signal level is required before an output swing from high to low or low to high can occur, hence obtaining the best possible performance in the presence of noise.

AGC action

Finally AGC is obtained from IC3. The output of IC3 controls the current in Tr1, and hence the gain of Tr1, by determining the voltage at the bottom end of R4. The positive input terminal of IC3 is taken to a reference obtained from a convenient level on the bias chain. IC2 attempts to adjust the gain of Tr1 in order to obtain the same level at TP1 as the reference level. Thus if the signal level falls, the voltage at TP1 rises causing current to flow into R14. The output of IC3 then falls slowly increasing the gain of Tr1, which returns the voltage at TP1 to the reference level (about 2·9V). When the carrier breaks for short periods, as for the seconds or minutes markers, IC3 starts to increase the receiver gain but is prevented from doing so very much by C12.

Note that on switch-on the receiver is in the minimum gain state with the output of IC3 high and gradually falling until the desired signal level is obtained. This normally takes only a few seconds, during which time the tone generator is continuously "on". The voltage to which the output of IC3 goes is a useful measure of signal strength and if desired a small meter measuring this level may be fitted.

Construction details

The PCB is shown in Fig. 3. Note that there are a total of four links on the circuit board to be fitted in addition to the components. Additionally, points 16 and 17 should be linked for a continuous output, if a switch is not fitted, as may be required if the receiver output is used to control circuits other than the on-board 555 timer.

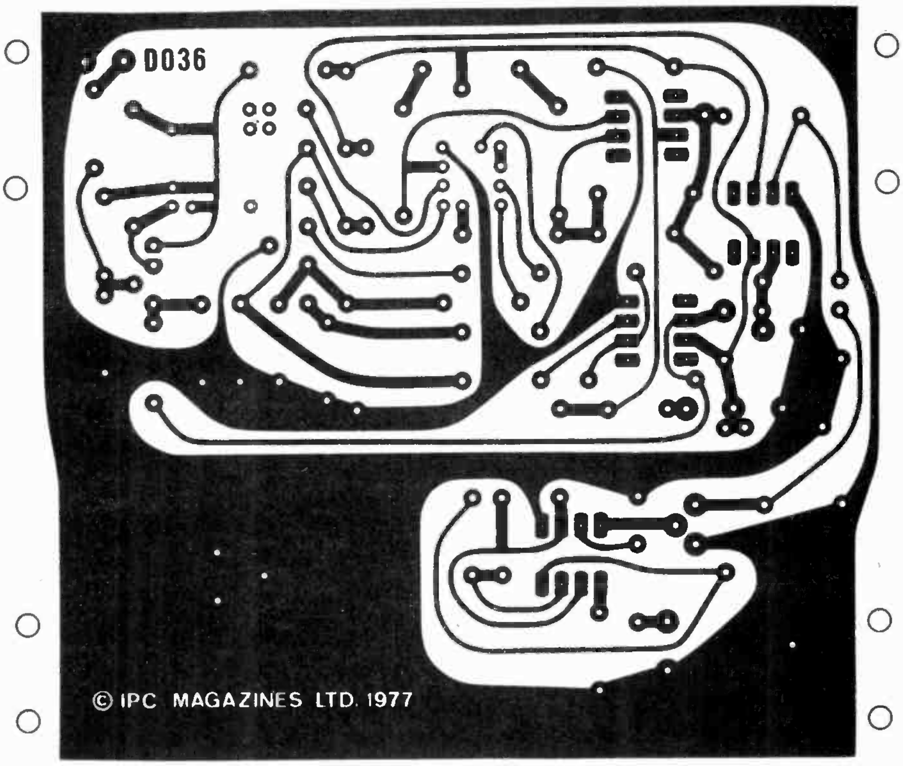
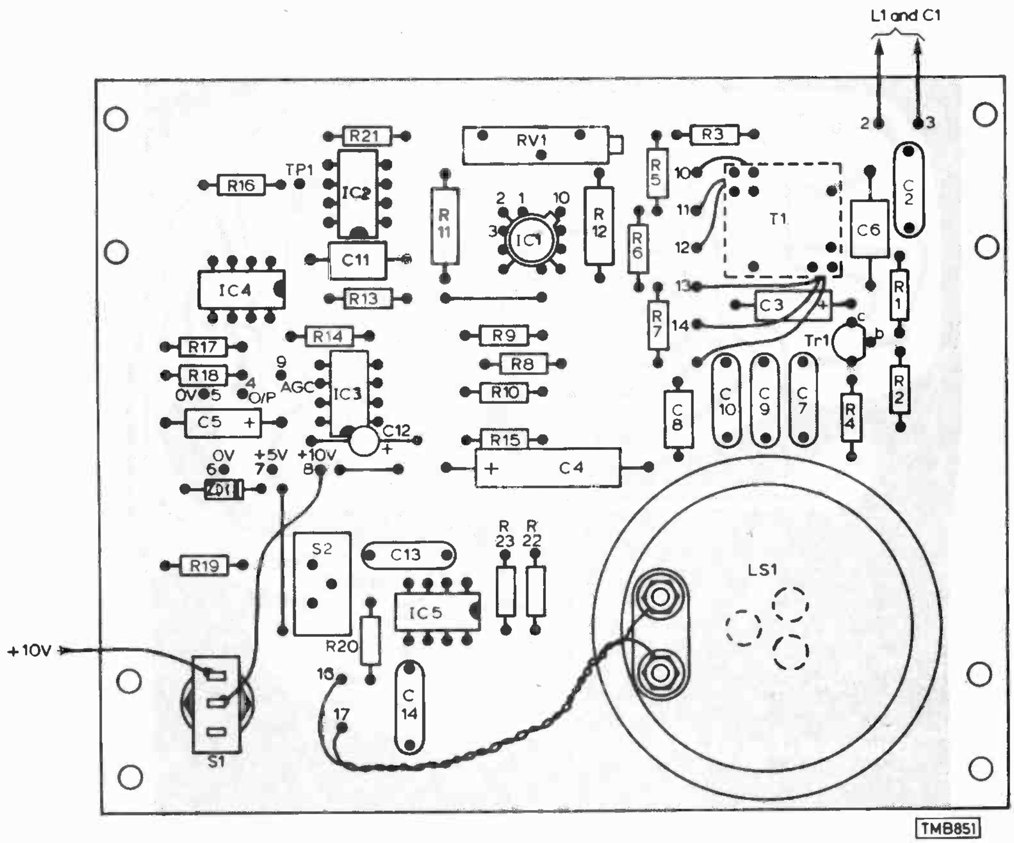


Fig. 3 (above): PCB copper side shown actual size.
Fig. 4 (below): PCB reversed showing component locations.



Note that the trimmer potentiometer VR1 is a minature multiturn type. It should have a *cermet* track for good resolution—the wirewound types of low resistance are difficult to adjust finely due to the incremental resistance of each turn of the track as the wiper traverses it. The ferrite rod aerial specified is a standard transistor radio type available from Denco (Clacton) Ltd. When ordering, specify a long wave coil only as this reduces the cost. The resonant frequency of the aerial can be trimmed by sliding the coil along the rod from its nominal position. It is important that the coil should not be near the end of the rod in its final position as the rate of change of inductance with position is too fast for good stability.

The coil on its former as received may be a loose fit on the rod, in which case it is a simple matter to first wind onto the rod sufficient "Sellotape" to achieve a firm but readily adjustable fit.

The transformer T1 has been designed using the Mullard RM6 core. The RM series of cores use bobbins to which pins are attached, so that a coil may normally be terminated on these before the two halves of the core are fitted. This is done for the primary only in our case, and the secondaries are left with flying leads to be connected directly to the PCB. The following instructions should be adhered to carefully, remembering that a 1 turn error is significant when the total number is small.

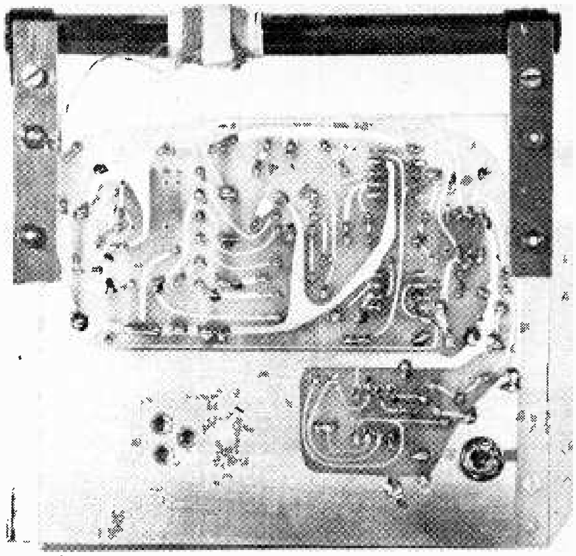
1. Strip enamel insulation from the wire end and attach the wire to the pin marked "start primary". Do not exert undue pressure on the pins which are mounted on a fragile base.
2. Fix the bobbin to a suitable mandril such as a twist drill; just over 6mm diameter is required which may be obtained by winding a thin layer of tape on a 6mm drill.

   Wind on wire evenly, top of bobbin moving towards you, with the pins facing to the right.
3. Complete 59 turns, cut wire, strip insulation and attach to "finish primary". Cover winding with 6mm wide tape.
4. Starting with wire in "slot 1" leave 30mm flying lead, identified as "start" by fitting sleeving or other means, and wind on 7 turns exactly turning in same direction as before. Form a loop 30mm long and twist the loop together: leave this a flying lead also in "slot 1". Continue to wind on a further 7 turns exactly, take the remaining end across to "slot 1" and leave 30mm flying lead. Wind on a turn of 6mm tape to fix the winding to the bobbin.
5. Repeat the procedure 4 above using "slot 2", which is on the same flange of the bobbin, facing "slot 1".

   The bobbin now has six flying leads which are in two groups of three, each of which has a start, centre tap and finish. Wire these to the PCB as indicated on the circuit.

After winding the coil, check that the faces of the two halves of the core are free from dirt and carefully assemble them round the coil. After fitting the clips make sure that the core halves are aligned at their edges. Fit the adjuster and screw it down 5 turns to the nominal position, using a screwdriver which fits the small slot—if necessary modify or make a screwdriver to fit (eg from a knitting needle) rather than risk damaging the adjuster.

Note that if the phasing of one of the secondary windings is reversed the output at TP1 will increase with increasing signal causing the AGC to latch the circuit up. If a mistake has been made in winding T1, all is not lost—simply reverse one of the secondary windings (eg swop the wire from 10 with the wire from 12).



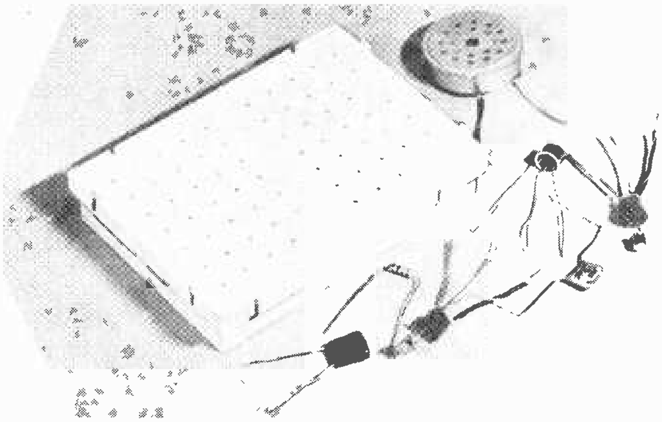
Setting up

The bandwidth of this receiver is about 300Hz which is of course much narrower than that of normal broadcast types. This is just sufficient to allow correct reproduction of the time code so that all the information transmitted is available at the receiver output and a wider bandwidth would merely admit more noise. Hence if a signal generator is used it will probably need to be set to 60kHz using a frequency counter: a 1 per cent error in frequency is 600Hz and therefore significantly off-tune. Fortunately the receiver can easily be adjusted to the "off-air" signal. First short-circuit points 2 and 3 to which the aerial secondary is connected. Switch on the receiver.

Depending on the initial setting of VR1 there will be either no output, or a continuous tone. If there is no output, turn VR1 clockwise until the continuous tone just appears. If there is already a continuous output on switching on turn VR1 anti-clockwise until the tone disappears and then clockwise about ¼ turn so that the tone has just been switched on again. There is of course no variation in the sound of the tone output—it is simply on or off. Un-short the aerial and make sure that the coil on it is in its nominal position. The signal will probably now appear.

The ferrite rod aerial is directional and maximum signal is obtained when the direction from which the received signal arrives is at right angles to the line of the aerial rod. If the rod is turned away from this direction a point may be found where the signal becomes noisy (the timer output intermittent instead of a pure tone). Reduce the noise to a minimum by tuning T1 and adjusting the aerial coil. If a voltmeter is available, connect it between 0V and the output of the AGC amplifier IC3. Adjust T1 and the aerial coil for a maximum reading on the voltmeter. Note that adjustments must be made slowly, due to the slow response of the AGC—otherwise the person making the adjustment becomes part of an unstable feedback loop!

S-DeCnology



DAVID GIBSON

9

THIS MONTH

'Light to Frequency Converter'

THERE are some circuits which can be used for a wide variety of applications, often with only minor modifications. This month's S-Dec project falls into that category. I can think of four applications (see later), but readers will doubtless think of others.

Circuit description

The project comprises a free-running multivibrator made up from transistors Tr1 and Tr2. The output from this oscillator is then fed directly to the base of Tr3, which in turn feeds the amplified signal to the loudspeaker in its emitter lead.

The frequency of a free-running or astable multivibrator is dependent upon the values of resistance and capacitance employed. In the circuit (Fig. 1) these components are the two capacitors, C1 and C2, and the resistors between the bases of the transistors Tr1/Tr2 and the positive rail. Resistor R3 is fixed at 47kΩ. However, the other base resistor, that of Tr1, is made up from a single fixed resistor R2 (12kΩ) and a light dependent resistor, LDR1. An LDR is simply a resistor whose exact ohmic value depends upon the amount of light falling on it. By using this element in the frequency determining section of a multivibrator, the intensity of light striking the LDR controls the frequency of oscillation. A bright light will cause a high note; shadow lowers the note quite considerably.

Transistor Tr3 acts as a direct-coupled voltage follower. It derives its drive signal from a potential divider formed by Tr2 and its collector load, R4. The remaining components, resistors R1 and LS1 form the loads for Tr1 and Tr3 respectively.

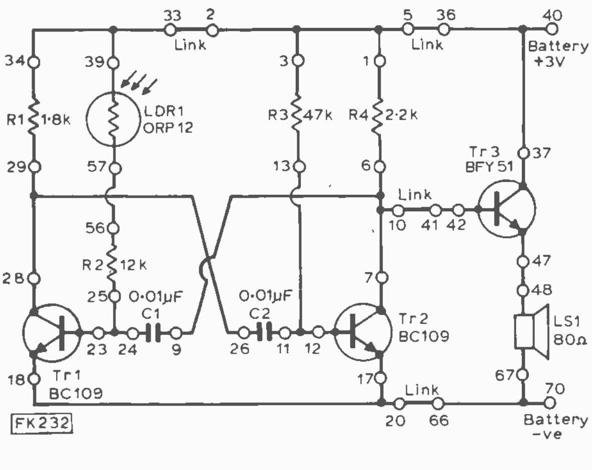


Fig. 1: Frequency-to-light converter circuit diagram. LDR1 controls C1 charging rate and hence the frequency of the oscillator.

Assembly and testing

Having plugged in all the components as per Fig. 1, check the assembled S-Dec against the component layout shown in Fig. 2. If all is in order, connect a 3V battery to S-Dec hole 40 (positive) and hole 70 (negative). A tone should be heard. Waving a hand in front of the LDR should vary the pitch of the note. Although a 3V battery was used with the prototype, the circuit will function perfectly from only 1·5V. On test, the prototype even worked at 0·5V! With 3V applied, the project draws some 15mA with the LDR pointed directly at bright

you will need . . . .

R1	1.8kΩ	C1	0·01μF
R2	12kΩ	C2	0·01μF
R3	47kΩ	Tr1	BC109
R4	2·2kΩ	Tr2	BC109
LDR1	ORP12	Tr3	BFY51
LS1	75 – 80Ω	B1	3V battery
One S-DeC			

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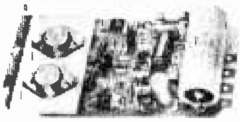

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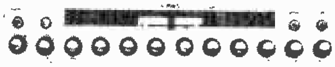

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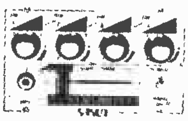

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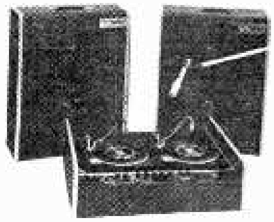

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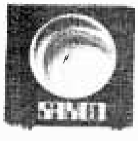

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light. In shadow, the current drops to around 1·5mA. Using 1·5V the 'bright light' current was measured as 6·5mA; in shadow it went down to 0·8mA—thus the battery should last a long time.

the seeker (blindfolded) wanders about with the LDR searching for the paper. Use dark paper if the carpet is light coloured. Continuing on this theme, a maze may be laid out and altered for each contestant.

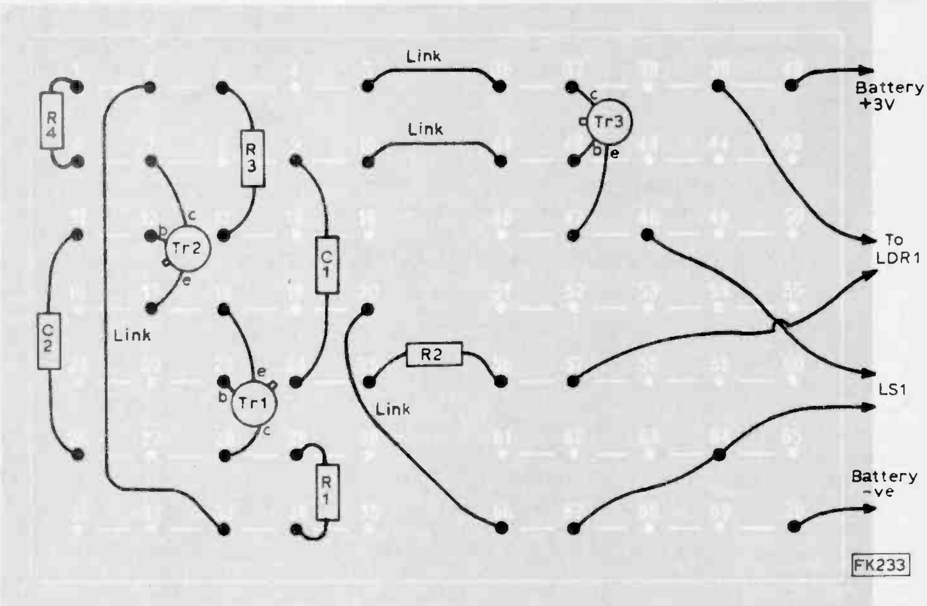
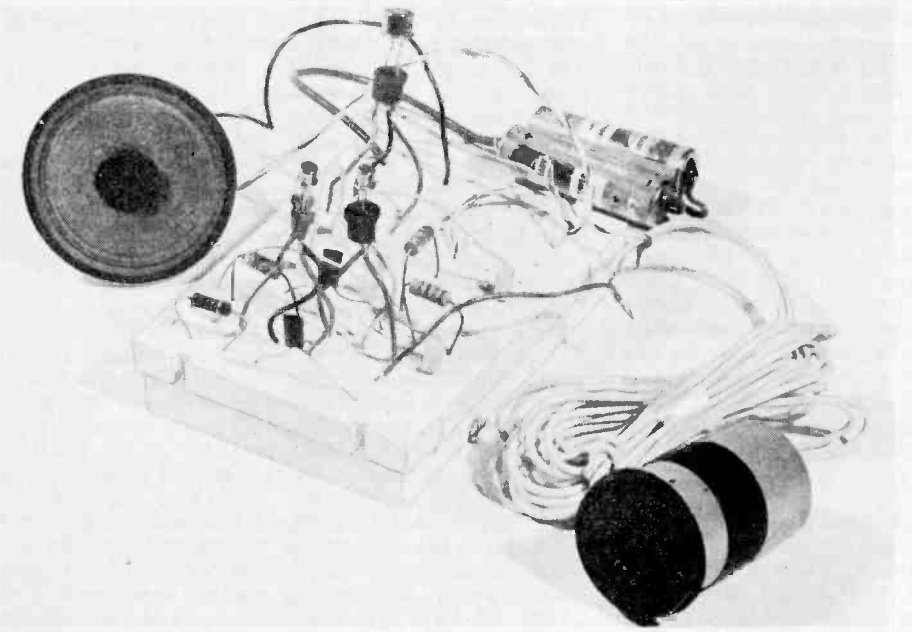


Fig. 2: Plan view of the assembled S DeC board. For more permanent construction, the components may be soldered directly on to Blobboard or Veroboard.



The assembled unit. The LDR is shown mounted in a plastic film can to give this component a narrower field of view. As a further refinement, a small lens may be fixed into the end cap with the LDR in the focal plane. This enables a high degree of differentiation between light and dark surfaces—even at a considerable distance.

Applications

The first application is that of a light-controlled mini-organ. By moving a light closer to or further from the LDR a tune can be played.

It is instructive to play "blind mans buff." By wearing a blindfold, it is possible to find the way around a room because the LDR, when pointed at different things, gives a different tone depending on the reflectivity of the object.

Treasure hunts might consist of pieces of white paper put on the floor. These are the treasure, and

In a more serious application, it could form a guard alarm. The trick here is to point the LDR at a light and adjust R2 until the note goes just above audibility. Anyone moving between LDR and light source will cause an audible note thus betraying their presence. Try using a 10kΩ potentiometer for R2.

The LDR will function much better if it is shielded in a container of some sort, such as a cigar tube or plastic film can. This prevents extraneous light from interfering with the pitch of the note. PW

ON THE AIR

AMATEUR BANDS

by Eric Dowdeswell G4AR

GOOD news from **Martin Sole,** long time correspondent of this column. He passed his RAE and is now G8NAT and active on 2m with SSB using a Liner 2 feeding an 8-element yagi beam. Martin is going on to get his code test and a 'full ticket' as he puts it. Congratulations Martin, and may you have many happy years on the air.

My request for info on the Crystal Calibrator No. 10 brought forth useful data from three readers, **J. P. Bell** of London N22, old friend **E. Kendall** G3APA and **C. Pettifer** of Slough, who tells me of some interesting 'DX' he worked with the old Army set 62 for which the calibrator was intended. Cliff very kindly offers to help anyone needing info on old Army sets. He can be found at 90 Uxbridge Road, Slough, Berks. But don't forget, lads, send return postage, a word of thanks and prompt return of anything loaned from Cliff. G3APA mentioned that SWM for Jan 1960 carried some info on mods to the filament circuit of the calibrator.

Michael Walker of Woodlesford, Leeds visiting RAF Locking was delighted to find G3RAF active and to listen to a few QSO's on 2m. Michael gets going on his studies for the RAE very soon so we wish you all the best OM. I was delighted to have a call at home from **Geoff Cole** G4EMN who had some business in Ashtead. He is secretary of the Wessex AR Group, mentioned before, and one forthcoming attraction is a visit to the School of Signals at Blanford on Sunday 24 July. Club net on 28.575MHz at 1030 Sundays or write to Geoff at 6 St. Anthonys Road, Bournemouth for more info, or ring 0202 20027.

Derek Gilbert and **Ian Horwill** share a receiver in Farnham, Surrey using a Heathkit SW717 and a long wire. The reply to queries on several prefixes must be my standard one! Send 35p to Geoff Watts 62 Belmore Road, Norwich for his invaluable prefix list. Cuts out all the guesswork and ensures that your prefix and country count is up-to-date and accurate. **D. F. Mathews** of 21 Portman Avenue, East Sheen, London SW 14 is very keen on direct conversion receivers and would appreciate any information on articles that have appeared on the subject. Some advance news of the North West Amateur Radio Convention to be run by the Lancaster ARS on Sept 17 and 18 next. Full info and booking forms from J. R. Morris Dept. of Physics, University of Lancaster, Bailrigg, Lancaster.

A first letter from **M. G. Hayman** BRS 37632 of London SE2 tells of his interest in SW listening and his intention to take the RAE this year. He started off with a HAC DX Mk2 set but now has a National NC120 with an ATU and 66ft inverted-L aerial. He would like to beg, borrow or buy any info or a manual on the NC120 so if you can help write to 'Woodleigh', 66 New Road, Abbey Wood, London SE2. **Robin Bayley** A9203 up in Shifnal, Shropshire is still logging the DX on his Eddystone EC10 and long wire, including A2, A6, and AP2 on Top Band! **Bob Firth** G3WWF got lumbered again with the job of scribe of the Wakefield and District ARS but I'm sure he enjoys his work really! A note to him at 6 Eastfield Drive, Woodlesford, Leeds or a ring to Leeds 825519 will bring all the gen on the society's activities. On 19 July G4DZU will talk on moonbounce and meteor scatter techniques while G3MFJ and Bob will be giving a lecture and demonstration of RTTY on 16 August.

Regular **Brian Harrison** has found the 10m band open down in Ore, Hastings with PY, CP, HC, PJ and ZP representing S. America. On 15m ZS3, CP, P2 (Surinam) and 9V1 were logged. Old friend **Alan Doherty** BRS34968, Portrush, Co. Antrim seems to have concentrated on the Pacific on 20m with 'dozens of KL7, KH6 and VE8! Alan operates the local marine VHF station around 156MHz and uses the same aerial system for 2m! Oscar 7 provided KL7, VE2 and W9 on the 2m downlink. Not bad when one remembers that the up link is on 432MHz! At the other extreme Alan now has 208 countries on 80m the latest being XT3, YS, A9, LU and TI.

In Cambridge **Dave Peck** BRS37621 reports a new type of QRM but this time he is causing it! Neighbours report QRM from the governor contacts on his RTTY machine! But this did not stop him from copying RTTY from A4, EA3, JA3, LA, OH, W and 9M2. Dave is starting up on 2m and is looking for a yagi to go with his rotator, cheap of course, and at least 10 elements. **Simon Robinson** in Stocksfield, Northumberland, kindly sent me an old 'give-away' dated October 1924 from *Popular Wireless*, which described how to make five 'special' crystal sets! Simon bought a pre-war Pilot radio set which only needed a couple of new electrolytics to get it going again. At 20p it was a cheap way to get on the SW bands! Now he has an ex-Army set and has given the Pilot away to an elderly invalid. But he still would like a proper communications receiver!

It was good to hear from **John Hodgson** (Morpeth) again after a long interval. He has progressed from a Mini-Clipper to a Realistic DX160 plus a 40ft long wire although John stuck to 20m and seems to have ignored the bandswitch! Pity! The log from **D. Waddell** located in Herne Bank was a joy to my eyes since the majority of the entries were for CW stations on 15 and 20m. In one period, 1145 to 1345, no less than 29 Japanese stations were copied on 15m CW. I'd like to hear from more of you who can copy CW and don't forget that there is often DX to be heard on CW when the SSB parts of a band seem to be dead.

Log Extracts

D. Waddell:— 20m CP3CN FM7WV FO8EI FY7AS HC1LT HK0BKX HK7UL JR6RRD (Okinawa) YS1O 9M8HF CP6EL FH8DF HH2MC TU2EF VS5MC 5U7AG **15m CE8AA CP6FN FG7AM TA1ZB UM8AX** CP6EL TR8SM 5N2NAS 5X5NK

J. Hodgson:— 20m CP6EL HC1BU HP2LT SV1FT (Crete) TT8SM VP2GAH VP9HS YB5AN ZF1MA 6Y5TD 8P6BN

D. Peck:— 20m RTTY A4XFW EA3OL IC8FHC JA3DAU K2CJP LA1K OH2HN WA1OFP WA8CZS 9M2CR **15m SSB** C5AAB HC5EE TU2GA **20m** HW6FIT KG6RT OY5J 5V4AH 9V4VV

A. Doherty:— 20m KM6FC KS6DV KX6BQ TU2GA VP8HZ VR1X VR3AK ZK1BA ZM7AT 3D2DM (Suva) 5V4AH 5W1AT **2m via Oscar 7** CT1WW KL7HDS SM2HDF VE2IB W2BXA W9SE

B. Harrison:— 10m CP6EL HC2HX LU9OA PJ2AAX ZP5AO **15m** A9XCC CP8AY P29AB 9V1RD **20m** CR4JR FO8RS HS1AKP TR8MG VR8N ZK1BA ZF1MA

R. Bayley:— A2GCO A6XO AP2AD **80m** CT2AP FP8DH OA8HF TG9HO **40m** AP2AD JA4AKU FP7EY **15m** VE7DIY VK9EV 6Y7PA

B. Harrison:— 10m AP2KS CE3EZ TR8WR VP2GAH ZP5AO **15m** C5AAB CX7DB JA8UI **20m** FO8EK FY7AN JW2CO (Bear Is.)

All SSB (or RTTY) except those in bold which are CW.

BROADCAST BANDS

MEDIUM WAVE DX

by Charles Molloy

"HOW does one QSL a broadcasting station" writes **Andrew Grendon** from Dun Laoghaire in the Irish Republic. The procedure, very briefly, is to send the station a reception report and hope that this will lead to a QSL card or verification letter in return. International broadcasters on the short waves are very pleased to receive letters from their listeners and provide colourful and interesting QSL cards and pennants for them. On the medium waves the DXer is usually outside the service area of his quarry and he really has the status of an eavesdropper! A lot more care then is required when writing to a medium wave station as one is depending on goodwill for a reply. Return postage in the form of an International Reply Coupon, obtainable from main post offices, should always be enclosed.

The object of the reception report, which is sent to the Chief Engineer, is to convince him that the DXer really did hear his station. Programme details, weather reports, commercials (jingles), station identification slogans, names of announcers, time checks, items of local news—the writer was able to give the name of the winner of a local beauty competition when writing to Radio ZDK in Antigua 1100kHz—these are the sort of items that should go into the report. The date, the time in either GMT or local time and of course the frequency in kHz should be mentioned. The report should end with a request for a confirmation of reception. The best time for obtaining programme information is during the period five minutes before the hour until five minutes after the hour, when programmes change and station identifications and commercials are broadcast.

"North American stations are good verifiers," writes **Ian Rennison** from Horsham in West Sussex. He mentions CKBW in Bridgewater Nova Scotia on 1000kHz whose Chief Engineer sent him an attractive QSL card, a two page sheet giving the history of the station, a paper mat printed in colour showing the coverage of CKBW, a leaflet giving a description of Bridgewater, a road map of the town and some tourist information of the area. Whew, all he wanted was a verie! Ian uses a Trio 9R59D receiver and a medium wave loop with differential amplifier. His log which covers the winter period includes 44 North American outlets plus Radio Belize on 834kHz; Radio Antilles, Montserrat on 930; Radio Jornal do Brasil on 940; Radio Margarita, Venezuela on 1020 and an unidentified broadcast heard at sunset on 1540kHz. The latter might be the Voice of Peace located in the Red Sea area and reported by a DXer in Cape Town in the June issue.

It is not essential to know the postal address when writing to stations in North America. "The Chief Engineer, WINS Radio, New York City, NY, USA" is typical of the format to use and station callsigns and the name of the town or city are broadcast frequently. When writing to other parts of the world is is usually better to use the postal address which can be found in the World Radio and TV Handbook, which comes out annually and can be ordered from bookshops.

Lawrence Bennett of Bristol is keen on obtaining QSL's. He reports receiving a QSL card from WINS on 1010 and WNEW on 1130. He says "I have been trying my hand at writing letters to stations in foreign languages and have had rather a good response." Radio Espana de Madrid, EAJ2 on 917kHz sent him a beautiful QSL card for a report in Spanish and Sud Radio Andorra 818kHz replied to a report in French with a card and two stickers. No need to be a linguist to write a report in a foreign language. Many DX clubs provide their members with report forms and vocabularies in various languages and all the DXer has to do is to fill-in the spaces with the appropriate details. A few years ago a German club produced a report form in Arabic which really was an achievement!

Tuning across the band, looking for interesting signals is the usual procedure adopted by DXers and a very good method it is too. New and unexpected broadcasts are heard this way. A few DXers tune to spot frequencies just to check on conditions. If CJON cannot be heard on 930 then it is unlikely that any other North American will be heard. There is a third, less known method of DXing and that is to tune to a chosen channel and remain on it waiting to see what comes up. Obviously the frequency should be selected with care.

Two interesting channels are 1484kHz and 1594kHz which, in the European area, are known as the International Common Frequencies. Large numbers of low power locals transmit here and in some parts of the UK they are used by local radio. On 1484 there are the American Forces (AFRTS) broadcasts from Iceland and Kenitra in Morocco as well as CSB90 in Madeira and Radio Gibraltar while 1594 has AFRTS in Athens, Manx Radio, Coimbra in Portugal and many others. In North America 1230, 1240, 1340, 1400 and 1490 are known among DXers as the Graveyard Channels and are the resting place of hundreds of local stations in the United States plus ZBM1 in Bermuda on 1230 and ZBM2 on 1340.

Each DXer will find his own favourite channels. For a start try 960kHz which is the home of CHNS in Halifax Nova Scotia, Radio Nacional Mendoza in Argentina, Radio Sutatenza in Colombia, Radio Victoria in Aruba (Netherland Antilles) which has programmes in English, and Music Radio in Hamilton Bermuda.

Radio Finland is now broadcasting its external service on two frequencies on the medium waves, 557kHz and 962kHz. The English programme which includes an item for DXers is on Thursdays and Saturdays at 2030GMT.

BROADCAST BANDS

SHORT WAVE BROADCASTS

by Derek Bell

THERE is a famous poem that thinks on things gone by and asks if there are still crumpets for tea, or words to that effect! A letter arrived chez Bell recently that asked if the Derby area had changed much. The writer **Harold Bailey**, now living in Cornwall, retired in 1965 after a lifetime's work in this area. Harold told tales of the old days of short wave DXing in the 1920's when "valves glowed like Blackpool illuminations" and one could hear America free of interference in the wee small hours. He also made a 6-inch TV set after Sutton Coldfield opened and was a member of the Derby local amateur radio society when it was known as the Derby and District 1911 club.

John Cook from Southend is also a long-time DX fan. He has reached the lofty heights of possessing a Grundig Sattelit and below is a handful of his loggings:—

4980	Radio Ghana at 2230
4990	Radio Nigeria at 2230
11765	FEBC at 0830
11835	4EVH at 2330
15335	Rad. Nac. de Colombia at 2235
15425	Radio Sri Lanka at 1230

We now devote a short time to QSL fans thanks to the good offices of **Roy Patrick** from Derby. He supplies this month's station information on WYFR the American Gospel station. They are building a new transmitter site 16 miles from Lake Okeechobee, Florida. The Scituate site will remain on the air until Florida is ready. They are also quoting a new address namely PO Box 157, London NW1, for QSL loggings. The other famous Gospel station HCJB, Quito, Ecuador has issued a new set of QSL cards showing transmitter equipment. Radio Canada have sent me their new card, in two shades of blue and white and it shows three examples of the Canadian communications satellites. These are the "Hermes", "Alouette" and "Anik" and along with the card goes a leaflet giving a brief technical description of each. This is another card that follows the RCI practice of having to be sent back to them for verification.

"What does 'DX' mean?" asks **R. J. Irvine** of Selly Oak. This is a question often asked, and the answer is that as initials they mean nothing. They are two letters chosen to stand for long-distance reception. In other words Radio New Zealand is DX reception for us in the UK compared to, say, Radio Nederland but as with many other initials they have tended to be applied to any distant station. *(How about "Distance Xtra"? A.E.D.)* R. J. also tempts me with the news that he has lashed up a SW set with two BC108's a 365pF varicap (?) and a coil. It sounds very simple so may I ask you to send me the diagram R.J. and then we can see if your loggings are justified.

The one great help that any DXer can have is a club. A friend of mine is convinced that DXers are hermits by nature but I have had a letter asking if I could mention a rapidly growing club namely the Twickenham DX Club, 37A Popes Grove, Twickenham, Middx., so with my compliments Gentlemen let's hope that the Hermit tag is a false one! **Mr. C. Slow** asks if he is allowed to submit reports to PW since his set is only a HMV domestic set with a 90ft aerial in the loft. This column, as I have mentioned before, is written by you, the readers, and I merely pass on the news and views of your good selves to others having the same interest. Many readers I am sure feel that they are not true DXers since they only possess domestic or portable sets. Many is the reader I have had send logs in from their home sets and then go on to be deeply involved and in some cases go on to the ultimate and take the RAE exam. Mr. Slow has some complimentary things to say about this column helping DXers for which my thanks.

Finally the latest edition of the Radio Berlin International newspaper has arrived and tucked away among the reports is their latest schedule. This shows that English is transmitted on 6080, 6115, 7185, 7300, 9730 and 7260 at 1830, 1930 and 2215, and with that I will close wishing you and yours best 73s.

VHF

by Ron Ham

IT shows the extent of amateur radio when a specialist column like this can report about readers activities from microwavelengths of 3cm to the relatively long wavelengths of 10m.

Many visitors to the RSGB exhibition at Alexandra Palace (May 6/8) were attracted to the lectures and demonstrations given by the Microwave Group, especially the reception of live TV pictures on 3cm (10GHz) from Ilford, 14km away. **Peter Kerry** G8ARO Farnham, tells me that "almost daily" he and his fellow enthusiasts hear of amateurs who are building gear for 10GHz and he is worried in case some give up in despair through the lack of a bit of advice or a trial QSO. He has asked me to say that any of the Southern Group would always seek to help a newcomer to microwaves. On April 24 G8ARO had a 59 contact with G3BNL/P over 60km between Hindhead and Old Reading on the GLC/Herts border, and again from Hindhead, on May 1st, he worked G8GKV/P and G3JHM/P, both 59, situated on Chanctonbury Ring, Sussex, a distance of

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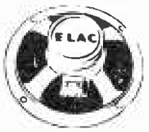

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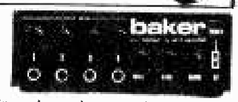

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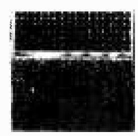

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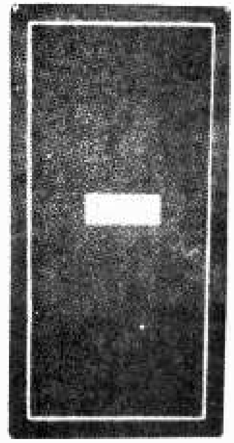

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34km. In four months operating, over a winter period, Peter has a 10GHz county score of six, from his regular site at Hindhead.

At 1908 on May 1st, **Nigel Golds,** BRS36910, West Chiltington, Sussex, received a 599 signal from 5B4CY on 10m, and I received strong signals from the German beacon, DL0IGI, at 1453 on the 11th, 1815 on 16th, 0815 on the 17th and 1345 on the 20th. The 10m band was open to CT, UK, YU, DJ and OK during the late afternoons of the 11th and 16th. Short skip conditions on 10m can often be linked with seasonal sporadic-E.

The first real opening of the 1977 sporadic-E "season" occured during the early morning of the 4th of May when 59+ signals poured into Sussex from about nine east-European broadcast stations, operating between 68 and 70MHz. On most days since late April there have been prolonged bursts of signals on the R1 vision channel, 49·75MHz, often accompanied by simultaneous bursts from Polish FM stations in the 4m band. Another region of the spectrum vunerable to sporadic-E disturbances is the 6/7m band, and, during the early mornings of the 4th, 11th, 16th and 17th May, many continental radio telephone signals were heard between 40 and 46MHz.

BROADCAST BANDS

Short Wave Reports by the 15th of the month to Derek Bell, 169 Max Rd., Chaddesden, Derby. **Medium Wave** Logs to Charles Molloy, 132 Segars Lane, Southport, PR8 3JG.

AMATEUR BANDS

Logs covering any amateur band/s in band/alphabetical order by the 25th of the month to **Eric Dowdeswell G4AR, Silver Firs, Leatherhead Road, Ashtead, Surrey, KT21 2TW.**

VHF

Reports on VHF matters to Ron Ham, Faraday, Greyfriars, Storrington, Sussex RH20 4HE.

Frank Luman, Glasgow, a Band II enthusiast, frequently heard Downtown Radio from Belfast on 96MHz during the first few days in May, which to him, is a good indicator of improved conditions. Frank has tried a variety of VHF arrays and is now considering giving a crossed yagi a try to improve his reception of those stations with circular polarisation. Keep us informed Frank, aerials are a most interesting subject.

Our regular contributor, **Alan Baker** G8LGQ Newhaven, who, incidently has been elected Chairman of the newly formed Brighton and District Radio Society, worked F, ON, PA and DJ in the 144MHz section of the IARU Region 1 contest on the 8th May. The best DX heard was a DM at 500 miles; although there was no indication of a tropo opening, Alan found the conditions most unusual. Both the Wrotham and French 2m beacons were below normal with him, yet there were frequent bursts of signals lasting about half a minute from the DX stations. Both Alan and myself monitored two brief tropospheric openings the first from late on the 17th to the early hours of the 18th and again from late on the 19th to early on the 20th. While our respective QTHs were linked by landline we heard a G station work LA6HL, strong signals from GW and from London stations who were beaming north. On the second occasion, we both heard strong signals from ON5NY, GW and northern G. Throughout each event I received a 569 signal from GB3EM on 70cms with only a dipole feeding my receiver.

Cmdr Henry Hatfield, Sevenoaks, observed a sunspot group and a plage on the 6th May and a small solar flare at 1027 on the 18th, with his spectrohelioscope. Both Henry and myself recorded bursts of solar radio noise at 136MHz on the 8th and G8LGQ heard the noise at 144MHz. There was an auroral alert during the evening of the 11th and **Charlie Newton** G2FKZ, London, said that some northern VHF signals were taking on an auroral tone. What about it readers, did you hear anything unusual that evening? G2FKZ, who is the RSGB auroral information co-ordinator, tells me that during the second phase of an aurora from about 2300 on May 2nd to 0130 on the 3rd, GM operators worked some 70 stations spread through 20 countries, including OH. Recent auroral activity reports, especially those containing beam headings, have made it possible for G2FKZ to establish a more definite auroral pattern.

From down under, another welcome letter from **Anthony Mann,** Applecross, W. Australia who says that conditions during April became unusually active. During the evening of the 11th a VHF trans-equatorial opening occurred and he received signals on R1 from two Chinese stations until about 1930 (local time). He was alerted to this opening at 1900 when there was a lot of activity from JA between 27 and 32MHz. On the 16th Anthony heard a South-Korean (KBS) station on 44·3MHz during the afternoon along with Russian stations on 38 and 44MHz. 10m was particularly active on the 11th and 16th and the International beacons 5B4CY, DL0IGI, and 3B8MS were heard around 1610 on the 6th. There was intense 10m activity on the 17th, but the MUF did not rise above 35MHz. Some sporadic-E disturbance was observed during the afternoon by a TV-DXer in NSW.

Thanks again for your most interesting reports. and believe me, they really are valuable.

KINDLY NOTE!

A 741 Signal Tracer July '77

In Fig. 1 and 4 one of the diodes D1/2 should be reversed to ensure that they are back-to-back.

Tele-Games June 1977

The mounting of the voltage regulator IC2 on the PCB, Fig. 6, is not too clear. The IC is mounted with the cooling fin **uppermost,** away from the PCB. The heatsink is made from a small piece of aluminium, bent at right angles, and bolted to the fin. See photograph on page 130.

RSGB CONVENTION 1977

Ron HAM, BRS 15744

THE success of the RSGB International Radio Communication Exhibition And Convention held at Alexandra Palace, London, over the week-end May 6-8, was obvious by the fact that some 6,000 people attended it. Both the Society, and John Hitchins G4FGN, who masterminded the whole affair, were justly rewarded by the enthusiasm of the visitors as they wandered around the 30 or so trade stands in the Grand Hall. The home constructor was especially catered for; he could buy anything from a host of small components, at reasonable prices, to a pneumatic mast and a super VHF array and rotor, to put on the top. In addition to the ever popular surplus gear, the traders were offering a wide range of the latest converters, receivers, transmitters and test gear, and, that all-important friendly bit of advice for their prospective customers.

There was something for everyone, films on Friday by ARRL, EMI-Varian, and RSGB, lectures on Saturday and Sunday on Aerials, Microwaves, Radio Astronomy, Raynet, RTTY, Synthesizers, the SWL, and VHF. Visitors could chat with HQ staff on the RSGB's own stand, visit the Society's book stall, or see the exhibitions by the Amateur Radio Mobile Society, British Amateur Television Group, RAIBC, RAYNET, AMSAT-UK, the Microwave and Propagation groups, and the Royal Corps of Signals.

At the dinner on Saturday evening, Mr R. W. Cannon, Technical Director Cable and Wireless, proposing the toast to the Society, referred to amateur radio as a national asset and said that he admired the way in which the "trade" had produced some very technical equipment at prices which most amateurs could afford. Replying, Dr John Allaway G3FKM Immediate Past President, thanked Cable and Wireless for supplying the regular HF propagation predictions for the Society's journal and he stressed the need for the RSGB to work with other national societies to persuade the newer countries to accept amateur radio. There was spontaneous applause from the 180 people present when Dr Allaway congratulated the Society's President, Lord Wallace of Coslany, on his appointment as the first Lord-in-Waiting to Her Majesty the Queen.

Proposing the toast to the Guests, among whom were representatives from France, Belgium, Yugoslavia and the USA, Dr Dain Evans G3RPE Executive Vice-President, spoke of the many sides to amateur radio and referred to Ed Tilton, W1HDQ, who gave one of the afternoon lectures, as "a legend in amateur radio". Replying for the guests, Dr J. A. Saxton, Director of the Appleton Laboratory, urged every radio amateur in the United Kingdom to give his wholehearted support to the RSGB and went on to congratulate all those responsible for this event at Alexandra Palace.

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ECC83	0·56
ECC84	0·63
ECC85	0·92
ECC88	0·96
ECC189	0·77
ECF80	0·90
ECF82	0·88
ECF86	0·78
ECH81	1·00
ECH83	1·06
ECH84	1·08
ECL80	0·80
ECL82	0·72
ECL83	0·93
ECL86	0·88
EF80	0·68

EF83	1·10
EF85	0·50
EF86	1·20
EF89	1·73
EF91	1·32
EF92	1·51
EF95	1·63
EF183	0·64
EF184	0·64
EH90	1·22
EL34	0·96
EL36	1·50
EL84	0·70
EL86	1·40
EL95	1·02
EM81	1·24
EY51	0·89
EY86	0·50
EY86/87	0·68
EY88	0·81
EZ80	0·60
EZ81	0·60
GY501	1·32
GZ34	1·24
OC83	0·60
PC86	1·08
PC88	1·08
PC97	0·88
PC900	0·92
PCC84	0·68

PCC85	1·02
PCC88	0·98
PCC89	1·05
PCC189	0·96
PCF80	0·72
PCF82	1·20
PCF86	0·92
PCF200	1·50
PCF201	1·50
PCF801	1·02
PCF802	0·72
PCF806	0·97
PCH200	1·73
PCL82	0·68
PCL83	0·92
PCL84	0·76
PCL85	0·72
PCL86	0·88
PCL805/850	0·80
PD500	3·00
PFL200	1·23
PL36	0·92
PL81	1·00
PL81A	1·00
PL82	0·48
PL83	1·73
PL84	0·84
PL500	0·96
PL504	0·96

PL508	1·32
PL509	2·16
PL802	1·80
PY33	0·68
PY81/800	0·72
PY82	0·70
PY86/7	0·70
PY88	0·68
PY500A	1·36
PY800	0·72
PY801	0·72
U26	1·15
U191	1·17
U193	0·56
UBC81	0·80
UBF89	0·65
UCC85	0·66
UCH81	1·73
UCL82	0·84
UCL83	1·02
UL84	1·23
UY85	0·80
6/30L2/ ECC804	1·20
6F23/EF812	1·32
30C1/PCF80	0·72
30C15/ PCF800	1·20

30C17	1·20
30C18/ PCF805	1·28
30F5/F818	1·00
30FL1/ PCE800	1·00
30FL2	1·00
30FL12	1·44
30FL14	1·28
30L1/PCC84	0·63
30L1/PCE800	0·68
30L15/ PCC805	1·32
30L17	1·32
30P4	0·92
30P4MR	1·63
30P1Z/ PC801	1·22
30P19/ PC802	0·92
30PL1/ PCL801	1·32
30PL13/ PCL800	1·44
30PL14/ PCL88	1·68
30PL15	1·44

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DK96	1·10
DL92	0·75
DL94	1·20
DY96	0·55
DY86	0·45
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DY802	0·47
EABC80	0·38
EAF42	0·70
EB91	0·30
EBC33	1·00
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ECC81	0·45
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ECC83	0·45
ECC84	0·50
ECC85	0·55
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ECL83	1·50
ECL86	0·65
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EF39	1·25
EF80	0·45
EF85	0·50
EF86 USSR	0·45

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EF89	0·60
EF91	0·65
EF92	0·75
EF95 USSR	0·30
EF95 UK	1·65
EF98	1·25
EF183	0·50
EF184	0·50
EL32	0·75
EL33	3·50
EL34	1·20
EL34 CH/SLOVACK	1·00
EL36	0·75
EL37	3·40
EL41	1·25
EL42	1·75
EL84	0·35
EL95	0·80
EM80	1·10
EM81	1·00
EM84	1·00
EM85	1·25
EM87	1·50
EY51	0·75
EY86	0·50
EZ40	1·25
EZ41	1·25
EZ80	0·30
EZ81	0·35
GY501	1·32
GZ30	0·65
GZ32	0·75
GZ34	0·80
HN309	1·50
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KT66	4·00
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KTW61	1·75
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PC88	0·85
PC97	0·55
PC900	0·75

PCC84	0·45
PCC88	0·65
PCC89	0·55
PCC189	0·65
PCF80	0·72
PCF82	0·50
PCF86	0·65
PCF801	0·55
PCF802	0·72
PCF805	1·28
PCF806	0·80
PCF808	1·28
PCL82	0·50
PCL83	0·92
PCL84	0·50
PCL85	0·60
PCL86	0·55
PCL805/85	0·80
PD500	3·00
PEN45	0·85
PL36	0·92
PL81	0·55
PL82	0·60
PL83	0·55
PL84	0·60
PL504	0·86
PL508	1·32
PL509	2·16
PL802	1·80
PY33	0·68
PY81	0·50
PY82	0·45
PY83	0·60
PY88	0·68
PY500A	1·36
PY81/800	0·50
PY801	0·72
U14	0·75
U25	1·00
U26	0·85
U191	0·75
UABC80	0·50
UAF42	0·70
UBC41	0·75
UBC81	0·50
UBF80	0·50
UBF89	0·50
UCC85	0·50
UCH42	1·00
UCH81	0·50

UCL82	0·50
UCL83	1·20
UL41	1·00
UF89	0·50
UL41	0·85
UL84	0·60
UY41	0·75
UY85	0·65
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1R5	0·55
1S5	0·40
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5R4GY	1·20
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6/3OL2	0·80
6AK5 USSR	0·30
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6K7M	0·75
6K8G	0·45
6K8M	0·75
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6L6GC	1·60
6Q7G	0·40
6Q7M	0·75
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6SN7GT	0·55
6SQ7GY	0·40
6U5G	2·00
6V6G	0·80
6V6GT	0·60
6X4	0·45
6X5G	0·45
6X5GT	0·55
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7B7	1·00
7C5	2·00
7C6	1·25
7H7	1·00
7R7	1·30
7S7	2·25
7Y4	0·75
12AT6	0·45
12AT7	0·45
12AU6	0·50
12AU7	0·45
12AX7	0·45
12BA6	0·50
12BE6	0·60
30C1	0·40
30C15	1·00
30C17	1·00
30C18	1·28
30F5	1·00
30FL1	1·00
30FL2	1·00
30FL14	1·28
30L15	0·95
30L17	0·95
30P4MR	1·30
30P12	1·00
30P19	0·95
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ACY18	0·65
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AD149	0·70
AD161	0·75
AD162	0·75
AF106	0·45
AF114	0·25
AF115	0·25
AF116	0·25
AF117	0·25
AF139	0·40
AF186	1·50
AF239	0·45
AFZ11	2·75
AFZ12	2·75
ASY26	0·45
ASY27	0·50
ASZ15	1·25
ASZ16	1·25
ASZ17	1·25
ASZ20	0·75
ASZ21	1·50
*AU113	1·70
*AUY10	1·70
*BA145	0·15
*BA148	0·15
BA154	0·10
BA155	0·12
BA156	0·13
BAW62	0·05
BAX13	0·07
BAX16	0·07
BC107	0·12
BC108	0·12
BC109	0·13
*BC113	0·15
*BC114	0·18
*BC115	0·19
*BC116	0·19
*BC117	0·22
*BC118	0·16
*BC125	0·18
*BC126	0·25
*BC135	0·15
*BC136	0·19
*BC137	0·16
*BC147	0·10
*BC148	0·10
*BC149	0·13
*BC157	0·12
*BC158	0·11
*BC159	0·13
*BC167	0·13
*BC170	0·16
*BC171	0·14
*BC172	0·13
*BC173	0·15
BC177	0·19
BC178	0·18
BC179	0·20
*BC182	0·11
*BC183	0·11
*BC184	0·12
*BC212	0·14
*BC213	0·14
*BC214	0·17
*BC237	0·17
*BC238	0·12
BC301	0·45
BC303	0·60
*BC307	0·20
*BC308	0·18
*BC327	0·22
*BC328	0·18
*BC337	0·19
*BC338	0·18
BCY30	1·00
BCY31	1·00
BCY32	1·00
BCY33	0·90
BCY34	0·90
BCY39	3·00
BCY40	1·25
BCY42	0·30
BCY43	0·32
BCY58	0·23
BCY70	0·18
BCY71	0·22
BCY72	0·17
BCZ11	1·50
BD115	0·60

BD121	1·50
BD123	1·50
BD124	1·00
BD131	0·51
BD132	0·54
*BD135	0·35
*BD136	0·36
*BD137	0·37
*BD138	0·40
*BD139	0·43
*BD140	0·47
BD144	2·00
BD181	1·38
BD182	1·48
BD237	0·80
BD238	0·85
BDX10	0·75
BDX32	2·25
BDY20	1·42
BDY60	0·75
BF115	0·39
BF152	0·25
BF153	0·25
BF154	0·25
BF159	0·35
BF160	0·30
BF167	0·39
BF173	0·39
BF177	0·38
BF178	0·45
BF179	0·48
BF180	0·45
BF181	0·45
BF182	0·45
BF183	0·45
BF184	0·39
BF185	0·37
*BF194	0·12
*BF195	0·11
*BF196	0·13
*BF197	0·14
BF200	0·32
*BF224	0·20
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BF257	0·37
BF258	0·42
BF259	0·45
*BF336	0·50
*BF337	0·53
*BF338	0·55
BFS21	2·27
BFS28	1·38
*BFS61	0·25
*BFS98	0·25
BFW10	0·90
BFW11	0·90
BFX84	0·38
BFX85	0·41
BFX87	0·35
BFX88	0·32
BFY50	0·28
BFY51	0·26
BFY52	0·26
BFY64	0·30
BFY90	1·32
BSX19	0·34
BSX20	0·34
BSX21	0·32
BT106	1·25
BTY79/400R	3·19
*BU205	2·25
*BU206	2·25
*BU208	2·50
BY100	0·45
BY126	0·14
BY127	0·15
BZX61 Series	0·20
BZY88 Series	0·13
CRS1/05	0·45
CRS1/40	0·60
CRS3/05	0·45
CRS3/40	0·75
CRS3/60	0·90
GEX66	1·50
GEX541	1·75
GJ3M	0·75
GJ5M	0·75
GJ7M	0·75
GM0378A	1·50
*KS100A	0·40
MJE340	0·58
MJE370	0·65
MJE371	0·81
MJE520	0·65
MJE521	0·75
MJE2955	1·25
MJE3055	0·75
*MPF102	0·30
*MPF103	0·30
*MPF104	0·30
*MPF105	0·30
*MPSA06	0·20
*MPSA56	0·20
*MPSU01	0·32
*MPSU06	0·40
*MPSU56	0·45
NKT401	2·00
NKT403	1·73
NKT404	1·73

NE555	0·45
OA5	0·75
OA7	0·55
OA10	0·55
OA47	0·14
OA70	0·30
OA79	0·30
OA81	0·30
OA85	0·30
OA90	0·08
OA91	0·08
OA95	0·08
OA200	0·10
OA202	0·11
OA210	0·75
OA211	0·75
OAZ200	0·65
OAZ201	0·65
OAZ206	0·65
OAZ207	0·65
OC16	1·25
OC20	2·00
OC22	2·50
OC23	2·75
OC24	3·50
OC25	0·90
OC26	0·90
OC28	2·00
OC29	2·00
OC35	2·50
OC36	1·50
OC41	0·50
OC42	0·50
OC43	1·50
OC44	0·50
OC45	0·50
OC71	0·45
OC72	0·45
OC73	1·00
OC74	0·50
OC75	0·60
OC76	0·50
OC77	1·20
OC81	0·75
OC81Z	1·00
OC82	0·75
OC83	0·55
OC84	0·60
OC122	1·50
OC123	1·55
OC139	1·25
OC140	1·95
OC141	2·25
OC170	0·60
OC171	0·60
OC200	1·00
OC201	1·50
OC202	1·25
OC203	1·25
OC204	1·25
OC205	1·75
OC206	1·75
OC207	1·25
OCP71	1·25
ORP12	0·70
*R2008B	2·25
*R2009	2·25
*R2010B	2·25
T1C44	0·36
T1C226D	1·30
T1L209	0·25
*T1P29A	0·50
*T1P30A	0·60
T1P31A	0·62
T1P32A	0·75
T1P33A	1·00
T1P34A	1·20
T1P41A	0·70
T1P42A	0·90
T1P2955	1·00
T1P3055	0·50
*T1S43	0·35
*ZS140	0·25
*ZS170	0·12
*ZS178	0·54
*ZS271	0·22
*ZS278	0·56
*ZTX107	0·11
*ZTX108	0·10
*ZTX109	0·12
*ZTX300	0·12
*ZTX301	0·13
*ZTX302	0·17
*ZTX303	0·17
*ZTX304	0·19
*ZTX311	0·12
*ZTX314	0·20
*ZTX500	0·13
*ZTX501	0·14
*ZTX502	0·16
*ZTX503	0·17
*ZTX504	0·20
*ZTX531	0·20
*ZTX550	0·16
1N914	0·07
1N916	0·07
1N4001	0·06
1N4002	0·07
1N4003	0·08
1N4004	0·09
1N4005	0·13
1N4006	0·15
1N4007	0·15
1N4009	0·15

1N4148	0·07
1N5400	0·14
1N5401	0·16
1S44	0·06
1S920	0·08
1S921	0·08
2G301	1·00
2G302	1·00
SG306	1·10
2N404	0·60
2N696	0·25
2N697	0·16
2N698	0·30
2N705	0·80
2N706	0·12
2N708	0·21
2N930	0·26
2N1131	0·26
2N1132	0·26
2N1302	0·37
2N1303	0·37
2N1304	0·45
2N1305	0·45
2N1306	0·50
2N1307	0·50
2N1308	0·60
2N1309	0·60
2N1613	0·33
2N1671	1·50
2N1893	0·33
2N2147	1·40
2N2148	1·65
2N2218	0·33
2N2219	0·42
2N2220	0·35
2N2221	0·22
2N2222	0·25
2N2223	2·75
2N2368	0·17
2N2369A	0·21
2N2484	0·21
2N2646	0·50
2N2904	0·35
2N2905	0·35
2N2906	0·25
2N2907	0·21
*2N2924	0·15
*2N2925	0·17
*2N2926	0·13
2N3053	0·25
2N3054	0·50
2N3055	0·65
2N3440	0·60
2N3441	0·80
2N3442	1·20
2N3525	0·90
2N3614	1·20
*2N3702	0·15
*2N3703	0·15
*2N3704	0·15
*2N3705	0·15
*2N3706	0·14
*2N3707	0·18
*2N3708	0·14
*2N3709	0·15
*2N3710	0·14
*2N3711	0·15
2N3771	1·60
2N3772	1·70
2N3773	2·65
*2N3819	0·36
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*2N3823	0·60
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*2N3904	0·21
*2N3905	0·22
*2N3906	0·22
*2N4058	0·20
*2N4059	0·15
*2N4060	0·20
*2N4061	0·17
*2N4062	0·18
*2N4124	0·17
*2N4126	0·17
*2N4286	0·20
*2N4288	0·25
52N4289	0·25
*2N5457	0·35
*2N5458	0·35
*2N5459	0·35
3N125	1·75
3N141	0·85
7400	0·20
7401	0·20
7402	0·20
7403	0·20
7404	0·26
7405	0·23

7406	0·55
7407	0·55
7408	0·28
7409	0·28
7410	0·20
7412	0·26
7413	0·45
7416	0·40
7417	0·40
7420	0·20
7422	0·25
7423	0·35
7425	0·35
7427	0·35
7428	0·50
7430	0·20
7432	0·36
7433	0·37
7437	0·42
7438	0·37
7440	0·22
7441AN	0·92
7442	0·78
7447AN	1·20
7450	0·20
7451	0·20
7453	0·20
7454	0·20
7460	0·20
7470	0·35
7472	0·36
7473	0·36
7474	0·40
7475	0·59
7476	0·42
7480	0·60
7482	0·85
7483	1·00
7484	1·00
7486	0·40
7490	0·52
7491AN	0·85
7492	0·60
7493	0·70
7494	0·80
7495	0·80
7496	0·90
7497	3·67
74100	1·75
74107	0·45
74109	0·86
74110	0·57
74111	0·86
74116	1·89
74118	0·95
74119	2·00
74120	1·10
74121	0·45
74122	0·60
74123	1·00
74125	0·80
74126	0·80
74128	0·80
74132	0·80
74136	0·68
74141	0·85
74142	3·00
74143	3·00
74144	3·00
74145	1·00
74147	2·45
74148	2·00
74150	1·75
74151	0·90
74154	2·00
74155	0·90
74156	0·90
74157	0·90
74159	2·50
74170	2·60
74172	5·00
74173	1·75
74174	1·57
74175	1·00
74176	1·10
74178	1·65
74179	1·65
74180	1·65
74190	1·48
74191	1·48
74192	1·25
74193	1·25
74194	1·25
74195	1·10
74196	1·20
74197	1·00
74198	2·25
74199	2·25
*76013N	1·75

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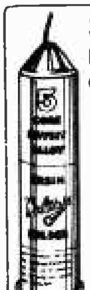

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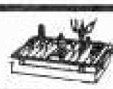

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200	0·35	0·50	0·45	0·40	0·58	0·60	0·68	1·14	—
400	0·40	0·60	0·50	0·45	0·87	0·88	0·98	1·40	—
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TRIACS—Plastic TO-220 Package Isolated Tab

	4A (a)	4A (b)	6·5A (a)	6·5A (b)	8·5A (a)	8·5A (b)	10A (a)	10A (b)	15A (a)	15A (b)
100V	0·60	0·60	0·70	0·70	0·78	0·78	0·83	0·83	1·01	1·01
200V	0·64	0·64	0·75	0·75	0·87	0·87	0·97	0·01	1·17	1·17
400V	0·77	0·78	0·80	0·83	0·97	1·01	1·13	1·19	1·70	1·74
600V	0·96	0·99	1·01	1·10	1·21	1·26	1·42	1·50	2·11	2·17

N.B.—(a) without internal diac. (b) with internal diac.

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7412	0·25
7413	0·40
7414	0·72
7417	0·43
7420	0·16
7425	0·30
7427	0·30
7430	0·16
7432	0·28
7437	0·80
7441AN	0·76
7442	0·65
7445	0·90
7447AN	0·81
7448	0·81
7470	0·32
7472	0·26
7473	0·30
7474	0·32
7475	0·47
7476	0·36
7480	0·55
7482	0·75
7486	0·32
7489	2·02
7490AN	0·49
7491AN	0·65
7492	0·57
7493	0·45
7494	0·85
7495	0·67
7496	0·82
74100	1·07
74107	0·35
74121	0·34
74122	0·47
74123	0·65
74141	0·78
74145	0·68
74154	1·30
74164	0·93
74165	0·93
74174	1·40
74175	0·94
74180	1·06
74181	2·70
74191	1·33
74192	1·20
74193	1·35
74194	1·20
74196	1·64

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301A	0·40*
307	0·55*
380	0·90*
381	1·60*
3900	0·70*
709	0·27
741	0·28
748	0·35
NE555	0·45
NE565	2·00*
NE566	1·50*
NE567	2·00*
CA3045	0·85*
CA3046	0·80*
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MC1351P	1·20*
MC1352P	0·75*
MC1353P	0·75
MC1458P	0·77
MC1496L	0·82*
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SAS570	2·25
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TAA310A	1·38
TAA550	0·45*
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TAA861	0·65
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BA148	0·13*
BA155	0·13
BA156	0·12
BA157	0·22
BA158	0·22
BA159	0·25
BY206	0·15
BY207	0·20*
BYX36-300	0·12
BYX36-600	0·15

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BYX36-1200	0·21
BYX38-300	0·50
BYX38-600	0·55
BYX38-900	0·60
BXY38-1200	0·65
BZX61 Series	0·26
BZX83 Series	0·11
BZY88 Series	0·11
OA5	0·50*
OA10	0·40
OA85	0·12
OA90	0·08
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OA200	0·09
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AC128	0·16
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AC141K	0·34
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AC142K	0·32
AC176	0·16
AC176K	0·32
AC187	0·18
AC187K	0·36
AC188	0·18
AC188K	0·32
AD149	0·45
AD161	0·35
AD162	0·35
AF114	0·20
AF115	0·20
AF116	0·20
AF117	0·20
AF118	0·50
AF124	0·25
AF125	0·25
AF126	0·25
AF139	0·35
AF239	0·37
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AL103	1·30
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AU110	1·75*
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BC107B	0·12
BC108	0·12
BC108B	0·12
BC109	0·12
BC109B	0·12
BC109C	0·15
BC117	0·19*
BC119	0·25
BC125	0·18*
BC126	0·20*
BC140	0·32
BC141	0·28
BC142	0·23
BC143	0·23
BC147	0·09*
BC148	0·09*
BC149	0·09*
BC157	0·09*
BC158	0·09*
BC159	0·09*
BC160	0·32
BC161	0·38
BC168	0·09*
BC169	0·12*
BC169C	0·14*
BC182	0·11*
BC182L	0·12*
BC183	0·10*
BC183L	0·10*
BC184	0·11*
BC184L	0·12*
BC186	0·20*
BC187	0·24*
BC207B	0·12*
BC212	0·11*
BC212L	0·12*
BC213	0·12*
BC213L	0·14*
BC214	0·14*
BC214L	0·15*
BC237	0·16*
BC238	0·16*
BC300	0·34
BC301	0·32
BC302	0·40
BC303	0·48
BCY30	0·55
BCY31	0·55
BCY32	0·60
BCY33	0·55
BCY34	0·55
BCY38	0·50
BCY39	1·15
BCY40	0·75
BCY42	0·30
BCY54	1·60
BCY70	0·12
BCY71	0·18
BCY72	0·12
BD115	0·55
BD131	0·36
BD132	0·40
BD135	0·36*
BD136	0·39*
BD137	0·40*
BD138	0·48*
BD139	0·58*
BD144	2·20
BD157	0·60
BD181	0·86
BD182	0·92
BD183	0·97
BD184	1·20
BD232	0·60
BD233	0·48
BD237	0·55
BD238	0·60
BD410	0·60
BDX32	2·30
BDY10	1·50
BDY11	2·00
BDY20	0·80
BDY38	0·60
BDY60	1·70
BDY61	1·65
BDY62	1·15
BDY95	2·14
BDY96	4·96
BF179	0·30
BF180	0·30
BF181	0·30
BF182	0·30
BF183	0·30
BF184	0·20
BF185	0·20
BF194	0·10*
BF196	0·12*
BF197	0·12*
BF224J	0·18*
BF244	0·17*
BF257	0·30
BF336	0·35*
BF337	0·32*
BF338	0·45*
BFW30	1·25
BFW59	0·30
BFW60	0·36
BFX29	0·26
BFX30	0·30
BFX845	0·23
BFX8	0·25
BFX86	0·25
BFX87	0·20
BFX88	0·20
BFX89	0·90
BFY11	1·10
BFY18	0·50
BFY40	0·50
BFY41	0·60
BFY50	0·20
BFY51	0·18
BFY52	0·19
BFY53	0·25
BFY64	0·35
BFY90	0·90
BSX19	0·16
BSX20	0·18
BSX21	0·20
BSY52	0·28
BSY53	0·39
BSY54	0·33
BSY55	0·74
BSY65	0·30
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BSY78	0·75
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BU204	1·60*
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MJ490	0·90
MJ491	1·15
MJE340	0·40*
MJE520	0·45
MJE521	0·55
OC43	0·95
OC44	0·32
OC45	0·32
OC46	0·20
OC70	0·30
OC71	0·35
OC72	0·22
OC84	0·40
OC139	1·30
OC140	1·30
OC170	0·23
TIP29A	0·44*
TIP30A	0·52*
TIP41A	0·54
TIP32A	0·64
TIP41A	0·68
TIP42A	0·72
2N404	0·40
2N696	0·20
2N697	0·20
2N706	0·15
2N1131	0·15
2N1132	0·16
2N1302	0·40
2N1303	0·40
2N1304	0·45
2N1305	0·45
2N1306	0·50
2N1307	0·50
2N1308	0·60
2N1309	0·60
2N1711	0·24
2N2102	0·44
2N2217	0·30
2N2369	0·14
2N2369A	0·14
2N2483	0·20
2N2484	0·16
2N2646	0·50
2N2711	0·20
2N2712	0·15
2N2904A	0·20
2N2905	0·18
2N2905A	0·22
2N2906	0·18
2N2925	0·14*
2N2926O	0·09*
2N2926R	0·10*
2N2926Y	0·09*
2N2926G	0·10*
2N3053	0·20
2N3055	0·50
2N3137	1·10
2N3440	0·56
2N3442	1·20
2N3570	3·60
2N3702	0·10*
2N3703	0·10*
2N3704	0·10*
2N3705	0·10*
2N3706	0·10*
2N3707	0·10*
2N3708	0·09*
2N3709	0·09*
2N3710	0·10*
2N3711	0·10*
2N3715	1·70
2N3716	1·80
2N3771	1·60
2N3772	1·90
2N3773	2·10
2N3819	0·28*
2N4347	1·10
2N4348	1·20
2N4870	0·35*
2N4871	0·35*
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4010BE	0·52
4011BE	0·20
4012BE	0·20
4013BE	0·50
4014BE	1·00
4015BE	0·95
4016BE	0·54
4017BE	1·00
4018BE	1·10
4019BE	0·50
4020BE	1·12
4021BE	1·03
4022BE	0·95
4023BE	0·20
4024BE	0·86
4025BE	0·20
4026BE	1·55
4027BE	0·62
4028BE	0·91
4029BE	1·10
4030BE	0·55
4041BE	0·80
4042BE	0·83
4034BE	1·00
4044BE	0·94
4046BE	1·32
4049BE	0·54
4050BE	0·54
4069BE	0·30
4070BE	0·50
4071BE	0·26
4072BE	0·26
4081BE	0·20
4082BE	0·26
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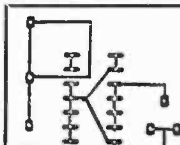

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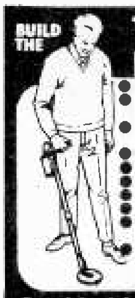

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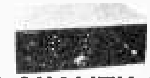

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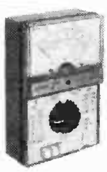

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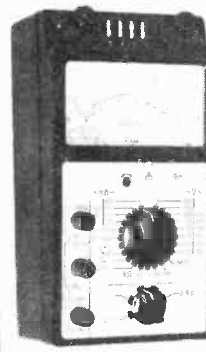

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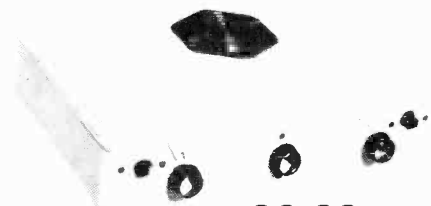

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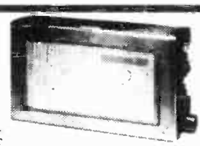

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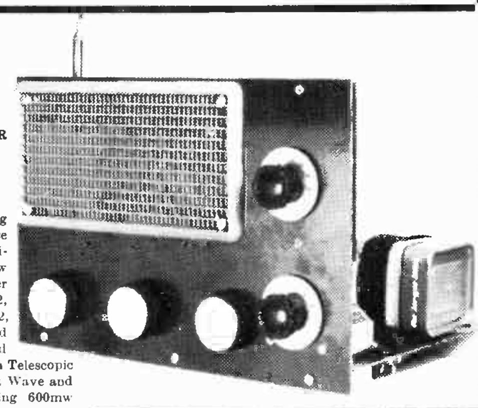

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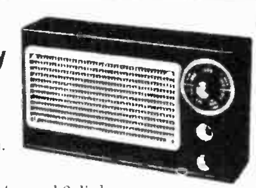

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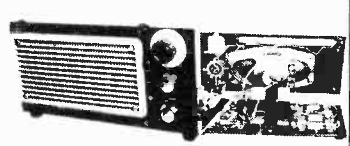

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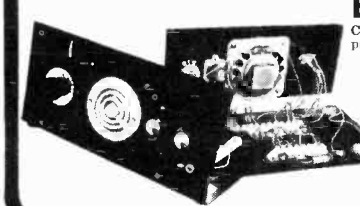

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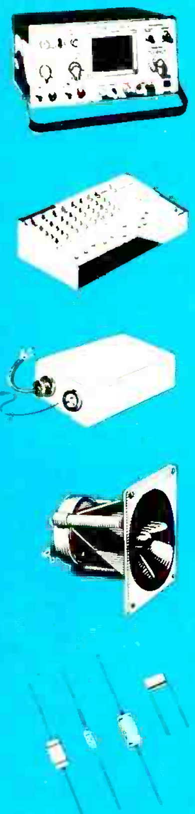

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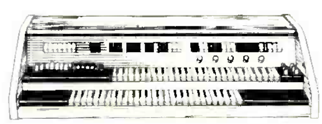

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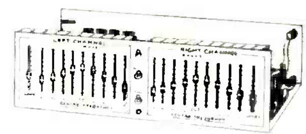

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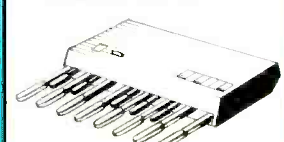

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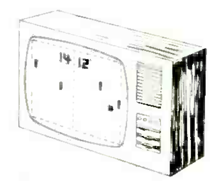

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