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MARCH 1980

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ELECTRONICS

VOLUME 16 No. 3 MARCH 1980

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NEWS AND COMMENT

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OUR APRIL ISSUE WILL BE ON SALE FRIDAY, 14 MARCH 1980
(for details of contents see page 61)

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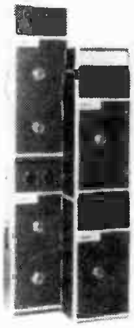

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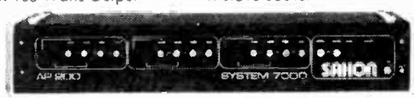

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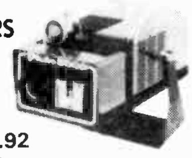

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Supply for 1 module **£17.19**
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FEATURES INCLUDE:
Twin Deck – Mic & Tape Inputs – Wide range bass & treble controls – Full headphone monitoring – Crossfade – Professional standard performance.

COMPLETE MIXERS (with case)
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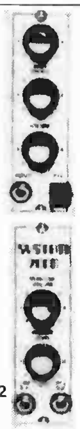

Make your own mixer Mono/Stereo up to 20 channels accept all inputs available as PCB only or complete on front panels

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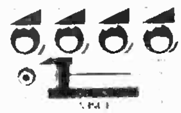

3 CHANNEL – 3kW **£33.92**
- ☐ Operates from 1W upwards
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+ £1 carr. complete

Module only **£22.71**
Panel **£3.39**

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£46.57
- ☐ Dimmer on each channel
- ☐ Automatic sound light level
- ☐ Logic circuitry throughout

Module only **£30.76** Panel **£3.39**

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CALLERS ONLY – (061) 832 8772 – COMPLETE UNITS ONLY

QUARTZ LCD 5 Function

Hours, mins., secs., month, date, auto calender, back-light, quality metal bracelet.

£6.65

Guaranteed same day despatch.
Very slim, only 6mm thick.

M1

SOLAR QUARTZ LCD 5 Function

Genuine solar panel with battery back-up. Hours, mins., secs., day, date. Fully adjustable bracelet. Back-light. Only 7mm thick.

£8.65

Guaranteed same day despatch.

M2

QUARTZ LCD 11 Function SLIM CHRONO

6 digit, 11 functions. Hours, mins., secs., day, date, day of week. 1/100th, 1/10th, secs., 10X secs., mins., Split and lap modes. Back-light, auto calendar. Only 8mm thick. Stainless steel bracelet and back. Adjustable bracelet. Metac Price

£9.55 Thousands sold!
Guaranteed same day despatch.

M3

QUARTZ LCD ALARM 7 Function

Hours, mins., secs,. month, date, day. 6 digits, 3 flags plus continuous display of day and date or seconds. Back-light Only 9mm thick.

£9.55

Guaranteed same day dispatch.

M4

MULTI ALARM 6 Digits 10 Functions

- Hours, mins., secs.
- Months, date, day.
- Basic alarm.
- Memory date alarm.
- Timer alarm with dual.
- Time and 10 country zone.
- Back-light.
- 8mm thick.

£18.65

M5

FRONT-BUTTON Alarm Chrono Dual Time

6 digits, 5 flags, 22 functions. Constant display of hours and mins., plus optional seconds or date display. AM/PM indication, month, date. Continuous display of day. Stop-watch to 12 hours 59·9 secs., in 1/10 second steps. Split and lap timing modes. Dual time zones. Only 8mm thick. Back-light. Fully adjustable open bracelet.

£19.95

Guaranteed same day dispatch

M6

SOLAR QUARTZ LCD Chronograph with Alarm Dual Time Zone Facility

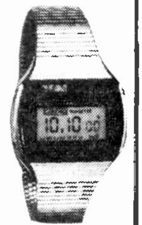
6 digits, 5 flags. 22 functions. Solar panel with battery back-up. 6 basic functions. Stop-watch to 12 hours 59·9 secs., in 1/10 sec., steps. Split and lap timing modes. Dual time zones. Alarm. 9mm thick. Back-light. Fully adjustable bracelet.

£17.95

M7

ALARM CHRONO with 9 world time zones

- 6 digits, 5 flags.
- 6 basic functions.
- 8 further time zones.
- Count-down alarm.
- Stop-watch to 12 hours 59·9 secs. in 1/10 sec. steps.
- Split and timing modes.
- Alarm.
- 9 mm thick.
- Back-light.
- Fully adjustable bracelet.



£24.55

M8

SOLAR QUARTZ LCD Chronograph

Powered from solar panel with battery back-up. 6 digit, 11 functions. Hours, mins., secs., day, date, day of week. 1/100th, 1/10th, secs., 10X secs., mins. Split and lap modes. Back-light, auto calendar. Only 8mm thick. Stainless steel bracelet and back. Adjustable bracelet. Metac Price

£11.55

Guaranteed same day despatch.

M9

QUARTZ LCD Ladies Day Watch

Only 25 x 20mm and 6mm thick. Hours, minutes, seconds, day, date, backlight and auto calendar. Elegant metal bracelet in silver or gold fully adjustable to suit very slim wrists. State colour preference.

£7.55

Guaranteed same day despatch.

M15

QUARTZ LCD Ladies Fashion Watch

Elegant bracelet in bronze/gold finish or silver colour. Hours, mins, secs, day, date, backlight and auto calendar. Adjustable for the slimmest of wrists. State colour preference.

£14.95

Guaranteed same day despatch

M17

QUARTZ LCD Ladies Cocktail Watch

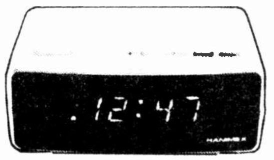
Highly functional watch which also suits those special occasions. Beautifully designed with a very thin bracelet which retains strength as well as elegance. Hours, mins, secs, day, date, backlight and autocalendar. Bracelet fully adjustable to suit slim wrists. State gold or silver finish.

£15.55

Guaranteed same day despatch

M18

HANIMEX Electronic LED Alarm Clock



Features and Specification
Hour/minute display Large LED display with p.m. and alarm on indicator 24 Hours alarm with on off control Display flashing for power loss indication Repeatable 9 minute snooze Display bright dim modes control Size 5.15" x 3.93" x 2.36" (131mm x 11mm x 60mm) Weight 1.43 lbs (0.65 kg) AC power 220V.

£10.20 Thousands sold!

Mains operated.

Guaranteed same day despatch.

M13

EXECUTIVE ALARM WATCH

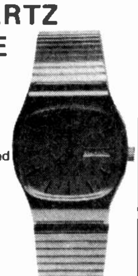
6 Functions plus Alarm: Conference signal, 5 minute snooze alarm. Conference signal sounds 4 secs., before main alarm to give advance warning and an option to cancel. Snooze sounds 5 mins., after main alarm and is always preceeded by the conference signal.

£12.55

M60

MACY QUARTZ ANALOGUE

Automatic Calendar Day and Date infinite bracelet. This mans watch has elegance as well as the robust appearance provided by a watch with traditional features. Accuracy is provided by a quartz crystal powered by a long life miniature battery.

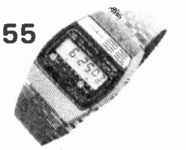


£24.95

M21

Metac price breakthrough for an Alarm Chronograph with Dual Time only

£13.55



OUTSTANDING FEATURES

- **DUAL TIME.** Local time always visible and you can set and recall any other time zone (such as GMT). Also has a light for night viewing.
- **CALENDAR FUNCTIONS** include the date and day in each time zone.
- **CHRONOGRAPH/STOPWATCH** displays up to 12 hours, 59 minutes, and 59.9 seconds.
- On command, stopwatch display freezes to show intermediate (split/lap) time while stopwatch continues to run. Can also switch to and from timekeeping and stopwatch modes without affecting either's operation.
- **ALARM** can be set to anytime within a 24 hour period. At the designated time, a pleasant, but effective buzzer sounds to remind or awaken you!

Guaranteed same day dispatch.

M16

HOW TO ORDER
Payment can be made by sending cheque, postal order, Barclay, Access or American Express card numbers. Write your name, address and order details clearly, enclose 40 pence per single item for post and packing or the amount stated in the advert. All products carry 1 year written guarantee and full money-back 10 day reassurance. Battery fitting and electronic calibration service is available to customers at any Metac shop. All prices include VAT currently at 15%.

Metac Wholesale:
Trade enquiries – send for a complete list of prices for all the goods advertised plus many more not shown also minimum order details.
Telephone orders: Credit card customers can telephone orders direct to Daventry (03272) 76545 or Edgware Rd. 01-723 4753 24 hours a day.

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CALLERS WELCOME Shops open 9-30am-6.00

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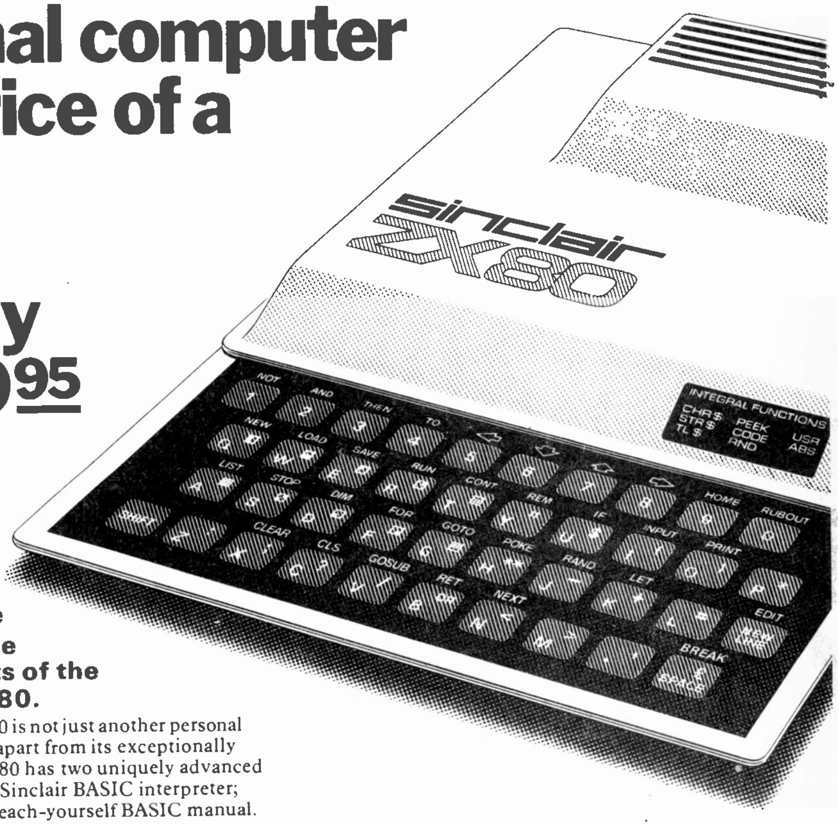
Britain's first comp

A complete personal computer for a third of the price of a bare board.

Also available ready assembled for £99.95

The Sinclair ZX80.



Until now, building your own computer could easily cost around £300 – and still leave you with only a bare board for your trouble.

The Sinclair ZX80 changes all that. For just £79.95 you get *everything* you need to build a personal computer at home...PCB, with IC sockets for all ICs; case; leads for direct connection to your own cassette recorder and television; everything!

And yet the ZX80 really is a complete, powerful, full-facility computer, matching or surpassing other personal computers on the market at several times the price. The ZX80 is programmed in BASIC, and you could use it to do quite literally anything from playing chess to running a power station.

The ZX80 is pleasantly straightforward to assemble, using a fine-tipped soldering iron. Once assembled, it immediately proves what a good job you've done. Connect it to your TV set...link it to an appropriate power source*... and you're ready to go.

Your ZX80 kit contains...

- Printed circuit board, with IC sockets for all ICs.
- Complete components set, including all ICs – all manufactured by selected world-leading suppliers.
- New rugged Sinclair keyboard, touch-sensitive, wipe-clean.
- Ready-moulded case.
- Leads and plugs for connection to any portable cassette recorder (to store programs) and domestic TV (to act as VDU).
- FREE course in BASIC programming and user manual.

Optional extras

- Mains adaptor of 600 mA at 9 V DC nominal unregulated (available separately – see coupon).
- Additional memory expansion board plugs in to take up to 3K bytes extra RAM chips. (Chips also available – see coupon.)

*Use a 600 mA at 9 V DC nominal unregulated mains adaptor. Available from Sinclair if desired (see coupon).

Two unique and valuable components of the Sinclair ZX80.

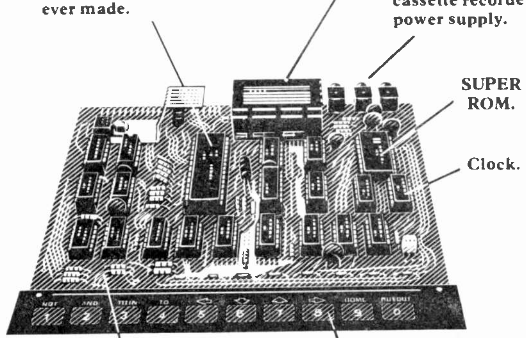
The Sinclair ZX80 is not just another personal computer. Quite apart from its exceptionally low price, the ZX80 has two uniquely advanced components: the Sinclair BASIC interpreter; and the Sinclair teach-yourself BASIC manual.

The unique Sinclair BASIC interpreter... offers these remarkable programming advantages

- **Unique 'one-touch' key word entry: the ZX80 eliminates a great deal of tiresome typing. Key words (RUN, PRINT, LIST, etc.) have their own single-key entry.**
- Unique syntax check. Only lines with correct syntax are accepted into programs. A cursor identifies errors immediately. This prevents entry of long and complicated programs with faults only discovered when you run them.
- Excellent string-handling capability – takes up to 26 string variables of any length. All strings can undergo all relational tests (e.g. comparison). The ZX80 also has string input – to request a line of text when necessary. Strings do *not* need to be dimensioned.
- Up to 26 single dimension arrays.
- FOR/NEXT loops nested up 26.
- Integer names of any length.
- BASIC language also handles full Boolean arithmetic, conditional expressions, etc.
- Exceptionally powerful edit facilities, allows modification of existing program lines.
- Randomise function, useful for games and secret codes, as well as more serious applications.
- Timer under program control.
- PEEK and POKE enable entry of machine code instructions, USR causes jump to a user's machine language sub-routine.
- High-resolution graphics with 22 standard graphic symbols.
- All characters printable in reverse under program control.

...and the Sinclair teach-yourself BASIC manual.

If the features of the Sinclair interpreter listed alongside mean little to you – don't worry. They're all explained in the specially-written 96-page book *free* with every kit! The book makes learning easy, exciting and enjoyable, and represents a complete course in BASIC programming – from first principles to complex programs. (Available separately – purchase price refunded if you buy a ZX80 later.)



PE VOLUME 16 No. 3 MARCH 1980

YOURS DISGUSTEDLY

"DEAR Sir, I am disgusted that in your recent car washing machine project you failed to give the winding details of the special toroidal transformer used in the automatic brush plunger. It would also have been very useful to have exact dimensions of the stainless steel slop tank to enable me to make one up.

I was annoyed to find this article was little more than a kit review, because some parts are only available from one supplier and no manufacturer's name has been given."

"Dear Sir, I am disgusted that in your recent automatic flasher project no kit of parts seems to be available. I have had to buy the p.c.b. from one supplier, the case from another and other components from a third source. Would it not be possible to arrange a kit of parts from one supplier for all your projects. This would greatly assist readers."

These are of course fictitious letters but are typical of many we receive.

Assuming we have identified a requirement amongst readers for a car wash and have achieved a useful, inexpensive, working design—maybe after years of trying—we find that some of the components required are not available to the hobbyist and others have to be specially made. The toroidal transformer, for instance, employs a new core material, only available from one industrial supplier who operates a minimum order charge of £20 (not at all unusual). The core then requires a primary winding of 1,000 turns and a secondary of 400 turns.

The questions we must ask ourselves are:

(1) Are many readers going to want to wind their own toroids and, if so, is it a practical proposition.

(2) Can we arrange manufacture of the complete transformer at a realistic price.

In view of the complexity of this particular component and the fact that by manufacturing in quantity our supplier can obtain transformers at a very good price, there is only one practical answer.

Moving on to the slop tank; the supplier imports a special pressed stainless steel tank—essential for normal operation of the design—from the States. Is it really worth giving full details to enable constructors to buy the stainless and make up a tank. Have you tried working stainless steel? Once again we must decide if this is a practical proposition for most readers. Obviously it is not, so we are back with our one kit supplier.

The truth in many situations is that a number of parts are so specialised it is only practicable to source a complete kit (or the special bits individually).

Going to the other argument, the second letter is one that we see more often.

It would be most unfair if we went to one supplier and asked him to supply kits; that excludes all the others. If we make no recommendations all retailers have the chance to supply. However, it takes time to assess demand and decide if it is worth buying-in any parts they do not normally carry. They must also decide if their price would be competitive with other companies who may also sell the kit.

It is our policy only to mention specific companies if: they have an involvement in the design; or they can supply parts not readily available to the hobbyist; or they own copyright. We believe this is in everyone's interest, it allows competition on most projects and ensures parts are available to readers. It also allows us to bring you some exceptional designs which might otherwise be lost.

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Technical Queries

We are unable to offer any advice on the use or purchase of commercial equipment or the incorporation or modification of designs published in Practical Electronics.

All letters requiring a reply should be accompanied by a stamped, self addressed envelope and each letter should relate to **one published project only.**

Components are usually available from advertisers; where we anticipate supply difficulties a source will be suggested.

Back Numbers

Copies of most of our recent issues are available from: Post Sales Department (Practical Electronics), IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF, at 75p each including Inland/Overseas p&p.

Binders

Binders for PE are available from the same address as back numbers at £4·10 each to UK or overseas addresses, including postage and packing, and VAT where appropriate. Orders should state the year and volume required.

Subscriptions

Copies of PE are available by post, inland or overseas, for £10·60 per 12 issues, from: Practical Electronics, Subscription Department, Oakfield House, Perrymount Road, Haywards Heath, West Sussex RH16 3DH. Cheques and postal orders should be made payable to IPC Magazines Limited.

Market Place

Items mentioned are usually available from electronic equipment and component retailers advertising in this magazine. However, where a full address is given, enquiries and orders should then be made direct to the firm concerned. All quoted prices are those at the time of going to press.

by David Shortland

CLEANING KIT

The CK-90 multi-purpose cleaning kit from 3M has been designed to clean recording heads, guides, capstans and tape paths. The cleaning solution which is also suitable for computer systems and typewriters is quick drying, leaves no residue, is non-flammable

and will not harm metals, plastics or painted surfaces.

Each kit contains two 4oz bottles of solution, ten double-ended cleaning wands and fifty lint free wipes.

The kit is priced at £11·50 and is available from accessory shops.

MICROPROCESSORS FOR HOBBYISTS

A new book which has just been published called Microprocessors for Hobbyists is based on two popular series from PE (Microprocessors Explained and Home Computers) both of which were written by our regular contributor R. W. Coles.

The book is a general introduction to microprocessors, typical architecture, instruction sets, machine code programming and peripheral chips.

The home computer section covers a typical system, the S100 bus structure, various peripherals available and a guide to choosing a suitable system. The final chapter deals with software and the high level language BASIC. A glossary of terms is also included to explain many of the "buzz words" used with microprocessors.

Copies of the book (ISBN 0-408-00414-2) which is priced at £2·95 including p&p are available from. **Newnes-Butterworths Borough Green, Sevenoaks, Kent.**

ELECTROVALUE

The latest Electrovalue catalogue which is now available covers a wide range of items including chokes, coils, i.c.s, books and a very comprehensive range of ferrite components. There is also a complete range of Nascom microcomputers and peripheral devices.

The catalogue is available free of charge together with a separate price list which is valid until the end of July. Updated price lists can be obtained by sending a stamped addressed envelope to **Electrovalue, 28 St. Judes Road, Englefield Green, Surrey TW20 0HB.**

NEWTRONICS

Newtronics have moved to larger and more convenient premises close to Highgate tube station.

At their new showroom they will be demonstrating the popular ELF II and the new Explorer /85 computer kits and peripherals. The company are now supplying products direct to the consumer with the result that all their prices have been drastically reduced. The Elf II is reduced from £79·95 to £59·95 with all peripherals being reduced pro-rata.

Newtronics, 255 Archway Road, London N6 5BS.

NEW CASE

A new size of vacuum-formed case has been introduced by Vero to compliment their existing range. Although specially designed for housing a keyboard and display panels, this enclosure has wide ranging applications in the instrument field.

Vacuum-formed from black textured ABS, the case is supplied in two sections which screw together. A flat area is provided at the rear of the case for cable entry.

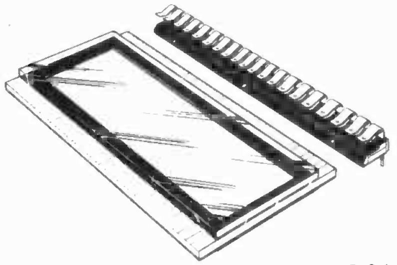
This intermediate size, with outside dimensions of 340 × 360 × 130mm is supplied with an anodised aluminium front panel 254 × 170 × 2mm thick, four self-adhesive rubber feet and case assembly screws.

The price of the case (75-2439K) is £16·71 excluding VAT and p&p.

Vero Electronics Limited, Industrial Estate, Chandler's Ford, Eastleigh, Hants.

L.C.D. CONNECTORS

A range of snap-on connector strips which provide an alternative to dual in-line mounting for liquid-crystal displays is now available from Hamlin Electronics. The strips, which



are available with pin lengths of 0·1 or 0·2 in. are supplied in 2 in. lengths for a range of standard displays, and have pin compatibility with the standard dual-in-line pins.

Hamlin Electronics Ltd., Diss, Norfolk, IP22 3AY.

DEMA SYSTEMS

The Dema electronic ignition unit which is claimed to provide both petrol economy and improved performance is being marketed by Maywood Technical Developments Ltd.

The system takes a 5 to 15V supply directly from the coil and stores 400V in the units capacitor. The points which normally determine the build up time are used simply to trigger off a thyristor. A variable pulse width circuit determines when the voltage should be fed to the HT coil and the spark plug. The unit monitors the revs and varies the length of time the spark is at the plug in order to achieve complete combustion.

The system is priced at £49·50 including VAT and p&p. For further information contact **M.T.D. Ltd., Peake House, 232 High Street, Harlington, Hayes, Middlesex.**

FLUKE DMM

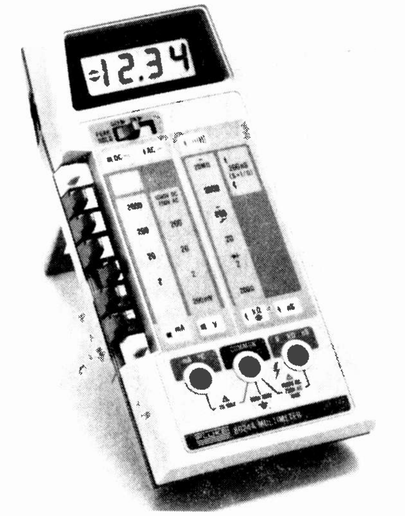
The latest DMM from Fluke is a $3\frac{1}{2}$ digit handheld DMM ideally suited for test and service applications. Fluke claim it is the first handheld DMM to offer logic level detection, direct temperature readout, a peak-hold facility and intermittent short circuit detection in addition to a full DMM capability.

Among the many features on the 8024A are direct temperature measuring capability from −100° to 1625° with any K type thermocouple, a peak-hold facility to store and display any a.c. or d.c. voltage or current peak, fast audible continuity checking and TTL logic state indication by visual or audible signal.

The peak-hold facility opens up many interesting applications such as transient detection for example in motor or lamp starting. Additionally, with hazardous circuits the operator can safely remove the leads before reading the display.

In logic circuits, the 8024A gives an instant visual or audible indication of TTL logic high or low. Fast response means it can also detect pulses or pulse trains up to 100kHz. On low frequencies, the tone warbles to give an indication of frequency level.

A fast 50μs settling time means that it is practically impossible to beat its high speed response even by running the leads very quickly down, say, an edge connector. Continuity is positively indicated by an arrow



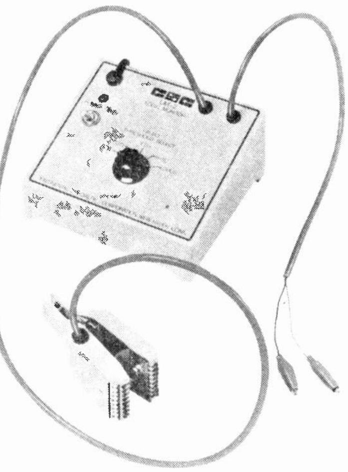
pointing up or down or by a 100ms 2kHz bleep.

The 8024A has $3\frac{1}{2}$ digit readout and a basic d.c. accuracy of 0·1 per cent. Temperature accuracy is 3 degrees ±1 digit from −20 to +300°C and the instrument is specified for a full one year. The price of the 8024A is £135 ex VAT and p&p.

For details contact **Fluke International Corporation, Colonial Way, Watford, Herts. WD2 4TT.**

LOGIC MONITOR

The LM-2 logic monitor from CSC is for testing digital i.c.s. It simultaneously displays the static and dynamic logic states at each pin of a 14 or 16 pin dual in-line circuit. The device comes complete with an isolated power supply and has a selectable threshold control which allows it to be used with a variety of logic families.



There are two basic units which comprise the LM-2: the connector/display unit which clips over the circuit under test and contains the comparator circuitry and 16 l.e.d. indicators; and the power-supply module, which contains a precision reference power supply and a logic-family selection switch covering CMOS, HTL, TTL, DTL and RTL circuitry.

The threshold switch is used to select the appropriate logic family, a clip lead is connected to the negative or ground line of the circuit under test (except for CMOS, when an additional positive lead is provided), and the clip module is slipped over the circuit under test.

Typical of states that can be seen from the monitor's 16 l.e.d. display are gate inputs rising and falling, pulses passing from circuit to circuit, flip-flops changing state, and decoders and encoders accepting and recording information.

Because of the self-contained power supply, there is no loading of the circuit under test—a problem that can cause logic-level shifts, false triggering and power-supply loading with some types of equipment. In addition, the power supply, in conjunction with the comparators, also provide a constant-current drive to the display indicators, ensuring uniform brightness.

CSC Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3AQ.

BAR CODE READER

A handheld light pen which reads standard black and white bar codes and outputs the digitally coded information, is now available from Jermyn-Mogul Distribution.

Manufactured by Hewlett-Packard and called the HEDS-3000 Digital Bar Code Wand, this low cost device is completely self-contained, comprising optical sensor, amplifier and digitiser.

Features include a single, non-critical supply voltage, a replaceable low friction tip, push to read switch, full TTL and CMOS compatibility and solid state reliability throughout.

Apart from its already obvious use in supermarkets, a major demand for this device will be in the field of portable data entry as bar code scanning is not only faster than keyboard entry but inherently more accurate.

One particularly interesting application is in service and repair where bar code labelled

printed circuit boards automatically set the parameters of the test equipment.

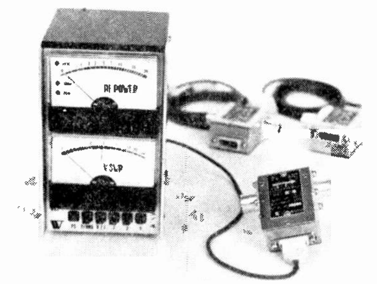
The price of the HEDS-3000 is £61·79 ex VAT. **Jermyn-Mogul Distribution, Vestry Estate, Sevenoaks, Kent. 0732 50155.**

VSWR/POWER METER

A combined VSWR and power meter offering direct reading of both functions without interpolation is now available from Zycomm Electronics.

In operation, the unit is autoranging for power output, covering 20W to 2kW in three ranges for 1·8–30MHz and 50–150MHz, and 2W to 200W for the 430–470MHz range. VSWR from 1 : 1 to infinity can be measured.

Separate sensing heads are supplied to



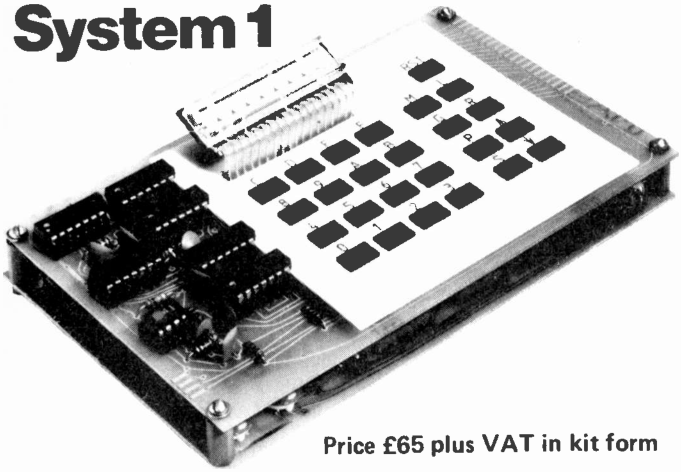
cover each frequency range, and these can be connected at any position in the feed line—including the mast head for precise radiated power indication. Press switches on the front panel allow the selection of the appropriate head, and the display of forward and reverse power as either peak or r.m.s. readings.

The electronic comparator included in the unit allows constant readout of VSWR irrespective of power variation, i.e. gives true indication during speech on SSB.

The price of the meter is £147·20 inc. VAT. **Zycomm Electronics Ltd., 47, 49 and 51 Pentrich Road, Ripley, Derbys.**

The Perfect Lead...

Acorn Microcomputer System 1



Price £65 plus VAT in kit form

This compact stand-alone microcomputer is based on standard Eurocard modules, and employs the highly popular 6502 MPU (as used in APPLE, PET, KIM, etc). Throughout, the design philosophy has been to provide full expandability, versatility and economy.

Specification

The Acorn consists of two single Eurocards.

1. MPU card
6502 microprocessor
512 x 8 ACORN monitor
1 K x 8 RAM
16-way I/O with 128 bytes of RAM
1 MHz crystal
5 V regulator, sockets for 2K EPROM and second RAM I/O chip.
2. Keyboard card
25 click-keys (16 hex, 9 control)
8 digit, 7 segment display
CUTS standard crystal controlled tape interface circuitry.

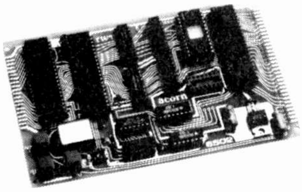
Keyboard instructions:
Memory Inspect/Change (remembers last address used)
Stepping up through memory
Stepping down through memory
Set or clear break point
Restore from break
Load from tape
Store on tape
Go (recalls last address used)
Reset

Monitor features
System program
Set of sub-routines for use in programming
Powerful de-bugging facility displays all internal registers
Tape load and store routines

Applications

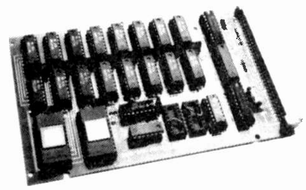
As a self teaching tool for beginners to computing.
As a low cost 6502 development system for industry.
As a basis for a powerful microcomputer in its expanded form.
As a control system for electronics engineers.
As a data acquisition system for laboratories.

START WITH SYSTEM 1 AND CONTINUE AS AND WHEN YOU LIKE



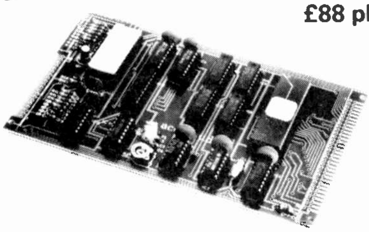
Acorn Controller
£35 plus VAT (min config.)

the CPU card of System 1, it allows for up to 4½ k EPROM, 1¼ k RAM and 32 I/O lines. It has on board 5 V regulator and optional crystal control. Custom programs may be developed on System 1 and the card makes an ideal dedicated hardware module.



Acorn Memory 8 k
£95 plus VAT (kit form)

A fully buffered memory card allowing up to 8 k RAM plus 8 k EPROM on one eurocard, in an Acorn system both BASIC and DOS may be contained in this module. Static RAM (2114) is used and the card may be wired into other systems.



Acorn VDU
£88 plus VAT (kit form)

A memory mapped seven colour VDU interface with adjustable screen format. Full upper and lower ascii and teletext graphics are features of this module which along with programmable cursor, light pen, hardware scroll etc., make this the most advanced interface in its class.

Acorn Software in ROM

Acorn BASIC — a very fast integer BASIC in 4 k
Acorn COS — a sophisticated cassette operating system with load and save and keyboard and VDU routines in 2 k
Acorn DOS — a comprehensive disc operating system in 4 k

Acorn Computers Ltd.
4A Market Hill, Cambridge, Cambs.
Cambridge (0223) 312772.

Order Form P.E.2

Please send me the following:

☐ (qty) Acorn Microcomputer kit @ £65 plus £9.75 VAT.
☐ (qty) Acorn Memory kit @ £95 plus £14.25 VAT.
☐ (qty) Acorn VDU kit @ £88 plus £13.20 VAT.
☐ (qty) Acorn Power Supply (for System 1 only) @ £5.95 plus £0.89 VAT.
☐ (qty) Acorn Microcomputer assembled and tested @ £79 plus £11.85 VAT.
☐ (qty) Acorn VDU assembled and tested @ £98 plus £14.70 VAT.

Post and packing free on all orders.

I enclose a cheque for £ . . . . .
(indicate total amount) made out to Acorn Computers Ltd.
Please send me further details of this and other Acorn options

Name ______________________
Address ______________________
____
____

ACORN COMPUTER

Acorn Computers Ltd. 4A Market Hill, Cambridge, Cambs. (0223) 312772. Regd. No. 1403810

INDUSTRY NOTEBOOK

By Nexus

Outlook

Never, in recent years, has the crystal ball been so clouded by external events, both political and economic. The domestic scene is unclear enough with the impact of contraction of heavy industries and industrial unrest, but when international factors are added the only certainty is uncertainty. Nobody knows the eventual outcome of the Iranian revolution, of the Rhodesia elections, of the U.S. elections, the nuclear power debate, arms limitations, the expected deaths or resignations of the elderly leaders in the USSR, the future cost and availability of oil, world interest rates and inflation, squabbles in formerly stable institutions like NATO and the European Common Market.

The list seems endless and probably is, the only good point emerging being a gradual realisation that no nation can plan and conduct its affairs in isolation from events elsewhere, maybe many thousands of miles distant and sometimes, by world standards, of only a minor character.

But through all the turbulence of the late 1970s and now for at least the early years of the 1980s if not beyond, the electronics industry has not only survived but has grown. Growth may have been erratic, profits wobbled, ownership of companies changed, as is characteristic of a dynamic industry in response to surges in demand and in rapid technological change, but the trend is still upwards. Apart from oil, electronics is probably the safest business to be in. But oil is said to be finite while electronics will go on for ever, which is a cheerful note for a winter's day.

Trend

The general trend was revealed in recent financial results of industry leaders. GEC showed a dip in profits, the result of heavy involvement in general engineering which was affected by the long engineering workers' strike. GEC's electronic companies continued to prosper. Racal only just scraped home with an unblemished record of 25 years of continuous growth and profits. In their case the engineers' strike was probably more marginal in effect, the major obstruction being the greatly increased value of the pound sterling in the international market.

But both the Racal and GEC are still active on the takeover trail. Avery is now in the bag for GEC and was followed by the acquisition of the industrial robot company Hall Automation Ltd. Racal, at the time of writing, had not revealed an expected bid for all or part of Decca but, in the interim, extended overseas activities through buying 65 percent of the New York based Vikonics for $1 million. This company will become Racal-Vikonics and as it is in the systems security business will be complementary to and a first-class U.S. outlet for Racal-MESL which came into the Group in January 1979. Racal has the option of buying the remaining shares in due course although some are likely to remain with Vikonics' founders as an incentive.

It is tedious to list orders but two are worth mentioning as significant in trend. First, for GEC whose Marconi Space and Defence Systems has booked its first defence order from China. It is for five FACE (Field Artillery Computing Equipment) systems worth £1 million with long-term business expected to follow. Second, for Racal-Milgo who in a single month recently won export orders worth £3¼ million. Only six years ago total exports for a whole year were less than this figure. The record month coincided with Racal-Milgo's move to a new headquarters building with 24,000 sq.ft. of floor area at Fleet, Hants.

Plessey, too, looks in much finer shape than for a long time and is firming everything up with yet another reorganisation.

Distribution

Although there are a handful of large electronics component distributors in the UK and lately a sprinkling of specialist MPU and instrument distributors, most are comparatively small businesses. We all used to believe that all the little firms would eventually be swallowed up by the big fish so that perhaps only six or seven "supermarkets" would blanket the country. We were wrong. True there are some big 'uns and doing very nicely thank you, but the great bulk are over 100 small independent companies carrying on the tradition of the corner shop.

The name of the game is customer service and this is an area where the small company can, and obviously does, score. It also attracts new entrants willing to have a go on their own rather than continue working in a big organisation.

The most recent example is House of Instruments (HI) which opened for business on January 1, 1980, from premises in Saffron Walden, Essex. The key figures are Gordon Pope and Fred Hutchinson both ex-executives from Gould Advance, Pope giving up his job as chairman and Hutchinson as instrument manager. It needs courage these days to start a new business but the two principles are extremely well-known, have a fine track record in the business and have some good products lined up as well as four salespeople on the road.

Crime

We have all heard of computer crime but nobody knows its extent. Interpol suggests that industrialised nations are losing as much as 2·5 percent of gross national product through fiddles by white-collar workers with the bulk being due to computer fraud. But this must be guesswork as it is admitted that computer fraud can be conducted successfully for years without detection.

At a recent Interpol conference some 50 basic types of fraud were listed but each has so many variations and subtleties that a full catalogue is a practical impossibility. The solution is that police fraud squads should now receive specialist training in computer technology and programming.

Fall of France

Chauvinistic France after years of struggle has at last surrendered to Sony advances. The news is that the Japanese company will open its first factory in France in 1981. It will be sited at Bayonne, close to the Spanish border, turning out tape recorder cassettes with a French workforce of 300 people. Sony has had a sales subsidiary in France since 1964 and has been hoping to expand ever since. The French government have now reversed their policy of exclusion in the interests of hoped-for exports and almost certain import savings to satisfy France's domestic market currently estimated at 25 million cassettes per year. Sony video cassettes will also be produced at Bayonne.

Spin-off

I recently spent an interesting day at the Royal Signals and Radar Establishment, Malvern. This was the home of the former TRE which generated so many war-winning inventions 40 years ago. I am pleased to report that a later generation of boffins are still at it as hard as ever although the urgency is less great than in the hectic years of World War 2.

Among the projects unveiled were a new battlefield radar for ground troops, highly portable, and a novel helicopter-borne radar which uses one of the rotor blades as the scanning antenna.

Those who are worried about the level of defence spending may be re-assured that all the money spent and the technology won does not go down the military drain. Much of it goes virtually as a free gift to industry and some is charged for. RSRE has two Queen's Awards for Technology under its belt, both won in 1979, a unique event for a single organisation.

Some of the fundamental research looks as far ahead as 1995 which even the most forward-looking commercial companies would have difficulty in financing. At the same time RSRE is still supporting older projects such as the Rapier missile system which has seen continuous improvement and is a world best-seller for Britain.

Audio Isolator...

G. Davies

THE audio opto-isolator is powered from a nine volt PP3 battery and *completely* isolates input from the output via an infrared light beam. Applications include safer connections from guitar to amplifier, microphone to PA, and is ideal for out of doors where added safety is required. It is also ideal when connection from one amplifier to another without the problem of earth loops is required. The unit switches on when the input jack is inserted. See Fig. 1.

SPECIFICATION

Maximum input 100mV R.M.S. (impedance up to 500k)
Output up to 100mV R.M.S. (impedance greater than 50k)

COMPONENTS . . .

Resistors

R1, R2	1M (2 off)
R3	10k
R4	100k
R5	1k

All resistors ¼W 5%

Potentiometers

VR1	100k hor. min. preset

Capacitors

C1	10n/50V cer.
C2, C4	4µ7/16V tant. (2 off)
C3	100n/35V tant

Integrated circuits

IC1	741
IC2	CNY171

Miscellaneous

ABS box 100 x 75 x 40mm
Printed circuit board
Stereo jack sockets (2 off)
PP3 battery and clip

CIRCUIT DESCRIPTION

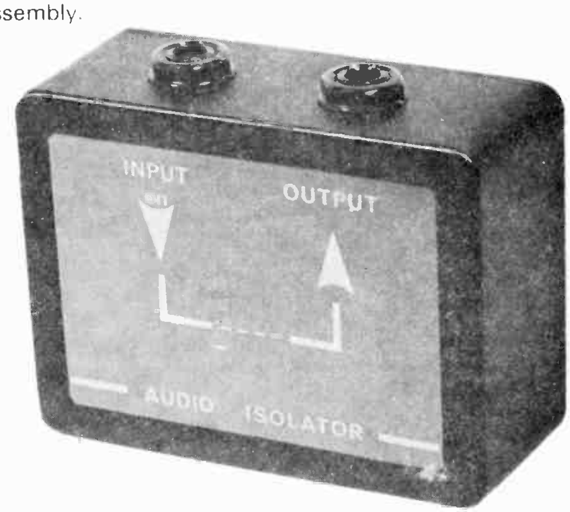
Resistors R1 and R2 form the bias for the 741 op. amp, and C1 decouples the input. The input signal modulates the input bias for IC1 applied to the non-inverting input. The output of IC1 is fed through the l.e.d. of the opto-coupler, IC2, the current being limited by R5. Negative feedback is applied from the potential developed across R5 to ensure low distortion driving the l.e.d. in a true current mode. (The voltage developed across R5 is proportional to the current passing through it, and the l.e.d.).

R4, R3 and C2 give an a.c. voltage gain of ten to provide adequate drive to the l.e.d.

The phototransistor in the opto-coupler in the configuration shown, acts as a current source which is converted into a voltage across VR1. The output voltage is limited to 0·6 volts peak to peak because of the forward voltage drop of the transistor junction. To ensure maximum output swing, the output transistor is biased at approximately 300mV by adjusting VR1 and measuring the d.c. voltage between pins 5 and 6 of IC2 with a high impedance meter. The pot VR1 can be adjusted by applying an input signal and adjusting for minimum distortion.

CONSTRUCTION

All components are p.c.b. mounted (see Figs. 2 & 3) and the whole p.c.b. assembly fits into two holes 12·5mm diameter, 38mm between centres in the side of an ABS box. To mount the jack sockets onto the p.c.b., junior hacksaw saw cuts in between the pads form an ideal solution for easy assembly. ★



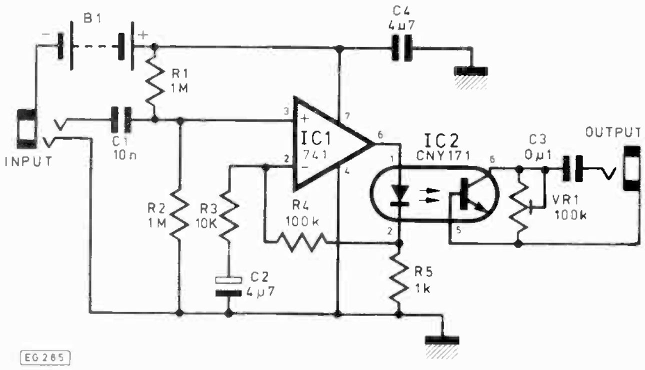
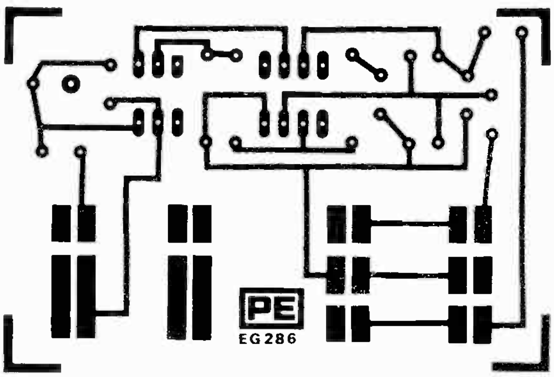


Fig. 1. Full circuit diagram. The input stereo jack socket is wired so that insertion of a mono jack plug will connect the battery to the circuit, thus eliminating the need for an ON/OFF switch

Fig. 2. Printed circuit layout (full size)



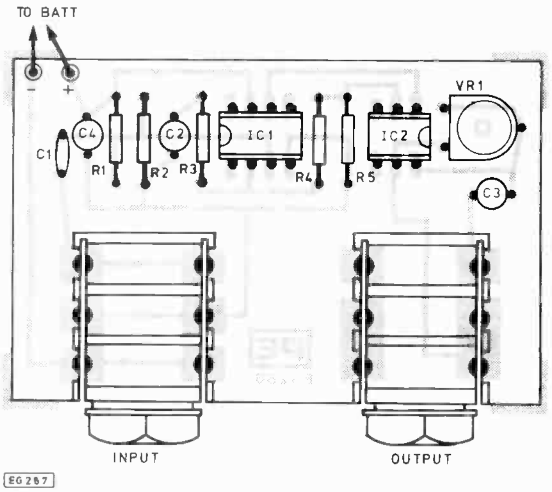


Fig. 3. Component layout of Audio Isolator. Four slots should be cut into the side of the board to accommodate the jack socket tags

Semiconductor UPDATE...

FEATURING 8041/ISBC 941 SUPER E-LINE

R. W. Coles

SLAVE CHIP

When any digital processor (such as a microprocessor chip) needs to converse with the outside world it usually has to rely heavily on external peripheral control logic circuits. This logic external to the processor itself can be minimised by trading off hardware for software; so that the processor becomes intimately involved in the transfer of data to or from the peripheral, perhaps a tape cassette or a printer.

The software solution certainly looks good from the circuit complexity point of view. A complete asynchronous serial I/O scheme can be implemented in software with the use of only two microprocessor pins and a couple of external buffers to replace the few dozen TTL packages which could be needed otherwise. The trouble is that software (or rather firmware in ROM) is quite expensive to write, and this method does not involve the CPU in a great deal of time wasting activity when in many situations its talents are urgently needed elsewhere. The software solution is therefore suitable only for very simple applications where the CPU doesn't have a lot of other things to do anyway.

For those more important CPUs, who find dealing with troublesome peripherals a tiresome job, the semiconductor manufacturers have produced dedicated I/O controllers which do some of the often needed jobs in hardware but with all the necessary logic squeezed on to a single LSI chip. The best known of these devices is probably the UART/USART/ACIA chip which can be used to relieve a processor of the need to control, slow, asynchronous serial I/O transfers. Data transfer of this sort, to and from teletypes, VDUs and other serial devices, can be a painfully slow process with the wide variety of transmission rates and data formats making the task quite complex. The necessary serial to parallel and parallel to serial registers, parity checking logic and start and stop bit insertion can all be done by the UART controller which the processor can treat just like a section of its own memory.

SOFT OR HARD?

Taking stock then, you can do it in software, or you can do it in hardware, but unfortunately, you can only do it with LSI hardware if it is an I/O function which is so common that the semiconductor manufacturers find it economic to make a special device to do the job. If you happen to be an industrial microprocessor user, however, there will be many occasions where your particular I/O control function is so special that you either have to go back to software or put up with a board full of TTL. Or, rather, you did have to until Intel introduced their 8041A Universal Peripheral Interface chip.

The 8041A is actually a complete microprocessor system in a 40 pin package, like the 8748 we considered last month, but unlike the 8748 the 8041 is optimised for use as the "slave" of a main processor such as the 8080, 8085 or 8086. The main processor converses with the 8041 over its normal eight bit data bus while the 8041 itself takes over all the time consuming data and formating and timing operations under the control of its own built in ROM based software. This solution provides the system designer with the best of both worlds: The flexibility of software driven I/O with all the convenience of a single LSI chip to do the work.

This is great for the industrial user who needs a thousand of these chips all with the same program, but what about those one-off jobs where ROM mask costs cannot be absorbed? Is it back to TTL? Well no, because good old Aunty Intel has considered the plight of small users like us and has programmed up an 8041 with a set of nine general purpose I/O routines which can be individually selected via the system bus.

The routines are aimed mainly at industrial applications such as switch sensing, motor speed control, stepper motor drive and simple serial I/O communications, but many other uses suggest themselves. This "custom" chip is coded ISBC 941 and it has all the usual facilities of the 8041 including 16 programmable I/O lines which can be used individually to implement functions such as pulse counting, pulse generation, period and frequency measurement and sensor monitoring.

The ISBC 941 comes in a 40 pin package, runs from a 5V supply, and can use either its own internal clock oscillator or one derived from the main processor clock.

E-LINE MUSCLE (SUPER E-LINE)

I like to buy British, but it is very difficult sometimes, especially in the electronics field. I know that Texas Instruments, National Semiconductor, General Instrument, Motorola, and several other American semiconductor firms do manufacture devices here, but when you buy from these firms, as of course you must in many instances, there is usually no guarantee that the devices you get will really be British or that your purchase will benefit the British economy in any way.

I for one have my fingers crossed that the ambitious plans of the new British Inmos memory and microprocessor organisation will bear fruit in due course, but until that great day arrives you can still do your bit for Britain by using the home-grown discrete transistors like those from Ferranti. Now we all have to use discrete transistors from time to time, don't we, and (own up now) I bet you use devices from Texas or Motorola without even thinking about it. Well don't, because if you need a good range of plastic silicon transistors you can't do much better than to buy them from our very own Ferranti Semiconductors.

Their main range of devices, which I would like to commend to you, is the family known as "E-line". This range comes in a plastic package of a very compact and neat design, and family members can be recognised by the fact that their code number begins "ZTX". These devices are by no means new, but you may not be too familiar with it because Ferranti don't have the same kind of advertising budget as some of their competitors. If my own experience with E-line devices is anything to go by however, they certainly make up for their lack of advertising in the quality of their transistors and you can pick just about any combination of polarity *(n.p.n./p.n.p.)*, current gain, and voltage rating you are ever likely to need from this versatile family.

Well so much for the unashamed plug of a British manufacturer—now for the hot news. To augment their existing range of E-line devices Ferranti have now introduced a brand new range of plastic transistors called "Super E-line". "Super" is the right word too, because I don't know of any other manufacturer anywhere who can pack so much power into such a tiny plastic T092 type package. Super E-line devices will dissipate 1·5W at a case temperature of 25 degrees C, and they'll handle voltages of up to 100V. Under surge conditions these very muscular transistors can sink 6 amps, and they have a minimum gain of 25 at 2A or 55 at 1A.

These sort of specs make Super E-line ideal for use in audio amplifiers, relay and lamp drivers, and anywhere else you need a very small device with a very hairy chest. In many circuits you will be able to use Super E-line in place of much bulkier power devices.

So do yourself a favour and buy British—it really is best sometimes!

BREADBOARD REVIEW

LAST year over the period December 4–8, the second *Breadboard* was held at the Royal Horticultural Halls, Westminster. At this annual event for the amateur of the technology, electronics was unchained from its usual business-like decorum, and the sixty or so exhibitors combined to produce a pre-Christmas electronic menagerie of synthesisers, effects units and microprocessor music; and a fulgurous psychodelia of lighting novelties, including a laser at the Watford Electronics stand.

The exhibition provided a panoptic view of the state of the art, with no unfair bias towards computers, musical instruments, hi-fi or anything else, although a radio enthusiast need not have spent long at the show. Robots demonstrated their agility, and cybernetic bits and pieces were seen "lopping" around under battery power. How long before some of the visitors fit this description? Demonstrations of various keyboard instruments by the maestros took place in listening areas. We even found Alan Boothman playing the *PE String Ensemble*.

SHARP MZ80K

The Newbear display included the Sharp MZ80K personal computer. This system is based on the Z80 microprocessor with a 14K extended BASIC, 10in VDU (40 characters × 25 lines), 78 key ASC11 keyboard, 50 pin connector for system expansion and a music synthesizer with 3 octaves. The machine is available in a range of memory sizes (6K, 10K, 18K, 22K, 34K plus 14K for the BASIC) and a PASCAL compiler will be available in the near future.

The cassette speed at 1200 b.p.s. is quite fast and the machine includes a tape counter.

The music synthesizer can be programmed either in BASIC or machine code and the volume is adjustable from inside the case. The two instructions for the synthesizer are MUSIC and TEMPO with the TEMPO instruction either increasing or decreasing the length of the note.

The Basic has to be loaded from cassette which takes about 2 mins but this system does enable other languages to be used.

The price of the machines range from £520. **Newbear Computing Store Ltd., 40 Bartholomew Street, Newbury, Berks. (0635 30505)**

WEST HYDE DEVELOPMENTS

TheWest Hyde stand had a wide range of cases and components on display including their latest keyboard enclosure, the Bocon Commander. This moulded ABS case has anodised aluminium front and rear panels with the rear aperture accepting a 19in rack frame 100mm high. The housing which has been designed to accept most proprietary keyboards is priced at £77·50 ex VAT and p&p.

A catalogue covering the complete range of cases, components, test equipment and tools is available free of charge from **West Hyde Developments, Unit 9, Park Street Industrial Estate, Aylesbury, Bucks HP20 1ET.**

CLEF PRODUCTS

The very busy Clef Products stand featured the *PE String Ensemble* (March–July 78) which is still a very popular design with constructors. Also on display were Clef's latest piano kits which have been based on the successful PE Joanna design with considerable refinements. The two designs are a 7¼ octave (88 note) and a 6 octave (72 note). A stage version of the 6 octave piano is also available which requires an external amplifier and speaker whilst the domestic versions contain

their own power amplifier and will operate with either a speaker or an external amplifier/speaker system.

Clef can supply ready built and tested instruments with full service instructions.

The price of the String Ensemble is £164·00, the 6 octave piano is £184·00 and the 7¼ octave £209·00 part kits are also available.

For a complete price list covering all Clef's kits, contact **Clef Products, (Electronics) Ltd., 16 Mayfield Road, Bramhall, Cheshire.**

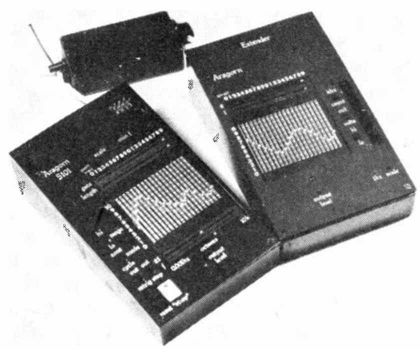
THE DIGITAL WAY

A device of considerable potential seen at the show is called a "Graph Transducer". A versatile interface between the analogue and digital worlds, this invention can form part of a range of instruments which synthesise virtually any waveform, graphically equalise, and allow serial analogue control.

Produced by Turner Electronics under licence from Aragorn Dynamics, the S201S is a completely digital graphic equaliser of electrically similar characteristics to conventional units, but which allows narrow band frequency control superior to tone controls, and presents no interface problems. Cascading permits resolution to the desired degree. Specification: 2 × 10 bands at 1 octave spacing. S/N ratio > 80 dB below 1V. Distortion < 0·1% (20Hz–20KHz). The AD2000 series console comprises four stereo equalisers.

Operated in the Voltage versus Time Mode, the Graph Transducer forms the basis of a range of units called "Arbitrary Waveform and Control Sequence Generators" which are capable of envelope shaping, wave form generation (timbre or tone), and, for example, sequential lighting control. The cycle pattern is set up using precision conductive plastic slider potentiometers and the time-base can be varied from microseconds to hours. An exceptionally stable logarithmic VCO is incorporated.

With the S103 unit, a counter indicates incremental status, measures frequency and



voltage, and an auto-ranging integrator smoothes the clastic signal. By superimposing the synthesiser's output on an existing waveform using a dual beam scope, the output can be adjusted to follow the original waveshape. In fact, using the memory mapped Computer Interface Board also available, a computer is conceivable which could learn to imitate any sound just by listening to it.

Two units from the range (S101 and S102) can be used to form a very superior conventional music synthesiser. Program card templates can remember waveforms.

Some sample prices are: S201S Stereo Equaliser—£142, S101 Control/Waveform Source—£184, AD2000 Equaliser Bank—£694. Details are available from **Precision Instrument Laboratories, Instrument House, 727 Old Kent Road, London SE15.**

TRANSPORTABLE ORGAN

If your last project was encased in a tobacco tin then it may not be a good idea to attempt to build one of the organs seen on the Aura Sounds stand, although Wersi do say that the Saturn (pictured below) is based on their "novel" d.i.y. method which makes construction easier. The console comes assembled, and prefabricated laced wiring harnesses eliminate one of the main causes of error.

The Saturn is described as a transportable organ, and has a list of attributes too long to quote here. Basically it has five-octave polyphonic keyboards, with an overall eight octaves available from a master generator providing a range of simultaneously available waveforms. The fixed stops give: Principal, Cello, Horn, Accordion, Trombone and Saxaphone all at 6', English Horn, Principal, Viola, Clarinet, Oboe, Schalmei and Trumpet all at 8', plus others.

The piano section gives: Celeste, Kinura, Honky Tonk, Harpsichord and Banjo, with tremolo, echo and damper functions.

Wersivoice rotating battle effect is included, along with auto accompaniment, and somewhere inside the cabinet is a string orchestra! Just to utilise any remaining space, a sound computer is also incorporated to give 32 user adjustable preset buttons. So if you have £5197 in your pocket, plus some petty cash for loudspeakers to go with it, the Saturn could be yours.

Anra Sounds, 14/15 Royal Oak Centre, Brighton Road, Purley, Surrey.

COMPSHOP

The main feature on the Compshop stand was our Compukit UK101 which has rapidly established itself as the country's fastest selling single board computer.

Also on display was the ITT 2020 which is the English version of the Apple II microcomputer. **Compshop, 14 Station Road, New Barnet, Hertfordshire.**

CHROMATRONICS

The Chromascope from Chromatronics is a video synthesiser which can create a whole range of abstract colour patterns on a TV set. The display which responds to a musical input is available in kit form for £169·95 inc. VAT.

The kit includes a cabinet, components, ready built encoder, modulator power supply and manual. **Chromatronics Coachworks House, River Way, Harlow, Essex CM20 2DP.**

COMPETITION WINNER

The winner of our Lektrokit competition (Sept '79) Mr. D. J. Speakman was at the exhibition to receive his prize of a Powerace 102 with a jumper wire kit and 16 pin test clip.

Our Advertisement Manager Mr. D. Tilleard (left) presented the prizes together with Mr. G. Wilson of Lektrokit.

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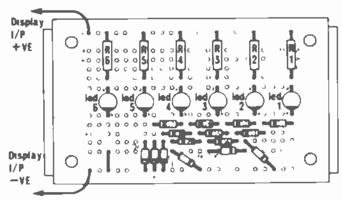

YOU WILL NEED

e.g. LED Bar Graph (a previous project)
components EXP300 or EXP350
D1 to D15 — Silicon Diodes
R1 to R6 Resistors
LED 1 to LED 6 Light emitting diodes

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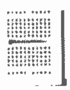

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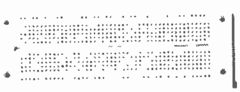
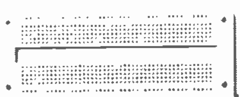
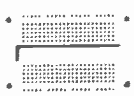


EXP 600 £6.30 Most MICROPROCESSOR projects in magazines and educational books are built on the EXP 600



EXP 650 £3.60 Has ·6" centre spacing so is perfect for MICROPROCESSOR applications



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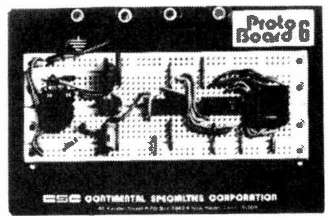
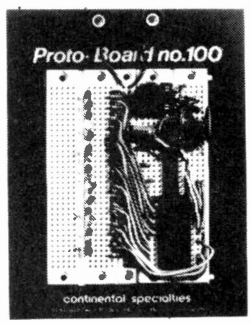


PB6 Kit, 630 contacts, four 5-way binding posts accepts up to six 14-pin Dips

PROTO-BOARD 6 KIT £9.20



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EXP 300	550	6	£ 7.76	
EXP 600			£ 8.39	
EXP 650	270	use with 0.6 pitch Dip's Strip Bus Bar	£ 5.00	
EXP 4B	Four 40 Point Bus Bars		£ 3.50	
PROTO BOARDS				
PB6	630	6	£11.73	
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Transistor Parameters...

If the amplitude of applied signals is small it is more convenient to replace the transistors by an equivalent circuit for determining externally, circuit parameters. Here common emitter h-parameters are discussed.

R. A. HATTON

LOOKING through transistor data sheets can be very frustrating if you don't know what the mass of data means or how it can be applied in designing a circuit. This article explains what the most commonly quoted parameters mean, and their relevance to a transistor circuit.

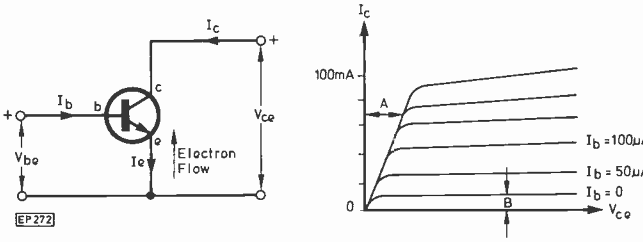
COMMON EMITTER MODE

Fig. 1 shows an *n.p.n.* transistor connected in the common-emitter mode, with normal voltage supplies and current flows labelled. Fig. 2 illustrates the typical output characteristics for such a transistor, and similar graphs can be found on most data sheets. The transistor is a current controlled device, and in the common-emitter mode a large current gain is possible, as shown by Fig. 2 where I_c is the collector current in mA, and I_b is the base current in µA.

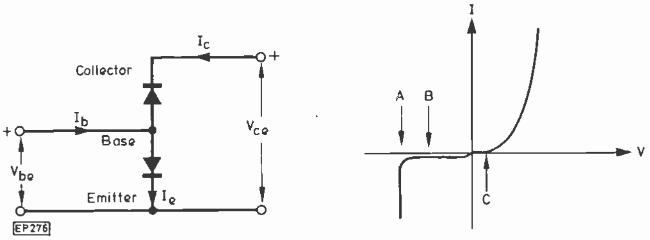
Note that the collector current depends only on the value of the base current, and not on the collector voltage (which means that V_{ce} can be a constant voltage power supply). For a given value of I_b, I_c is nearly constant for all values of V_{ce}, except near 0 volts and at very high levels (not illustrated, but typically about 50 volts). To appreciate what happens at these two extremes, look at the diode equivalent in Fig. 3 of a transistor. The collector-base diode is reverse biased, and the emitter-base diode is forward biased for normal operation. Fig. 4 shows the current flow in a semiconductor junction diode, and it will be noticed that in the reverse biased condition there is a sudden increase in current flow when the voltage at point A is reached. This is a result of avalanche breakdown, which will cause the destruction of the junction, and must not be allowed to occur. Hence for "safe" operation of the device the voltage at point B must not be exceeded. As the other diode is forward biased there is little voltage drop across it, and consequently approximately all V_{ce} is dropped across the reverse biased collector-base diode, and so a maximum value of V_{ce} must be stated to prevent destruction of the transistor from too high a power supply voltage. This parameter is quoted as V_{ceo} (max), the O suffix indicating that this voltage is measured with the base open circuit.

It will be noted from Fig. 4 that between zero volts and point C no current flows in the forward biased diode. This means that before current can flow into the emitter there must be at least this small voltage present across the base-emitter. It is called the "knee" voltage, and for silicon devices it is 0·7 volts. This explains why V_{ce}, as illustrated in Fig. 2, must have a minimum value (point A) before collector current will flow.

When the base current is zero, it is also evident from Fig. 2 that a small collector current, shown by B, flows. This is the leakage current which arises from the reverse biased diode across the collector-base.



Figs. 1 and 2. Transistor in common emitter mode with output characteristics



Figs. 3 and 4. Diode equivalent of transistor with diode voltage/current characteristic

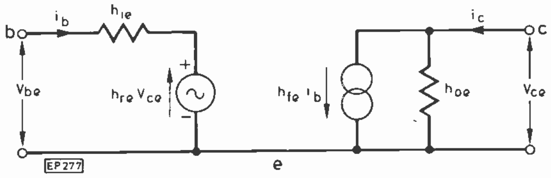


Fig. 5. Hybrid parameter circuit

Where i indicates input, o output, f forward, r reverse, e common emitter. Solving the equations for various circuit conditions:

$$h_{ie} = \frac{v_{be}}{i_b}\Bigg|_{v_{ce}=0}$$ input resistance with output short-circuit (ohms)

$$h_{re} = \frac{v_{be}}{v_{ce}}\Bigg|_{i_b=0}$$ reverse voltage ratio with input open-circuit (ratio)

$$h_{fe} = \frac{i_c}{i_b}\Bigg|_{v_{ce}=0}$$ forward current gain with output short-circuit (ratio)

$$h_{oe} = \frac{i_c}{v_{ce}}\Bigg|_{i_b=0}$$ output admittance with input open-circuit (mhos)

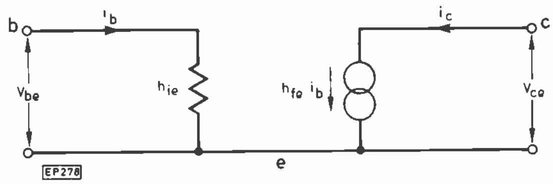


Fig. 6. Simplified hybrid parameter circuit

This current, which should be as small as possible in a good transistor, is termed I_{ceo}, the 0 suffix indicating that it is measured with the base open circuit. This leakage current flows in addition to the required collector current, and so the actual collector current $I_c = \beta I_b + I_{ceo}$, where β is the current ratio I_c/I_b, which is the ratio of output current to input current or current gain. This is an important parameter in circuit design, and β, which is called the common-emitter current gain, is usually found on data sheets as h_{fe}.

HYBRID PARAMETERS

The h parameters are derived from a model of the transistor. Fig. 4 shows this for small signal changes about an operating point, and is known as the hybrid-parameter equivalent circuit for a common emitter bipolar transistor. The input side consists of the base circuit resistance h_{ie} and a voltage generator to take account of the junction potential, and it produces a voltage given as $h_{re} \cdot V_{ce}$, where h_{re} is the reverse voltage transfer ratio. The output side consists of a current generator which produces a current given by $h_{fe} \cdot i_b$ (small letters indicate small signals) or i_c, and a parallel resistance which covers the output admittance (inverse of resistance) h_{oe}. The parameters are defined by the following two equations:

input voltage $v_{be} = h_{ie} \cdot i_b + h_{re} \cdot v_{ce}$
output current $i_c = h_{fe} \cdot i_b + h_{oe} \cdot v_{ce}$

Of these parameters h_{re} and h_{oe} are usually very small, and consequently they are often neglected in circuit calculations in order to simplify things. Fig. 6 shows the simplified model, using just h_{fe} and h_{ie}, and Fig. 7 shows a common-emitter amplifier with its (simplified) model equivalent circuit.

As may be expected, the larger the current flowing through a semiconductor device, the larger the quantity of heat which is dissipated through the bulk of the material. There comes a point when the material has too high a current flowing through it to allow the necessary rate of dis-

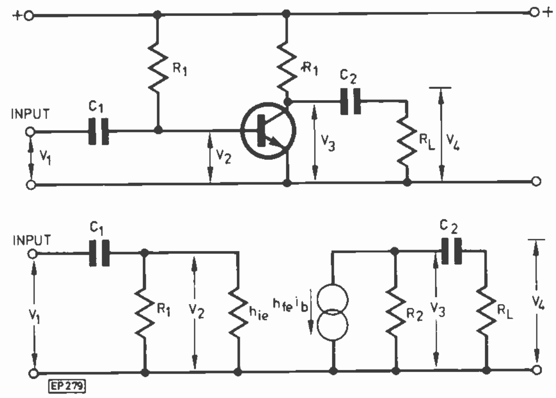


Fig. 7. Simple common emitter amplifier and its hybrid equivalent circuit

sipation for safe operation. This results in the destruction of the device, and you will find stated in data sheets the maximum collector current above the device will break down—i_c max.

POWER DISSIPATION

The manufacturer also quotes the maximum power dissipated by the transistor, and when this power has been reached it must equal the electrical power input, given approximately by $V_{ce} \cdot I_c$, and, of course, must not be exceeded. It may be necessary to calculate the power dissipation of a transistor when mounted on a heatsink, in which case the following equation would be used:

$$P_{max} = \frac{(T_j - T_a)}{(\theta_1 + \theta_2 + \ldots)}$$

Here T_j is the maximum junction temperature for safe operation, and T_a is the ambient air temperature around the device (which will probably be above room temperature, because of the surroundings). θ_1 is the thermal resistance between the junction and the transistor mounting base, and can be found on the data sheet as $R_{th(j\text{-}case)}$ and it is expressed in C°/mW. θ_2, θ_3 etc., are the thermal resistances of all other components in the heat flow path to, and including, the heat sink.

One final point, while considering temperature, I_{ceo} is very much temperature dependant so any quoted value must be at a stated temperature (usually room temperature) and steps must be taken in a design to exclude the effect of temperature. ★

News Briefs

LITERATURE AVAILABLE

INTEL (UK) have just published a 20-page brochure, called *Intelligence*, which provides a brief description of all their microcomputer families as well as the most popular memory products. The main characteristics of each family is discussed in turn and brief details of the support available are given. The brochure is intended for engineers who are unfamiliar with Intel's product range and is available free of charge. Details from—Intel Corporation (UK) Ltd., Dorcan House, Eldene Drive, Swindon, Wiltshire SN3 3TU.

Greenweld have produced a new 1980 catalogue. Lots of new lines have been added and to cater for the bulk buyer quantity prices on many lines are included. There are also many reductions in prices.

Included with every catalogue is a bargain list and 60p of discount vouchers.

The new Vero catalogue will be included in the despatch as soon as these are available.

Price of all this? 40p plus 20p postage from—Greenweld, 443 Millbrook Road, Southampton SO1 0HX.

IEETE LAUNCHES TRAINING SCHEME

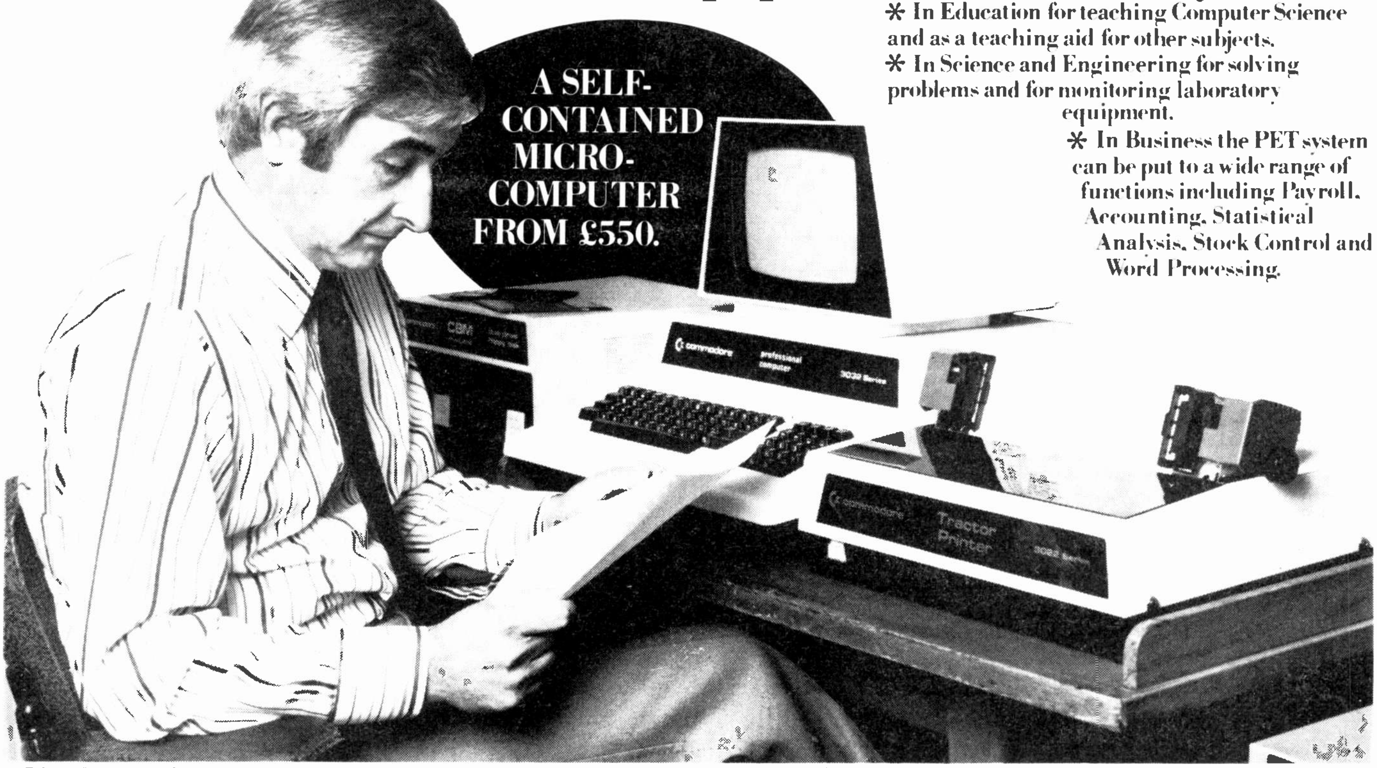
THE Institution of Electrical and Electronics Technician Engineers (IEETE) has just published comprehensive training requirements for Technicians in electrical and electronic engineering. The scheme follows the pattern adopted for Technician Engineers, published by the Institution in 1977, and is designed to be supplemented by programmes applicable to the different sectors of industry. Organisations conducting training schemes to meet their own specific needs are being encouraged to submit them to the Institution for approval.

The publication of the two IEETE schemes highlights the importance of sound practical training in the qualifying process which, combined with an appropriate academic award, ensures that Technician Engineers and Technicians are equipped to meet the demands of rapidly advancing technology.

Further information and copies of both schemes are available from The Secretary, IEETE, 2 Savoy Hill, London WC2R 0BS. Telephone 01-836 3357.

Your Commodore PET System

The Commodore PET is Britain's best selling microcomputer and the most popular choice in every field:–



* In Education for teaching Computer Science and as a teaching aid for other subjects.
* In Science and Engineering for solving problems and for monitoring laboratory equipment.
* In Business the PET system can be put to a wide range of functions including Payroll, Accounting, Statistical Analysis, Stock Control and Word Processing.

Not least of its attractions is the price of a PET – from £550 for a self contained unit, to under £2,500 for the complete system including Floppy Disk Unit and high-speed Printer. Ask your nearest Commodore dealer below for details about Commodore hardware, software and training courses.

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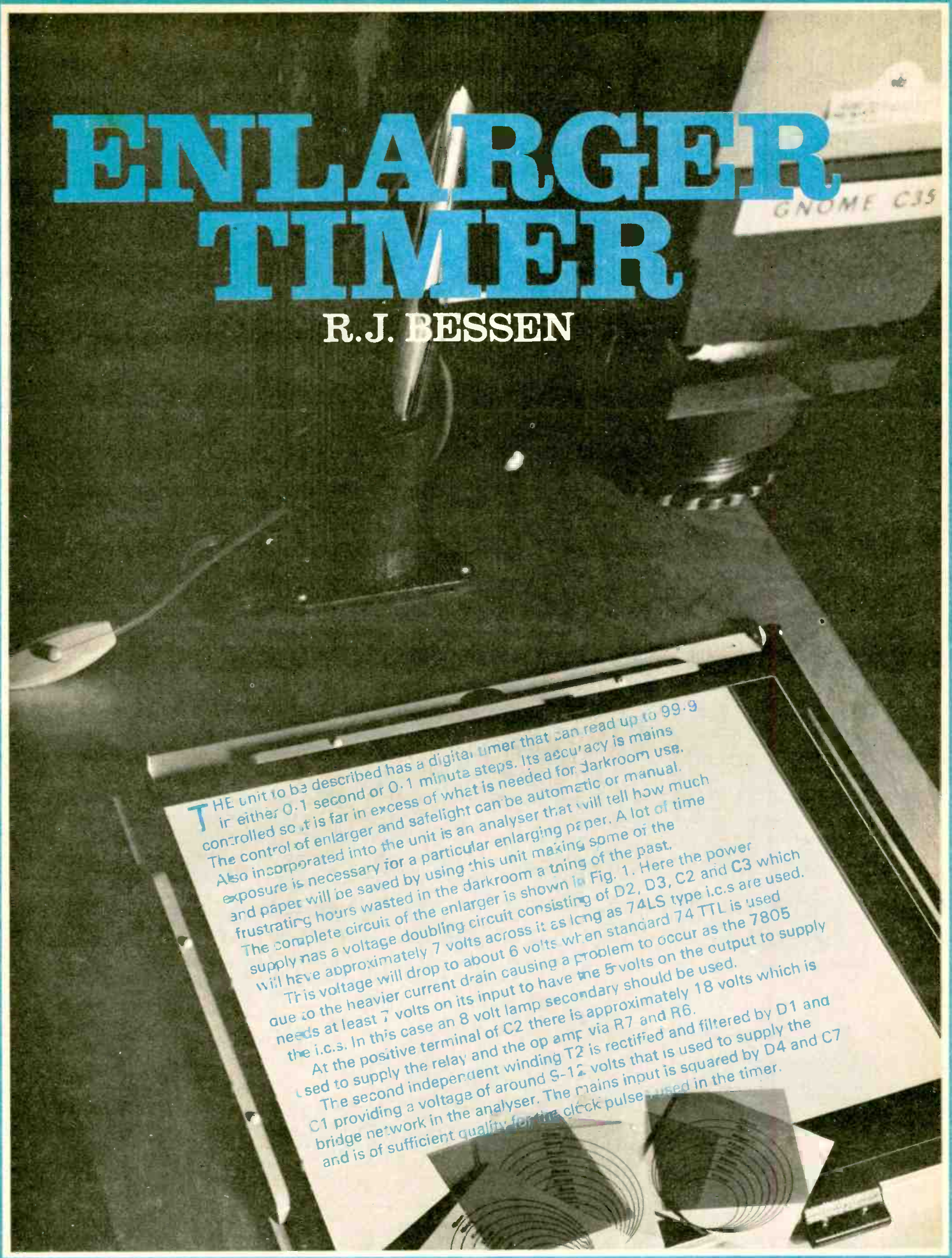


ENLARGER TIMER

R.J. BESSEN

THE unit to be described has a digital timer that can read up to 99·9 in either 0·1 second or 0·1 minute steps. Its accuracy is mains controlled so it is far in excess of what is needed for darkroom use. The control of enlarger and safelight can be automatic or manual. Also incorporated into the unit is an analyser that will tell how much exposure is necessary for a particular enlarging paper. A lot of time and paper will be saved by using this unit making some of the frustrating hours wasted in the darkroom a thing of the past.

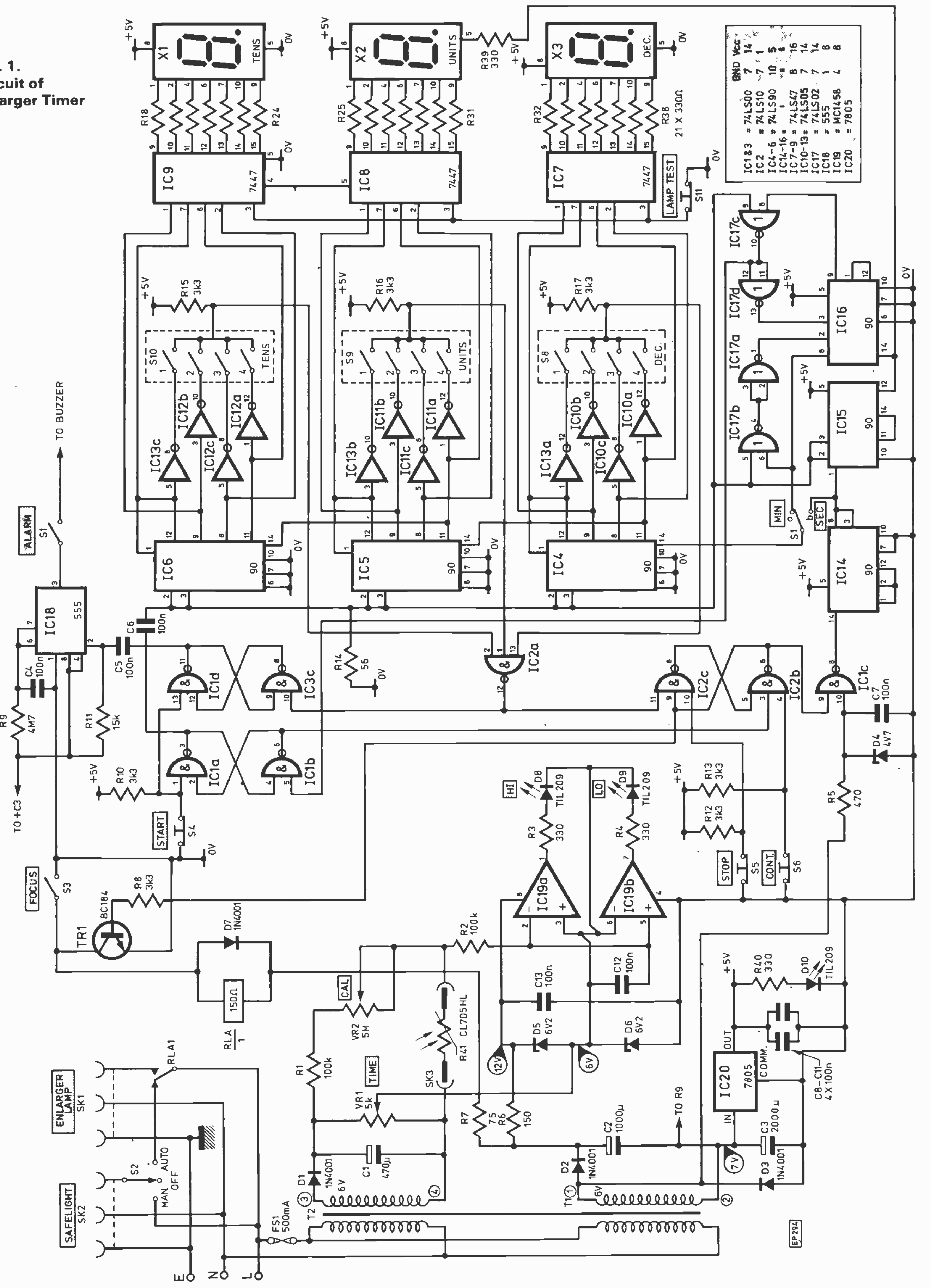
The complete circuit of the enlarger is shown in Fig. 1. Here the power supply has a voltage doubling circuit consisting of D2, D3, C2 and C3 which will have approximately 7 volts across it as long as 74LS type i.c.s are used.

This voltage will drop to about 6 volts when standard 74 TTL is used due to the heavier current drain causing a problem to occur as the 7805 needs at least 7 volts on its input to have the 5 volts on the output to supply the i.c.s. In this case an 8 volt lamp secondary should be used.

At the positive terminal of C2 there is approximately 18 volts which is used to supply the relay and the op amp via R7 and R6.

The second independent winding T2 is rectified and filtered by D1 and C1 providing a voltage of around 9-12 volts that is used to supply the bridge network in the analyser. The mains input is squared by D4 and C7 and is of sufficient quality for the clock pulse used in the timer.

Fig. 1.
Circuit of Enlarger Timer



ANALYSER

The analyser section has a bridge network consisting of VR1 (known as the time dial) forming two arms, the third is R1, which is the reference from which the time dial is calibrated, against the resistance of the cadmium sulphide cell that makes up the fourth arm. VR2 is used to calibrate the unit for various speeds and makes of paper. Across the bridge is the 9 volt supply, which provides the potential and polarity at the output depending upon the resistance of the cell and where the wiper arm of VR1 is set (disregarding VR2 for the moment).

When the wiper of VR1 is at the zero side of the 9 volts the voltage appearing at the wipers (being the output of the bridge) will be out of balance. The negative output goes to the input of the op amps which will have a positive output if the inverting input is more negative than the non inverting input.

It should be noted that the inputs of the two op amps are reverse connected so that when there is a voltage at their inputs their outputs are out of phase i.e. one will have a positive output and the other will have a negative output. Since VR1 wiper of the bridge goes to (—) of IC19b and (+) of IC19a only the former will have a positive on its output causing D9 to be forward biased and illuminating it. This l.e.d. is termed low ('lo'), meaning that VR1 needs to be rotated to a higher dial reading. Moving VR1 wiper towards positive will eventually balance the bridge so that there is no voltage across the inputs of the op amps.

As the wiper arm of VR1 passes through balance the output of the bridge will now be positive with respect to VR2 wiper causing IC19a to have a positive output bringing on D8 ('hi').

TIMER

The timer section can be divided into three areas, clock, control and counter with display. Decade counters make up the clock circuit deriving its timing from the mains frequency. The input is squared by D4 and C7 then passed to IC14 which divides by 5 to give a 0·1 second pulse that goes to S7 and to IC15 which further divides by 10. A 1 second pulse will result that is used to indicate the decimal point on the three digit display, as well as going into IC16 to divide it by 6 to give a 0·1 minute clock pulse. This pulse also goes to S7 which will select whether the display, that can read up to 99·9, will be in minutes or seconds.

Pins 2 and 3 of the 7490 chips are the reset pins and if both of these go high the b.c.d. output will be zero, and will stay that way until one or both inputs go to a low. When these chips are used as straight decade dividers resetting them is easy, however, as pins 2 and 3 of IC16 are used to reset automatically when the count reaches 6 it becomes slightly more complex to reset it to zero on demand. IC17 wired as two OR gates solves the problem.

Under operating conditions pins 5 and 9 of IC17 have a low on them that has no effect, allowing the outputs 8 and 9 of IC16 to pass through the NOR gates to 2 and 3 of IC16. When the reset pulse comes along the high that is now on pins 5 and 9 of IC17 will pass onto 2 and 3 of IC16 regardless of what is on 6 and 8 of IC17. If this resetting wasn't done, clock errors could occur in the minute timing because at the first clock pulse there could be a number stored in IC16 which may only need another pulse on its input to give an output pulse. In other words 0·1 minute will be on the display yet only 1 second has passed.

The control circuitry consists of IC1 and IC2 and three thumbwheel switches, S8, 9 and 10. When S4 is pushed the debounce circuit IC1a and IC1b does two things, the low going pulse at pin 6 sets a second bistable IC2c and IC2b to put a high on pin 9 of IC1c to enable the 50Hz on pin 10 to get through, as well as turning TR1 on that energises the relay to bring on the enlarger. A second function of the high going pulse at IC1a, pin 3 is to reset all the 7490s, and since R14 ties the reset line to a low, and C6 stops the high on pin 3 of IC1a from having any further effect on them, they will commence to count at the same time the enlarger comes on. After 2 seconds a low appears on pin 5 of IC1b that comes from pin 10 of IC17 and is used to reset the debounce circuit for further timing.

A problem occurs with this arrangement in that timing cannot be achieved below 2 seconds, because until this circuit is reset a low appears on pin 3 of IC2b. This stops IC2b/2c from being reset by the low going pulse that will come from pin 12 of IC2a when the time set by the thumbwheel switches is achieved, however it is extremely unlikely that the enlarger will be on for less than 2 seconds. One advantage of using this pulse to reset the debounce circuit is that a SPDT push button is not necessary.

Two other push buttons are used in the control circuitry and they are S5 and S6. S5 will stop the count by resetting IC2b/2c putting a low on IC1c inhibiting the 50 Hz and turning the enlarger off with the display not affected by this action. To continue the timing, S6 is pushed setting IC2b/2c, allowing the 50Hz to pass once more. These switches allow the exposure to be stopped and then commenced again without losing track of the time.

COUNTER AND DISPLAY

The counter and display section is made up of a very common circuit in three decade counters ICs 4, 5 and 6 with seven segment displays driven by ICs 7, 8 and 9. Connected to the b.c.d. outputs of IC4, 5 and 6 are hex inverters, connected to form buffers between the decade counters and thumbwheel switches S8, 9 and 10. The buffers are necessary because whatever number is selected it is connected to the common, e.g. if 5 is selected 1 and 4 are commoned, consequently without the buffers pins 8 and 12 of the 7490 would also be connected giving a false display.

When the time that is selected by the thumbwheel switches is reached the b.c.d. output from the 7490s will match the b.c.d. of the switches which now will have a high on all commons. These highs go to IC2a putting a low on its output pin 12 which resets IC2b/2c stopping the count and turning the enlarger off. The elapsed time will be on the display and will stay there until the start button is pushed.

ALARM

The remaining circuitry consisting of a 555 chip IC18 and a bistable IC1d and IC3c is used to turn on an alarm via S1. As mentioned when the timer reached its count a low appeared on pin 12 of IC2a. Besides being responsible for stopping the count it is also used to reset IC1d and IC3c. When this happens the low going pulse at pin 11 of IC1d is differentiated by C5/R11 which triggers IC18, that is wired up as a monostable, to give a high out of pin 3 to energise a small solid state buzzer.

The time the buzzer will be on depends upon the RC network R9/C4 which will be about 1 second with the components in circuit.

The purpose of the bistable is to stop the 555 from triggering every time the thumbwheel switches are moved. By its action no more trigger pulses can appear until it is set again by pushing the start button S4.

Leading zero blanking can be wired into the circuit if desired as well as lamp test.

The switch S2 associated with the safelight is wired so that in the auto position RLA1 will control when the safelight

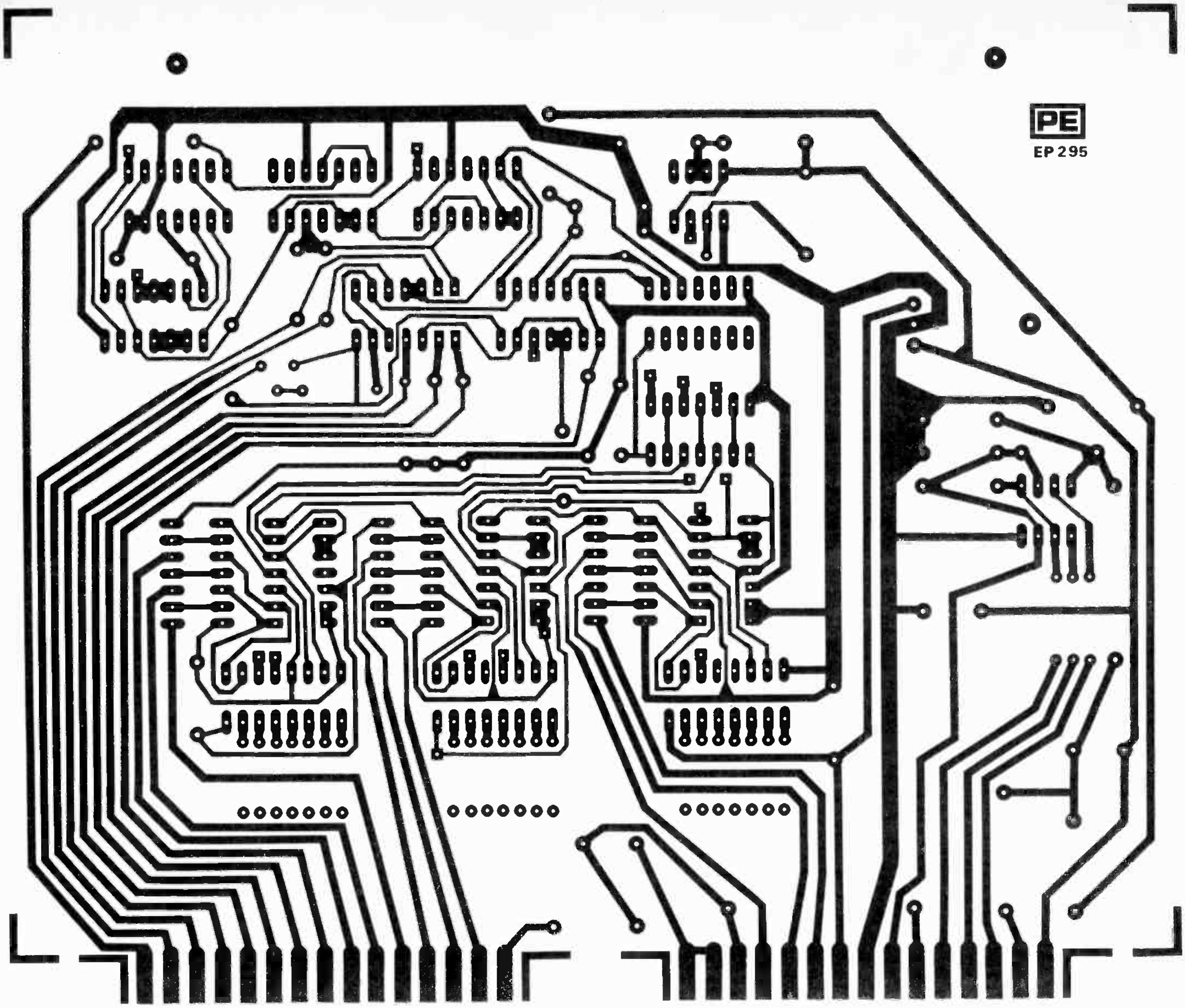


Fig. 2. Underside of printed circuit board

is on, i.e. with the enlarger on the safelight is off and vice versa. In the manual position the safelight is on all the time. This allows working with black and white papers (cutting, developing) while the timer is being used for the developing of films. It saves unplugging the safelight and putting it in a wall plug.

The timer is very useful in controlling motorised agitators when developing films or colour paper and this is what was in mind when the buzzer circuit was put in as it allows other work to be carried out, without having to constantly worry about the time.

S1 keeps the alarm from sounding which can be annoying when exposing paper. For colour work the safelight switch is put in the off position.

CONSTRUCTION

It is recommended that the double sided p.c. board shown be used due to the number of i.c.s in the circuit. The cost of the board is a small price to pay for the ease in constructing the circuit. If using the board begin at the bottom section of the board by inserting and soldering pieces of wire at the pads that have a dot next to them as these are used to connect both sides of the board together. Under two of the 7447 chips there are pads that have two dots and these will also have to have the wire "pins" if leading zero blanking is required. There should be 14 joins plus the two for blanking.

The i.c. sockets can now be inserted if they are to be used otherwise solder the chips direct to the board making sure they are correctly orientated by taking note that on the top of the board pin 1 is marked for all chips as is the last two digits for all the TTL i.c.s. After making sure all the pins on the chips are soldered insert the diodes and resistors and solder them on the bottom side of the board. Turn the board over and you will notice that some of the components go through pads which have to be soldered to the component leads as they are also used to complete the circuit from top to bottom, as do some of the capacitors that can now be inserted.

Finally the regulator chip can be mounted by carefully bending the leads so that the hole through the metal tag will line up with the one in the board having the copper area that is the heat sink. This now completes the main board.

The display board is fairly straightforward as it only has the three displays and R40 which is used to limit the current to D10 which is the indicator for the calibration dial. A 40 pin 0·6in socket can be used if desired.

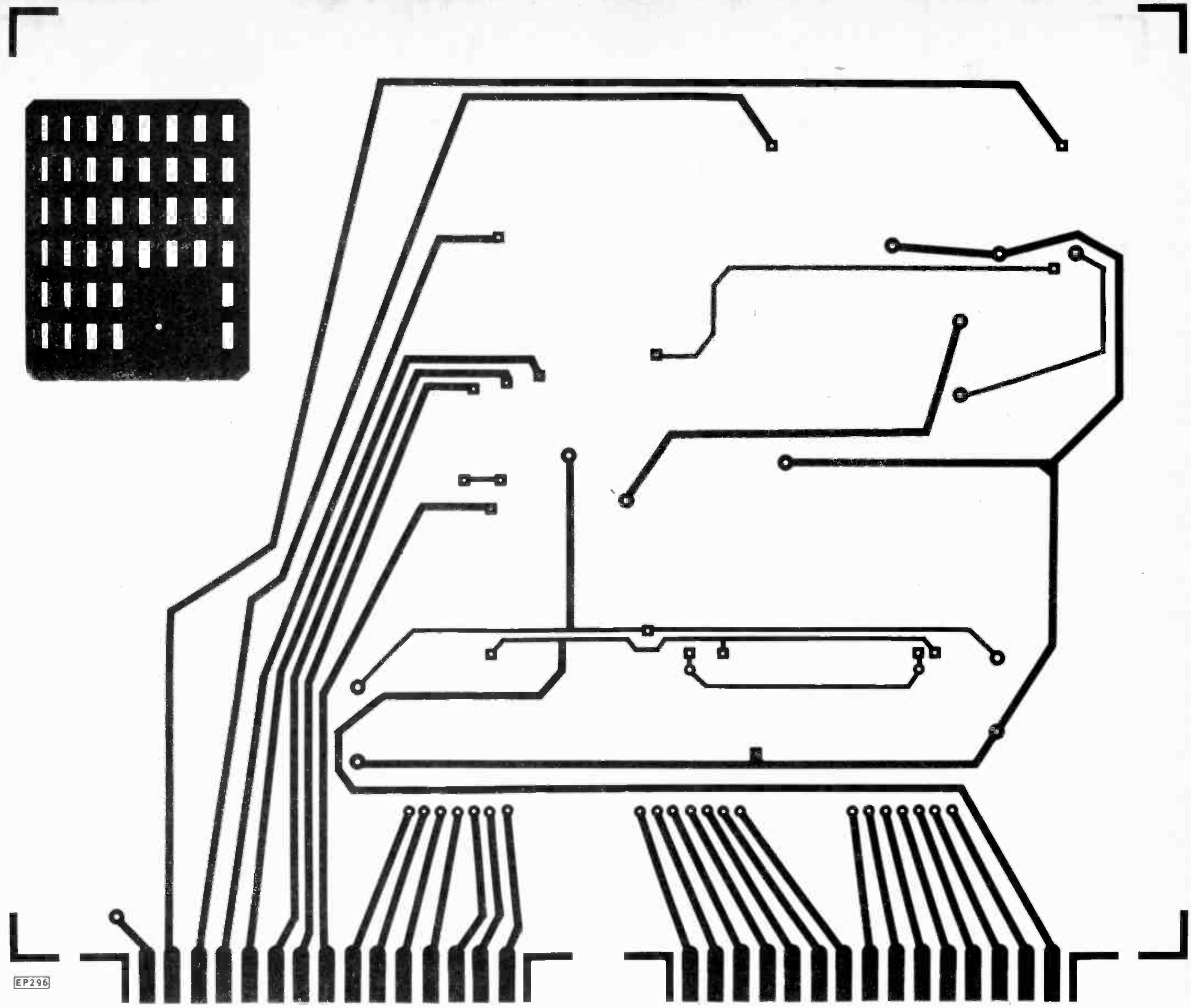


Fig. 3. Topside of printed circuit board

Mounting and wiring the mains voltage components should now commence paying attention to the safelight switch and making sure the lamp sockets bypass the fuse. A power switch can be mounted on the back of the panel if desired. Once all the chassis mounting components are in place (all but the main board) the wiring of the board to the chassis can go ahead. The board should ideally be mounted in edge connectors that are mounted on the front panel.

Ribbon cable is a definite advantage especially for the displays and b.c.d. switches, heavier gauge wire will be necessary for the 6 volts from the transformers. After checking the wiring you are in a position to turn the unit on.

TESTING

Place the alarm switch on, sec/min switch to sec., focus to off, safelight to auto and the three thumbwheel switches on 111. When power is applied the buzzer will sound and a random number will appear on the display that will read 0 when the start button is pushed. The display should now be counting at a 0·1 second rate and will continue so until either the stop button is pushed or the count reaches 111. If the stop button was pushed, the continuous button once pushed will allow the count to continue until 111 is reached. Failure for this to happen or if the count stops at some other number then the odds are the thumbwheel switches are wired up incorrectly.

While the unit is counting the decimal point in the units display will be flashing at a second rate and anything plugged into the enlarger socket will be on. This will go off at the end of the count and whatever is plugged into the safelight socket will come on. Flicking the focus switch to on will switch the enlarger on and turn off the safelight that can be turned back on by placing the safelight switch to manual. The only time the buzzer should sound (other than when the unit is first turned on) is when the display reaches whatever is set by the thumbwheel switches.

DIALS

The two dials are made of 3in diameter perspex and are shown full size in Fig. 5. Calibration batons and numerals can be used from Letraset. Accuracy of the time dial depends upon the quality (tolerance) of the 5k lin potentiometer and if in doubt it will be necessary to calibrate your own dial using 1 or 2 per cent resistors.

Four 100k and four 10k in parallel and series combinations will give all the times necessary.

For the CL705HL cell the following values with times, will

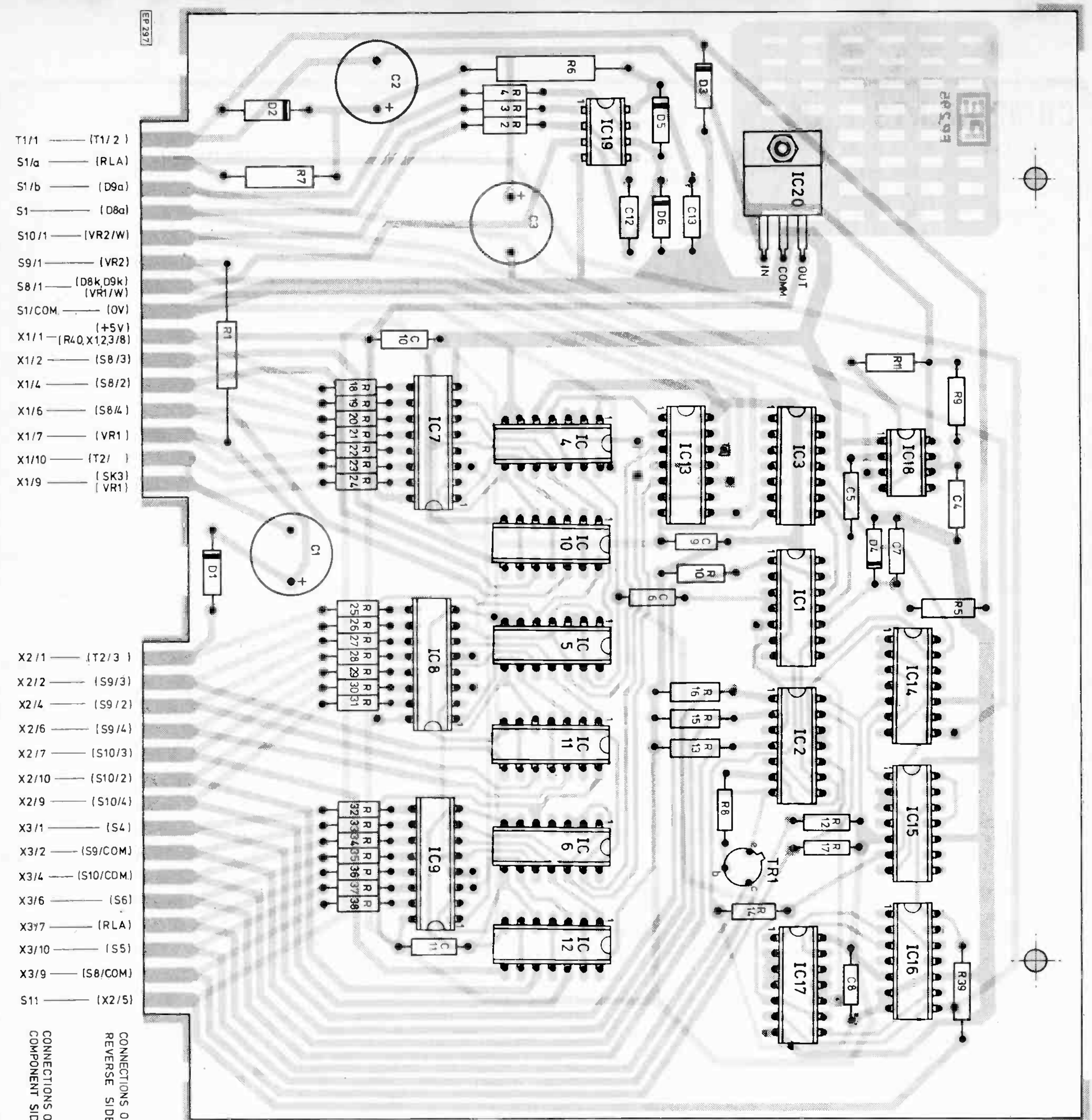


Fig. 4. Component overlay for the printed circuit board

be needed, 10k for 1 sec, 20k for 2 secs, 100k for 10 secs, 150k for 15 secs etc. These resistors take the place of the cell during calibration with the calibration dial at 0.

To zero calibrate short out VR2 with a piece of wire. The hole in the centre of the dials need to be enlarged to just over $\frac{3}{8}$in so that it clears the potentiometer mounting screw. Ideally, D8 and D9 should be a dual colour type l.e.d. that is situated under the time dial both to partially illuminate the dial and act as a marker. D10 is a single red type used to illuminate the cap dial.

The advantage of the dual type is that it will always be on so at, or near, balance the dial reading can easily be seen.

COMPLETION

In the prototype the fascia panel was made up of thin gauge aluminium as it is not loaded. Two bends are introduced to produce a sloping front and the whole drilled to suit components purchased.

USING THE ANALYSER

There are two basic methods of taking readings, one is the integrated (average) that uses a diffusion screen under the lens to give an average light to the cell and is the method that I use on most occasions. If the negatives are not average then the spot method may have to be used. Separate calibrations are necessary for both methods.

INTEGRATED METHOD

Make a test print using an "average" negative. Select what you consider to be the best exposure as the analyser accuracy for all future exposures depends upon this step. Say 10 seconds gave the best print. Leaving the enlarger exactly as it was for the test print put the cell on the masking frame.

The diffusion screen is placed under the lens making a note where you put it as it needs to be in the same position for future prints. A good idea is to make a holder similar to the one used to hold the red filter that is on most enlargers.

COMPONENTS . . .

Resistors

R1	100k 1%
R2	100k
R3, R4	330 (2 off)
R5	470
R6	150 2W
R7	75 1W
R8	3k3
R9	4M7
R10	3k3
R11	15k
R12, R13	3k3
R14	56
R15-R17	3k3 (3 off)
R18-R40	330 (23 off)

All 5% $\frac{1}{4}$W carbon film

Capacitors

C1	470µ 16V elect
C2	1000µ 16V elect
C3	2000µ 16V elect
C4-C12	100n (9 off)

Diodes

D1-D3	1N4001 (3 off)
D4	BZY88C-4·7
D5-D6	BZY88-6·2 (2 off)
D7	1N4001
D8-D10	TIL209 (3 off)

(D8-D9) preferably MV5491, XC5491 two colour l.e.d.)

Integrated Circuits

IC1	74LS00
IC2	74LS10
IC3	74LS00
IC4-IC6	74LS90
IC7-IC9	74LS47
IC10-IC13	74LS05
IC14-IC16	74LS90
IC17	74LS02
IC18	555
IC19	MC 1458
IC20	7805

Transistor

TR1 BC184

Photocell

R41-CL705HL (Clairex)
Ace Mailtronix, Tootal St., Wakefield, West Yorkshire

Switches

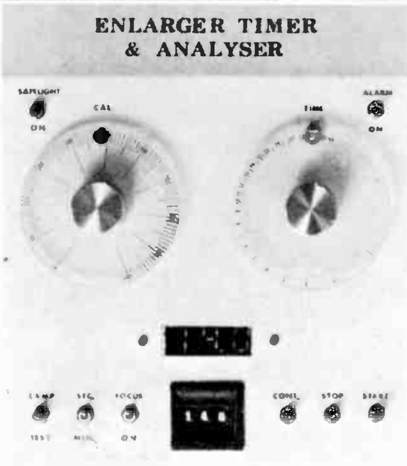
S1	Single pole on/off
S2	Single pole three way
S3	Single pole on/off
S4	Press to break
S5	Press to break
S6	Press to break
S7	Single pole change over
S8-S10	BCD thumbwheel (3 off)

Displays

X1-X3 FND507 (3 off)

Miscellaneous

Miniature buzzer 6-9V, 15mA, T1-Mains transformer with independent 6V, 0·5A independent secondaries (R.S. 207-194)



Control fascia of timer. The enlarger, safelight and probe sockets are arranged at the back. 'Hi' and 'Lo' l.e.d.s appear at either side of the display

Now with the time dial on 10 seconds and with the safelight switch in auto (as the cell is sensitive to all colours) adjust the calibration dial until the l.e.d.s are both on and make a note of the reading on the calibration dial. Whenever that brand and grade of paper is used, just set the calibration dial to it. If you use several types of paper make a calibration for all of them.

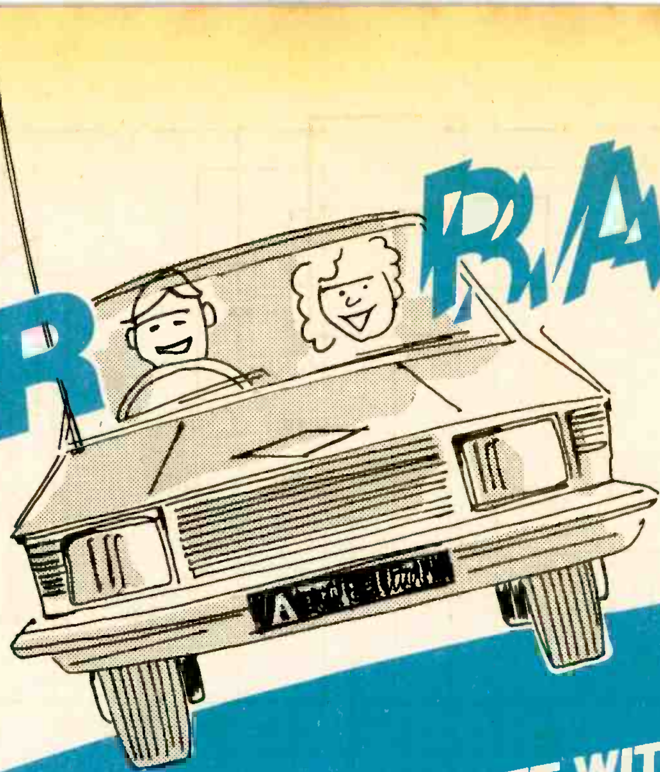
SPOT METHOD

The only difference between this method and the integrated one is the diffusion screen isn't used and the cell looks at a shadow (brightest portion).

A diffusion screen can be made from a piece of perspex that has been rubbed with a piece of fine emery paper. Another suitable material is draughtmen's tracing film or they are available from photographic shops. ★

Fig. 5. Full size details of dials

CAR RADIO



A 5 PUSH BUTTON SET WITH A 6W OUTPUT

THE PE Traveller car radio has been designed around a pre-aligned tuner unit, ceramic filter and 6 watt audio amplifier i.c. The result of this design is a receiver which is straightforward in both construction and alignment. The Traveller, which costs approximately half the price of an equivalent commercial car radio and is available in complete kit form from RTVC, achieves an excellent performance, with one long wave and four medium wave push buttons and includes tone control.

CIRCUIT DESCRIPTION

The complete circuit diagram of the Traveller is shown in Fig. 1. The aerial signal which is fed to the aerial tuning circuit via the r.f. choke L1 is impedance matched to the wide band amplifier designed around TR1. The input to this amplifier is protected against static discharge by the voltage dependent resistor (R1).

The output of the wide band amplifier (TR1 collector) is fed to the input of mixer/oscillator circuit. The resistor R8 sets the internal a.g.c. range of the pre-aligned i.f. module and a second a.g.c. line is fed to the input of the wide band amplifier via resistor R7. The value of this resistor can be altered to adjust the sensitivity of the receiver or a 100k preset resistor can be used. Any adjustment of the sensitivity will of course be a compromise between sensitivity, signal handling, interference etc. The maximum signal capacity of the set can be achieved by ensuring TR1 is ultimately reverse biased by the a.g.c. circuit. However, one problem encountered when using an amplifier in front of a self oscillating mixer is r.f. blocking.

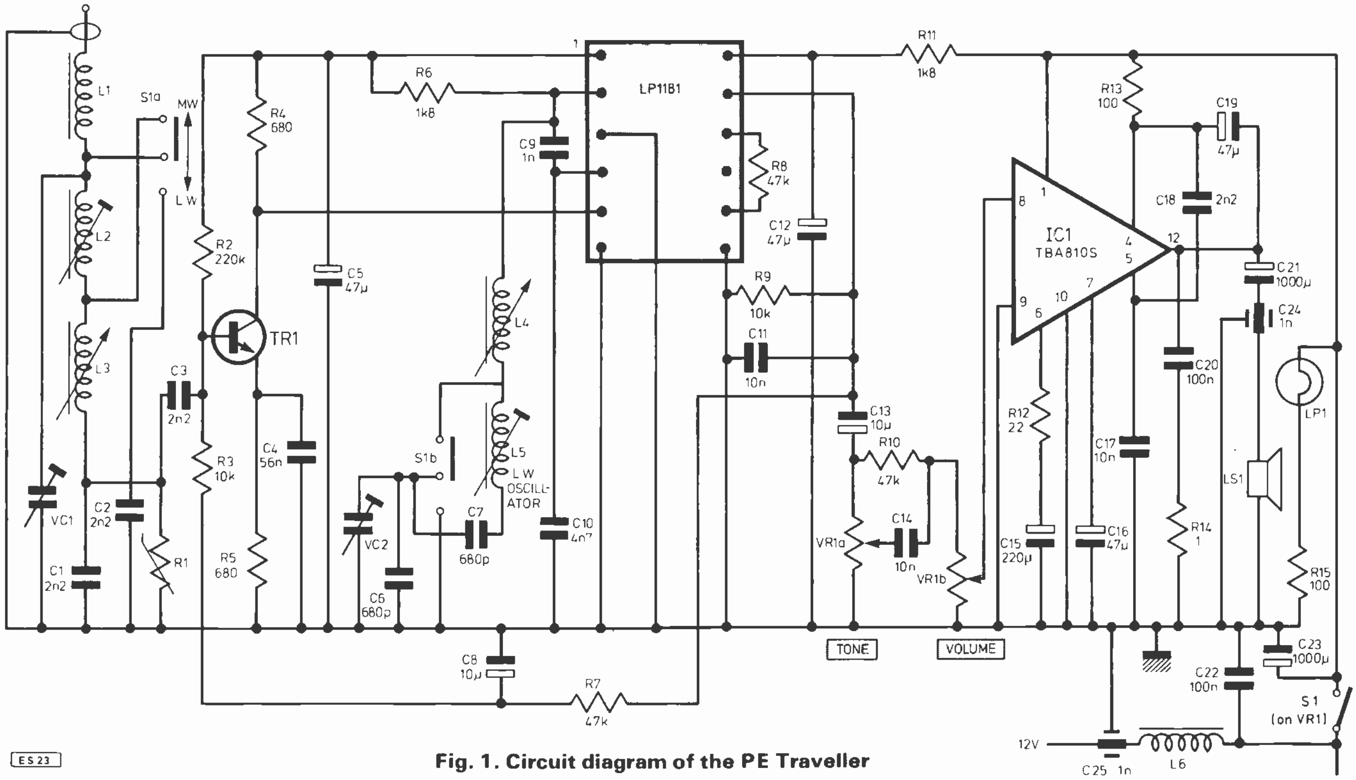


Fig. 1. Circuit diagram of the PE Traveller

When a receiver is rapidly tuned to a strong carrier (by push buttons) a very large signal can appear at the mixer input before the a.g.c. has time to operate. The oscillator may be prevented from operating and the receiver will be blocked. This can be avoided by keeping the r.f. amplification much lower than could otherwise be achieved.

The i.f. signal output of the LP1181 module is decoupled by C8 and fed to the input of the audio amplifier (IC1) via the tone and volume controls. The TBA 810S is a 12 lead quad in-line i.c. which will provide a 6W output at 14·4V with a maximum current of 2·5A. The audio i.c. which has a thermal limiting circuit can withstand a short circuit on the load with supply voltages up to 15V.

CONSTRUCTION

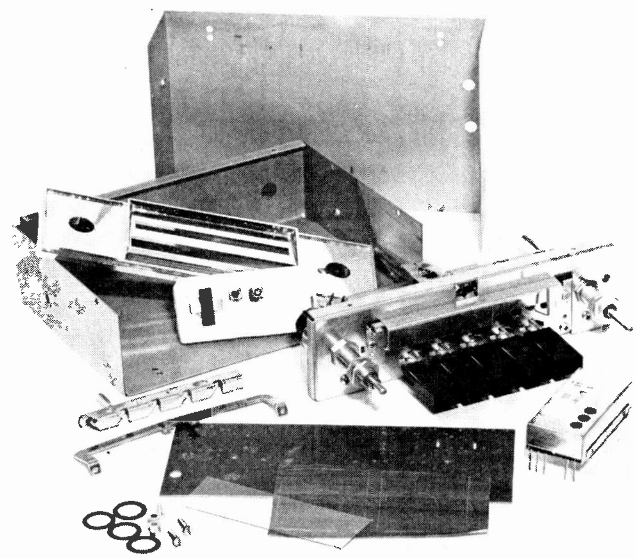
The printed circuit board design of the Traveller is shown in Fig. 2 with the component layout in Fig. 3. The smallest components should be fitted first and care should be taken when soldering IC1 and TR1 that excess heat is not applied to them. When fitting the r.f.–i.f. amplifier module ensure the orientation is correct by using the position of the three holes shown in Fig. 3. After the p.c.b. has been assembled, cut all the excess leads from the components including the pins above the wave change switch S1. Carefully check the orientation of the electrolytic capacitors and the transistor TR1. Also check that there are no solder splashes shorting out the p.c.b. tracks.

A small modification should be carried out to the tuner unit before the p.c.b. is fitted. The switch bar at the back of the tuner should be removed and the modified switch bar and p.c.b. mounting bracket fitted in its place. Take care not to disturb the slide biasing spring fitted underneath the switch bar. A self tapping screw should be used to "tap" the two holes on the mounting bracket.

The tone, volume and on/off switch S2 should be fitted to the tuner unit and the capacitor C14, resistor R10 and wire links soldered as shown in Fig. 4. The p.c.b. can now be mounted onto the tuner unit using two self tapping screws

SPECIFICATION

Frequency range	m.w. 540kHz – 1620kHz l.w. 150kHz – 260kHz
Intermediate frequency	470kHz
Sensitivity	Typically 2µV @ 1MHz
Power output	6 watts r.m.s.
Speaker impedance	4 to 15 ohms (max power into 4 ohms)
Polarity	Negative earth only



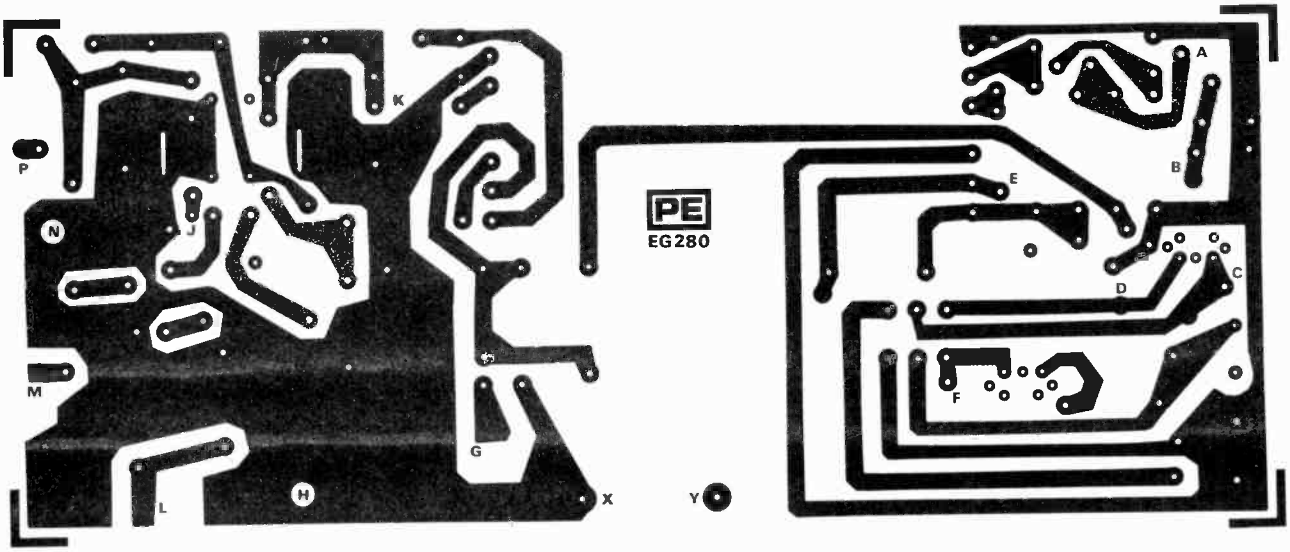


Fig. 2. Printed circuit board design

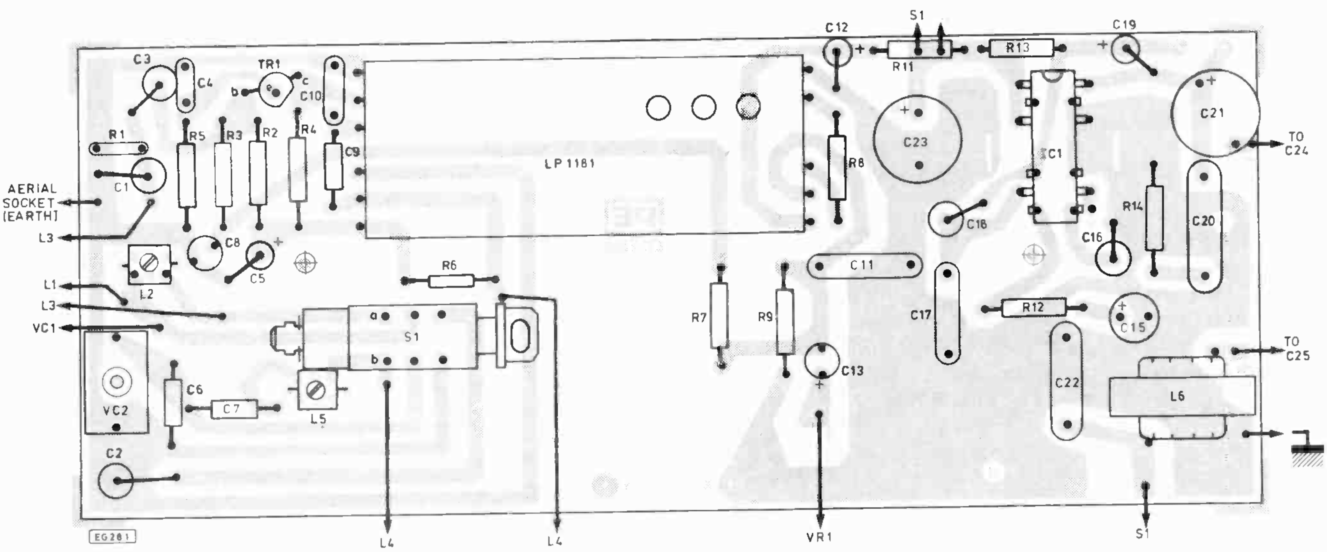
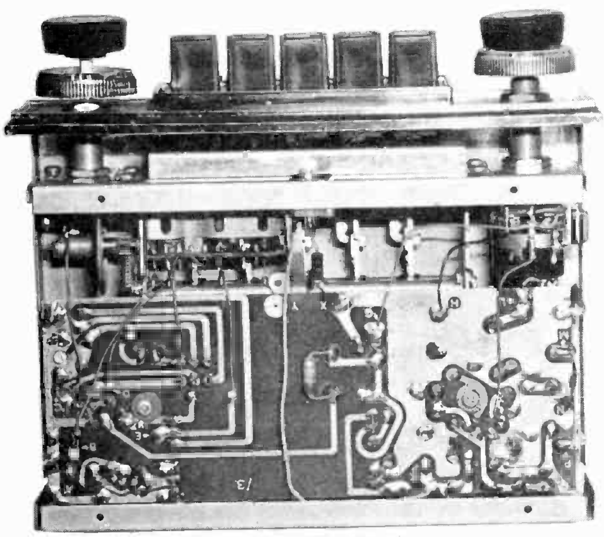
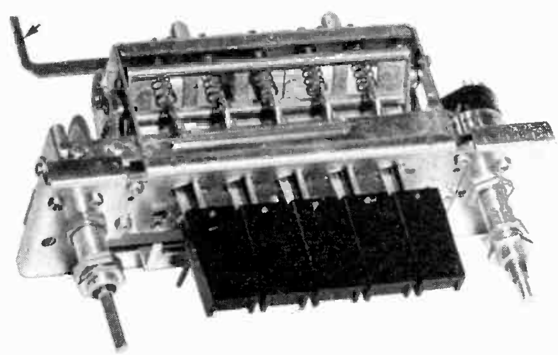


Fig. 3. Component layout





The switch bar (shown arrowed) should be removed and the modified unit screwed on to the tuner in its place. Check the operation of the push-buttons before the printed circuit board is fitted into position.

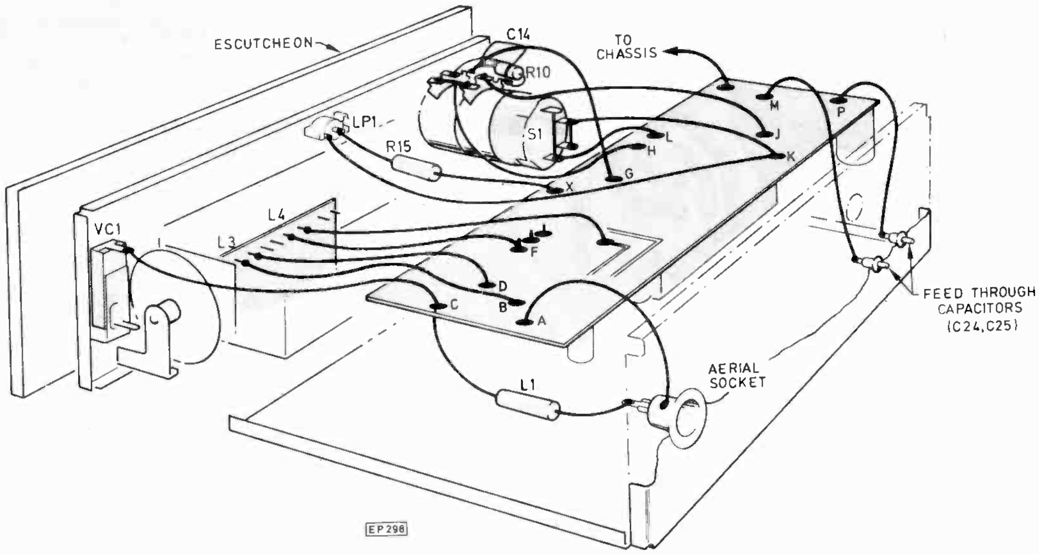


Fig. 4. Complete wiring diagram for the Traveller

COMPONENTS . . .

Resistors

R1	VDR 6V
R2	220k
R3, R9	10k (2 off)
R4, R5	680 (2 off)
R6, R11	1k8 (2 off)
R7, R8, R10	47k (3 off)
R12	22
R13, R15	100 (2 off)
R14	1

All resistors ½W 10% carbon

Potentiometers

VR1	Dual concentric log with on/off switch (approx. 20k)

Capacitors

C1, C2, C3, C18	2n2 (4 off)
C4	56n
C5, C12, C16, C19	47μ (4 off)
C6, C7	680p (2 off)
C8, C13	10μ (2 off)
C9	1n
C10	4n7
C11, C14, C17	10n (3 off)
C15	220μ
C20, C22	100n (2 off)
C21, C23	1000μ (2 off)
C24, C25 (feed through capacitors)	1n (2 off)
VC1	Attached to tuner approx. 80p max
VC2	140p max

Semiconductors

TR1	BF394 or BF195
IC1	TBA 810S

Miscellaneous

LP1181 r.f. – i.f. module. Tuner unit. P.c.b. Control knobs. Aerial socket

L1 r.f. choke, L2, L5 l.w. coils L3, L4 attached to tuner, L6 supply choke.

Constructor's Note

A complete kit of parts for the Traveller is available from **Radio & TV Components (Acton) Ltd., 21 High Street, Acton, London W3 6NG.** The price is £10·50 plus £1·75 p.&p. (pack 7).

with insulated washers. Before tightening the screws ensure the switch bar lug is located into the arm of S1. The operation of the wave change switch (S1) should then be checked by pressing the two push buttons nearest the tuning control. The movement should be the same in both directions. If necessary release the screws and adjust the position of the p.c.b. until the switch movement is correct.

The indicator lamp LP1 should be fitted next and the p.c.b. should be wired to the tuner unit (Fig. 4). The back panel of the radio should be drilled to accept the battery and speaker feed-through capacitors (C24, C25) (Fig. 4). Before soldering the battery and speaker capacitors clean the panel and terminals with emery cloth. The connections to the back panel should be made before the panel is fitted into position. The earth braid should be fitted to the case using a 6BA screw and nut.

TESTING AND ALIGNMENT

Oscillation may be prevented on longwave if the oscillator coil's inductance (L5) is too far out from its correctly aligned position. To overcome this problem unscrew the core of the coil (anticlockwise) so that the plastic top of the core is approximately 2 mm above the can. If the problem still occurs the value of R3 should be reduced.

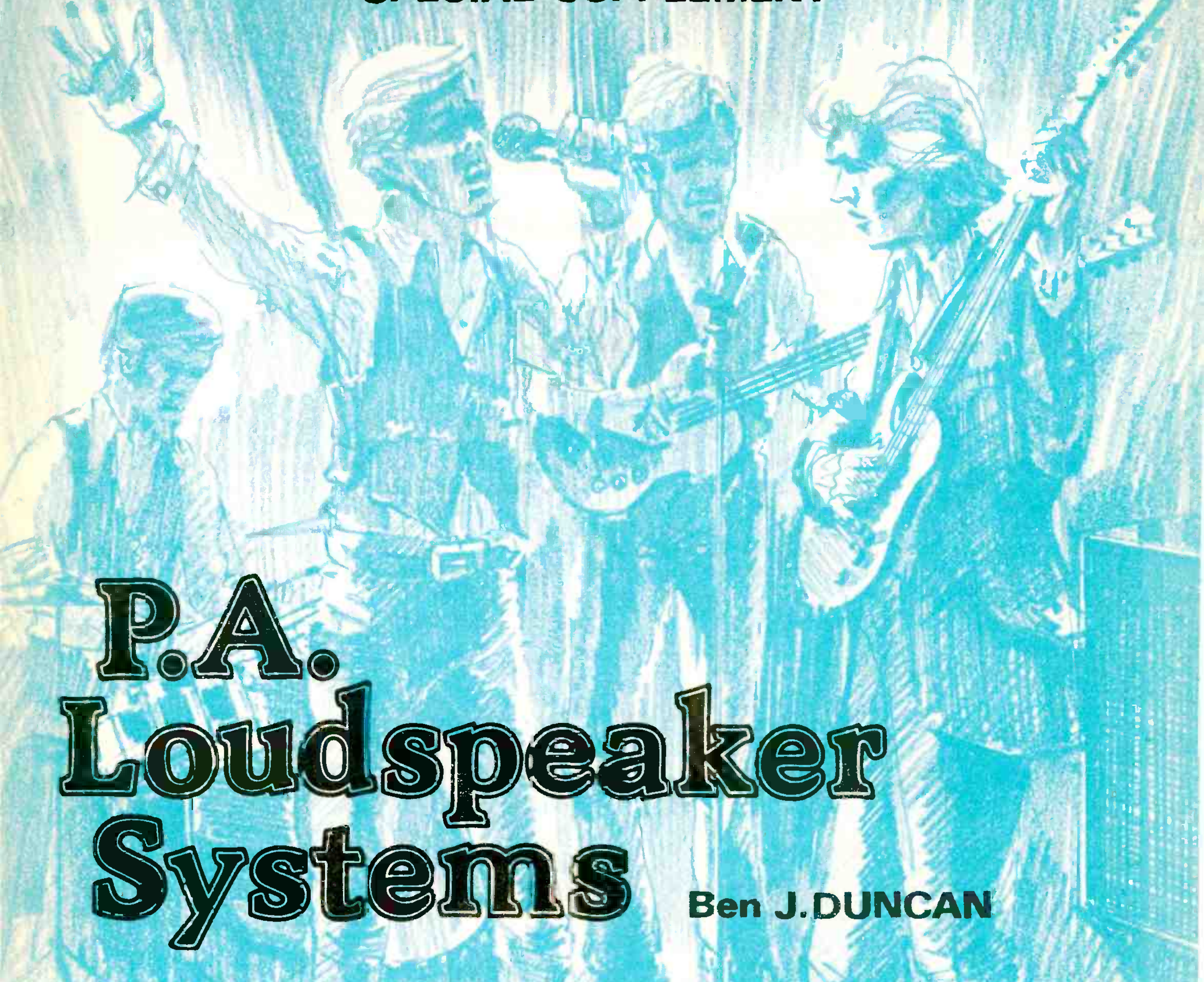
For simplicity, "bench alignment" is recommended. The speaker, 12V supply and aerial (if an r.f. signal generator is not available) should be connected, then the set switched on and tuned to the medium wave. The scale (attached to the escutcheon) should be held in front of the radio and the set manually tuned to 250 metres. Adjust the trimmer (VC2) on the p.c.b. to receive radio 3 (247 metres). Switch to the longwave, tune to 1500 metres and adjust the l.w. oscillator coil (L5), with a non-metallic tuning tool, to receive Radio 4. Adjust the l.w. aerial coil (L2) for maximum output.

If an r.f. generator is available tune the set to the extreme h.f. end on m.w. and adjust the trimmer (VC2) on the p.c.b. to receive 1620kHz modulated signal. On l.w. tune to the extreme l.f. end and adjust the l.w. oscillator coil (L5) to receive a 150kHz modulated signal. Then set the generator to 200kHz and tune the set to receive this signal (1500 metres) and adjust the l.w. aerial coil (L2) for maximum output.

After the set has been correctly aligned fit the back and top panels into position using self tapping screws.

NEXT MONTH: Installation and suppression.

SPECIAL SUPPLEMENT



P.A. Loudspeaker Systems

Ben J. DUNCAN

Over the past years PE has published a number of designs for various guitar effects units and other pieces of equipment for the pop group. People working in this area are often familiar with the vast range of equipment available but not always knowledgeable on the correct methods of setting up and operating such equipment. Nowhere is this lack of knowledge more evident and potentially more audibly noticeable than in the use of PA loudspeaker systems. This supplement sets out to describe methods of achieving good sound at high listening levels, the type of equipment available and how to use it.

Since many of the enclosures available are still made to imperial rather than metric measurements and specifications are based on imperial units, for the sake of this supplement we have also employed them.

ROCK BANDS require high power sound systems, colloquially known as "PA" systems to attain the levels they require in auditoriums. The greatest difficulties and inadequacies in any audio system remain in the area of loudspeakers and acoustics and no-where are these inadequacies more manifest than in high power live sound amplification systems. Such systems require special techniques far removed from domestic sound systems if high sound quality is to be achieved.

Whilst the atmosphere and excitement of a live performance often compensate for poor sound quality, audiences are becoming more critical, largely because their familiarity with high fidelity sound reproduction in the home leads them to expect the same standards elsewhere. That "audiences

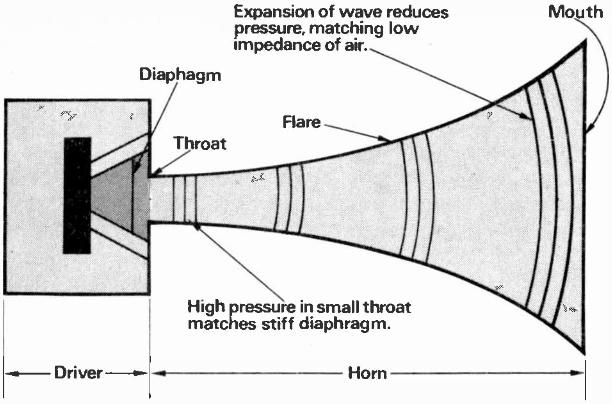


Fig. 1. Showing the various parts and operation of the horn

accept poor sound quality" is a common view, but this statement needs careful qualification. Running a sound system into severe overload on peaks is often acceptable, but indistinct vocals are not. The concept of live sound quality embraces far more than the main criterion of domestic sound quality—harmonic distortion. The vagaries of hall acoustics, phase interactions in multiple speaker arrays and the frequent need to push sound systems to their limits are other criteria which are unique and crucial to the sound quality of a live performance.

SOUND LEVELS

Discotheque levels lie between 105dB and 115dB, yet a lone soprano can exceed 104dBA, a symphony orchestra can notch up 115dBA, jazz bands have been measured at 125dBA and a lone rock drum kit at one metre can hit 130dB. Audience noise in excess of 120dBA has also been measured. These figures put typical rock concert levels of between 110 and 125dB into sharp perspective, especially when it is borne in mind that many musical instruments are capable of exceeding the threshold of pain (125dB) on their own.

HORN LOADED LOUDSPEAKERS

Most PA systems spend their life on the road, and apart from the need for exceptional physical robustness, size and weight must be sensibly limited if life on the road is to be tolerable. The heaviest and bulkiest items in a PA rig are the loudspeakers; clearly, the fewer needed the better. Thus very efficient loudspeakers are sought. It is pertinent to bear in mind that direct radiator (infinite baffle) loudspeakers are, at best, 2 per cent efficient.

If high sound quality is required, then this can only be achieved in exchange for even lower efficiency, as exemplified by domestic high fidelity loudspeakers, which are frequently less than 0·5 per cent efficient. Vented (bass reflex) enclosures offer somewhat higher efficiency, typically around 2–8 per cent, but only at low frequencies.

Prior to the birth of heavy metal rock and giant outdoor festivals, it was rarely considered necessary to amplify a whole band, and column loudspeakers were adequate for vocal amplification. Then, about a decade ago, the quintessential rock band Iron Butterfly used a 30 year old RCA loudspeaker design on stage at the Albert Hall, and a power revolution had begun.

Iron Butterfly had discovered the RCA "W-Bin", a horn-loaded loudspeaker designed for cinemas. Horn loading provides the most efficient loudspeaker action; horn loudspeakers are typically 25–50 per cent efficient. Moreover, the best horns provide arguably the most realistic sound reproduction available. There is no doubt that for high power sound reproduction, horn loudspeakers are superior to all others on the basis of sound pressure level (SPL) per £, size, weight, sound quality and control of dispersion.

Inevitably, horn loudspeakers are the mainstay of live sound systems. Thus a knowledge of horn characteristics is essential if high power sound systems are to be competently engineered.

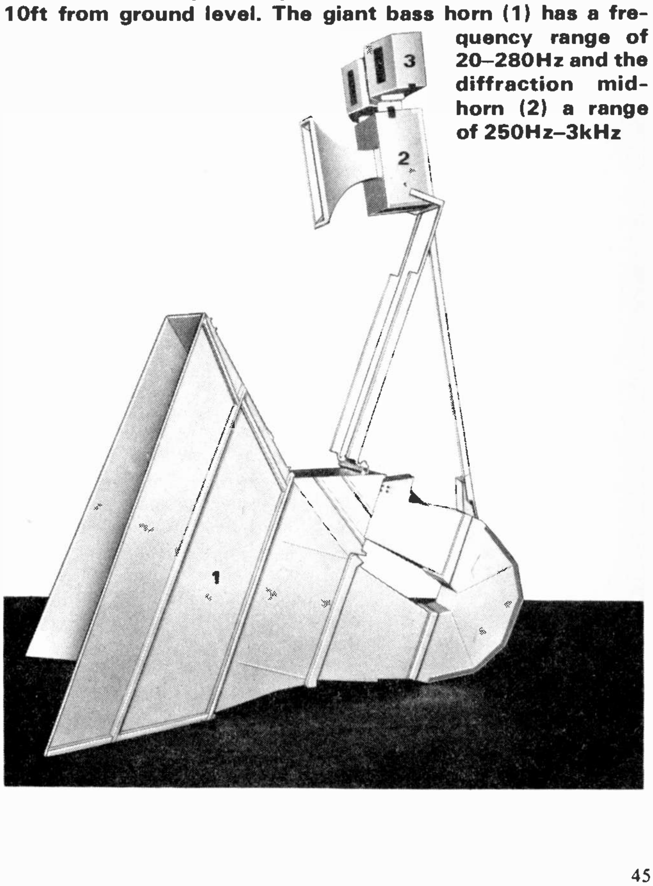
THE HORN

The horn is an acoustic transformer, matching the elasticity of air (a low impedance) with the stiffness (high impedance) of a loudspeaker diaphragm, by a graduated change in air pressure (Fig. 1). This transformer action is the secret of the horn's high efficiency. If a horn is asked to reproduce sufficiently long wavelengths, then adequate air pressure cannot be achieved at the throat. The horn then reverts to direct radiation, and its output falls sharply. The horn is thus a high pass filter, and cannot be used below this critical point, known as the *cutoff frequency*.

The area of the throat and the mouth, the flare curve, the cutoff frequency, and the length of a horn are closely related by physical equations. This relationship of five variables leads horns to have very definite and critical dimensions, unlike other loudspeakers.

Whenever a diaphragm moves, it causes distortion, particularly intermodulation distortion. This is perceived as "muddiness" and is very objectionable at high levels. A direct radiator diaphragm must move large distances to produce high SPL's, especially at low frequencies. Large diaphragm movements produce correspondingly large amounts of intermodulation distortion. The movement of a horn loaded diaphragm is typically 10 to 500 times less for the same sound output, thus horns can be driven harder without incurring excessive levels of intermodulation products.

The author's horn stack. The mouth of the horn is 6ft high and the wide dispersion piezo-electric treble horns (3) are 10ft from ground level. The giant bass horn (1) has a frequency range of 20–280Hz and the diffraction mid-horn (2) a range of 250Hz–3kHz



In exchange for greatly reduced levels of intermodulation distortion, horns produce low order harmonic distortion. This is a consequence of the high air pressure at the throat, which causes *air overload distortion.* The magnitude of this distortion is governed by the flare curve, the power input and the horn's operating bandwidth. The flare curve is usually exponential or tractrix (involute cantenary) for high power sound systems, these curves being a compromise between efficiency and air overload distortion.

Limiting the operating bandwidth of any loudspeaker reduces intermodulation distortion, but bandwidth limitation in horn loudspeaker systems is especially useful, since it also minimises air overload distortion. Crossover networks, to achieve these limitations, are considered later.

Air overload distortion is predominantly 2nd harmonic, and is thus palatable to the ear. Thus horn loading exchanges low efficiency and high levels of *dissonant* intermodulation distortion (IMD) for high efficiency, critical dimensions and low order, and hence innocuous, harmonic distortion.

HORNS IN PRACTICE

Horn dimensions are closely related to the wavelengths of the sound they handle, thus bass horns (affectionately known as *bass bins*) are inherently large. Ideally, for smooth frequency response, the perimeter of a horn's mouth should be four times greater than the lowest wavelength to be reproduced. Thus for a cutoff frequency of 20Hz, a mouth of 40,000ft^2 is indicated! Clearly some compromises must be accepted in practice. This figure assumes loading into free space.

Each time the solid angle of radiation is halved, the mouth area can be halved. Likewise, if a higher cutoff frequency and a less than perfectly regular response is accepted, the mouth area can be greatly reduced. For example, a typical PA horn which is *wall loaded* (against a wall and on the floor, and thus radiating into a solid angle of π radians) and exhibits a 60Hz cutoff frequency, will only require mouth dimensions of 3ft by 2½ft.

Because horn length and mouth size are closely related, a horn with a nominal cutoff frequency of 60Hz with smaller mouth dimensions is possible, or instead, a lower cutoff frequency for any given mouth size. This is achieved by *foreshortening* the horn, that is, cutting it short before its mouth area expands to excessive dimensions.

Foreshortened bass bins exhibit a highly irregular response over the first two octaves, which result in coloured and distorted low bass. Thus it is far better to sacrifice the low frequencies and attain a smooth response than to drive a horn below its legitimate cutoff frequency. Table 1 shows the minimum mouth dimensions for wall loaded bass bins.

Table 1. The minimum mouth dimensions of bass bins for audibly smooth frequency response.

Mouth Area (ft^2)	Min. driving frequency in Hertz Wall loaded	Corner loaded
28·0	30	20
15·7	40	29
10·1	50	35
7·0	60	42
5·1	70	50
3·9	80	62
3·1	90	65
2·5	100	71
ft^2	Hz	Hz

This table can be used to ascertain the minimum frequency at which a bass bin may be driven for an audibly smooth frequency response, regardless of manufacturers' specifications, which are rarely euphemistic.

In practice, few bass bins are sufficiently big to have a regular frequency response below 60Hz for reasons of mobility. Corner loading extends the response, as shown in the table, but mounting bins in a corner is not often possible.

It is common to use vented enclosures to cover the first two octaves; many bass bins have reflex ports which are driven by the rear radiation from the diaphragm. This seems an elegant solution, but it is far better to use a separate vented enclosure and to enclose the rear of the horn driver. The compression chamber so formed linearises the response of the horn.

For all their advantages, bass horns are a perpetual problem in live sound systems. The three best solutions if smooth frequency response is desired are:

(1) Use a giant bass horn to provide smooth response down to 20Hz or lower.

(2) Use a readily portable bass horn, typically responding down to 60 or 50Hz, together with several (less efficient) vented cabinets to cover 20–60Hz.

(3) Corner load the above horn to provide a smooth response down to 35–42Hz, and accept the absence of the lowest audio frequencies. (In practice, a frequency response which rolls off sharply around 40Hz is quite adequate in live sound systems.)

Midrange and treble horns are small and rarely need to be compromised in the manner that bass horns are. However, they may also suffer from an uneven response over the first octave above their cutoff frequency, which is heard as a "honk". This characteristic has given horns a bad name, but it is simply a case of inexpert application. The simple solution is to drive a honking horn at a higher frequency, that is, crossover at a higher frequency.

CROSSOVERS AND BANDWIDTH LIMITATIONS

A small direct radiator will handle the entire audio bandwidth, but limiting the bandwidth over which a loudspeaker operates greatly lowers IMD, particularly at high powers. Moreover, air overload distortion in horns is proportional to the operating bandwidth. For this reason, horns are rarely driven over more than three octaves.

When a horn is driven below its cutoff frequency, the diaphragm is no longer pressure loaded and it reverts to direct radiation. This implies large amplitude diaphragm excursions, which quite apart from producing highly distorted sound, may endanger the diaphragm. This effect is particularly fatal to high frequency horns, since they commonly use compression drivers which are designed solely for horn loading and cannot withstand the large diaphragm movements that are inherent to direct radiation. Clearly a good, steep crossover network is essential in horn loudspeaker systems if driver damage is not to occur.

The simplest crossover networks are passive (Fig. 2). In order to handle high powers—even over 50 watts—without great losses, these are expensive.

The performance of the simple LC filter illustrated is dependent upon the loudspeaker to which it is connected, and the combination presents a capricious load to the power amplifier, which may be upset. For these reasons, more complex LC or RLC networks are used in domestic sound systems. These provide very good performance, but unfortunately at the expense of efficiency. For this reason alone, crossover networks which appear in series with loudspeakers are to be strongly depreciated in high power

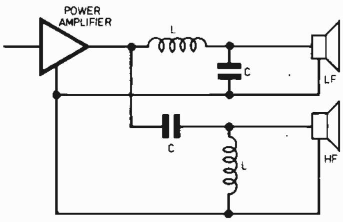


Fig. 2. Simple LC filter arrangements

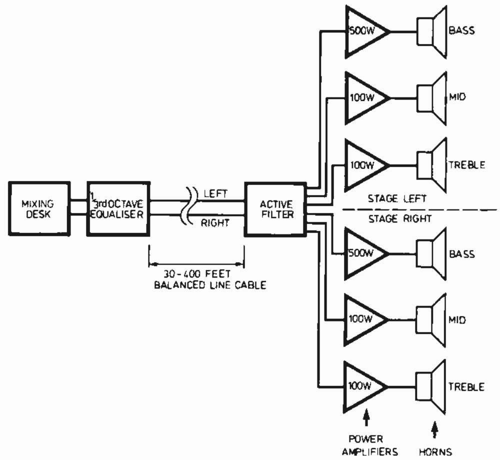


Fig. 3. A tri-amplified system using bandpass filters

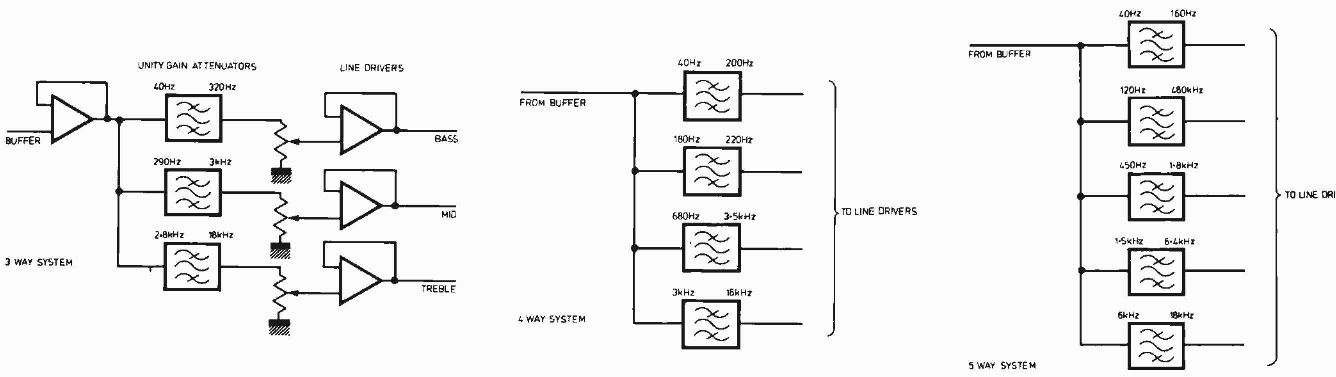


Fig. 4. Typical 3, 4 and 5 way systems

sound systems. Furthermore, any form of network in series with a loudspeaker can give rise to an audible "dullness", especially when the characteristically transparent sound of horn loudspeakers is considered.

The vast majority of professional high power sound systems now employ active crossovers. The term "active" indicates that the crossover filters use active devices; transistors or op-amps. Such filters are usually located immediately prior to the power amplifiers. By imposing bandwidth limitations in the small signal stages, a separate amplifier is required for each frequency band (Fig. 3). Thus a three-way active crossover uses three amplifiers and is said to be "tri-amplified".

The advantages of this method far outweigh the cost of additional amplifiers:

(1) Active filters can be readily produced with steep slopes without the great losses inherent in steep passive filters. Steep slopes allow horns to be driven harder and closer to their cutoff points with less risk of damage. Active filter slopes are commonly two to four times steeper than passive filter slopes.

(2) Switchable slopes and crossover frequencies are a practical proposition. It is possible to compensate for the difference in cutoff frequency of a bass bin when it is wall or corner loaded.

(3) The load resistance of an active filter is well defined. This ensures predictable filter performance.

(4) The power amplifiers are connected directly to their respective loudspeakers. This ensures good damping at low frequencies.

(5) Around 50 per cent of the energy of rock music lies below 350Hz, thus amplifier clipping occurs initially in the bass power amplifier(s). The resultant high order harmonics are directed solely to the bass bins, whose drivers are incapable of reproducing these high frequencies efficiently. Thus they are masked by legitimate (undistorted) high frequency signals.

(6) Intermodulation distortion is minimised in the power amplifiers as well as in the loudspeakers.

(7) Amplifer-loudspeaker combinations can be optimised, particularly in terms of power and impedance.

As a result of factors 1, 5, 6 and 7, a system using active filters can be driven much harder before the sound becomes "dirty". Thus a 1,000 watt tri-amplified system sounds much louder than a 1,000 watt system using passive filters. The improvement in sound quality is also far from subtle.

For an acceptable level of air overload distortion, the operating bandwidth of a horn is usually limited to three octaves. Thus a minimum of three horns is needed to cover the audio band. Starting at 40Hz, the typical crossover frequencies will be around 320Hz and 2·5kHz. Restricting the bandwidth even more, and using many horns to cover the audio spectrum may appear to be a means to very high quality. Whilst this is broadly true, anomalies around the crossover points, particularly if they infringe upon the critical midrange frequencies, are troublesome. Moreover, the proliferation of amplifiers and horns would be costly and leads to great bulk and weight.

The law of diminishing returns sets in after five way systems, and tri- and quad-amplification are the most common configurations. Fig. 4 illustrates typical 3, 4 and 5 way systems. Note that it is difficult to avoid the critical midrange frequencies (750–3,000Hz) with the 5 way system if the number of octaves handled by each filter is to be kept reasonably constant. Note also that the bass filters have a bandpass characteristic, in order to protect the bass bins from high level signals below their cutoff frequency.

POWER AMPLIFIERS

All loudspeakers are readily damaged by excessive power inputs over long periods. When sound systems are operated by people who are not technically minded, it is always a good rule to use a loudspeaker rated at 10 to 100 per cent over the amplifier power. In high power systems, it is preferable for the loudspeakers to be overloaded before the power amplifiers, because the sound of an overloaded loudspeaker is much more pleasant than that of an amplifier driven into clipping. This assumes that the sound engineer is familiar with the sound of a distressed horn, and does not prolong its agony for any longer than absolutely necessary.

One of the essences of live music, especially rock, is the crescendo. It is necessary to try to achieve real dynamic range, because of this it is often not possible for sound systems to handle rock crescendos at realistic levels. One solution is to reduce the dynamic range requirements by using a limiter, but this greatly detracts from the performance. A compromise solution is to accept that something has to be overloaded on occasions, and this is usually the bass loudspeakers. A good 100 watt, 15 inch driver will, for instance, accept 500 watts of programme for a few seconds without undue distress. This reserve power handling capability should only be needed or used at climatic points, otherwise the loudspeakers will not live long.

In a tri-amplified system, each horn will usually have its own amplifier. High frequency horns generally use compression drivers which are capable of providing SPL's in the region of 140dB at full power, thus it is unlikely that they will need to be overloaded. Compression drivers are quite easily damaged by excessive inputs, thus it is unwise to use an amplifier rated in excess of 100W to power a horn rated at "100 watts programme". If the horn is rated at "100 watts r.m.s.", then it is in order to drive it with a slightly higher power amplifier provided (a) the system is *never* driven with pure sine waves and (b) the excess power capacity is only used sparingly. Bearing in mind that clipping will usually occur in the bass channels first, the bass amplifiers should be rated well above the r.m.s. rating of the loudspeaker amplifier powers, typically being two to five times greater.

The majority of professional power amplifiers on the market are very good, but the distortion figures at the maximum power output, particularly at the extremes of the audio band, are always revealing. Also, a good power amplifier should drive impedances well below its nominal load impedance at full power. In PA applications, the need for absolute reliability cannot be overstressed. Amplifiers with massive heatsinks, "redundant" output stages, thermal cutouts, failure and status indicators, welded steel cases, robust panel components and readily accessible fuses or circuit-breakers are a great help.

HORN DISPERSION CHARACTERISTICS

PA loudspeaker dispersion characteristics should be neither laser-like nor omnidirectional. When sound emanates from an aperture much smaller than the wavelength of that sound, the aperture is said to be a point source, and the radiation is omnidirectional. The wavelength of a 200Hz note is about five feet. At this frequency then, a 15 inch direct radiator acts as a point source. A bass bin, however, has dimensions which approach five feet, and thus bass bins are relatively directional at this, and higher frequencies. The larger a horn's mouth, the lower the frequency

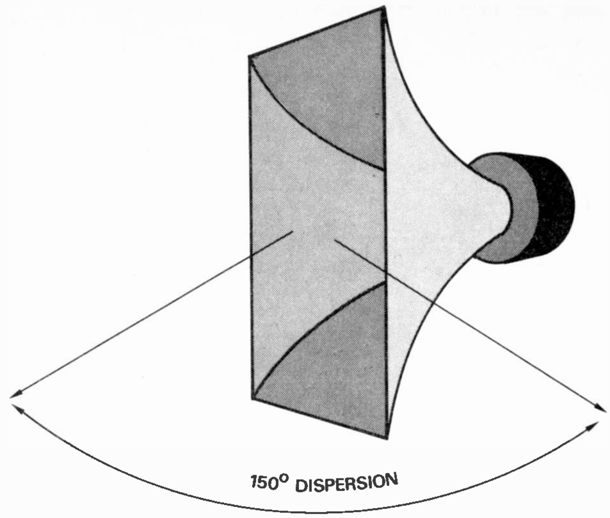


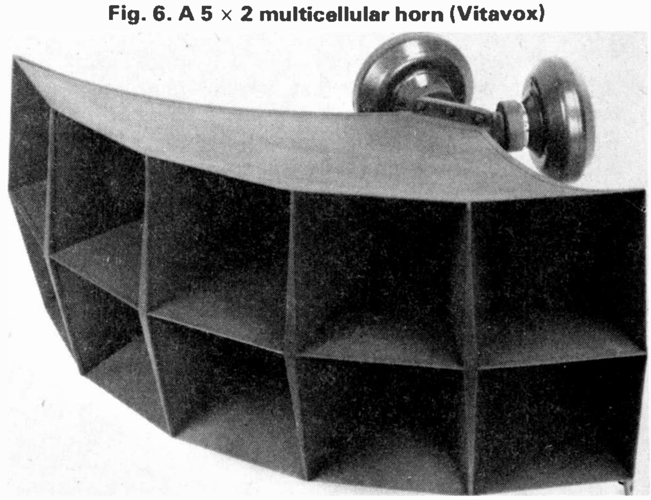
Fig. 5. The midrange diffraction horn

at which sound dispersion can be channelled forwards. Therefore, giant horns are to be preferred at outdoor concerts, where sound that does not reach the audience directly is lost sound.

Unlike direct radiators, the dispersion characteristics of high frequency horns are readily tailored. Direct radiators are invariably very directional at high frequencies, but the flare of a horn can be modified to diffract sound waves and provide very wide vertical and horizontal dispersion. The midrange diffraction horn (Fig. 5) has flares which suggest wide vertical dispersion. Indeed, diffraction horns are regularly seen mounted sideways, in the mistaken belief that this gives the best dispersion! In fact, the dispersion is typically 150 degrees in the horizontal plane when the horn is used as illustrated. This dispersion is a result of diffraction about the sharp vertical (unflared) edges of the horn.

If we couple lots of small horns, which approach point sources, to a common driver, we can achieve wide dispersion, and because the total mouth area of the horn (equal to the sum of the individual horns or segments) is large, the cutoff frequency can be low. Also, each segment points in a slightly different direction, which further promotes wide angle dispersion. The dispersion characteristics are thus partially controlled by the segments, which gives such a horn very flexible dispersion properties. This is the multicellular horn (Fig. 6), with a dispersion angle of 150 degrees by 60 degrees vertical. Many horns which look like multicells are merely bifurcated.

Fig. 6. A 5 × 2 multicellular horn (Vitavox)



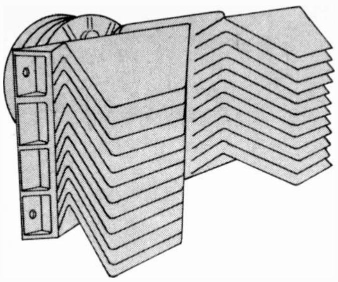


Fig. 7 (left). The acoustic lens

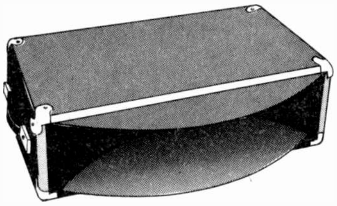


Fig. 8 (right). A radial horn

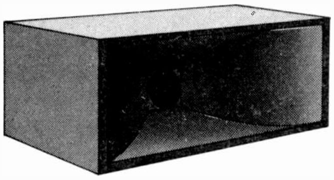


Fig. 9 (left). A "JBL" style long throw "mid-bin"

The acoustic lens (Fig. 7) defies visual analysis. It diffracts sound, but not only in the direction implied by the slanted plates. In fact, the dispersion is predominantly horizontal, being typically 140 degrees by 40 degrees. The lens is currently popular in live sound systems, but its cutoff frequency is usually quite high, and it usually has to be used with direct radiators. It is inferior to the multicellular horn in terms of efficiency, cost and dispersion flexibility. Moreover, the multicell has a much lower cutoff frequency, although the levity of a lens makes it amenable to roadies!

The wide dispersion horns described so far are used to cover the front rows at a large venue, or for comprehensive coverage in clubs and small halls. These are *short throw* horns. In larger halls, narrow dispersion horns are required to supply concentrated sound to the rear seats; these are *long throw* horns, and are usually of the radial variety (Fig. 8). However, in four way systems, high bass frequencies (200 to 600Hz) are often handled by the "JBL" style long throw "mid-bin", as depicted in Fig. 9. Both types of long throw horn have typical dispersions of 60 degrees by 30 degrees vertical.

THE MINIMUM SOURCE IDEAL

When several loudspeakers operating over the same bandwidth are close together, interaction occurs and spurious phase cancellations result. This "phase distortion" causes colouration (which is displeasing to the ear) and upsets the dispersion properties of loudspeakers. It can also exacerbate acoustic feedback problems. To minimise phase distortion, the minimum number of sound sources (over each band) should be used. This is an especially good reason for never using direct radiators in high power sound systems. A horn will replace 10 to 50 direct radiators, thus it is possible to get much nearer to the minimum source ideal using horns; indeed, in small PA systems it is often possible to achieve the ideal of only one sound source over each band of frequencies.

THE STACK

PA horns should be stacked up—hence "the stack". For small halls, where wide dispersion is all that is required, assuming a tri-amplified system is used, a three horn stack is ideal. This consists of bass, midrange and treble horns in ascending order. In larger halls, long throw mid and treble horns may be necessary, hence a minimum of five horns.

Interactions between long and short throw horns can be minimised by thoughtful angling and stacking. If higher SPL's are required, additional three or five horn stacks can be used. The stack is thus a *module.* However, the concept of a stack as a *certain physical configuration* must be dispensed with when several stacks are used in tandem. If they are merely used like building bricks, serious phase irregularities will occur; a rearrangement of the components of the composite stack is usually necessary. As SPL requirements increase, given that efficiency cannot be augmented, a proliferation of horns is inevitable, and skill is required in order to produce good results.

STACKS FOR SMALL HALLS

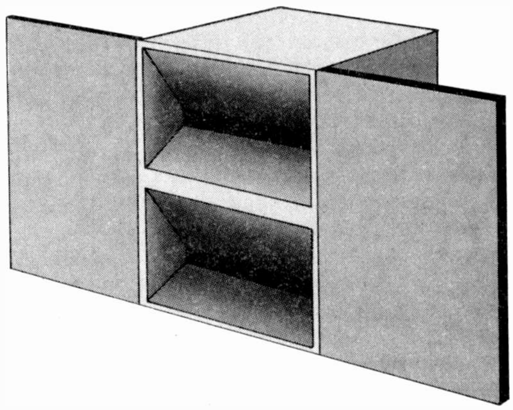
The author's horn stack shown on the second page of this supplement uses a giant bass horn with a cutoff frequency of 20Hz when corner loaded. A midrange diffraction horn provides wide angle coverage, and for low cost, piezoelectric diffraction horns are used above 3kHz. Several are required to counter the "deadness" common to small halls which have been acoustically treated. Note the strategic angling for minimal interaction. The stack is often at audience level, thus the midrange and treble horns are mounted well above head level to prevent excessive sound absorption. This stack weighs 80kg and is equivalent to 2 tonnes of direct radiator loudspeaker cabinets!

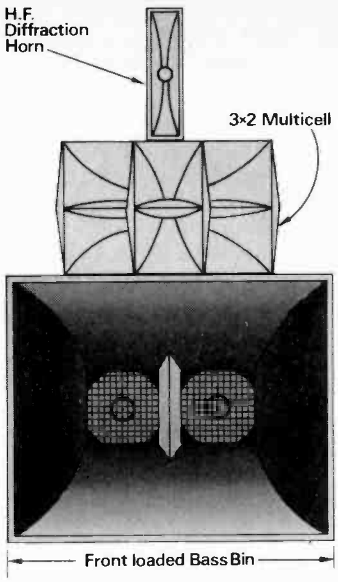
Table 1 shows that corner-loading a bass bin provides the lowest cutoff frequency, but wall loading is often the best that can be achieved. When using a single bass bin, however, wall loading is negligible. In this case, providing a solitary bin with baffles (Fig. 10) will greatly enhance the low frequency response. If a separate vented enclosure is used, this should be stacked immediately above the bass bin(s). Using the high frequency horns described earlier, Figs. 11a and 11b show alternative and broadly equivalent approaches to horn stacks for small venues, where wide dispersion is all that is required.

STACKS FOR LARGE HALLS

In large halls, long throw horns are required to reach the furthermost seats, though these should not be used unless

Fig. 10. A bass bin fitted with baffles





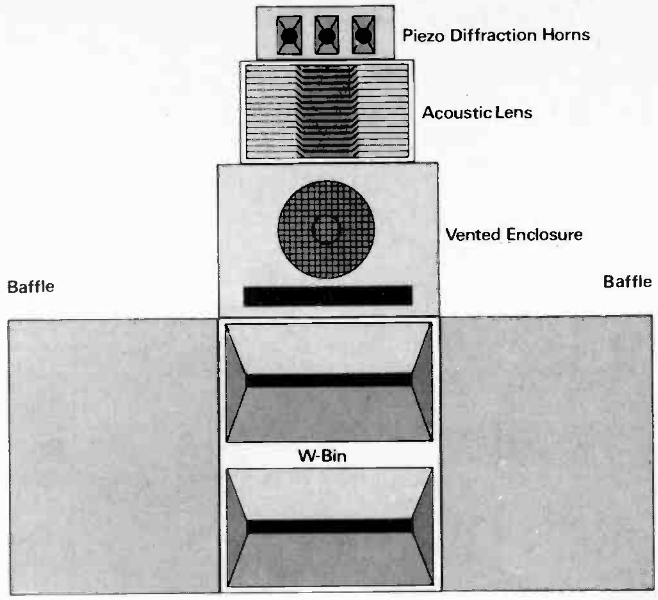


Fig. 11a (above) and 11b (right). Alternative approaches to horn stacks for small venues

absolutely necessary. Bass reflex enclosures do not have long throw properties, thus large numbers of bass bins will be required to project the low bass; when these are tightly stacked together, they provide highly effective mutual wall loading which greatly augments their bottom end response. Fortunately, the inevitable phase irregularities resulting from this arrangement will usually cause cancellation well above the bass crossover point.

The long throw horns should preferably be mounted well above the main stack, typically on the proscenium arch or on scaffolding, as shown in Fig. 12. In the side view of this stack note that the long throw horns are angled downwards, *into* the audience. Otherwise the sound is likely to hit the rear wall—and be reflected back! This slap-back echo is a perpetual problem in clubs with low ceilings and the need to *build stacks high* whenever possible cannot be overemphasised. As stack height increases, it becomes progressively easier to set the long throw horns at an angle that discriminates between the rear wall and the rear seats. If scaffolding is not available, it will be necessary to mount the long throw horns on top of the stack. A wedge provides the necessary 10 degrees to 15 degrees of downwards tilt.

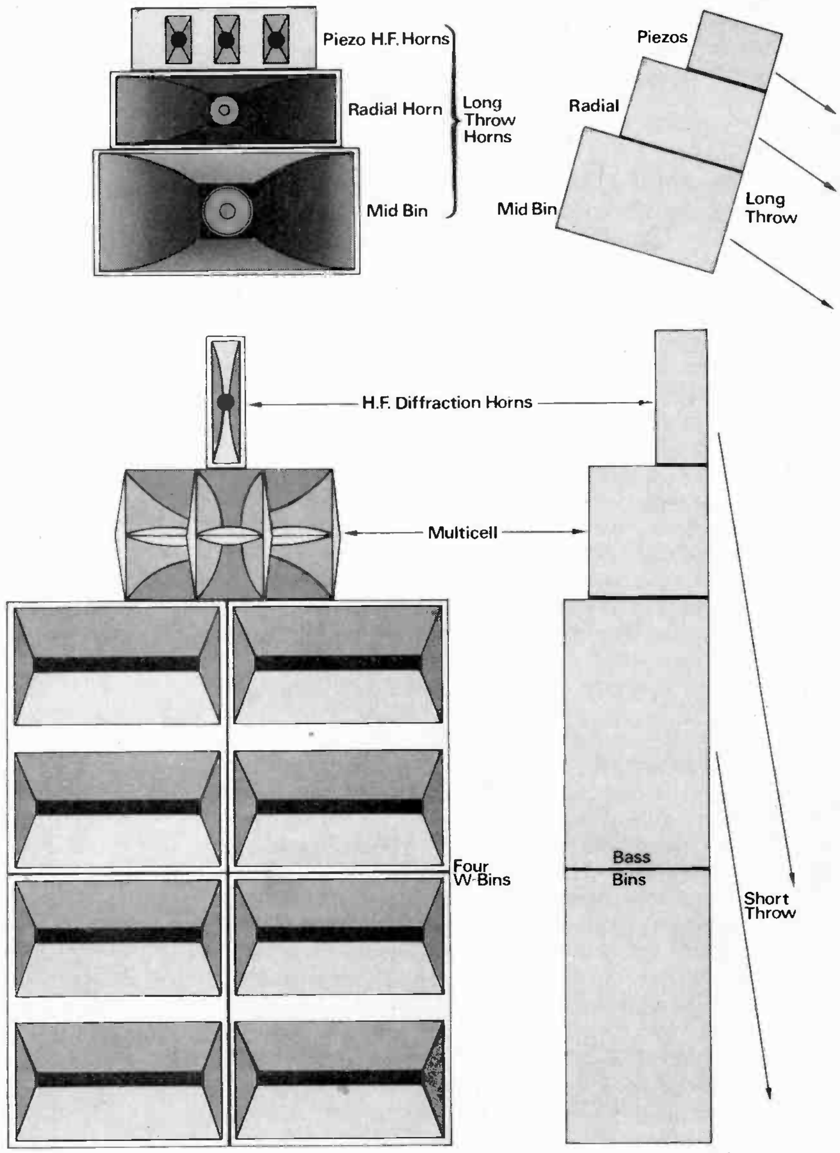
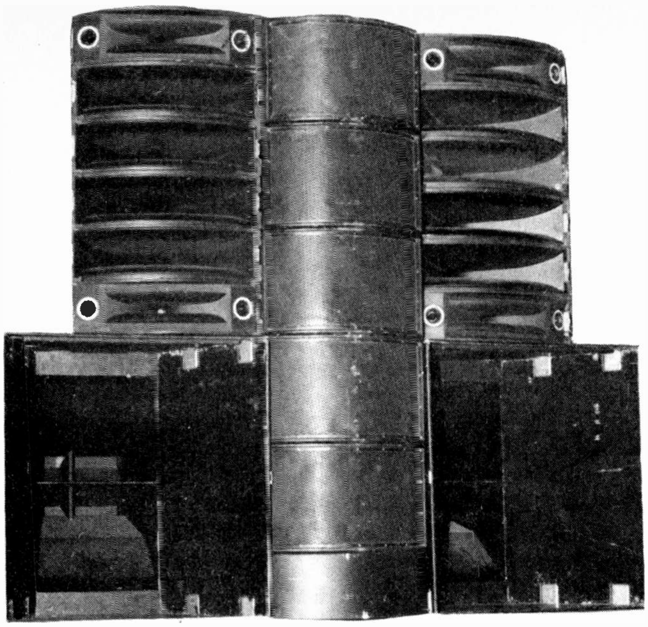
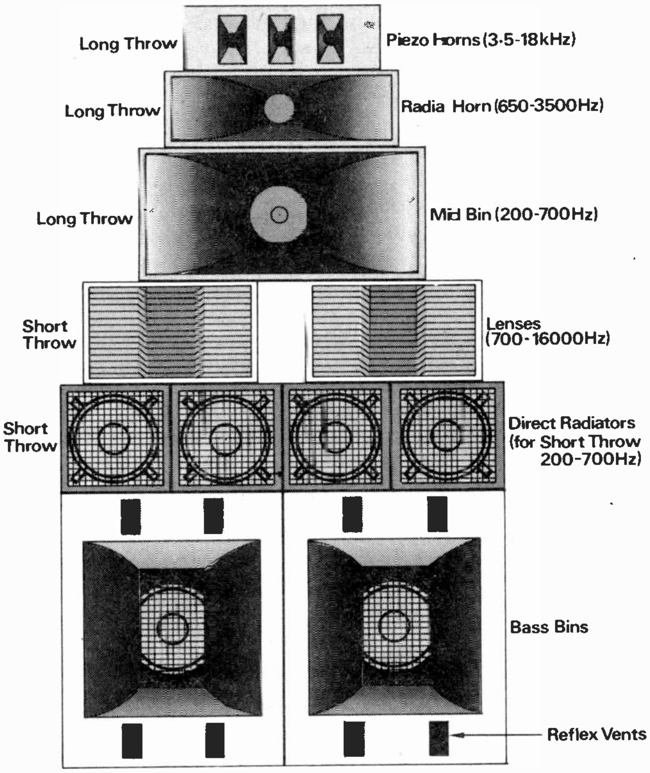


Fig. 12. A horn stack with long throw horns mounted above the main stack and angled downwards



A "5kW" horn loaded stack made up of: two Cerwin-Vega bass bins each with two 750W 18in drivers (frequency range 40–250Hz); five "Philishave" bins—shown in the centre—these are Martin 212 midrange horns, 250W each (frequency range 250–1500Hz); 8 JBL 2350 radial horns—80 degrees by 60 degrees dispersion—100W each (frequency range 1500–4800Hz); four JBL 2345 radial horns—90 degrees by 40 degrees dispersion—100W each (frequency range 4800Hz–16,000Hz); these incorporate four JBL Bullet treble horns which cover the same frequency range. (Courtesy Muscle Music)

Fig. 13. An impressive PA stack



An alternative, and very impressive looking stack is depicted in Fig. 13. It is currently fashionable to use acoustic lenses and direct radiators in place of the multicellular horn for short-throw midrange and treble. However, the low efficiency of these units takes us away from the minimum number of sources once again. When a stack of this kind is used, or several of the stacks illustrated in Fig. 12 are partnered, it is expedient to angle the high frequency speakers away from each other as much as possible to minimise interaction (Fig. 14). Excessive angling, however, will cause a lot of sound to hit side walls which is not helpful! Likewise, boxes containing arrays of piezo-electric horn tweeters usually have bevelled fronts.

STEREO

So far it has been assumed that the sound system has a stereo format, with stacks either side of the stage. This layout is far from ideal. A minority of the audience will be suitably seated to hear an acceptable stereo effect. Transient sounds from percussive instruments will sometimes be heard as two discrete signals out of time with the music. Many sound engineers limit stereo to drums and special effects, hence the stacks will be working largely in mono. If we dispense with stereo altogether, then phase anomalies between the two stacks can be eliminated. A central horn cluster on the proscenium arch is sometimes a viable solution, and works very well.

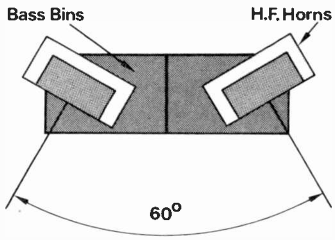
The heavy bass bins may have to remain on stage, but by a suitable choice of crossover frequency, their phase anomalies can be minimal. In theory, the vertical displacement of the mid/treble horn cluster is not readily sensed by the ears. However, people differ and the cluster can be distracting, particularly if it is more visible than the musicians!

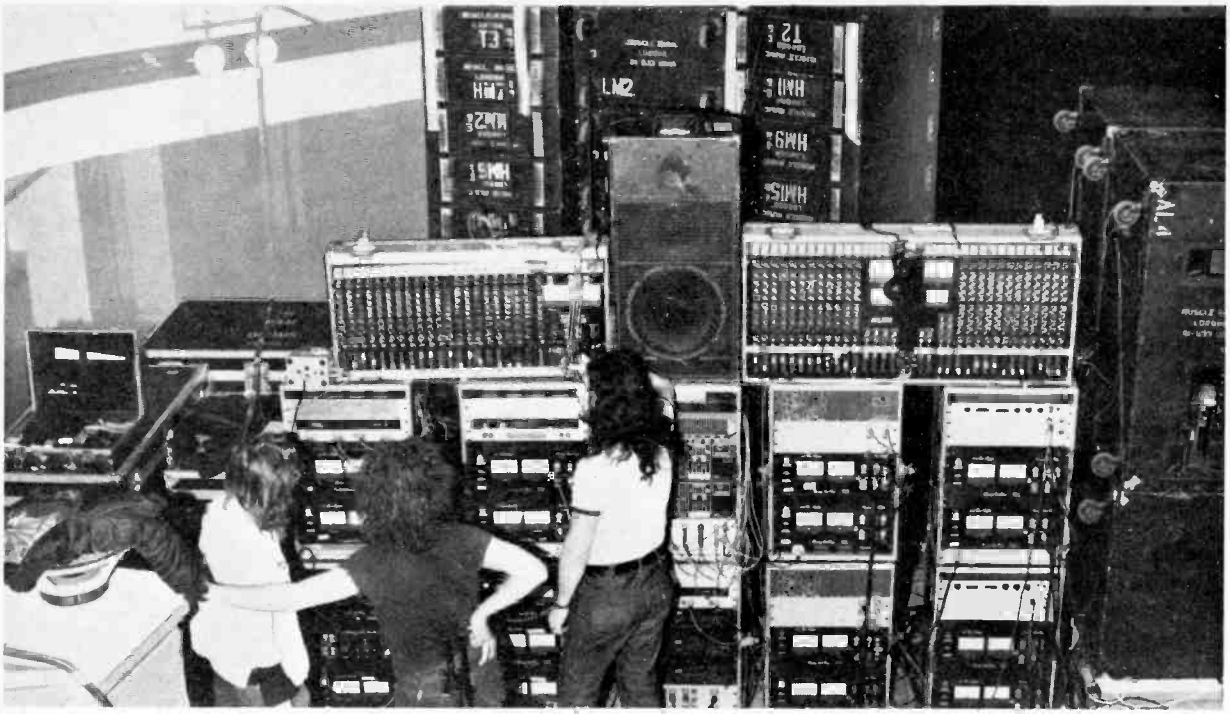
Another idea, akin to tri-amplification, is to split up a sound system such that separate amplifiers and loudspeakers are used for drums, keyboards, vocals, etc. The advantages are similar: the sound is subjectively louder, it is cleaner and the imagery is also greatly improved, giving a better impression of *live* performance rather than a glorified discotheque plus stage act. This is, of course, the situation in a small band without a "PA"!

MIXING

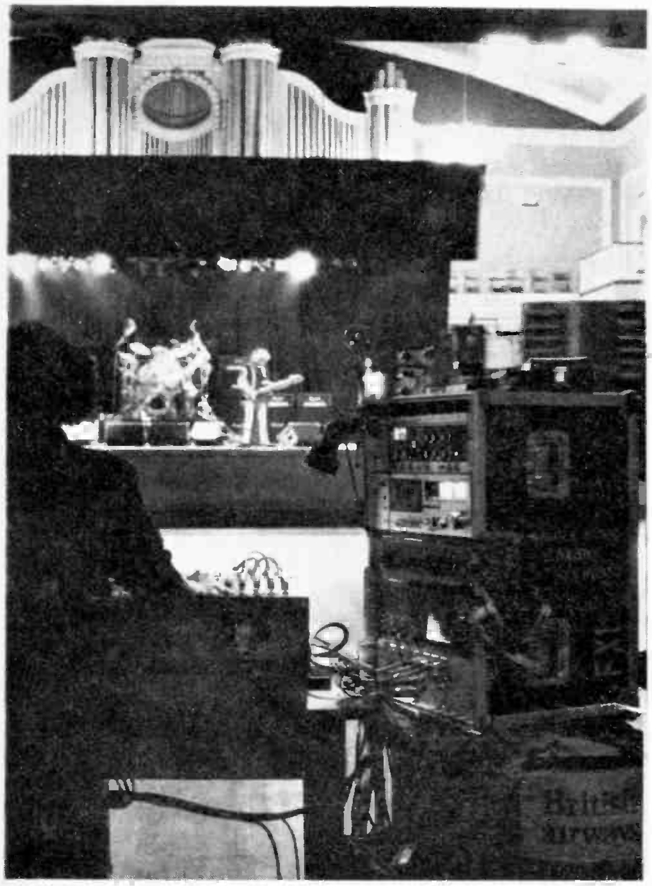
In a four piece jazz-rock band, for instance, it is possible to increase the power of the instrument amplifiers to around 300 watts before the drum kit requires amplification. At this point it would be usual to consider mixing the whole band and using a common sound system. If the advantages of mixing could be sacrificed for sound quality and imaging, an alternative step would to be use a "drums amplifier". Each instrument would retain its own separate "sound system", little intermodulation can occur and the music remains totally realistic in terms of imagery.

Fig. 14. Angling of h.f. horns for minimum interaction





A rear view of the 5kW stack, shown on the previous page, together with a 2kW sidefill stack (shown on the extreme right) for stage monitoring. Also shown are two 5kW amplifier and crossover racks. (Courtesy Muscle Music)



The mixing desk used with the equipment shown above and on the previous page. The group can be seen in the background together with the sidefill stack and 5kW stack which are just visible above the equipment on the right

With a little ingenuity and a few wires, sound balance could still be controlled by someone off stage. For small bands, the important point is to avoid using a common sound system until it is both absolutely necessary and sufficient funds are available to purchase good equipment of high power handling capacity. It is often far better to hire a good PA system when the need arises than to own cheap but inadequate equipment.

Always place your amplifiers as close as possible to the loudspeakers so that the shortest possible speaker cables can be used. Although it is feasible to have long speaker leads with little power loss by using $6mm^2$ and similarly massive cables, the large capacitance and inductance of such cables may have insiduous effects on sound quality, quite apart from the great cost. For lengths under 5 metres, $1mm^2$ two core sheathed p.v.c. cable is ideal, though butyl rubber cables are somewhat tougher.

Budding sound engineers are reminded that in large PA rigs, unseen, and sometimes rather humorous, dangers can lurk. In 1972, a well-known British manufacturer equipped the Lincoln rock festival with a 10kW system. This promptly blew someone off the stage when an organist hammered on a chord miked through the system! ★

FURTHER READING

Paul Klipsch—Loudspeaker performance *(Wireless World,* February 1970)

Jack Dinsdale—Horn loudspeaker design *(Wireless World,* March–June 1974)

Adrian Hope—Hearing Damage *(Studio Sound,* August & December 1975)

Dave Martin—Speaker technology for sound reinforcement *(Studio Sound,* March 1976)

Stephen Court—Quality performance *(Studio Sound,* November 1976)

Richard Galbraith—Rock music and hearing loss *(J.AES,* March 1977)

Ken Dibble—Design considerations for a PA speaker system *(Studio Sound,* May 1977)

Terry Nelson—Sound on stage *(Studio Sound,* May 1978)

CMOS

		4020	50p	4050	25p
		4022	50p	4060	80p
		4023	13p	4066	30p
		4024	40p	4068	13p
4001	13p	4025	13p	4069	13p
4002	13p	4026	90p	4070	13p
4007	13p	4027	28p	4071	13p
4009	30p	4028	45p	4072	13p
4011	13p	4029	50p	4081	13p
4012	13p	4040	55p	4093	36p
4013	28p	4041	55p	4510	60p
4015	50p	4042	55p	4511	60p
4016	28p	4043	50p	4518	65p
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		7474	22p	74145	55p
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7402	10p	7485	55p	74151	40p
7404	12p	7486	20p	74154	65p
7406	22p	7489	135p	74157	40p
7408	12p	7490	25p	74164	55p
7410	10p	7492	30p	74165	55p
7413	22p	7493	25p	74170	100p
7414	39p	7494	45p	74174	55p
7420	12p	7495	35p	74177	50p
7427	20p	7496	45p	74190	50p
7430	12p	74121	25p	74191	50p
7432	18p	74122	35p	74192	50p
7442	38p	74123	38p	74193	50p
7447	45p	74125	35p	74196	50p
7448	50p	74126	35p	74197	50p
7454	12p	74132	45p	74199	90p

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LED's	0.125in.	0.2in	each	100+
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Green	TIL211	TIL221	13p	12p
Yellow	TIL213	TIL223	13p	12p
Clips	3p	3p		

DISPLAYS

DL704	0.3 in CC	130p	120p
DL707	0.3 in CA	130p	120p
FND500	0.5 in CC	100p	80p

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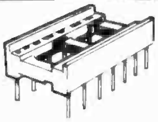

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3.75 x 17	205p	185p	
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741	16p	LM378	230p	TBA800	70p
747	45p	LM379S	410p	TBA810S	100p
748	30p	LM380	75p	TDA1022	620p
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7107	900p	LM3909	65p	TL084	125p
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AC128	16p	BD132	35p	2N3055	50p
AC176	18p	BD139	35p	2N3442	135p
AD161	38p	BD140	35p	2N3702	8p
AD162	38p	BFY50	15p	2N3703	8p
BC107	8p	BFY51	15p	2N3704	8p
BC108	8p	BFY52	15p	2N3705	9p
BC108C	10p	MJ2955	98p	2N3706	9p
BC109	8p	MPSA06	20p	2N3707	9p
BC109C	10p	MPSA56	20p	2N3708	8p
BC147	7p	TIP29C	60p	2N3819	15p
BC148	7p	TIP30C	70p	2N3820	44p
BC177	14p	TIP31C	65p	2N3904	8p
BC178	14p	TIP32C	80p	2N3905	8p
BC179	14p	TIP2955	65p	2N3906	8p
BC182	10p	TIP3055	55p	2N4058	12p
BC182L	10p	ZTX107	14p	2N5457	32p
BC184	10p	ZTX108	14p	2N5459	32p
BC184L	10p	ZTX300	16p	2N5777	50p
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BC212L	10p				
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	100					8p
		220				10p
				470		15p
	1000					23p

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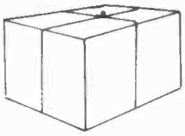

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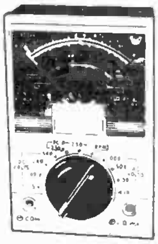

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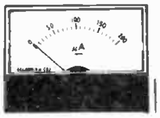

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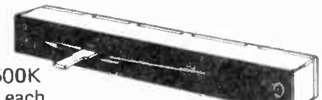

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Part 2 - Kenneth Amor

CONSTRUCTION

THE SYSTEM is constructed on four boards, two of which are non clad Veroboards, and the remaining two are i.c. stripboards which have edge connector pads that are not used in the Modem. See Figs. 2.2, 2.3, 2.4 and 2.5.

APPLICATIONS INFORMATION

The following section deals with uses to which the acoustic modem may be put. It deals with various applications; many enabling things to be done over a telephone that could not normally have been achieved without the use of this device.

Data transfer from a data bus on any minicomputer, or for that matter any device that presents its output in parallel form is possible. Obtain and study the AY-5-1013A data sheet.

This Integrated circuit is probably the most useful device ever produced for data transmission and interfacing with microprocessors etc. Basically its function is to accept a parallel 8 bit word, and when it is told, clock that data out in serial format, inserting its own start, stop, and parity checking bits automatically. The device is split into two parts, transmitter and receiver. It is designed to interface directly a parallel output device to a modem.

Having incorporated this device in the acoustic modem system the possibilities are endless in terms of data that may be sent over long distances. A block diagram of the UART is shown in Fig. 2.1, as a transmitter with associated waveforms.

It so happens that General Instruments produce another Integrated circuit that is able to interface directly with the 'UART'. This i.c. is General Instruments 2376 Keyboard Encoder. This device is a Read-Only Memory (ROM) that will

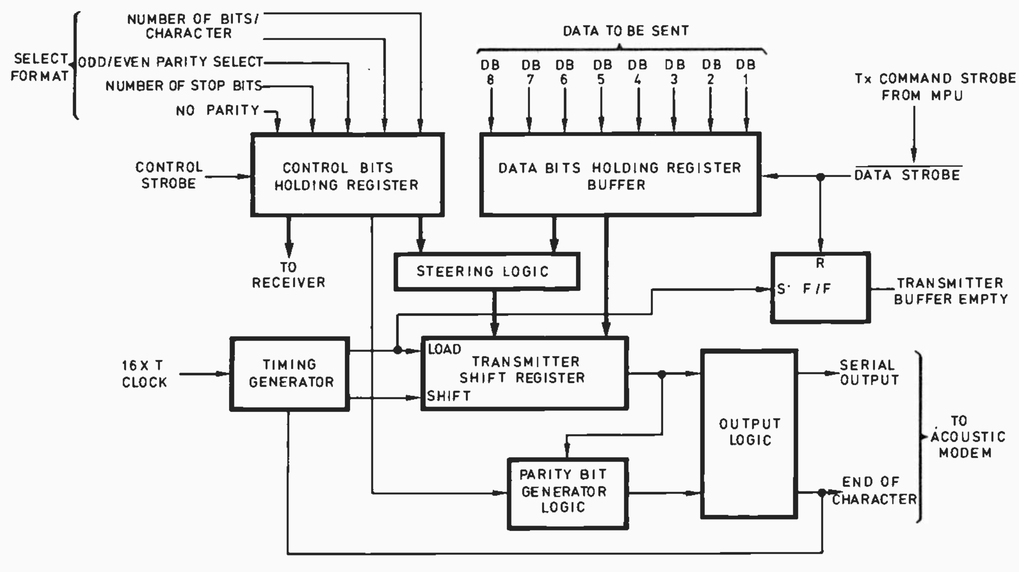
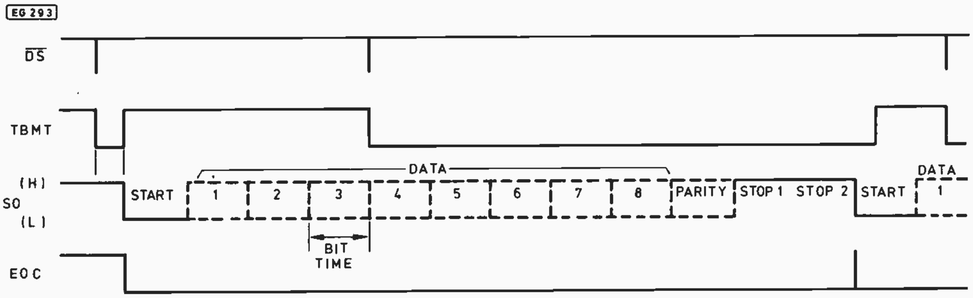
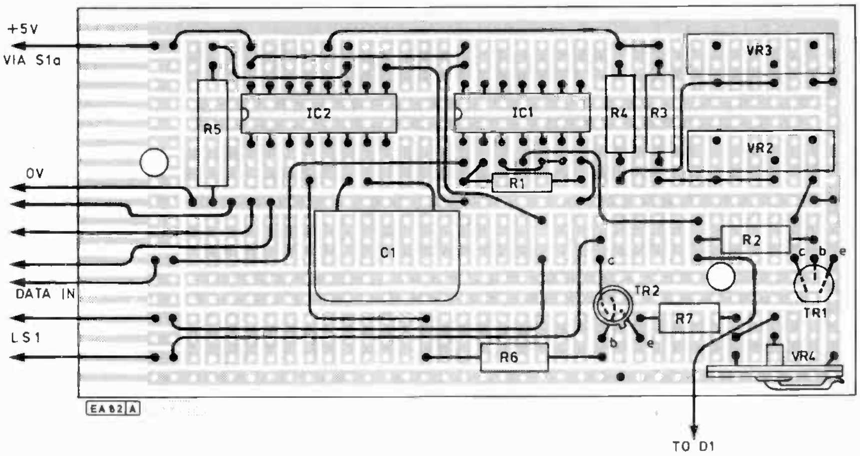


Fig. 2.1(a). UART Transmitter block diagram



(b) UART Transmitter waveforms

Fig. 2.2. Modem Transmitter board



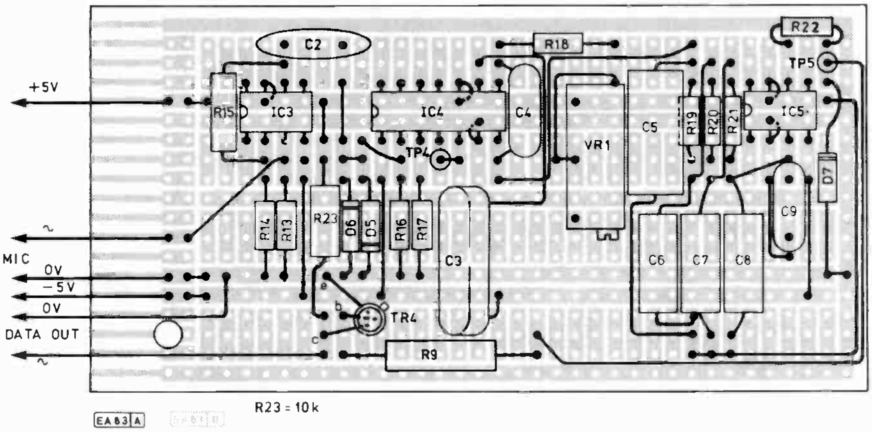
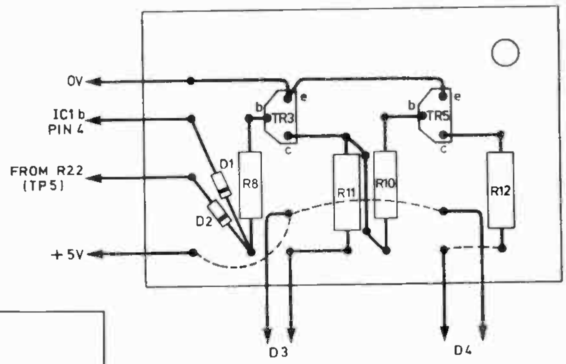


Fig. 2.3. Modem Receiver board

Fig. 2.4. LED Driver board



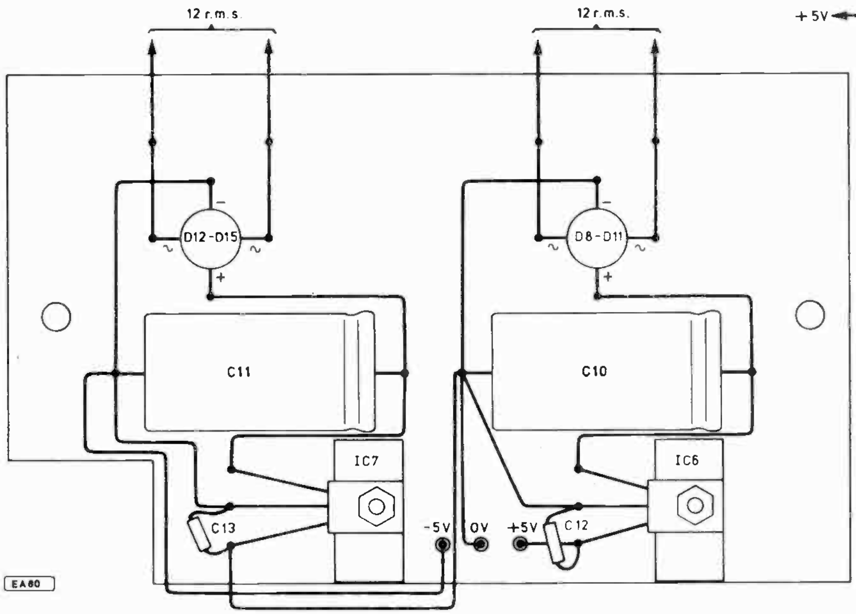


Fig. 2.5. Power Supply board

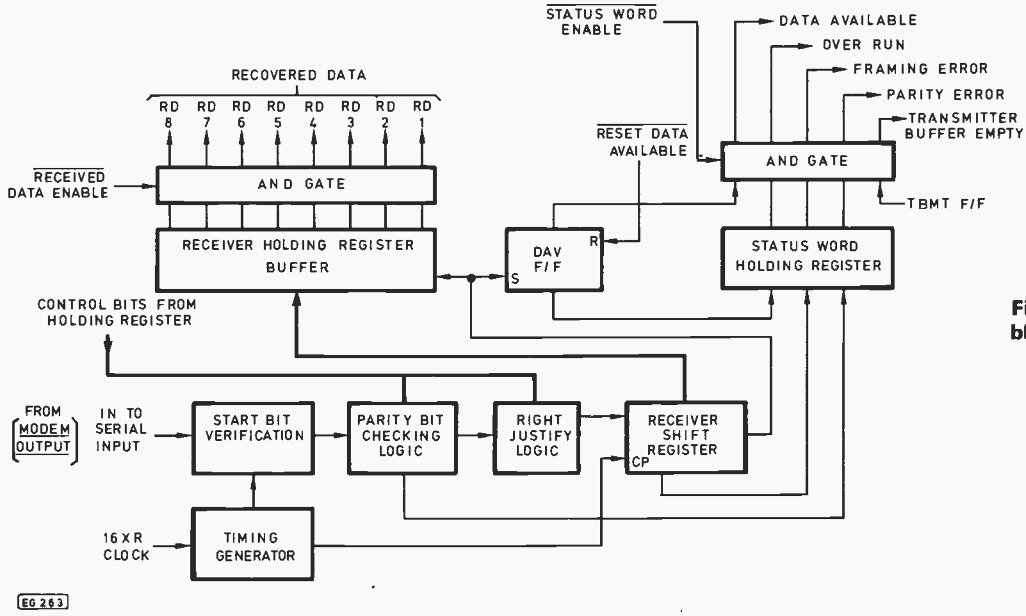
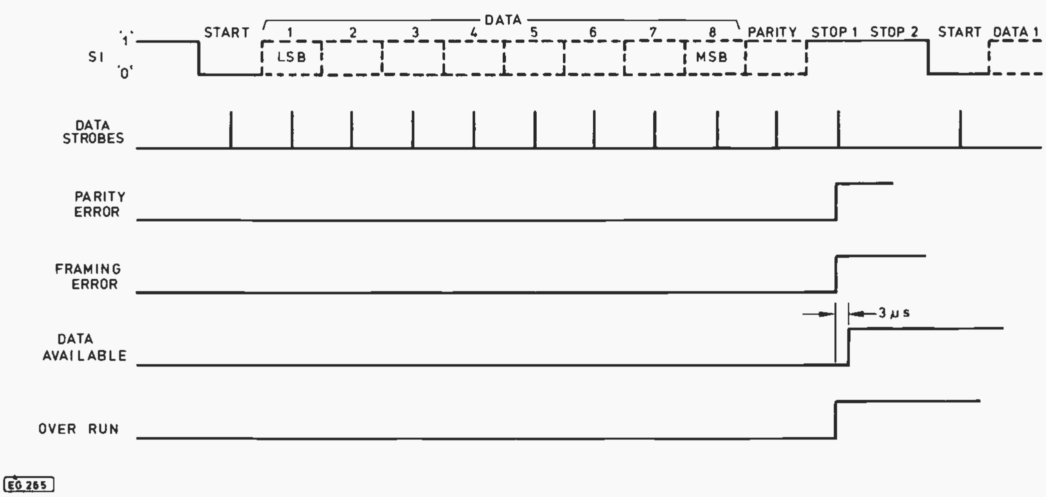


Fig. 2.6(a). UART Receiver block diagram



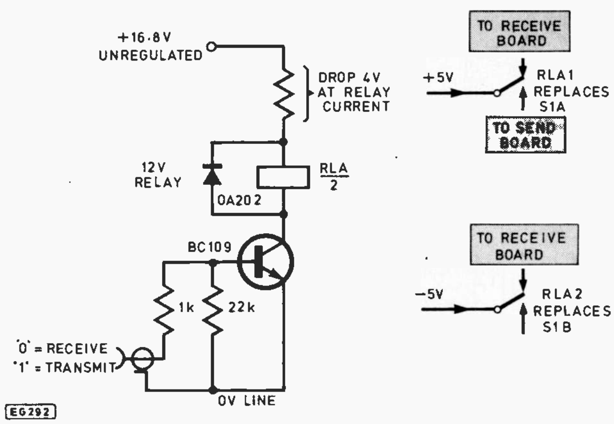
(b). UART Receiver waveforms

encode all the characters on a standard "QWERTY" (typewriter) keyboard and produce an output in parallel ASCII along with a strobe pulse. Keyboards have become inexpensive now and some of them are already encoded using the 2376 ROM. The Parallel output and strobe from such a keyboard may be used to directly load the AY-5-1013A UART with ASCII code and then send by FSK via the modem to the distant terminal.

SIGNALS IN DC LEVELS

It is even possible to send and receive low frequency signals, and d.c. may also be transmitted using Binary coded data, since our UART may be loaded with any 8 bit parallel data. From 8 bits of data we could resolve a quantity into $2^0 + 2^1 + 2^2 + 2^3 + 2^4 + 2^5 + 2^7 + 2^8$ parts which decimally speaking $= 1 + 2 + 4 + 8 + 16 + 32 + 64 + 128$ which is equal to 255. The method used to convert a d.c. voltage or a slowly changing signal to 8 bit binary is known as Analogue-to-Digital conversion. A very useful integrated circuit can be used to do just this. It is the Ferranti ZN425E. This chip will accept an analogue signal and decode it into 8 bit parallel data. It will also work in the reverse mode converting the digital data to an analogue signal.

Fig. 2.7. Circuit for automatic Send/Receive



There is a worthwhile modification to the acoustic modem to further improve its versatility. This is to do away with the Send/Receive switch and arrange for remote Send/Receive under the control of an external device. This modification is outlined in Fig. 2.7. ★

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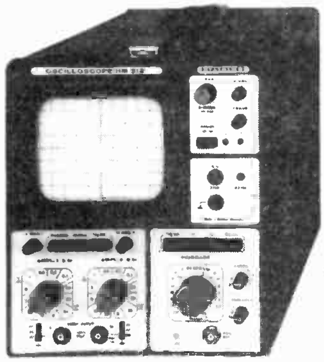

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A selection of readers' original circuit ideas. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.

Why not submit *your* idea? Any idea published will be awarded payment according to its merits.

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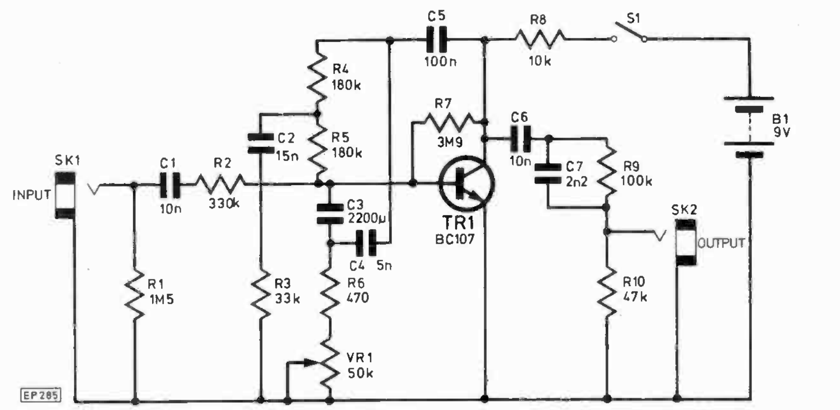
Each idea submitted must be accompanied by a declaration to the effect that it is the original work of the undersigned, and that it has not been accepted for publication elsewhere.

WAH-WAH PEDAL



MANY guitarists will be familiar with the Wah-Wah pedal, but many of the available makes or published designs are often unsatisfactory—especially for professional use. As a guitarist, I have found that some units have a very small or uneven range, whereas others are too harsh—often with annoying 'clicks', which give a scratchy sound, which totally spoils higher notes. Even commercially available units have disadvantages—notably in background noise, changing in volume as the pedal is moved, and, of course, price.

So, with these problems in mind, it was decided to sit down to design a really high-quality unit, delicately balanced between the harsh and smooth sounds. This circuit produces a subtle but effective sound, perfect for guitars or other electric instruments, and may be used as a treble booster.

This unit is best built as a pedal. One of the jack sockets (usually the input) should be replaced with a switched socket to connect the negative supply when a plug is inserted. A foot-switch should be fitted to by-pass the circuit. The value of the potentiometer depends on the swing of the pedal, but it should be made to give a swing from 0 to 50k.

The unit is simple to construct and gives a really superb sound—especially if used with the recently published 'phaser'. A really worthwhile project.

Richard Fuller,
Much Hadham,
Herts.

200 WATT TEMPERATURE CONTROLLER

THE temperature controller described was designed for propagator heaters rated up to 200 watts, but can be used in many applications where good control is required. The stability is typically within 0·5°C of the set point and the temperature range is approximately 10 to 40°C.

For safety considerations, the temperature sensor is electrically isolated from the mains side of the controller and connected to earth. This means that if the device itself becomes damaged in any way, there would be no danger.

A National Semiconductor LX5700H integrated circuit temperature transducer is used as the sensor. This has an operational amplifier fabricated on the same chip and gives an output directly proportional to degrees Kelvin at 10mV/°K. (Note: °K = °C + 273.2.)

The output is compared with a stable reference voltage by means of the differential amplifier IC1. Potentiometer VR1 determines this reference voltage which thus sets the operating temperature of the controller.

If necessary, the lower and upper limits can be extended by altering R1 and R2 respectively. However, one should have in mind that the maximum permissible temperature is restricted by the operating temperature range of the sensor which is −85 to +125°C for the one used. The output from IC1 is applied via TR1 to the unijunction transistor (TR2) firing and triac switching circuit to provide full-wave, phase-controlled a.c. power to the load.

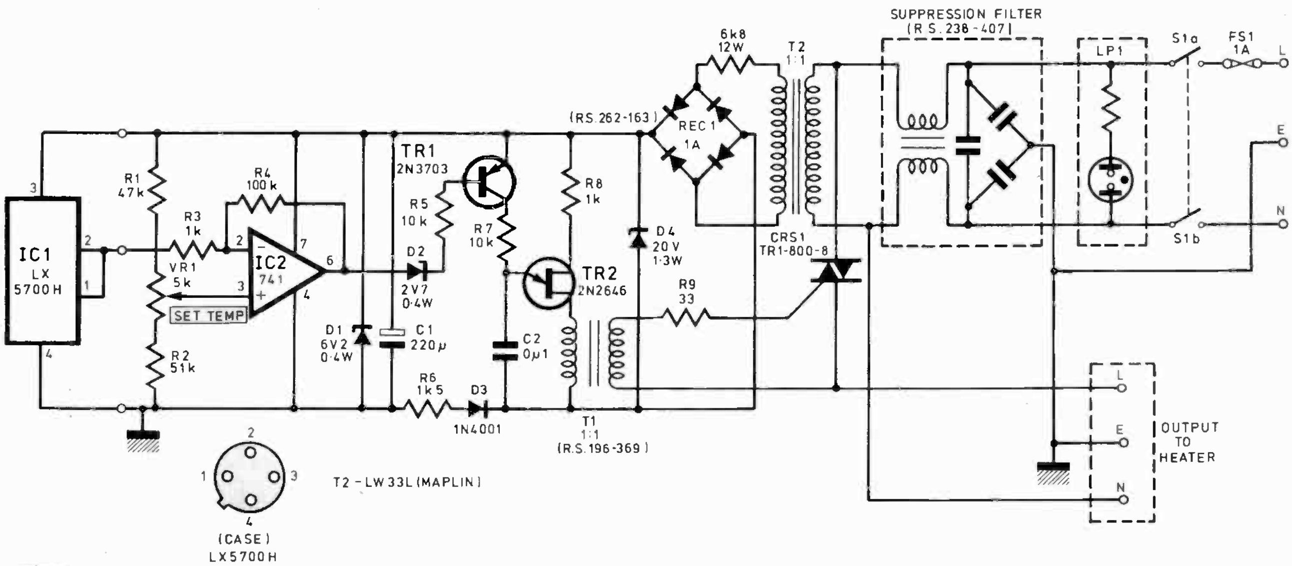
The 2·7V Zener diode D2 in series with the 10k base resistance is included to ensure TR1 can switch hard off even if the output voltage swing from IC1 does not fully approach the supply voltage.

The pulse transformer T1 provides isolation for the triggering pulses and the supply to the unijunction trigger circuit is isolated from the mains with transformer T2. This supply is then rectified and clamped to 20 volts by the Zener diode D4. The Zener diode D1 and associated capacitor C1 provides a 6·2V smoothed d.c. supply for the preceding circuitry. As the reference voltage is taken off this supply D1 should preferably be a temperature compensated Zener such as a Mullard 1N821 or RS 283–097.

The mains filter is provided to suppress radio frequency interference caused by triac switching. It should be mentioned that as the triac is rated at 8A it is only necessary to increase the rating of the filter to improve the maximum power capability of the controller (e.g. RS 238–435 for 2A or 238–390 for 5A load). However, if used at maximum power, the triac must be mounted on a heat sink having a thermal dissipation of 4° C/W (e.g. RS 401–497). Alternatively, as the tab is electrically isolated, it may be fixed directly to the chassis for heat dissipation.

The sensor itself can be made into the form of a probe by insulating with sleeving and encapsulating with silicon rubber compound or expoxy resin.

D. Wedlake,
University College,
Newport Rd.,
Cardiff,
CF2 1TA.



EG 245

SIMPLE GUITAR TREMOLO

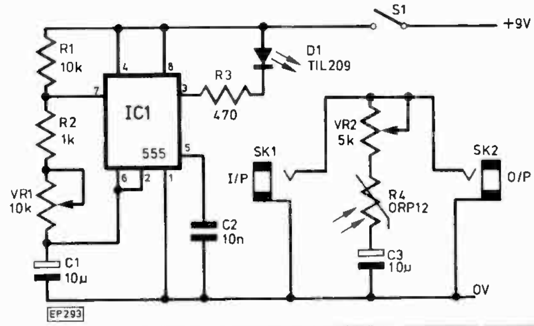
FROM switch-on, C1 starts to charge via R1, R2, and VR1 (VR1 determines the rate of charge/discharge and therefore the frequency of operation). When C1 reaches $\frac{2}{3}$ of the supply voltage, pin 7 switches to the low state, C1 then discharges through pin 7, via R2, VR1. Discharge stops when the voltage across C. decreases to $\frac{1}{3}$ of the supply, this activates the trigger (pin 2) and the cycle starts again.

The output from pin 3 is used to drive the l.e.d. via a 470 ohm resistor. The light from this varies the resistance of R4 which via C3 and VR2, short-circuits the line and consequently attentuates the signal, VR2 controls the depth of attentuation.

Although the output from the 555 is a square-wave this is not really noticeable except at low frequencies, which are not normally used for this application anyway.

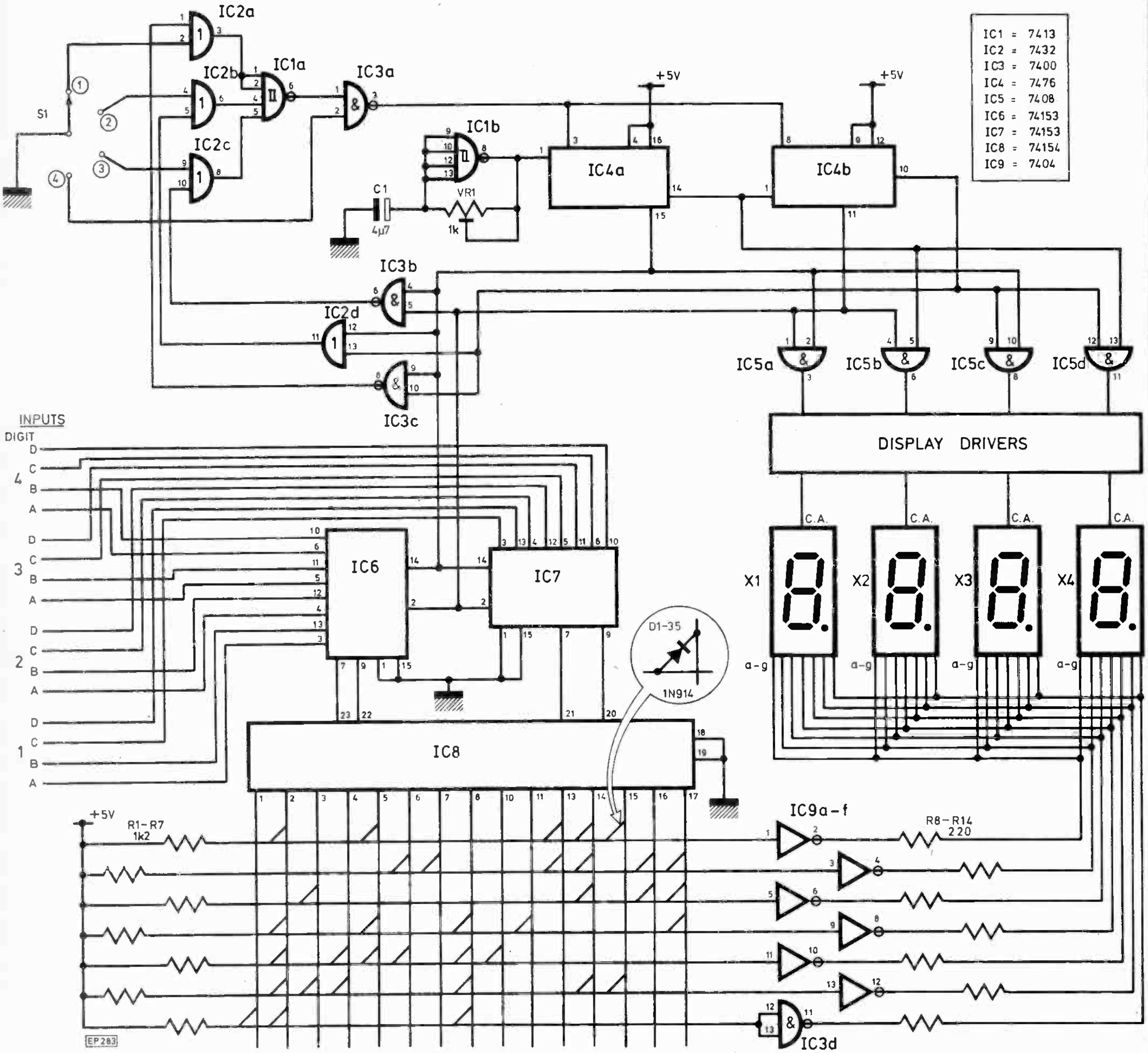
It is important to house the unit in a light-proof box.

A.R. Curtis,
Bedhampton,
Hants.



EP293

HEXADECIMAL DISPLAY



THIS four-digit display is capable of displaying the letters A–F as well as the digits 0–9, making it ideal for use with microprocessors, in the monitoring of address buses for example. However, it may be used in frequency meters, clocks, etc., although using 7447s would be easier in these latter cases. It is designed to act as a direct drive display, but may be used as a multiplexed display by applying the inputs directly to IC8 and the display drivers, leaving out ICs 1–7.

IC1b, VR1, and C1 form an oscillator which clocks the two-stage counter IC4. The outputs are decoded by IC5 to multiplex the display. IC1a, IC2, and IC3a–c reset the two flip-flops; S1 controls at which point in the count they reset. It is therefore possible to alter the number of operating digits in the display.

ICs 6 and 7 are multiplexers, controlled by IC4, which sequentially feed each of the four four-bit binary data inputs through to the decoder IC8. The sixteen outputs are fed to a diode matrix.

The seven diode matrix outputs are fed through invertors and current-limiting resistors to a common anode display (4 × FND507, 2 × DL727, etc., etc.). Non-l.e.d. displays may be used, provided that suitable display drivers are used, and that no more than 16mA are required per segment. The gates IC5a–d will source 800μA to operate the display drivers. The decimal points may be separately driven, if they are required. L.c.d. displays should *not* be used.

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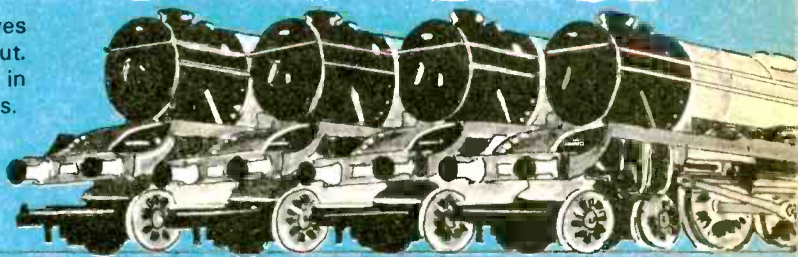
2 Wire Train Controller

This unusual design enables a number of model locomotives to be individually controlled on one interconnected layout. Construction for a four channel controller will be described in detail but it is possible to extend the unit up to ten channels.



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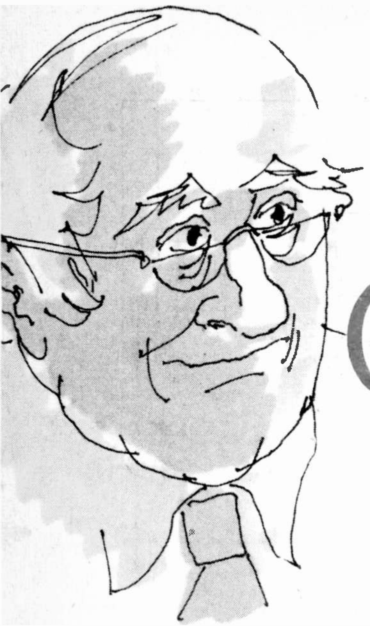


Simple Conversation Aid

J.M.Watt M.B.Ch.B.

DEAFNESS is one of the most disabling afflictions amongst the elderly. While not life endangering this condition causes considerable hardship and places many restrictions upon the sufferer. These mainly elderly people tend to miss vital parts of a conversation, misunderstanding the simplest of messages resulting in them being regarded as slow witted and dull. The effort of repeating a casual remark three or four times is enough to deter most of us from even attempting to hold a conversation with anyone who is 'hard of hearing'. The result is that the deaf often become isolated and ignored. Whereas the blind receive sympathy all too often the deaf receive nothing but contempt and irritation.

HEARING AIDS

The electronic design and construction of hearing aids is no problem in the age of microelectronics. However, conventional hearing aids while having the advantage of cosmetic concealment and portability are often inadequate when conversation rather than the stereotyped responses of everyday life is required. It is the striving for cosmetic acceptability (very important if they are to be worn and not rejected in embarrassment) which renders these hearing aids acoustically rather than electronically poor.

Moulded earpieces may be worn comfortably and inconspicuously, but are poor at reproducing the lower frequencies because of their size. The sound from such earpieces is of necessity distorted and may cause problems even for those of us with normal hearing.

The other acoustic/electronic interface is the microphone. Here again size may be the problem in the behind the ear type of hearing aid where the size of the sound receiving surface is limited. This restriction causes low sensitivity and distortion. The pocket type of hearing aid is less attractive to the wearer because of the unsightly cord leading to the ear, but it can incorporate a reasonably sized microphone with minimal distortion. The disadvantage of this type of aid is that it is usually hidden in the clothing and is liable to pick up the rustle of the fabric as the wearer moves.

In order to hold a conversation with a relatively deaf person, a device with better acoustic rather than electronic properties than the conventional hearing aid would be of use. A circuit was therefore built which would amplify a signal from a microphone and supply a pair of earphones. In fact the results obtained using a cheap crystal microphone insert, and a pair of inexpensive headphones was quite encouraging, and the prototype unit is now in daily service being preferred by the patient to her NHS hearing aid for one-to-one conversation, and watching television.

THE CIRCUIT

The input from a high impedance microphone is fed to IC1 through C1. The 741 i.c. functions as a high gain preamplifier driving the push pull output stage. The gain obtained by the 741 may be varied by changing the value of R5, the gain increasing as the resistance is increased. Base bias for the output transistors is provided by the R3, R4, D1, network, the forward voltage across D1 separating the bases sufficiently to reduce crossover distortion.

The circuit diagram in Fig. 1 shows this simple unsophisticated device which is easily constructed by most people in a very short time, and costs little more than £1 (the microphone and earphones, may be bought for about £5).

COMPONENTS ...

Resistors

R1	33k
R2	33k
R3	10k
R4	10k
R5	180k

All $\frac{1}{2}$W carbon 10%

Capacitors

C1	0·33μ
C2	100μ 16V electrolytic

Semiconductors

D1	1N 4002
TR1	BC 142
TR2	BC 143
IC1	741

Miscellaneous

0·1in Veroboard. Stereo jackplug socket. PP7 battery. 3$\frac{1}{2}$mm jack plug and socket. Microphone (crystal insert is sufficient). Light coax, cable. Headphones

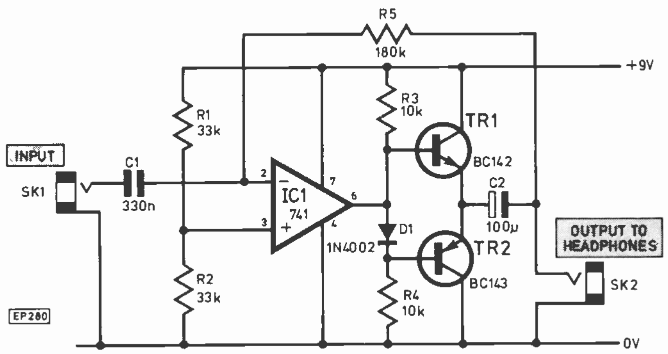


Fig. 1. Circuit of Conversation Aid

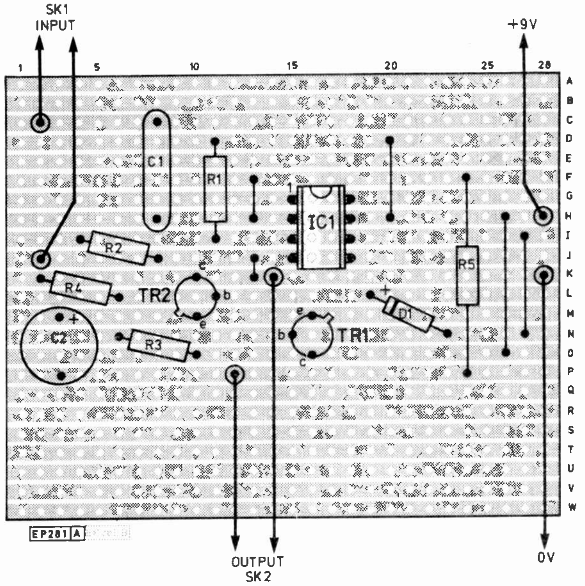


Fig. 2. Veroboard Layout

A Veroboard layout is presented in Fig. 2, the output of the mono amplifier being supplied to the headphones.

The whole unit including a PP7 battery was housed in a plastic box 5in × 2·5in × 2·5in and the microphone was attached using light weight coaxial cable, and a 3½mm jack plug and socket.

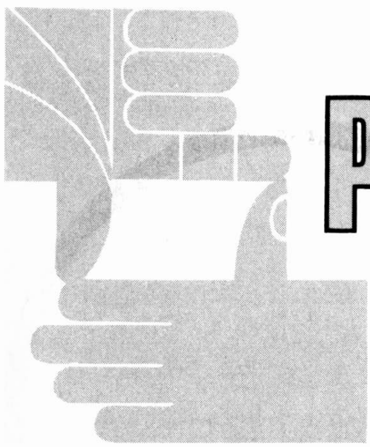
APPLICATION

Cheap and simple electronics can play a useful role in alleviating the problems of deafness once the idea of miniturisation is abandoned. Concealed hearing aids are a great benefit to the deaf, but they have their limitations. The device described will not help the truly 'stone deaf', but may do much to retain or restore the domestic harmony and social life of the 'hard of hearing'. ★

Countdown

Waveform And Function Generators (mini) Feb. 19-21. National Microprocessor and Electronics Centre, London (close to Tower of London). All mini-exhibitions held at this centre run concurrently with a permanent exhibition of electronics. **L1**
BEX Feb. 20-21. Pavilion Bournemouth. **K**
IEA/Electrex Feb. 25-29. National Exhibition Centre, Birmingham. **I**
Wire Preparation (mini) Mar. 4-6. National Microprocessor and Electronics Centre, London. **L1**
Keyboards And Switches (mini) Mar. 18-20. National Microprocessor and Electronics Centre, London. **L1**
Viewdata March 26-28. Wembley Conference Centre, London. **O**
Computer-Aided Design (conference & exhibition) March 31-April 2. Metropole, Brighton. Details: CAD 80/0483-31261
Small ATE April 1-3. National Microprocessor and Electronics Centre, London. **L1**
Applying Microprocessors April 8-10. National Microprocessors and Electronics Centre, London. **L1**
Seminex April 14-18. Dept. Physics, Imperial College, London. **H1**
Communications 80 April 14-18. National Exhibition Centre. **I**
Calibration April 15-17. National Microprocessor and Electronics Centre, London. **E1**
Welsh Amateur Mobile Rally April 20. Memorial Hall. **C**
Electronic Test & Measuring Information April 22-24. Wythenshaw Forum, Manchester. **T**
International Conference On The Electronic Office April 22-25. London Penta Hotel. Organised principally by the Institute of Electronics & Radio Engineers. 99 Gower St., London WC1E 6AZ
North Midlands Mobile Rally April 27. Drayton Manor Park, Tamworth, Staffs. Details: Norman Gutteridge, 68 Max Rd., Quinton, Birmingham.
All-Electronics Show April 29-May 1. Grosvenor House, London. **E**
The Mersey Micro Show April 30-May 2. Adelphi Hotel, Liverpool. **O**
Compec Europe May 6-8. Centre International Rogier, Brussels. **L**
Great British Electronics Bazaar June 20-22. Alexandra Palace. **E**
Intel Fair June 24. Wembley Conference Centre, London. **U.**
Tempcon July 1-3. Wembley Conference Centre. Exhibition devoted to temperature control & measurement. **T**
Transducer July 1-3. Wembley Conference Centre. **T**
Microsoftware (symposium) July 7-10. University of Sussex. **S1**
The 1980 Microcomputer Show July 10-12. Royal Lancaster Hotel, London. **O**
Avionics (symposium) Sept. University of Surrey. **S1**
Harrogate International Festival of Sound Aug. 16-19 (18 & 19 trade). The Exhibition Centre + hotels. **X**

E Evan Steadman, 34-36 High st., Saffron Walden, Essex. ✆ 0799 22612
C Barry College of F.E. Radio Society, College of Further Education, Colcot Rd, Barry, S. Glam. CF6 8YJ.
H1 Seminex Ltd., 79 High st., Tunbridge Wells, Kent. TN1 1XZ. ✆ 0892 39664/5
I Industrial Trade Fairs, Radcliffe Ho., Blenheim Court, Solihull, W. Midlands B91 2BG. ✆ 021-705 6707
K Douglas Temple Studios, 1046 Old Christchurch Rd., Bournemouth, Dorset BH1 1LR. ✆ 020 20533
L Iliffe Promotion, Dorset Ho., Stamford St., London SE1 9LU. ✆ 01-261 8437/8
O Online Conferences, Cleveland Rd., Uxbridge, Middx. UB8 2DD. ✆ 0895 39262
T Trident International Exhibition, Abbey Mead Ho., 23a Plymouth Rd., Tavistock. Devon PL19 8AU. ✆ 0822 4671
U Brian Crank Associates, 58 London Rd., Southborough, Kent. ✆ 0892-31812 38414
X Exhibition & Conference Services, Claremont Ho., Victoria Ave., Harrogate, Yorks. ✆ 0423-62677
L1. P. Smith, London World Trade Centre, Europe House, London E1 9AA. ✆ 01-488 2400
S1 Society of Electronic & Radio Technicians, 57-61 Newington Causeway, London SE1 6BL. ✆ 01-403 2351



PATENTS REVIEW...

Copies of Patents can be obtained from :
the Patent Office Sales, St. Mary Cray, Orpington, Kent   Price 95p each

NOISE ELIMINATOR

Pioneer of Japan has filed a British patent application (No. 2 020 131, dating back to March 1978 under the new laws) which describes an interesting idea for rejecting unwanted noise from audio circuits. The invention is directed primarily at car stereo systems but could have wider applications.

In a car system the cassette deck or radio receiver sections are coupled to the amplifier section by screened leads, but noise from the ignition, windscreen wipers and switches can still breakthrough and pollute the reproduced programme signal. Moreover if power supply current for the amplifier also flows in the screens, any ripple in the power supply will superimpose on the audio signal. These problems are especially noticeable with modern car systems, which are of very high amplification power and aim at true high fidelity. Interference can be rejected by the use of a transformer or photo coupler ahead of the amplifier, but the additional components are expensive if distortion or band limiting is to be avoided. Pioneer now claim that a differential amplifier system is the solution.

As shown in figures 1 and 2, audio source A (tape deck or radio receiver) feeds amplifier B via a pair of differential amplifiers. The first differential amp (for the left channel) is based on transistors Q1, Q2 with their emitters connected commonly through load resistors R1, R2. A constant current source transistor Q5 is collector coupled to the emitters of Q1 and Q2. The second diff amp (for the right channel) is similar i.e. transistors Q3, Q4, load resistors R3, R4 and transistor Q6 (Fig. 2).

FIG. 1

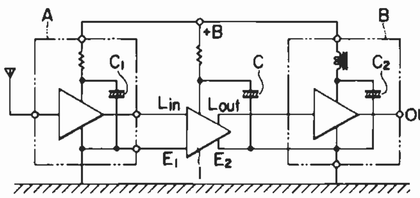
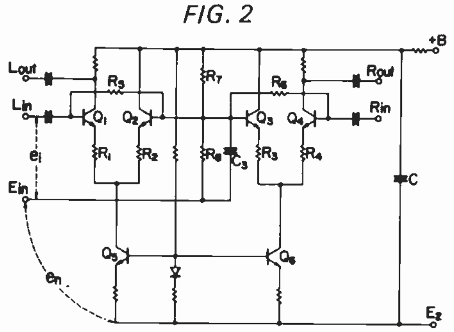


FIG. 2



If a noise voltage e_n is induced between the terminals E_{in}, E2 this voltage is directly applied to common input E_{in} and common terminal E2. So noise e_n is applied to the bases of transistors Q1, Q3. Audio signal e_i, on which the noise voltage e_n is superimposed is applied to the input terminals L_{in} and R_{in}, so a corresponding signal is applied to the bases of transistors Q1, Q4. A differential signal appears at the outputs L_{out} and R_{out} of the diff amps. This signal exactly corresponds to the audio signal output from the source A. So there is no trace of noise e_n at the output terminals L_{out}, E2, and R_{out}. Hence the amplifier B produces a noise-free signal.

Pioneer point out that because the circuit does not rely on a bulky transformer or photocoupler it can be reduced to i.c. chip form and mass produced at low cost and of very compact size.

ANTI-SOUND

The concept of anti-sound is not new. For years engineers have been working towards a system which mimics ambient noise, but in anti-phase, so that the net result is silence. The Munich company Messerschmitt-Bolkow-Blohm GmbH already has several patents on inventions in this field and is now applying for protection on an interesting idea intended to overcome one of the major problems to date. This is non-linearity between the noise sensor and the anti-noise generator. UK patent application no. 2 019 695 (filed under the new laws and dating back, hopefully not significantly, to 1 April 1978), offers lengthy mathematical back up for Messerschmitt's claim to success with an apparently novel approach. This involves the integration of both the sound sensor and sound generator into a single unit.

Figure 1 shows a combined sensor/generator with a thin walled diaphragm 1 which seals air space 3 in a housing 2. A capacitive distance measuring device 4 determines the time characteristics of the deflection of the diaphragm caused by arriving sound. A signal derived according to the maths in the patent is transmitted to a control 5 which applies a voltage proportional to the deflection signal to a grid electrode 6 beneath the diaphragm. The diaphragm generates appropriate sound waves to interfere with those which it senses, thereby reducing the ambient sound level in the immediate vicinity.

Figure 2 shows a slightly different combined unit, with a rigid plate diaphragm 11 buckled into housing 12 to seal a vacuum 13. A control force is derived from an accelerometer 14 and applied to the diaphragm 11 via control circuit 15 for a magnet and moving coil arrangement 16. The diaphragm is thus again driven to transmit sound waves which interfere with those which it senses.

FIG. 1

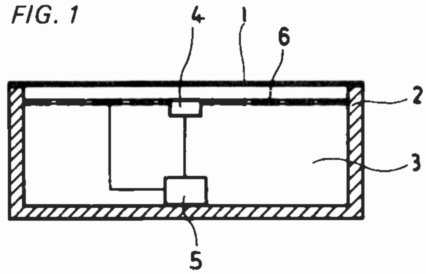
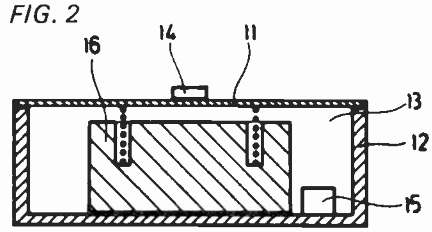


FIG. 2



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For some time now we have been on the lookout for a well presented ladies digital watch that would make a good offer. The problem with most inexpensive ladies watches is that the case design is often ugly, bulky, flashy or a combination of all three. However, when this particular ladies watch appeared in the office and girls from other magazines in the building started asking for them we knew we had a winner.

The watch is a straightforward design with a built-in light. It displays time, date and seconds with a four-year calendar, is l.c.d. and has no extra gimmicks. It comes in a stainless or gilt case with matching fully adjustable bracelet and has a black face surrounding the display. Above all, it is neat and good looking for everyday use.

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FRANK W. HYDE

INDIA AND HER SATELLITES

Since the first satellite coverage of India, when a geostationary craft was moved to a position to serve for a trial period, plans were finalised for the future of the continent's own system. The geostationary craft was the ATS-6 and was used to test the use of television educational methods. This craft was moved back to its position about a year later and proceeded with its normal tasks.

India has now leased one quarter of an Intelsat 4A transponder which has been operating with the first of the Insat ground stations. Testing of the first domestic link, between Madras and Delhi began operation in August 1979 and completed its task in November. Another experiment aboard the *Ariane* as a passenger payload, is an Indian built two transponder experimental satellite which is due for launching in 1980.

In addition to the transponder India has built two scientific satellites. These were launched by Russia.

At the present time the finalising of the design of a remote sensing satellite for dealing with natural resources to be launched in the 1983-1984 period in a polar orbit, is in progress.

COVERAGE AND CONTROL

The whole continent including remote islands, Andamans and Nicobar, will be covered with levels of ground facility. These are large earth stations with two 14·6m antennae, medium stations with one 14·6m antenna and remote area terminals. In addition to these principle stations there will be more than 100 meteorological platforms for data collection and six mobile ground stations. There will also be a number, not defined, of low cost ground stations which will be used for direct television coverage.

The Master Control Facility will be at Hassan in Southern India, a Network Control Facility will be at New Delhi and the third major facility will be the Meteorological Data Utilisation Centre also at Delhi.

The Master Control Facility will provide orbit raising as well as in-orbit control. It is expected that this will be completed by October 1980. The Meteorological Facility will be completed before first launch.

Insat 1-A is expected to reach full utilisation by mid 1982. Insat 1-B will be launched in the second half of 1982.

Insat is a joint venture of the nation's Space Department, Posts and Telegraph Department of the Ministry of Communications, Indian Meteorological Department of the Minsitry of Tourism and Civil Aviation, and Doordarsham, the Television section of the Ministry of Information and Broadcasting.

The Space Department is the responsible body for establishment of the space facilities. The Post and Telegraph Department is responsible for the telecommunications ground system and for the utilisation of the ground systems whilst the Meteorological Department is responsible for similar facilities in regard to meteorology.

LAUNCH OF INSAT 1-A and 1-B

Insat is designed so that it may be launched either by shuttle or by the NASA/McDonnel Douglas Delta 3910 expendable booster. India's agreement with NASA provides for a Delta back-up option should a shuttle slot not be available. In either case a McDonnel Douglas payload assist module will be used to boost the satellite from a low earth orbit to the geostationary orbit. One of the Satellites will be at final orbit longitude 74°E and the other at longitude 94°E.

The satellites will have twelve transponders for telecommunications and two for television and radio direct broadcasting. The telecommunications transponders will receive ground signals at 5935-6425MHz. and transmit on down link frequencies of 3710-4200MHz. The minimum output will be 32 dbw equivalent isotropic radiated power after seven years in orbit.

The television transponders will receive at 5855-5935MHz. and will transmit at 2555-2635MHz. They are designed to have a final life output of 42 dbw. All the transponders will have a bandwidth of 36MHz.

The telecommunications transponders will provide 6,000 channels interconnecting a network of 35 fixed and mobile earth stations of various sizes and capacities. Conventional systems will be used in heavily populated areas but in remote or sparsely populated areas small receiver aerials only will be employed. The low cost receiving aerials will be between three and four metres in diameter. Disaster warnings and ordinary radio programmes could be given in this direct broadcast network.

RADIOMETER

The satellites will carry a high resolution radiometer which will make available at two hourly intervals visible and infra red images of the whole Earth. The visible images 0·55-0·75 micrometres will have a resolution of 2·5km and the infra red 10·5-12·5 micrometres a resolution of 11km.

The other facilities are 100 unattended land and sea based data collection platforms. These will transmit meteorological data, hydrological and oceanographic data to the Delhi centre. Radiometric data will be down linked on a discrete channel at 4034·55MHz. Collection platform data will have a 200kHz bandwidth at 4038·1MHz. The up-link for this data will be 402·75MHz.

Observations of weather systems will include cyclones, sea surface and cloud top temperatures, water bodies, snow and other terrain changes which will include areas adjacent to India. Thus the close watch of cyclones will enable forcasts up to 12-24 hours in advance of other available methods. This will advance warning times by the direct broadcast system.

The snow coverage facilities are expected to assist the regulation of reservoirs for irrigation, irrigations control and flood control. The sea surface temperature is expected to make it possible to make earlier forecasts of the onset of monsoon periods. In fact there are all the facilities for the Indian continent to control the utilisation of its own natural resources and agriculture.

The meteorological information will be transmitted in real time from the Delhi Earth Station to the New Delhi Data Centre over a microwave link. The New Delhi Centre will analyse process and store data from the platforms and transmit processed images over telecommunications lines to the forecasting offices of the Meteorological Centre.

THE EARTH STATIONS

Five of the stations will have very high gain facilities of the order of 31 db/°K. These will be located at the main switching centres of the National Communications system. They will provide remote area communications and an up-link for feeding the ordinary television networks. They will also provide the telephone trunk service. All but the station at Shillong will have two antennae so that there can be simultaneous links with Insat 1-A and 1-B.

Twelve medium sized stations will be erected at Leh and Jullunder in the north of India, Lucknow, Patna, Bhubaneshwar, Ahmedabad and Jaipur in the centre, Hyderabad and Ernakulam in the south, the Laccadive Islands in the Southwest and the Andaman and Nicobar Islands in the southeast. These will provide trunk telephone service and Television up-link feed. The gain of these stations will be 27·5 db/°K.

Twelve remote area terminals with a gain of 19·7 db/°K will be used for the telephone service only. These will be at Srinagar in the north, Arunachal Pradesh, Nagaland, Imphal, Mizoram, Agartala and Gangtok (Sikkim) in the north east, Bujand Johpur in the west, Goa and Pondicherry in the south and Minicoy south of the Laccadives, in the southwest.

Six mobile terminals are also to be included in the system. Four of them will be stations which are transportable having gains of 19·7 db/°K. The remaining two will be emergency stations which can be airlifted or moved on jeeplike vehicles. These will be capable of providing both telephone and television uplink feed service. All the high frequency (4-6 GHz) earth stations will be linked via the control centre at New Delhi.

THE SATELLITES

The satellites will use three axis stabilisation with a precision momentum bias attitude control system. Two off-axis momentum wheels will be used in the primary mode and a single pitch and yaw wheel. Two-axis infrared earth sensors and a digital sun sensor provide attitude reference. Spacecraft thrusters will fire to unload the wheels.

The antennae reflectors will be deployed when the satellite is in orbit. The circular reflector 1·4 metres in diameter will be used for all the 6-GHz up link reception. Down link will use half of the 4-GHz channels. This reflector will use dual band horns for transmit and receive.

A 1·5 × 1·6 metre reflector at the opposite end of the satellite will transmit the remaining 4GHz channels and also the 2·5GHz down link signals. The antennae produce circular beams but are so designed that the edges limit the flux outside the territory of India. Four printed circuit crossed dipole antennae will be mounted on the earth viewing face of the satellite for the reception of UHF signals from the data collection platforms.

The satellite will weigh 1,279lbs when in geostationary orbit. The overall dimensions, when all the arrays, antennae, and solar sail are extended, will be 5·8 × 1·4 × 17·9 metres.

The solar sail, to counteract the effect of the solar wind on the asymmetrical solar array, is a ten foot high conical array.

POWER ARRAY

The solar power array is made up of five panels arranged with a vacant panel area to allow a clear view for the meteorological sensor. The array is 11·5 sq metres and designed to produce 900W at the end of the spacecraft's seven year life design.

A boost motor for control at apogee uses liquid propellant. This together with the solar sail and the microprocessor control system are innovations not in operation in any earlier design.

MICRO PROMPT

The hardware and software exchange point for PE computer projects

SECRET POLLING

Here is a suggestion for a "secret" key polling subroutine on the UK101, sent in by *J. M. Leach of Deal, Kent.*

```
100 POKE 11,0 : POKE 12,253 :
    X=USR (X) ; A=PEEK (531)
    : RETURN
```

Now try

```
10 GOSUB 100 : PRINT CHR$
   (A) ; GOTO 10
```

The routine described will return any single character from the keyboard without the need to press the RETURN key. This is useful in computer games. However, we should point out that this routine will *wait* until a key is pressed before commencing execution.

The method suggested in *PE November 1979*, on page 30, whereby the keyboard buffer address (57088) is POKEd with the appropriate Row number, and the PEEKed for the expected Column number, has one major advantage. With this method, the machine will sweep past the statement and ignore it if no key is pressed. The more dynamic, or real-time games need this feature, so that if there is no operator response, the machine will continue to animate the screen graphics.

When the latter is used, Control C must first be disabled by POKEing 530, 1. Use the keyboard matrix diagram of page 14 in the Compukit Manual for Row and Column numbers. You will soon discover the relative merits of these two methods.

101 USERS' GROUP

Sir—Having read your magazine for some years now I have always been interested in your many and varied projects. In the last few months I have followed with great interest your series on the Compukit UK101. I own one of these and it was very reassuring to see a magazine of your standing devoting so much space to this item.

Recently I have started a user group for the UK101 and all the members have at some time read the series. For this reason, when I decided to expand the club, I thought it wise to contact you.

The group serves as a clearing house for programs as well as providing useful hints on construction and most other aspects of the 101. We hope to be able to produce a newsletter in the very near future, and perhaps a cassette or two of the most popular programs.

Adrian Waters,
101 Users Group.

For further information, contact: Mr. Waters, Cadover, 117 Haynes Rd., Hornchurch, Essex.

DODGEY DIMENSIONS

Sir—I have built the UK101 and consider it to be superb value. However, recently I discovered a bug in my machine. If during a program I DIMension a string array with the first subscript having one of the following values: 1, 3, 4, 6, 7, 9, 10, etc., the machine hangs up when the program has been run, followed by ?FRE(0). When reset, Warm Start ?FRE(0) gives 0 ⌐ERROR.

eg.

```
10 DIM A$(3)
RUN
?FRE(0) . . . hangs up
Warm Start
?FRE(0) 0 ⌐ ERROR

10 DIM A$ (5, 3)
RUN
?FRE(0) 7302
OK
```

Not dimensioning means the machine defaults to 10 and is therefore expensive on memory. My solution at the moment is to DIM at the next highest acceptable number. This results in a loss of memory. All other statements perform normally. I would appreciate any advice on this problem.

Our Compukit does the same. Does anyone have a solution to this?

REACTION TO UFOs

Two CHAMP Programs have been submitted by Peter Davies of Birmingham.

The first program is a "Reaction Timer" which records the time between a signal on the display and the microprocessor being interrupted by one of the keys on the keyboard being pressed. The program first clears RAM register 0 which is used to store the display data. The index registers are cleared and stored with data for the subsequent delay. A delay of approximately 10 seconds follows, after which, eights are displayed to signal the user to press one of the keys. After a delay of approximately ten milliseconds a three digit counter is incremented. The counter is continually incremented every ten milliseconds until the microprocessor is interrupted.

When an interrupt occurs the contents of the three digit counter are converted to 7-segment code using the subroutine in CHOMP, LOKY. The code is then continually displayed until the reset button is pressed.

Since there is a three digit counter, times between 10 milliseconds and 4·44 seconds are recorded. If a key is pressed before the first delay has run out, the display will show 000 making it very difficult to cheat. Also after 4·44 seconds the display will show 000 to prevent the counter from starting again.

Reaction Timer

Address	Data	Mnemoic	
200	42	JUN 2	
1	05	05	
2	00	NOP	
3	42	JUN 2	Interrupt Vector
4	4A	4A	
5	28	FIM 8	Clears RAM register 0
6	00	00	
7	29	SRC 8	
8	FC	CLB	
9	E0	WRM	
A	79	ISZ 9	
B	07	07	
C	2C	FIM C	Clears registers For counter
D	00	0C	
E	2E	FIM E	
F	00	00	
210	20	FIM 0	loads registers For delay
1	00	00	
2	22	FIM 2	
3	00	00	
4	24	FIM 4	
5	AA	AA	
6	70	ISZ 0	10 second delay
7	16	16	
8	71	ISZ 1	
9	16	16	
A	72	ISZ 2	
B	16	16	
C	73	ISZ 3	
D	16	16	
E	74	ISZ 4	
F	16	16	

```
220   DF   LDM F  ]  Displays eights
1     28   FIM 8  ]  on screen.
2     80   80     ]
3     29   SRC 8  ]
4     E5   WR1    ]
5     E6   WR2    ]
6     E0   WRM    ]
7     0C   EIN    ]
8     20   FIM 0  ]  Data for ten
229   05   05     ]  millisecond delay
A     22   FIM 2  ]
B     E0   E0     ]
C     70   ISZ 0  ]
D     2C   2C     ]
E     71   ISZ 1  ]  ten millisecond delay
F     2C   2C     ]
230   72   ISZ 2  ]
1     2C   2C     ]
2     6D   INC D  ]
3     AD   LD D   ]
4     F1   CLC    ]
5     FB   DAA    ]
6     BD   XCH D  ]  3 - digit
7     1A   JNC    ]  decimal counter
8     28   28     ]
9     F1   CLC    ]
A     6C   INC C  ]
B     AC   LD C   ]
C     FB   DAA    ]
D     BC   XCH C  ]
E     1A   JNC    ]
F     28   28     ]
240   F1   CLC    ]
1     6E   INC E  ]
2     AE   LD E   ]
3     FB   DAA    ]
4     BE   XCH E  ]
5     1A   JNC    ]
6     28   28     ]
7
8
9
A     0A   SBO       Interrupt routine
B     50   JMS 0   - Jump CHOMP
C     CE   CE        subroutine LOKY
D     50   JMS 0   - CHOMP subroutine
E     B1   B1        DDRV
F     42   JUN 2
250   4D   4D
```

The initial 10 second delay can be altered by having different values at address 215.

The second program is a game called "Destroy". The idea is that the user controls a ground base and must destroy U.F.O's flying overhead. This program will be shown in the next Micro Prompt.

TORPEDO RUN

This program in BASIC, simulates a submarine attack on a ship which moves across the screen from left to right, disappears from the screen, then reappears on the left but slightly lower down. A torpedo is fired by pressing 1 on the keyboard. The number of torpedoes used is displayed on the screen. A maximum of nine torpedoes may be fired, after which the computer comments on your performance.

Hits are achieved by the torpedo striking amidships. The ship then stops in its tracks and an explosion is seen. The number of hits achieved is also displayed on the screen.

```
4   CLEAR
5   FOR Z = 1 TO 30 : PRINT :
    NEXT
10  A = 53248 : C = 54240
15  FOR I = 1 TO 1024
20  A1 = A+1 : A2 = A+2 : A3 =
    A+3 : A4 = A+4
25  A5 = A+5 : A6 = A+6 : A7 =
    A+7 : A8 = A+8
30  A9 = A+9 : B1 = A+10 : B2 =
    A+11 : B3 = A+12
32  POKE 54123 , 84 : POKE 54134 ,
    72
35  POKE B3 , 196 : POKE B2 , 158 :
    POKE B1 , 158
40  POKE A9 , 159 : POKE A8 , 160
    : POKE A7 , 161
45  POKE A6 , 160 : POKE A5 , 159
    : POKE A4 , 158
50  POKE A3 , 158 : POKE A2 , 198
    : POKE A1 , 32
52  POKE 530 , 1
55  POKE 57088 , 254 : POKE 57088
    , 127
60  IF Q = 1 THEN 500
65  IF PEEK (57088) = 127 THEN V
    = V+1 : GOTO 500
70  A = A+1 : FOR G = 1 TO 50 :
    NEXT G
71  POKE 54125 , (48 + V)
72  IF C2 = A9 THEN 600
73  IF C2 = A8 THEN 600
74  IF C2 = A7 THEN 600
75  IF C2 = A6 THEN 600
78  NEXT I
80  Q = 0 : GOTO 10
500 Q = 1
510 C1 = C : C2 = C1 - 64 : C3 = C1
    + 64
520 POKE C1 , 149 : POKE C2 , 193
    : POKE C3 , 32
530 C = C - 64 : T = T+1 : IF T = 17
    THEN 550
540 GOTO 70
550 C = 54240 : T = 0 : Q = 0
560 IF V = 9 THEN 700
570 GOTO 70
600 POKE (C2 - 64) , 9
610 P = P+1
620 POKE 54136 , (48 + P)
630 FOR D = 1 TO 2000 : NEXT D
640 GOTO 78
700 FOR Z = 1 TO 30 : PRINT :
    NEXT
710 IF P < 3 THEN PRINT " STAY
    A CIVILIAN !" : GOTO 770
720 IF P < 5 THEN PRINT "
    REPORT FOR AN EYE TEST "
    : GOTO 770
730 IF P < 7 THEN PRINT " YOU
    DID WELL " : GOTO 770
740 IF P < 9 THEN PRINT " VERY
    IMPRESSIVE " : GOTO 770
750 PRINT " EXCELLENT .....
    CAPTAIN SIR "
770 PRINT : PRINT : PRINT :
    PRINT : PRINT
780 INPUT " ANOTHER PATROL
    ?" ; P $
790 IF P $ = "Y" THEN 4
800 FOR Z = 1 TO 30 : PRINT :
    NEXT
810 PRINT " ENJOY YOUR SHORE
    LEAVE "
820 PRINT : PRINT : PRINT :
    PRINT : PRINT
830 END
```

Lines 5. 700 and 800 clear the screen. X = USR (X) could be used instead. to cause a jump to a machine code routine resident in a protected area of RAM. A suitable machine language routine for clearing the screen was published in *PE September 1979*.

Lines 35 – 50 dictate the shape of the ship

Lines 72 – 76 detect a hit

Line 520 dictates the shape of the torpedo

Lines 500 – 570 controls the torpedo travel

The program is a result of experimenting with the graphics on the Compukit 101 and is certainly not meant to be a lesson in the art of programming. It is a program that runs on less than 2K of memory, and may be of some use to the newcomer to the 101.

M. D. E. Connor,
Swansea.

COMPUKIT UPDATE

By *Dr. A. A. BERK*

NOW that many people are running Compukits, it is possible to sit back and take stock of the situation. As with any new device teething troubles have emerged, but are now mostly resolved by modification to the p.c.b.. The main purpose of this column is to keep Compukit owners, and anyone else interested, abreast of current developments in software and hardware. There are several updates which will be of interest to readers, and these are presented below.

CASSETTE TAPE SPEED

The cassette interface has provoked a large number of questions and comments on the Compukit, and I shall attempt to answer the most frequent one here.

The speed of transfer of cassette information is dependent upon the clock frequency sent to the ACIA (IC14). If you double this frequency, each byte sent serially from it, will appear in half the time and hence recording will occur at twice the rate (600 BAUD). If the clock speed is doubled again, 1200 BAUD will be achieved. There is one major problem, however. Reading information back from the tape and converting audio frequency signals to digital waveforms, depends upon the tape speed being reasonably constant both in the short term and over a long period of time. The ACIA's normal clock speed, producing 300 BAUD, is quite consistent with all normal variations, and even tolerates most speed variations between different machines. If you refer to the cassette interface diagram in your Compukit

Manual, you will notice that data acquisition depends upon the time-constant of monostable IC69, and a comparator, effectively, IC63.

The timing of this arrangement is independent of tape speed, and as the speed of data retrieved is increased, the tolerances in this system must be more and more exact. The device cannot be expected to function reliably at, say, 1200 BAUD.

Some speed variation does seem possible, however, and doubling the frequency of the Tx clock has produced some reliable results. If you would like to try faster cassette storage, perform the following modification (refer to cassette interface diagram).

At present, pin 9 of IC63 (7474) is connected to Tx clock (pins 4 and 3 of IC14). Take Tx clock from pin 11 of IC63 instead of pin 9. This bypasses IC63's divide by two function. This modification is worth experimenting with, as several people claim full success. Try modifying and then recording and playing back on the same machine.

The Software of the Compukit takes care of cassette handling automatically for any Tx clock frequency, as it handshakes with the ACIA during the process. Some adjustment to the value of R53 and C11 may prove fruitful if the above modification remains unsuccessful.

110 BAUD TELETYPE

The cassette interface is also used to run serially interfaced printers such as the Anadex. Many people have asked if it is possible to run standard 110 BAUD Teletypewriters. The answer now appears to be *yes*. This is something new, and hence apologies to those who have asked this question before and been given a negative answer.

The problem is that doubling or halving frequencies to change from 300 BAUD to 600, 1200, 150, 75 etc. is easy. Multiplying by 110/300, however, is not so simple. It requires an interesting calculation around the design characteristics of the 74163 synchronous presettable binary counter. In the present system, a frequency of 125kHz (output C3 from IC59) is divided by 13 using IC57 and one NAND gate (IC58). IC63 then divides this by 2 to supply a frequency of 4·8077kHz to the Tx clock of IC14. 4·8kHz is the correct frequency for a 300 BAUD rate. This is derived from Freq./BAUD rate = 16. Here, a 10-bit frame is used consisting, technically, of one start bit, one byte and one stop bit.

To derive the correct rate for 110 BAUD teletypes, a Tx clock of 1·76kHz is necessary. IC57 may be fed with 31·25kHz from output C5 of IC60 (pin 14) and then made to divide this by

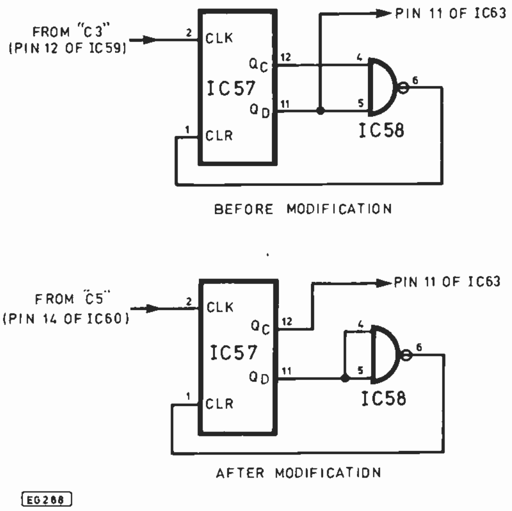


Fig. 1. Before and after TTY modification

nine. IC63 then divides by two and forms a Tx clock frequency of approximately 1·736kHz which is within about 1·4 per cent of the required frequency and quite accurate enough for this application.

The only problem lies with the format of each frame sent to the teletype. 110 BAUD machines expect two stop bits along with the byte being sent, and the Compukit software sends just one, via IC14's internal registers. However, I have an old RO35 working beautifully from the Compukit with the following mod., and I should be most grateful for any feedback on its success in general. This is at present a *send only* mod., and no thought has been given to receiving from a teletype as the Compukit has its own full keyboard.

The mod. is shown in Fig. 1, and consists of:

(1) cutting the connection between IC58 pin 4 and IC57 pin 12,

(2) joining pins 4 and 5 of IC58 (still joined to pin 11 of IC57),

(3) joining pin 11 of IC63 to pin 12 (instead of pin 11) of IC57,

(4) feeding pin 2 (CLK) of IC57 from output C5 (pin 14 of IC60) instead of C3.

It is worth making this modification switchable if it is to be used to any extent.

Fig. 2. Compukit's screen address map

DECIMAL	HEX.	0 — 11 0 — B	12 — 23 C — 17	24 — 35 18 — 23	36 — 24 —
53248	D000				
53312	D040				
53376	D080				
53440	D0C0				
53504	D100				
53568	D140				
53632	D180				
53696	D1C0				
53760	D200				
53824	D240				
53888	D280				
53952	D2C0				
54016	D300				
54080	D340				
54144	D380				
54208	D3C0				54254 (DEC.)

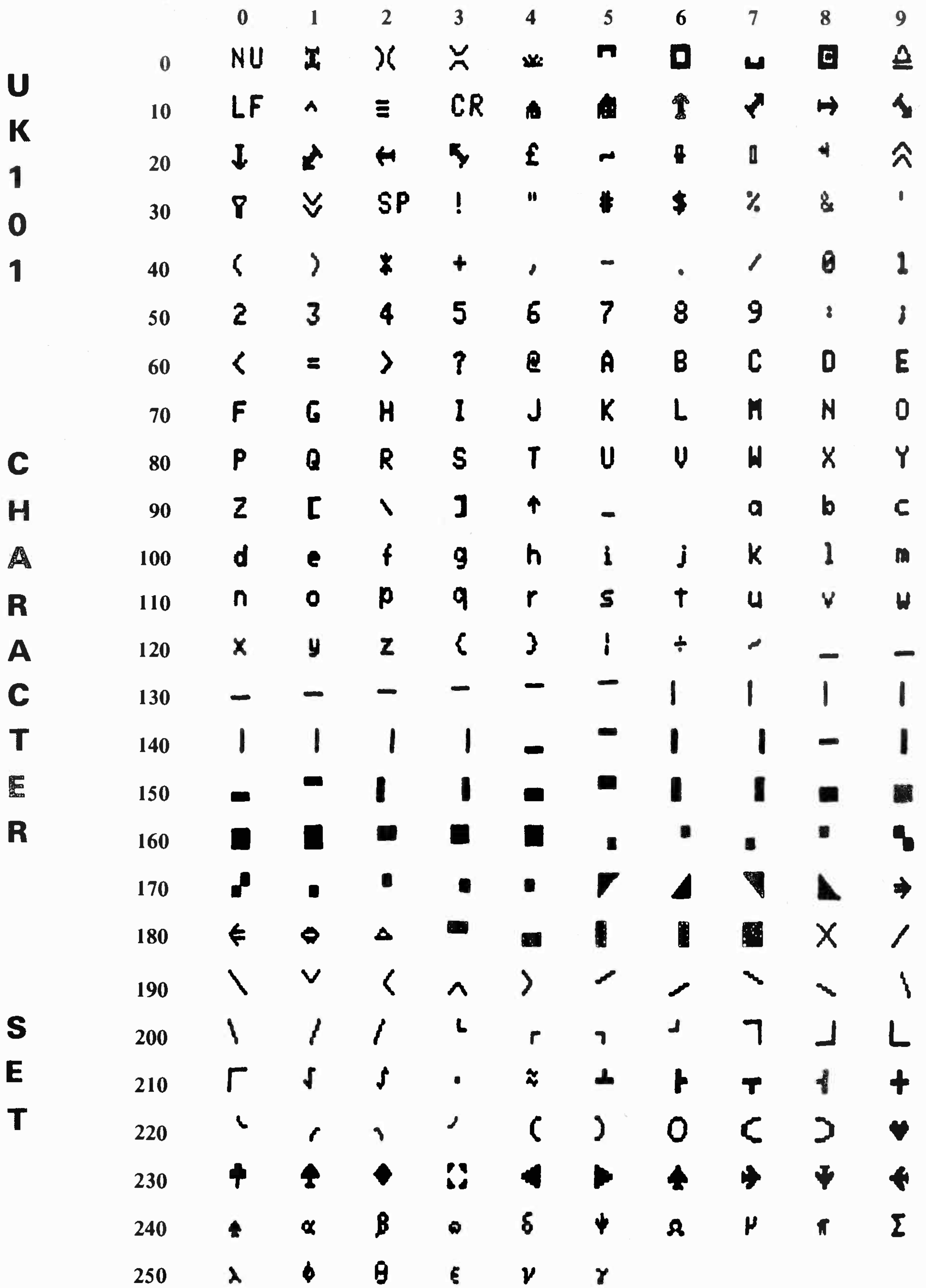


Fig. 3. UK101 character set. Note that CHR$ 183–187 are chequered (i.e. half-tones)

GRAPHIC CHARACTER SET AND VDU

To change the subject entirely many people have asked for a copy of the graphic character set with the numbers by which they can be "reached". For instance, if you type:

PRINT CHR$(53)

the character "5" appears on the screen.

The diagram in Fig. 3 shows the complete character set with numbers to be placed inside the CHR$ function for their printing. To select the correct value of a given character, add its row and column numbers together. For instance, PRINT CHR$(179) gives the "⇛" sign.

The manual supplies a program to help with identifying these characters, but the diagram presents them for "hard copy" reference.

As to the screen address of each character slot, Fig. 2 shows the VDU address map in decimal and hexadecimal for reference. The map has 16 lines and 48 character positions per line. Your TV may show less—experiment with the following to find out:

The first character on each line is given an address, and the top of the map supplies an offset to be added to this for addressing each character on a given line. To simplify the diagram, the 48 characters on each line are split into fields of 12 characters, each with decimal and hexadecimal ranges of offset for each field. For instance, at the centre of the screen there is a square of four character positions. These are addressed as shown in Fig. 4.

Fig. 4. Addresses of centre block of characters

D1D7 (HEX) 53719 (DEC)	D1D8 53720
D217 53783	D218 53784

Try printing the numbers: 1,2,3,4, as below, in these positions before reading on:

1 2
3 4

There are two ways to do this:

(a) Use the machine code monitor and load the numerical code for 1,2,3,4 in hexadecimal addresses: D1D7,D1D8,D217, D218.

(b) Use POKE as follows:

```
POKE 53719,49
POKE 53720,50
POKE 53783,51
POKE 53784,52
```

In (a), the codes for 1,2,3,4 are determined by changing the decimal codes in Fig. 2 to hexadecimal; i.e., 49 (decimal) for "1" becomes 31 in hexadecimal, 50 (decimal) becomes 32 (hex) and so on. In order to use the machine code monitor in any application, it is essential to be fully conversent with hexadecimal numbering, and its conversion to and from the decimal system. This subject is quite large and complex, and will be dealt with in the next edition of this column, to appear in two months time.

If you examine the end of each line in Fig. 3, you will notice that the address of each line ending (the 48th character on a line) is not contiguous with the address of the start of the next line. For instance, the last character on the first line has address 53248 + 47 which equals 53295 (decimal). The second line starts at address 53312 and not 53296. There are 16 character addresses missing, in fact, on the end of each line. These addresses are valid Read/Write memory locations, but do not appear on the screen. They could be used as scratchpad memory by your own machine code routines. Be a little careful how you re-enter BASIC after a low level routine, as BASIC prints "OK" followed by the cursor as well as at least one line of spaces and possibly a screen scroll-up if the cursor is on the lowest line.

A final note concerns a problem mentioned by two people: it appears to be a rare condition, but if the characters on your VDU display seem to flicker after an hour or two of use, several actions are worth trying. First and foremost, clean all the solder flux from your board using methylated spirit or one of the excellent flux solvents on the market. Play special attention to IC28 and any areas where there is an 8MHz signal line. If this does not work fully, try changing IC28 and/or adjusting the values of R81 and C60. This capacitor may not be supplied as a small disc ceramic and it may help to change it for one.

It only remains for me to wish all of you who have a Compukit, the very best of luck with your programming, especially if this is your first contact with the art. My feeling is that the ability to program and use a computer, as well as the basic skills of soldering and familiarity with silicon chips, etc., will form a most important area of general knowledge in the future. The Compukit has already played an important part in accelerating this process.

POINTS ARISING

CORRECTION TO SOFTY REVIEW IN JANUARY ISSUE.

A note of correction is in order for the *SOFTY Review* (January issue). The origin of the word "Firmware" in that article is stated in a manner which has often been heard—perhaps erroneously. The more common meaning, which should have been included, is that it is firm and unchangeable if stored in ROM. Many thanks to those who have been so PROMpt to point this out!

We would also like to correct two other inaccuracies in the review. Firstly Phil Morris is not "of Videotime Products" but provided a limited design service for the interface board—he is chief designer of PCL Ltd. Secondly Videotime Products market Softy but do not manufacture it.

CONSTANT DISPLAY FREQUENCY METER *(August 1978)*

It has recently come to light that 74123 devices from some manufacturers are not compatible with the requirements of the Frequency Meter, and will not oscillate correctly with the circuit as published. In order to achieve correct oscillation it may be necessary to disconnect the end of R2 that is on Pin 13 of IC1 and take it direct to the +5V line.

COMPUKIT—*4 (November 1979)*

Two corrections to PIA, Fig. 4.1. Reset (pin 34) should go to +5V, pulsed to OV for reset. Pin 25 should go to 02 (pin 31 on J1). Also, current amplification is necessary to drive the l.e.d.s.

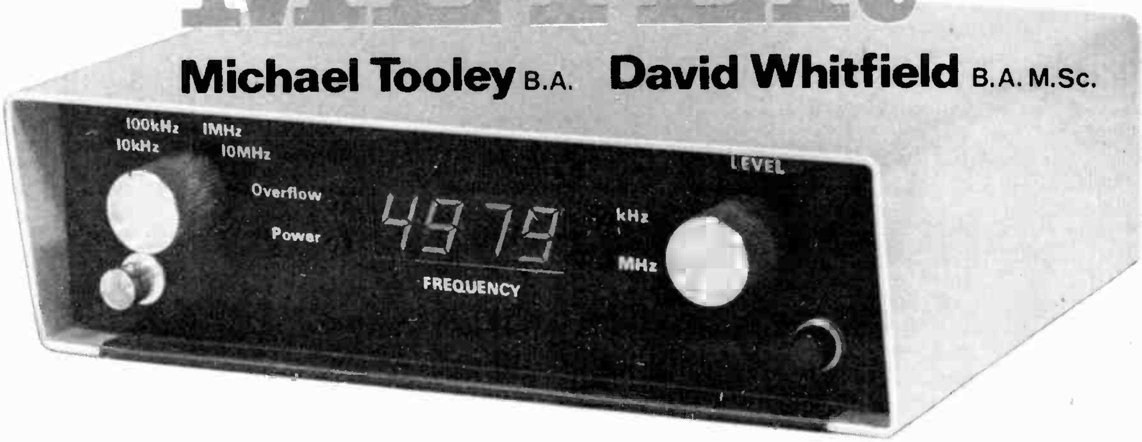
The address decoding of Fig. 4.3 is incorrect. The two lower NOR gates should be OR gates.

ACOUSTIC MODEM *(February 1980)*

The Test Oscillator "earthy" o/p line, shown in Fig. 4, should be taken from OV and not the bottom end of the 10µF capacitor.

FREQUENCY METER

Michael Tooley B.A. **David Whitfield** B.A. M.Sc.



THE digital frequency meter to be described here is a general purpose low-cost unit. It has been designed using some recently available devices to allow the meter to be used for portable applications. The facilities available to the user may easily be extended beyond the basic needs of portable applications, and the performance may be enhanced by the addition of the v.h.f. prescaler which will be described next month

DESIGN FEATURES

The specification of the portable DFM is shown opposite. Only two front panel controls are provided; range selection, and a combined power switch and level control. The display readout is limited to 4 digits in order to minimise power dissipation and cost.

A block diagram for the complete instrument is shown in Fig. 1. The input amplifier and all of the logic is included on a single p.c.b. (shown by the dotted line), with only the controls, displays and input/output sockets external to the board. The circuit is simple to set up, requiring only one preset adjustment (adjustment of the time standard oscillator frequency to exactly 1 MHz).

CIRCUIT DESCRIPTION

The circuit diagram of the input amplifier, level shifter and waveform shaper is shown in Fig. 2.

The input amplifier consists of a voltage limiter followed by a high impedance amplifier. The peak amplitude of the signal applied to the gate of the junction FET, TR1, is limited to approximately ±600 mV by the action of R1, D1 and D2. The FET itself is used in a self-biasing circuit. The gate is tied to ground by R2, and the stage presents a high impedance to the signal. The d.c. source potential is produced by the current flowing in R3, and this provides the necessary negative bias. The source load is decoupled to a.c. by C2 to give a low frequency roll-off at approximately 10 Hz, while the high frequency performance is enhanced by C1.

The excursion limits of the voltage waveform at the emitter of TR2 are varied by the setting of VR1, allowing variation of the level as required for the level shifting function. The actual switching levels of the waveform shaper are preset by the characteristics of the Schmitt-input gate, IC1c.

Fig. 3 shows the overall response characteristics of the input stages to sinewave signals.

CONTROL LOGIC AND SIGNAL GATE

The circuit diagram of the control logic and signal gate is shown in Fig. 4.

The control logic governs the sampling rate of the instrument (the rate at which the input frequency is re-measured), and performs all of the necessary "housekeeping" functions,

SPECIFICATION

Frequency Range:	10 Hz to 5 MHz (minimum) 8 Hz to 7 MHz (typical performance)
Input Sensitivity:	Better than 200 mV r.m.s. 10 Hz to 5 MHz 10 mV r.m.s. at 1 kHz (typical)
Display Ranges:	1. 1 Hz to 9·999 kHz (kHz units) 2. 10 Hz to 99·99 kHz (kHz units) 3. 100 Hz to 999·9 kHz (kHz units) 4. 1 kHz to 9·999 MHz (MHz units)
Front Panel:	Display range selector switch (S1) Input level control (VR1)/power switch (S2) Signal measurement inlet (SK1) TTL power indicator (D18) kHz display units indicator (D4) MHz display units indicator (D8) Display over-range indicator (D3) 4-digit decimal point display Mains indicator
Rear Panel:	6 volt d.c. inlet sockets (SK4 and SK5) D.c. supply fuse (F2) 1 MHz TTL outlet (SK2) 1 kHz TTL outlet (SK3) Mains inlet socket
Power Requirements:	+5 volts d.c. at 160 mA (standby) +5 volts d.c. at 250 mA (maximum) Power from 6V battery supply or mains regulator

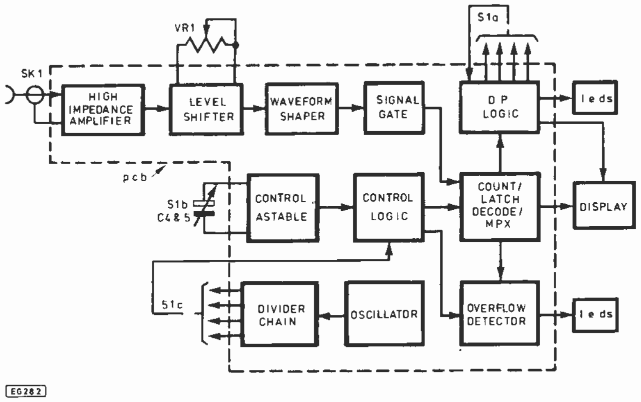


Fig. 1. Block diagram of the D.F.M.

ensuring, for example, that the display counters are all reset to zero before the input signal is re-sampled. The signal gate acts on commands from the control logic and provides the counting/display circuitry with the number of pulses which is appropriate to the range selected and to the input signal frequency.

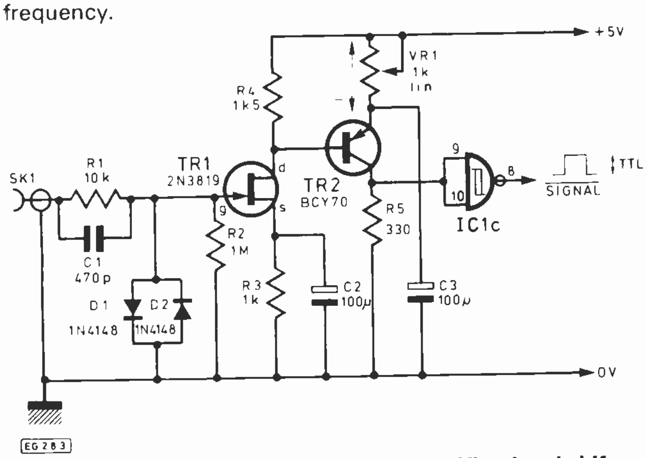


Fig. 2. Circuit diagram of the input amplifier, level shifter and waveform shaper

A 555 timer, IC2, is arranged as a control astable which has an output with a HIGH:LOW ratio of approximately 7:2. The signal sampling sequence is initiated by HIGH-to-LOW transition of the astable output. This transition causes the next LOW-to-HIGH transition of the selected clock signal to invert the normal output states of IC3a, driving the Q output HIGH, and opening signal gate, IC1a. The next LOW-to-

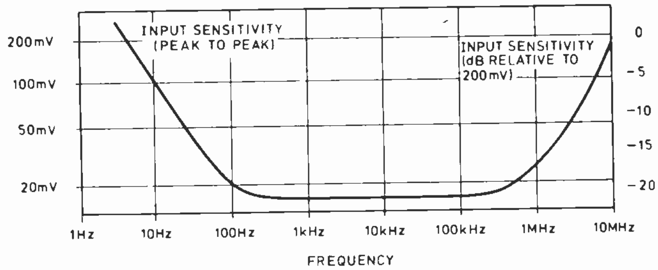


Fig. 3. Input stage response characteristic

HIGH clock edge restores the state of the outputs on IC3a, thereby closing the signal gate. The Q output on IC3b is also driven HIGH, and this allows the accumulated count to be transferred to the display latches, as well as inhibiting IC3a until the start of the next sampling period. The LOW-to-HIGH transition of the control astable output completes the display latching and, after a short delay introduced by R9 and C6, clears the counters ready for the next sampling period. The circuit is then dormant until the next HIGH-to-

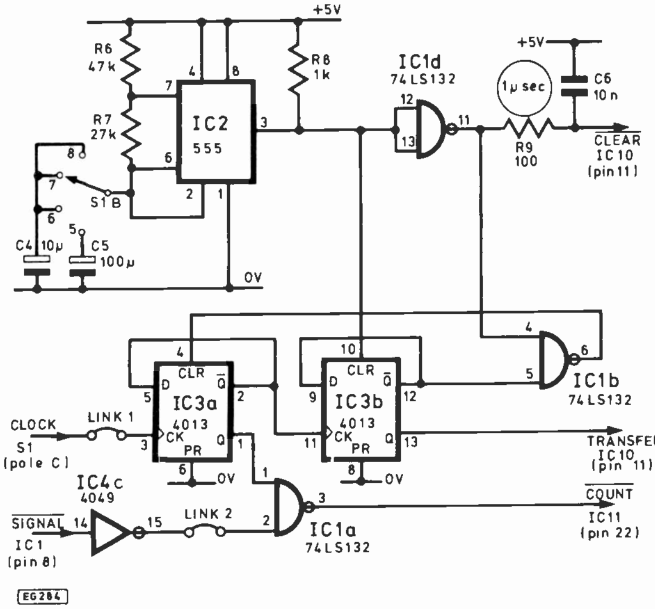


Fig. 4. Circuit diagram of the control logic and signal gate

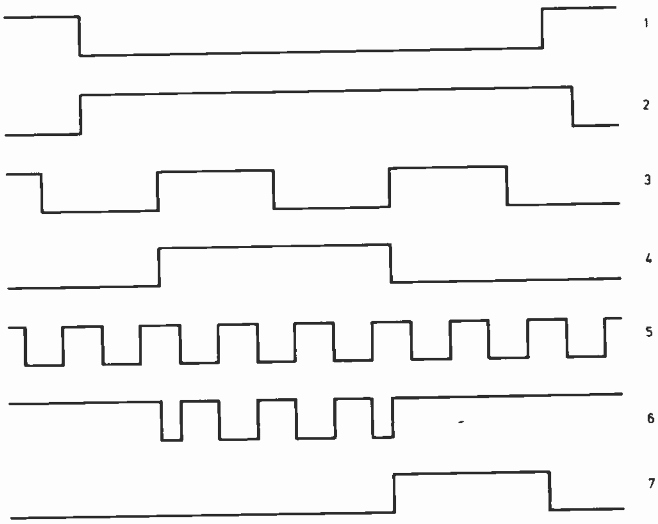


Fig. 5. Timing diagram

LOW astable transition, when the whole sequence is repeated. A timing diagram for the operational sequence is shown in Fig. 5.

The rate at which the signal is re-sampled is set by the combination of R6, R7 and C4/C5. The values of these components have been chosen, within the other design constraints, to give a sampling rate which, on ranges 2 to 4, is slow enough to allow the display to be easily read, yet fast enough to allow alterations to be made to the input signal frequency without the display becoming tedious. The resolution of range 1 requires that a much longer re-sampling interval is used, hence the different value of capacitor.

TIME STANDARD OSCILLATOR AND DIVIDER CHAIN

The portable DFM is designed to provide the user with display resolutions of between 1 Hz and 1 kHz, and employs gate sampling periods of between 1 second and 1 msec, respectively, for this purpose. The signals used to generate these sampling intervals are pulse trains of frequencies 1 Hz, 10 Hz, 100 Hz, and 1kHz, to give display resolutions of 1Hz,

COMPONENTS . . .

Resistors

R1, R11, R12, R13	10k (4 off)
R2, R10	1M (2 off)
R3, R8	1k (2 off)
R4	1k5
R5	330
R6	47k
R7	27k
R9	100
*R14	270 (7 off)
*R15	150 (7 off)
R16, R17, R18	470 (3 off)

All resistors $\frac{1}{4}$W 5% carbon.
*See text.

Capacitors

C1	470p polystyrene
C2, C3, C5	100μ elect. (3 off)
C4, C10, C13, C14, C16, C22	10μ elect. (6 off)
C6, C9, C11, C12, C15, C17, C18, C21	10n ceramic (8 off)
C7, C8	22p polystyrene (2 off)
C19	2200μ elect.
C20	220n polyester
VC1	2–22p trimmer

Semiconductors

D1, D2	1N4148 (2 off)
D3, D4, D8, D18	TIL209 (4 off)
D5, D6, D7, D9, D10, D11, D12	IN914 (7 off)
D13, D14, D15, D16, D17	IN4001 (5 off)
D19	BZY88 C6V2
TR1	2N3819
TR2	BCY70
IC1	74LS132
IC2	555
IC3	4013
IC4	4049
IC5	4068
TR3-TR6	2N3906 (4 off)
IC6	4020B
IC7, IC8, IC9	40160 (3 off)
IC10	74LS74
IC11	ZN1040E
IC12	74LS32
IC13	5V 1A i.c. regulator

Miscellaneous

SK1 BNC or similar coaxial socket to mount on front panel
SK2–5 4mm sockets or similar to mount on rear panel
S1 3P 4W rotary switch
S2 2P mains switch (combined with VR1 1k linear)
F1 100 mA fuse and holder
F2 500 mA fuse and holder
T1 9–0–9V 500 mA transformer
N1 Mains neon
4-digit multiplexed l.e.d. display (see text)
Display filter
Printed circuit board, Veroboard
Case (Vero G-range 3G)
X1 1MHz crystal

Constructor's Note

Components and p.c.b. are available from **Howard Associates, 59 Oatlands Avenue, Weybridge, Surrey KT1 9SU.**

10 Hz, 100 Hz, and 1kHz, respectively. In this case, it is the pulse repetition frequency (p.r.f.) of the generating signals which is important, rather than the individual mark and space intervals.

The time standard oscillator is used to generate a reference signal at a p.r.f. of 1 MHz. A 1 kHz gating signal is derived from this reference, and the remaining signals are then produced from this by a chain of decade dividers. The circuit details for the time standard oscillator and divider chain are shown in Fig. 6.

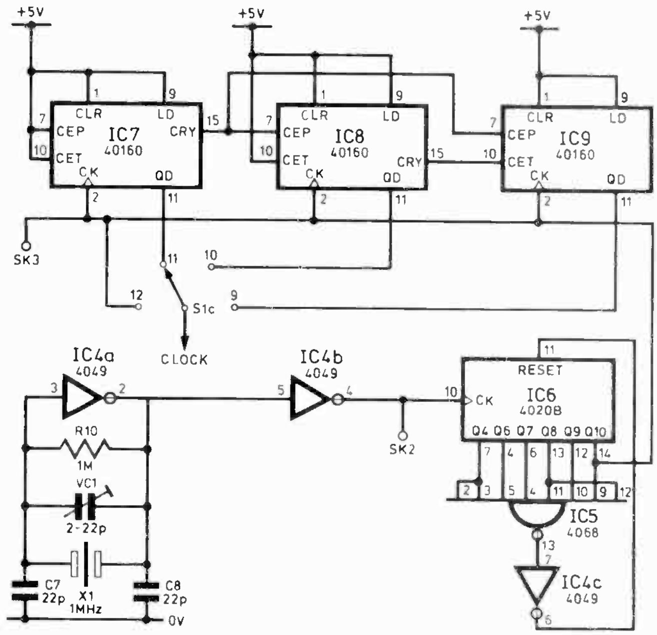


Fig. 6. Circuit diagram for the standard oscillator and divider chain

The oscillator circuit uses a single inverter, IC4a, in a feedback loop with a 1 MHz crystal, X1, used to determine the frequency of oscillation. Fine frequency adjustment is provided by VC1, and the d.c. path around the loop is completed by R10. A second inverter, IC4b, is used to buffer the oscillator output and to improve the waveform shape. The resulting 1 MHz reference signal is brought out to SK2 on the rear panel for external use.

The oscillator output from IC4b is applied to the input of a 14-stage ripple counter, IC6. This counter, in combination with the decoder IC5, is arranged to produce an output at 1 kHz p.r.f. This is achieved by configuring the decoder to detect a count of 2000. A reset pulse is then generated to the counter, giving the stage an overall division ratio of 1000:1. The output, which is also brought out to SK3, is then at a p.r.f. of 1 kHz, and mark: space of approximately 1:1.

The pulse trains at 100 Hz, 10 Hz and 1Hz are generated successively by the decade synchronous counters, IC7, IC8 and IC9, respectively. The use of CMOS devices throughout the oscillator and divider stages improves the stability, guarantees oscillator startability, and reduces the power dissipation when compared to equivalent TTL designs.

COUNTING AND DISPLAY CIRCUITS

The pulse counting and display circuits are shown in Fig. 7. A single VLSI device is used to perform all of the functions of a 4-digit counter, memory latch, 7-segment decoder, and display driver. The use of a multiplexed display drive also allows the constructor a wide choice of display devices. Four

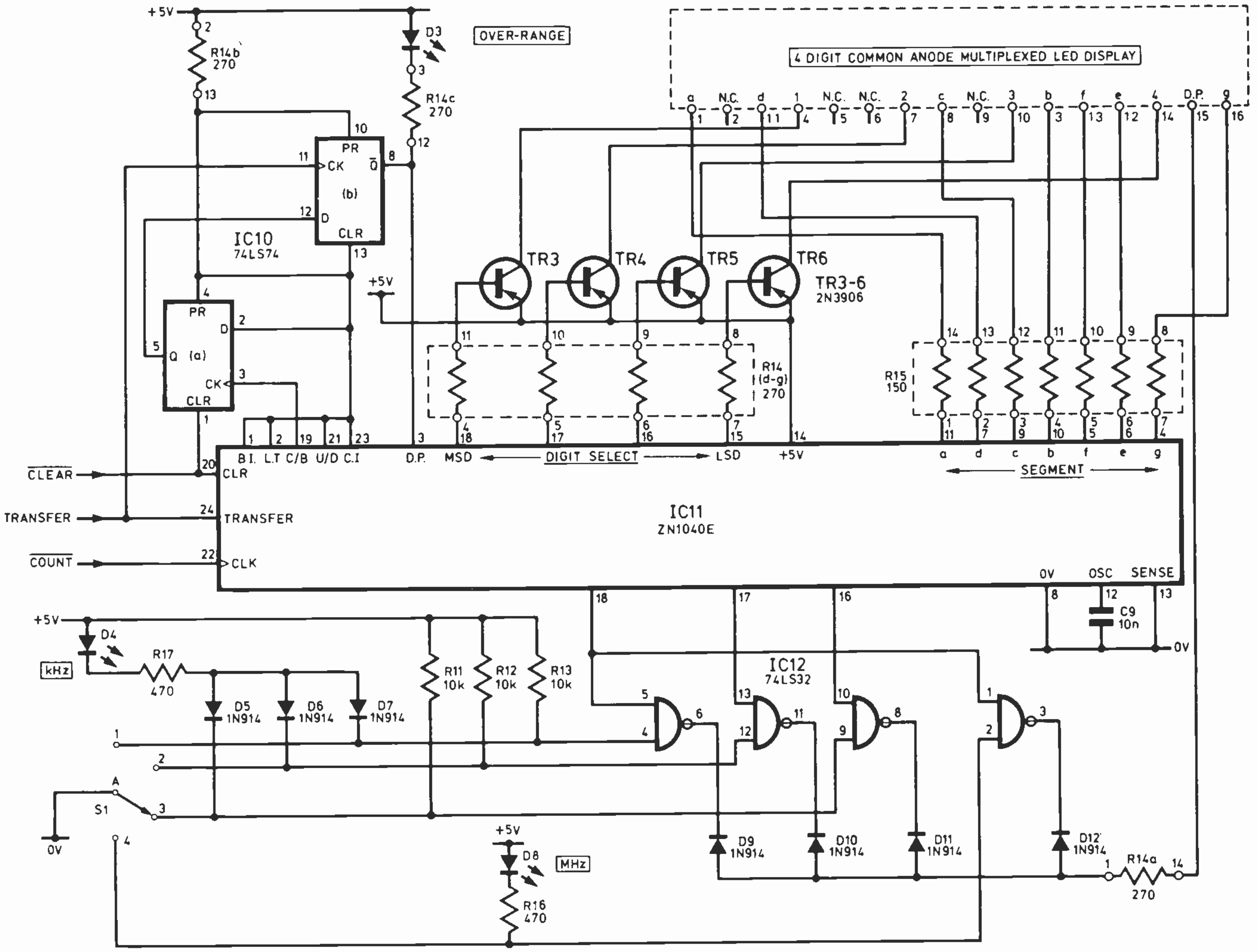


Fig. 7. Circuit diagram of the pulse counting and display circuit

discrete 7-segment l.e.d. displays or a 4-digit multiplexed display may be used. Further, the ZN1040E may be programmed to drive either common anode or, with slightly more external components, common cathode types of display.

The pulse train periodically produced by the signal gate (COUNT) is counted by the decade counters within IC11. The resulting count is then saved in the memory latches following the TRANSFER command from the control logic. The decade counters are then cleared down ready for the next measurement cycle. The latched count value is decoded into an equivalent 7-segment drive format. The internal multiplexing circuits then cause this segment drive information to be presented at the segment drive outputs; each of the 4 digits being strobed in turn. The appropriate "digit select" output is enabled synchronously with the segment outputs, causing only the required segments of the selected digit to become illuminated. In this way, each of the 4 displays are scanned in turn; the scan rate being set by C9. The brightness of the displays is set by R15, with the transistors TR3 to TR6 being used to enable each of the 4 common anode displays in turn. The circuit thus causes the number of pulses presented on the COUNT input line to be displayed to the user. The remaining circuitry is used to handle display over-ranging, decimal point control. and range indication functions.

The maximum number of pulses which may be counted and displayed by the circuit shown is 9999. If an "overflow" indicator is fitted, then this could also be used as an extra "half" digit in the display. For example, a 12 kHz signal may be displayed on range 1 by using the display to show "2000", while the overflow indicator provides the missing leading "1".

IC10a is used to detect any over-range indication from IC11 and IC10b is used as a memory latch, causing D3 to be illuminated in the event of overflow. As with the remainder of the circuits, the detector and latch are cleared and reloaded each time the input signal is re-sampled. Correct operation of the display in overflow mode is ensured by using the Q̄ output of IC10b to disable the leading-zero suppression facility whenever an over-range condition is detected.

The decimal point logic required to illuminate the decimal point is arranged for common anode displays having the decimal point to the right of the digit. The negative-AND gates of IC12, together with the discrete OR function provided by D9 to D12, allow S1A to enable the appropriate decimal point cathode synchronously with the related segment cathodes. The steering diodes, D5 to D7, ensure correct operation of the decimal point while illuminating the "kHz" l.e.d. on ranges 1, 2 and 3. An advantage of this circuit configuration is that the complication of a multi-wafer

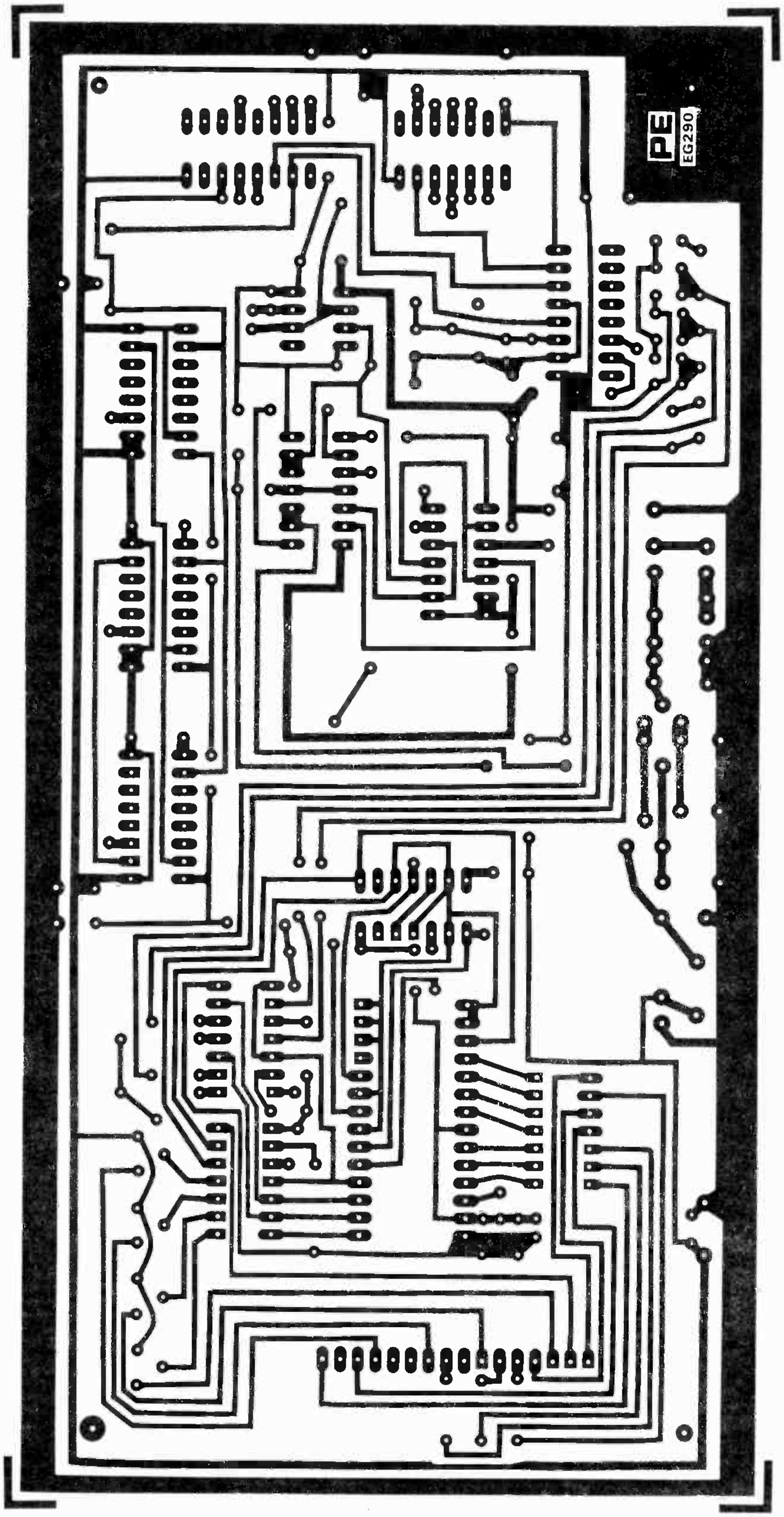


Fig. 10. P.c.b. design for the D.F.M.

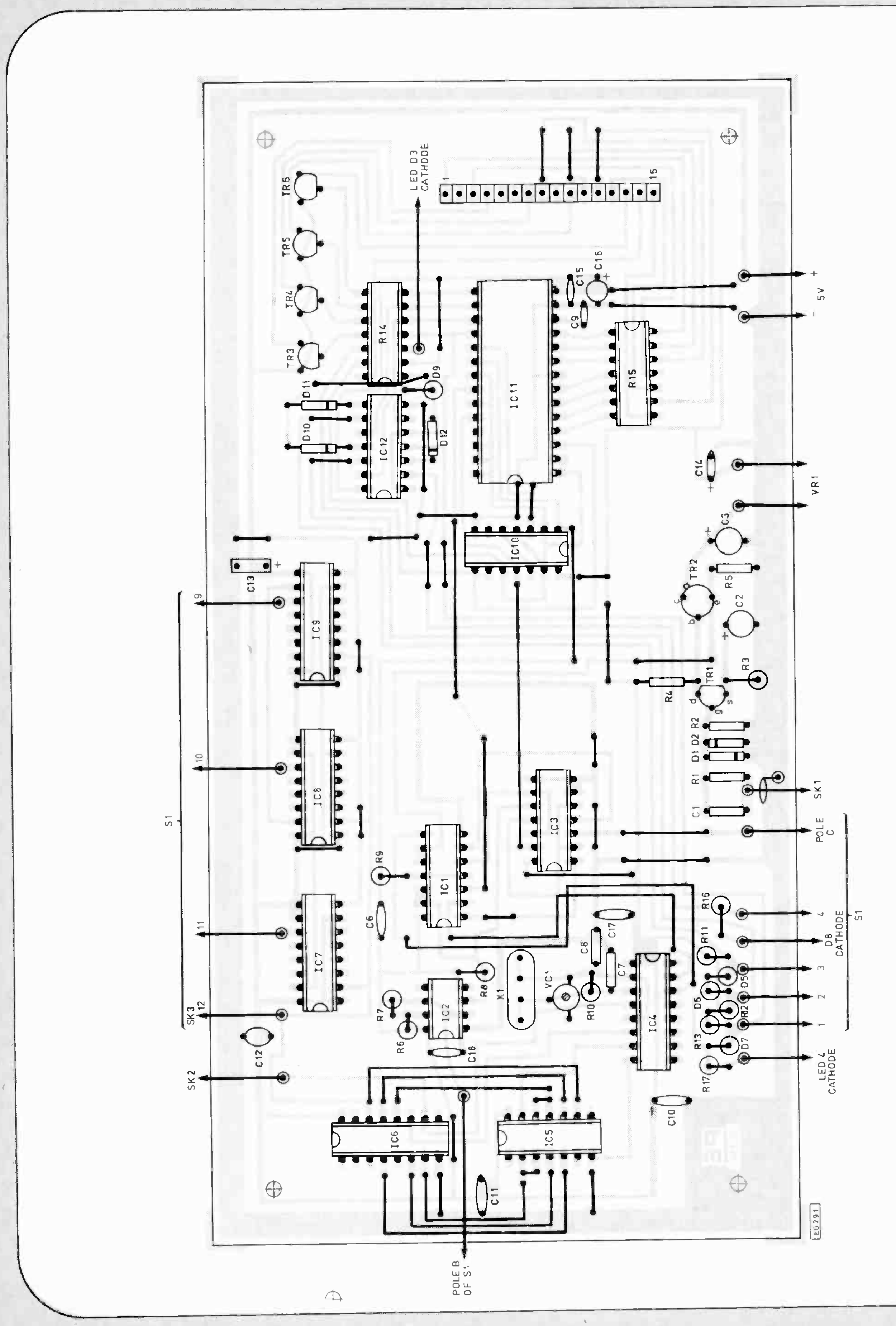


Fig. 11. Component layout

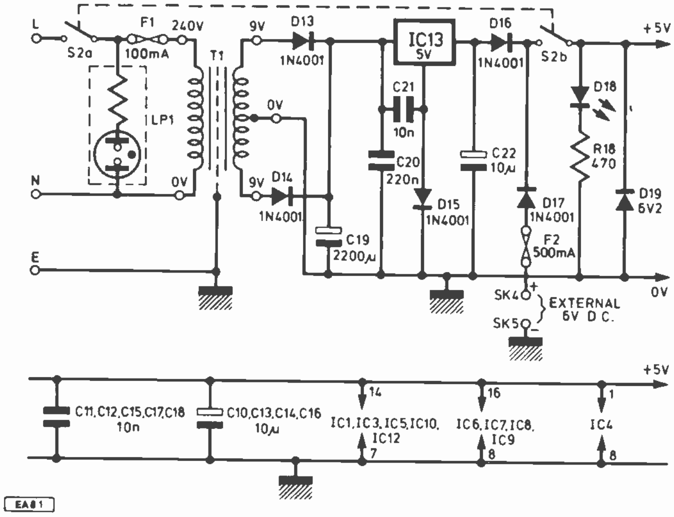


Fig. 8. P.s.u. circuit diagram

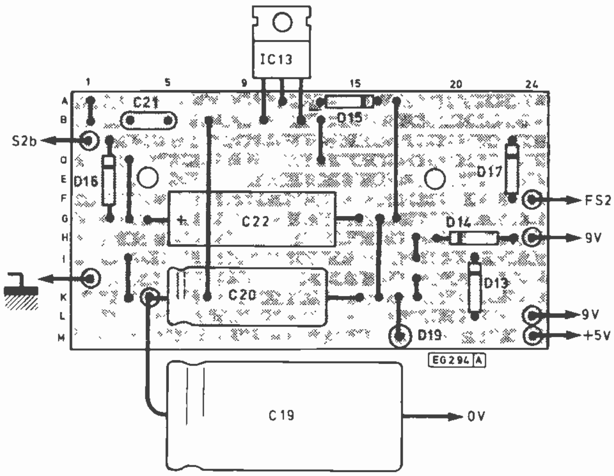


Fig. 9. Veroboard layout of the p.s.u.

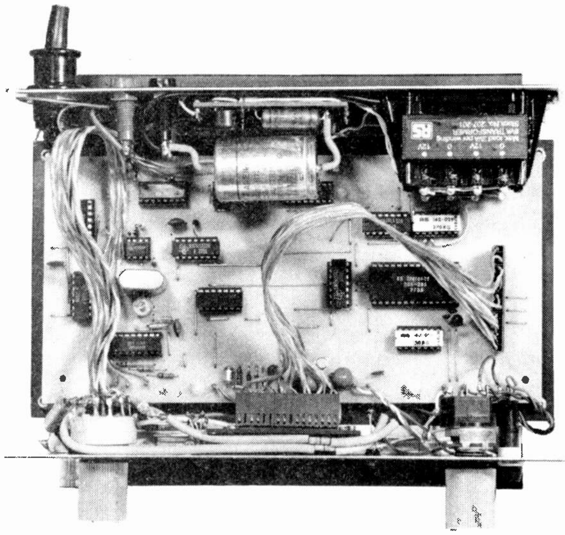
rotary switch is avoided; only a standard 3-pole 4-way switch is required.

POWER SUPPLY

The power supply circuit shown in Fig. 8 is a single +5V d.c. rail at up to approximately 300 mA. This particular arrangement is suitable both battery and mains operation. In portable applications, a 6V battery pack is connected to SK4 and SK5, otherwise the mains supply is used as shown. In either case the instrument power is switched by S2.

Capacitors C20 and C21 are used to remove high frequency noise from the supply rail which would otherwise adversely affect the performance of the time standard oscillator. D15 is used to bias the regulator, IC13, to overcome the voltage drop introduced by D16 in the switching circuit. The facility of battery operation may be omitted by the removal of diodes D15 and D16 (replace them with wire links), and the omission of D17, SK4 and SK5.

The Veroboard design for the p.s.u. is shown in Fig. 9.



Internal view of the D.F.M.

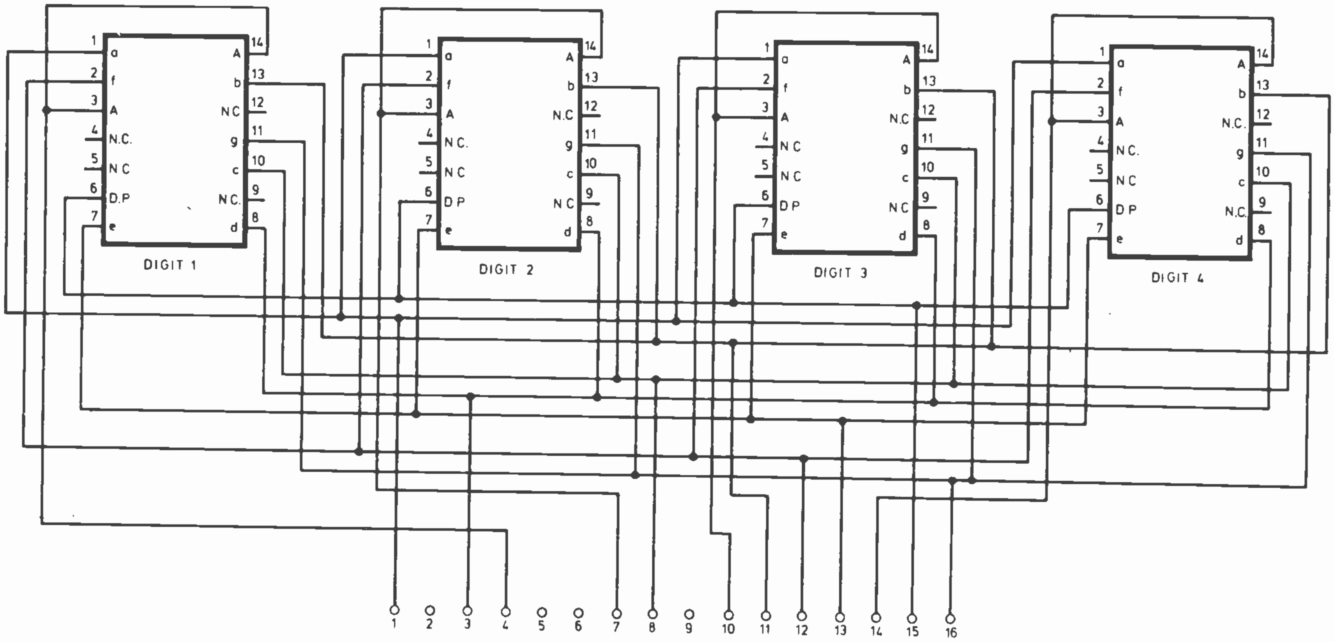


Fig. 12. Wiring diagram for discrete display

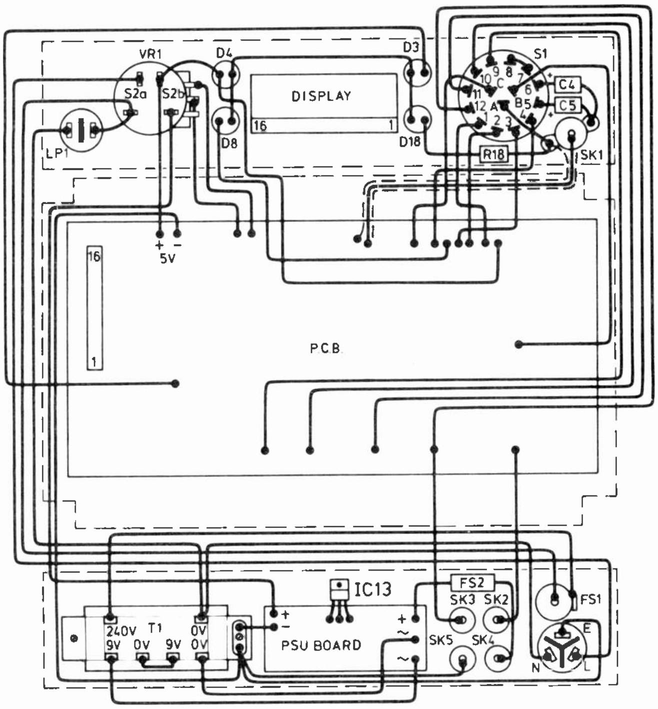
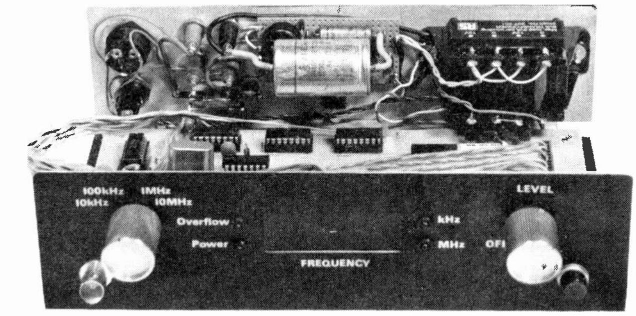
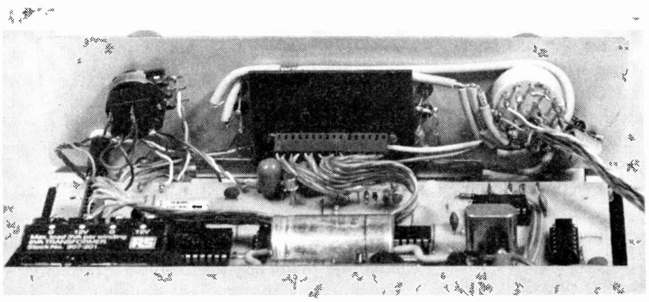


Fig. 13. D.F.M. wiring diagram

CONSTRUCTION

The p.c.b. design for the D.F.M. is shown in Fig. 10, with the corresponding component layout in Fig. 11. It is recommended that the i.c.s and any thick film resistor networks are mounted in d.i.l. sockets. Constructors should also note that many of the i.c.s are CMOS types, and these should be handled with the usual care.





The p.c.b. has been designed to allow thick film resistor networks to be used for R14 and R15. In the case of R15, the substitution of different networks provides a simple method of adjusting the display brightness. Thus, the use of higher-valued (220Ω, 270Ω or higher) or lower-valued (100Ω) networks allows the display characteristics to be tailored to the particular application. Lower resistance values will increase the brightness of the display, but will also have the effect of increasing the current consumption correspondingly, and vice versa. The value of R14 should not be varied significantly from the value specified.

The input signal frequency is displayed to the user on a 4-digit seven-segment l.e.d. display. The display requires only 12 connections between the p.c.b. and the display hardware; these may conveniently be made with a short length of ribbon cable (with or without 0·1" pitch plugs and sockets). Alternatively, the multiplexed display may be synthesized from four discrete common anode displays. Fig. 12 shows how four typical displays should be interconnected; the simplification in wiring effort offered by the multiplexed display is self-evident! Whichever type of display is adopted, the operational characteristics will be identical.

The printed circuit board is mounted on the base plate of the case with four pillars, while the remainder of the components and controls are mounted either on the front or on the rear aluminium panels. The interconnection wiring is illustrated in Fig. 13.

The power supply components are mounted on the rear panel, with the regulator attached to the panel (using an insulating kit) to provide the necessary heatsink. The Veroboard circuit is mounted in the case on four small pillars. ★

News Briefs

TELESOFTWARE

A NEW way of using the Oracle Teletext service will enable future teletext receivers to play games, calculate mortgages and tax returns, run educational courses and a lot more.

The electronic signals which are used to carry the teletext information within the TV broadcast are very similar to those used in computer technology, so by replacing pages of written text with pages of a computer program a viewer has simply to select the program of his choice from Oracle. And like the information already on Oracle, these telesoftware programs would be free of charge.

In the future, by adding a microprocessor to the design of TV sets, they will be able to receive, decode and execute telesoftware programs in addition to receiving normal Oracle information. No special technical knowledge will be needed as operating telesoftware will be as easy as selecting pages on Oracle.

The applications of telesoftware on Oracle are almost as varied as the imagination. For example, it will allow future TV sets to play a wide range of video games. And by simply selecting a new program the set can instantly become a highly specialised but simple-to-use calculator. The same TV can become a flexible home educational unit, with a wide range of subjects, which may be learnt as fast or as slowly or as often as required by the individual. It could let you know your social security entitlements or even help detect credit card fraud. Telesoftware will also permit future Oracle receivers to display higher definition graphics and handle different alphabets, such as Russian or Greek—perhaps even still-pictures.

In co-operation with ITV, Mullard Applications Laboratory have designed and built an experimental telesoftware receiver.

Further research is under way already to establish compatible technology standards for a future telesoftware service. ITV is now investigating many areas of application for the system, including its use in education, work on which is being given a high priority. It is hoped that in the future telesoftware will become as integral of the Oracle service as the news headlines or weather forecast are today and will provide the viewer with even more value for money from his television screen.

Readout...

A selection from our Postbag

Readers requiring a reply to any letter must include a stamped addressed envelope.
Opinions expressed in Readout are not necessarily endorsed by the publishers of Practical Electronics.

AY3 Anybody?

Sir—May I, through your columns, make mention of an anomalous situation that has come to my notice. Following Mr. Lenton-Smith's article in PE (September 1978) on the TDA 1008 gating/divider i.c., I was anxious to use these in an organ I am building, only to find that no supplier stocks any of the AY3 series which is necessary for the full range of pitches. I have searched catalogues and many advertisements, but every firm which stocks the 1008 only has the AY1 top octave generator, which is inadequate.

I have enquired of the manufacturers, General Instruments, who tell me that the AY3 series is still made, and it would therefore seem that amateur suppliers do not bother to read data sheets before deciding what to stock.

If I have missed any supplier who does stock the AY3, perhaps they would let me know. Otherwise, I can only advise your readers that they should save their money by not buying the TDA 1008, and go back to the tedious business of hand-building diode gates.

B. D. Arnold,
Worthing.

Hazard

Sir—I wondered if through your magazine I may draw attention to a small but definite radiation hazard originating in certain ex-Government equipment which was available for a considerable period after the last War.

The specific item which caused me to write this letter is a revolution counter which contains two large moving coil meters with edgewise scales about 10mm long, scaled 6-14-18-22-26-30 and marked "Engine Speed Hundreds of r.m.p.". The graduations and numbers are filled with Radium activated luminous paint very thickly applied. From previous experience with an ex-Government watch which had burn marks on the dial from the paint on the fingers I decided recently to do some tests on the meters. (I work at the University of Birmingham). The results confirmed my suspicions. At (10cm 4 inches) from the scales a Geiger counter registered 1000 counts per second. Interposing $1\frac{1}{2}$mm aluminium sheet to remove beta and alpha emission reduced this to 100 c.p.s. However, since a Geiger counter is only one or two per cent efficient for gamma rays the true rate would be several thousand per second. Although I am not qualified to make an accurate assessment of the activity a rough calculation indicates several millicures which I believe is a quantity that would require a licence if used for teaching purposes.

I therefore suggest that anyone having old ex-Government equipment with luminous type dials or pointers (warning, it will no longer be luminous because of degeneration of the phospor) should have them properly disposed of—not burned, buried or dumped on the local tip.

Radium is dangerous if ingested and burning will simply spread it about as most readers will realise.

B. Manning,
Kidderminster.

Coded

Sir—R. W. Coles, in Semiconductor Update, seems less than au fait with codes and cyphers.

There certainly are unbreakable codes despite the best computers. Both in theory, and in practice, there is no way of breaking ciphers based on true random numbers as long as each number sequence is used only once.

The codes that are broken are based on pseudo random numbers, or similar, but even here long sequences of messages are necessary to break into a new sequence of code.

The real gem of modern ciphers is the "trap door" cipher. Each user will publish his own code for anyone to send messages to him. Using a secret second code he will decipher the messages but no one else can succeed in this aim. A further technique is double encoding which gives 100 per cent proof that the message is from the named sender not a fraudulent source. The sender uses his secret code and the others published code. The receiver uses the others published code and his own secret code. No one else can use this combination.

In theory the trap door method can be decoded by computer by well known techniques. The snags are that the biggest and fastest of possible computers would take many millions of years to do what the known code will solve in seconds. So far no one has been able to find a short cut. Those wishing to use their own randon number techniques should beware of most published and commercial methods. These collapse under quite simple analysis. For example many always end in odd or even digits or alternate between them, on a regular basis.

To begin to have any value, even in less esoteric uses, a random series should pass the basic test that, in any base, any one digit will be followed by all possible other digits, and itself, in approximately equal proportion when averaged over a few thousand digits. A simple program, using a two dimensional array, will soon show up any fault here.

R. G. Silson,
Tring.

Career

Sir—I read with interest your section on industry in the November issue of *Practical Electronics* and it seems to me that you could maybe supply me with some information.

Starting in October, 1980, I will be entering university to study one of the following courses, so could you advise me which course of study would lead an honours graduate to the best possible position on entering industry (involved with microprocessor systems, which seem to be playing an ever increasing role in industry) in terms of pay and promotion prospects. Either an honours graduate from Strathclyde University in one of their new degrees, first instituted in 1979, or an honours graduate in physics who has undergone "post-graduate" study in "microprocessors and digital electronics", which I know Glasgow University offers.

Unbiased advice from particular companies and universities is hard to come by.

Vincent Farrelly,
Glasgow.

We asked our Industry Notebook contributor Nexus to offer Mr Farrelly some advice:

You will realise that it is equally as difficult for us to forecast employment prospects in the mid-80s, when you will have qualified in your chosen profession, as it is for yourself to do so. What can be said with absolute certainty is that any degree student in electronics will be in demand, both in the United Kingdom and overseas. There is an acute shortage of such people now and this is likely to continue to the end of this century and beyond. So you need have no fear of unemployment in the future, whatever specialised discipline you embark upon.

As to the choice of courses open to you, this in our opinion depends very much on your personal interests. If you read Computer Science and Microprocessor Systems then you are firmly in the computer sector, admittedly very broad including industrial automation but with emphasis on applications.

The course in Electronic and Microprocessor Engineering appears to be more broadly based in electronics with microprocessors and their design and application coming as a speciality later. You will observe that there is a great deal of overlap, the difference between the two courses being one of emphasis, the first towards application, the second towards engineering.

Your third option, a physics degree, gives you many openings for specialisation as a post-graduate including, of course, microprocessors. This would provide, one imagines, much greater flexibility if, for example, you decided after the first year or two that microprocessors were rather boring and that you might prefer to be a nuclear engineer or enter some other branch of electronic engineering.

Only you can make the choice but any science- based degree will stand you in good stead for the future. Provided you have a good grounding in electronics you will find that most industrial companies or organisations, if you prove your capability and are clearly keen to advance, will encourage you in your chosen specialisation at a later date. *Nexus*

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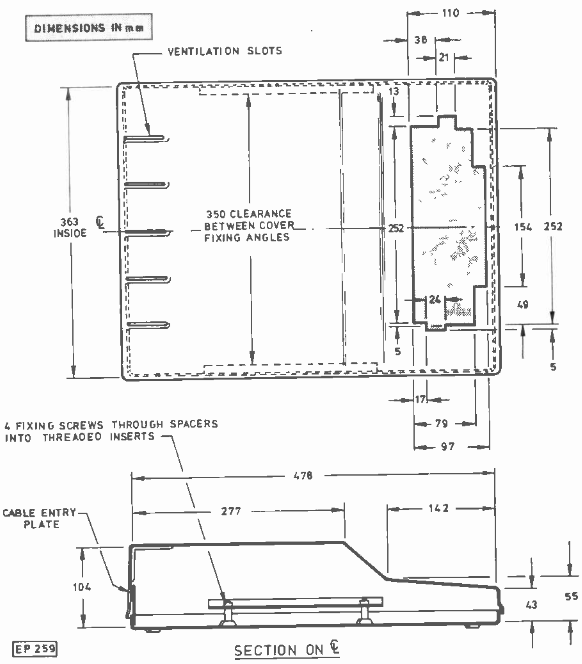

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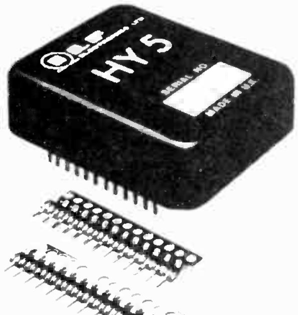

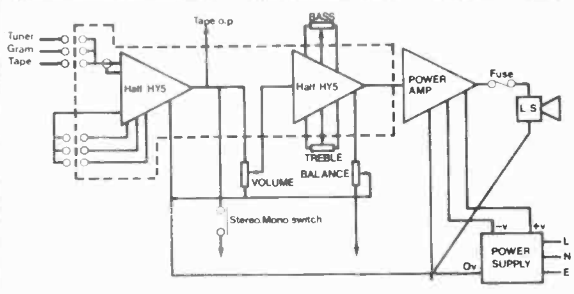

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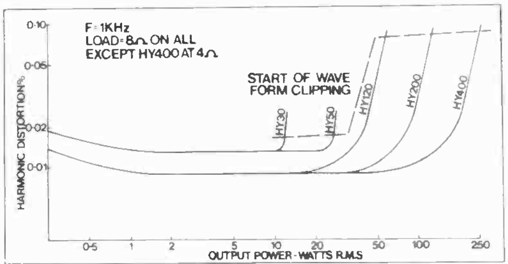

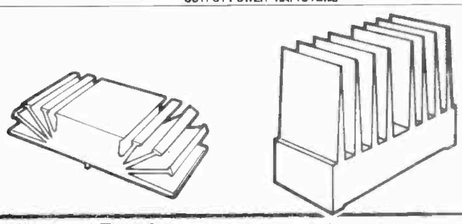

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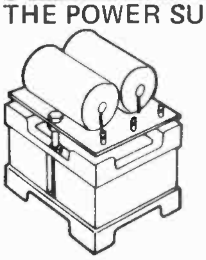

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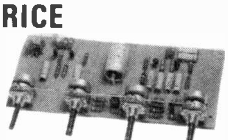

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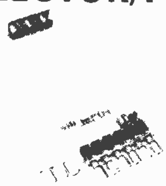

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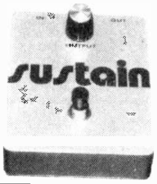

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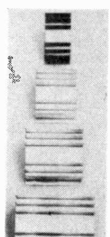

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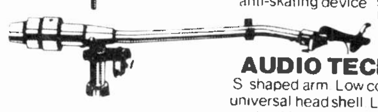

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CAPACITOR PAKS

16201	18 electrolytics	4.7uf-10uf
16202	18 electrolytics	10uf-100uf
16203	18 electrolytics	100uf-680uf

ALL 3 at SPECIAL PRICE of £1.30

16160	24 ceramic caps	22pf-82pf
16161	24 ceramic caps	100pf-390pf
16162	24 ceramic caps	470pf-3300pf
16163	24 ceramic caps	4700pf-0.047pf

ALL 4 at SPECIAL PRICE of £1.80

RESISTOR PAKS

16213	60 ¼w resistors	100ohm-820ohm
16214	60 ¼w resistors	1K-8.2K
16215	60 ¼w resistors	10K-82K
16216	60 ¼w resistors	100K-820K

ALL 4 at SPECIAL PRICE of £1.80

16217	40 ½w resistors	100ohm-820ohm
16218	40 ½w resistors	1K-8.2K
16219	40 ½w resistors	10K-82K
16220	40 ½w resistors	100K-820K

ALL 4 at SPECIAL PRICE of £1.80

IC SOCKET PAKS

SJ36	14	8 pin
SJ37	12	14 pin
SJ38	11	16 pin
SJ39	8	18 pin
SJ40	7	20 pin
SJ41	6	22 pin
SJ42	5	24 pin
SJ43	4	28 pin
SJ44	3	40 pin

ALL at ONLY £1.00 EACH

F.E.T.'s

2N3819	£0.17
2N5458	£0.18
2N4220	£0.28
2N4860	£0.25

(PROGRAMMABLE UNIJUNCTION)

2N6027	£0.25
BRY56	£0.25

VOLTAGE REGULATORS

Case T0220

Positive		Negative	
uA7805	£0.65	uA7905	£0.70
uA7812	£0.65	uA7912	£0.70
uA7815	£0.65	uA7915	£0.70
uA7818	£0.65	uA7918	£0.70
uA7824	£0.65	uA7924	£0.70
UA723 14 pin DIL	£0.35		
LM309K T03	£1.10		

OPTOELECTRONICS
DISPLAYS

1510	707 LED Display	Price each	£0.70
1511	747 LED Display	Price each	£1.50
1512	727 LED Display	Price each (dual)	£1.55

L.E.D.'s

				Price each
SJ78	.125	LED Diffused	RED	£0.08
SJ79	.2	LED Diffused	RED	£0.08
S120	.125	LED Bright	RED	£0.09
S121	.2	LED Bright	RED	£0.09
1502	.125	LED Diffused	GREEN	£0.11
1505	.2	LED Diffused	GREEN	£0.11
1503	.125	LED Diffused	YELLOW	£0.11
1506	.2	LED Diffused	YELLOW	£0.11
SJ80	.2	LED Bright	YELLOW	£0.14
SJ82	.2	LED Clear illuminating	RED	£0.10
SJ83	.125	LED Clear illuminating	RED	£0.10

2nd QUALITY LED PAKS

1507	10	assorted	colours & size	£0.65
S122	10	.125	RED	£0.50
S123	10	.2	RED	£0.50

LED CLIPS

1508/.125	.125	5 for £0.10
1508/.2	.2	5 for £0.12

SJ81	1	Infra RED emitter – Fairchild FP100	£0.25
SJ98	5	Photo Detector MEL11 + Data	£1.00
ORP12		NORP12 Cad Cell	£0.45
SJ99	4	ITT 5870 ST Nixie Tubes	£1.00

SJ29 Texas NPN silicon transistors 2S503=BC108 TO-18 metal can – perfect & coded
50 off £2.50 – 100 off £4.00 – 1000 off £35.00

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SJ100 12v Electric Drill 7,500 RPM for all your PCB drilling complete with 2 drills ·1 & ·15 **£5.50**

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Min. 3 lbs in weight consisting of a fantastic assortment of Electronic Components – Pots, Resistors, Condensers, Switches, Relays.
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2015 **£0.35 each**

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AMPLIFIERS

AL10	3 watt Audio Amplifier Module 22-32v supply	£2.87
AL20	5 watt Audio Amplifier Module 22-32v supply	£3.74
AL30A	7-10 watt Audio Amplifier Module 22-32v supply	£4.36
AL60	15-25 watt Audio Amplifier Module 30-50v supply	£5.39
AL80	35 watt Audio Amplifier Module 40-60v supply	£8.44
AL120	50 watt Audio Amplifier Module 50-70v supply	£13.74
AL250	125 watt Audio Amplifier Module 50-80v supply	£20.49

STEREO PRE-AMPLIFIERS

PA12	Supply voltage 22-32v input sensitivity 300mv suit: AL10/AL20/AL30	£7.78
PA100	Supply voltage 24-36v inputs:– Tape, Tuner, Mag P.U., Suit: AL60/AL80	£16.05
PS200	Supply voltage 35-70v inputs:– Tape, Tuner, Mag P.U., Suit: AL80/AL120/AL250	£16.59

MONO PRE-AMPLIFIERS

MM100	Supply voltage 40-65v inputs: Mag, P.U., Microphone Max. output 500mv	£11.30
MM100G	Supply voltage 40-65v inputs: 2 Guitars, Microphones Max. output 500mv	£11.30

POWER SUPPLIES

PS12	24v Supply suit 2×AL10, 2×AL20, 2×AL30 & PA12/S.450	£1.50
SPM80	33v Stabilised supply – suit 2×AL60, PA100 to 15 watts	£4.40
SPM120/45	45v Stabilised supply – suit 2×AL60, PA100 to 25 watts	£5.80
SPM120/55	55v Stabilised supply – suit 2×AL80, PA200	£5.80
SPM120/65	65v Stabilised supply – suit 2×AL120, PA200, 1×AL250, PA200	£5.80
SG30	15-0-15 Stabilised power supply for 2×GE100MKII	£3.80

MISCELLANEOUS

MPA30	Stereo Magnetic Cartridge Pre-Amplifier-input 3.5mv Output 100mv	£2.98
S.450	Stereo FM Tuner Supply Voltage 20-30v – Varicap tuned	£23.24
STEREO30	Complete 7 watt per Channel Stereo Amplifier Board – includes amps, pre-amp, power supply, front panel, knobs etc – requires 2050 Transformer	£19.18
BP124	5 watt 12v max. – Siren Alarm Module	£3.50
GE100MKII	10 channel mono graphic equaliser complete with sliders and knobs	£23.00
VPS30	Variable regulated stabilised power supply 2-30v 0-2 amps	£7.60
PS250	Consists – 1 capacitor & 4 diodes for constructing unstabilised power supply for AL250 to 125 watts	£3.78

TRANSFORMERS

			P&P
2034	1.7 amp 35v suit SPM80	£5.40	£1.21
2035	2 amp 55v	£6.35	£1.47
2036	750mA 17v suit PS12	£3.20	
2040	1.5 amp 0-45v-55v suit SPM120/45, SPM120/55v	£5.20	£1.21
2041	2 amp 0-55v-65v suit SPM120/55, SPM120/65v	£6.80	£1.47
2050	1 amp 0-20v suit Stereo 30	£3.25	£0.75
1725	150mA 15-0-15v suit SG30	£1.77	

ACCESSORIES

139	Teak Cabinet suit Stereo 30, 320×235×81mm	£5.45
140	Teak Cabinet suit STA15 425×290×95mm	£7.50
FP100	Front Panel for PA100 & PA200	£1.80
BP100	Back Panel for PA100 & PA200	£1.60
GE100FP	Front Panel for one GE100MKII	£1.75
2240	Kit of parts including Teak Cabinet, chassis sockets, knobs to build 15 watt stereo amplifier	£19.95

DIODES

Type	Price	Type	Price	Type	Price
AA119	£0.06	OA70	£0.06	IN4004	£0.06
BA100	£0.08	OA79	£0.08	IN4005	£0.07
BA148	£0.13	OA81	£0.08	IN4006	£0.08
BA173	£0.13	OA90	£0.08	IN4007	£0.09
BAX13	£0.05	OA91	£0.08	IN5400	£0.12
BAX16	£0.06	OA95	£0.08	IN5401	£0.13
OA200	£0.06	IN34	£0.06	IN5402	£0.14
OA202	£0.07	IN60	£0.07	IN5404	£0.15
BY100	£0.18	IN4148	£0.05	IN5406	£0.19
BY126	£0.12	IN4001	£0.04	IN5407	£0.23
BY127	£0.14	IN4002	£0.04	IN5408	£0.28
OA47	£0.06	IN4003	£0.05	IS44	£0.03

LINEAR

Type	Price	Type	Price	Type	Price
CA270	£0.95	SL414A	£1.75	TBA810	£0.85
CA3089	£1.70	SN76013N	£1.65	TBA820	£0.65
CA3090	£3.00	SN76023N	£1.60	uA703	£0.20
LM380	£0.80	SN76115	£1.60	uA709C	£0.25
LM381	£1.35	TAA550	£0.30	uA710	£0.25
LM3900	£0.50	TAA621A	£1.80	uA711	£0.26
MC1310P	£0.85	TBA120B	£0.60	741P	£0.16
NE555	£0.18	TBA641A	£1.10	TAA661	£1.25
NE556	£0.55	TBA800	£0.75	TAA661B	£1.25

SPECIAL OFFER!
COMPONENT PAKS

O/NO	Quantity	£ p
SJ1	200 Resistors mixed values	0.50
SJ2	200 Carbon resistors ¼-½ watt preformed	0.50
SJ3	100 ⅛ watt miniature resistors mixed values	0.50
SJ4	60 ½ watt resistors mixed values	0.50
SJ5	50 1-2 watt resistors mixed pot values	0.50
SJ6	50 Precision resistors 1-2° tol. mixed	0.50
SJ7	30 5-10 watt wirewound resistors mixed	0.50
SJ11	150 Capacitors mixed types & values	0.50
SJ12	60 Electrolytics all sorts mixed	0.50
SJ13	50 Polyester/polystyrene capacitors mixed	0.50
SJ14	50 C280 type capacitors mixed	1.00
SJ15	40 High Quality electrolytics 100-470mf	1.00
SJ16	40 Low Vts Electrolytics mixed up to 10v	0.50
SJ17	20 Electrolytics transistor types mixed	0.50
SJ18	20 Tantalum bead capacitors mixed	0.50
SJ20	2 large croc clips 25A rated	0.30
SJ21	Large 7½" 'Mains Neon Tester' screwdriver	0.85
SJ22	Small pocket size 'Mains Neon Tester'	0.55
SJ23	Siemens 220v AC Relay DPDT contacts 10amp rating – housed in plastic case	1.00
SJ24	Black PVC tape (⅝) 15mm × 25m – strong tape for electrical & household use	**0.35 per roll 1.50 5 rolls**
SJ25	100 Silicon NPN transistors all perfect & coded – mixed types with data & equivalent sheet	2.50
SJ26	100 Silicon PNP transistors all perfect & coded – mixed types and cases data and equivalent	2.50
SJ27	50 Assorted pieces of SCR's diodes & rectifiers incl. stud types all perfect – no rejects fully coded – data incl.	2.50
SJ28	20 TTL 74 series gates – assorted 7401 – 7460	1.00
SJ33	PC Board – mixed bundle PCB fibreglass/paper single & double sided – super value!	0.75
SJ34	200 sq. ins. (approx) copper clad paper board	0.80
SJ35	100 sq. ins (approx) copper clad fibre glass	0.80
SJ49	8 dual gang carbon pots log & lin mixed values	1.00
SJ50	20 assorted slider knobs – chrome/black	1.00
SJ51	1 Switchbank 5 way incl. silver knobs	0.50
SJ52	1 pak of vero board approx 50 sq. ins mixed	1.00
SJ53	1 Mammoth I.C. Pack: approx. 200pcs assorted fall-out integrated circuits including logic 74 series, linear-audio and D.T.L. many coded devices but some unmarked – you to identify	1.00
SJ54	20 slider pots mixed values & sizes	1.00
SJ56	6 100K lin 40mm slider pots	0.50
SJ57	6 100K log 40mm slider pots	0.50
SJ58	6 1K lin 40mm slider pots	0.50
SJ59	6 5K lin 40mm slider pots	0.50
SJ60	4 5K log 60mm single	0.50
SJ61	4 100K log 60mm single	0.50
SJ62	5 15mm chrome knobs standard push fit	0.50
SJ63	1 Instrument knob – black winged (29 × 20mm) with pointer ¼" standard screw fit	0.15
SJ64	1 Instrument knob – black/silver aluminium top (17 × 15mm) ¼" standard screw fit	0.12

METAL CASE DUAL SLIDER POTS: 45mm travel

SJ65	10K log	0.25 each
SJ66	100K lin	0.25 each
SJ67	Chrome slider knobs to fit	0.10 each
SJ68	30 ZTX300 type transistor NPN pre-formed for P/C Board colour coded blue – all perfect	1.00
SJ69	30 ZTX500 type transistor PNP pre-formed for P/C Board colour coded white – all perfect	1.00
SJ70	25 BC107 NPN TO106 case perfect transistors code C1359	1.00
SJ71	25 BC177 PNP TO106 case perfect transistors code C1395	1.00
SJ72	4 2N3055 silicon power NPN transistors TO3	1.00
SJ73	6 TO64 SCRs 5Amp assorted 50v – 400v all coded	1.00
SJ74	8 way ribbon cable – colour coded individually PVC insulated solid tinned copper conduction	0.20 meter
SJ75	FM coax cable – plain copper conduction cellular polythene insulated and plain copper braided PVC sheath – impedance 75 ohms	0.10 meter
SJ76	1 Board containing 2 × 5 pin DIN sockets 180° 0 2-2 pin DIN loudspeaker sockets	0.30
SJ77	A 5 pin DIN 180° chassis/normal socket incl. DPDT switch	0.20
SJ83	5 Germ. OCP71 type photo transistors	1.00
SJ84	10 BD131 NPN transistors low Hfe rejects	0.50
SJ85	6 PNP Darlington Power Transistors TO-126	0.50
SJ86	5 PNP TO-3 germ. power transistors at VLTS10-20VCB	0.50
SJ87	20 Asst. heat sinks TO1/5/18/92	0.50
SJ88	2 Post Office relays	0.50
SJ89	20 Mixed values 400mW zener diodes 3-10v	1.00
SJ90	20 Mixed values 400mW zener diodes 11-33v	1.00
SJ91	10 Mixed values 1W zener diodes 3-10v	0.50
SJ92	10 Mixed values 1W zener diodes 11-33v	0.50
SJ95	8 Silicon Bridge Rectifiers up to 4Amp 200v + Data	£1.50
SJ96	1 Battery holder to take 6 × HP7's	£0.10
16168	5 assorted ferrite rods	0.50
16169	2 tuning gangs MW/LW	0.50
16170	50 meters asst. colours single strand wire	0.50
16171	10 Reed switches	0.50
16172	3 Micro switches	0.50
16173	15 assorted pots	0.50
16177	1 pack assorted hardware	0.50
16178	5 Main slider switches assorted	0.50
16179	1 pack assorted tag strips	0.50
16180	15 assorted control knobs	0.50
16181	3 Rotary wave change switches	0.50

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Superb	8, 16	12	30	Hi-Fi	**£22**
Auditorium	8, 16	12	45	Hi-Fi	**£20**
Auditorium	8, 16	15	60	Hi-Fi	**£30**
Group 35	8, 16	12	40	PA	**£12**
Group 45	4, 8, 16	12	45	PA	**£15**
Group 50	4, 8, 16	12	60	PA	**£20**
Group 50	8, 16	15	75	PA	**£30**
Group 75	4, 8, 16	12	75	PA	**£24**
Group 100	8, 16	12	100	PA	**£29**
Group 100	8, 16	15	100	PA	**£35**
Disco 100	8, 16	12	100	Disco	**£29**
Disco 100	8 16	15	100	Disco	**£35**

4 CHANNEL TRANSISTOR MIXERS

Add musical highlights and sound effects to recordings. Will mix Microphone, records, tape and tuner with separate controls into single output. 9 volt battery operated with switch for Two channel stereo working. **£8.00**

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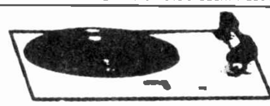
EMI 15 × 8½in. 3-way Loudspeaker System 5in. Bass, 5in. Middle, 3in. Tweeter; 3-way Crossover & Ready Cut Baffle. Full assembly instructions supplied. Response 60 to 20 000 c.p.s. 12 watt RMS 8 ohms £10·95 per kit. Two kits £20. Suitable Bookshelf Cabinet **£9.50** each. Post £1.60.



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Ideal for Groups, Disco, P.A. and Musical Instruments. 4 Inputs speech and music 4 way mixing.
Output 4/8/16 ohm, a.c. Mains 240V.
Separate treble and bass controls.
100 volt line model **£14** extra.

£85 Post £1.60

BAKER COMPACT 50 WATT AMPLIFIER

IDEAL FOR DISCOS, GROUPS, PUBLIC ADDRESS

Two inputs with volume controls. Master treble bass and volume controls. Suitable for all loudspeakers. **£65.** Post £1.60.

R.C.S. SOUND TO LIGHT DISPLAY MK II

Complete kit of parts with R.C.S printed circuit Three 1000W channels Will operate from 200mV signal source CABINET extra £4 KIT = **£18.00**

R.C.S. 10 WATT AMPLIFER KIT

This kit is suitable for record players, tape play back, guitars, electronic instruments or small PA systems. Two versions are available. The mono kit uses 13 semiconductors. The stereo kit uses 22 semiconductors. Both kits have printed front panel and volume, bass and treble controls. Spec. 10W output into 8 ohms 7W into 15ohms. Response 20c.s to 30Kc.s. Size 9½ × 3 × 2in. A/C mains operated.

Mono kit **£12·50** Stereo kit **£20** Post 45p

Easy to build. Full instructions supplied

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8/350V	22p	8+8/450V	50p	50+50/300V	50p
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32/500V	75p	16+16/450V	50p	100+100/275V	65p
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300-0-300V 100mA. 6·3V amp	**£5.80**
300-0-300 120mA 2 · 6 3V 2A C T 6 3V 2A	**£8.50**
220V 45mA 6 3V 2A	**£2.50**
HEATER TRANS 6 3V 3A **£2** ½ amp	**£2·20**
GENERAL PURPOSE LOW VOLTAGE Tapped outputs at	
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3A 6 8 10 12 16 18 20 24 30 36 40 48 60	**£12·50**
5A 6 8 10 12 16 18 20 24 30 36 40 48 60	**£16·00**

5 8, 10 16V ¼A **£2·50** 12V 100mA **£1·30** 12V 300mA **£1.50.** 12V 750mA **£1.75.** 40V 2A tapped 10V or 30V **£3.50.** 10-0-10V 2A **£3.** 40V 2A **£3.50.** 30V 5A + 34V 2A C.T. **£4.** 2 × 18V 6A **£11.** 12-0-12V 2 amp **£3.50.** 25-0-25V 2 amp **£4.50.** 20-0-20V 1A **£3.50.** 30V 1½A **£3.30.** 20V 1A **£3.** 9V 3 amp **£3.50.** 60V, 40V, 20V 1A **£4.** 32-0-32V 6½A **£11.** 9V 250mA **£1.50,** 30V 2 amp **£3.50.**
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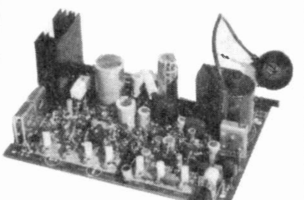

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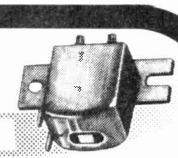

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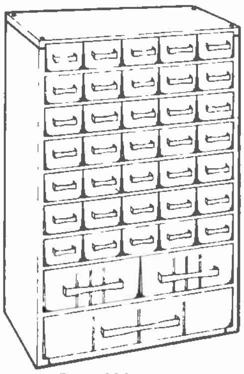

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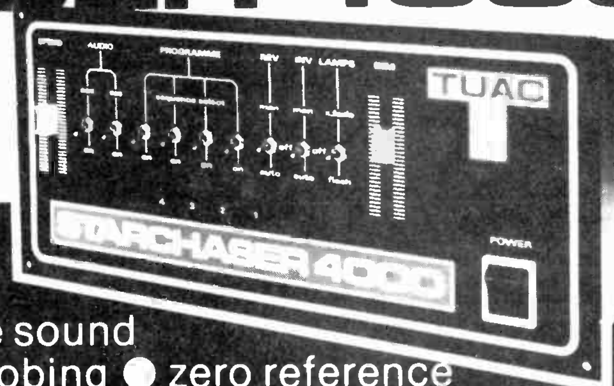

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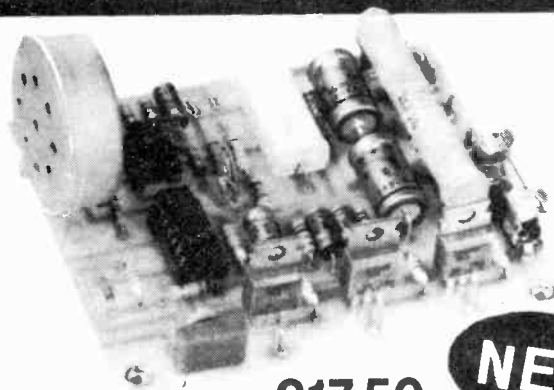

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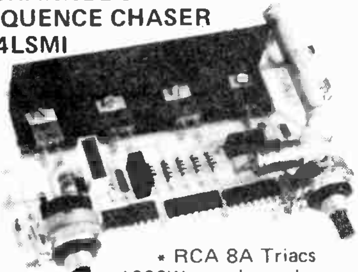

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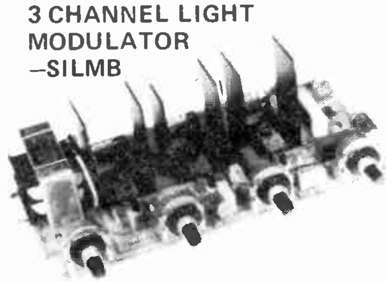

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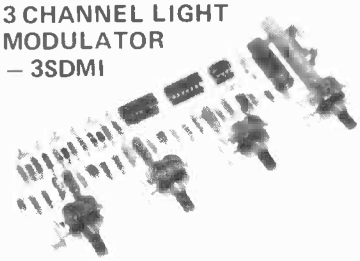

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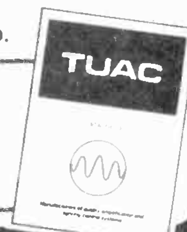

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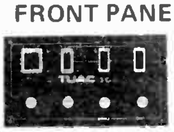

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74LS266	.43
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AC187	.22
AC188	.22
AD149	.61
AD161	.48
AD162	.48
AF114	.35
AF115	.35
AF116	.35
AF117	.35
AF139	.40
AF239	.48
ASY26	.48
BC107	.10
BC108	.10
BC109	.10
BC147	.08
BC148	.08
BC149	.09
BC157	.09
BC158	.09
BC159	.09
BC168	.14
BC169C	.12
BC177	.16
BC178	.16
BC179	.16
BC182L	.12
BC183L	.12
BC184L	.12
BC187	.32
BC212L	.12
BC213L	.12
BC214L	.12
BC327	.12
BC441	.35
BC461	.35
BC477	.25
BC478	.25
BC479	.25
BC547	.14
BC548	.14
BC549	.14
BC557	.14
BC558	.14
BC559	.14
BCY70	.17
BCY71	.17
BCY72	.17
BD131	.44
BD132	.44
BD135	.43
BD136	.43
BD139	.43
BD140	.43
BD239C	.36
BF160	.35
BF167	.32
BF177	.28
BF178	.29
BF179	.35
BF180	.23
BF181	.32
BF184	.24
BF185	.24
BF194	.10
BF195	.10
BF196	.10
BF197	.10
BF200	.32
BF244B	.35
BF272	1.29
BFX88	.28
BFY50	.23
BFY51	.23
BFY52	.27
BRY39	.74
BSX20	.21
MJ481	2.14
MJ2955	1.14
MJE340	.69
MJE2955	1.17
MJE3055	.92
MPF102	.40
MPF103	.41
MPF104	.41
MPF105	.41
MPF106	.58
MPSA05	.28
MPSA06	.28
MPSA55	.28
MPSA56	.28
MPSU05	.55
MPSU06	.62
MPSU55	.60
MPSU56	.64
OC28	1.79
OC35	.92
OC36	1.14
OC44	.36
OC45	.26
OC71	.29
OC72	.35
OC81	.31
ORP12	2.11
TIP29C	.58
TIP30C	.65
TIP31A	.51
TIP31C	.72
TIP32A	.56
TIP32C	.81
TIP41A	.72
TIP41C	.90
TIP42A	.74
TIP42C	.89
TIP2955	.72
TIP3055	.66
TIS43	.41
TIS91	.25
ZTX107	.13
ZTX108	.13
ZTX109	.13
ZTX300	.15
ZTX301	.18
ZTX302	.21
ZTX303	.20
ZTX304	.20
ZTX311	.20
ZTX312	.20
ZTX341	.20
ZTX500	.15
ZTX501	.16
ZTX502	.22
ZTX503	.17
ZTX504	.21
ZTX531	.25
ZTX550	.25
2N914	.36
2N1304	.58
2N1308	.53
2N1309	.58
2N1711	.23
2N1893	.35
2N2218	.36
2N2219	.23
2N2220	.30
2N2221	.26
2N2222A	.22
2N2646	.55
2N2904	.25
2N2905	.23
2N2906	.21
2N2907	.23
2N2925	.10
2N2926G	.12
2N2926O	.12
2N3053	.23
2N3054	.56
2N3055	.51
2N3442	1.67
2N3702	.12
2N3703	.12
2N3704	.12
2N3705	.12
2N3706	.12
2N3707	.12
2N3709	.12
2N3710	.12
2N3711	.12
2N3772	1.94
2N3773	3.31
2N3819	.26
2N3904	.15
2N3906	.15
2N4248	.91
2N5447	.16
2N5449	.20
2N5777	.72
2N6111	.79
2N6288	.79
3N141	1.23
40673	.81

DIODES

AA129	.10
BA100	.17
BA102	.31
BA115	.25
BA145	.21
BA148	.21
BA154	.15
BAX16	.13
BB105B	.36
BR100	.36
OA47	.13
OA79	.13
OA90	.09
OA91	.09
OA200	.09
OA202	.10
IN914	.05
IN4148	.05

SOCKETS

	DIL	W/W
8 pin	.10	.24
14 pin	.13	.36
16 pin	.14	.39
18 pin	.20	.46
20 pin	.22	.59
22 pin	.25	—
24 pin	.28	.64
28 pin	.32	.69
40 pin	.47	1.12

IC PINS

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500	2.39
1000	3.98

ZENERS

BZY88 1.3v to 33v	.09
BZX61 3.3v to 100v	.15

RECT's

IN4001/2	.05
IN4003/4	.06
IN4005	.06
IN4006/7	.07
IN5400/1	.13
IN5402/3	.14
IN5404/5	.17
IN5406/7	.20
IN5408	.25
BY126/7	.13
BY164	.61

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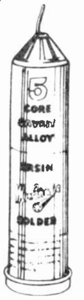

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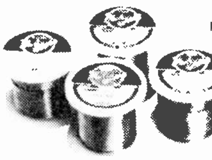

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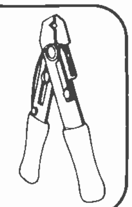

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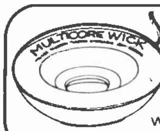

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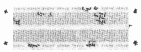
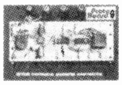


EXP300



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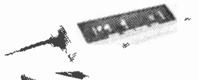

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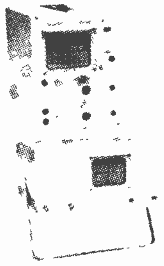

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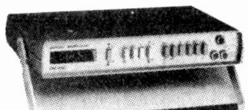

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SINCLAIR DM450 £114·95
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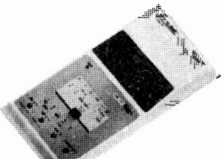
DM350 3½ digit display DM450 4½ digit display. Both provide six functions in 34 ranges. D.C. voltage 10µV to 1200V (100µV on DM350) A.C. voltage 100µV to 750V. D.C. current 1nA to 10A. A.C. current 1nA to 10A resistance 10mΩ to 20MΩ (100mΩ opn DM350). Accessories for DM350 & 450 as for DM235 below. Full spec. on request. Please send S.A.E.



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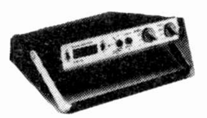

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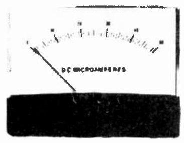

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12FE06	6+6	1A EACH	2·43	72p
20FE06	6+6	1·6A EACH	3·06	84p
50FE06	6+6	3A EACH	3·74	84p
60FE06	6+6	4A EACH	4·58	102p
06FE09	9+9	0·3A EACH	1·82	60p
08FE09	9+9	0·5A EACH	2·19	60p
12FE09	9+9	0·75A EACH	2·43	72p
20FE09	9+9	1A EACH	3·06	84p
50FE09	9+9	2·5A EACH	3·74	84p
60FE09	9+9	3A EACH	4·58	102p
06FE12	12+12	0·25A EACH	1·82	60p
08FE12	12+12	0·3A EACH	2·19	60p
12FE12	12+12	0·5A EACH	2·43	72p
20FE12	12+12	0·8A EACH	3·06	84p
50FE12	12+12	1·8A EACH	3·74	84p
60FE12	12+12	2·5A EACH	4·58	102p
80FE12	12+12	3A EACH	5·66	120p
06FE15	15+15	0·2A EACH	1·82	60p
08FE15	15+15	0·25A EACH	2·19	60p
12FE15	15+15	0·4A EACH	2·43	72p
20FE15	15+15	0·6A EACH	3·06	84p
50FE15	15+15	1·5A EACH	3·74	84p
60FE15	15+15	2A EACH	4·58	102p
80FE15	15+15	3A EACH	5·66	120p
06FE20	20+20	0·15A EACH	1·82	60p
12FE20	20+20	0·25A EACH	2·43	72p
20FE20	20+20	0·5A EACH	3·06	84p
50FE20	20+20	1·2A EACH	3·74	84p
60FE20	20+20	1·5A EACH	4·58	102p
80FE20	20+20	2A EACH	5·66	120p

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66FE12	0-6-12	5A	5·30	102p
70FE12	0-6-12	6A	5·66	120p
90FE12	0-6-12	8A	6·75	138p
12FE24	24+24	0·2A EACH	2·43	72p

Type	Voltage	Current	£	p/p
60FE24	24+24	1·2A EACH	4·58	102p
80FE24	24+24	1·5A EACH	5·66	120p
50FE28	28+28	0·75A EACH	3·74	84p
60FE28	28+28	1·1A EACH	4·58	102p
80FE28	28+28	1·4A EACH	5·66	120p
20FE30	30+30	0·35A EACH	3·06	84p
50FE30	30+30	0·75A EACH	3·74	84p
60FE30	30+30	1A EACH	4·58	102p
80FE30	30+30	1·2A EACH	5·66	120p

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12FE50	12-0-12	1A	2·40	72p
20FE80	20-0-20	1A	3·00	84p
50FE80	20-0-20	2A	3·70	84p
60FE100	28-0-28	2·2A	4·50	102p
80FE70	24-0-24	3A	5·66	120p
90FE50	15-0-15	6A	5·80	120p
90FE80	30-0-30	3A	5·80	120p
100FE26	26-0-26	3·5A	6·05	138p
100FE28	28-0-28	3·5A	6·05	138p
100FE30	30-0-30	3A	6·05	138p
100FE36	36-0-36	3A	6·05	138p
150FE15	15-0-15	7A	7·47	150p
150FE26	26-0-26	5A	7·47	150p
150FE30	30-0-30	4A	7·47	150p
150FE36	36-0-36	4A	7·47	150p
150FE42	42-0-42	3A	7·47	150p
250FE28	28-0-28	8A	8·60	175p
250FE30	30-0-30	7A	8·60	175p
250FE42	42-0-42	5·5A	8·60	175p

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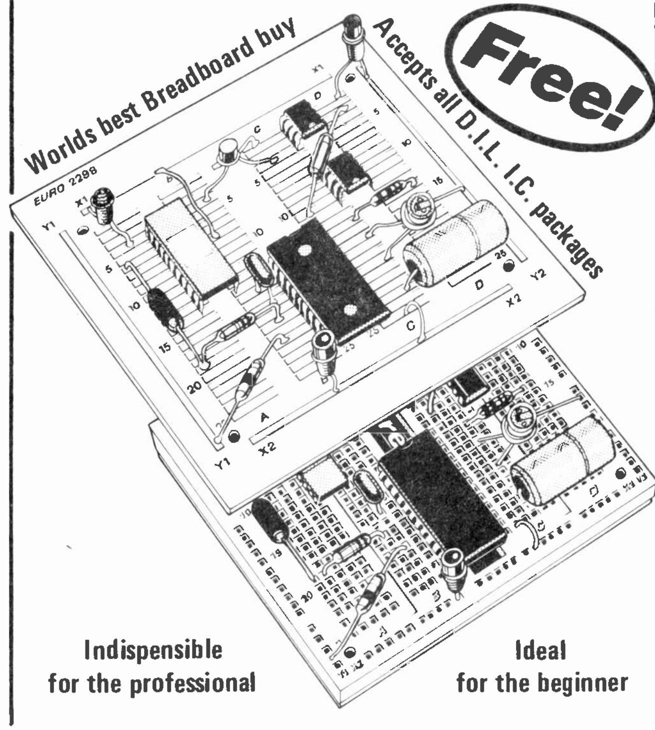

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2N3055	50p
2N3442	140p
2N3702 to 2N3711	11p
2N3772	150p
2N3773	250p
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2N3820	40p
2N3823	70p
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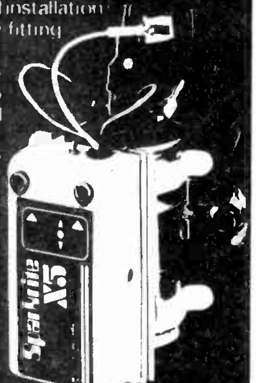

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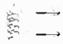

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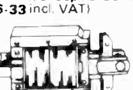

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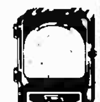

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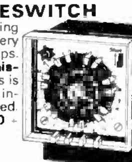

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