PRACTICAL
# ELECTRONICS

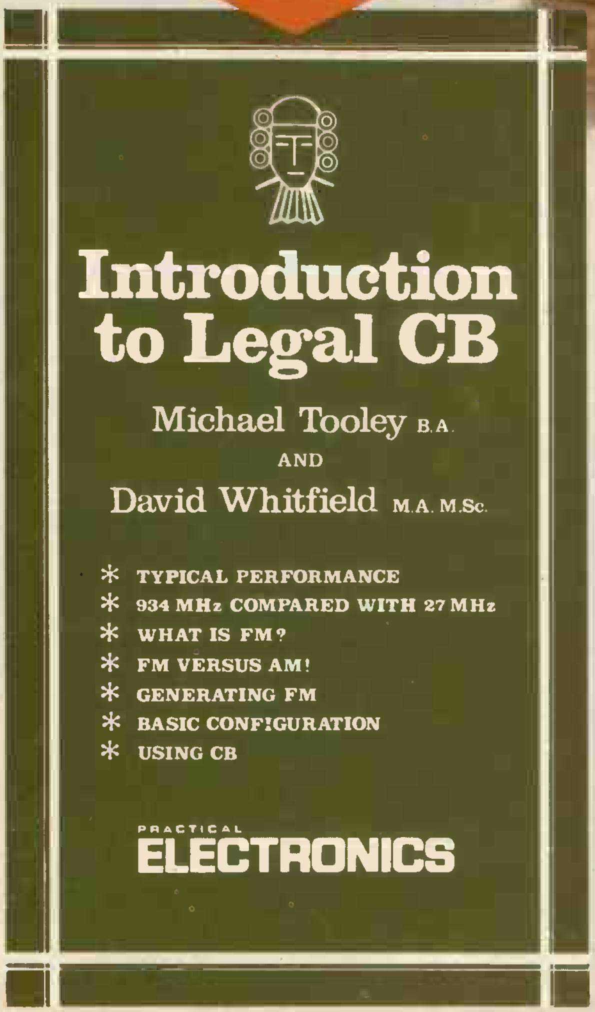
Australia $1.25 New Zealand $1.3 Malaysia $4.95 IR 90p (inc. VAT)

SEPTEMBER 1981

65p

# FREE!
BOOKLET

U.K. ISSUES ONLY



## Introduction to Legal CB

Michael Tooley B.A.

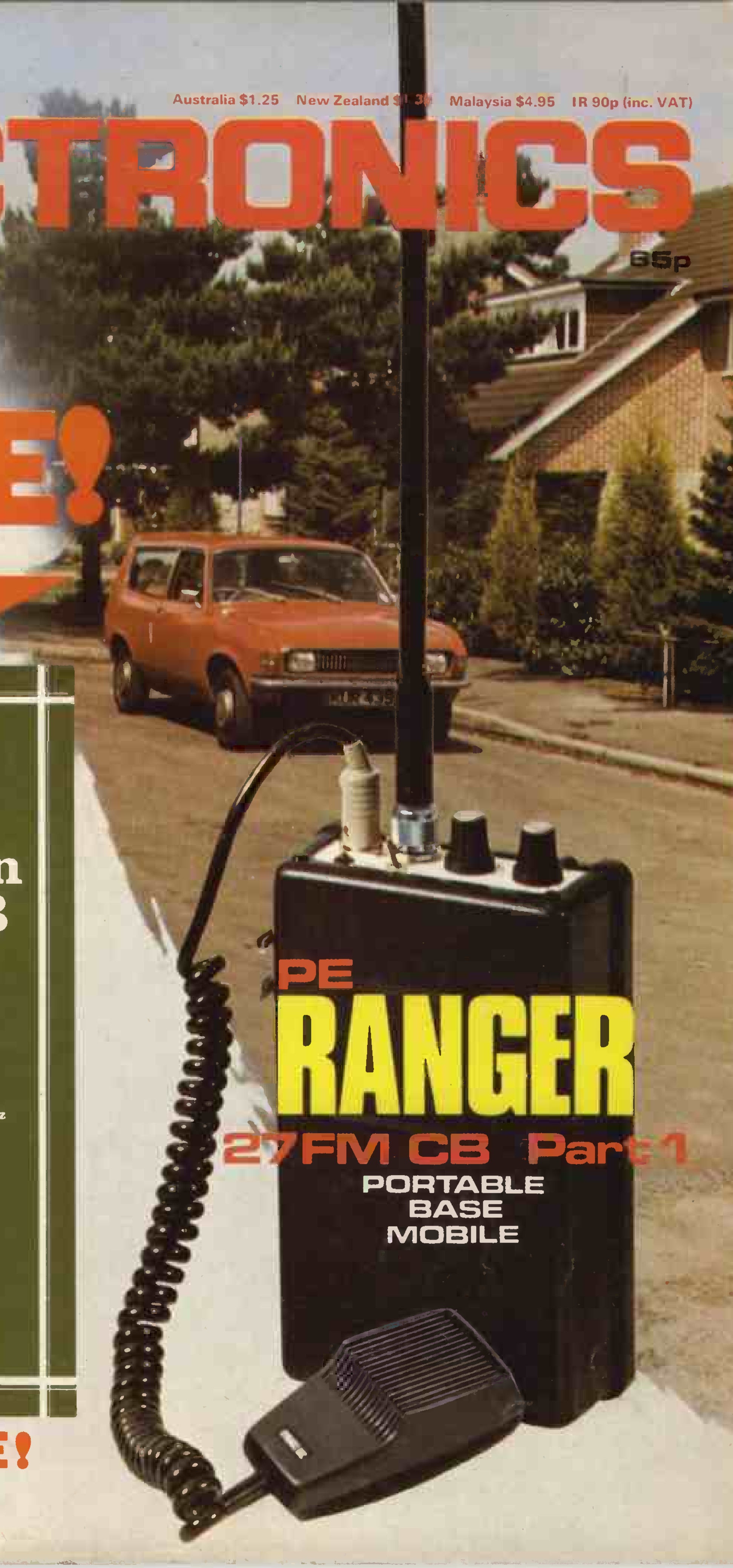
AND

David Whitfield M.A. M.Sc.

* TYPICAL PERFORMANCE
* 934 MHz COMPARED WITH 27 MHz
* WHAT IS FM?
* FM VERSUS AM!
* GENERATING FM
* BASIC CONFIGURATION
* USING CB

PRACTICAL ELECTRONICS

IN THIS ISSUE!



PE
# RANGER
27FM CB Part 1
PORTABLE
BASE
MOBILE

## Unique in concept—the home computer that grows as you do!

# The Acorn Atom

# £120

plus VAT and p&p

Special features include

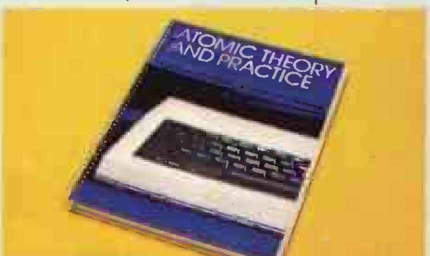
* FULL SIZED KEYBOARD
* ASSEMBLER AND BASIC
* TOP QUALITY MOULDED CASE HIGH RESOLUTION COLOUR GRAPHICS*

* optional


Also available ready-built **£150** plus VAT and p&p

● The picture shows mixed graphics and characters in three colours

The Acorn Atom is a definitive personal computer. Simple to build, simple to operate. A powerful, full facility computer with all the features you would expect.
Just connect the assembled computer to any domestic TV and power source and you are ready to begin. (Power requirement: 8V at 800mA). There is an ATOM power unit available – see the coupon below.




**FREE MANUAL**

Free with every ATOM, kit or built, is a computer manual. The first section explains and teaches you BASIC, the language that most personal computers and the ATOM operate in. The instructions are simple and learning quickly becomes a pleasure. You'll soon be writing your own programs. The second section is a reference manual giving a full description of the ATOM's facilities and how to use them. Both sections are fully illustrated with example programs.

**The standard ATOM includes:**

HARDWARE

● Full-sized QWERTY keyboard ● 6502 Microprocessor ● Rugged injection-moulded case ● 2K RAM ● 8K HYPER-ROM ● 23 integrated circuits and sockets ● Audio cassette interface ● UHF TV output ● Full assembly instructions

SOFTWARE

● 32-bit arithmetic (±2,000,000,000) ● High speed execution ● 43 standard/extended BASIC commands ● Variable length strings (up to 256 characters) ● String manipulation functions ● 27 x 32 bit integer variables ● 27 additional arrays ● Random number function ● PUT and GET byte ● WAIT command for timing ● DO-UNTIL construction ● Logical operators (AND, OR, EX-OR) ● Link to machine – code routines ● PLOT commands, DRAW and MOVE

**The ATOM modular concept**

The ATOM has been designed to grow with you. As you build confidence and knowledge you can add more components. For instance the next stage might be to increase the ROM and RAM on the basic ATOM from 8K + 2K to 12K + 12K respectively. This will give you a direct printer drive, floating point mathematics, scientific and trigonometric functions, high resolution graphics.

From there you can expand indefinitely. Acorn have produced an enormous range of compatible PCB's which can be added to your original computer. For instance:
● A module to give red, green and blue colour signals ● Teletext VDU card (for Prestel and Ceefax information) ● An in-board connector for a communications loop interface – any number of ATOMs may be linked to each other or to a master system with mass storage/hard copy facility ● Floppy disk controller card. For details of these and other additions write to the address below.

ACORN COMPUTER 4a Market Hill, CAMBRIDGE CB2 3NJ

Your ACORN ATOM may qualify as a business expense. To order complete the coupon below and post to Acorn Computer for delivery within 28 days. Return as received within 14 days for full money refund if not completely satisfied. **All components are guaranteed with full service/repair facility available.**

Please send me the following items:

| Quantity | Item | | Item price inc. VAT+p&p | TOTALS |
|---|---|---|---|---|
| | ATOM KIT – 8K ROM + 2K RAM (MIN) | | @ £140.00 | |
| | ATOM ASSEMBLED–8K ROM+2K RAM (MIN) | | @ £174.50 | |
| | ATOM KIT – 12K ROM + 12K RAM (MAX) | | @ £255.00 | |
| | ATOM ASSEMBLED–12K ROM+12K RAM (MAX) | | @ £289.50 | |
| | 1K RAM SETS | | @ £11.22 | |
| | 4K FLOATING POINT ROM (inc in 12K Version) | | @ £23.30 | |
| | PRINTER DRIVE | 6522 VIA | @ £10.35 | |
| | (inc in 12K version) | LS244 Buffer | @ £3.17 | |
| | MAINS POWER SUPPLY (1.3 amps) | | @ £10.20 | |
| | | | TOTAL | |

To: Acorn Computer Ltd., 4a Market Hill, CAMBRIDGE CB2 3NJ
I enclose cheque/postal order for £______
Please debit my Access/Barclaycard No.______
Signature______
Name (Please print)______
Address______
Telephone No.______
Registered No: 1403810. VAT No: 215 400 220 PE/9/81

PRACTICAL
# ELECTRONICS

**VOLUME 17 No. 9 SEPTEMBER 1981**

## CONSTRUCTIONAL PROJECTS



## GENERAL FEATURES



## NEWS AND COMMENT



**OUR OCTOBER ISSUE WILL BE ON SALE FRIDAY, 11 SEPTEMBER 1981**
(for details of contents see page 31)

# Right first time.

*Portable VOM*

*Rechargeable Light*

If you've never built a kit before, Heathkit have some very pleasant surprises for you. Their kits are easy to build. Simple, but detailed instructions take you through every stage. Everything is included. Even the solder you need is there.

Follow the steps and you'll end up with a hand-crafted, well designed piece of equipment. Much better than shop bought, mass-produced. Because you built it yourself.


*Digital Clock*

There's a great range of kits to start you off. From a buzzer alarm to a digital electronic clock, or a portable rechargeable fluorescent light to a portable VOM.

With all this going for you, you can count yourself very lucky you started off with Heathkit. Because all first time kit builders will get a free soldering iron and 10% discount off ten selected kits.

*Buzzer Alarm*


To: Heath Electronics (UK) Limited, Dept ( PE9 ), Bristol Road, Gloucester GL2 6EE.

To start me off, please send me a copy of the Heathkit catalogue. I enclose 28p in stamps.

Name ______________________

Address ______________________

______________________

**You build on our experience**

**HEATHKIT**

HEATH ZENITH

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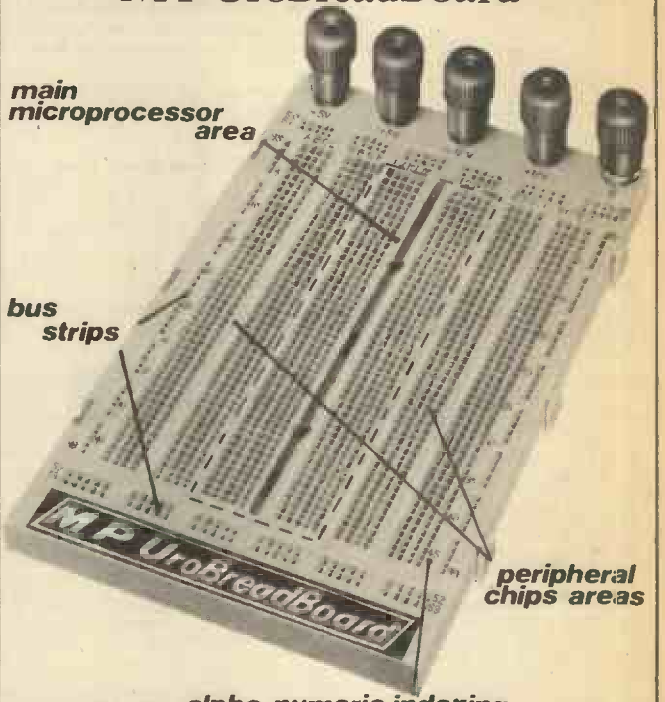
# If you're into MICROPROCESSORS then they should be into an M P UroBreadBoard




- MPU Section accepts 24, 28, 40 & 64 pin DIL microprocessors
- Auxiliary Areas accept any .3" or .6" RAM, ROM or peripheral chip
- Power Bus Strips on all sides
- 5 incoming turret Power Terminals
- Component Support Bracket included
- Over 1400 contact points
- Alpha-Numeric column and row indexing
- Eurocard size (160mm x 100mm)
- Slots onto all BIMBOARDS
- Non-Slip rubber backing
- Ideal for schools and colleges
- Long life, <10m.ohms, nickel silver contacts

## The PROFESSIONALS breadboard that BEGINNERS can start on

**BOSS** *INDUSTRIAL MOULDINGS LTD*

2 Herne Hill Rd, London SE24 0AU, England
Telephone 01-737 2383 Telex 919693
Cables & Telegrams: LITZEN LONDON SE24

Please send me ......... MPUroBreadBoard(s) at £18.00

This price includes VAT & PP, is applicable from March 1981 but please add 15% for Overseas Orders, make cheques/P.O. payable to BOSS Industrial Mouldings Ltd and allow 10 days for order processing and cheque clearance etc.

I enclose a cheque/P.O. to the value of £..............................

Name . . . . . . . . . . . . . . . . . . . . . . . . . . .
Company . . . . . . . . . . . . . . . . . . . . . . . . .
Address . . . . . . . . . . . . . . . . . . . . . . . . .
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Telephone Number . . . . . . . . . . . . . . . . . . . PE 9

# CHROMASONIC electronics

DEPT P.E. 48 JUNCTION ROAD, ARCHWAY, LONDON N19 5RD
TELEPHONE 01-263 9493 01-263 9495 100 YDS FROM ARCHWAY STATION & 9 BUS ROUTES

**YOUR SOUNDEST CONNECTION IN THE WORLD OF COMPUTERS**

## PET

**4008 8K RAM**
**4016 16K RAM**
**4032 32K RAM**
**4040 Dual Drive Disk**

4022 80 column tracks feed.
3023 80 column friction feed.
C2N Cassette Unit.
For the business man we stock the 8000 range inc. 8032 and 8050 with daisy wheel printers coming soon.

PHONE FOR MOST COMPETITIVE PRICES
WORD PROCESSING AND 32K SYSTEMS
PHONE FOR DETAILS

## VIDEO GENIE

**£279** EG3003

Utilises Z80, 12K level II Basic, Integral Cassette Deck, UHF O/P, 16K RAM, all TRS80 features. Simply plugs into monitor or UHF TV. With V.U. Meter.

| | |
|---|---|
| PARALLEL PRINTER INTERFACE INC. CABLE | £33.00 |
| CHROMASONICS PROGRAMABLE SOUND KIT | £24.95 |
| SOUND KIT (FITTING EXTRA) | £7.00 |
| LOWER CASE KIT (FITTING EXTRA) | £27.50 |
| COLOUR KIT (FITTING EXTRA) | £34.95 |
| EXPANSION BOX WITH/WITHOUT RS232 | £215/£185 |
| 16K/32K RAM CARD | £94/£129 |

## APPLE

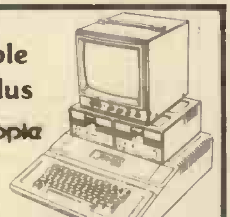
**APPLE II PLUS**

Complete Systems
48K Machines

| | |
|---|---|
| Disk Drive with Controller | £349.00 |
| Disk Drive without Controller | £285.00 |
| Colour Card | P.O.A. |
| Graphics Tablet | P.O.A. |

Accessory Cards, Software
All Available – Phone for details.

Apple II plus



## PRINTERS

Interfaces and Cables for APPLE II, PET, TRS80, RS 232, UK101, SHARP SUPERBOARD All Available

**EPSON MX80 £359**
Dot-matrix printer with Pet graphics interface. Centronics parallel and serial. Pet and Apple compatible. True bidirectional, 80 cps.

**EPSON MX80 FT/1 £399**
Dual single sheet friction and tractor, 9 wire head, true descenders.

**EPSON MX80 FT/2 £449**
An FT/1 with high resolution graphics.

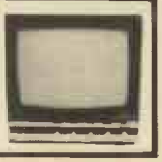
**EPSON MX70 £259**
Tractor feed, 7 wire head high resolution graphics.

**SEIKOSHA GP80A £199**
Dot matrix 5 x 7, 80 columns 30 cps. graphics, double width characters.

JUST PHONE FOR FURTHER DETAILS

## MONITORS

| | |
|---|---|
| MON 10" (illust) B&W | £82.00 |
| 9" Green Monitor | £98.00 |
| Hitachi professional monitors | |
| 9" Black & White | £99.95 |
| 12" Black & White | £149.00 |



## UK101

DOWN IN PRICE

| | |
|---|---|
| UK 101 Kit inc. 8K Memory | £125 |
| Ready Built inc. 8K Memory | £175 |
| Complete in case | £199 |
| 4K Expansion 8×2114 | £14 |
| Memory Expansion Kit | |
| 8K | £79.95 |
| 16K | £106.95 |
| Printer Interface | £29.95 |
| Sound generator plus P10 Kit | £29.95 |
| Cases | £24.50 |

## NEW

| | |
|---|---|
| Chromasonics Sound Kit | £24.95 |
| Colour Kit | £84.95 |

Inc. Demo Tape & Full Documentation. Send for details.

VIC 20

## VIC 20

**Colours**
24 total. 8 for characters, 8 for border, 16 for screen mixed as you wish. Basic colours on program keys are black, white, red, blue, light blue, green, yellow, and purple.

**Sound**
3 Tone Generator for music
"White Noise" Generator for language and sound effects.
Each Generator gives 3 octaves.
Reproduction is through tv speaker.

**Character/Line Display**
22 Characters by 23 lines
64 ASCII characters, pet-type graphic character set.

**Keyboard**
DIN typewriter keyboard with 8 programmable function possibilities via 4 special function keys. Colours are directly addressable from the keyboard.

**Peripherals/Accessories**
VIC Datacassette with special interface to guarantee high reliability read/write quality (PET/CBM compatible).
VIC 1515 – Low cost VIC DOT Matrix printer
VIC 1540 – Single disk unit with 170k Byte capacity.

Price only **£165**
cassette deck **£34.95**


## TANTEL

**PRESTEL BY TANTEL**

**COMMUNICATION AT YOUR FINGER TIPS FOR BUSINESS & HOME. UP TO DATE INFO**

180,000 pages of information on Travel, News, Investment, Holidays, Hotels Etc., Etc.

**£170**

TANTEL IS POST OFFICE APPROVED. SEND FOR DETAILS.
DEMONSTRATION AVAILABLE AT OUR SHOWROOM.

BARCLAYCARD VISA

Please add VAT 15% to all prices. Postage on computers, printers and cassette decks charged at cost, all other items, P&P 30p. Place your order using your Access or Barclaycard (Min. tel order £5). Trade and export enquiries welcome. Official orders welcome.

# AND OTHER PROJECTS

**PHOTOGRAPHS** in this advertisement show two of our units containing some of the P.E. projects built from our kits and PCBs. The cases were built by ourselves and are not for sale, though a small selection of other cases is available.

**LIST**—Send stamped addressed envelope with all U.K. requests for free list giving fuller details of PCBs, kits and other components.

OVERSEAS enquiries for list Europe—send 50p: other countries—send £1.00.

## KIMBER-ALLEN KEYBOARDS AND CONTACTS

**KIMBER-ALLEN KEYBOARDS** as required for many published projects. The manufacturers claim that these are the finest moulded plastic keyboards available. All octaves are C to C, the keys are plastic, spring-loaded, fitted with actuators, and mounted on a robust aluminium frame.

3 Octave (37 notes) **£25.50** 4 Octave (49 notes) **£32.25** 5 Octave (61 notes) **£39.75**

**CONTACT ASSEMBLIES** (gold-clad wire) – 1 required for each KBD note:
Type GJ – SPCO **33p** ea. Type GB – 2 pr N/O **37½p** ea.

### P.E. 6-CHANNEL MIXER

A high specification stereo mixer with variable input impedances

| | | |
|---|---|---|
| Basic comps & PCB's | KIT 90-8 | £56.43 |
| Extra 2-channel set with PCB | KIT 90-9 | £10.21 |
| Set of Text photocopies | TEXT 90 | £1.50 |
| Knob, skts, sw's | | See our list |

### RHYTHM GENERATORS

Several available, including programmable 16 beat 64000 pattern, and pre-programmed 15 pattern using either M252 or M253 rhythm chips. A selection of effects instruments circuits is also available.

### WIND & RAIN EFFECTS UNIT

A slightly modified version of the original P.E. unit.

| | | |
|---|---|---|
| Basic comps, PCB & chart | KIT 28-1 | £4.84 |
| Text photocopy | TEXT 28 | 28p |
| Knobs, skts, sw's | HW 28 | £1.65 |

### P.E. ENVELOPE SHAPER WITH VCA

Has an integral Voltage Controlled Amplifier, and has full manual control over the A.D.S.R. functions.

| | | |
|---|---|---|
| Basic comps, PCB & chart | KIT 50-1 | £8.03 |
| Text photocopy | TEXT 50 | 58p |
| Knobs, skts | HW50 | £1.32 |

### P.E. TRANSIENT GENERATOR

An ADSR envelope shaper without VCA, and additionally providing Repeat-triggering enabling a synthesiser to be programmed for mandolin of banjo effects.

| | | |
|---|---|---|
| Basic comps, PCB & chart | KIT 63-2 | £7.62 |
| Text photocopy | TEXT 63 | 58p |
| Knobs, skts | HW63 | £1.82 |

### P.E. EXTERNAL-INPUT SYNTHESISER-INTERFACE

Allows external inputs such as guitars, microphone etc., to be processed by synthesiser circuits.

| | | |
|---|---|---|
| Basic comps, PCB & chart | KIT 81-1 | £3.90 |
| Knobs, sets | HW 81 | £1.18 |

### P.E. TUNING FORK

Produces 84 switch-selected frequency-accurate tones with an LED monitor clearly displaying beat-note adjustments.

| | | |
|---|---|---|
| Set of basic comps, incl. power supply, PCBs & charts | KIT 46-3 | £23.32 |
| Text photocopy | TEXT 46 | 97p |
| Knobs, skts, sw's | HW 46 | £2.89 |

### P.E. TUNING INDICATOR

A simple octave frequency comparitor for use with synthesisers and other instruments where the full versatility of KIT 46 is not required.

| | | |
|---|---|---|
| Basic comps, PCB & chart | KIT 69-1 | £8.19 |
| Text photocopy | TEXT 69 | 58p |
| Knobs, skts, sw's | HW 69 | £1.56 |

### DIGITAL EXPOSURE UNIT

Controls up to 750 watts in ⅛ second steps up to 10 minutes, with built-in audio alarm.

| | | |
|---|---|---|
| Basic comps, PCBs | KIT 93-3 | £23.45 |
| Text photocopy | TEXT 93 | £1.20 |
| Knobs, skts | HW 93 | £2.48 |

### P.E. DISCOSTROBE

A 4-channel light show controller giving a choice of sequential, random, or full strobe mode of operation.

| | | |
|---|---|---|
| Basic comps, PCB & chart | KIT 57-3 | £19.37 |
| Text photocopy | TEXT 57 | 78p |
| Knobs, skts, sw's | HW 57 | £7.30 |

### P.E. CONSTANT DISPLAY FREQUENCY COUNTER

A 4-digit counter for 1Hz to 99kHz with 1Hz sampling rate. Readout does not count visibly or flicker due to blanking.

| | | |
|---|---|---|
| Basic comps, PCB & chart | KIT 79-4 | £31.61 |
| Text photocopy | TEXT 79 | 78p |
| Knobs, skts, sw's | HW 79 | £4.67 |

### P.E. VOICE OPERATED FADER

For automatically reducing music volume during talkover – particularly useful for discos.

| | | |
|---|---|---|
| Basic comps, PCB & chart | KIT 30-1 | £4.37 |
| Text photocopy | TEXT 30 | 28p |
| Skts | HW 30 | 32p |

### P.E. DYNAMIC NOISE LIMITER

Very effective stereo circuit for reducing the hiss found in most tape recordings.

| | | |
|---|---|---|
| Basic comps, PCB & chart | KIT 97-1 | £8.07 |
| Text photocopy | TEXT 97 | 75p |

### P.E. DYNAMIC RANGE LIMITER

Preset to automatically control sound output levels.

| | | |
|---|---|---|
| Basic comps, PCB & chart | KIT 62-1 | £5.31 |
| Skts | HW 62 | 44p |

**ALL KITS INCLUDE SPECIALLY DESIGNED PRINTED CIRCUIT BOARDS**

**MORE KITS AND COMPONENTS ARE IN OUR LISTS**

**PRICES ARE CORRECT AT TIME OF PRESS.**
**E. & O. E. DELIVERY SUBJECT TO AVAILABILITY.**

**PHONOSONICS**

# Put your *ideas* in our box.

Meet the Idea Box. The shortest distance between idea and working prototype or one-of-a-kind instrument.

It's a great time-saver! You design the circuit, we provide the power supplies . . . assembled and tested . . . and the right case to house it all.

The Idea Box comes complete with three highly regulated low-ripple power supplies (fixed 5VDC @ 1A; + and −15VDC, variable, @0.5A). Plus your choice of a solderless breadboard, a pre-etched, pre-drilled PCB which emulates the hole connection of the solderless breadboard's pattern, or a blank foil board you can use for existing PCB designs. All, housed in our attractive, high-impact case (4"H × 10"W × 7"D), complete with aluminum front panel and hardware. Priced from £79.75.

The Idea Box has the capacity for big ideas as well as small ones. You can stack any of the three circuit cards, in any combination.

So, before you tackle your next project, get a head start with a little help from us: have an Idea Box on hand. After all, good ideas shouldn't be kept waiting.

GLOBAL SPECIALTIES CORPORATION

G.S.C. (UK) Limited, Dept. 5Q
Unit 1, Shire Hill Industrial Estate,
Saffron Walden, Essex CB11 3AQ.
Telephone: Saffron Walden (0799) 21682.
Telex: 817477.

For further information, and your FREE catalogue fill in this coupon NOW and return to:

G.S.C. (UK) Ltd., Dept. 5Q
Unit 1, Shire Hill Industrial Estate, Saffron Walden,
Essex CB11 3AQ.

NAME ____________________

ADDRESS ____________________

____________________

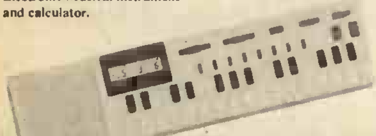
# CUBE MANIA – FREE OF CHARGE

With purchases totalling over £17.50. Only on request at time of ordering. Offer closes 31/8/81. Subject to availability.

## BECOME AN INSTANT MUSICIAN NO EXPERIENCE NECESSARY

The success story of 1981. Hundreds sold already!
As featured on "Tomorrow's World"

**Create your own music with a VL-TONE. You combine the sound, rhythm and tempo and the VL-1 plays it back . . . beautifully!**
**CASIO VL-TONE (VL-1)**
**Electronic Musical instrument and calculator.**



(RRP £39.95)
**ONLY £35.95**

VL-1 records and plays back up to 100 notes as a melody. One Key Play or Auto Play of Piano, Violin, Flute, Guitar and Fantasy, or create your own unique sounds with A.D.S.R. 10 built-in Auto Rhythms and Tempo control. LCD digital readout of notes and tempo. Also a calculator. Battery powered with memory and program retention. Integral amplifier/speaker. Output jack. With Song Book. Dims: 1¼x11½x3".

## CASIOTONE POLYPHONIC KEYBOARDS

With built-in amplifier and loudspeaker

**MT-30**

(RRP £115)
**ONLY £95**

22 instruments over 3 octaves. 4-position sound memory. Battery or mains. O/P jack. Dims: 2¼x22½x6¾". 6lb.

## *** NEW *** CASIOTONE CT-202

"Son of success . . . The two harpsichords demonstrate the Casiotone's talent for sparkling, crystal clear tones . . . Even more impressive is the clav . . ." (Melody Maker).

(RRP £325)
**ONLY £275**

49 instruments over 4 octaves. 4 voice memory function with push button selection. 3 vibrato settings and sustain. Pitch control. O/P jacks. AC only. 3¾x34¼x11 3/16". 15.8lbs.

**CT-301**

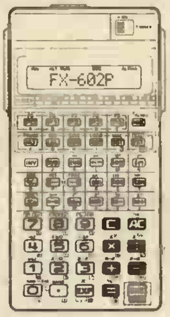
(RRP £285)
**ONLY £245**

14 instruments over 4 octaves. 8x2 rhythm accompaniments. Vibrato and delayed vibrato. Start/stop, synchro start, tempo control, tempo Indicator, and rhythm volume. Pitch control. AC only. O/P jacks. 4½x31½x12¾". 27lbs.

**CT-401**

(RRP £345)
**ONLY £295**

As 301 plus following: 16 rhythm accompaniments, will fill-in. Casio Auto Chord for one finger or auto accompaniment. Plays major, minor and 7th chords with bass. Balance control, C.A.C. lever, chord lever, memory lever and octave switch. Dims as 301. Weight 28.2lbs.



## CASIO'S POWERFUL NEW PROGRAMMABLE THE VERSATILE FX602P

(RRP £84.94) **ONLY £74.95**

- LCD alpha/numeric (dot matrix) scrolling display.
- Variable range of input capacity from 32 program steps with 88 independent memories to 512 steps with 22 memories.
- Memory and program retention when switched off.
- Up to 10 pairs of unconditional jumps (GOTO). Manual Jump.
- Conditional jumps and count jumps.
- Up to 9 subroutines, up to 9 depths (levels).
- 50 built-in functions, all usable in programs.
- 33 parentheses at 11 levels.
- An almost infinite number of programs can be stored on cassette tape via optional FA-1 adapter. (Price £19.95).
- Two lithium batteries last approx. 660 hours (continuous) with Auto Power Off after approx. 6 minutes non-use.
- Dims: 9.6x71x141.2mm (⅜x2¾x5½"). Wallet.

## CASIO SCIENTIFICS

With liquid crystal display for long battery life

*** NEW MODELS ***

**FX5** Junior scientific with fractions, square roots, cube roots, squares, reciprocals, pi, three pairs of parentheses etc. RRP £10.95) **£8.95**

**FX7** Similar to above plus trigs. (RRP £12.9?) **£10.95**

**NEW FX550. Top of the range**

FX550 FX100 FX81

**FX550.** 10 digits, 50 scientific functions. One lithium battery lasts 13,000 hours. Auto power off facility. ⅜x2¾x5½" (RRP £21.95) **£19.95**

**FX100.** 10d, 44f, 7,500 hours from 2xAA batteries. APO ⅞x3x5¾" (RRP £18.95) **£16.95**

**FX81.** 8d, 30f, 4,000 hours (2xAA) APO (RRP £14.95) **£12.95**

**SUPER SCIENTIFICS WITH TIME DIMENSION**

**FX8100.** 46f. Clock, calendar, alarm, hourly chimes, countdown alarm, stopwatch. ⅜x2¾x5½" (RRP £27.95) **£24.95**

**FX6100.** 39f. Hand held version without calendar. **£17.95**

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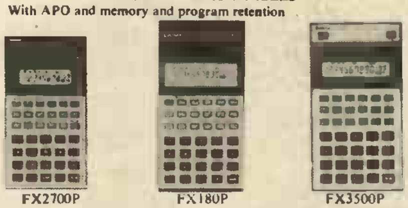

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| 74LS86 | 39p |
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| 74LS126 | 50p |
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| 74LS138 | 69p |
| 74LS139 | 75p |
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| 4025 | 20p |
| 4026 | 130p |
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| 4028 | 75p |
| 4029 | 80p |
| 4030 | 50p |
| 4031 | 195p |
| 4033 | 145p |
| 4035 | 104p |
| 4036 | 290p |
| 4037 | 105p |
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| 4048 | 56p |
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| 4050 | 40p |
| 4051 | 69p |
| 4052 | 75p |
| 4053 | 73p |
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| 4055 | 121p |
| 4056 | 121p |
| 4059 | 560p |
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| 4063 | 112p |
| 4066 | 56p |
| 4067 | 422p |
| 4068 | 19p |
| 4069 | 19p |
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| 4071 | 25p |
| 4072 | 25p |
| 4075 | 20p |
| 4076 | 88p |
| 4077 | 23p |
| 4078 | 29p |
| 4081 | 23p |
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| 4086 | 68p |
| 4089 | 130p |
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| TL490 | 175o |
| XR2206 | 295p |
| XR2207 | 375p |

### CHARACTER GENERATORS

| | |
|---|---|
| RO-3-2513VC | 550p |
| SN74S 262AN | £9 |
| CG4103 | 595p |

### FLOPPY DISC CONTROLLERS

| | |
|---|---|
| FD1771 B 01 S/D Inverted Bus | £18 |
| FD 1791 B-01 D/D Inverted Bus | £29 |
| FDC 3400 | £12 |

### MEMORIES

| | |
|---|---|
| 2114L 450 NS | 145p |
| 2114L 200 NS | 160p |
| 4118 250 NS | 625p |
| 4116 150 NS | 250p |
| 4116 200 NS | 140p |
| HM4864 200 NS | £14 95 |
| TC5514P 450 NS (Same as 6514) | 325p |
| HM6116 200 NS | £12.95 |

### EPROMS

| | |
|---|---|
| 2708 450 NS | 350p |
| 2716 5V 450 NS | 295p |
| 2532 32K 450 NS | £8.95 |
| 2732 Intel Type 450 NS | £8.95 |
| 2564 (8Kx8) 450NS 28 pin NEW! | £75.00 |

### UARTS

| | |
|---|---|
| AY5 1013A | 325p |
| AY3 1015D | 398p |
| IM6402 1PL | 325p |

### CPU'S

| | |
|---|---|
| 6502 | 500p |
| 6504 | 650p |
| 6505 | 700p |
| 6800 | 400p |
| 6802 | 600p |
| 6809 | 1400p |
| 8080A | 400p |
| 8085A | 600p |
| Z80 | 495p |
| Z80A | 595p |
| Z8001 | £99 |
| Z8002 | £80 |

### 3½in. DIGIT LCD DISPLAY with "Lo Bat" sign.

| | |
|---|---|
| LCD106 | £5.95 |

### INTERFACE LINEAR

| | |
|---|---|
| MC1488 | 70p |
| MC1489 | 70p |
| DM8123 | 125p |
| 75150 | 125p |
| 75154 | 125p |
| 75182 | 195p |
| 75322 | 250p |
| 75324 | 325p |
| 75325 | 325p |
| 75361 | 350p |
| 75365 | 295p |
| 75451 | 50p |
| 75491/2 | 75p |
| 8T26 | 140p |
| 8T28 | 140p |
| 8T95 | 140p |
| 8T97 | 155p |

### VOLTAGE REGULATORS — Sale

| | |
|---|---|
| 7805/7812 | 45p |
| 7905/7912 | 55p |
| 78H055C | 500p |
| 78GHKC | 575p |
| LM323K | 450p |
| LM723 | 30p |

### DISPLAYS

| | |
|---|---|
| FND500 | 80p |
| FND510 | 80p |
| FND567 | 125p |
| DL704 | 85p |
| DL707 | 85p |
| MV57164 | 225p |

### CHRYSTALS

| | |
|---|---|
| 5.0688 MHZ | 295p |
| 14.31818 MHZ | 295p |
| 20.00000 MHZ | 325p |

## SUPER SALE!

| Quantity | 1-24 | 25-99 | 100+ |
|---|---|---|---|
| ICL7106 3½ digit LCD A/D Converter | £5.75 | £4.75 | £4.00 |
| LCD 106 3½ Digit LCD Display with "Lo Bat" Sign for above | £5.95 | £4.95 | £4.00 |
| AY-3-8910 Computer Sound IC | £5.95 | £5.25 | £4.50 |

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**MAN 3630 HALF DIGIT (±1)**

These are not sub-spec devices as sold by our competitors.
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Your choice at never-to-be-repeated prices.

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|---|---|---|---|
| MAN 3630 | 75p | 60p | 50p |

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Order early to avoid disappointment.

## NEW SUPER MUSIC MACHINE KIT!

AT LAST an affordable kit that can be PROGRAMMED TO PLAY ANY SONG OR GROUP OF SONGS! Instead of a nightmare of numerous ICs and special expensive Bipolar ROMs, the SUPER MUSIC MACHINE uses a SPECIAL MASK PROGRAMMED COMPUTER CHIP, one CMOS gate and the most popular erasable EPROM, the 2708/2708 series. BASIC KIT includes drilled, plated and screened PC board and ALL components except the EPROM and 12V transformer. The basic kit will play short renditions of 25 tunes through its 7 WATT AMPLIFIER SECTION. Add an optional ROM and any tune programmed will be played. If you have the equipment to program 2708 EPROMs, we supply full information on programming your own music!

**FEATURES**

- Basic kit contains 25 short tunes in the main IC!
- Will address external ROM for up to 1,000 MORE NOTES per ROM! (ROM is not included.)
- Operates on 12V AC or 12V DC at 500mA. (Using unit on 12V DC and with optional ROM requires 9V bias battery, not included.)
- **7 watts of audio power** will drive 8 or 16 ohm speakers or horn speakers (not included)
- DIP switches not included
- 'NEXT TUNE' provision steps sequentially through all tunes.
- Tune address can be wire jumper selected or board is designed to take DIP switches
- PITCH, VOLUME and TEMPO are all adjustable
- SPECIAL 'CHIME' SEQUENCES can be activated regardless of tune address to provide for multiple doorbell applications.
- All tunes consist of electronic musical notes played one at a time. There are no chords or harmony sound to the music
- STEP-BY-STEP ASSEMBLY INSTRUCTIONS provided.
- Large number of PREPROGRAMMED ROMS with popular and classical tunes readily available. Send sae for list and prices.

£16.35 · £1 p&p · VAT £2.60 – £19.95 Total

## SE 01 Sound Effects Kit

The SE 01 is a complete kit that contains all the parts to build a programmable effects generator. Designed around the new Texas Instruments SN 76477 Sound Chip, the board provides banks of MINI DIP switches and pots to program the various combinations of the SLF Oscillator, VCO Noises, One Shot and Envelope Controls. A Quad Op Amp IC is used to implement and Adjustable Pulse Generator Level Comparator and Multiplex Oscillator for even more versatility. The 3¼ · 3 PC Board features a prototype area to allow for user added circuitry. Easily programmed to duplicate Explosion, Phaser Guns, Steam Trains, or almost an infinite number of other sounds. The unit has a multiple of applications. The low price includes all parts, assembly manual, programming charts and detailed 76477 chip specifications. It runs on a 9V battery (not included). On board 100MV amp will drive a small speaker directly, or the unit can be connected to your stereo with incredible results! (Speaker not included) **COMPLETE KIT ONLY £12 · £1 P&P · VAT £1.95 – £14.95 TOTAL**

## BOOKS BY HOWARD W. SAMS INC. SALE!

(Please order books by reference number and title. Please add 75p P&P per book. No VAT)

| REF | TITLE | NORMAL PRICE | SALE PRICE |
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| 21168 | Active Filter Cookbook | £10.95 | £7.75 |
| 21440 | Aviation Electronics | £6.75 | £5.75 |
| 21558 | Audio IC OP Amp Application | £5.95 | £4.75 |
| 21586 | Basic Programming Primer | £6.50 | £4.75 |
| 21554 | Boolean Algebra for Computer Logic | £4.50 | £3.75 |
| 21447 | The 8080A Bugbook Microcomputer Interfacing & Programming | £5.04 | £3.75 |
| 21465 | Building and Installing Electronics Intrusion Alarms | £3.95 | £2.75 |
| 21524 | The Cheap Video Cookbook | £4.50 | £3.75 |
| 21398 | CMOS Cookbook | £7 75 | £6.75 |
| 21652 | Computer Dictionary 3rd Ed | £8 95 | £7.75 |
| 21693 | Computers & Programming Guides for Scientists & Engineers | £11 95 | £8.75 |
| 21697 | 8085A Cookbook | £7 50 | £5.75 |
| 21539 | Design of Active Filters with Experiments | £5 95 | £4.75 |
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| 21537 | Design of Op Amp Circuits with Experiments | £5 95 | £4.75 |
| 21686 | Design of VMOS Circuits with Experiments | £5 95 | £3.75 |
| 21550 | Introductory Experiments in Digital Electronics & 8080A Microcomputer Programming & Interfacing Book 1 | £9.95 | £7.75 |
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| 21351 | How to Buy and Use Minicomputers and Microcomputers | £7.50 | £5.75 |
| 21684 | How to Program & Interface the 6800 | £10 50 | £7.75 |
| 21459 | How to Program Microcomputers | £6.75 | £4.75 |
| 21127 | How to Read Schematic Diagrams | £4.25 | £3.75 |
| 21613 | How to Use Integfated Circuits Logic Elements | £4.50 | £3.75 |
| 21527 | IC Converter Cookbook | £10.50 | £8.75 |

## 6809 S-100 SINGLE-BOARD COMPUTER — SALE

- Meets IEEE S-100 Standard!
- Uses Motorola's Powerful MC6809 CPU!
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- 2K RAM!
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- Selectable BAUD Rates!
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6200, as itemised. ONLY £39.96 exc VAT
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"Perhaps the next famous composer will not direct a 150-piece orchestra but rather a trio of microcomputers controlling a bank of AY-3-8910s." BYTE July '79.

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If you liked 'Invaders' you'll love ASTEROIDS IN SPACE by Bruce Wallace! Your spaceship is travelling in the middle of a shower of asteroids. Blast the asteroids with lasers, but beware BIG ASTEROIDS FRAGMENT INTO SMALL ASTEROIDS! The Apple game paddles allow you to rotate your spaceship, fire its laser gun, and give it thrust to propel it through endless space. From time to time, too, you'll encounter an alien spaceship whose mission is to DESTROY YOU, so you'd better destroy it first! High resolution graphics and sound effects add to the arcade-like excitement this program generates. RUNS ON ANY APPLE II WITH AT LEAST 32K AND ONE DISK DRIVE! ON DISKETTE
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## POWER UP TO 480 WATTS RMS SINGLE CHANNEL

AMPLIFIER WITH HEAT SINK

## Which amplifier?

I.L.P. Amplifiers now come in three basic types, each of which is available with or without heatsink. Having decided the system you want – home hi-fi (models HY30, 60 or 120 for example), super quality hi-fi with extra versatility (MOS120, MOS200) or Disco/PA/Guitar (HD120, HD200 or HD400) you will then decide whether amplifiers housed within their own heatsinks or plate amplifiers for bolting to a metal chassis will suit. With choice such as this and a brilliant new range of I.L.P. functional modules to choose from you now have the chance to build the finest audio system ever offered to the constructor.

### BIPOLAR Standard, with heatsinks / Without heatsinks

| MODEL NUMBER | OUTPUT POWER Watts rms | DISTORTION T.H.D. Typ at 1kHz | DISTORTION I.M.D. 60HZ/7kHz 4:1 | SUPPLY VOLTAGE TYP/MAX | SIZE mm | WT gms | PRICE | VAT | MODEL NUMBER | SIZE in mm | WT gms | PRICE | VAT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HY30 | 15w/4-8Ω | 0.015% | <0.006% | ±18±20 | 76x68x40 | 240 | £7.29 | £1.09 | | | | | |
| HY60 | 30w/4-8Ω | 0.015% | <0.006% | ±25±30 | 76x68x40 | 240 | £8.33 | £1.25 | | | | | |
| HY120 | 60w/4-8Ω | 0.01% | <0.006% | ±35±40 | 120x78x40 | 410 | £17.48 | £2.62 | HY120P | 120x26x40 | 215 | £15.50 | £2.33 |
| HY200 | 120w/4-8Ω | 0.01% | <0.006% | ±45±50 | 120x78x50 | 515 | £21.21 | £3.18 | HY200P | 120x26x40 | 215 | £18.46 | £2.77 |
| HY400 | 240w/4Ω | 0.01% | <0.006% | ±45±50 | 120x78x100 | 1025 | £31.83 | £4.77 | HY400P | 120x26x70 | 375 | £28.33 | £4.25 |

*Protection:* Load line, momentary short circuit (typically 10 sec) *Slew rate:* 15V/μs *Rise time:* 5μs
*S/N ratio:* 100db *Frequency response (–3dB):* 15Hz – 50kHz
*Input sensitivity:* 500mV rms *Input impedance:* 100kΩ *Damping factor:* (8Ω/100Hz)>400

### HEAVY DUTY with heatsinks / Without heatsinks

| MODEL NUMBER | OUTPUT POWER Watts rms | T.H.D. | I.M.D. | SUPPLY VOLTAGE | SIZE mm | WT gms | PRICE | VAT | MODEL NUMBER | SIZE in mm | WT gms | PRICE | VAT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HD120 | 60w/4-8Ω | 0.01% | <0.006% | ±35±40 | 120x78x50 | 515 | £22.48 | £3.37 | HD120P | 120x26x50 | 265 | £19.84 | £2.98 |
| HD200 | 120w/4-8Ω | 0.01% | <0.006% | ±45±50 | 120x78x60 | 620 | £27.38 | £4.11 | HD200P | 120x26x50 | 265 | £23.63 | £3.54 |
| HD400 | 240w/4Ω | 0.01% | <0.006% | ±45±50 | 120x78x100 | 1025 | £38.63 | £5.79 | HD400P | 120x26x70 | 375 | £34.28 | £5.14 |

*Protection:* load line, PERMANENT SHORT CIRCUIT (ideal for disco/group use should evidence of short circuit not be immediately apparent).
The Heavy Duty range can claim additional output power devices and complementary protection circuitry with performance specs. as for standard types.

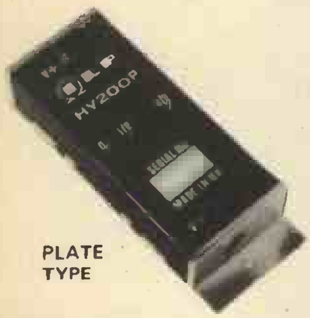


PLATE TYPE

### MOSFET Ultra-Fi, with heatsinks / Without heatsinks

| MODEL NUMBER | OUTPUT POWER Watts rms | T.H.D. | I.M.D. | SUPPLY VOLTAGE | SIZE mm | WT gms | PRICE | VAT | MODEL NUMBER | SIZE in mm | WT gms | PRICE | VAT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MOS120 | 60w/4-8Ω | <0.005% | <0.006% | ±45±50 | 120x78x40 | 420 | £25.88 | £3.88 | MOS120P | 120x26x40 | 215 | £23.32 | £3.50 |
| MOS200 | 120w/4-8Ω | <0.005% | <0.006% | ±55±60 | 120x78x80 | 850 | £33.46 | £5.02 | MOS200P | 120x26x80 | 420 | £28.53 | £4.28 |
| MOS400 | 240w/4Ω | <0.005% | <0.006% | ±55±60 | 120x78x100 | 1025 | £45.39 | £6.81 | MOS400P | 120x26x100 | 525 | £38.91 | £5.84 |

*Protection:* Able to cope with complex loads, without the need for very special protection circuitry (fuses will suffice).
**Ultra-fi specifications:**
*Slew rate:* 20V/μs *Rise time:* 3μs *S/N ratio:* 100db *Frequency response (–3dB):* 15Hz – 100kHz
*Input sensitivity:* 500mV rms *Input impedance:* 100kΩ *Damping factor:* (8Ω/100Hz)>400

### POWER SUPPLY UNITS

| MODEL NO. | FOR USE WITH | PRICE | VAT |
|---|---|---|---|
| PSU30 | ± 15V combinations of HY6/66 series to a maximum of 100mA or *one* HY67 | £4.50 | £0.68 |
| | The following will also drive the HY6/66 series except HY67 which requires the PSU30. | | |
| PSU36 | 1 or 2 HY30 | £8.10 | £1.22 |
| PSU50 | 1 or 2 HY60 | £10.94 | £1.64 |
| PSU60 | 1 x HY120/HY120P/HD120/HD120P | £13.04 | £1.96 |
| PSU65 | 1 x MOS120/1 x MOS120P | £13.32 | £2.00 |
| PSU70 | 1 or 2 HY120/HY120P/HD120/HD120P | £15.92 | £2.39 |
| PSU75 | 1 or 2 MOS120/MOS120P | £16.20 | £2.43 |
| PSU90 | 1 x HY200/HY200P/HD200/HD200P | £16.20 | £2.43 |
| PSU95 | 1 x MOS200/MOS200P | £16.32 | £2.45 |
| PSU180 | 2 x HY200/HY200P/HD200/HD200P or 1 x HY400/1 x HY400P/HD400/HD400P | £21.34 | £3.20 |
| PSU185 | 1 or 2 MOS200/MOS200P/1 x MOS400/1 x MOS400P | £21.46 | £3.22 |

*All models except PSU30 and PSU36 incorporate our own toroidal transformers.*

PSU

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Designed specially by I.L.P. for use with any two power amplifiers of the same type to double the power output obtained and will function with any I.L.P. power supply. In totally sealed case, size 45 x 50 x 20mm, with edge connector. It thus becomes possible to obtain 480 watts rms (single channel) into 8Ω. Contributory distortion less than 0.005%.
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# OF A NEW ERA ILP


## Which modules?

In launching eighteen different units all within amazingly compact cases to help make complete audio systems using I.L.P. power amplifiers, we bring the most exciting, the most versatile modular assembly scheme ever for constructors of all ages and experience. Study the list – see how these modules will combine to almost any audio project you fancy – and remember *all I.L.P. modules are compatible with each other*, they connect easily. Modules HY6 to HY13 measure 45 x 20 x 40mm. HY66 to HY77 measure 90 x 20 x 40mm. They are so reliable that all I.L.P. modules carry a 5 year no quibble guarantee.

| MODEL NO. | MODULE | DESCRIPTION/FACILITIES | CURRENT REQUIRED | PRICE | VAT |
|---|---|---|---|---|---|
| HY6 | MONO PRE AMP | Mic/Mag. Cartridge/Tuner/Tape/ Aux + Volume/Bass/Treble | 10 mA | £6.44 | £0.97 |
| HY7 | MONO MIXER | To mix eight signals into one | 10 mA | £5.15 | £0.77 |
| HY8 | STEREO MIXER | Two channels, each mixing five signals into one | 10 mA | £6.25 | £0.94 |
| HY9 | STEREO PRE AMP | Two channels mag. Cartridge/ Mic + Volume | 10 mA | £6.70 | £1.01 |
| HY11 | MONO MIXER | To mix five signals into one + Bass/Treble controls | 10 mA | £7.05 | £1.06 |
| *HY12 | MONO PRE AMP | To mix two signals into one + Bass/Mid-range/Treble | 10 mA | £6.70 | £1.01 |
| *HY13 | MONO VU METER | Programmable gain/LED overload driver | 10 mA | £5.95 | £0.89 |
| HY66 | STEREO PRE AMP | Mic/Mag. Cartridge/Tape/Tuner/Aux + Volume/Bass/Treble/Balance | 20 mA | £12.19 | £1.83 |
| HY67 | STEREO HEADPHONE | Will drive headphones in the range of 4Ω – 2KΩ | 80 mA | £12.35 | £1.85 |
| HY68 | STEREO MIXER | Two channels, each mixing ten signals into one | 20 mA | £7.95 | £1.19 |
| HY69 | MONO PRE AMP | Two input channels of mag. Cartridge/ Mic + Mixing/Volume/Treble/Bass | 20 mA | £10.45 | £1.57 |
| HY71 | DUAL STEREO PRE AMP | Four channels of mag. Cartridge/Mic + Volume | 20 mA | £10.75 | £1.61 |
| *HY72 | VOICE OPERATED STEREO FADER | Depth/Delay | 20 mA | *To be announced* | |
| *HY73 | GUITAR PRE AMP | Two Guitar (Bass/Lead) and Mic + separate Volume/Bass/Treble + Mix | 20 mA | £12.25 | £1.84 |
| †HY74 | STEREO MIXER | Two channels, each mixing five signals into one + Treble/Bass | 20 mA | £11.45 | £1.72 |
| †HY75 | STEREO PRE AMP | Two channels, each mixing two signals into one + Bass/Mid-range/Treble | 20 mA | £10.75 | £1.61 |
| †HY76 | STEREO SWITCH MATRIX | Two channels, each switching one of four signals into one | 20 mA | *To be announced* | |
| †HY77 | STEREO VU METER DRIVER | Programmable gain/LED overload driver | 20 mA | £9.25 | £1.39 |

* Ready August – may be ordered now
† Ready September – may be ordered now

*All the above modules operate from ± 15V minimum to ±30V maximum – higher voltages being accommodated by use of dropper resistors. HY67 can only be used with the PSU 30 power supply unit.*

The modules are encapsulated and include latest design high quality clip-on edge connectors.

For easy mounting we recommend
**B6** Mounting board for modules HY6 – HY13
78p + 12p. V.A.T.
**B66** Mounting board for HY66 – HY77
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# PRACTICAL ELECTRONICS

## STEREO TUNER KIT


This easy to build 3 band stereo AM/FM tuner kit is designed in conjunction with Practical Electronics (July Issue).
For ease of construction and alignment it incorporates three Mullard modules and an I.C. IF. System

**Features**
VHF - M.W. - L.W. Bands. Interstation muting and A.F.C. on VHF.
Tuning Meter. Two back printed P.C.B's. Ready made chassis and scale.
Aerial: AM - Ferrite Rod, FM - 75 or 300 ohms.
Stabilized power supply with "C" core mains transformer.
All components supplied are to P.E. strict specification.
Front scale size 10½" x 2½" approx.
Complete with circuit diagrams and instructions.

INTRODUCTORY PRICE-ONLY
**£17.95**
plus £2.50 p&p

## HIGH POWER MODULE KITS

**125 WATT MODEL £10.50**
plus £1.15 p&p (Illus)
**200 WATT MODEL £14.95**
plus £1.15 p&p

### SPECIFICATIONS

| | |
|---|---|
| Max. Output power | 125 watt RMS |
| Operating voltage (DC) | 50-80 Max. |
| Loads | 4-16 ohms |
| Frequency response measured at 100 watts | 25Hz-20KHz |
| Sensitivity for 100 watts | 400mV @ 47K |
| Typical T.H.D. @ 50 watts 4 ohms load | 0.1% |
| Dimensions | 205 x 90 and 190 x 36 mm |

The power amp kit is a module for high power applications—disco units, guitar amplifiers, public address systems and even high power domestic systems. The unit is protected against short circuiting of the load and is safe in an open circuit condition. A large safety margin exists by use of generously rated components, result, a high powered rugged unit. The PC Board is backprinted, etched and ready to drill for ease of construction, and the aluminium chasis is preformed and ready to use. Supplied with all parts, circuit diagrams and instructions.

### ACCESSORIES

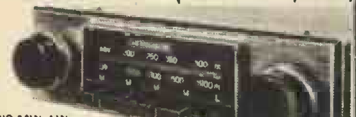
Suitable LS coupling electrolytic for 125W model **£1.00** plus 25p p&p.

Suitable LS coupling electrolytic for 200W model **£1.25** plus 25p p&p.

Suitable Mains Power Supply Unit for 125W model **£7.50** plus £3.15 p&p.

Suitable Twin Transformer Power Supply for 200W model **£13.95** plus £4.00 p&p

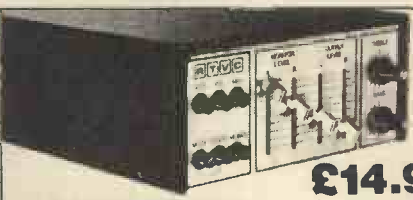
## PRACTICAL ELECTRONICS CAR RADIO KIT (Constructors pack 7)



2 WAVE BAND MW LW
- Easy to build
- 5 push button tuning
- Modern styling design
- All new unused components
- 6 watt output
- Ready etched & punched P.C.B.
- Incorporates suppression circuits
- Now with tape input socket

All the electronic components to build the radio, you supply only the wire and solder as featured in the Practical Electronics March issue. Features: Pre-set tuning with five push button options, black illuminated tuning scale, with matching rotary control knobs, one, combining on/off volume and tone-control, the other for manual tuning, each set on wood simulated fascia.
The P.E. Traveller has a 6 watts output, neg ground and incorporates an integrated circuit output stage, a Mullard IF module LP1181 ceramic filter type, pre-aligned and assembled and a Bird pre-aligned push button tuning unit. The radio fits easily in or under dashboards.
Complete with instructions. **£10.50** plus £2.00 p&p

**CONSTRUCTORS PACK 7A**
Suitable stainless steel fully retractable locking aerial and speaker (approx. 6" x 4") is available as a kit complete **£1.95** per pack. p&p £1.15



**£14.95**
plus £2.90 p&p

## 10+10 WATT STEREO AMPLIFIER KIT

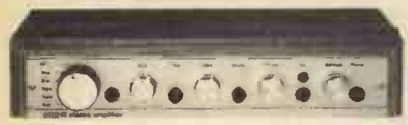
- Featuring latest SGS/ATES TDA 2006 10 watt output I.C.'s with in-built thermal and short circuit protection.
- Mullard Stereo Preamplifier module.
- Attractive black vinyl finish cabinet. Size 9" x 8⅜" x 3⅜" approx.
- Converts to a 20 watt Disco amplifier.

To complete you just supply connecting wire and solder. Features include din input sockets for ceramic cartridge, microphone, tape or tuner. Outputs—tape, speakers and headphones. By the press of a button it transforms into a 20 watt mono disc amplifier with twin deck mixing. The kit incorporates a Mullard LP1183 pre-amp module, plus power amplifier assembly kit and mains power supply. Also featured 4 slider level controls, rotary bass and treble controls and 6 push button switches. Silver finish fascia panel with matching knobs and contrasting ready made black vinyl finish cabinet and ready made metal work. For further information instructions are available price 50p. Free with kit.

### SPECIFICATIONS

Suitable for 4 to 8 ohms speakers

| | |
|---|---|
| Frequency responce | 40Hz — 20KHz |
| Input Sensitivity | P.U. 150mV Aux. 200mV Mic. 1.5mV |
| Tone controls | Bass ± 12db @ 60Hz<br>Treble ± 12db @ 10KHz |
| Distortion | ·1% typically @ 4 watts |
| Mains supply | 220-250 volts 50Hz |



## 30 + 30 WATT STEREO AMPLIFIER BUILT AND TESTED

Viscount IV unit in teak simulate cabinet silver finished rotary controls and pushbuttons with matching fascia, red mains indicator and stereo jack socket. Functions switch for mic magnetic and crystal pickups, tape and auxiliary. Rear panel features fuse holder, DIN speaker and input socket 30 + 30 watts. RMS 60 + 60 watts peak for use with 4 to 8 ohm speakers. Size 1 4¾" x 10" approx.

READY TO PLAY **£32.90** plus £3.80 p&p

**BSR** chassis record deck with manual set down and return, complete with stereo ceramic cartridge. **£8.50** plus £3.15 p&p when purchased with amplifier.
Available separately £10.50 plus £3.16 p&p.

**8" SPEAKER KIT** 2 8" approx. twin cone domestic use speakers £4.75 per stereo pair plus £1.70 p&p when purchased with amplifier. Available separately £6.75 plus £1.70 p&p.

**STEREO MAGNETIC PRE-AMP CONVERSION KIT.** All components including P.C.B. to convert your ceramic input on the 10+10 amp to magnetic. £2.00 when purchased with kit featured above. £4.00 separately inc. p&p.

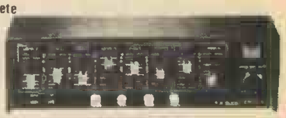
## MULLARD LP1183 STEREO PREAMP

FREE!

Original listed price over £5.00. Suitable for ceramic and auxiliary inputs, when you purchase 2 power module kits.

## 50 WATT MONO MIXER AMPLIFIER

Six individually mixed inputs for two pick ups (Cer. or Mag.), two moving coil microphones and two auxiliary for tape, tuner, organs etc. Eight slider controls - six for level and two for master bass and treble, four extra treble controls for mic and aux. inputs.
Power output 50 watt R.M.S. (continuous) for use with 4 to 8 ohms speakers. Finish: Attractively styled black vinyl case, with matching fascia and knobs. Complete and ready for use.



**£39.95**
plus £3.70 p&p

## HI FI STEREO AMPLIFIER MODULES

- Mullard LP1183 built preamplifier suitable for ceramic and auxiliary inputs. £1.95 plus 70p p&p.
- Mullard LP1184 built preamplifier suitable for magnetic/ceramic and auxiliary inputs. £4.95 plus 80p p&p
- Matching I.C. 10 + 10 Stereo Power amplifier kit. £3.95 plus £1.15 p&p
- Matching power supply kit with transformer. £3.00 plus £1.96 p&p
- Matching set of 4 slider controls complete with knobs for bass, treble and volumes £1.70 plus 80p p&p.
- Complete with application notes.

# RTVC

323 EDGWARE ROAD, LONDON W2
21B HIGH STREET, ACTON W3 6NG
ACTON: Mail Order only. No callers
**ALL PRICES INCLUDE VAT AT 15%**
All items subject to availability. Price correct at 1/8/81 and subject to change without notice.
For further information send for instructions 20p plus stamped addressed envelope.
NOTE: Goods despatched to mainland and N. Ireland only.
Persons under 16 years not served without parent's authorisation.
R TVC LTD. reserve the right to alter, update or improve their products without notice.

## 100 WATT MONO DISCO AMPLIFIER

Brushed aluminium fascia and rotary controls
Size approx 14" x 4" x 10¼. Five vertical slide controls, master volume, tape level, mic level, deck level, PLUS INTER DECK FADER for perfect graduated change from record deck No. 1 to No. 2, or vice versa. Pre fade level controls (PRL) lets YOU hear next disc before fading it in. VU meter monitors output level.
Output 100 watts RMS 200 watts peak. **£76.00** plus £4.60 p&p

Personal Shoppers EDGWARE ROAD LONDON W2 Tel: 01-723 8432. 9.30am-5.30pm. Closed all day Thursday ACTON: Mail Order only. No callers GOODS DESPATCHED TO MAINLAND AND N. IRELAND ONLY

PE VOLUME 17 No. 9 SEPTEMBER 1981

## THE PROTECTION RACKET

PROTECTION in this day and age has become a dirty word but don't knock it, we can provide some protection to you when buying by mail order from adverts in PE. Every so often you will find a statement in our ad. pages about the Mail Order Protection Scheme, it is in your interest to read and be aware of the protection this scheme provides. The protection is against advertisers that become insolvent or bankrupt, it does not cover classified ads. or orders placed as a result of receipt of a catalogue, so it is limited!

In some magazines you will find the protection further limited by a maximum amount being placed on payment of claims made against any one company and also on all claims made by readers in any one year. In such a case you could find yourself with no protection, especially in troubled times when a number of companies go to the wall. The protection offered by PE is not limited in this way but it is dependent on a claim being made in the specified manner and on the advertiser being declared bankrupt or insolvent, a process which can take some time (claims against Metac, who last advertised in PE a year ago, have only recently been paid—but our readers did get their money back).

Unfortunately, the scheme is voluntary and not all publishers offer such protection. There is nothing to prevent the directors of an insolvent company, owing money to mail order buyers and to the magazines in which they advertised, from starting their own publication carrying mail order advertising and offering no protection scheme to readers. It's OK while the advertisers are solvent but what happens when one goes, owing mail order customers large sums?

## VOLUNTARY SCHEME

It could be argued that this problem has been caused by the very publications that provide readers with protection—PE included—because the publishers operate the scheme voluntarily. This was thought to be preferable to being forced by the Director General of Fair Trading to instigate a scheme under law. Because the scheme has remained voluntary not all publishers operate it and therefore not all buyers are covered. If in doubt, ask the advertisement department of the publication concerned, they should be able to give full details of the scheme, including the procedure for making a claim, and should be able to show a relevant statement made in the publication.

Not only because we operate this scheme, but also because we like to get paid for the adverts that appear in PE, we vet our advertisers carefully and it is not unusual for us to refuse to carry advertising material from some companies. If you do have a valid complaint against an advertiser we can help sort it out—everyone makes mistakes occasionally, and even the biggest companies can flounder.

## PRICE

We regret to inform you that from next month the price of PE will be 75p, this increase is due to rising costs. We are only too well aware of the effects of increasing prices on us all, we will do our best to ensure that PE represents good value for money.

*Mike Kenward*




*Editorial Offices:*
Practical Electronics,
Westover House,
West Quay Road, Poole,
Dorset BH15 1JG
Phone: *Editorial* Poole 71191

**We regret that lengthy technical enquiries cannot be answered over the telephone (see below).**

*Advertising Offices:*
Practical Electronics Advertisements,
King's Reach Tower,
King's Reach, Stamford Street, SE1 9LS
Telex: 915748 MAGDIV-G

**Make Up/Copy Dept.: 01-261 6601**


**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 and p.c.b.s are usually available from advertisers; where we anticipate difficulties a source will be suggested.

**Back Numbers**
Copies of some of our recent issues are available from: Post Sales Department (Practical Electronics), IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF, at 95p each including Inland/Overseas p&p.

**Binders**
Binders for PE are available from the same address as back numbers at £4·30 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 £11·80 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.

# ...NEWS &

**Edited by David Shortland & Jasper Scott**

# CB: Licence Proposals

**Further proposals regarding the British CB service were detailed by the Minister of State at the Home Office, Mr Timothy Raison in a speech to the Radio, Electrical and Television Retailers Association on July 9th. Extracts from Mr Raison's speech are printed below.**

"I now turn to the arrangements for bringing the new service into operation. Users will need a licence which will define what equipment may be used, and how it may be operated. CB apparatus which is to be marketed in the United Kingdom will be required, by interference regulations made under section 10 of the Wireless Telegraphy Act 1949, to conform to the technical standards outlined in the relevant Home Office performance specifications and to be certified accordingly.

These specifications cover the minimum requirements necessary to minimise interference to other services without unduly increasing the cost of the CB apparatus. To assist retailers and users to identify this interference free equipment a standard mark of compliance is recommended in the specification.

If equipment is marketed in contravention of the regulations it will be open to the Home Secretary, by issuing a notice under section 12 of the 1949 Act, to prohibit the manufacturer or importer concerned from selling such equipment.

I very much hope that British manufacturers will seize the opportunity of producing CB equipment. There was a good deal of initial interest, as witness the number of people who asked for a copy of our draft performance specifications, but my impression is that this interest has receded somewhat in recent months. It may be that some manufacturers here will be able to convert existing sets to the approved Home Office specifications at an economic cost, and we should certainly welcome this. There is a legal difficulty in that virtually every AM set in this country has been imported illegally and has therefore evaded the payment of import duty and VAT, but I understand that Customs and Excise are looking at this problem as sympathetically as possible.

Finally, I should say something about the licensing arrangements. I cannot give much by way of detail because the system is still being set up. It has to be able to cope with hundreds of thousands, possibly millions, of users and this constitutes no small task. The system will however be run by the Post Office, and will be similar to that used for TV licences. Licences will be available at the counters of most Post Offices as well as by post from the central record keeping agency. Renewals will be dealt with in the same way. We have made good progress and there is no reason to suppose that the licensing system will not be ready to operate in the autumn. We have not yet established the licence fee; clearly it will have to cover the quite considerable costs involved in setting up a licensed CB service and dealing with the associated interference, but we have no intention of pitching the fee at a discouragingly high level.

We are giving some thought to the conditions of use. We shall want to make these as simple as possible and while it will be necessary to include standard conditions such as the usual prohibition on grossly offensive transmissions and on advertising or soliciting for business, we intend to make the conditions less restrictive than in most other radio transmitting licenses. There are many points for consideration; for example, should the licensee be enabled to allow members of his household and his employees to operate his CB equipment, and how many items of equipment should be covered by the licence fee? What arrangements should be made to control the use of equipment hired out by the licensee? It will be advisable to ban the use of CB equipment in aircraft: should any further restrictions be placed on where CB equipment is used, or are such matters better left to a code of practice to be negotiated with the CB organisations? All these matters have to be settled before the licensing system comes into effect.

To sum up, our aim has always been to have a legal service in operation by the autumn. This has dictated an extremely tight time-table; a complex licensing system has to be created and millions of licence forms and fee stamps have to be designed, printed and distributed. Manufacturers and importers have to know the permitted standards so that they may design, manufacture and market the equipment accordingly which means in turn that the order banning all 27 MHz equipment has to be amended. In addition we have to produce regulations on the criteria that will have to be met to prevent interference to other authorised services.

We are on course to complete all these stages in time. I have no doubt that legalised CB will give a great deal of pleasure to a large number of people, including many who have at present no thought of using such a facility. It is the Government's hope that with this credible alternative to the illicit equipment now in widespread use the many CB enthusiasts will turn to it and continue to enjoy their hobby with approved equipment that will reduce the amount of interference to other users of radio."

# FUNCTION GENERATOR

**The TG102 Function Generator is the latest product complementing the Thandar range of test instruments.**

**It is mains operated and has a frequency range of 0·2Hz to 2MHz producing sine square and triangle waveforms plus d.c. from a variable amplitude 50Ω output. TTL output is also provided. External sweep facility is available enabling >1000:1 frequency change within a selected range.**

**The TG102 comes complete with mains lead and 1 year warranty and costs £145 plus VAT.**

**A. Marshall (London) Ltd., Kingsgate House, Kingsgate Place, London NW6 4TA (01-624 8582).**

# MARKET PLACE

**Items mentioned are available through normal retail outlets unless otherwise specified. Prices correct at time of going to press.**

## SAFGAN 'SCOPE

*Safgan Electronics has recently introduced a new range of reasonably priced high performance dual trace oscilloscopes.*

*Designated the DT-400 Series, these oscilloscopes cover a bandwidth range from 10MHz to 20MHz, and all models have vertical sensitivities from 5mV/div to 20V/div in 12 calibrated 1-2-5 steps. DT-400 series is made up of the following models; DT-410 10MHz at £169. DT-415 15MHz at £175. DT-420 20MHz at £188 (all prices plus VAT).*

*Time base speed for all models range from 0·5s/div to 200ms/div in 18 calibrated 1-2-5 steps; the fastest sweep speed can be expanded by x5 to 100ns/div.*

*All three have Z-modulation and XY facility providing matched X and Y inputs. The series offer Bright Line Auto, Normal and TV field triggering modes with a sensitivity below 0·5 div for internal triggering sources which can be CH1 or CH2 and 100mV for External source. Trigger Level and (+)ve, (−)ve slope selection are also incorporated.*

*Safgan Electronics Ltd., 56 Bishop's Wood, St. John's, Woking, Surrey, GU21 3QB (04862 66836).*

## CASIO GO PRO


**Following the success of Casio's first keyboard instrument, the Casiotone 201, Casio have now brought out its successor, the 202, which incorporates many refinements and can really be classed as a professional instrument.**

**The 202 has the same size (49 note) keyboard as the 201, and the same 8-note polyphony and method of voice selection. That, really, is where the similarities end.**

**Casio have added many new voices and duplicated some of the old ones from the 201 giving a total of 49 (the 201 had 29). Brass string and organ voices are particularly realistic.**

**Moving the control panel from the right to the left-hand end of the keyboard may not appear to be a great step forward, but for anyone playing at a gig it's a considerable advantage.**

**The 202 performs well as a home entertainment instrument, as it is very compact and has a built-in speaker and amplifier. However, it really comes into its own when used by the professional or amateur musician playing in a group—either as the players sole instrument or as an add-on to another keyboard such as an electric piano.**

**The Casiotone 202 is available at a discount price of £275 (inc. VAT and p&p) from Tempus, Dept PE, 164–167 East Road, Cambridge CB1 1DB. (0223 312866)**

## New Government Green Paper on Copyright Reform...

A green paper giving the Government's views on future copyright reform was published on July 15. Mr Reginald Eyre, Parliamentary Under Secretary of State, who announced the publication, stressed that it was a green paper, and that it invites public reaction on a wide range of issues covering all aspects of copyright.

Points likely to be of particular interest to readers are: that the Government has not been convinced that it would be right to introduce a levy on audio and video recording equipment or blank tapes (this had been suggested to compensate for loss of royalties due to illegal copying), and, as regards computing, the Government proposes that all forms of stored program—i.e. on magnetic tape or in ROM—should receive complete copyright protection.

## Briefly...

P.c.b.s for many PE projects are now available while you wait from Crofton Electronics Ltd. Crofton inform us that they can make up most p.c.b. designs very quickly, and callers can wait for single boards. They can also supply by mail-order. Crofton Electronics Ltd., 35 Grosvenor Road, Twickenham, Middlesex TW1 4AD.

● ● ● ●

*Program Power the Leeds based software company are to produce a new magazine for Nascom enthusiasts. Called Micro Power the magazine will contain articles on a wide range of hardware and software topics.*

*The first issue will appear in August and will include articles on the design of a programmable character generator and the start of a series on interfacing printers to Nascom. The magazine is priced at 95p including p&p.*

*Program Power, 5, Wensley Road, Leeds, LS7 2LX.*

● ● ● ●

Electronic kit manufacturers Powertran Electronics, who are known in particular for their musical designs, inform us that their 1981/82 catalogue is available free on request. It contains comprehensive details and photographs of all their kits as well as a current price list.

Powertran Electronics, Portway Industrial Estate, Andover, Hants SP10 3NN (0264 64455).

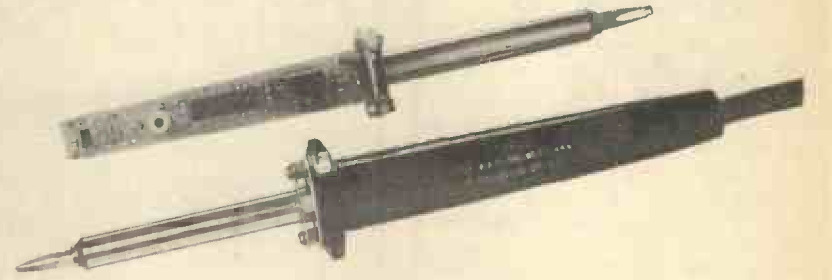
● ● ● ●

*A new low-cost thermal printer has been introduced by Cricket Peripherals.*

*Features of the Cricket 101 include self-test initialisation message after power on, 97 characters including £ sign, single or double width selectable from control codes, quiet operation and simple mechanics. The standard interface is Centronics parallel, and there are optional interfaces available for PET, Apple, Nascom and Sorcerer. Other interfaces will be available soon.*

*The Cricket 101 is priced at £199·50 including VAT, carriage (mainland) and one roll of paper. Interfaces are priced at £35. Cricket Peripherals, 92 London Road, Knebworth, Herts.*

## ADVANCED IRON



**An electronic thermostat in Adcola's new 444 soldering iron is claimed to eliminate all the problems experienced by users of mechanically controlled soldering tools.**

**This soldering iron has been designed to operate off the majority of 24V 50Hz 50VA soldering stations, and has the control circuit contained in the handle. The temperature is fully adjustable within the range of 220°C to 420°C.**

**Adcola attributes the success of this instrument to the fact that the circuit contains an i.c. manufactured to their own design and specification. Incorporating a zero-crossing switch which eliminates switching transients, it controls the bit temperature through a thermocouple and a triac. The heating element has no magnetic effect and the instrument can be earthed.**

**The soldering tool is supported by a range of more than ten iron-plated 3/16"/4·75mm dia. profiles of soldering bits/tips.**

**As an introduction, Adcola is currently offering two evaluation kits at a special reduced price. Kit 1 comprises of the 444 instrument, a selection of 5 long-life bits/tips and a safety stand for £21·00, and Kit 2, without the safety stand for £17·00. The normal one-off price of the Unit 444 is £18·50, with the usual discounts for quantities.**

**Adcola Products Ltd., Adcola House, 113 Camden Rd., London SW4 6LH (01-622 0291).**


## BECKMAN 310

A hand-held 3½ digit multimeter, the Tech 310, has been added to the range of instruments manufactured by Beckman. The multimeter features a 2000 hour battery life, continuity and semiconductor test functions and overload protection on all 26 ranges.

Measurements can be made across five d.c. voltage ranges from 200mV to 1500V full scale; five a.c. voltage ranges spanning 200mV to 1000V full scale; five a.c. and d.c. current ranges, 200µA to 2A full scale (a separate input extends the range to 10A); and six resistance ranges with full scale values from 200 ohm to 20 Mohm.

The 310 is priced at £99 plus VAT and p&p Beckman Instruments Ltd., Electronic Components UK Sales, Mylen House, 11 Wagon Lane, Sheldon, Birmingham B26 3DU.

# MARKET PLACE

## Thorn erect Satellite Receiver

With satellite broadcasting of telecommunications and TV soon to become a reality in some of its export markets and interest in the medium developing in the UK, Thorn Consumer Electronics Limited have erected a 3 metre dish satellite receiver aerial at their Enfield engineering laboratories to establish a reference source for experimental satellite signals and for evaluation of various aerial technologies.

Each European country has been allocated five possible channels for satellite transmissions and both France and Germany are scheduled to begin direct broadcasting by satellite in 1984. In the UK, the Home Office has suggested that two out of the five available UK satellite channels could start broadcasting although a commencement date has not yet been fixed. A recent Home Office publication, indicated that a DBS system could operate four years after a go-ahead decision is taken.

## *POINTS ARISING . . .*

### *EPROM PROGRAMMER (Jan. '80)*

There is an error in the printed circuit layout as shown in Fig. 2.1, and the following correction should be implemented to make the track layout conform with Fig. 5 (December 1979): the track which serves $\overline{CS}$ of IC5 and IC6 (pin 8) should be cut before it reaches the junction serving the link L7. Having been severed, the $\overline{CS}$ track should be surface wired by hand to connect to IC13 pins 4 and 5. It will be found easiest to refer to component overlay diagram Fig. 2.3.

### *DIGITAL DESIGN PART 1 (Aug. '81)*

Due to printing problems a number of errors crept into the first part of this article.
Fig 1.5 The 'new functions' should read $\overline{A}\,\overline{B}$, $\overline{A}+\overline{B}$, $\overline{\overline{A}\,\overline{B}}$, $\overline{\overline{A}+\overline{B}}$
Fig 1.6 The 'voters' column should read C B A (left to right)

On page 44 second column it should read 'Hence, Q=A $\overline{B}$+$\overline{A}$ B, Expression number 8 just below should read $\overline{A}\,\overline{A}=\overline{A}$

At the bottom of the same page when we are looking at the truth table, the second and fourth lines should read: A+B is the same as $\overline{\overline{A}\,\overline{B}}$ and $\overline{A+B}$ is the same as $\overline{A}\,\overline{B}$

On page 45 second column above Fig.1.7a, we should read A+B is the same as $\overline{\overline{A}\,\overline{B}}$

On page 46 under 'Filling in the map', the first paragraph should read: we can say that the column=1 if A=1 AND B=0, so the column is A $\overline{B}$

### *EPROM PROGRAMMER (Aug. '81)*

In Fig. 1, R4 should go to pin 20 and not pin 21. In Fig. 2, R4 should be connected to comply with the revised Fig. 1. Also, there is an unnecessary break in the stripboard track at F24 which should be removed.

### *COLOUR BOARD REVIEW (Aug. '81)*

Our apologies to Chromasonic Electronics of North London for mis-spelling their name throughout this article.

### *CAPACITANCE METER (July '81)*

The connection from IC1 pin 6 to pin 7 (see Fig. 2) is absent from the p.c.b. diagram of Figs. 4 and 5. This connection should be made for correct operation.

## Countdown . . .

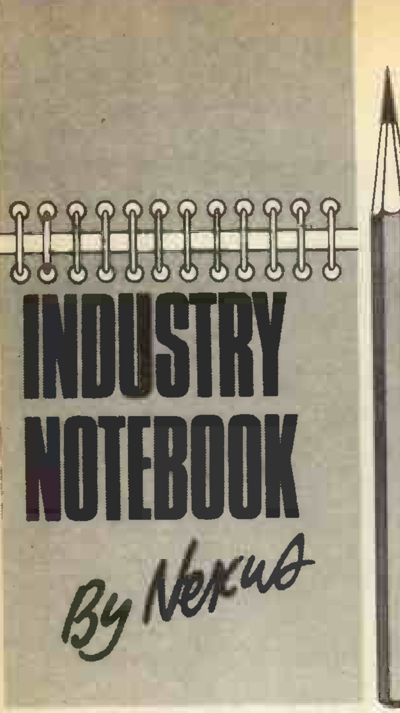
**Please check dates before setting out, as we cannot *guarantee* the accuracy of the information presented below.**

**Harrogate Int. Fest. of Sound** Aug. 15–18. Royal Hall Exhibition Centre & Hotels. **X**
**Solar Energy Exhibition** Aug. 23–28. Brighton. **M**
**BEX Cardiff** Sept. 3–4. Centre Hotel. **K**
**Business & Light Aviation** Sept. 3–5. Cranfield Airport. **Z1**
**Microprocessor Workshop** Sept. 7–8. University of Liverpool. **D**
**Laboratory** Sept. 8–10. Grosvenor House, Park Lane, London. **I**
**Personal Computer World Show** Sept. 10–12. Cunard Hotel, London. **M**
**West of England Electronics Show** Sept. 15–17. Bristol Exhibition Centre. **Q**
**Microtest** Sept. 21–24. (Symposium) Kent University, Canterbury. **S1**
**Business Telecoms & Electronic Office** Sept. 23–25. Royal Lancaster Hotel, London. **O**
**BEX Edinburgh** Sept. 30–Oct. 1. Assembly Rooms. **K**
**Viewdata** Oct 6–8. Wembley Conference Centre, London. **O**
**BEX Bristol** Oct 14–15. Exhibition Centre. **K**
**Video Show** Oct. 16–18. West Centre Hotel, London. **Z1**
**International Business Show** Oct. 20–29. NEC Birmingham. **A2**
**Testmex** Oct. 27–29. Wembley Conference Centre, London. **T**
**Computer Graphics** (Ex. & Conf.) Oct. 27–29. **O**
**BEX Southampton** Nov. 4–5. Polygon Hotel. **K**
**Viewdata & TV User** Nov. 4–6. West Centre Hotel, London. **Z1**
**Breadboard** Nov. 11–15. Royal Hort. Halls. **B7**
**IFSEC** (Fire & Security) Nov. 17–19. RDS Dublin. **V**
**Compec** Nov. 17–20. Olympia, London. **Z1**
**Electronics** Nov. 17–20. Olympia, London. **I**
**BEX Plymouth** Nov. 18–19. Holiday Inn. **K**
**INTRON** Nov. 24–26. RDS Dublin. **V**
There are **continuous events** and **permanent exhibition** at the National Micro & Electronics Centre. **L1**

**1982**

**Electronics OEM Assemblies** Feb. 2–4. Royal Hort. Halls, Westminster, London. **T**
**Electronic Test & Measurement** March 30–April 1. The Forum, Wythenshawe. **T**
**Laboratory, Edinburgh** March 30–31. Assembly Rooms, George Street. **E**
**Sensors & Systems** March 30–April 1. The Forum, Wythenshawe, Manchester. **T**
**Laboratory, Manchester** April 7–8. New Century Hall, Corporation Street. **E**
**All Electronics Show** April 19–21. The Barbican, City of London. **E**

| | |
|---|---|
| **A2** | Hart Browne & Curtis ✆ 01-439 8556 |
| **B7** | Modmags ✆ 01-437 1002 |
| **D** | Liverpool Univ., Brownlow Hill, PO Box 147 |
| **E** | Evan Steadman, Saffron Walden ✆ 0799 22612 |
| **I** | ITF, Solihull ✆ 021-705 6707 |
| **K** | Douglas Temple, Bournemouth ✆ 0202 20533 |
| **L1** | World Trade Centre ✆ 01-488 2400 |
| **M** | Montbuild Exhibitions ✆ 01-486 1951 |
| **O** | Online, Northwood, Middx. ✆ 09274 28211 |
| **Q** | Exhibitions for Industry ✆ 0883 34371 |
| **S1** | Sert ✆ 01-403 2351 |
| **T** | Trident, Tavistock ✆ 0822 4671 |
| **V** | SDL ✆ Dublin 763871 |
| **X** | Exhibition & Conference, Harrogate ✆ 0423 62677 |
| **Z1** | IPC Exhibitions, Sutton ✆ 01-643 8040 |




## Showbiz

So 1982 is to be designated the Year of Information Technology! I shall call it YIT and I'm already wondering just what it will do that wouldn't happen of its own volition.

My scepticism is based firmly on precedent. Older readers may recall the famous National Plan which foundered after a few months. The era of the White Heat of Technological Revolution left most of us stone cold.

National Productivity Year also left the nation unmoved. This was spread over 1962 and 1963 when Britain had the lowest percentage increase of national product per man-year than any other industrial nation. Japan, West Germany and Italy, the three defeated nations of World War 2, were already racing away with their respective economic miracles.

Sixteen years later Britain was still at the bottom of the productivity league table in heavy industry and the long period of drift ended only when harsh reality affected job prospects. In retrospect, National Productivity Year with its 1,500 separate events staged to explain the meaning of productivity, why an increase was necessary for national survival, and how to achieve it, was a waste of time.

Will YIT prove to be more effective? The Government is to top up the taxpayers' contribution to new electronics technology to £200 million. Not to be sneezed at but peanuts compared with the billions still being poured into nationalised steel, coal, railways, shipbuilding and BL.

## Data Communications

If we really need YIT the assumption must be that we are lagging behind in information technology and need a good kick up the backside. If we look at data communications, the heart of the matter, in fact we are doing quite well. Taking as a yardstick the number of network termination points (NTPs), i.e. the interfaces between user equipment and the PTT services, Britain is leading the field in Europe by a handsome margin.

I take the figures from the last Eurodata Report which was researched in 1979. The United Kingdom was top user with 117,000 NTPs, followed by West Germany (61,700), France (54,000) and Italy (45,500). The also-rans at the bottom of the league were Ireland (966), Portugal (794), Luxembourg (649) and Greece (639).

Of course these figures are misleading for obvious reasons. Tiny Luxembourg with a population of only 356,000 people would clearly need less NTPs in total than the United Kingdom with its 56 million population.

A more realistic league table can be constructed by re-casting the figures as the number of NTPs installed per thousand of the working population. The UK then emerges with a figure of 5·2 per 1,000, still well ahead of West Germany (2·87), France (3·03) and Italy (3·16). Note that the three runners-up to the UK in the four biggest countries have now changed order with Italy rising and West Germany dropping from second to fourth in the big country group.

But in this new formulation, if we include all 17 countries in the Survey, the UK drops to second position behind Sweden with its 5·66 NTPs per 1,000 and is only marginally ahead of little Luxembourg (5·15) which has almost miraculously climbed from next to bottom to the number three spot.

Eurodata, when it crystal-balled in 1972 on what would happen in 1979, underestimated the growth rate of data communications by 100 percent. Undeterred by such a gross error, or perhaps inspired by it, the crystal ball has again been employed, this time to forecast the figures for 1987.

In 1987 the UK will still have the largest number of NTPs (377,000) of any country in Europe and Sweden will still be top of the NTP per 1,000 league table with a figure of 26·4. But, sadly, in this table the UK will have dropped back to sixth place (16·8), having been overtaken by Luxembourg (23·9), Switzerland (22·2), Belgium (21·3) and the Netherlands (17·0). Note that the top five are now all small countries. But of the 'big four' of UK, West Germany, France and Italy, the UK will still be top on either calculation.

Overall growth rate for Europe in installed terminals is forecast at 26 percent per year but only 10 percent in hardware value, confirming once again that electronics is the only field in which hardware costs relatively consistently fall.

Looking at the above figures a conclusion may be drawn that salesmen have been busy and potential users have snapped up opportunities offered. And that the UK, far from needing YIT, could teach the rest a few wrinkles. On reflection YIT may yet prove a boon if only to provide extra employment for exhibition specialists, advertising copywriters, printers and organising committees.

Honesty compels me to add a final footnote. If the forecast for 1987 is correct, top of the league in Europe, Sweden, will by then only have achieved the same level of usage as in the United States today.

## First Hoppers

A major triumph for Britain was the launch of Racal's Jaguar-V VHF combat radio, claimed to be the world's first anti-jamming frequency-hopping transceiver. Already in production, it was a little ahead in time against Marconi's Scimitar, a similar private venture development, and is still well ahead of the United States Sincgars-V project. Racal has already taken orders for the British Army and for three other NATO countries. At this stage one assumes the orders are in sample quantities for field trials and evaluation by the armed forces concerned.

Racal is said to be in negotiation with other customers and forecast a sales potential for Jaguar-V running into hundreds of millions of pounds over the next ten years. Competition, however, will be fierce. The Marconi Scimitar was publicly shown within a month of the Jaguar launch and will be attacking the same market.

## New Knights

Two new electronics Knights Bachelor were in the Queen's Birthday Honours list. They were Godfrey Hounsfield, 'father' of the EMI body-scanner and a Nobel prize-winner, and Ernie Harrison, chairman and managing director of Racal Electronics Group for his services to export. One a brilliant scientist, the other an outstanding man of business, both have served their country well.

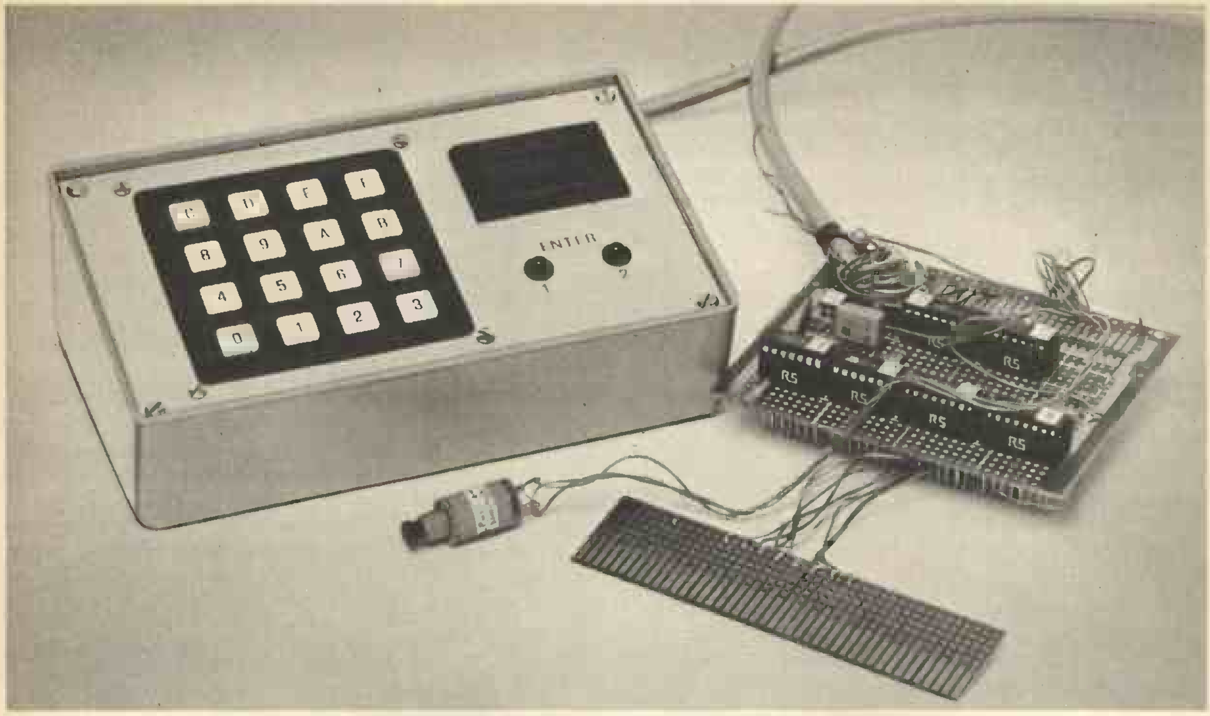
## Aerospace

Electronics was well represented at the Paris Air Show. A British breakthrough, shown publicly for the first time, was the holographic head-up display (HUD) which Marconi Avionics has developed for the United States Air Force for fitting in F-16 multi-role fighters and A-10 close-support tank-busters. The new HUD enables these aircraft to operate safely at low altitudes in total darkness.

British exhibitors came home with another £300 million of orders, mostly for export, of which about one third will find its way to the electronics industry. A good show in both senses.

## Competition

The break-up of British Telecom's total monopoly is certainly having a galvanising effect. Nearly a thousand salesmen are to be recruited and trained by Telecom and will actually be given targets to attain and bonuses to be earned in the business sector where competition will be hottest. No need for a sales effort for the private user. There are still some 300,000 hopeful residential customers awaiting connection although, we are promised, they will not be forgotten.



# REMOTE KEYBOARD

J. LEWIS

MICROCOMPUTERS are fine and great fun—especially for the first few weeks or even months when they are a novelty—but the honeymoon period wears off and one starts to wonder what useful purpose they can be put to. An obvious application is in the home, to provide control of the various systems e.g. heating, lighting and security. However, if this is to be done it becomes obvious that the microcomputer itself has to be located away from prying fingers which could so easily key in incorrect instructions or operate the Load or Reset switches and cause a horrendous crash. What is needed is a remote keyboard designed to be idiot-proof.

The circuit described here was specifically designed for a Elf II microcomputer to allow different modes of operation to be selected, and accept the entry of a six digit security code. The circuit (Fig. 3) is applicable to other microcomputers though the actual interfacing may differ according to input/output lines available. First thoughts might suggest that the new keyboard could be daisy chained to the existing one, but this raises all sorts of problems, not least that of the Input or Enter key. Many people find difficulty in accepting the concept that you actually need to "enter" the digit into the computer. This might be one reason why reverse polish notation as used on Hewlett Packard calculators never took the mass market by storm. What is needed is a keyboard which tells you what to do, and when it has been done automatically enters it into the microcomputer. The following circuit does just that.

### HOW IT WORKS

A matrix type keyboard is used which has 8 output lines, four of which are connected to the columns and four to the rows (Fig. 1). When any key is depressed a unique contact is made between one of the columns and one of the rows. Such keyboards are designed to be used in conjunction with a special decoder integrated circuit. Two of the most popular being the 74C922 and the 74C923. These are CMOS devices and can handle either a 16 key or 20 key keyboard respectively. For this application 16 keys were sufficient and so the 74C922 is ideal.

A block diagram of the 74C922 is given in Fig. 2. By connecting a capacitor between pin 5 and −ve the internal oscillator is enabled so that the keyboard matrix is scanned to detect any key closures. Key bounce is, thankfully, eliminated by connecting another capacitor between pin 6 and −ve. The decoded output from the keyboard is present in BCD form on pins 14 to 17. As a keyboard entry is made so the "Data Available" line, pin 12, goes high and returns to low when the key is released even if another key is depressed. After the normal debounce period it will go high again indicating the acceptance of another entry. The 74C922 has tri-state capability on its 4 data output lines thus enabling it to be connected directly to a data bus. This tri-state feature is controlled by pin 13 which, when high, ensures the data outputs present a high impedance to the bus. On grounding this pin the decoded output from the keyboard—which has been stored in internal latches within the i.c.—is put on to the bus. In this particular application the tri-state mode is not required and so pin 13 is grounded.

The output from this i.c. is only half a byte wide and whilst software could handle it, the sensible course is to offer a whole byte at a time. This is easily done using a quad D type register such as the 4076. By connecting the clock line of this i.c. to the Data Available output of the 74C922 data can be latched into the 4076, thus giving the full byte required

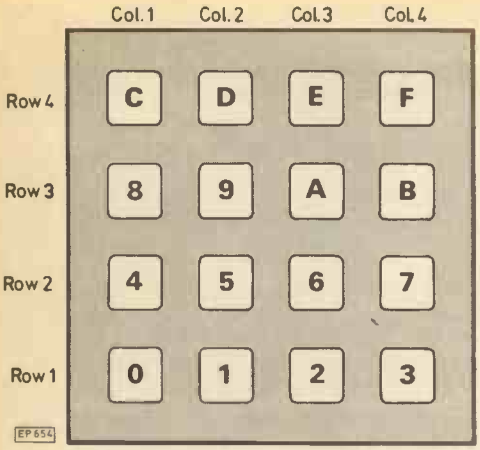



**Fig. 1. Keyboard and its column/row designations**

for the data bus. A tri-state facility is available on the 4076 and use is made of it to isolate the i.c. from the bus line when not in use. It is an active low operation which means that whilst pins 1 and 2 (Output Disable) are held high, the four output lines present a high impedance to the bus; take them low and the data in the latch is put onto the bus.

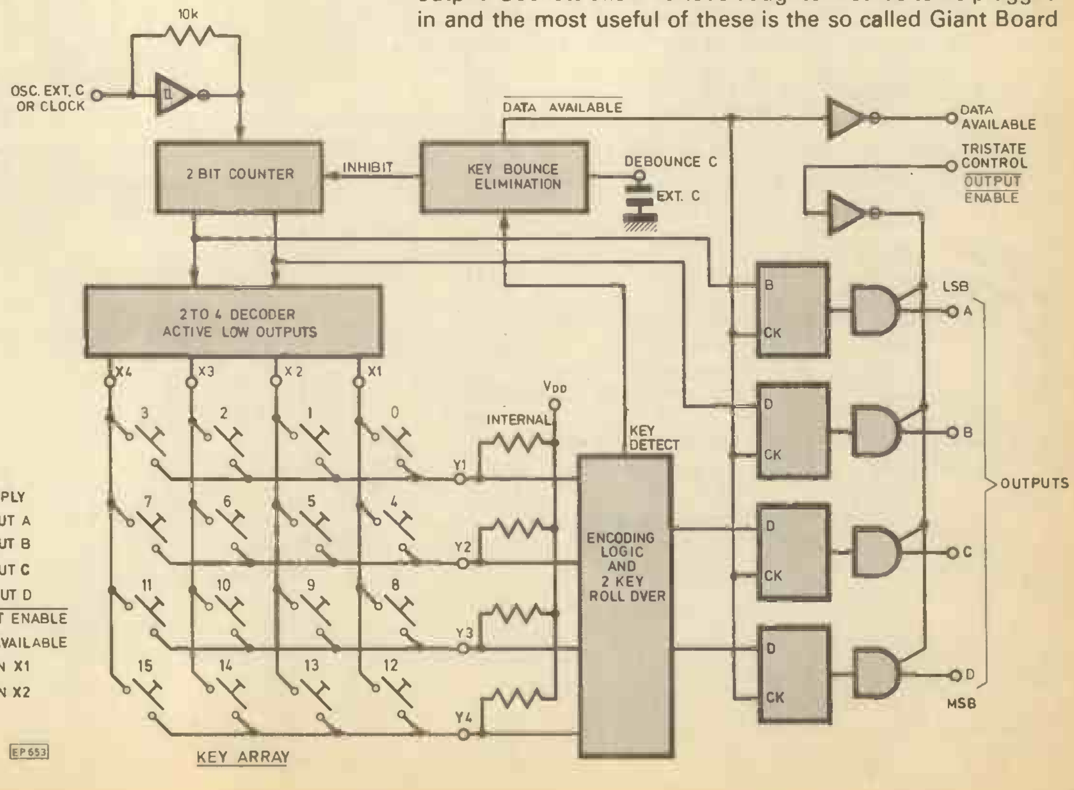
In the case of IC1 the tri-state feature could not be used since its outputs were connected to the inputs of IC2. If they had been, then anything that happened to be on the high order part of the bus when the data available pin went high would be transferred into IC2. To overcome this a 4066 quad analogue switch is interposed between the outputs of IC1 (74C922) and the bus. The 4066 is similar to the 4016 except it has a much lower "on" resistance. The signal on any particular input is only transferred to the corresponding output when its "Control" is taken high. By connecting all 4 "Controls" together, simultaneous transfer of the high order part of the byte is achieved.

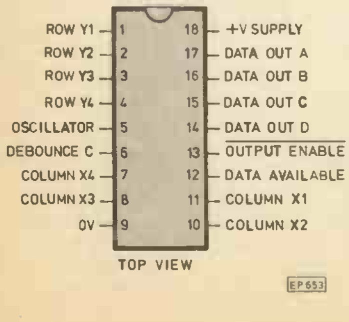
In order to signal to the computer that a byte of data, i.e. two keyboard entries, was available, a 4013 dual D type flip-flop is used. The output from the Data Available pin of IC1 clocks one half of the 4013 whilst the resulting output from Q1 clocked the second half. By connecting the $\overline{Q}$ outputs to their respective Data Inputs the flip-flop action was ensured by Q2 going high as the second data entry is made. The set and reset pins are connected so that on acceptance of the input by the computer the correct conditions are forced onto both Q1 and Q2. So that the user would know which digit he was supposed to enter next, a couple of l.e.d.'s were included as shown in Fig. 3. When D1 is illuminated it means that the first digit is to be entered, when it is, D2 turns on as well. When both digits have been entered the two l.e.d.'s are extinguished until the byte is accepted by the micro. Suitable legends were placed near these l.e.d.'s to indicate the action required.

## YOUR GOOD ELF

At this point a little digression about the Elf itself might be worthwhile. It is based on that excellent, though often maligned, microprocessor the RCA 1802. This is a 40-pin CMOS device with 91 easy to use (and understand) instructions. Being CMOS it is not too concerned about exact voltage levels, has a very low current consumption and high noise immunity. The actual clock frequency can be as high as 6·4MHz though the power dissipation rises with clock frequency, it will also operate down to d.c. levels as well. Interfacing to other RCA COSMAC products is simple and being CMOS it works well with i.c.'s from the 4000 range, you do not need expensive low power TTL items. There is an interrupt line, four flag lines, a toggle output and after decoding, 14 unique input/output commands. Combine these with the 16, 2 byte wide, internal registers which can be used for program pointers, memory pointers or storage and you have an ideal micro for both the home experimenter and commercial applications. The Elf II consists of a mother board containing the 1802, 256 bytes of RAM, a keyboard and control switches together with all the necessary decoding circuitry, a 2 digit l.e.d. display, crystal clock together with a video chip which can be used to give a TV output. Sockets allow various daughter boards to be plugged in and the most useful of these is the so called Giant Board

**Fig. 2. Block diagram of the 74C922 decoder i.c.**



which has a ROM monitor, cassette interface, provision for RS232C interface, an 8 bit parallel input port, an 8 bit parallel output port, decoding of the 14 input/output lines as well as address decoding for additional memory up to 64K. The other sockets accept 4K RAM boards etc. Thus one can easily build up a microcomputer which will readily interface with the real world. Tiny and extended BASIC are also available but in this particular application machine code was used.

To connect the remote keyboard to the Elf the following procedure was used though obviously there is no need to use the actual flag or input lines indicated since others serve the same purpose. For other microprocessors the system can be adapted to utilise the facilities they have. The Byte Ready signal from the 4013 was inverted using a 4011 and connected to the EF3 flag line. These flags are software monitored and when the appropriate signal is present a branch can be initiated. The interrupt line could also have been used and would have given a slightly faster response. The byte itself is read by sending a pulse originating from the 6D input instruction to the remote keyboard circuitry. This Read signal not only enables both the 4066 (IC3) and IC1, although this needs an inverted signal, hence the use of IC5, but also resets the flip-flop (IC4). Thus the input from the keyboard is entered into the computer and can cause a branch to a particular routine. It is helpful to repeat the byte entered on a display at the keyboard so that the user can see what has actually been accepted; not only does this allow any keying mistakes to be corrected but also serves as a reminder as to which routine is currently running. The additional circuitry for this is given in Fig. 4. Note that the driver i.c.'s for the two l.e.d. displays must be capable of decoding the full four line BCD into hexadecimal format—figures 0 to 9 and letters A to F. The 9368, a t.t.l. device, will do this. Some only decode the numerical portion whilst others give a different character set, for example H,E,L,P.

**Example of entry program for the Remote Keyboard using the ELF**

| | | |
|---|---|---|
| 00 | 90 | Initialisation |
| 01 | B3 | |
| 02 | F8 | |
| 03 | A0 | |
| 04 | A3 | |
| 05 | E3 | |
| 06 | 3E | Short branch if EF3=0 |
| 07 | 06 | |
| 08 | 6D | Input—enable/reset line goes high |
| 09 | 64 | Echo input to display on Elf motherboard* |
| 0A | 30 | Branch back |
| 0B | 06 | |

* May not be required.

## LOCATION

Whilst this is called a remote keyboard the actual decoding circuit must be as close as possible to the microcomputer itself to minimise the length of the bus lines joining them. Shielded multicore cable can be used for interconnections to the keypad and displays, though ribbon cable is equally suitable.

When the six digit security number is being entered the user needs to be reminded which pair of digits are currently being entered. Again l.e.d.'s can be used with suitable labels and, with the other l.e.d.'s already provided for individual digit entry, makes the use of driver i.c. worthwhile. A suitable one is the UL2004 which incorporates an internal resistor allowing direct interface with CMOS circuits. These 3 l.e.d.'s

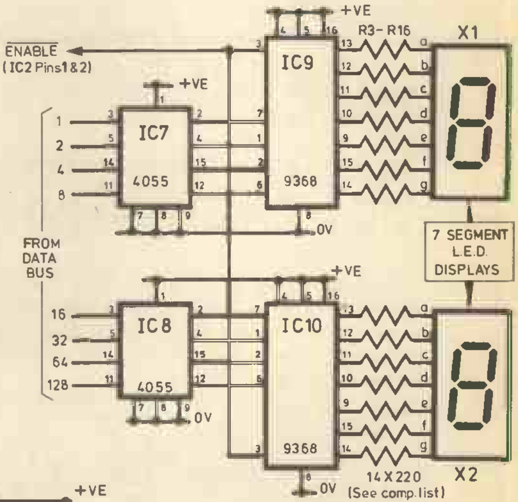



**Fig. 4. Additional circuitry for 7-segment display**

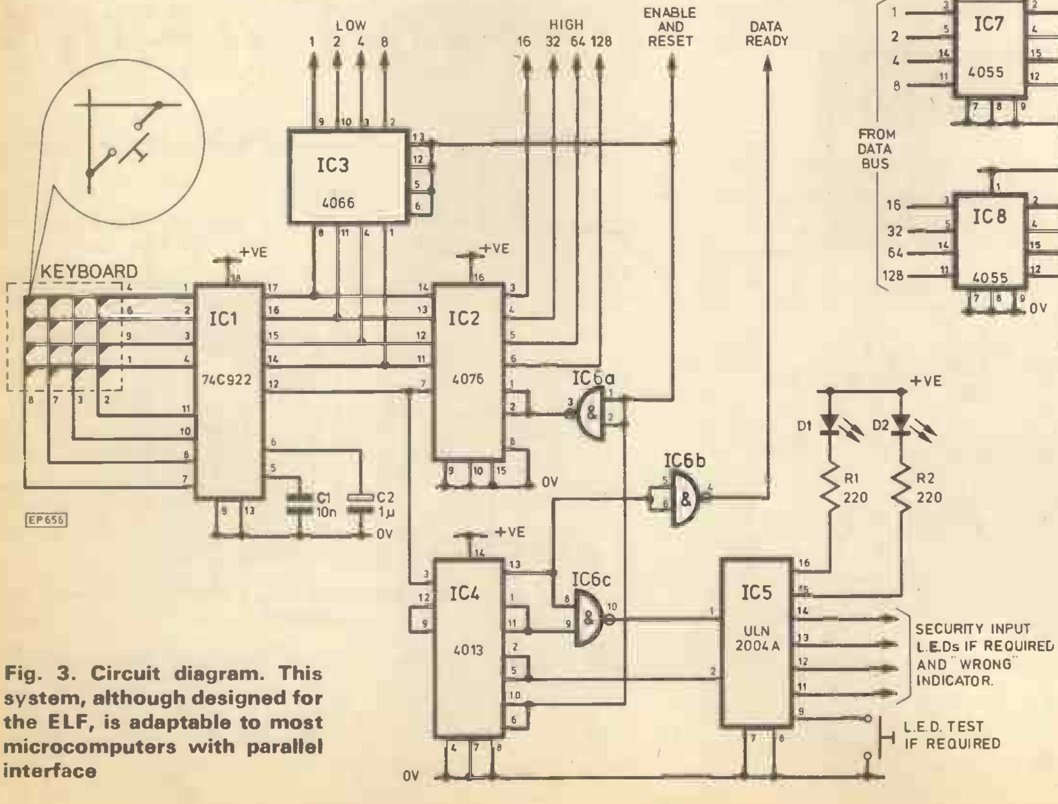



**Fig. 3. Circuit diagram. This system, although designed for the ELF, is adaptable to most microcomputers with parallel interface**

**NOTE**

The prototype was wire-wrapped on stripboard to suit space and other constraints. Since layout is not critical, no drawing is given because construction will largely be a matter of conforming to application requirements.

| SWITCH POSITION | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Y1,X1 | Y1,X2 | Y1,X3 | Y1,X4 | Y2,X1 | Y2,X2 | Y2,X3 | Y2,X4 | Y3,X1 | Y3,X2 | Y3,X3 | Y3,X4 | Y4,X1 | Y4,X2 | Y4,X3 | Y4,X4 |
| DATA OUT A | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| B | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 |
| C | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| D | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

**Table 1. Truth table for keyboard decode**

should be under software control using three of the bits available from the 8 bit parallel output port on the Elf's Giant Board. As each pair of digits is entered it is checked but not repeated in the display and the program ensures that all 6 digits are entered before any indication that the number is wrong is given. Thus a person could not obtain the code by looking over the user's shoulder nor is any indication given as to which pair of digits is incorrect thus increasing the security aspect. If necessary another l.e.d. could be used to show a wrong sign and this could be derived from a spare bit on the output port. Software counts the number of attempts made and also the time taken. If either exceeds a preset number the computer refuses to accept any more security entries and would only respond to the two digit routine entries, one of which would override the block on security numbers.

Other remote keyboards could also be added, say, at the front and back doors, in the kitchen should any household functions need controlling etc., thus ensuring that what started out as an expensive toy actually does earn its keep. At the same time you will be one of the few people who have entered the silicon age with a micro that does practical tasks and can understand the instructions of dumb humans. ★

## COMPONENTS . . .

**Resistors**
All resistors for a 5 volt supply are 220/270 ohms

**Capacitors**

| | |
|---|---|
| C1 | 10n poly or disc |
| C2 | 1µ tant. |

**Integrated Circuits**

| | |
|---|---|
| IC1 | 74C922 |
| IC2 | 4076 |
| IC3 | 4066 |
| IC4 | 4013 |
| IC5 | ULN2004A |
| IC6 | 4011 |
| IC7, IC8 | 4055 (2 off) |
| IC9, IC10 | 9368 (2 off) |

**Diodes**

| | |
|---|---|
| D1–D6 | red |
| Displays | red (check segment connections before use) |

**Keyboard**

16 key matrix type

# SPEECH RECOGNITION SYSTEM OR HOW KATRINA GOT BIG EARS

## BY ANTHONY YOUNG

THE advertisement announced BIG EARS in bold capital letters making me wonder if this was a joke from Toy Town; however, a quick scan of the text showed that this was another product from William Stuart Systems. As I already own an audio oscilloscope and a colour graphics system from the same stable I felt confident that my £45 + VAT was not going to buy a toy. I confess to being somewhat relieved that when I unpacked my parcel less than a week later the name Big Ears was not on the brushed aluminium front but in its place an impressive "Speech Recognition System Interface SR1."

Big Ears or SR1 can be connected to any personal computer like NASCOM, TRS 80, PET, UK101, Superboard or to any other via a spare user input port. In my case, an 8K UK101, hooking up couldn't have been much simpler with just five connections to be made. Five core ribbon cable and standard 5 pin DIN plug are provided so plugging in the SR1 is quite straightforward. Power requirements are low so the +5 volts needed comes from the motherboard via the ribbon cable. All this is explained in a very clear User Manual containing Connection Details, Software Loading Instructions, User Instructions, Demonstration Software, Theory of Operation and BASIC Software Listings. A small part of the software is written in machine code and is provided in a form to suit the most popular 6502 or Z80 based systems.

The purpose of the SR1, if you hadn't guessed, is to provide speech input to your computer and open the door to direct man-machine communication. For anyone who has formed a close interpersonal love affair with their computer (yes Ursula Katrina 101 is a person) then giving her Big Ears could well extend a beautiful relationship. To be more exact it is more like one Big Ear in that her ear comes in the form of an electret condenser microphone plugged into the smart aluminium facia of a black metal case 15cm × 12cm × 5cm using a standard jack plug. Relationships can blossom in that with a speech recognition system it's conceivable that one's computer could be verbally commanded to execute various options in robot control, games programs, etc. Captain Kirk could command "Fire" to zap the Klingons or a remote controlled vehicle could be requested to move "Forward", "Back", "Left" or "Right". It is even conceivable that I could flirt with Ursula Katrina via an interactional conversation program in which she would only have learned (and thus understood) my voiceprint; such faithfulness!

The minimum amount of memory required by the SR1 is 5K but since machine code real-time input routines are loaded into the top of user memory the last one K must be located in the 8th K sockets leaving the 5th, 6th and 7th sockets empty in the UK 101/Superboard. However, now that 2114 Rams aren't so expensive one might as well upgrade to 8K unless funds are very tight. 8K will allow a larger vocabulary to be stored.

The demonstration software (BASIC) is very interesting providing correlation tables for the words learnt and a 5 × 6 two-dimensional array of numbers as the individual word's "voiceprint". During the learning stage the computer asks for the word to be spelled and then spoken. The spoken word should be repeated 4 to 8 times to achieve optimum recognition and the voiceprint is printed each time. It is naturally important to speak clearly and consistently. Having taught the computer a number of words it is then possible to test its recognition. It can have problems understanding the difference between Fine, Pine and Wine but less problems distinguishing between Apples, Pears and Raspberries. The computer compares the voice it hears with its averaged memory voiceprints and perceives you to have said the word which has the highest correlation. It signals its understanding by printing "You said Raspberries" or whatever. Both the correlation table and voiceprint printout can be deleted by removing lines and the computer's response can be tailored to individual needs.

The computer's voice perception is based on frequency analysis of the first and second formants of the speech waveform. The interface unit SR1 separates the formants and delivers digital values to the computer which then performs frequency analysis for each of sixty-four 16ms sampling periods. This is implemented in machine code. For each period the two formant counts are then compared against threshold data values to determine which frequency ranges are present. The two range indices are then used to determine which location in a two-dimensional array will be incremented. Thus the sixty-four 16ms samples must all fit in this two-dimensional histogram forming a kind of "frequency-space". To learn a word four or more such histograms are averaged and normalised to have a mean value of zero with a uniform standard deviation. The resulting averaged voiceprint-histogram is stored for future correlation.

If necessary the sensitivity of the SR1 can be adjusted by going inside the cabinet with a small screwdriver and adjusting a preset potentiometer; clockwise to increase and anti-clockwise to decrease. The systems software is listening for the first sound in order to start sampling but if the system is too sensitive it could be triggered by background noise. In noisy environments this adjustment is very useful as sensitivity can be set low and the speaker can speak up. Don't clear your voice or stutter because Ursula (or whoever) will be less than understanding about it. Moreover one should remember that with sixty-four samples of 16ms any phrase or word to be learnt should not last longer than about one second. This is quite okay in practice as long as one avoids Welsh railway station names.

If one wishes to use the SR1 in the application of data enquiry (which might need a large vocabulary) then the secret of success is to use key words to define which group of words the computer can expect you to be using next. In this way the computer need only compare the word it hears with a reasonably small group of words and the chance of misunderstandings is thus correspondingly reduced. Words which the computer might confuse can be located in different groups. Vocabulary, therefore, can grow like a tree. An example of this is a Travel Reservation System which might initially ask "Inland, European or Intercontinental?" Each of these headings might access 8 or 10 destinations with further destinations to be found by "Other" always being one of the options.

In conclusion Ursula Katrina's Big Ear might not be quite as perceptive as a human ear but then it's not such fun to nibble either. Notwithstanding that I'm still convinced that she's got the hot-heatsinks for me . . . "Love me Katrina?" . . . "I DO HONEY" . . . If only things could always be that easy.

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| 7912 | 12V | 60p |
| 100mA | | |
| 78L05 | 5V | 29p |
| 78L12 | 12V | 29p |
| 500mA | | |
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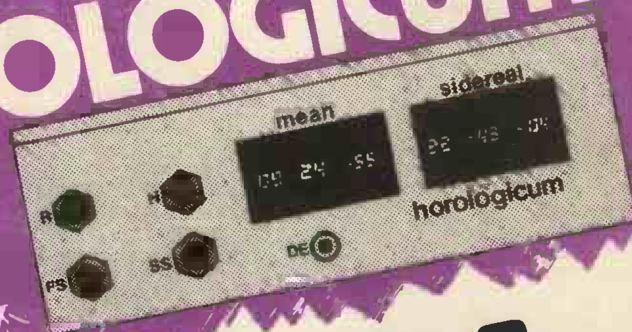



Knowledge of the celestial co-ordinates and Local Sidereal Time enables an astronomer to find any object in the sky. This article describes a portable "star clock" which indicates both GMT and Local Sidereal Time.

## *Also...* HEADPHONES WITH A DIFFERENCE

Use of normal stereo headphones gives rise to the "outside the head effect". This headphone amplifier provides some of the original sound perspective.

# PRACTICAL ELECTRONICS

OCTOBER ISSUE ON SALE FRIDAY SEPTEMBER 11th

# Analogue FREQUENCY METER

Andy Flind

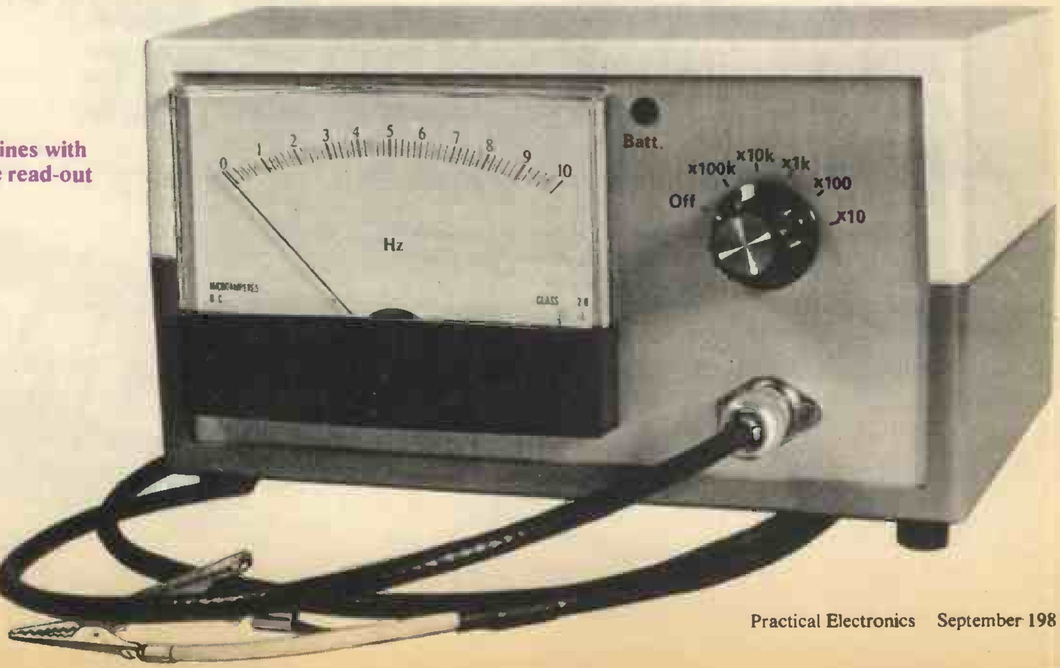
A FREQUENCY meter is a most useful item of equipment for the experimenter's workshop, but hitherto the choice of design for amateur constructors has been somewhat limited. Broadly speaking, there are two normal approaches to the problem; digital, in which cycles are counted over a fixed period and digitally displayed, and analogue where a pulse of fixed width is generated by each cycle and the pulses fed directly into a meter. The digital method is very accurate but is also complex and expensive; too much so for many would-be constructors. The analogue approach is far simpler and cheaper, but in general cannot measure frequencies much beyond 100KHz, and the accuracy, particularly at the higher end of this range, is usually so poor that it cannot be considered as much more than a toy.

**HYBRID APPROACH**

By combining these two techniques, a hybrid instrument can be built which falls nicely between the two above types in terms of accuracy, cost and complexity. The approach chosen for this project was to build a basic analogue with a fixed range of 0 to 100Hz, since at this low frequency calibration is simple and excellent accurancy can be obtained, and then extra ranges were added by prescaling with cheap C-MOS decade divider stages. Fig. 1 shows a block diagram of the instrument. The input signal is amplified and squared to make it suitable for driving digital circuitry, and it is then fed to four divide-by-ten stages. Each CMOS chip contains two such divider stages and costs less than one pound, so that the cost of providing extra ranges in this way is very reasonable indeed. The actual degree of division required is selected by a switch and the signal then passes to a monostable generating a fixed-width pulse for each cycle fed to it. These pulses could be mechanically integrated by feeding directly into the meter, but the linearity is improved and meter flicker at low frequency reduced by the use of a further integrator circuit. A voltage regulator provides a constant supply voltage to maintain accuracy as the battery gradually deteriorates. It was intended originally to attempt to obtain an accuracy of 2% from this project; however, on test against a digital instrument it has proved better than 1% over most of its range, which is probably more than sufficient for most experimenters. The maximum frequency that can be measured with the top range is 1MHz.

The complete circuit diagram appears in Fig. 2. The power supply is similar to that used in *PE Magnum* metal detector projector, the main differences being the use of a 1458C dual op-amp, and the addition of an l.e.d. to indicate battery failure. The bias current required by TR2 in this circuit is normally too small to light an l.e.d., but when the supply voltage drops too far the bias circuitry saturates in an attempt to correct the output and the bias current jumps to about 10mA—just right for lighting the lamp. This semi-discrete circuit was used in preference to a three-terminal i.c. regulator, as firstly it delivers a symmetrically split output, ideal for op-amp circuitry, and secondly, it will function until its input is only a fraction of a volt above the required output, very useful where the current is supplied by batteries. Most i.c. regulators need a differential of at least two volts to operate.

The input signal is amplified and shaped by IC2, R7 and R8 provide positive feedback so that the output of this stage is never linear but switches rapidly from rail to rail. It will handle any input waveform. The minimum input that will operate it is about 200mV; at about 600mV protection diodes D1 and D2 start to conduct and clamp the level fed to IC2, so the maximum input voltage that can be applied is about 200V peak-to-peak, after which R6 would start to overheat. In practice, a maximum input of 50V is suggested.




**Digital accuracy combines with quantitative analogue read-out**

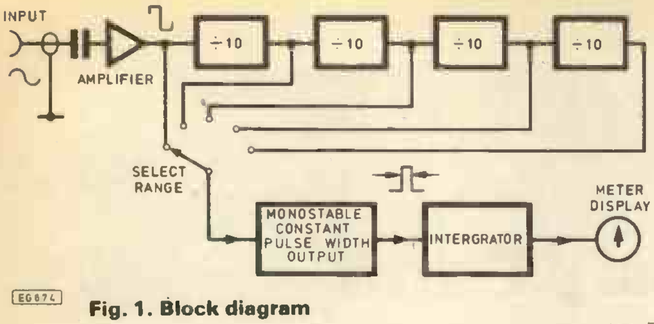
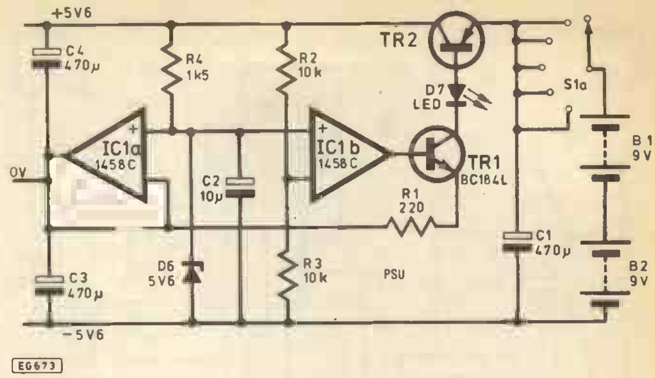



**Fig. 1. Block diagram**



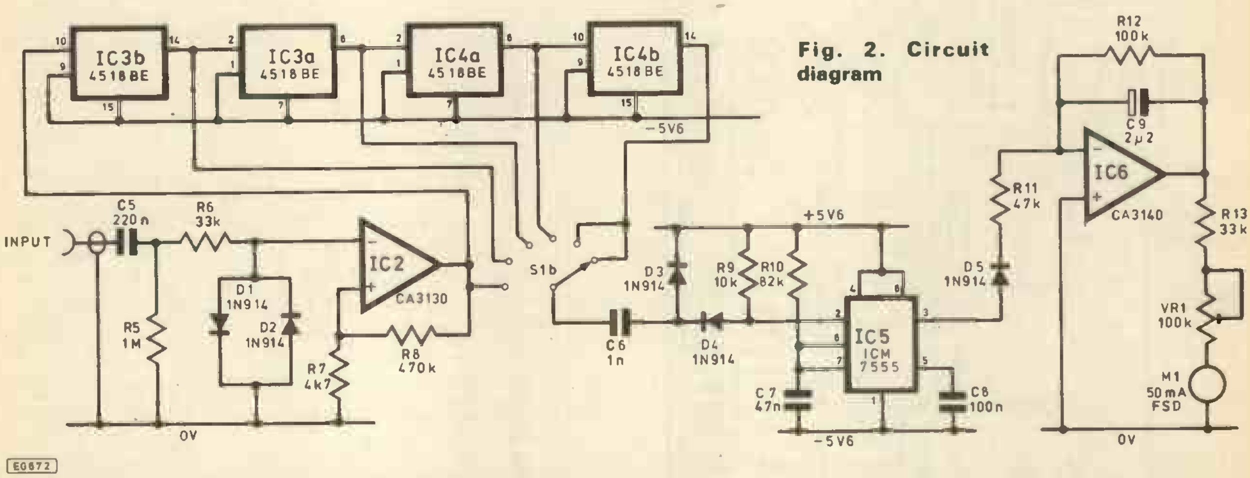




**Fig. 2. Circuit diagram**

On test, this input circuit has been found reliable to beyond 1·2MHz. Two C-MOS 4518 dual decade dividers are ripple-cascaded to give four stages of division by ten, providing the instrument with a total of five ranges. The required output is selected by S1b. Capacitor C6, D3 and D4, and R9 differentiate the signal to provide short negative spikes for triggering the monostable timer IC5. If the input frequency is too high for the range selected, the period of the input signal to the timer may be shorter than the timer's output period, and in this condition the timer will trigger on multiples of the input cycles. To prevent false readings due to this, the timer period must be less than half the shortest input period expected, so that for any excessive input frequency the meter will simply read f.s.d. plus. The period of a frequency of 100Hz is 10mS, so R10 and C7 have been chosen to give a timer output about 4mS.

IC6 is essentially an integrator with a discharge resistor R12 across its capacitor. The inverting input will be maintained at 0V, so each timer pulse dumps a fixed *packet* of current through R11 into C9, regardless of the output voltage. This output voltage will, of course, alter until the current out through R12 balances the net current coming in through R11. VR1 and R13 were selected to provide a suitable f.s.d. point on a 50μA meter since this is readily available. Other meters may be used if the values of these two resistors are suitably altered. The use of an integrator confers two advantages; firstly the linearity of the output is improved, and secondly there is less needle flicker on the meter. In fact, the flicker is not apparent at all above 5% of meter scale.

## CONSTRUCTION

All the electronic components for this project are mounted on a single p.c.b. It is suggested that this board is constructed in stages, testing at each step so that any problems can be easily traced and dealt with as they arise. Start by fitting the five wire links on the board, followed by the power supply components R1, 2, 3, and 4, C1, 2, 3, and 4, ZD1, TR1 and 2, and IC1. Temporarily connect the l.e.d. and connect up the battery supply, preferably through a 100 Ohm resistor, which will limit the current somewhat if a fault is present. Check that the output voltages are correct. The l.e.d. will not light unless the supply voltage falls to around the 11V2 total output voltage. If there is no output, first check that l.e.d. and Zener polarities are correct.

Continue the construction with the input stage; R5, 6, 7, and 8, C5 and 10, D1, D2 and IC2. Apply power and an a.c. input of around half a volt. In many cases the house wiring induces a.c. and a wet finger will do. Then check the output from IC2 pin 6. This will appear on the link just above the i.c. and can be monitored with an oscilloscope, or heard as a loud buzz on an earphone (use a d.c. blocking capacitor). If it doesn't work, check R7 and R8 first, its easy to confuse the colours on these resistor values. Now go to the other end of the circuit and construct the integrator, with R11, 12 and 13, VR1, C9 and 12 and IC6. Temporarily connect the meter and supply, and check that the meter goes to zero. If you place one wet finger on the top end of R11 and another on a +5V6 point (positive end of C4) you should get a reading on the meter. If this works, fit the timer components R9 and 10, C6, 7, and 8, D3, 4 and 5 and IC5. Attach all the wires for the range selector switch and connect the two most right-hand ones together. Inject a 50Hz input using a few volts from a mains transformer. The meter should read, and VR1 can now be used to set it to mid-scale. This is the only calibration adjustment required for this project! If all seems correct, complete the board with C12 and the two divider chips, observing the usual C-MOS handling precautions. Use sockets for these two if you prefer, although on the prototype they were soldered directly to the board. The other ranges can be checked by shorting each switch lead in turn

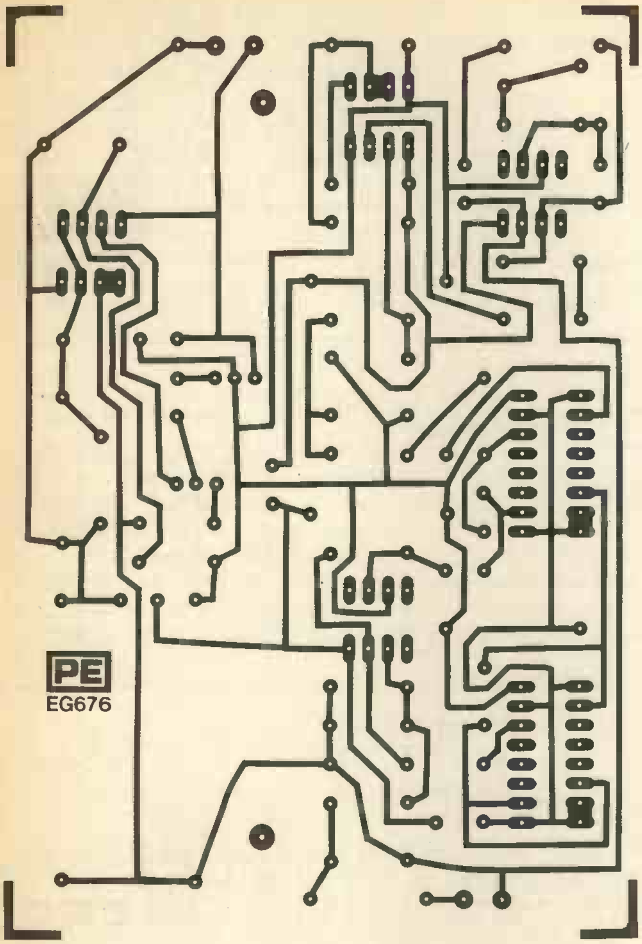



Fig. 3. Printed circuit

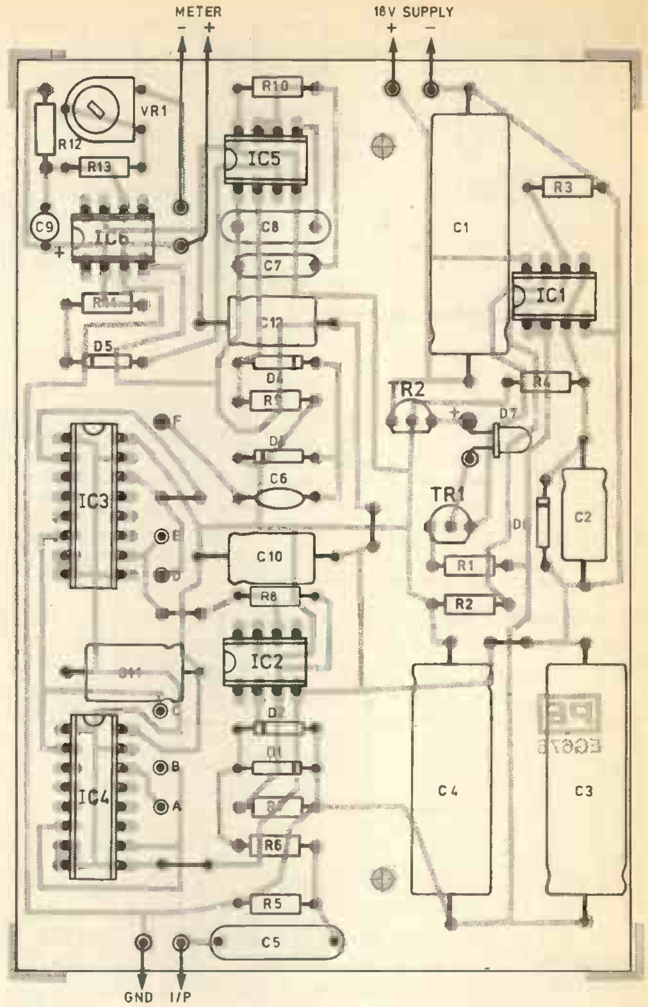



Fig. 4. Component layout

## COMPONENTS . . .

### Resistors

| | |
|---|---|
| R1 | 220 |
| R2, 3, 9 | 10k (3 off) |
| R4 | 1k5 |
| R5 | 1M |
| R6, 13 | 33k (2 off) |
| R7 | 4k7 |
| R8 | 470k |
| R10 | 82k |
| R11 | 47k |
| R12 | 100k |

### Potentiometers

| | |
|---|---|
| VR1 | 100k sub-min hor. preset |

### Capacitors

| | |
|---|---|
| C1, 3, 4 | 470μ 25V electrolytic (3 off) |
| C2 | 10μ 25V electrolytic |
| C5 | 220n polyester |
| C6 | 1n ceramic plate |
| C7 | 47n polyester |
| C8 | 100n polyester |
| C9 | 2μ2 25V tant. bead |
| C10, 11, 12 | 1μ 63V electrolytic (3 off) |

### Transistors & Diodes

| | |
|---|---|
| TR1 | BC184L |
| TR2 | BC214L |
| D1, 2, 3, 4, 5 | 1N914 |
| D6 | BZY88C5V6 5V6 400mW Zener |
| D7 | TIL 209 red. |

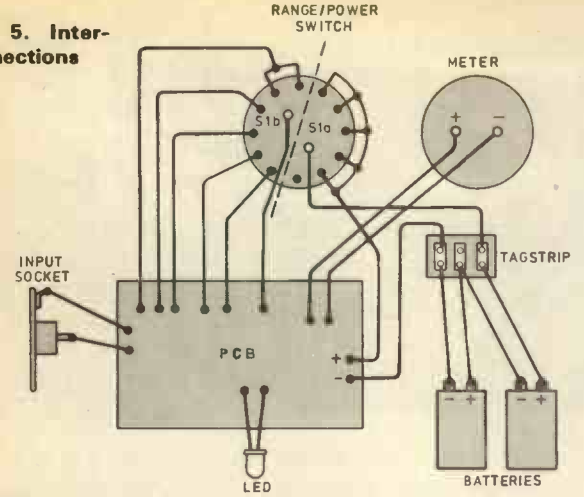
### Integrated Circuits

| | |
|---|---|
| IC1 | 1458C |
| IC2 | CA3130 |
| IC3, 4 | C-MOS 4518BE |
| IC5 | ICM7555 |
| IC6 | CA3140 |

### Miscellaneous

P.c.b.
Switch S1, 2 pole 6 way
Meter, 0–50μA FSD
Case, Verobox, Vero part no. 202-21036G,205 × 140 × 110mm
Coax socket
Tagstrip
Control knob
2 × PP3 battery clips

Fig. 5. Interconnections




EG675

to the lead furthest to the right (the timer input), and applying an appropriate input signal. Aternatively, they can be functionally checked with a 50Hz input, as the meter needle will give a small kick for each timer pulse on any range. Note that on the top range, however, a 50Hz input will only give one kick every 200 seconds. If these ranges are working at all, though, they are automatically as accurate as the basic 100Hz range.

The board is designed to mount directly into the specified Verobox using two of the self-tapping screws provided. An "L" shaped aluminium bracket is fitted to the other end of the box with the other two self-tappers, and this holds the batteries firmly against the box side. The total drain of the circuit is only about 12mA so a pair of PP3 batteries is a perfectly adequate source of power. The meter is the large four-inch scale 50µA unit available from Maplin, chosen for its large clear scale, and also because this scale has 100 divisions. A little careful work on the scale plate with typing error ink and a letter transfer sheet provided the appropriate markings. The meter, switch, l.e.d. and input socket are all mounted on one of the aluminium panels, and interconnected as shown in Fig. 5. A small piece of tagstrip is used to make the necessary connections between the battery leads. A final check and adjustment of the calibration of the lowest range should be carried out when construction is complete.

The prototype instrument has proved very accurate and useful, and is extremely simple to use. The total construction cost is somewhere around £20, but of this a very large proportion is accounted for by the case and meter. If preferred, the board could be housed in an alternative, cheaper case and used in conjunction with the workshop test meter, providing accurate measurement of frequency at even lower cost. ☆

# PATENTS REVIEW...

**Copies of Patents can be obtained from:**
**the Patent Office Sales, St. Mary Cray, Orpington, Kent. Price £1·45 each.**

## IMPROVED PA

The Marconi Company of Chelmsford, Essex, has a British patent (BP 1 586 441) on a public address system which automatically tailors the reproduced sound level to the ambient noise. All too many PA systems are inaudible or unintelligible and this is largely due to incorrect sound level setting; they either distort or get lost in the background noise. Manual control is possible but cannot cope with rapid fluctuations in noise level; it is also labour intensive.

The Marconi idea relies on the well-known phenomenon whereby a moving coil loudspeaker can be used "in reverse" as a microphone. This phenomenon is already relied on in areas of strict security where there is a PA system installed. The PA system is switched into the microphone mode whenever it is not in use. An attempt to bomb one of Britain's largest cruise liners was foiled through the use of just such a system.

Fig 1.

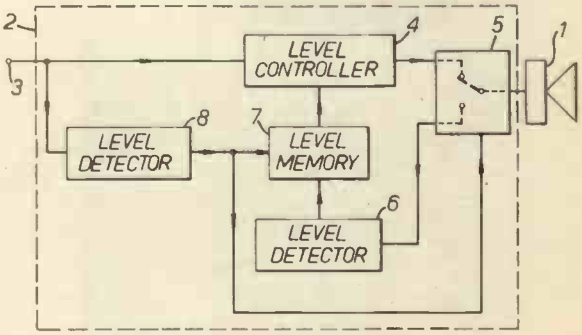



Figure 1 shows the basic Marconi layout. At a reproduction setting of switch 5, the loudspeaker 1 reproduces an audio signal from input 3. The signal is passed through a gain level controller 4. The switch 5 is held in the reproduction position whenever level detector 8 senses the presence of an audio signal at 3. When this signal disappears, or falls below a pre-determined threshold level, switch 5 changes state so that the loudspeaker 1 functions as a microphone and feeds a signal representative of the ambient background noise level to level detector 6. This detector provides a control signal which is stored at 7. When the switch 5 changes back to the reproduction state the level memory 7 sets the gain of level controller 4 to a value which is appropriate for audible reproduction of the PA message through loudspeaker 1. The output of detector 8 also feeds memory store 7 to provide an update on the level of signal to be reproduced.

By correlation of the inputs to memory 7, the speaker 1 will produce audible announcements irrespective of the input level at 3 and the background noise in the vicinity of the loudspeaker.

# THE Electronic Car

When the implications of the 1970's fuel crisis finally sank home, the future for private motorised transport looked bleak. But the new decade has arrived and although the motor industry is in recession, it is facing the challenge of fuel economy legislation with a powerful new ally—micro-electronics. Instead of gloomy predictions that we would be driving around in converted milk floats (mass produced in Hong Kong), we have retained the comfort and performance levels and reduced fuel consumption.

This level of improvement has been achieved mostly by refining the mechanical design of petrol engines close to its theoretical efficiency limits. Further improvements will be more difficult and this is where the microprocessor comes in.

## ENGINE CONTROL

The immediate answer to improve engine efficiency was mechanically controlled fuel injection, which had been developed to a sufficient degree in motor racing. In today's commercial environment of spiralling labour and raw material costs, hydraulic and mechanical controls are becoming more expensive to manufacture while microprocessors and associated electronics are becoming cheaper and more sophisticated.

Whilst a mechanical system cannot monitor any more than two input variables (say speed and load), without a drastic increase in complexity and bulk, a microprocessor can handle virtually all the information that the system generates. These can be engine and ambient temperatures, barometric and boost pressures, fuel variations and even instantaneous conditions in the combustion chambers and exhaust system. Additionally, the inherent flexibility of the microprocessor as a programmable device allows it to predict trends in ongoing conditions, such as rising engine temperature, and optimize efficiency at all moments in time. This compares with the somewhat crude correction of an unintelligent mechanical controller which is also subject to error through wear (and rust?).

Bosch, the West German automotive components group, have had in production since 1979 just such a system, called "Motronics" (Fig. 1) which is in use in certain up-market cars such as Porsche and BMW. The system controls spark ignition as well as fuel injection, exact settings are calculated from available data sampled 400 times a second. These settings are calculated using data stored in a fixed memory (ROM), which customises the module to the engine's performance characteristics, hence the system can be easily adapted for use with any petrol engine.

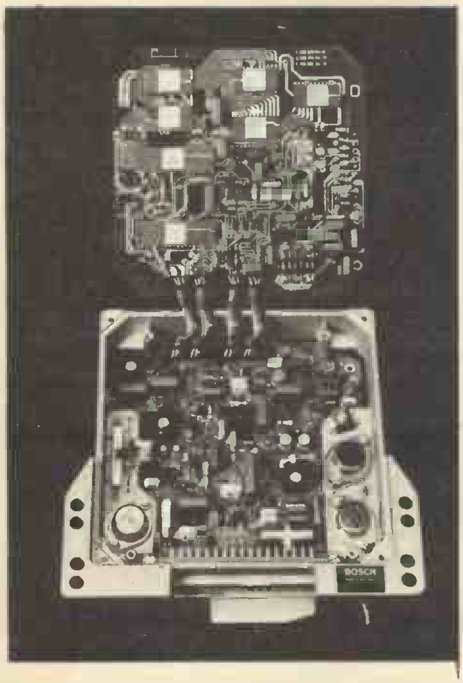
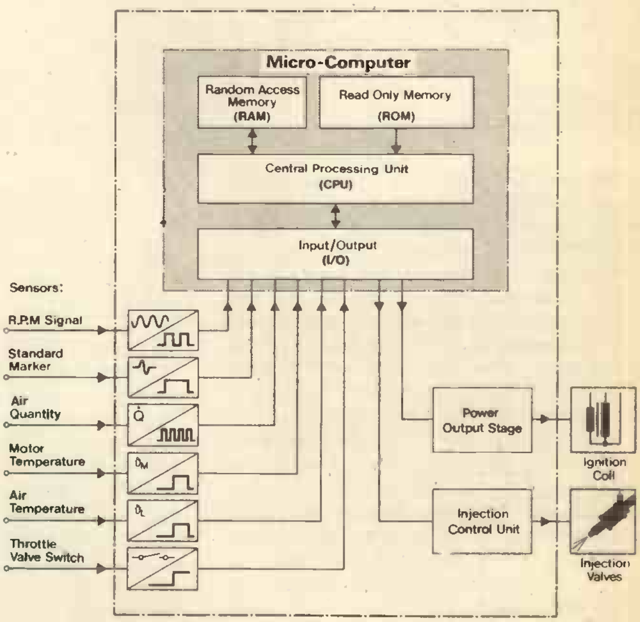
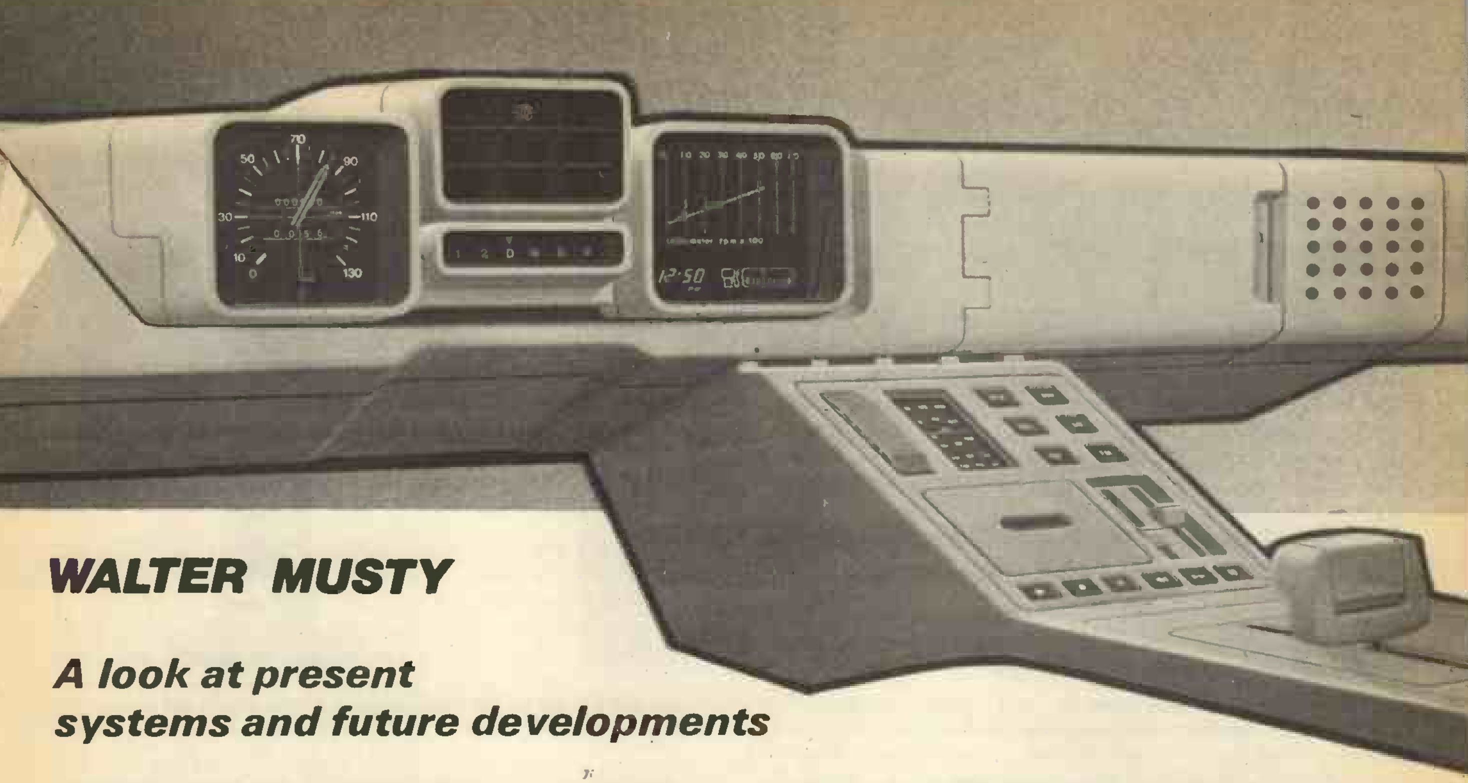



**Fig. 1. (a) View of the Bosch "Motronic" electronic control unit.**



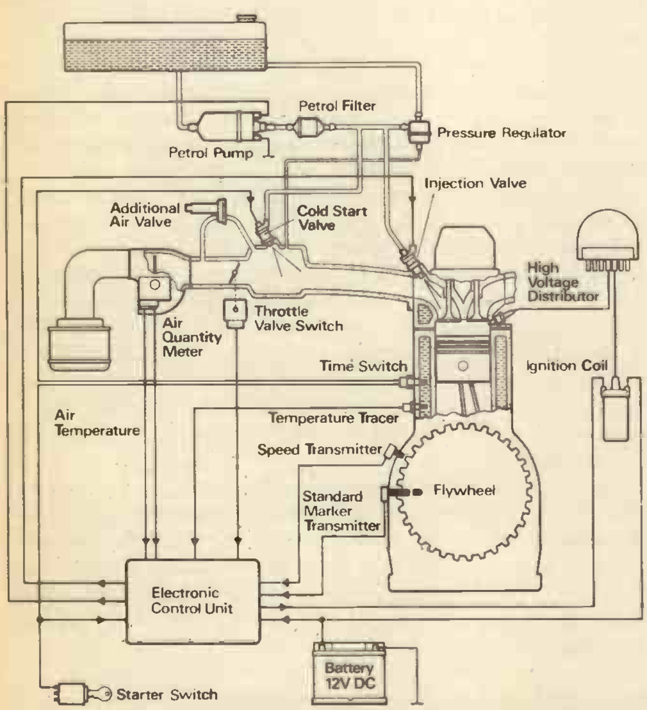

**(b) Simplified block diagram of the Motronic control unit. (Courtesy: Robert Bosch Ltd.)**



# WALTER MUSTY

## A look at present systems and future developments

From its memory, the computer, with some processing, can output 4096 near ideal ignition dwell-angle settings for a particular load/speed situation. These are corrected with respect to ambient conditions such as air and engine temperature and atmospheric pressure. The same applies to fuel injection control with added functions such as fuel cut-off on the overrun (i.e. when you take your foot off the throttle), this alone gives a 5 per cent increase in economy. The system's efficiency is particularly pronounced in the case of engines which have a high compression ratio and run on lean mixtures of un-leaded petrol.




**(c) Diagram of the Motronic control system as used on cars such as Porsche or BMW. (Courtesy: Robert Bosch Ltd.)**

So while present claims for fuel savings are in the range of 5 to 20 per cent (dependent on the driving conditions), the system has the potential to adapt to and improve the coming generation of "clean" economy engines.

Although the microcomputer was designed around a standard microprocessor and memory chips, these and the other electronic components in the Motronic system have been selected to satisfy extreme environmental conditions. Whereas the normal operating range for commercial electronics is 0 degrees C to +70 degrees C, Bosch designers have allowed for a −40 degrees C to +130 degrees C temperature range. Mechanical impact up to 100 times the acceleration due to gravity is taken in its stride.

### ELECTRICAL SYSTEM CONTROL

Apart from improving efficiency and performance, manufacturers are looking to electronics to rationalize and hence to reduce manufacturing costs of existing electrical systems in the car. The electrical wiring harness, which distributes power and controls accessories, is bulky, expensive and labour intensive to actually fit into the car during production. In use, it is also a major factor in unreliability of the car as a whole. The system planned for the future electronic car is a single power ring running around the body tapped into by solid state power switches. These will be controlled by a series digital data line.

Data transmissions are handled by a microprocessor which also interfaces with the driver's control panel. Each switch on the panel has a specific digital code which is matched to a unit on the control line. If, for instance, the rear window demister is selected, the microprocessor senses the switch closure and sends a digitally coded message down the line. Although all the units connected receive the data, only the rear window module responds to the unique code and latches its associated switch to energize the window heater element.

The module itself will be a general purpose one with several power switches, so it can be used throughout the car and control different functions which are physically grouped together. For example, the rear lamp cluster, which normally comprises driving, brake, reversing, fog and turn indicator lamps, would normally need 6 wires runnning the length of the car. In the digital system, the control module is built into the lamp cluster, with the power ring and data control line connected to it.

When fully developed, the module electronics could well be a


**Practical application of "ALI" driver guidance system, currently tested in the Ruhr area of West Germany. The display panel supplies the following information: distance to nearest petrol station; distance to nearest telephone; road hazard warnings and route directions**

simple microprocessor with integral memory, a single integrated circuit which in quantity costs less than £5 at today's prices. Such a system can be further developed to be self monitoring, i.e. when a lamp is powered up the module senses this and sends a status message back to the microprocessor which gives the driver a direct panel indication.

The data message line will probably be a fibre optic cable, which transmits the codes in bursts of visible light rather than electric current. Optoelectronic sensors will replace traditional ones, such as mechanical micro switches, and will impart high reliability to more sophisticated sensing applications such as fuel/air flow and rotational speed.

## ELECTRONIC DRIVER AIDS

A microprocessor makes an ideal system monitoring unit as the application requires a scan of a large number of subsystems such as fuel tank, oil pressure, engine temperature. These can be displayed continuously or only when they reach a critical value (with audible warning), the relationship between various parameters can be processed to give the driver better information without distracting him from the task of actually driving the car!

Up to now emphasis (especially in the USA) has been on fuel consumption and digital displays with GM's Tripmaster, the Ford Miles To Empty display and the Chrysler Tripcomputer. The nearest to a fully integrated electronic dashboard is Aston Martin's Lagonda, which utilizes l.e.d. technology but has no computer. AM's design department has developed an l.c.d. panel for their 200mph Bulldog, but are reluctant to introduce electronics in any other areas of their cars as the microprocessor in the first Lagonda had reliability problems.

In Europe, one of the most active companies in this field are BMW, whose top models boast an impressive range of electronics headed by the already mentioned fuel injection–ignition system designed by Bosch.

BMW's Check Control System is an on-board computer which supplements existing analogue instruments. The control panel has 12 calculator-type push-buttons and a four-digit illuminated display, each button doubles as a data entry or command function. Normally, the unit displays time but on command will display: outside temperature (with buzzer warning when below freezing point—for warning against black ice), average speeds (with preset speed limit buzzer warning), estimated time to arrival, distance to destination, instant and average fuel consumption, and miles to empty. Additional interesting functions are digital code entry for ignition immobilization (as in cash dispensers), stop-watch function for checking acceleration, and programmable timer which can actuate the car heater before the driver actually gets in.

There are many possibilities for electronic driver comforts, a his/hers electronic seat adjustment memory is perhaps the ultimate in electronic extravagance. Perhaps the most effective driver aid is the incredible ALI system from Blaupunkt of Germany. ALI is an abbreviation in German for car driver leading and information system. The system consists of a relatively simple transmitter-receiver unit in the boot of the car, and a liquid crystal display and graphic display module with calculator push-buttons.

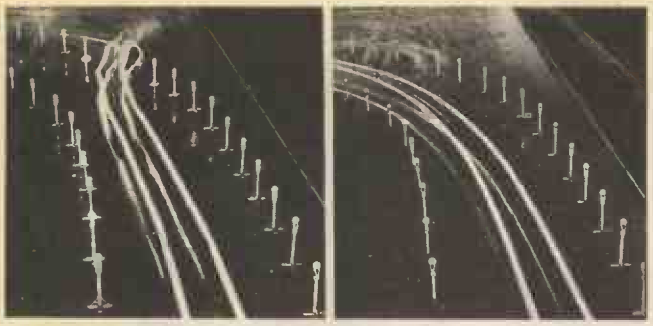
The roads contain aerial loops which communicate with the car's transceiver as it passes. Actual information handling is done partly in the roadside electronic control boxes, and these are all linked by cable to a large central computer which controls long-term traffic flow on the whole autobahn system.

At the moment, operation is limited to a pilot scheme covering 60 miles and 83 flyover intersections. The number of cars involved is about 400. In spite of the system's complexity, it is simple for the driver to use. The driver enters a map reference number for his destination and drives off. As the car approaches a junction, the unit gives a bleep and a simple diagram appears on its screen making it obvious whether to turn off or carry straight on. Should the driver make a mistake the unit will take this error into account and direct him to the next most direct route. If this is not worthwhile, then it indicates a U-turn at the next intersection.

The message exchanges are repeated three times to eliminate errors, the transfer takes about 20 milli-seconds which allows for cars travelling at speeds up to 155 mph. The cost of the car electronics is less than £100, but the pilot scheme has already cost £3 million. Nevertheless, the cost of converting the whole motorway system will still be only one per cent of the original construction costs.

## BRAKING

Perhaps the biggest contribution of electronics to car safety is the anti-lock braking system. One system, the ABS, has been developed jointly by BMW and Bosch. ABS consists of a



**This photo shows the benefits of the Bosch Anti-Skid Braking system (A.S.B.), which is the result of microchip technology. The situation is panic braking on a slippery road surface. Left: without A.S.B. Right: with A.S.B.**

microprocessor and a series of sensors that measure the rotational speed of each wheel. If any wheel begins to lock, a solenoid valve adjusts brake pressure on that wheel to keep maximum traction with the road. This means the car will stop in a straight line on almost any surface, in the minimum possible distance, even if the driver applies excessive pedal pressure. In practice, ABS reduces the stopping distance on a wet road at 70 mph from 150 yards to 90 yards—well worth the £800 BMW charge as an option.

For $6000 the infra-red goggles developed and marketed by CCS, Communication Control of New York, seem slightly worse value for money, but come in handy should the headlamps fail in an unlit tunnel. CCS can also fit your car with remote ignition control, bomb sniffer and electronic surveillance transmitters, plus the usual bullet proof windows, machine guns and tear gas ducts, all suitable for local shopping trips! With annual revenues of $18 million, CCS seem to have carved a niche in this particular market sector, which consists mainly of extremely scared (and wealthy) industrialists or people with skeletons in their cupboards. The former Shah of Iran ordered a fully fitted Cadillac in 1979 for $250,000 but never collected it, forfeiting his $50,000 deposit.

With diagnostic computers in widespread use in garages, a logical progression will be to use the on-board computer to perform this task at the touch of a button. It can also give a readout of the state of serviceable items like brake pads, brake fluid and oil levels, using digital letter dashboard displays. A step in this direction has already been taken by Ford with their concept car Probe 1, the dashboard layout looking as if it may have been taken from the NASA space shuttle flight deck.

Before such a system can be fully implemented, low cost sensor technology must be further developed. Bosch seem to be the leader among car electronics firms with yet another innovative


**Trip Computer from Smiths Industries**

but impressive safety feature, electronic tyre pressure monitoring. The tyre pressures are monitored in a non-contacting manner using high frequency pressure switch and sensor units, when pressure falls below a preset level, the switch stops radiating pulses which after a delay cause audible and visual warnings to be actuated by the processing unit.

## COLLISION RADAR

Still in a state of early development, mobile radar is being tested in Germany with a view to helping drivers maintain correct distances between cars. The radar operating frequency is about 35 GHz. A microprocessor processes the input information and displays a correct driving speed for that particular distance. There are still quite a few problems to be overcome, for instance how to blank out spurious reflections on bends and interference from other cars working on the same frequencies.

Should the radar computer mistake an articulated lorry for a low-lying bridge, electronics still saves the day with Bosch's passive restraint control processor. It actually detects the onset of a collision and activates air bags to protect the car's occupants before death or injury; the system is claimed to positively distinguish a collision from normal driving!

**Futuristic instruments display including keyboard designed by Hugo G. Poole for Smiths Industries**

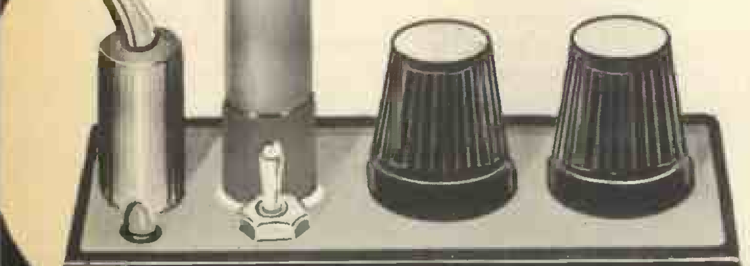
## THE FUTURE

When will the showrooms be flooded with these mobile amusement arcades? In the next few years we will see electronics slowly infiltrate the mass market cars just as Porsche and BMW are doing now. But it won't be until around the end of the decade before we have all-electronic computerized Cortinas available. Before then, the whole motor trade has to evolve sufficiently to cope with the service and back-up requirements of the built-in computer technology.

Labour rates for a skilled mechanic are around £12 per hour, how much will trained computer and electronic service engineers cost to the motorist? To employ such people will be unavoidable but the cost can be minimized by making the electronics in the car self-diagnostic to a large extent. This means faults will be traced as easily as they are in colour televisions, which match computers in complexity, but can be serviced at the customer's home by relatively unskilled technicians.

The design of the electronic car will have to be rationalized in a similar way with easily replaceable standard modules which if produced in large quantities can be made cheaply. The number of processors will be limited to say two, one for control and one for monitoring and diagnosis of the automotive parts and the electronics themselves. When a thorough service is necessary then the powerful garage diagnostic computers will be plugged into the car computer's diagnostic plug and will pin-point the fault. ★

# PE RANGER



## IMPORTANT

The Home Office 27MHz CB Specification (MPT 1320) carries the following as part of the Foreword.

The Wireless Telegraphy Act 1949 provides that no radio equipment may be installed or used except under the authority of a licence granted by the Secretary of State. All Citizens Band Radio equipment, whether hand held, mobile or base station, must be covered by a licence; it is a condition of this that the apparatus fulfils, and is maintained to, certain minimum technical standards.

The manufacturer, assembler, or importer of citizens band equipment is responsible for ensuring that the apparatus conforms with the specification; and any additional requirements imposed by regulations under the Wireless Telegraphy Act 1949. Conformity with the required standards may be established by tests carried out by the manufacturer, assembler or importer, or by a reputable test establishment acting on his behalf, but in either case conformity with the specification will remain the responsibility of the manufacturer, assembler or importer.

At the time of going to press CB licences were not available to the general public but it is anticipated that availability will be announced shortly. However readers can be ready with the PE Ranger to use this new facility as soon as it becomes legal.

Copies of MPT 1320 (27MHz) and MPT 1321 (934 MHz) are available from Government Bookshops and booksellers for £1·90 each.

The PE Ranger 27FM will only meet the Home Office specification for UK CB if it is constructed using a complete kit of parts obtained from Modus Systems and assembled exactly in accordance with the instructions given in this article. We do not recommend this project to anyone who has not successfully completed the construction of other electronic equipment.

Readers who hold the appropriate radio amateurs licence may use the PE Ranger on the 10m band.

CITIZENS Band radio is shortly to become legal in the UK and the PE Ranger 27FM offers you the chance to take advantage of this new system and develop its potential to meet your personal needs. The Ranger provides an ideal starting point for the newcomer and experienced operator alike. The introduction of the new service is expected shortly after the publication of this article and you have the opportunity to be on the air as soon as licences are issued.

The Ranger is not just a rig which you will outgrow as your operating experience increases. It forms a part of an overall system which can expand with each new application you find for CB. The base and mobile adaptor will extend the range and facilities of the basic transceiver for use in the car, home and boat.

The first parts of the PE Ranger series describe the construction and basic principles of operation of a self-contained hand-portable transceiver for short-range personal communication. Future articles will cover the testing and alignment procedures, which will require a minimum of test equipment, and the construction of a base and mobile unit.

### BUILDING A RANGER?

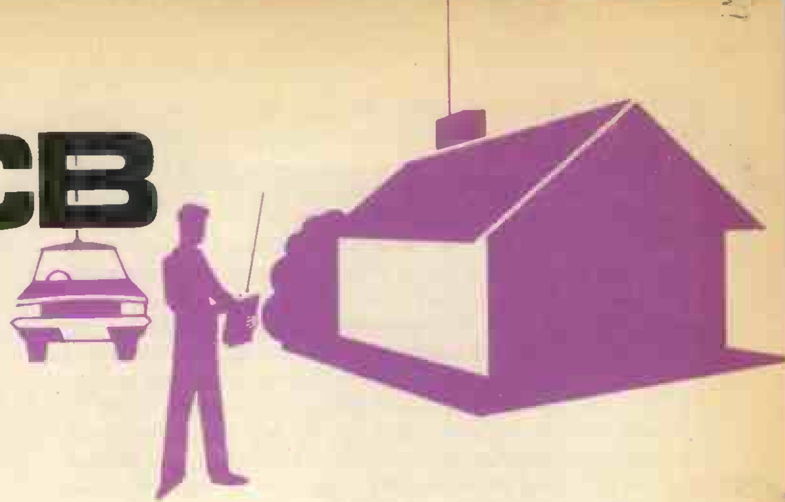
The first question asked by many would-be constructors will be, "Could I build a Ranger?". The basic requirements are: the ability to solder neatly, a few basic tools, the use of a d.c. voltmeter, and a complete set of components. With these requirements satisfied, the answer to the original question is, "Yes".

The tools required are: a soldering iron (maximum 25W or temperature controlled) with a miniature bit, a supply of

# 27FM CB

## PART ONE

MICHAEL TOOLEY B.A.
DAVID WHITFIELD M.A. M.Sc.



**THE PE RANGER IS A HAND-HELD 0·5W CB TRANSCEIVER WHICH HAS BEEN DESIGNED TO BE EASILY EXPANDED USING A BASE/MOBILE ADAPTOR INTO A 4W BASE STATION SUITABLE FOR USE IN THE HOME, CAR AND BOAT.**

## SPECIFICATIONS

### GENERAL

| | |
|---|---|
| Modulation: | FM |
| Frequency range: | 27·6 to 28·0MHz (CB version)<br>28·0 to 29·5MHz (Amateur version) |
| Number of channels: | Six |
| Channel spacing: | 10kHz |
| Operating temperature range: | −5°C to +45°C |
| Power supply: | Internal 12V rechargeable battery 250mAh<br>External 12V d.c. (nominal) negative ground<br>External 240V a.c. (nominal) 50Hz |
| Battery drain: | Receive standby 46mA (typical)<br>Receive average audio level 60mA (typical)<br>Transmit 250mA (typical) |
| Battery charger: | Internal constant current charger operates when external supplies are connected and the transceiver is not in use. Full charge in 10 to 14 hours |
| Controls and external connections: | On/off switch combined with volume control<br>Squelch on/off<br>Channel selector switch<br>Transmit and battery condition indicator l.e.d<br>Microphone socket (5-pin d.i.n.)<br>Mains input (2-pin)<br>Aerial socket (u.h.f.)<br>External d.c. input<br>Auxiliary socket (6-pin d.i.n.) |
| Dimensions: | 200mm x 120mm x 40mm |
| Weight: | 1·2kg |
| Optional extras: | Base and mobile station adaptor<br>Helical antenna<br>10dB fixed attenuator |

### TRANSMITTER

| | |
|---|---|
| Power output: | 0·5W (increased to 4W with the base/mobile adaptor) |
| Output impedance: | 50Ω |
| Spurious output: | Less than 50nW above 80MHz<br>Less than 250nW at all other frequencies |
| Frequency stability: | Better than 25 parts per million over the temperature range −5°C to +45°C and supply voltage range 9 to 14·5V |
| Audio response: | 240 to 3·4kHz at −1dB referred to 1kHz<br>50Hz to 5kHz at −6dB referred to 1kHz<br>Response falling at 12dB/octave above cut off |
| Deviation: | ±2·5kHz maximum |
| Audio input impedance: | 10kΩ |
| Microphone sensitivity: | Less than 10mV for rated system deviation |
| Speech processing: | Less than 3dB change in output for 20dB change in input level |
| Crystals: | 9MHz fundamental HC18/U |

### RECEIVER

| | |
|---|---|
| Sensitivity: | 1µV for 10dB quieting or better |
| Input impedance: | 50Ω |
| Selectivity: | Better than 20dB at ±10kHz |
| Audio output: | 0·5W maximum |
| Audio response: | 100Hz to 5kHz at −3dB referred to 1kHz |
| Frequency stability: | Better than 25 parts per million over the temperature range −5°C to +45°C and supply voltage range 9 to 14·5V |
| Intermediate frequency: | 455kHz |
| Crystals: | 27MHz third-overtone series resonant HC18/U |

mulitcored solder, a pair of long nosed pliers, a pair of good quality side cutters, wire strippers (optional), a sharp knife or scalpel, a small screwdriver, a magnifying glass (optional), and a trimming tool (which may be made by filing down a plastic knitting needle to the correct dimensions). With the tools above and a set of components, it should be possible to follow the instructions given and successfully complete the PE Ranger 27FM without any previous experience of r.f. constructional projects. However, we suggest you do not build the PE Ranger if you have not successfully completed other electronic projects. It cannot be stressed too greatly that the recommended printed circuit board layout must be followed exactly if predictable results are to be obtained. Depending on the experience of the constructor, the Ranger may be built in 2 to 4 evenings, and the testing and alignment completed in a further 1 to 2 evenings, depending on the time spent and the facilities/test equipment available. In the event of problems being encountered, a detailed fault finding guide is given in the latter part of the constructional notes. When care has been taken to check the identification and orientation of all components before soldering, and when the finished p.c.b. has been carefully inspected after completion, few problems should be experienced; the majority of problems arise from wrongly fitted components and poor soldering (solder splashes and dry joints in particular).

## DESIGN PHILOSOPHY

The design of the PE Ranger 27FM inevitably represents an engineering compromise between the various design and performance parameters. One over-riding design constraint is, of course, the Home Office Performance Specification for *"Angle modulated 27MHz radio equipment for use in the Citizens Band Radio Service"*. Within the limits of this specification, however, there is plenty of scope for many different practical implementations of an FM transceiver which will meet the Home Office performance requirements. Indeed, it is usually the case that there will be at least as many different designs produced as there are different designers working on a particular problem!

The main design aim was to produce a low cost, hand-portable FM transceiver suitable for personal communication. Operation from internal re-chargeable nickel-cadmium batteries, while involving a higher initial outlay than for dry batteries, was considered an essential feature for portable use. The life cycle cost of a unit powered exclusively from dry batteries will otherwise rapidly exceed the total cost of the equipment itself! To this end, the Ranger has been designed with re-chargeable batteries, a mains power supply and automatic battery charging circuits, all included inside the case. Operation from an external d.c. source such as a 12 volt car battery is also possible, and the NiCads may even be re-charged in this way.

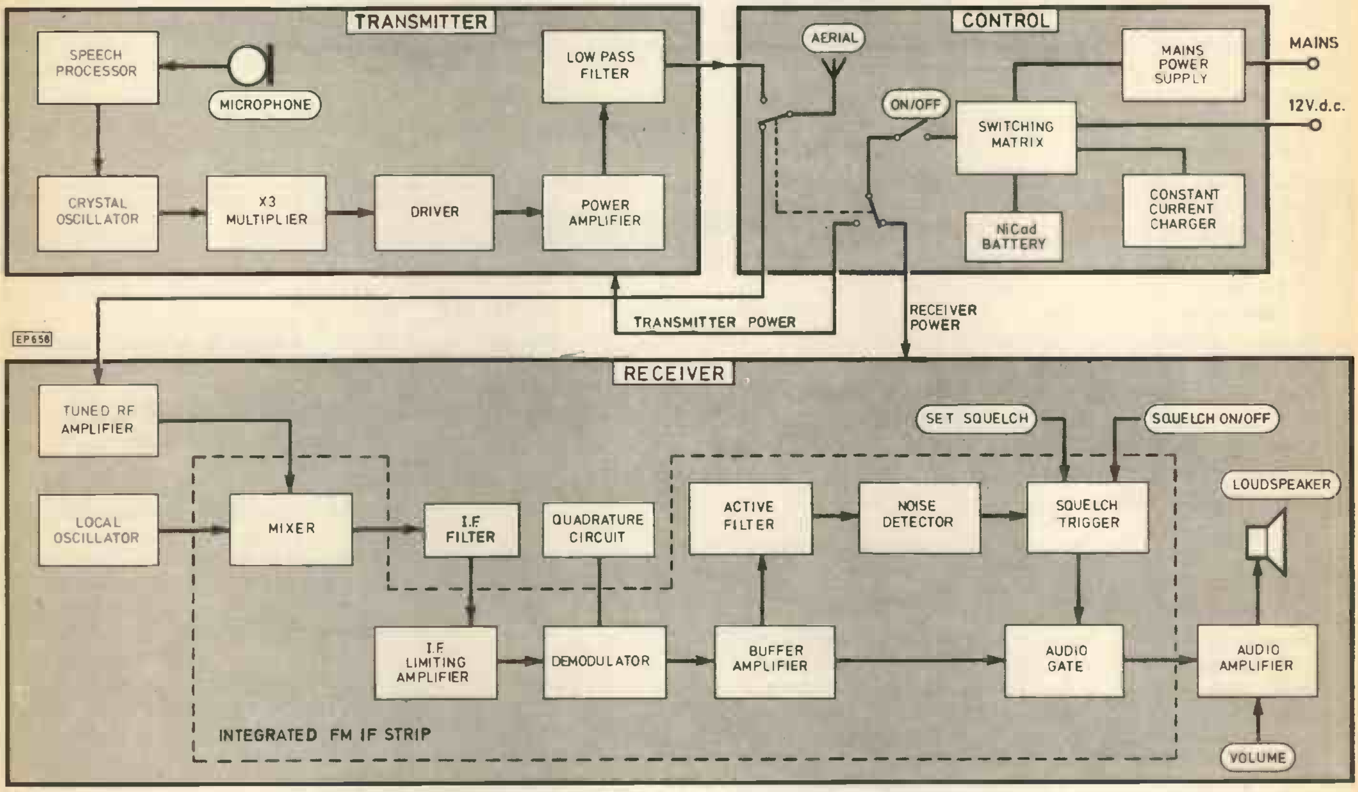



**Fig. 1.1. Block diagram of the PE Ranger**

The transceiver itself makes use of integrated circuits in the design wherever possible. This allows a high level of performance to be achieved at low cost in the smallest possible space, while keeping to standard constructional techniques. Wherever possible, preset adjustments are kept to a minimum, with test points provided for simplifying the alignment procedure, and readily available components are used. Careful attention to the design of the p.c.b. ground plane and the component layout allows all of the components except the sockets and controls to be mounted on one single-sided p.c.b. The completed design is therefore compact, repeatable, cost-effective and straightforward to align. The robust case, flexible helical antenna, integral batteries and loudspeaker, detachable microphone, and rugged transmitter design all contribute to making the PE Ranger 27FM a self-contained transceiver which is suitable for a wide range of applications.

## SYSTEM DESCRIPTION

The PE Ranger 27FM comprises four functional modules; transmitter, speech processor, receiver, and power supply. Fig. 1.1 shows how these modules are arranged in the basic transceiver.

In the transmitter, a low frequency (9MHz) fundamental crystal oscillator is used to define the output frequency. The speech processor amplifies the microphone signal, provides active limiting and low pass filtering, and then adjusts the level to set the maximum transmitter deviation. The output of the speech processor is used to frequency modulate the fundamental oscillator by means of a varicap diode. The modulated 9MHz signal then drives a frequency multiplier stage to produce an output on 27MHz. This 27MHz signal then undergoes two stages of RF amplification to provide an output of around 500mW (r.m.s.) into 50Ω. A multi-stage low pass filter is included in the path between the p.a. stage and the aerial to provide a high rate of attenuation of unwanted spurii. The overall design of the transmitter features bandpass coupling between stages, and this assists in achieving a low harmonic content in the output. The alignment procedure is simple, with test points provided for each stage, and only a simple d.c. voltmeter is required to complete the alignment of the transmitter.

The receiver features a conventional superhet arrangement with an intermediate frequency (i.f.) of 455kHz. The signal frequency is applied via the RF amplifier stage to one of the mixer inputs. The local oscillator drive for the second input is derived from an overtone oscillator running at 455kHz below the signal frequency. The 455kHz i.f. output from the mixer is filtered to remove unwanted mixing products, amplified in a five-stage limiter, and then demodulated. The combined i.f. amplifier and demodulator stage also provides the squelch facilities. Final audio amplification of the recovered signal is provided by an i.c. audio power amplifier. The use of a high gain amplifier, with its associated i.f. filter, ensures that alignment of the receiver is a very straightforward task, with a minimum of preset adjustments.

## SPECIFICATIONS

In designing a piece of equipment for Citizens Band use consideration has to be given to meeting the specifications laid down by the Home Office. These are primarily concerned with the following aspects of equipment performance:

(a) Maximum power output and effective radiated power.
(b) Accuracy and stability of the transmitted frequency.
(c) Frequency deviation and bandwidth of the transmitted signal.
(d) Spurious radiation from the transmitter and receiver.

In each performance area limiting values are specified and these should not be exceeded under both normal and extreme conditions. To this end the Home Office require that tests be made either on a sample of the equipment type or, for simplicity's sake, on one item only. In this latter case equipment manufacturers, importers or assemblers must, from time to time, carry out subsequent tests to ensure that the specifications are still being met. In the case of the PE Ranger it is therefore necessary to establish that not only the performance of the prototype conforms to the given specification but also that sample units be tested, after assembly, to check that they also comply with the Home Office requirements. For this reason constructors are warned that the specifications quoted in this article are only likely to be valid for transceivers constructed:

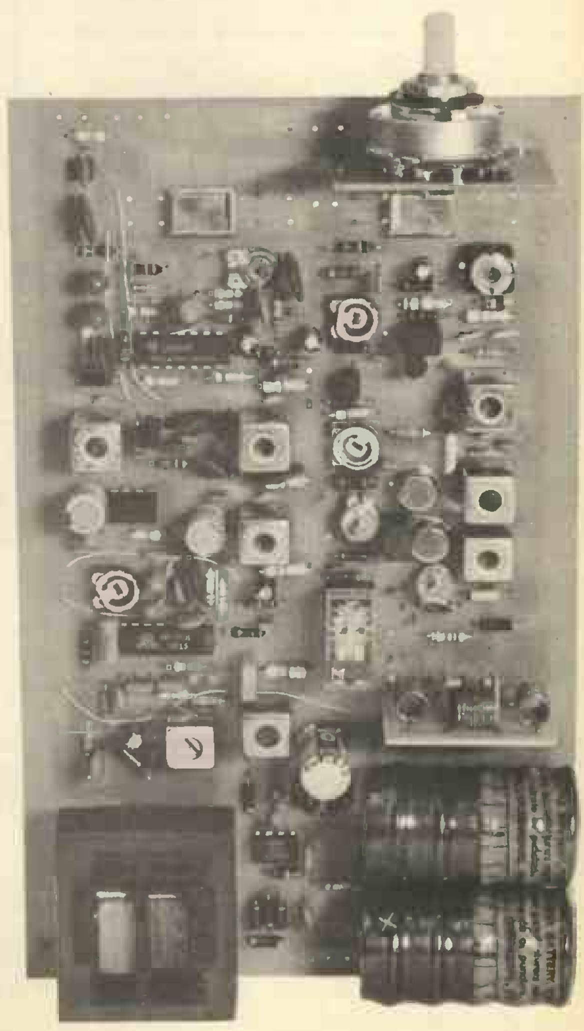
(a) Using the components, p.c.b. and enclosure specified
(b) Closely following the constructional details and alignment instructions given.

Any major departure from either the recommended components or alignment procedure may result in a finished transceiver which not only fails to perform to the quoted specification but fails to comply with the Home Office requirements. It should also be noted that, on any particular piece of equipment, performance specifications may be marginally different from those quoted due both to minor variations in individual components and to alignment tolerances.

## CIRCUIT DESCRIPTION

The complete circuit diagram for the PE Ranger 27FM is shown in Fig. 1.2. To assist in locating a particular component, identification symbols are allocated distinctly to the transmitter, receiver and control sections, respectively, of the Ranger. Components in the transmitter and speech processor are numbered from 1, e.g. R1, C1, IC1, etc. Receiver components are numbered from 100, e.g. R100, C100, IC100, etc. The control section numbers components from 200, e.g. R200, C200, etc.

The selection of transmit or receive is by means of the



**Prototype p.c.b. design of the PE Ranger**

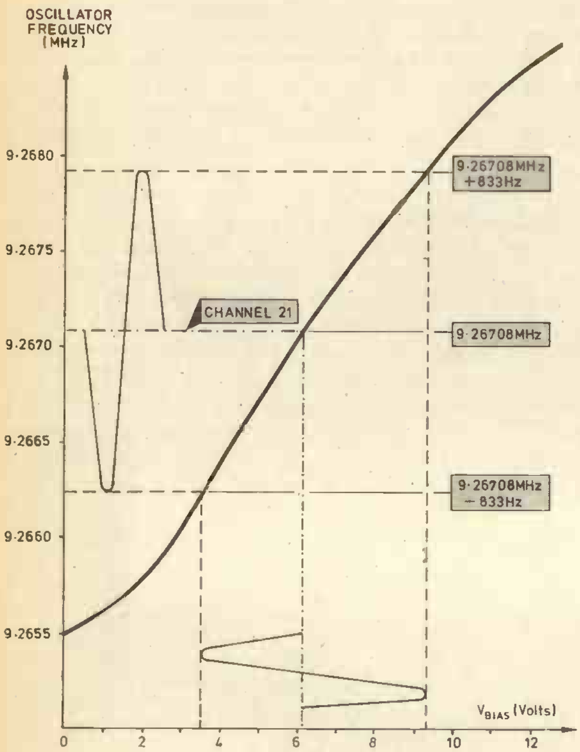
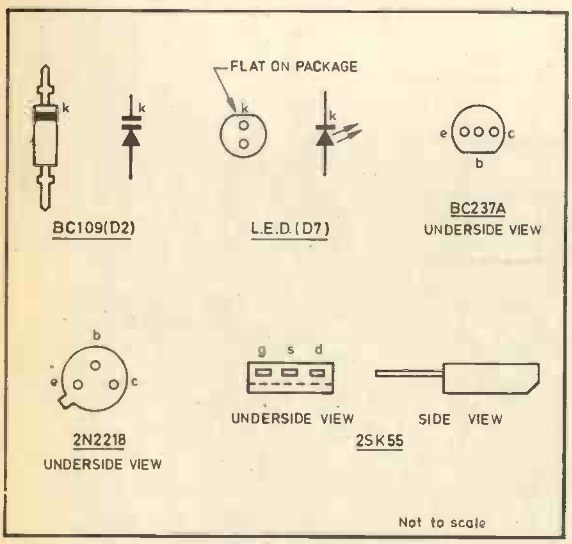



**Fig. 1.3. Deviation characteristic for the frequency modulator**




COMPONENT POLARIZATION

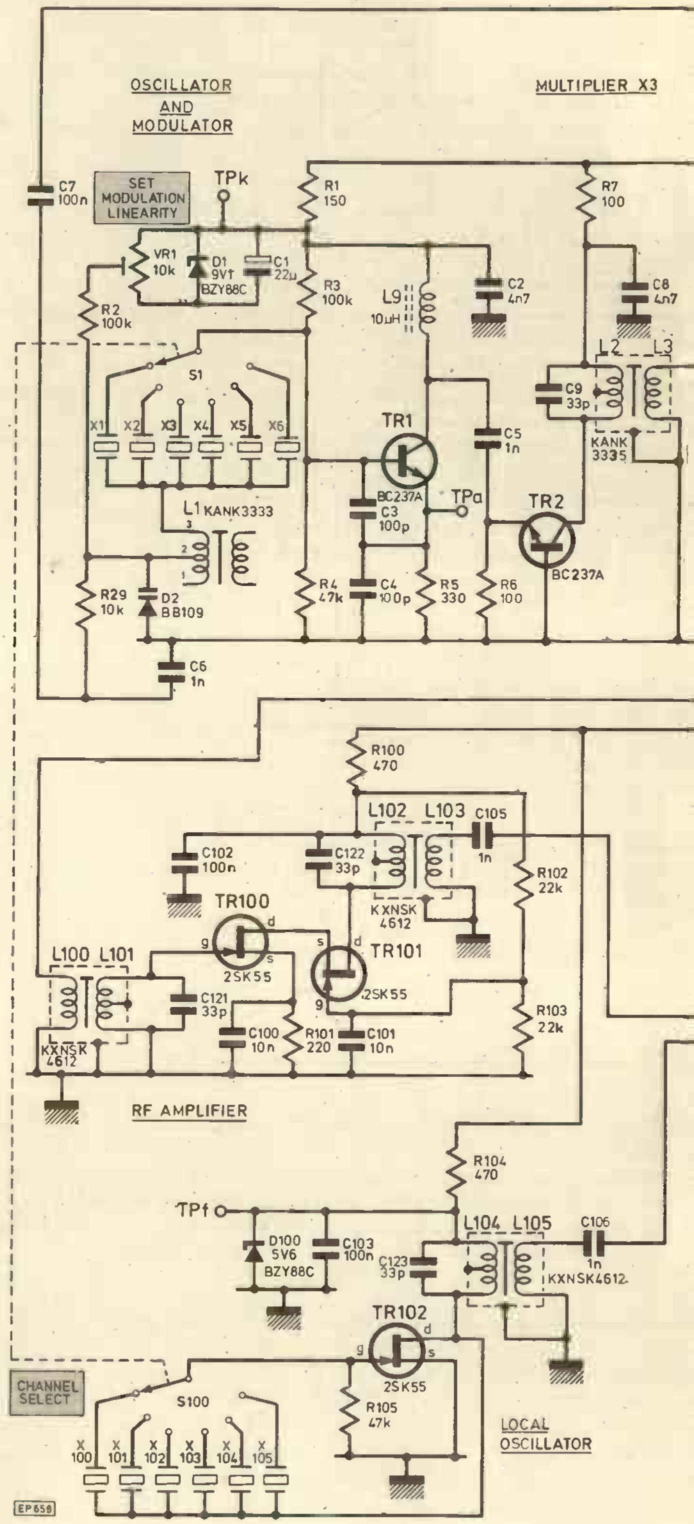
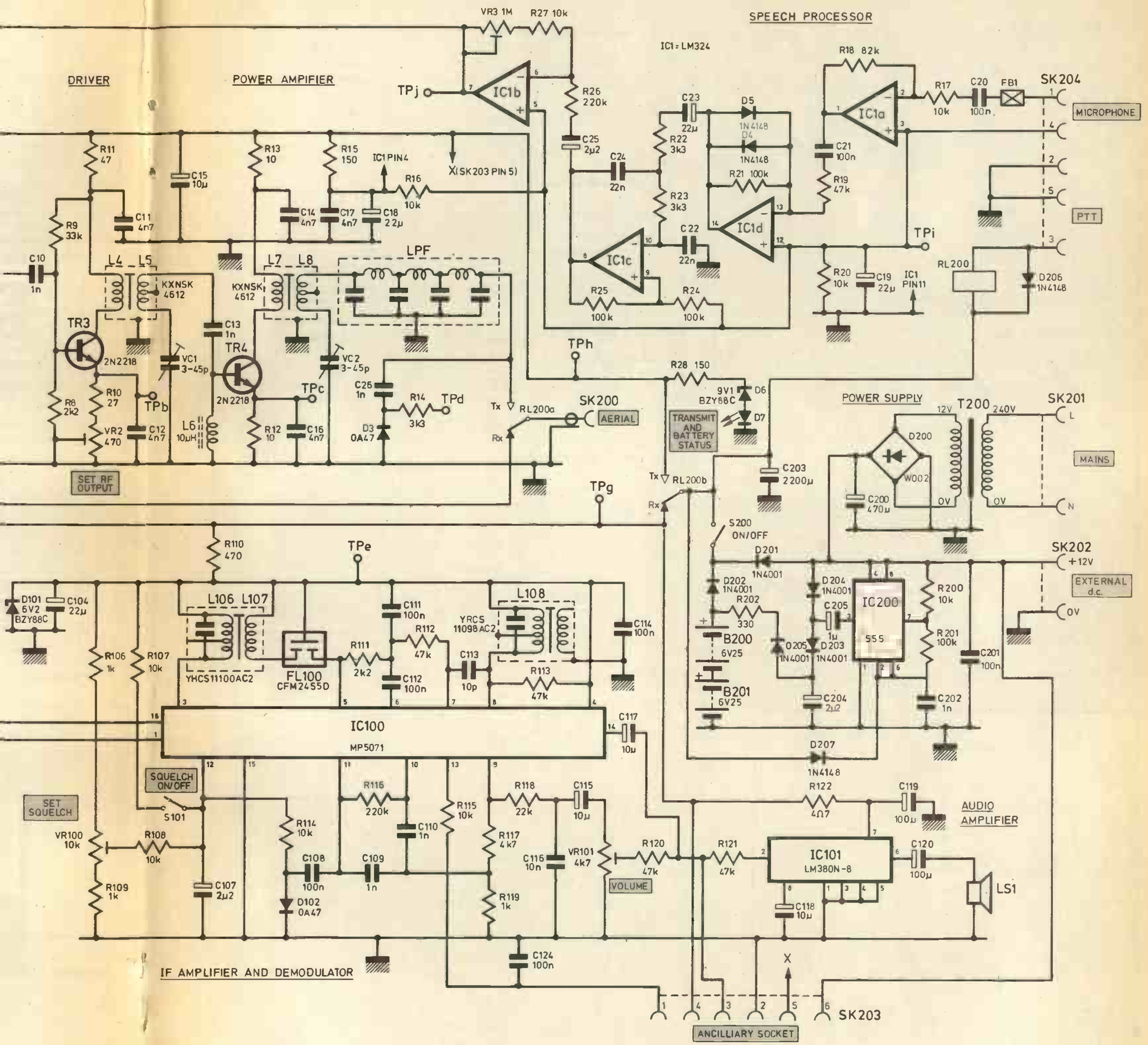



**Fig. 1.2. Complete circuit diagram of the PE Ranger**


DRIVER
POWER AMPIFIER
SPEECH PROCESSOR
IC1 = LM324
LPF
POWER SUPPLY
AUDIO AMPLIFIER
IF AMPLIFIER AND DEMODULATOR
SET RF OUTPUT
TRANSMIT AND BATTERY STATUS
AERIAL
MICROPHONE
PTT
MAINS
EXTERNAL d.c.
SQUELCH ON/OFF
SET SQUELCH
VOLUME
ANCILLIARY SOCKET
SK200
SK201
SK202
SK203
SK204
IC100 MP5071
IC101 LM380N-8
IC200 555
T200
LS1

# COMPONENTS . . .

## TRANSMITTER

### Resistors

| | |
|---|---|
| R1, R15, R28 | 150 (3 off) |
| R2, R3, R21, R24, R25, R26 | 100k (6 off) |
| R4, R19 | 47k (2 off) |
| R5 | 330 |
| R6, R7 | 100 (2 off) |
| R8 | 2k2 |
| R9 | 33k |
| R10 | 27 |
| R11 | 47 |
| R12, R13 | 10 (2 off) |
| R14, R22, R23 | 3k3 (3 off) |
| R16, R17, R20, R27, R29 | 10k (5 off) |
| R18 | 82k |

All resistors ¼W 5% carbon

### Potentiometers

| | |
|---|---|
| VR1 | 10k hor. preset |
| VR2 | 470 hor. preset |
| VR3 | 1M hor. preset |

### Capacitors

| | |
|---|---|
| C1, C19 | 22µ 10V elect. (2 off) |
| C2, C8, C11, C12, C14, C16, C17 | 4n7 ceramic (7 off) |
| C3, C4 | 100p ceramic plate (2 off) |
| C5, C6, C10, C13, C26 | 1n ceramic (5 off) |
| C7, C20, C21 | 100n ceramic (3 off) |
| C9 | 33p ceramic plate |
| C15 | 10µ 16V elect |
| C18 | 22µ 16V elect |
| C22, C24 | 22n ceramic (2 off) |
| C23 | 22µ 16V elect |
| C25 | 2µ2 16V elect |
| VC1, VC2 | 3–45p trimmer (2 off) |

All electrolytic capacitors are vertical p.c.b. mounting types

### Semiconductors

| | |
|---|---|
| TR1, TR2 | BC237A (2 off) |
| TR3, TR4 | 2N2218 (2 off) |
| D1, D6 | BZY88 C9V1 (2 off) |
| D2 | BB109 |
| D3 | OA47 |
| D4, D5 | 1N4148 (2 off) |
| D7 | Red l.e.d. |
| IC1 | LM 324N |

### Miscellaneous

| | |
|---|---|
| L1 | KANK 3333 |
| L2/L3 | KANK 3335 |
| L4/L5, L7/L8 | KXNSK 4612 (2 off) |
| L6, L9 | 10µH choke (2 off) |
| S1 | 2p 6w rotary p.c.b. switch |
| X1–X6 | 9MHz fundamental HC18/U crystal (6 off) |
| LPF | Low pass filter module |
| FB1 | Ferrite anti-parasitic bead |

## RECEIVER

### Resistors

| | |
|---|---|
| R100, R104, R110 | 470 (3 off) |
| R101 | 220 |
| R102, R103, R118 | 22k (3 off) |
| R105, R112, R113, R120, R121 | 47k (5 off) |
| R106, R109, R119 | 1k (3 off) |
| R107, R108, R114, R115 | 10k (4 off) |
| R111 | 2k2 |
| R116 | 220k |
| R117 | 4k7 |
| R122 | 4Ω7 |

All resistors ¼W 5% carbon

### Potentiometers

| | |
|---|---|
| VR100 | 10k hor. preset |
| VR101 | 4k7 potentiometer with a s.p.s.t. switch |

### Capacitors

| | |
|---|---|
| C100, C101, C116 | 10n ceramic (3 off) |
| C102, C103, C108, C111, C112, C114, C124 | 100n ceramic (7 off) |
| C104 | 22µ 10V elect |
| C105, C106, C109, C110 | 1n ceramic (4 off) |
| C107 | 2µ2 16V elect |
| C113 | 10p ceramic |
| C115, C117, C118 | 10µ 16V elect (3 off) |
| C119, C120 | 100µ 16V elect (2 off) |
| C121, C122, C123 | 33p ceramic plate (3 off) |

### Semiconductors

| | |
|---|---|
| D100 | BZY 88 C5V6 |
| D101 | BZY 88 C6V2 |
| D102 | OA47 |
| TR100, TR101, TR102 | 2SK55 (3 off) |
| IC100 | MP 5071 |
| IC101 | LM 380N-8 |

### Miscellaneous

| | |
|---|---|
| L100/L101, L102/L103, L104/L105 | KXNSK 4612 (3 off) |
| L106/L107' | YHCS 11100 AC2 (2 off) |
| L108 | YRCS 11098 AC2 |
| FL100 | CFM 2455D |
| S100 | Combined with S1 |
| S101 | Toggle switch s.p.s.t |
| X100–X105 | 27MHz 3rd overtone HC18/U crystals (6 off) |
| Loudspeaker | 50–75mm diameter 16Ω |

## CONTROL

### Resistors

| | |
|---|---|
| R200 | 10k |
| R201 | 100k |
| R202 | 330 |

All resistors ¼W 5% carbon

### Capacitors

| | |
|---|---|
| C200 | 470µ 25V elect |
| C201 | 100n ceramic |
| C202 | 1n ceramic |
| C203 | 2200µ 16V elect |
| C204 | 2µ2 25V elect |
| C205 | 1µ 25V elect |

### Semiconductors

| | |
|---|---|
| D200 | W005 |
| D201, D202, D203, D204, D205 | 1N4001 (5 off) |
| D206, D207 | 1N4148 (2 off) |
| IC200 | NE555 |

*Components cont. . .*

**Miscellaneous**

| | |
|---|---|
| RL200 | Relay type 221 DO12 p.c.b. mounting 12V 2p c/o |
| S200 | S.p.s.t. switch (see VR101) |
| SK200 | Round SO239 socket |
| SK201 | Reversible chassis mains plug |
| SK202 } SK203 } | 5-way d.i.n. socket |
| SK204 | 5-way 180° d.i.n. socket |
| B200, B201 | 6·25V 250 mAh Nicad pack |
| T200 | 0–12V 3VA p.c.b. transformer |

**General**

Case
P.c.b.
Knobs (2 off)
Microphone with PTT switch
Helical whip aerial
Mains lead

**Constructors' Note**

The PE Ranger 27FM will only meet the Home Office specification for UK CB if it is built from a complete kit of parts from Modus Systems—exactly in accordance with the instructions given in this series of articles. No responsibility will be accepted by Modus Systems for sets which do not meet the specification due to incorrect assembly or alignment. The following prices have been specially arranged for PE readers.

The PE Ranger 27FM kit including injection moulded case, mains and car input, rechargeable batteries, microphone, helical $\frac{5}{8}$ wave aerial and crystals for two channels, £49·95 plus £1·40 p&p, plus VAT (£59·05 inclusive) or £97·00 for a matched pair of transceiver kits with crystals for two channels plus £2·80 p&p, plus VAT (£114·77 inclusive).

Extra sets of crystals are £2·25 for each channel plus 50p p&p (for any quantity), plus VAT.

Extra plastic covered helical $\frac{5}{8}$ wave aerials (overall length 50mm) for mobile or base station use, £3·95 each, plus 80p p&p, plus VAT.

**Modus Systems Ltd., Dept AP, PO Box 30, Letchworth, Herts. SG6 3DQ (✆ 046 26 74468/76392).**

press-to-talk (PTT) switch on the microphone. When the PTT switch is not depressed, RL200 is in the default position, and the receiver is selected. Depression of the PTT switch energises the coil of relay RL200, causing the aerial to be reconnected to the transmitter output, and d.c. power to be redirected from the receiver to the transmitter and speech processor stages.

The overall block diagram for the PE Ranger 27FM shown in Fig. 1.1, will be used as the basis for the description of the circuit operation in the sections which follow.

## TRANSMITTER

The transmitter output frequency is defined by a 9MHz crystal oscillator, the output of which subsequently undergoes frequency multiplication to produce a 27MHz signal on the channel frequency. Modulation is applied directly to the crystal oscillator to produce frequency modulation of the carrier.

The 9MHz oscillator stage uses a bipolar transistor, TR1, configured as a Colpitts oscillator, whose frequency is defined by the crystal selected by S1. A varicap diode, D2, is used to frequency modulate the oscillator. A varicap is a diode whose capacitance when reverse-biased varies inversely with the bias voltage, i.e. the capacitance decreases as the bias voltage is increased. Used in series with the crystal, the varicap diode increases the oscillator frequency as the bias voltage rises. This characteristic is exploited to allow the audio signal from the speech processor to modulate the carrier frequency. The deviation characteristic for the oscillator and modulator working on channel 21 is shown in Fig. 1.3. It can be seen that the overall transfer characteristic of the modulator is not quite linear, but that the deviation available is considerably more than is required. A limited operating range may therefore be chosen over which the response is linear for the deviation required (maximum ±2·5kHz). The maximum deviation allowed by the Home Office specification corresponds to a swing of ±833Hz on the 9MHz frequency; Fig. 1.3 indicates that the varicap bias could be set to approximately +6 to 7 volts for zero modulation input in order to give substantially linear performance. It also becomes clear from this graph that the bias voltage for the varicap must be stabilised against supply voltage fluctuations if the carrier frequency is to be stable. VR1 provides the means of adjustment for the varicap bias voltage, and R1/D1/C1 stabilise the bias to the diode.

One result of inserting a varicap diode in series with the crystal in the oscillator is to increase the effective series capacitance. This has the effect of increasing the frequency of oscillation, and L1 is therefore included to compensate for this change by reducing the frequency. L1 also provides a fine adjustment for the zero-deviation oscillator frequency.

The oscillator output is taken from the collector of TR1 to minimise the loading effects, and the signal is used to drive the frequency multiplier stage. TR2 operates as a frequency tripler in common base configuration. This arrangement provides a high power gain and high output impedance, which is required to match to the output tuned circuit, L2/L3. The tuned circuit has a high Q factor to ensure that only the third harmonic (at 27MHz) is coupled to the driver stage.

TR3 is a tuned amplifier whose gain may be adjusted via VR2 to vary the drive level to the power amplifier. VR2 operates by varying the emitter current flowing in TR3. The tuned collector load for TR3, L4/L5, is arranged as an impedance step-up to simplify the matching arrangements; this type of arrangement is only appropriate for low power applications.

The power amplifier again uses the common emitter configuration, and TR4 provides around 10-13dB of gain. The output is coupled in a similar fashion to the driver stage, and is passed to the low-pass filter network, and then to the aerial. The output stage is matched to a 50 ohm impedance.

In the transmitter there is extensive decoupling of the supply rail for all of the stages. This decoupling, in conjunction with the short connections to the earth plane, is essential to ensure stability of the transmitter and to suppress the generation of unwanted spurii. On no account should the decoupling be omitted and good quality ceramic capacitors should be used throughout; the aim is to produce a supply rail which has negligible signal impedance. Test points are provided all along the transmitter chain to assist in the tuning up procedure.

**NEXT MONTH: Circuit description and construction**


**FRANK W. HYDE**

## THE INTERNATIONAL ULTRAVIOLET EXPLORER

The IUE has now passed its third birthday and provided data of outstanding excellence. This orbiting astronomical observatory is a joint venture between the United Kingdom Science Research Council, the eleven member European Space Agency and the National Aeronautical and Space Administration of the United States. During its continuing life more than 600 scientists have made use of its facilities. Data is collected continuously at three main centres, one at the Goddard Spaceflight Tracking Centre, another at the NASA ground station at Maryland, and for about ten hours a day at the ESA tracking station at Villafranco del Castillo (VILSPA) near Madrid in Spain.

In the three years of operation the satellite has obtained about 20,000 ultraviolet spectra of astronomical objects. The images which are stored on magnetic tape are kept at the Science Research Council, World Data Centre at Ditton Park, Great Britain. This data is accessible to all astronomers. The data Centre is unique in the world in that it is the largest and most important store of astronomical spectra in the world.

The actual time allowed for the SRC share of the IUE time is a maximum of 160 eight hour shifts during any one year. This is very much oversubscribed by United Kingdom observatories. The reason for this situation is the flexibility of the instrumentation on board the IUE. The design is such that the press of a button provides instantly different modes of operation. For example an astronomer could be focused on a bright source at very high resolution and by pressing the appropriate instruction button, move to a fainter object at lower resolution. The cameras are of remarkably high sensitivity and allow studies to be made of objects which to the ultraviolet eye are very faint such as quasars and external galaxies.

Spectrographic studies of Saturn, Jupiter, asteroids and comets in the solar system have already been made. The more distant objects studies have been carried out on many stars, from those that are very young and those that are highly evolved. Extensive stellar winds have been detected in the hotter and more energetic stars. As a result some theories have had to be rewritten. Another area of surprise was the success in studying corona and the chromospheres of cool stars. It was not thought that these would be accessible to ultraviolet detection.

In the interstellar medium some exciting discoveries have been made. For example, the detection of a hot halo enveloping the galaxy itself. It extends out over a distance of 10,000 parsecs. The temperature is of the order of 10,000°K. It is possible to suggest also that this would apply to the nearby neighbours, the Greater and Lesser Magellanic Clouds. It is possible that the high redshift quasara which show multiple absorption lines could be partly caused by the halos of intervening galaxies. One of the most exciting of the observations carried out recently was on the 'twin' quasar which is believed to be a double image of a very distant quasar formed by a massive intervening galaxy which is acting as a gravitational lens. The ultra violet of the spectra are consistent with this interpretation.

The IUE was launched on 26th January 1978 from Cape Canaveral, Florida, by a NASA DELTA 2914 rocket. It is placed in a geosynchronous orbit over the Atlantic. It has a perigee of 28,000kms and an apogee of 46,000kms. Its design life was for three years but it is clear that it will last longer than this. It has been decided that observations will continue so long as useful data is being returned or the satellite remains operational.

## GIOTTO AND HALLEY'S COMET

Giotto, which will be the first European Space Agency vehicle to go deep into space beyond the Earth will give the ESA an outstanding opportunity to come close to the comet if it arrives on time. Comets are believed to consist of some of the most primitive material in the Solar System. There will only be four hours of close study of the tail as the spacecraft passes through it. Thus high speed measurements must be made. The distance from Earth will then be greater than the distance of the moon. There are therefore technical problems for the radio link to the 60m Parkes radio telescope in Australia.

In addition to the observations of the cometary nucleus (if indeed there is a nucleus) the scientists concerned with the mission are particularly interested in investigating the cometary dust. The interaction of the tail with the solar wind is an important area for study because the conditions are not unrelated to the development of heating processes in fusion plasmas in the laboratory. Giotto will be equipped with a telescope with electronic colour imaging and with automatic microprocessor control to counteract the effects of the spinning spacecraft. The two dimensional tinted image of the comet will be accurately defined in contrast and transmitted to Earth in real time via the telemetry channel. The pictures will be used to control the vehicle on its course. The real time imaging is important because the spacecraft may be damaged during hazardous parts of the encounter. Dr. Gary Hunt will be involved in the two dimensional imaging and also with the associated software. This will be principally for the analysis of the images so that the mass flows subliming from the nucleus to the coma and the tail can be quantified.

The spacecraft will speed through the cometary dust at 68km/sec. At that velocity a 0·1g of dust will explode through 8cm of aluminium. Since it would be impossible to provide for protection at such thickness in a space craft, an ingenious solution has been adopted to safeguard the vehicle from dust impacts. Two thin shields well separated will be sufficient. In the first contact the particle of dust will explode and will be vapourised to burst on the second sheild 25cm away as a diverging ionised plasma which will be spread over a wide area. Tests have shown that this will work well and will enable a number count even with large masses. There is an enormous dynamic range to cover as the density of the tail increases as penetration proceeds into the denser layers. The range may well be from $10^{-17}$g to $10^{-3}$g.

Plasma analysers will be used to provide space-time resolution of the velocity distributions of the ions and electrons in the plasma and the impacting solar wind. A magnetometer will study the bow shock and the plasma flows and instabilities set up where the ionised atmosphere of the comet reacts with the solar wind. It is unfortunate that the United States fiscal plans have meant the maximum coverage of the mission will be decreased leaving the present mission to the European Space Agency, the Japanese with a lightly loaded probe and the USSR with the Venus orbiter on its return. The maximum effort will be from ESA and the USA will have to wait for the next return in 2062.

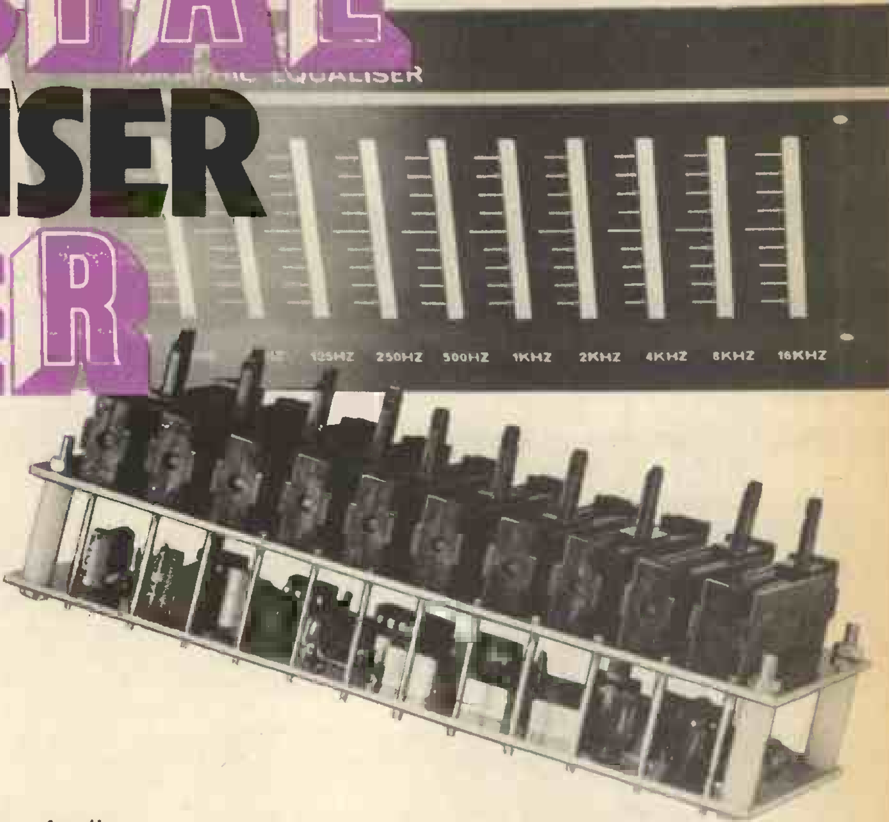
## THE 30inch STEAVENSON TELESCOPE

Last October the Steavenson telescope was erected at the new observatory at an elevation of 3,000 feet in the Sierra Nevada, in Spain. The French 22inch was already installed. The Steavenson was moved from the Royal Greenwich Observatory where it had been refurbished. It was decided to ship it as nearly assembled as possible to avoid double testing and re-assembly. To this end only the optics and electronics were separated. The team of French, Spanish and British astronomers and technicians worked enthusiastically together. It is hoped that the 30 inch will be able to give its full use in the new and better observational conditions.

## SHUTTLE EXPERIENCE

In a personal conversation with the Shuttle Commander John Young, he told me that he had expected a 'kick in the back of the neck' at take off. This did not happen and in fact it was smooth and easy with full voice communication throughout. A point that showed his past experience as an Astronaut was indicated by the fact that his own heart beat was normal but his co-pilot Astronaut Crippen experienced twice the normal rate.

# SPECIAL EQUALISER OFFER




## £21·50

**INCLUDING V.A.T., POSTAGE AND PACKING**

A graphic equaliser to match our *Audio Analyser* project. This offer has been specially arranged by PE with BI-PAK to coincide with the publication of our *Audio Analyser*. The graphic equaliser on offer matches the analyser and provides ten channel audio correction. Knobs and a black aluminium front panel are also provided.

### SPECIFICATION

Ten channel mono graphic equaliser (2 required for stereo)

Overall measurements: 155 x 66 x 55mm

Control Frequencies: 31, 62, 125, 250, 500, 1k, 2k, 4k, 8k and 16k (Hz)

Control Range: ±12dB cut or boost per channel

Dynamic Range: 110dB

Maximum Input: 3V r.m.s.

Maximum Output: +15dB

Frequency Response: 30Hz –20kHz (±1dB)

T.H.D.: 0·005%

Power: 15V –0–15V at 50mA

**Offer closes Friday, October 16, 1981.**

**To: BI-PAK Semiconductors, PO Box 6, Ware, Herts. Tel. Ware 3182.**

**Please complete both parts of the coupon in BLOCK CAPITALS**

Please send me .... graphic equaliser modules at £21·50 each inclusive. (Knobs and front panel provided.)

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# DRUM SYNTHESISER

P. BAILEY

THE synthesiser was originally developed using a keyboard, as the key contact was the easiest method of implementing the switching function required. However, as time passed by, other methods of controlling the basic synthesiser circuits were investigated, and the drum synth was born.

This works on the principle of a pick-up or sensor of some kind picking up the vibrations of a drum or pad and then feeding these signals to the circuitry which controls the synth. Note that this signal is only a trigger signal and that the synth produces the actual sound.

The unit to be described here can use one of a variety of methods to pick up the drum signal and trigger the envelope shaper etc. in the synth which is contained in a separate case. It runs off a regulated mains power supply which could be used to power external equipment if desired.

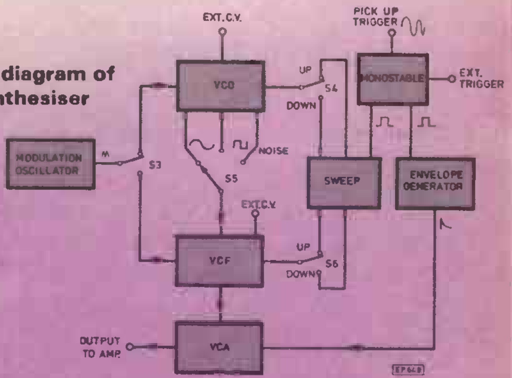
## BLOCK DIAGRAM

Fig. 1 shows the basic arrangement of the circuits in the synth. The sweep generator circuit provides a rising or falling envelope (as selected) which is mixed with the triangle wave output from the modulation oscillator, and an external control voltage if desired, and fed to the voltage controlled oscillator (VCO) and voltage controlled filter (VCF) to control their frequencies. The output of the VCO (sinewave, squarewave or white noise as selected) is fed directly to the VCF and passes on to a voltage controlled amplifier (VCA) which is controlled by an envelope generator, triggered by the drum pick-up. This gives the sound its percussive envelope, essential in imitating drums etc. From here the sound is fed to the external amplifier or tape recorder as required via the output socket.

## MODULATION OSCILLATOR

The circuit for this is shown in Fig. 2. It is a standard integrator/comparator oscillator circuit and its purpose is to generate a linear triangle wave, frequency variable over the low frequency range cycling the pitch of the VCO or cut-off frequency of the VCF as described earlier. IC1, R2, and C2 form an integrating network. C2 charges up linearly via R2 until it triggers IC2, which forms a comparator. On triggering, the output switches polarity and so charges C2 in the opposite direction at a rate dependent on the setting of VR1. When S1 is in the l.f. (low frequency) position, C1 is placed in parallel with C2, increasing its capacitance and thus decreasing the frequency. The range is about 0·5Hz to 200Hz on a.f. (audio frequency) and 1 cycle in 30 secs. to 10Hz on l.f. S3 routes the modulation voltage to the VCO or VCF in the proportion set by VR2, the oscillator being disconnected when not required by S2.

**Fig. 1. Block diagram of the Drum Synthesiser**




## VOLTAGE CONTROLLED OSCILLATOR

This generates the actual signal which will form the final sound. It has two waveshapes, sine and square, and a white noise output which will be discussed later. The circuit for the VCO and noise generator is shown in Fig. 3. It is based on a custom i.c., the SSM2044. This is a completely integrated voltage controlled low-pass filter system in one package requiring very few external components. The system comprises an exponential converter for controlling the cut-off frequency exponentially from a linear control voltage which is fed in at pin 13, a four-pole low-pass filter block based on transconductance amplifiers which has a −24dB/octave cut-off slope and minimum control range of 10,000:1, and a circuit for controlling Q (or resonance) from an input control current fed into pin 2. If the Q current is increased beyond a certain value, the filter is forced to oscillate at the cut-off frequency producing a pure sinewave at the output. This is the principle used to generate the sinewave in the VCO, the range being approximately 25Hz to 2·5kHz. The output appears at pin 3 of the i.c. and is a current. This is converted into a voltage and buffered by IC3, so producing a sinewave of around 8V peak to peak depending on the setting of VR3. VR3 sets the voltage which is converted into a current by R7 and controls the Q. This allows accurate setting of the Q for maximum stability over the oscillation range, and greatest purity in the sinewave.

The control voltages for the VCO from the modulation oscillator, the sweep circuit via S4 and VR5, the manual frequency potentiometer, and external input, are summed by IC6 and the resulting voltage is attenuated to around 80mV

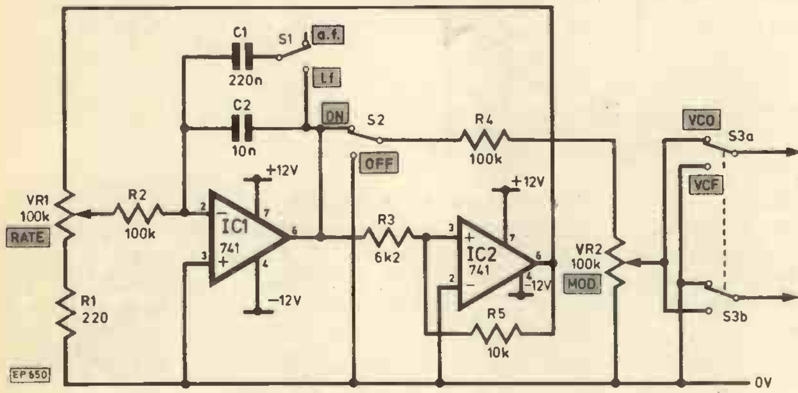



Fig. 2. Circuit of the modulation oscillator

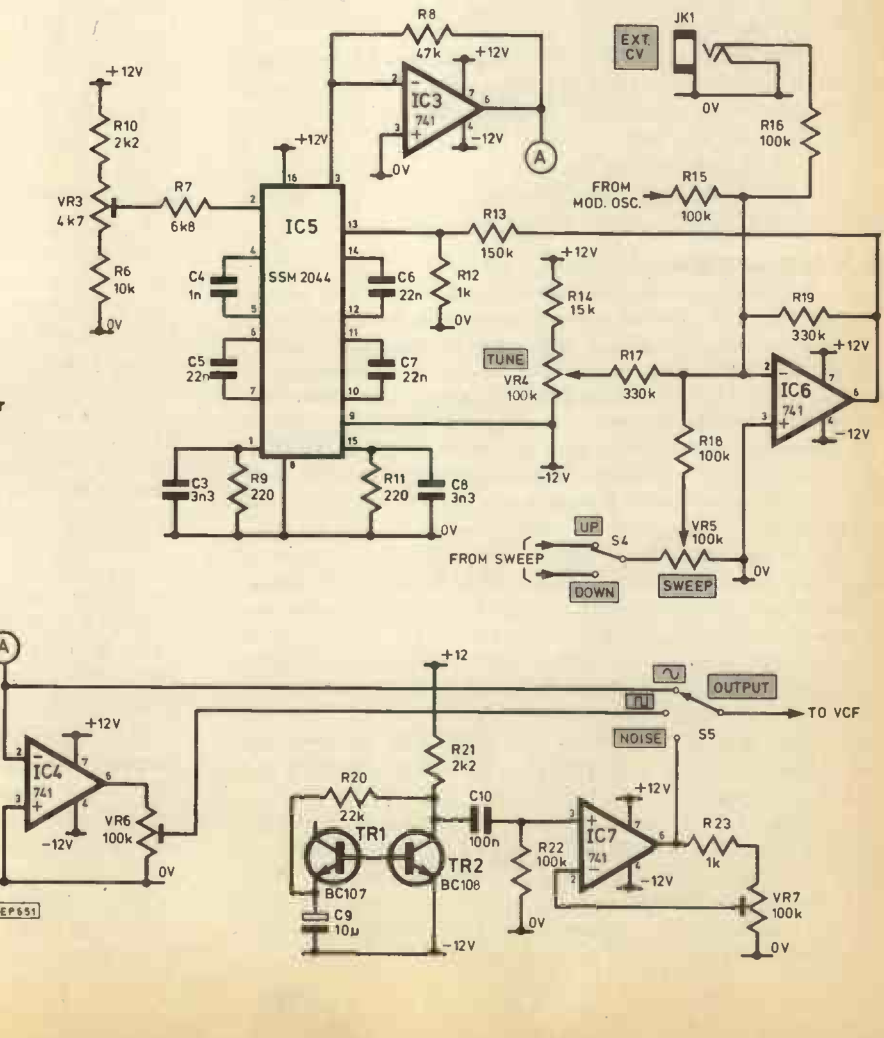



Fig. 3. Circuit of the VCO and noise generator

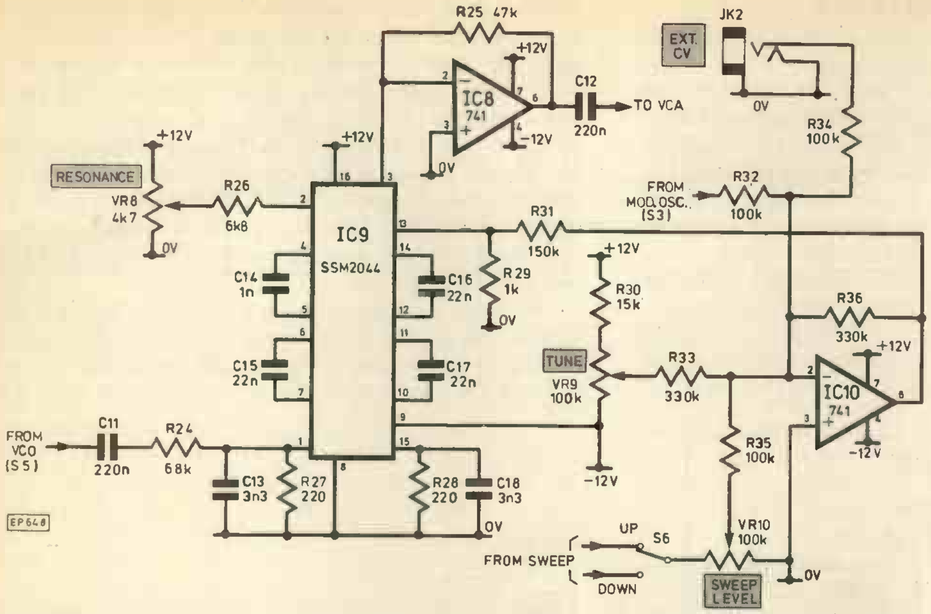



**Fig. 4. Circuit of the voltage controlled low pass filter**

by R13 and R12, and fed to pin 13 of IC5. Although some exponential oscillators using discrete components suffer from temperature drift problems in the exponential generating transistor, the on-chip exponential generator in the SSM2044 has circuitry which keeps this drift to a minimum and the prototype was found to be thermally stable, the oscillator settling down a few seconds after switch on.

The sinewave is fed to a simple comparator formed around IC4. This produces a squarewave of adjustable amplitude by VR6.

The noise generator uses a reverse biased transistor emitter/base junction (TR1) to produce white noise which is amplified by TR2 and further amplified by IC7, the gain of which can be set by VR7.

Switch S5 selects the desired output waveform: sine, square, or noise. The presets VR6 and VR7 are adjusted so that all waveforms are at the same level.

## VOLTAGE CONTROLLED FILTER

Once the basic signal has been generated, some way of controlling its timbre or tonal quality must be provided to give variation in the sound, since raw squarewave or white noise becomes boring very quickly. This quality is affected by the voltage controlled filter which is a low-pass type. This filter has an exponentially voltage controllable cut-off frequency, variable over roughly the same range as the VCO, a cut-off slope of −24dB/octave, and resonance variable up to oscillation. It uses the same chip as the VCO, the SSM2044.

The circuit is shown in Fig. 4. The same combination of control voltages as in the VCO is used in the VCF, i.e. sweep, modulation oscillator, manual, and external. These are summed in the required proportions by IC10. This provides the control voltage for IC9. VR8 provides a variable voltage which is converted to a current by R26 and controls the filter's Q. The input signal is taken directly from the waveform selector switch of the VCO. IC8 converts the output current into a voltage and buffers it, this signal going directly to the next stage.

Since the VCF's cut-off frequency is exponentially related to control voltage, as in the VCO, the VCF and VCO will track each other with fair accuracy if controlled by the same voltages. Better tracking accuracy could have been achieved using close tolerance resistors, but in this application the added expense was felt to be unnecessary.

## TRIGGER INPUT CIRCUIT

Each time a sound is required in any instrument, it must be initiated in some way, i.e. plucking a string, or pressing a key. In a drum synth the sounds are initiated by the signals from a transducer placed near to or on a drum, as mentioned earlier. These signals are of no use to the synth, since a sharp, high level pulse is required. For this reason an amplifier and pulse generator are used.

The circuit is shown in Fig. 5 and is very simple. The incoming low level signals are first attenuated to the desired amplitude by the sensitivity control VR11, and then amplified by a non-inverting, variable gain, op-amp circuit using IC11. The gain can be set by VR12 to any value between 1 and the op-amp's open loop gain (typically around 100,000). Thus by setting the gain high, when a low level signal is presented to the input, a high level, squared-up signal will appear at the output, due to the clipping action of the circuit.

To provide a stable voltage representing an on or off condition, a capacitor C20 is charged via D1 by this squared waveform so rectifying it. D1 allows only positive pulses to charge the capacitor and prevents it from instantly discharging when the op-amp output falls to zero. R38 controls the decay time of the capacitor and allows it to discharge quickly on removal of the input waveform. The voltage across this capacitor is used to trigger the monostable pulse generator formed around two gates from IC12. This triggers on the positive excursion of the voltage across C20, producing a positive pulse of around 0·01s long. This is what is fed to the circuits requiring a trigger signal.

A manual switch is included so that sounds can be set up without the unit being connected to a microphone or pickup. Also included is an external trigger input which requires a positive d.c. pulse of about 8V or above (absolute maximum 12V). When a jack plug is inserted into the external trigger socket the drum input circuit is automatically disconnected. R39 ensures that the input to IC12a is never left floating, otherwise instability could occur, causing false triggering.

## SWEEP MODULATION

This circuit, as explained earlier, provides a rising or falling voltage each time the synth is triggered. The speed of the change of voltage is controllable via the decay pot. The circuit is shown in Fig. 6. CMOS switches IC13a and IC13b, together with IC14, C22, R41, and VR13 form a simple envelope generator. IC12c is connected as an inverter so that when one of the CMOS switches is on, the other is off.

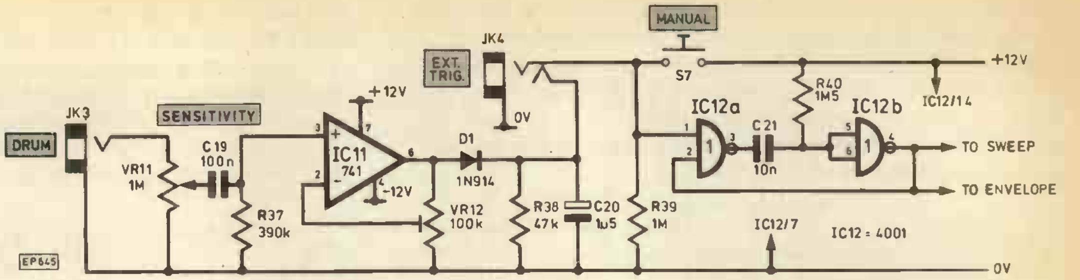



**Fig. 5. Circuit of the trigger input**

When the trigger input is low the input to switch IC13b is high and it is on, so holding C22 at ground potential via VR13. When the trigger input becomes high IC12c is switched, IC13a switches on, and C22 charges via R41 to approx. +10V. When the trigger pulse is removed IC13b switches back on again and C22 discharges to ground at a rate determined by the resistance of VR13. Thus a falling envelope as in Fig. 7a is produced. The voltage on C22 is buffered by IC14 to provide a usable output. This output is inverted by IC15 to provide the rising envelope as shown in Fig. 7b. The VCO and VCF each contain a switch which selects the direction of the sweep envelope, and a potentiometer to control the amount of sweep modulation. The decay control can vary the decay time from approximately 0·1s to 10s.

## VOLTAGE CONTROLLED AMPLIFIER

So far, since the VCO and noise generator are on all the time, the output of the drum synth would be a continuous sound, hence some method of switching on the output and controlling its decay time is required. The circuit which does this is the voltage controlled amplifier together with the envelope generator. For simulating percussive sounds, which is what the drum synth does, an envelope with fast attack time and slower decay time is necessary. This means that the sound, when initiated by the trigger pulse, must increase in volume to its maximum almost instantly, and then die away to zero at a preselected rate. To produce this effect an envelope generator produces a positive-going envelope voltage with the above characteristics which is fed to the VCA, a device which gives an output signal proportional to its control voltage, so shaping the output signal.

The circuit can be seen in Fig. 8. The voltage envelope is generated in the same manner as in the sweep generator, C23 charging via R44 to give a fast attack, and discharging via VR14 giving variable decay. Since only a positive envelope is required no inverter is included.

The VCA is based on the CA3080 transconductance op-amp i.c. This functions similarly to an ordinary op-amp but its output is multiplied by a current injected into pin 5, called $I_{abc}$. Thus by feeding a signal into the inputs the gain and hence amplitude of the signal can be linearly controlled by varying $I_{abc}$. IC17 together with TR3 and R45 convert the envelope voltage into a current suitable for controlling IC18. When IC16's output is 0V then there is no output from the VCA since $I_{abc}=0$. VR15 converts the current output of IC18 into a voltage, and also sets the volume to the output socket via C24.

## POWER SUPPLY

The synth is powered from a mains ±12V stabilised power supply. This uses two integrated circuit regulators, the 78M12 and 79M12, to provide positive and negative voltage rails as can be seen from Fig. 9. Each rail can provide a maximum of 500mA before the regulator's current limit acts. Since the drum synth draws only around 40mA from each rail, external equipment could be driven from the PSU. For instance if two drum synths were built only one power supply could supply both via a socket on the back of the case for example. Note that if the maximum current is required to be drawn then the regulators will require heatsinks. D3 shows that the power is on.

## CONSTRUCTION

Construction should begin with the preparation of the case. The prototype was housed in a rexine covered case size 13in x 8in x 4½in. The drilling dimensions are shown in Fig. 10. The diameters of the mounting holes for the switches and l.e.d. will depend on the particular components


**Fig. 7(a). Falling envelope**


**Fig. 7(b). Rising envelope**

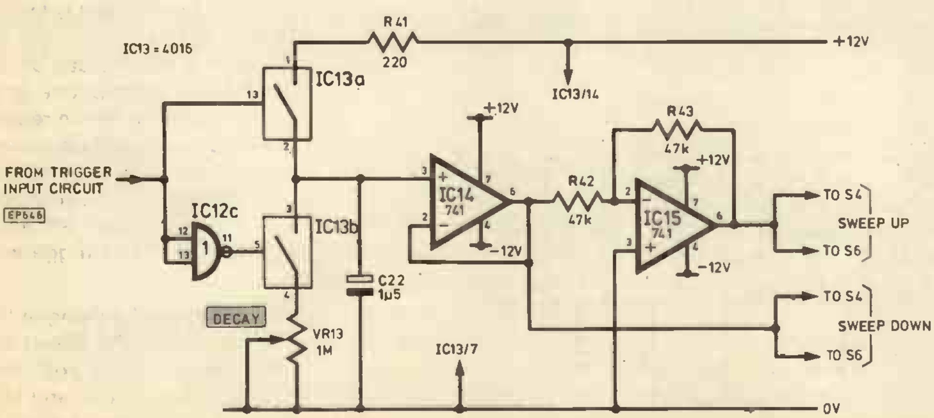



**Fig. 6. Circuit of the sweep modulation generator**

used by the constructor. Once all the case drilling has been completed, the front panel can be covered in Con-Tact or similar, or painted if desired. It can now be lettered with white rub-down lettering, and then sprayed with clear varnish to protect it. The transformer should be mounted to the back panel with 8BA bolts, and connected to the mains lead and mains switch as shown in Fig. 10.

damaged by leakage from a soldering iron tip. IC12 and IC13 should be left in their protective foam until all other circuit board construction is complete. Then they should be put into the sockets, keeping handling to a minimum.

Begin preparing the circuit board by drilling the mounting holes and making the breaks in the copper strips. Now the PSU can be constructed. When building the power supply,

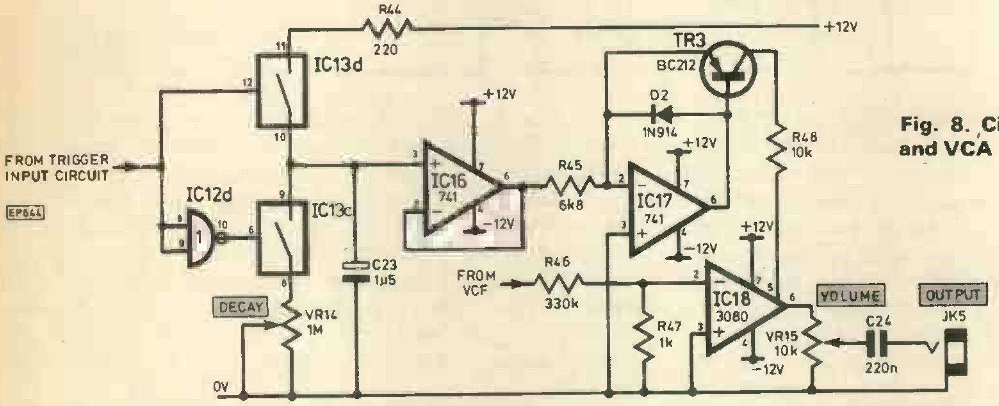



**Fig. 8. Circuit of the envelope generator and VCA**

All potentiometer spindles should be cut to length and the potentiometers, switches, sockets, and l.e.d. mounted to the panel. These should be wired up as shown, the panel mounted components being connected too. Uninsulated, single-core wire is used to link all the common connections at the back of the panel. Otherwise lightweight, stranded wire should be used for interconnection.

The use of coloured wire greatly helps in the identification of wires and their functions. A source of suitable wire is a metre of 25 or 36 core multicore cable. The wires to the circuit board need not be connected yet. Attention can now be turned to this circuit board.

Most of the components are contained on a 115 holes x 36 strips piece of Veroboard, excepting those soldered directly to the potentiometers and switches on the front panel so as to minimise the number of wires running to and from the circuit board. It is recommended that the power supply section be built and tested first. Once working this will provide power for testing the other sections. Circuit layout is shown in Fig. 11.

To make building, testing, and setting up easier, each circuit is laid out on the board so as to be completely isolated and independent from all the other circuits, apart from sharing power supply connections. This allows each one to be built and tested without having built any others onto the board. A convenient procedure is to build the circuit board up from left to right. It is recommended that i.c. sockets or Soldercon pins be used for all i.c.s particularly IC5 and IC9 to prevent them being overheated during soldering, and IC12 and IC13 since these are CMOS chips and could be

double check the polarity and positioning of all the components. Check carefully that the regulators have been inserted facing the right way round. The power supply constructed, the transformer should be connected (mains to the primary) and with a voltmeter across +12V and −12V the mains should be switched on. If there is no reading on the voltmeter then switch off immediately and check for any breaks missed out on the circuit board underside, and wiring errors. If a reading is obtained, then measure the voltage of the positive and negative rails with respect to ground. These should be approximately 12V. This being successful, the construction of the rest of the sections can begin.

The i.c. sockets should be soldered in place first since the presence of these will aid the positioning of the other components. Resistors and capacitors should be soldered in next, attention being paid to the polarity of the electrolytics and tantalums. The transistors and diodes should now be soldered, preferably using a heatshunt. Ensure that the diodes have been inserted the correct way around, the end with the red band is the end with the bar on the diagram (the cathode). Veropins are recommended to be used for all leads entering and leaving the board, as these allow wires to be connected and disconnected easily when testing etc.

## TESTING

Preliminary testing of each section as it is built can be performed as follows.

**Mod. Osc.** Connect VR1 temporarily to the circuit board. Connect an amplifier, with its volume set very low, to pin K8

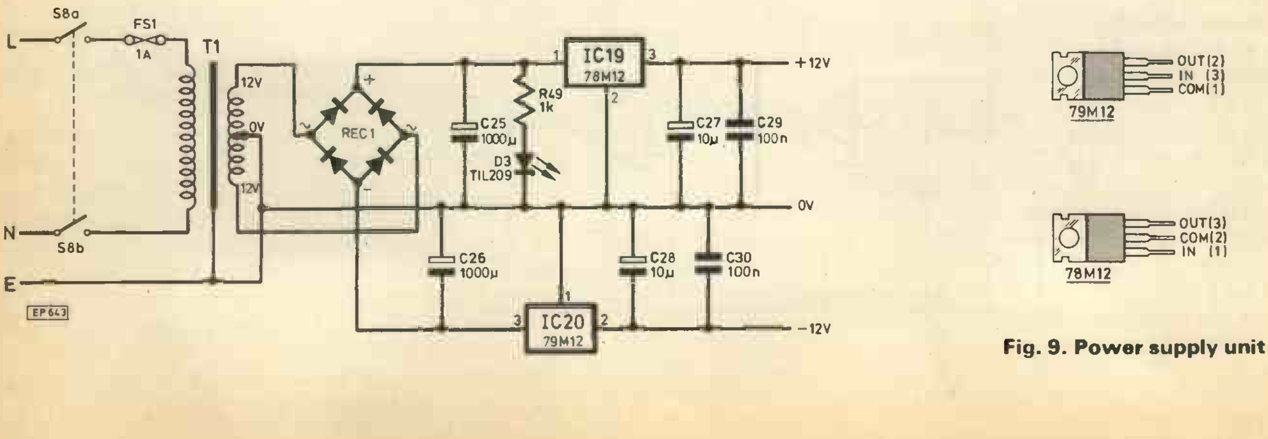
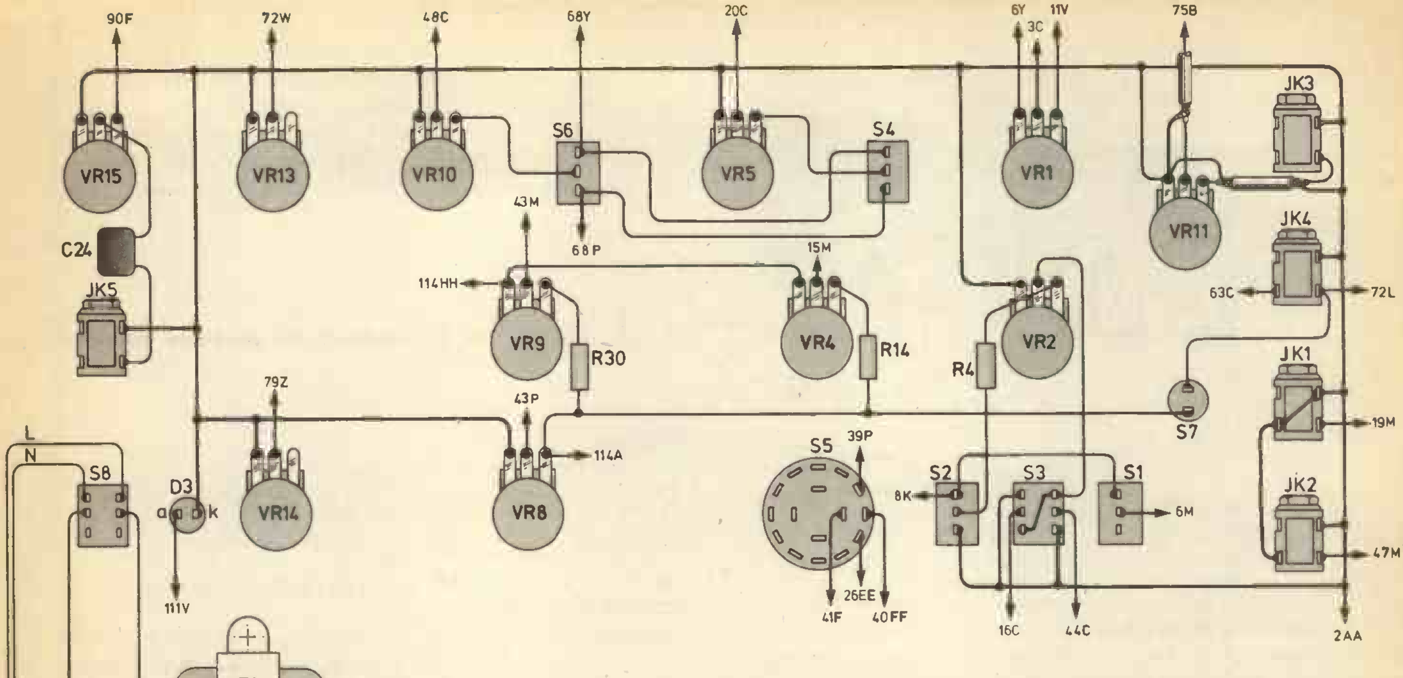



**Fig. 9. Power supply unit**



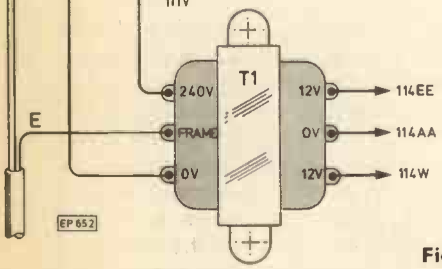




**Fig. 10. Front panel layout**

and check that a tone can be heard, VR1 altering the frequency. Short pins K8 and M6 together and the pitch should become a series of clicks.

**VCO** Adjust VR3 to max. (slider at +ve end). Connect an amplifier to pin EE26 and then pin FF40. Both should produce an audio tone.

**Noise Generator** Connect an amplifier to pin P39. The characteristic rushing sound of white noise should be heard.

**VCF** Connect pin P44 to the +12V rail and check that a tone can be heard at pin Y54.

**Sweep** Connect VR13 temporarily to the board and connect a voltmeter (25V d.c. range) with positive to pin Y68. Short pin L72 to +12V briefly and the voltage should rise on the voltmeter and then decay to zero at a rate adjustable by VR13. Also make sure that an inverted output is available at pin P68 (remember to reverse the voltmeter connections).

**VCA** Connect pin C82 to noise gen. pin P39 and solder VR14 and VR15 temporarily to the board. Connect an amplifier to pin F90 and short pin to +12V as before. The sound should be heard and then decay in volume to zero at a rate adjustable by VR14.

**Trigger Input** Adjust VR12 to nearly max. (slider near 0V). Connect a voltmeter to pin C63. The voltage should rise from zero in a positive direction when a finger is placed on pin B75 (the hum induced in a finger should be sufficient to trigger the circuit). The reading should return to zero when the finger is removed.

These tests having been successfully completed, then the circuit board can be mounted in the case using 1in 8BA bolts and $\frac{1}{2}$in 8BA spacers. The wires to the front panel can now be connected too, as shown in Fig. 10. Note that screened lead should be used on all board/front panel connections on the drum input circuitry. This completes the construction of the drum synth although the circuits are still to be set up.

## SETTING UP

For this the unit need not be connected to a drum, but should be connected to an amplifier via the output socket. An oscilloscope is a very useful piece of equipment during the setting up, but if one is not available then the process can be performed by ear. Switch the synth on and connect the 'scope or amplifier to the VCO sinewave output (pin EE26). Adjust VR3 for as pure a sinewave as possible. Make sure of the full range by observing the waveform whilst rotating VR4 between its extremes. If the waveform deteriorates or disappears then adjust VR3 until this is stopped. Note the sinewave amplitude, and now connect the 'scope or amp to the squarewave output (pin FF40). If this is impure then adjust VR3 once more slightly, rechecking the sine output. Adjust VR6 until the squarewave is at the same amplitude as the sinewave. Now check the noise output (pin P39) and adjust its level (via VR7) to that of the others. This done, if using a 'scope observe the output of the modulation oscillator (pin K8) which should be a triangle wave. All waveforms should be symmetrical about zero. The gain in the input section of the trigger circuitry should be set so that the wiper of VR12 is almost at the end connected to ground. If it is found that sensitivity is too high, or low, then this setting can be altered to correct this. Moving the wiper towards IC11 output reduces the gain. It now remains to check out each section of the synth, using the "Manual" front panel push switch to trigger it.

## USING IT

The unit will normally be triggered by a conventional drum, and several methods are possible. A contact microphone can be constructed using a small crystal microphone insert. A length of screened lead should be connected to this to allow it to be plugged into the synth. This insert can be taped onto the side of a drum so picking up the drum vibrations and triggering the unit. Low impedance transducers such as loudspeakers and earphones also will provide a trigger signal. A special drum can be constructed for use with the synth. This would include a pad for the drum stick to strike, and a miniature loudspeaker beneath this to collect the sound and provide a triggering signal. A cassette recorder microphone could be used, or virtually any other type of microphone. This would be mounted on a

# COMPONENTS

**Resistors**

| | |
|---|---|
| R1,R9,R11,R27,R28,R41, R44 | 220 |
| R2,R4,R15,R16,R18,R22, R32,R34,R35 | 100k |
| R3 | 6k2 |
| R5,R6,R48 | 10k |
| R7,R26,R45 | 6k8 |
| R8,R25,R38,R42,R43 | 47k |
| R10,R21 | 2k2 |
| R12,R23,R29,R47,R49 | 1k |
| R13,R31 | 150k |
| R14,R30 | 15k |
| R17,R19,R33,R46,R36 | 330k |
| R20 | 22k |
| R24 | 68k |
| R37 | 390k |
| R39 | 1M |
| R40 | 1M5 |

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

**Potentiometers**

| | |
|---|---|
| VR1,VR2,VR4,VR5,VR9, VR10 | 100k lin. |
| VR3 | 4k7 vertical preset |
| VR6,VR7,VR12 | 100k vertical preset |
| VR8 | 4k7 lin. |
| VR11,VR13,VR14 | 1M log. |
| VR15 | 10k log. |

**Capacitors**

| | |
|---|---|
| C1,C11,C12,C24 | 0·22µF polyester C280 |
| C2,C21 | 10nF mylar |
| C3,C8,C13,C18 | 3n3 ceramic |
| C4,C14 | 1nF ceramic |
| C5,C6,C7,C15,C16,C17 | 22nF mylar |
| C10,C19,C29,C30 | 0·1µF polyester C280 |
| C20,C22,C23 | 1·5µF 25V elect. |
| C25,C26 | 1000µF 25V elect. |
| C9,C27,C28 | 10µF 25V elect. |

**Switches**

| | |
|---|---|
| S1,S2,S4,S6 | miniature SPDT toggle |
| S3 | miniature DPDT toggle |
| S5 | 4-pole 3-way rotary |
| S7 | push-button momentary action |
| S8 | miniature DPDT mains toggle |

(All switches available from Maplin)

**Semiconductors**

| | |
|---|---|
| D1,D2 | 1N914 |
| D3 | TIL209 |
| TR1 | BC107 |
| TR2 | BC108 |
| TR3 | BC212 |
| IC1–4,IC6–8,IC10,IC11, IC14–17 | 741 8-pin IC |
| IC5,IC9 | SSM2044 (Digisound) |
| IC12 | CD4001 |
| IC13 | CD4016 |
| IC18 | CA3080 |
| IC19 | 78M12 +12V 500mA voltage regulator (Maplin) |
| IC20 | 79M12 −12V 500mA voltage regulator (Maplin) |
| REC1 | W005 50V 1A bridge rectifier |

**Miscellaneous**

| | |
|---|---|
| T1 | 12–0–12V 1A mains transformer, |
| JK1–5 | $\frac{1}{4}$in. mono switched jack socket, |
| FS1 | 1A fuse and holder |

Veroboard 115 holes x 34 strips,

| | | |
|---|---|---|
| I.c. sockets | 8-pin | 14 off |
| | 14-pin | 2 off |
| | 16-pin | 2 off |

Case: 13in. x 8in. x 4$\frac{1}{2}$in.,
8 BA nuts, bolts, and spacers,
screened cable, mains cable, stranded wire, knobs etc.

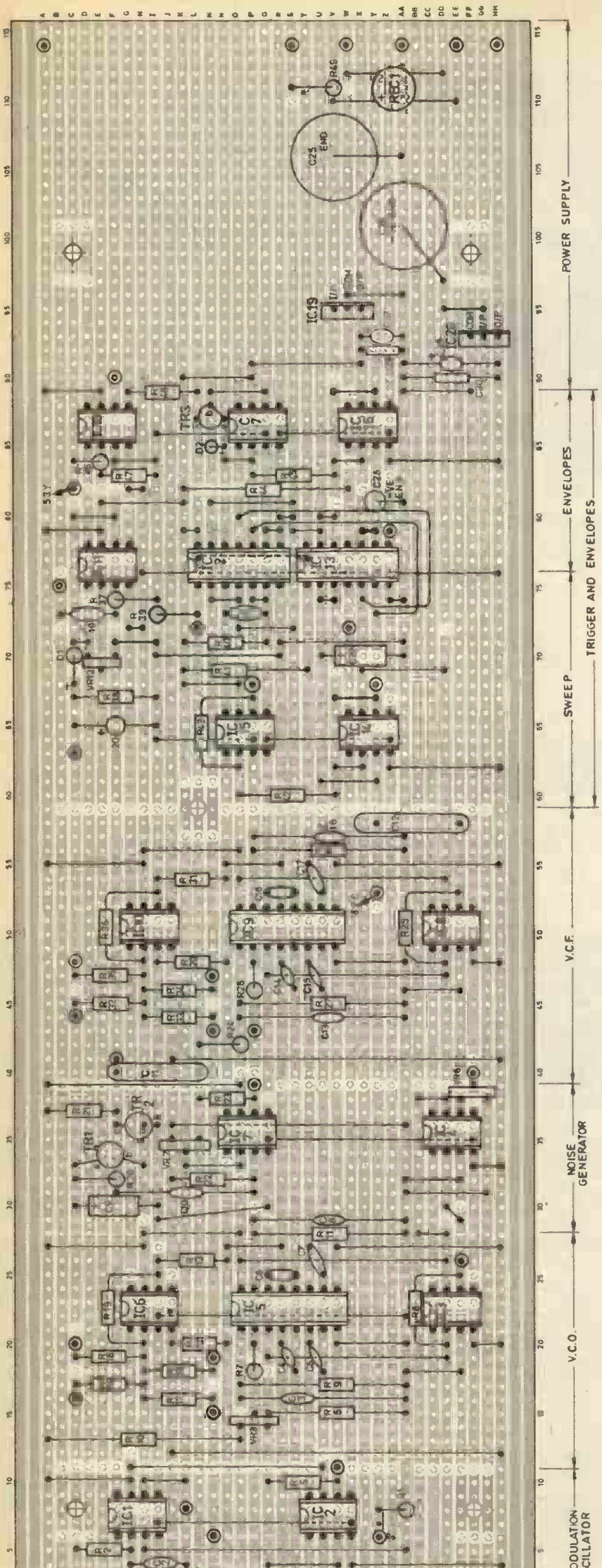
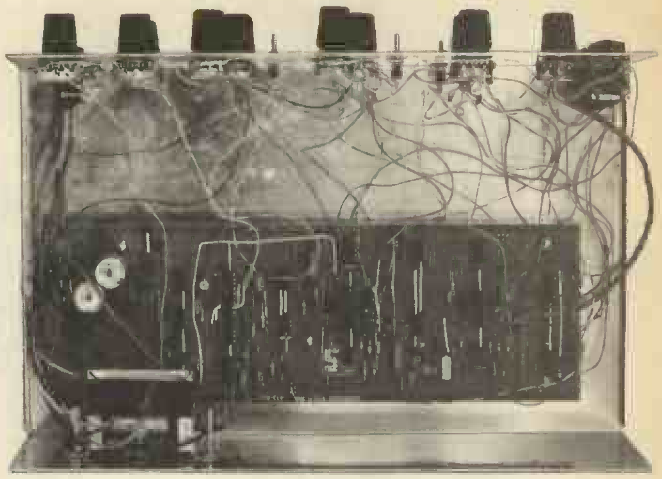



**Fig. 11. Veroboard component layout**



**Internal layout**

microphone stand and placed beneath a drum with the bottom skin removed. A Shure Unidyne B was found to trigger the synth reliably. The choice of triggering arrangement is really up to the constructor who can use a method best suited to the way he will be using the unit. It should also be borne in mind that when used with a microphone, a clap or even a shout can be used, so extending the versatility even further.

## VCO/VCF CONTROL INPUTS

The external control voltage inputs for the VCO and the VCF are included so as to extend the usefulness of the synth. These may be used with any device which produces a control voltage (absolute maximum 12V) such as a foot pedal or another synthesiser. These sockets were primarily designed to allow the synthesiser to be connected to a sequencer, the ext. trig. input also being used, requiring a positive pulse. The control voltage law is around 3 volts/octave, but it should be noted that the VCO and VCF may not be accurately exponential over their full range since component tolerances, the lack of temperature compensation, and the use of 741 op-amps may cause inaccuracies. Nevertheless, they are fairly exponential over the central part of their range. The use of even a simple sequencer allows a wide range of rhythms to be generated.

With the VCA "Decay" control adjusted for a short, slight decay and the sine output of the VCO being used, an ordinary drum sound is produced, from a bass drum through to bongos and woodblocks as the VCO "Tune" control is adjusted. Increasing "Decay" and adding "Down Sweep" to the VCO produces the well-known "pew-pew" disco Syndrum sound. Using the square output of the VCO, synthesiser "waa-waa" sounds can be obtained by increasing "Sweep" on the VCF. Adding low frequency modulation to the VCF in large amounts produces a burbling noise. Using "Noise" and "Sweep" on the VCF, noises varying from sea and thunder to jet-plane whooshes can be achieved by varying the VCF "Tune" and "Resonance" controls. With a short, punchy VCA decay, and a suitably set VCF, snare drum sounds can be obtained using "Noise". Obviously these are just a few of the sounds which can be produced, and the limit is really the user's ingenuity. ★

# Semiconductor UPDATE...

## FEATURING MC13002 GL-105XX IR-2E01

R. W. Coles

### ANALOGUE LSI

Large Scale Integration (LSI) is an everyday technology to be found in nearly every home in the country, living inside calculators, electronic games, door-chimes, personal computers and the like. The thing you may have overlooked about this new domestic revolution is that all of these LSI based gadgets are essentially *digital* in design and construction. In other words, they are either dedicated logic arrays made up of a custom arrangement of gates, or they are a form of dedicated microprocessor, made into a door-chime, for example, by a custom program inserted during the manufacturing process.

Any analogue functions that do crop up in these gadgets are either provided by external circuitry, perhaps using Small or Medium Scale Integration, or are implemented on the mainly digital LSI chip using a certain amount of "Electrickery" to bend digital gates to an analogue function. Needless to say, the performance of analogue circuitry produced using this latter method leaves a lot to be desired, although for interface to game paddles or other simple transducers, which do not require high precision or high frequency processing, the method can be made quite adequate.

The reason for all this is that making logic gates is kids' stuff in comparison with making, for example, a stable High Frequency amplifier with very low distortion, and anyway the High Frequency system would probably need bulky external reactive components such as i.f. transformers so in the past there hasn't been much commercial pressure to achieve the ultimate in miniaturisation. Technology marches inexorably on, and the thoroughbred microprocessor chips, now moving rapidly into the VLSI era (the V stands for Very!) are starting to look askance at their analogue "poor relations" and wondering whether they really relish the prospect of having to shake hands with tatty old analogue SSI chips which are not really in the same class of Silicon at all!

In addition to that rather whimsical interpretation of the situation, it can certainly be stated that there are now increasing commercial pressures to introduce radically new "miniature" analogue gadgets such as televisions in the mould of the Sinclair Microvision. The trouble seems to be that the manufacturers have saturated the market with televisions to the extent that most trade now comes from the trickle of sets bought as replacements for obsolete or expensive-to-repair models, and from those customers who are prepared to buy a new set if it features innovations such as Teletext, Viewdata, or small size.

There isn't a lot that can be done about the wear-out market (Built-in premature wear-out would NOT be popular with the customer!) but new ideas and extra features will always find a market, and hence the pressure to produce LSI components for televisions, so that they can be turned into the equivalent of the humble "tranny" radio, small and cheap so that families will aspire to owning not two sets but three, or even four!

### MONOMAX

One expression of the effect of this pressure is a new wonder chip from Motorola. Coded the MC13002 in its 625-line European version, this device makes possible a television using only two integrated circuits, a tuner module, and six transistors for power output stages. The chip carries out all the video processing functions required by a black and white television, and (this is the important bit) the chip requires only ONE external passive component, actually a high stability resistor for an on-chip oscillator, replacing hordes of resistors, capacitors, and chokes in the conventional layout. The nickname Monomax is meant to indicate that this is the maximum number of parts for a monochrome TV currently possible on one chip, but Motorola also predict that a COLOUR version will become available fairly soon.

On the MC13002 you get a 100 microvolt input sensitivity at an i.f. frequency of 35 to 60MHz, 2·5V of sound i.f. output, and 1·2V of video signal. Subsystems on the chip include a video i.f. amplifier, detector, AGC and noise processor system, horizontal and vertical sync generators and signal processors, a video processor and a power supply regulator. The second chip you need to add is a device such as the TDA1190P sound channel processor which is already with us, and also uses few external passive components. The Monomax will run from supplies between 10·8 and 15 volts, and dissipates less than 500mW, making it ideal for miniature battery powered TV sets. It is, however, not limited only to the portable sets, its signal processing is good enough for sets with much bigger screens using mains supplies.

The chip itself is not huge by digital standards but it does include 200 linear bipolar devices and 200 logic gates ('fraid you can't do anything these days without a FEW gates!), and it will soon be one of those jelly bean parts which will only set you back a couple of pounds or so.

### BAR TALK

Digital displays are excellent for high precision measurements of parameters which change only very slowly with time, but if the rate of change or the peak value of a changing signal carries valuable information then a digital meter is excruciatingly difficult to use. (Hands up all those who decided to "get with it" by buying a digital multimeter, only to discover they still needed one of the steam versions for a surprisingly wide range of jobs. Me for one!)

If you need a simple analogue display device for a project, and you don't like the idea of using a delicate, bulky, and expensive moving coil meter don't despair, use a solid state bargraph display with a row of l.e.d.s which light up progressively to indicate signal level. This system isn't going to win any prizes for precision, but it will provide you with a compact and rugged indicator which gives easily interpreted information on rates of change and signal excursions. All you will need is a row of l.e.d.s, a handful of comparator circuits, a voltage reference generator, and a bunch of resistors to set the thresholds of each comparator and the l.e.d. currents. Oh, and if you need to respond to an a.c. signal, for a VU meter perhaps, then you will need a signal amplifier and a detector to give a reasonable drive for the comparators.

If that doesn't sound too simple to you, it's probably because you haven't run into a family of bargraph components recently introduced by Sharp of Japan, which actually make the whole job as easy as pie. The family consists of 11 l.e.d. bars, some with five points, coded GL-105XX, and some with seven points, coded GL-107XX, in a very wide choice of colours including composite types where the first (say) five points are in "restful" green, and the remaining two points are in "watch-it!" red. Complementing the displays, Sharp have two driver chips, the IR-2E01 for five point displays, and the IR-2E02 for the seven point versions. Inside these chips you get a signal amplifier, detector, voltage reference, comparators, resistor chain, and constant current l.e.d. drivers with the only extra components required being a single l.e.d. current setting resistor, and the smoothing and gain setting components of your choice for the signal amplifier, which is only required for low-level a.c. inputs anyway. There is even a pin which gives a logic output when a signal large enough to turn on the least significant l.e.d. is present.

Both drivers come in 16 pin plastic d.i.p.s and will perform on supply voltages of up to 18 volts. How's that for simplicity!

# Digital Design Techniques...

Tom Gaskell B.A.(HONS) ELEC. ENG.

## Part 2 Power Supplies... Inputs & Outputs

LAST month* we worked through some of the theory surrounding digital circuit design, and we looked at logic families and logic gates. This month we launch into some of the more practical aspects of designing and constructing with digital i.c.s.

As discussed in Part 1, TTL requires a 5 volt supply, well regulated and of a fairly high current. The range of voltage allowed is actually from 4·75V to 5·25V for normal operation; outside this range and the i.c.s may not work properly, and any voltage higher than 7 volts will destroy the i.c. Regulation and ripple should both be better than 5%. Standard TTL takes typically between 12 and 30mA per package, and LS (Low Power Shottky) TTL typically 1 to 3mA, hence the power supply should be well decoupled to prevent spurious voltages on the power supply rail from affecting logic operation. This is best done by connecting 0·1µF disc ceramic capacitors across the power supply rails, as near as possible to the i.c.s themselves, at a rate of one capacitor per 3 to 5 i.c.s. Several 10µF 25V capacitors can also be added, per board, across the supply rails. The power supply tracks should be as broad and short in length as possible.

The +5V supply to TTL is called Vcc (stands for Voltage to the Collectors).

The 0V supply to TTL is called Ground (abbreviated to GND).

It is usual to earth the "Ground" line to mains and chassis earth at one point only, to avoid hum and earth loops; there should be one connection from mains earth to the chassis, and one connection from mains earth to 0 volts; at the power supply preferably.

### CMOS

This is a much more tolerant family with respect to power supply requirements. The supply to the latest "B" series of CMOS can be anything from 3 to 18V although it is usual to see it being used in the range 5 to 15V. Below 3V will cause the i.c. to malfunction, and above 18V can cause permanent damage. Because of this wide voltage range, ripple and regulation need not be as critically controlled as with TTL supplies, although it is always a good idea to have as smooth and well regulated a supply as possible; because of the lower power consumption of CMOS this is fairly easy to do. Decoupling is not necessary to the same extent as with TTL; one or two 0·1µF disc ceramic capacitors per board is more than adequate under normal conditions. Again, the shorter and wider the power supply tracks the better, but this is not as critical as with TTL.

*See the Points Arising on page 21

The +VE supply to CMOS is called Vdd (stands for Voltage to the Drains).

The 0 volts supply to CMOS is called Vss (stands for Voltage to the Sources).

Although it is usual to earth the Vss supply rail to mains and chassis earth at one point (as with TTL), it is occasionally more convenient to earth the Vdd supply instead. (If you ever do this, beware of incoming signals that may be of different polarity).

The majority of CMOS circuits can be quite easily and effectively run from a simple small battery; such as a PP9 and 9 volts is an ideal voltage. TTL is much more difficult to power by batteries as regulation is needed, and the battery life will be very limited. Whatever power supply you use, be very careful to connect it the right way round!! Both CMOS and TTL can be easily damaged by mis-connection of the supplies.

The use of mains powered supplies can be costly in small projects, but pays off very soon in larger systems. Quite simple supplies can be used, with i.c. voltage regulators providing control of the output. Fig. 2.1 shows a suggested mains power supply, which is conventional and self explanatory. The four diodes (or bridge rectifier) rectify the a.c. from the transformer to full-wave d.c., which is smoothed by C1. The voltage regulator stabilises and regulates this voltage, while C2, C3 and R1 prevent unwanted oscillation of the i.c. itself. For currents above 100 or 200mA, the voltage regulator should have a heatsink fitted, although it is well protected; these i.c.s have built in thermal overload and short circuit protection. Although 5 or 12 volt regulators can be used with the transformer intended for the 15 volt regulator, their power dissipation will be considerably more, and they are likely to require more heatsinking than if they used lower input voltages. Note, though, that the input of

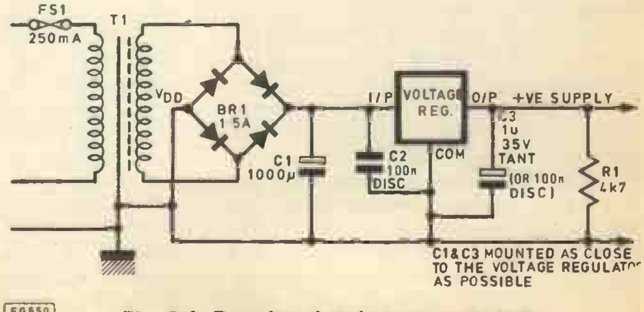



Fig. 2.1. Regulated mains power supply

the d.c. level should be 3 volts or more above the required output voltage to allow the regulator i.c. to work properly. Remember that the d.c. voltage level is the transformer secondary a.c. r.m.s. voltage multiplied by 1·414 minus 1·2V (the two diode drops);

V.d.c. (Unreg)=(1·414 V.a.c.)—1·2

## INPUTS AND OUTPUTS

Fig. 2.2a shows the circuit diagrams of TTL and CMOS input and output configurations. The TTL inputs have single protection diodes, and are frequently connected to multiple-emitters of the TTL input stage; these are specially formed transistors with several emitters. Each emitter can behave conventionally on its own, or can act together with the other emitters forming the relevant logic function. The use of this type of transistor removes the need for more active elements and diodes on the input, and speeds up operation of the circuit. The output stage has a fairly high current sinking transistor to speed up the change from logic 0 to logic 1. This configuration is known as a "Totem Pole" output.

Because of the very high input impedance of CMOS and the danger of static charges causing damage, the inputs have a resistor/diode network as shown in Fig. 2.2b. This input network should not be relied upon to "catch" high voltages applied knowingly to the inputs—that should be done using external diodes—but they are quite effective at protecting against static and other transient damage. The moderately high output impedance (usually in the range of 200 to 500 ohms) can also result in damage being done; hence the output protection diode configuration.

The relative performance of TTL and CMOS inputs and outputs is shown in Fig. 2.3; these are typical limits for the majority of logic inputs and outputs in each family.

## UNUSED INPUTS

If the logic input to a TTL i.c.is left "floating", i.e. not connected to anything, it will naturally go to a logic 1 state. In this condition though, it is very susceptible to noise, transient spikes of voltage, etc. In critical cases the unused input should be connected to Vcc with a 1kO resistor. Note that several inputs can be paralleled; only one 1kO resistor is needed for up to 10 paralleled unused inputs. (Never connect a TTL input directly to Vcc—transient voltages can very easily destroy it if this is done without a series resistor.) If the logic input is not critical of the occasional spurious pulse, of course, no resistors are needed because the input can be left to "float". If a logic 0 state is required for an unused TTL input, connect that input directly to ground, NOT via any resistor. Of course, any unused logic input can be connected to any logic output, as long as fan-out is not exceeded (see below). Note CMOS inputs must never be left floating.

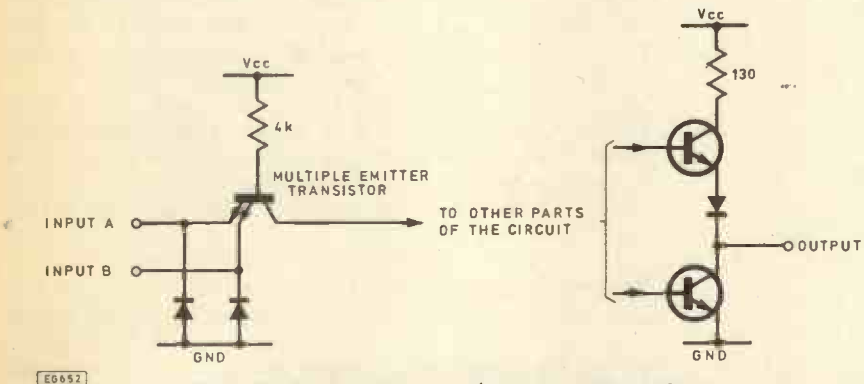



**Fig. 2.2a. Typical TTL input/output configurations**

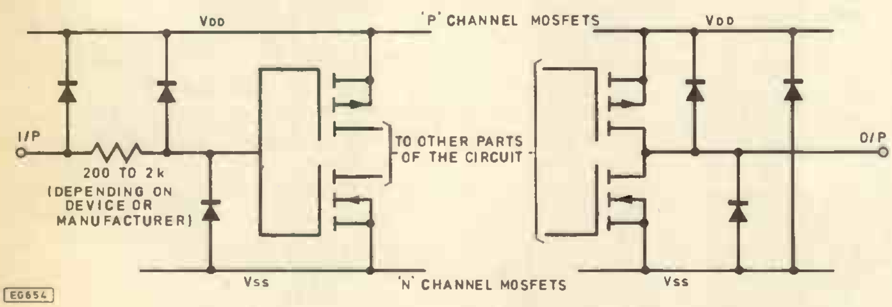



**Fig. 2.2b. Typical CMOS input/output configurations**

| PARAMETER | STANDARD T.T.L. 5V SUPPLY | CMOS 5V SUPPLY | CMOS 15V SUPPLY |
|---|---|---|---|
| Output voltage in logic 0 state (min) (at low output currents) | 0 | 0 | 0 |
| Output voltage in logic 0 state (max) | 0·4V | 0·01V | 0·01V |
| Output voltage in logic 1 state (min) | 2·4V | 4·99V | 14·98V |
| Output voltage in logic 1 state (max) | 3·3V | 5V | 15V |
| Typical max output current in logic 0 state | 12mA | 0·5mA | 0·6mA |
| Typical max output current in logic 1 state | 4mA | 0·3mA | 0·5mA |
| Typical quiescent supply current for whole i.c. | 15mA | 0·005μA | 0·005μA |
| Maximum input current (typically) | 1mA | 10pA!! | 10pA!! |
| *Maximum* voltage at input which is still seen as logic 0 (i.e. lower threshold) | 0·8V | 1·5V | 6·5V |
| *Minimum* voltage at input which is still seen as logic 1 (i.e. upper threshold) | 2·0V | 3·5V | 8·5V |

**Fig. 2.3. Input/output performance of TTL and CMOS**

## FAN IN/FAN OUT

Any logic output can only satisfactorily drive up to a certain number of logic inputs. For standard TTL the limit is 10 logic inputs, for CMOS it is greater than 50. To increase the number in either case, it is necessary to make one or more of the logic inputs being driven that of a buffer (or two inverters in series). The output of this buffer stage can then go out to drive a further 10 or 50 gates, as appropriate.

## DRIVING LOADS

The input/output performance chart of Fig. 2.3 shows that, whereas TTL can drive small loads reasonably successfully; 4mA for logic 1 typically, and 12mA for logic 0, CMOS is very poor indeed at load driving. (To be on the safe side, you should always use TTL load driving at logic 0, i.e. current "sinking". It is generally far better at this than current sourcing). In both families there are special i.c.s which are designed to make interfacing and driving loads somewhat easier.

In TTL this is mainly provided by "open collector" outputs; i.e. the final output is an *npn* transistor, with its emitter connected to ground and its collector taken directly to the output pin; there is no pull-up to Vcc. Many logic gates and other logic devices can be provided with open-collector outputs; these can drive l.e.d.s, relays or other similar loads directly, fed from the Vcc supply rail or even a higher voltage than Vcc in some cases. Figs. 2.4a and 2.4b show the arrangement of such types of load driving. When an inductive load (e.g. a relay) is used, don't forget the statutory protection diode across it, to protect the TTL output transistor from huge reverse voltage spikes caused by the back e.m.f. from the load.

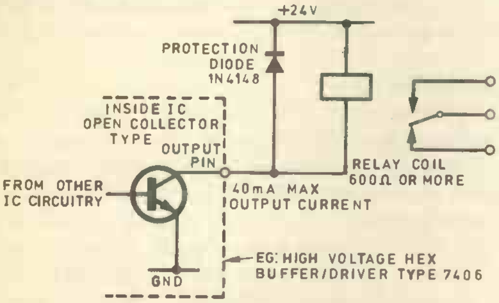



**Fig. 2.4a. Open collector driving of a l.e.d.**

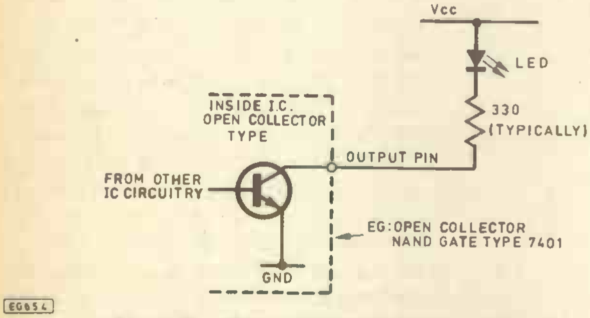



**Fig. 2.4b. High voltage driving of a relay**

CMOS i.c.s type 4049 and 4050 are inverting and non-inverting buffers respectively, with six buffers in each i.c. package. They are designed primarily to enable CMOS devices to drive TTL inputs, but are useful generally as high current drivers. Although their source current is only between 1 and 2·5mA, they can sink 6mA at 5V, and more than 16mA at 15V—a very handy amount of current, which can drive l.e.d.s, some relays and similar loads. The inputs of these devices are unusual, in that they can be fed with logic levels between +3V and +15V, yet the power supply can be different in voltage; for example, the i.c. can have an input range of 0 to 15V, yet a supply rail of only +5V, in which case the output voltage range is 0 to +5V. If the supply rail is 15V, then the output range becomes 0 to +15V. When using these devices to drive several loads simultaneously, be aware that the maximum power dissipation for the i.c. package is 200mW, and above this thermal damage can occur.

For displaying information on "7-Segment" l.e.d. displays (i.e. the type found in many calculators and clocks) a decoder/driver is available in CMOS; the 4511. This is designed to have a high current source capability to make interfacing with displays easier, and has a capability of driving up to 25mA per segment. We shall look into the driving of 7-segment displays later in the series.

Finally, the 4017 CMOS "Decade counter" is able to drive l.e.d.s directly, due to its internal current limiting on outputs. The actual device itself will be looked at later, so for the moment it is sufficient to mention that it has this output capability. See Fig. 2.5a. Direct driving is only safe at sup-

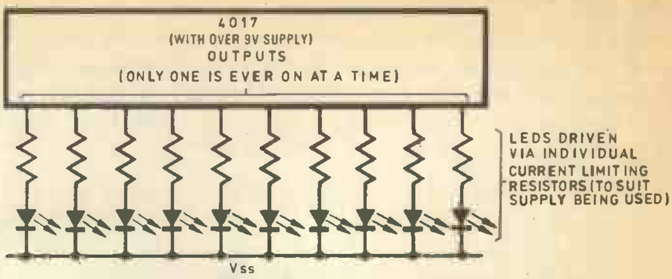



**Fig. 2.5a. A 4017 driving l.e.d.s with Vdd>9V**

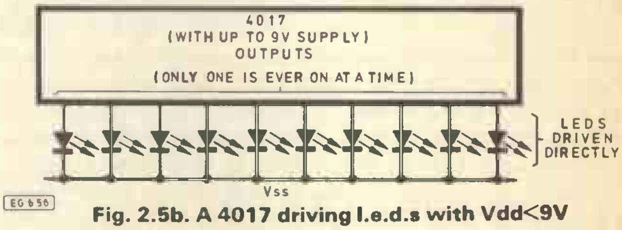



**Fig. 2.5b. A 4017 driving l.e.d.s with Vdd<9V**

plies of up to 9 volts; above this, individual resistors should be used in series with each l.e.d. as shown in Fig. 2.5b. Since only one output is ever on at once, there may be a temptation to connect all the l.e.d. cathodes together, and take them down to Vss with a single common resistor; this is a temptation to avoid! The l.e.d.s can break down when reverse biassed, which they all would be with the exception of the l.e.d. that's turned on, and this can cause large currents to flow in the 4017 output stages, resulting in possible damage. So, for a Vdd of over 9 volts, stick with the circuit of Fig. 2.5a.

## CURRENT BOOSTING

A simple way of doubling the output current of a CMOS logic gate is to connect another gate in parallel! Simply join up the inputs of the two gates and the outputs. The two gates (or more) should be in the same i.c. package, though, because variations in transfer characteristics between packages could cause large transition currents to flow. This paralleling procedure also applies to TTL but is used less due to the inherently higher output currents of TTL.

The usual method of boosting output current is to add a small extra circuit; examples are shown in Fig. 2.6. In prac-

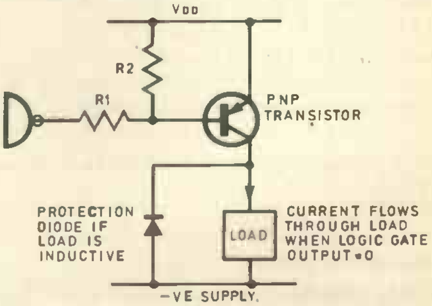



**Fig. 2.6a. Load driving circuit for logic 1**

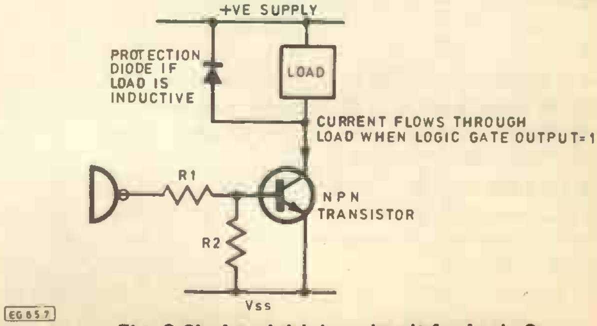



**Fig. 2.6b. Load driving circuit for logic 0**

tice, the values of R1 and R2 are determined by the gate output capability. If we assume 0·3mA maximum output current for the gate, then resistor R1 will be:

$$R1 = \frac{(Vdd—0{\cdot}6)}{0{\cdot}3} \text{ (approx.)}$$

R2 ensures that the transistor turns fully off when the logic gate output has gone back to the state which results in no current flowing through the load. A good "rule of thumb" is to make it very roughly one third of the value of R1, so:

$$R2 = \frac{R1}{3} \text{ (approx.)}$$

Since the transistor base current is limited by these resistor values, it follows that the transistor gain determines the maximum current that we can expect to drive through the load. For conventional medium to high gain silicon transistors we can obtain currents of at least 30mA using this technique, usually even more. If considerably more current than this is required it will be necessary to add extra stages of transistor drive circuitry in "darlington" or other fairly conventional circuit configurations.

One of the easiest ways to interface loads with CMOS and TTL logic is by using VFETs. These are high power handling f.e.t.s with extremely low input current requirements. The circuitry couldn't be easier; see Fig. 2.7. Note that many

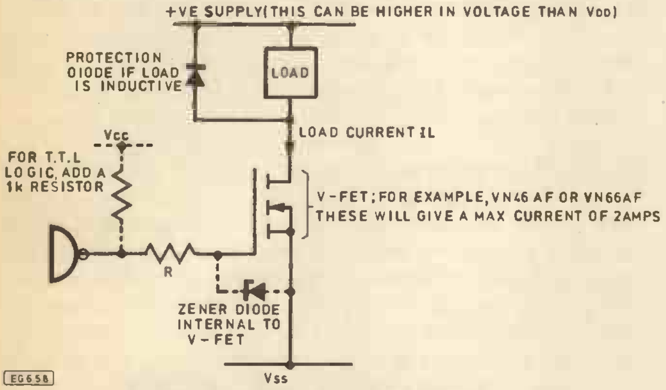



**Fig. 2.7. VFET interface circuit**

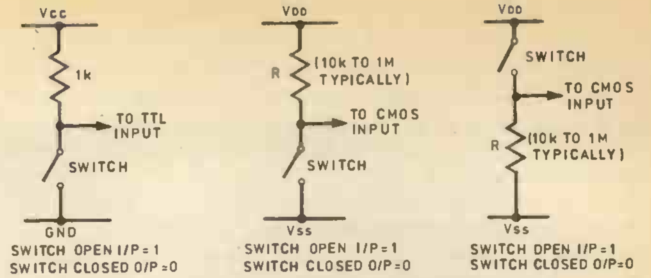
VFETs have a 15V Zener diode between their most negative point and their gate, as a protection device. If Vdd is 15V or lower, there is no problem and the resistor R can be left out, with the output of the CMOS device connecting to the VFET gate directly. For a Vdd of 15 to 18V, resistor R should be added to limit the current passing into the Zener diode; a typical value would be 100k. Although they are not cheap, these devices are slowly falling in price, and they do represent a very easy and effective way of interfacing logic with high current loads.

## LOGIC AND SWITCHES

In most logic circuits there is a requirement for human intervention or operation by means of a switch. This is a simple matter if the switch function is basic; re-setting a counter, switching on a l.e.d. via some interface logic, or whatever. Fig. 2.8 shows these basic switch circuits. Note, that in order to reverse the switch action of the TTL circuit an inverter of some sort must be added; the switch cannot be taken to Vcc in the same way as with CMOS.

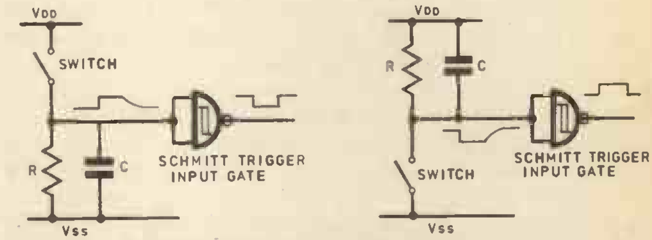
## CONTACT BOUNCE

The problem with the circuits in Fig. 2.8 is that of "contact bounce". All mechanical switches suffer from this problem. When the switch is activated the "wiper" or moving contact swings across to touch a fixed contact. As they touch there is a momentary period when the contacts "bounce" apart,




EG659 **Fig. 2.8. Simple logic input switches**

then make contact again, then bounce apart, etc., etc. This process can last for several milliseconds before the logic level coming out of the switch finally becomes stable. This "bounce" can result in spurious pulses being fed into logic inputs, in turn leading to false operation of the circuitry. In many cases these spurious pulses may not matter, but where they could cause problems a "de-bouncer" circuit is needed. The most simple of these simply stretches any pulses to such a duration that they all "merge" into one another, and the logic change is a single one without any pulses; this pulse stretching circuit is one that we looked at last month, and is shown again here in Fig. 2.9 (TTL should not use the versions shown in Fig. 2.9; the "latch" debouncer circuit described next month should be used instead.)




EG660 **Fig. 2.9. Simple contact de-bouncing circuits for CMOS logic for either a 0 or 1 output.**

The time constant RC should be long enough to maintain the logic level during the entire period of contact bouncing; typical values are 100k and 0·1µF, or even 1M and 0·1µF These circuits can be effective in many applications. With poor switches, and in particularly critical circuitry, though, the occasional small pulse can still get through. Electrically noisy environments can exaggerate this problem, needless to say. Next month we shall be looking at a more sophisticated circuit for switch de-bouncing as well as touch switches, timers, oscillators and testing. But now we'll turn to the practical aspect of the series and look at constructional techniques and the first of our mini-projects the Multi-Alarm.

## CONSTRUCTIONAL TECHNIQUES

There are two basic approaches to building logic circuits; the components and link wires can be plugged into and built up on a "breadboard" or a "printed circuit board" (p.c.b.) can be made up from a specially designed master artwork, and the components all soldered onto this, with most interconnections being done automatically by the p.c.b. tracks.

## BREADBOARDS

These are wafer-shaped plastic blocks, with a large number of small holes in an 0·1 inch grid. Beneath this pattern of holes sit a number of high quality spring clips which grip wires and component leads pushed through the holes, and interconnect them in groups of five "holes" at a time. Interconnection between groups of sockets can be done by using insulated single cored wire, stripped back at each end.

Because no soldering is involved, there is no risk of heat damaging components. All parts can be used and re-used "ad infinitum" and component values can be experimented with and selected very rapidly. Wiring changes and i.c. changes are, of course, virtually instantaneous. Along each long edge of the breadboards there are continuous rows of holes which act as power supply distribution to all parts of the circuit.

## PRINTED CIRCUIT BOARDS

These are more robust and compact than breadboard circuits, but can take a long time to make, or are expensive to buy. Changing interconnections is very messy; tracks must be cut and wire links added. Changing components is a slow process, and if repeated several times it can cause the copper track to peel away from the board; for this reason, i.c.s are best fitted into good quality i.c. sockets. (Never use "cheap and cheerful" sockets, because unimaginable problems can be caused by oxides forming on the contacts, and the contacts losing touch with the i.c. pins).

"Stripboards" are a mixture of the flexibility of breadboards and the robustness of p.c.b.s. They have strips of copper on a p.c.b. type basis, with arrays of holes on an 0·1 inch grid. Connections are by soldering, and areas of the board are linked together with wire links again. The most well known type of stripboard is "Veroboard". Another type is called "Matchboard" which have the tracks ready cut and laid out in the same layout as breadboards. This enables breadboard designs to be instantly transferred across to the more permanent "Matchboard" without needing to cut tracks and without needing to re-lay the circuit.

## CONSTRUCTIONAL AND CHECKING HINTS

For complex circuit layouts, a good idea is to trace or photocopy the circuit or layout diagrams then draw in the interconnection on this in red pen as you add them. In this way, should your train of thought be disturbed, you won't have forgotten how much you have done.

Beware of trying to force i.c.s into socket or breadboards if their "leg" spacing seems too wide. The solution is to lie all the legs on one side of the i.c. on a metal sheet or plate on the bench, and apply gentle pressure to the whole i.c. to bend the legs nearer to being at right angles to its body. Then turn the i.c. over, and repeat the procedure for the opposite row of legs. Only a tiny movement of the legs is needed, and BE GENTLE! The i.c. should then slot more easily into the socket contacts.

Before switching on, check that the power supply or battery is connected the right way round, and visually check for any obvious short circuits. If possible, check the inter-wiring. A short cut way of doing this fairly effectively is to look at the circuit assembly, and find any i.c. pins which are not connected to anything; check back with the circuit or layout diagram to see if those pins really should be connected to something or not. Not all i.c. pins are used, but this method can show up a surprising number of faults nonetheless. Finally, ensure that all CMOS inputs not being used are connected to the 0 volts supply (Vss) or the +ve supply (Vdd), or another CMOS output. Whatever you do, don't apply any signals into an i.c. without its power supply being turned on.

## THE MULTI-ALARM

This is a multi-purpose project, which can be used in many different ways. Basically, it's an 8 input alarm system; a negative edge on any input switches on a relay (to drive an alarm bell or similar, external to the unit), and light up a front panel l.e.d. to indicate which channel or channels the alarm was triggered by. A "reset" switch is provided, as is an "arm" switch, which sounds a buzzer for 30 seconds and disables the alarm system, to allow you to get clear of the sensors before the alarm is activated.

The alarm sensors can be anything you want them to be! Make switches, break switches, touch switches, water-level switches, light level switches and even switches that sound the alarm when you break a light beam. Any of these, and more, can be incorporated, with any mixture of different types in the one unit. The Multi-Alarm, then, can be used not only as a simple burglar alarm, but as a general purpose monitor/alarm system.

## CIRCUIT DESCRIPTION

The circuit diagram of this Multi-Alarm which is shown in Fig. 2.10 is based on Schmitt trigger input NAND gates, connected in pairs as latches. Because Schmitt devices are used, the inputs to these latches can be touch switches, slowly changing voltages, etc., which gives the system its flexibility. One output of each latch lights a l.e.d. via a conventional transistor driver circuit, to indicate that the channel has been triggered. The other latch outputs feed the input of an 8 input NOR gate, IC5. Hence, if any latch is operated; the output of IC5 goes to logic 0, which is inverted by IC6b, and turns on relay 1 via R33, R34 and TR11 (a standard transistor driving stage). D12 protects the transistor from back e.m.f. voltage surges. The relay contacts are used to sound an external alarm.

When the "arm" switch S2 is pressed, this starts the timing period of IC8, which is a standard 7555 i.c., connected as a timer. R28 and C3 set the timing interval of 30 seconds approximately. When the timing period starts, the output pin 3 of IC8 goes to logic 1, which is inverted by IC7d, and fed to IC7b pin 6. Since IC7a and IC7b are connected as an oscillator of approx. 1kHz, this input of logic 0 starts the oscillator, which feeds the loudspeaker via TR9 and TR10. Two transistors are used in a "darlington" configuration to give more current gain and hence drive the low resistance of the loudspeaker directly. RL is included if the loudspeaker is a low impedance (4 ohms to 40 ohms), and is a 1 watt resistor, to limit power dissipation in the loudspeaker . . . and reduce the very noisy level! D11 protects TR9 and TR10 from back e.m.f. voltage surges. The transistor driver stage is fed from pin 4 of IC7b, instead of pin 3 of IC7a (which would be more usual), in order that the input to the driver stage is at logic 0 when the oscillator is turned off, preventing a continuous current flow through the loudspeaker.


**Front and rear views of the Multi-Alarm**

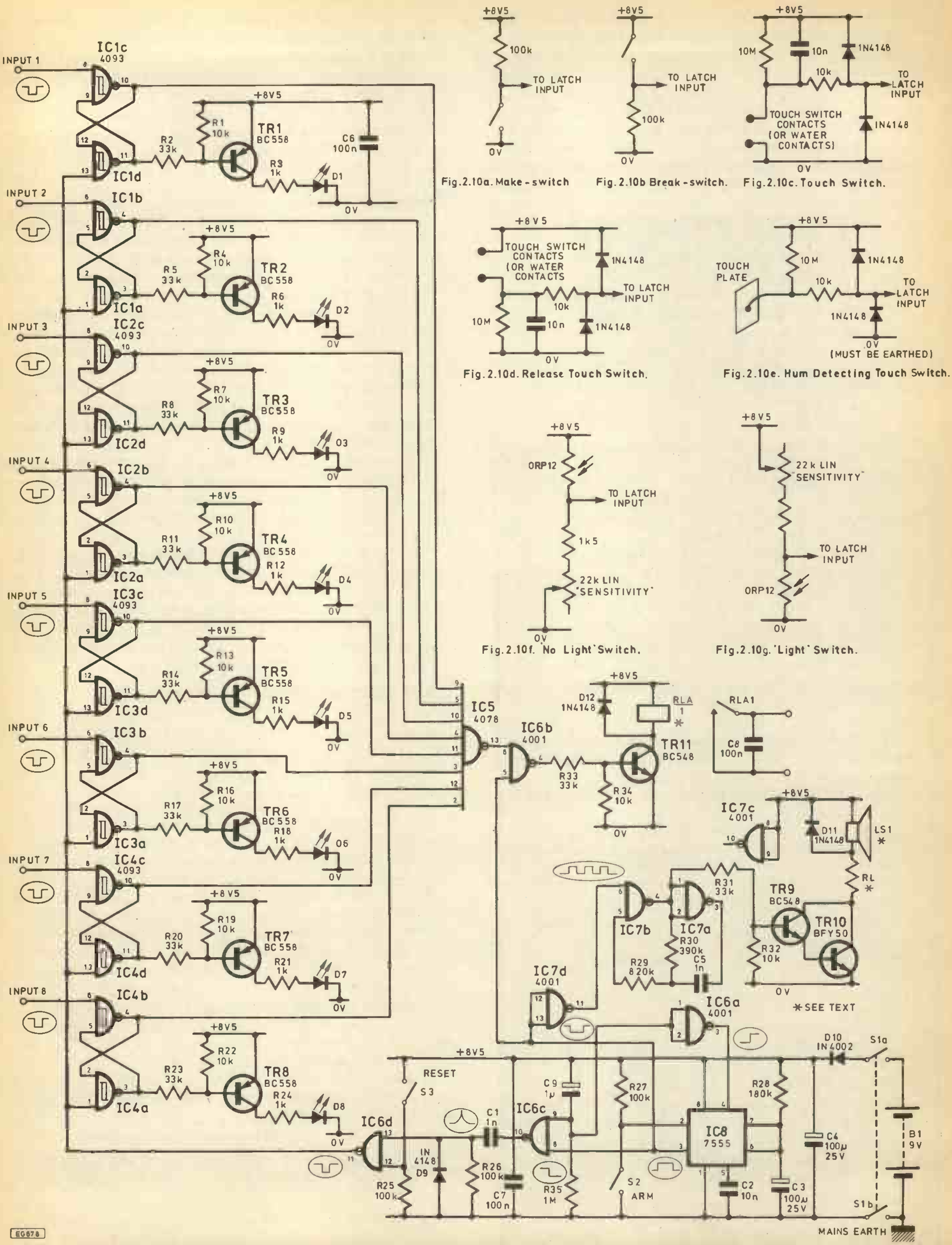
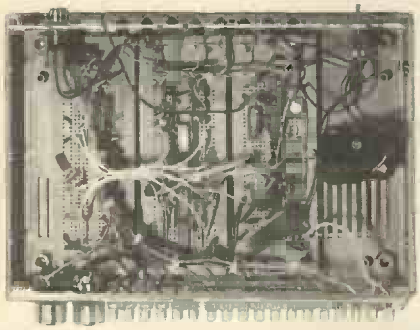



**Fig. 2.10. Complete circuit diagram of the Multi-Alarm unit including alternative inputs for triggering alarm**

Also during the timing period, pin 5 of IC6b is kept at logic 1, preventing any "latched" conditions of the input latches from turning on the relay. At the end of the timing period, the output of IC8 goes to logic 0, so pin 10 of IC6 goes to logic 1. The network of C1, R26 and D9 produces a short positive-going pulse from this logic level change, which is inverted by IC6d and passed to the "reset" inputs of all the latches. Hence, when the "arm" switch is pressed, a loudspeaker sounds while you have time to get out of the way, the alarm relay is prevented from operating, then as the "arm" period ends the inputs are all reset, and wait to be triggered. Pressing S3 also causes a logic 0 level to be fed to the latch resets by IC6d. D10 protects the circuit against incorrect connection of the battery, and C4, C6 and C7 are to help smooth out any spurious pulses on the power supply rails. C9 and R35 form a power-on reset circuit, which provides a pulse to reset the latches after approximately 1 second, and which is inverted by IC6a to reset IC8 immediately after switch-on.



## COMPONENTS . . .

**Resistors**

| | |
|---|---|
| R1, R4, R7, R10, R13, R16, R19, R22, R32, R34 | 10k (10 off) |
| R2, R5, R8, R11, R14, R17, R20, R23, R31, R33 | 33k (10 off) |
| R3, R6, R9, R12, R15, R18, R21, R24 | 1k0 (8 off) |
| R25, R26, R27 | 100k (3 off) |
| R28 | 180k |
| R29 | 820k |
| R30 | 390k |
| R35 | 1M0 |
| RL | 1W, see text |

All resistors ¼ or ⅓W 10% carbon except where otherwise stated.

**Capacitors**

| | |
|---|---|
| C1, C5 | 1n ceramic plate (2 off) |
| C2 | 10n polyester |
| C3, C4 | 100µ 25V elect (2 off) |
| C6, C7 | 100n 25V disc ceramic (2 off) |
| C8 | 100n polyester |
| C9 | 1µ0 35V tant |

**Semiconductors**

| | |
|---|---|
| D1 to D8 | Red l.e.d. 0·2in with fixing clips (8 off) |
| D9, D11, D12 | 1N4148 (3 off) |
| D10 | 1N4002 |
| TR1 to TR8 | BC558 (8 off) |
| TR9, TR11 | BC548 (2 off) |
| TR10 | BFY50 |
| IC1, IC2, IC3, IC4 | 4093 (4 off) |
| IC5 | 4078 |
| IC6, IC7 | 4001 (2 off) |
| IC8 | ICM 7555 |

**Miscellaneous**

S1 single or double pole toggle switch
S2, S3 pushbutton single pole push-to-make (2 off)
Battery holder
Small loudspeaker
Matchboard EXP-300PC Global Specialties (3 off)
Benchtopper case CTB-1 Global Specialties
Terminal blocks

### CONSTRUCTION

The prototype unit was made up on three Match boards. The front panel has the l.e.d.s fitted to it with conventional plastic l.e.d. clips. If required, the power switch (S1) could be hidden, or it could be a key-operated lock switch, to add security.

The arrangement of the rear panel depends somewhat on the particular inputs being used, but a good arrangement is that a length of terminal strip is fixed to the panel, with the interconnecting wires taken through holes in the panel immediately adjacent to their relevant termination. The relay contacts can also be taken to the rear panel in this way. The two potentiometers, which can be seen are sensitivity controls for two of the inputs of this unit which are "light level" inputs; they could equally well be pre-set potentiometers on the input board. The loudspeaker is glued over the grille in this top half of the case, and connected to the circuitry with a flying lead; don't forget to solder a protection diode across it the right way round!

All interconnections between boards and panels can be done in thin flexible wire, and the cathodes of the l.e.d.s can be joined together with one long length of bare copper wire, to simplify wiring. Be careful with the l.e.d.s—they are easy to damage if their leads are handled roughly. Finally the battery holder can be fixed to the bottom half of the case using "Sticky Fixers" self adhesive foam pads.

### CONSTRUCTION OF THE INPUT DEVICES

When using resistive touch switches (or "water level detecting switches") in Figs. 2.10c and 2.10d, don't use offcut pieces of Matchboard or Veroboard; the base material can absorb moisture and the switch will "stick" on. Use instead pieces of "fibreglass" based p.c.b. material, or metal strips fixed to a piece of plastic. Note, though, that mains circuitry of any sort should never be taken near water, so ensure that the Multi-Alarm is being powered by batteries, not a mains power supply, if its to be used as a fluid level detecting system.

The hum detecting touch switch requires that the Vss (i.e. 0 volts) supply be connected to mains earth to operate reliably. The touch plate can be any piece of metal, so try a piece of p.c.b. material or Matchboard (moisture has no effect) or even a piece of aluminium foil. If a piece of double-sided p.c.b. material is used, you'll find that touching the reverse side from the one connected to the unit will also work! If you want to protect a metal object from being fiddled with or pilfered, simply place it on the touch switch plate; it then becomes a touch switch too!

Finally, the "light level" switch (Figs. 2.10f and 2.10g) are considerably improved if the ORP 12 light-dependent-resistor is housed in an opaque tube a few inches long, to "funnel" the light towards it, and cut out unwanted light effects. (Putting a lens in the tube to focus the light works even better.) The circuit in Fig. 2.10f can be used to detect the breaking of a beam of light in this way.

**NEXT MONTH:** As well as the topics mentioned above there will also be a special offer to PE readers of a GSC experimenters kit.

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### 12/24V RANGE PRI 220/240V

SEC: 0 12V 0V 12V

| TYPE | amps 12v | amps 24v | price £ | p-p £ |
|---|---|---|---|---|
| 242 | 0.3 | 0.15 | 1.70 | 0.40 |
| 213 | 1 | 0.50 | 2.65 | 0.87 |
| 71 | 2 | 1 | 2.77 | 1.10 |
| 18 | 4 | 2 | 3.98 | 1.43 |
| 68 | 3 | 1.5 | 3.46 | 1.43 |
| 85 | 5 | 2.5 | 6.06 | 1.43 |
| 70 | 6 | 3 | 6.67 | 1.43 |
| 108 | 8 | 4 | 8.03 | 1.43 |
| 72 | 10 | 5 | 8.66 | 1.73 |
| 116 | 12 | 6 | 9.31 | 1.90 |
| 17 | 16 | 8 | 11.46 | 2.05 |
| 115 | 20 | 10 | 13.69 | 2.05 |
| 187 | 30 | 15 | 19.23 | 2.35 |
| 232 | 40 | 20 | 27.61 | 4.50 |
| 226 | 60 | 30 | 35.35 | 4.00 |

### 15/30V RANGE PRI 220/240V

SEC: 0V 12V 15V 0V 5V 9V 15V
VOLTS AVAILABLE 3 ⟶ 15 — 0 — 15

| TYPE | amps 15v | amps 30v | price £ | p-p £ |
|---|---|---|---|---|
| 112 | 1 | 0.50 | 2.84 | 1.10 |
| 79 | 2 | 1.0 | 3.29 | 1.10 |
| 3 | 4 | 2 | 6.18 | 1.43 |
| 20 | 6 | 3 | 7.19 | 1.73 |
| 21 | 8 | 4 | 8.52 | 1.73 |
| 51 | 10 | 5 | 10.57 | 1.90 |
| 117 | 12 | 6 | 11.94 | 2.05 |
| 88 | 16 | 8 | 16.14 | 2.20 |
| 89 | 20 | 10 | 18.54 | 2.35 |
| 90 | 24 | 12 | 20.57 | 2.55 |
| 91 | 30 | 15 | 23.63 | 2.65 |
| 92 | 40 | 20 | 33.21 | 4.50 |

### 25/50V RANGE PRI 120/220/240V

SEC: 0V 20V 25V 0V 8V 15V 25V
VOLTS OUT 5 ⟶ 25 — 0 — 25

| TYPE | amps 25v | amps 50v | price £ | p-p £ |
|---|---|---|---|---|
| 102 | 1 | 0.50 | 3.29 | 1.43 |
| 103 | 2 | 1.0 | 4.09 | 1.43 |
| 104 | 4 | 2 | 7.65 | 1.73 |
| 105 | 6 | 3 | 9.09 | 1.90 |
| 106 | 8 | 4 | 12.24 | 1.90 |
| 107 | 12 | 6 | 16.15 | 2.20 |
| 118 | 16 | 8 | 22.46 | 2.55 |
| 119 | 20 | 10 | 27.05 | 2.55 |
| 109 | 24 | 12 | 32.44 | 3.50 |

### 30/60V RANGE PRI 120/220/240V

SEC: 0V 24V 30V 0V 10V 18V 30V
VOLTS 6 ⟶ 30 — 0 — 30

| TYPE | amps 30v | amps 60v | price £ | p-p £ |
|---|---|---|---|---|
| 124 | 1 | 0.5 | 3.30 | 1.43 |
| 126 | 2 | 1 | 6.36 | 1.43 |
| 127 | 4 | 2 | 7.86 | 1.73 |
| 125 | 6 | 3 | 11.78 | 1.90 |
| 123 | 8 | 4 | 14.72 | 2.20 |
| 40 | 10 | 5 | 17.10 | 2.20 |
| 120 | 12 | 6 | 19.44 | 2.35 |
| 121 | 16 | 8 | 27.70 | 2.65 |
| 122 | 20 | 10 | 32.05 | 4.00 |
| 189 | 24 | 12 | 37.02 | 5.00 |

### 48/96V RANGE PRI 120/220/240V

SEC: 0V 36V 48V 0V 36V 48V
VOLTS 12 ⟶ 48 — 0 — 48

| TYPE | amps 48v | amps 96v | price £ | p-p £ |
|---|---|---|---|---|
| 430 | 1 | 0.5 | 4.69 | 1.43 |
| 431 | 2 | 1 | 7.84 | 1.73 |
| 432 | 4 | 2 | 12.94 | 2.05 |
| 433 | 6 | 3 | 14.62 | 2.20 |
| 434 | 8 | 4 | 20.04 | 2.45 |
| 435 | 10 | 5 | 28.75 | 2.65 |
| 436 | 12 | 6 | 36.16 | 4.00 |
| 437 | 16 | 6 | 39.47 | 4.60 |

### AUTOTRANSFORMERS 240/220 — 115V 65VA — 10KVA

0V 115V 220V 240V

| TYPE | va | price £ | p-p £ |
|---|---|---|---|
| 25 | 65 | 3.90 | 1.10 |
| 64 | 80 | 4.82 | 1.10 |
| 4 | 150 | 6.21 | 1.43 |
| 69 | 250 | 7.54 | 1.43 |
| 53 | 350 | 9.73 | 1.90 |
| 67 | 500 | 11.70 | 2.20 |
| 83 | 750 | 13.51 | 2.05 |
| 84 | 1000 | 18.31 | 2.35 |
| 95 | 2KVA | 34.36 | 5.00 |
| 73 | 3 | 64.74 | 5.00 |
| 57 | 5 | 97.85 | 6.50 |
| 101 | 10 | 179.05 | 10.00 |

### CASED AUTOTRANSFORMERS

240V LEAD IN:115V 2PIN SOCKET OUT

| TYPE | va | price £ | p-p £ |
|---|---|---|---|
| 56W | 20 | 6.60 | 0.87 |
| 64W | 80 | 8.43 | 1.43 |
| 4W | 150 | 10.86 | 1.73 |
| 69W | 250 | 13.17 | 1.90 |
| 67W | 500 | 20.46 | 2.20 |
| 84W | 1000 | 30.24 | 2.55 |
| 95W | 2000 | 54.83 | 5.00 |
| 73W | 3000 | 78.67 | 6.50 |

### LINE ADJUSTMENT AUTOTRANSFORMERS

0 200 210 220 230 240 250

| TYPE | va | price £ | p-p £ |
|---|---|---|---|
| 415C | 50 | 2.31 | 0.87 |
| 416C | 100 | 3.46 | 0.87 |
| 417C | 200 | 4.00 | 1.10 |
| 418F | 350 | 6.26 | 1.43 |
| 419F | 500 | 6.74 | 1.73 |
| 420E | 750 | 8.33 | 1.90 |
| 421F | 1000 | 11.64 | 2.05 |

### MAINS ISOLATORS (SAFETY SCREEN)

PRI 120/220/240V SEC 60V 55V 0V 55V 60V 60V 55V 0V 55V 60V

| TYPE | va | price £ | p-p £ |
|---|---|---|---|
| 149F | 60 | 8.40 | 1.73 |
| 150F | 100 | 9.71 | 1.73 |
| 151F | 200 | 13.84 | 2.05 |
| 152F | 250 | 16.69 | 2.20 |
| 153F | 350 | 20.77 | 2.55 |
| 154F | 500 | 26.03 | 2.65 |
| 155F | 750 | 36.75 | 5.00 |
| 156F | 1000 | 47.42 | 6.00 |

### MAINS ISOLATORS (SAFETY SCREEN)

PRI 380/415/440V SEC 60V 55V 0V 55V 60V 60V 55V 0V 55V 60V

| TYPE | va | price £ | p-p £ |
|---|---|---|---|
| 243F | 60 | 8.40 | 1.43 |
| 244F | 100 | 9.76 | 1.73 |
| 245F | 200 | 13.93 | 2.05 |
| 246F | 250 | 16.69 | 2.20 |
| 247F | 350 | 20.77 | 2.55 |
| 248F | 500 | 26.03 | 2.65 |
| 249F | 750 | 36.75 | 5.00 |
| 250F | 1000 | 47.42 | 6.00 |

### INVERTER

INV. 1. Cased, 13 amp, 3 pin £49.95 P&P £2.65.
INV. 2. Open £30.95 P&P £2.65.

### P.C.B. 120/220/240V. 0-12-0-12V.

| | price | P&P |
|---|---|---|
| 6VA – 467 PCB | 1.89 | 0.58 |
| 9VA – 468 PCB | 2.24 | 0.58 |
| 12VA – 470 PCB | 2.39 | 0.58 |
| 25VA – 471 PCB | 2.52 | 0.87 |
| 50VA – 472 PCB | 4.63 | 1.43 |

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# AUDIO ANALYSER

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

## PART 2

THIS second part concerns construction, testing and using of the samples together with possible extensions and modifications.

### CONSTRUCTION

Construction of the Audio Analyser uses a Vero G-range case to house the various circuit boards and ancillary components. The case (type 4B) is approximately 298mm(W) x 170mm(D) x 80mm(H), excluding the aluminium sleeve. Assembly is best carried out in two phases; first the printed circuit boards should be constructed, and then these are mounted in the case along with the remaining components, and the wiring is added. The following notes are a guide to constructors and include points which may require special attention.

The printed circuit board design for the audio processor stage is shown in Fig. 10, with the corresponding component layout in Fig. 11. There are no special handling considerations for any of the components and the two i.c.s may be soldered directly onto the board, after the orientation has been carefully checked, or mounted in DIL sockets.

The eight octave filter channels and the monitor channel all make use of the printed circuit track design shown in Fig. 12. A component layout for the filter channels is shown in Fig. 13. The board has been designed to accommodate capacitors which have a mounting pitch of between 5mm and 15mm. Capacitors should be mounted so as to project no more than 7–8mm from the surface of the board, and the leads cropped close on the bottom. There is sufficient space on the board to allow vertical capacitor types to be mounted horizontally by bending the leads at 90°. As mentioned earlier, VR1 and/or VR2 may be replaced by fixed value resistors, typical values being 3·9k for VR1 and 10k for VR2. The board is shown wired for a bar graph display; the link 'a-b' should be replaced with a link 'b-c' for moving dot display. It is suggested that all filter channels are wired to operate in the same display mode to avoid the user suffering from mental indigestion! The i.c.s should be carefully checked for the correct orientation before being soldered to the board. Low profile DIL sockets may be used as long as the maximum height limitation is not exceeded; the filter boards are mounted on a 10mm pitch and allowance must be made for board thickness and component leads on the bottom of the adjacent board. The l.e.d.s should be mounted with their leads flat and parallel to the surface of the board. The lead length should be cut such that the rear of the l.e.d. body adjoins the front edge of the board. It is important, therefore, that the lead length of the l.e.d.s used is a minimum of 12–13mm to allow them to be mounted without having to extend the leads. The colour(s) of l.e.d.s used is a matter of personal choice; the prototype used green types since this colour is most restful to the eye for prolonged viewing.

The inter-p.c.b. connectors specified are a low cost type which are supplied with blanking plugs to obstruct any selected pin positions in the socket. This feature allows optional use of the three unused pin positions on each board to code the actual filter boards to ensure that all 8 boards may only be inserted together in the correct positions. The suggested codings are given in Table 1 for the positions of the blanking plugs in the sockets. Should this coding system

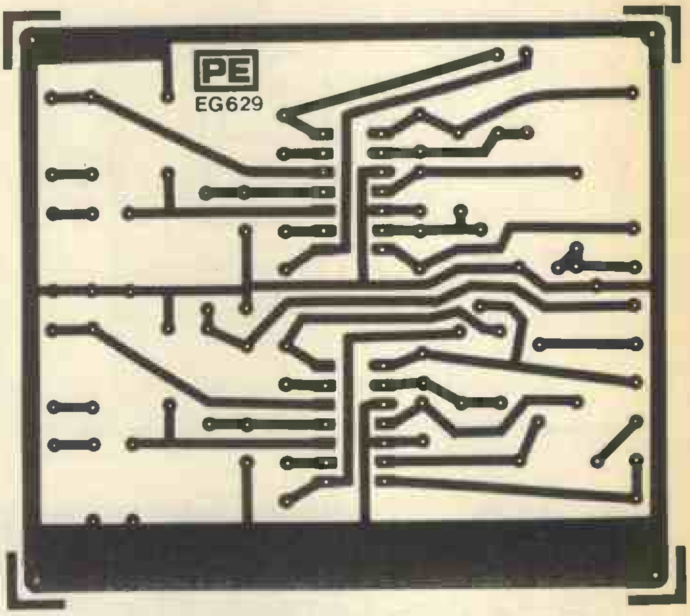



Fig. 10. P.c.b. track pattern for Audio Processor

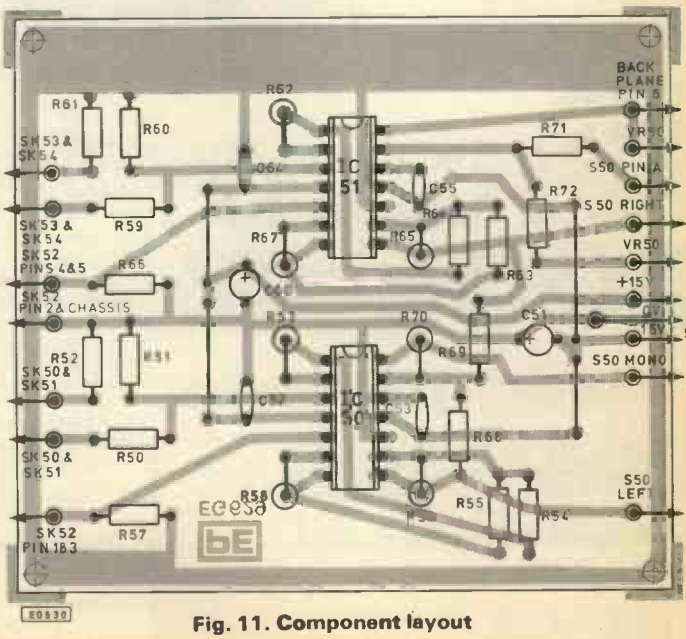



Fig. 11. Component layout

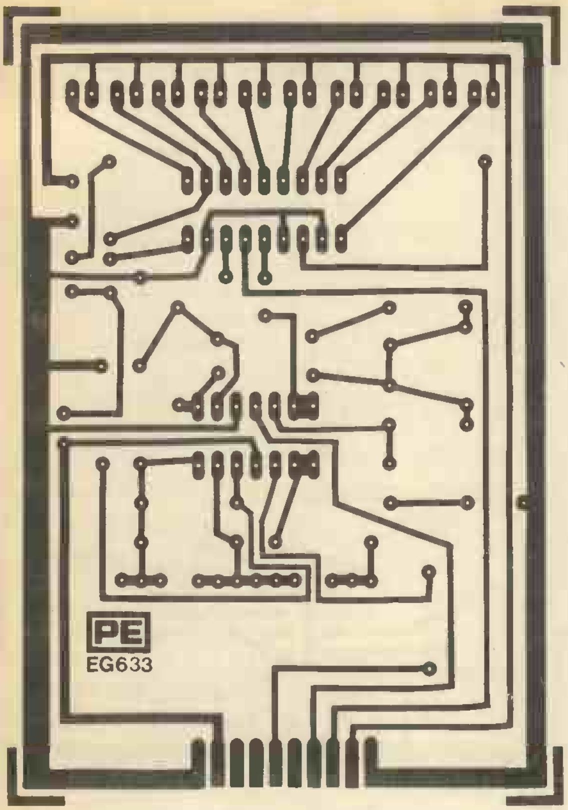



Fig. 12. Etching detail for the filter and display boards

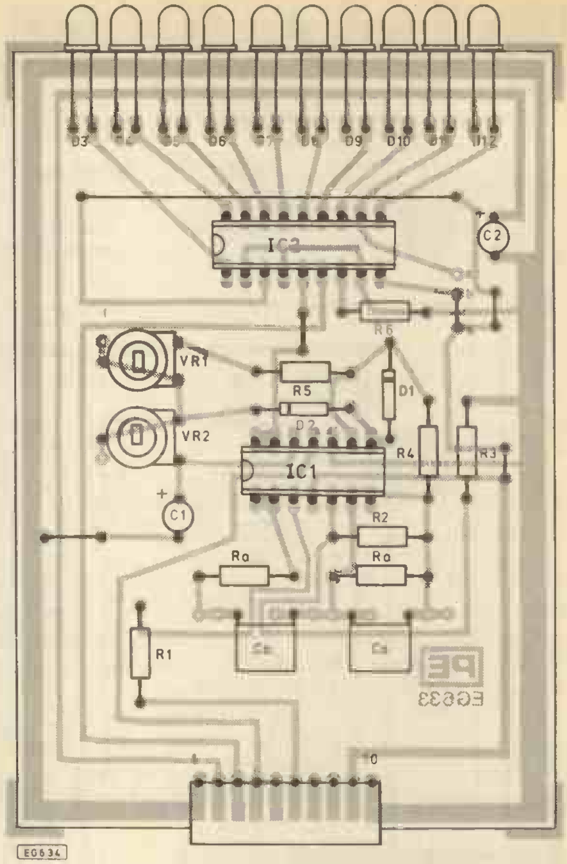



Fig. 13. Component layout

be adopted, it is necessary to remove the corresponding pins from the associated plugs mounted on the backplane, otherwise only the 64Hz board will fit at all!

The monitor channel uses the same component layout as the filter channels with the following exceptions. R2 is omitted and R3 is replaced by a wire link. 'R' closest to connector pin 1 is replaced by R7, and 'R' closest to pin 10 is replaced by R8. 'C' adjacent to pin 10 is omitted, and 'C' next to pin 1 is replaced by C3. All other components are as for the filter channels.

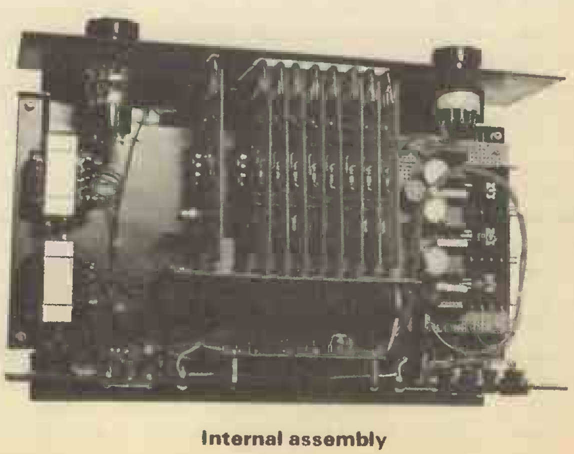
## PSU BOARD

The power supply printed circuit board track design is shown in Fig. 14, with the corresponding component layout in Fig. 15. The regulator i.c.s should have their leads preformed prior to being mounted on the heatsinks on the board. No insulating kits need be used, but the mounting hardware should be arranged to avoid contact with the case.

The final board in the case is the backplane on which the p.c.b. connector plugs and 3 capacitors are mounted. The track pattern is shown in Fig. 16 with a component layout shown below in Fig. 17. If preferred, the backplane p.c.b. may be fabricated from a piece of 0·1in pitch Veroboard of similar size, 135mm x 75mm. Where coded polarisation plugs have been used on the filter boards, the corresponding pins on the plugs should be cut off at this stage.

When all of the printed circuit boards have been assembled, a careful visual examination should be made to verify the correct orientation of all polarised components (diodes, capacitors, i.c.s and rectifiers), and to ensure that there are no inadvertent short circuits due to solder splashes or bridges. After this check, which may save many hours of toil at a later stage, has been completed, the second stage of assembly may proceed.

A suggested overall layout giving the positions of the p.c.b.s and major ancillary components is shown in Fig. 18. Initially the front and rear panels should be removed from the case to allow drilling of suitable holes for sockets and controls etc., and cutting of two display windows. A cutting diagram for the front panel is shown in Fig. 19, while sockets on the rear may be positioned as convenient, taking care to leave adequate clearance for the audio processor board and the two backplane support brackets. The mounting detail for the backplane and filter/monitor boards is shown in side view in Fig. 20. Two lengths, each approximately 135mm, of plastic binding comb (as used for edge binding reports etc., and available from stationers) are used to support the bottom edge of the backplane and to act as a locating and securing guide rail for the filter/monitor boards. Two bent aluminium brackets are used to secure the top of the backplane to the rear of the case. The locating strip should



Internal assembly

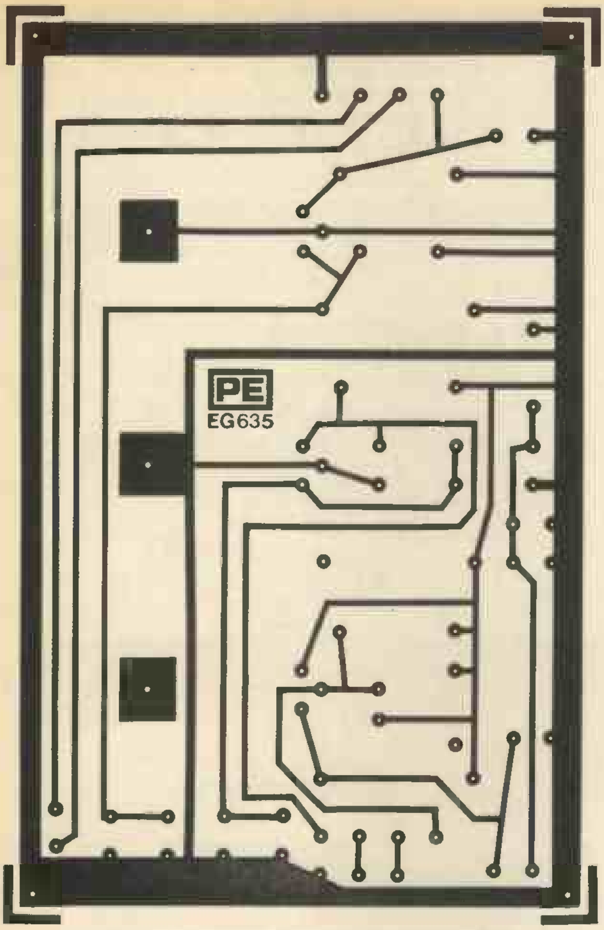



**Fig. 14. Etching detail for p.s.u. board**

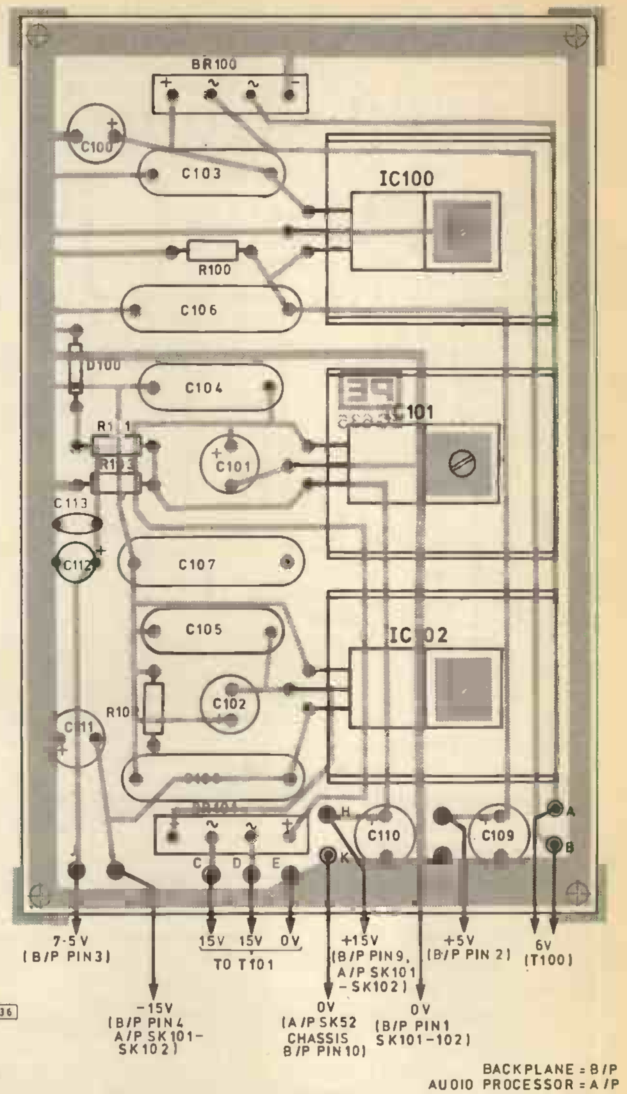



**Fig. 15. Component layout**

have nine slots, one for each board, each of a width equal to the thickness of the p.c.b.s, cut with a hacksaw to the depth shown in the inset of Fig. 20. The position of these slots are given by the positions of the channel boards when fitted to the backplane. The lengths of binding comb are fixed to the base of the case with one of the cyanoacrylate 'super-glues'.

After the two strips have been fixed to the base of the case, the audio processor board and the various sockets should be mounted on the rear panel. A length of ribbon cable may then be used to link between the sockets and the PCB as this simplifies removal for fault finding or modification. Any inter-socket wiring should also be added at this time, e.g. SK50→SK51, SK53→SK54, etc. The rear panel is now re-attached to the base of the case, and the backplane p.c.b. secured in place with its two mounting brackets. The power supply p.c.b. and two mains transformers are now installed in the case, and the front panel temporarily re-attached complete with S50 and VR50 in place. All remaining interconnection wiring should now be added, with sufficient length included in the leads to VR50 and S50 to allow the front panel 1 to be folded down through 90° and move forward to facilitate installation/removal of filter/monitor boards.

After the interconnection wiring has been completed and checked, the unit is ready for testing. The filter/monitor p.c.b.s should not be fitted at this stage, but it is probably a worthwhile exercise to verify the correct mechanical alignment of the backplane, locating strip and front panel. It is also useful for future use if a p.c.b. extender card is made for the filter/monitor boards. This is no more than a piece of Veroboard 70mm wide with a 10-way plug at one end and a socket at the other, using the copper tracks to interconnect.

## TESTING AND USING THE ANALYSER

The first stage in testing is to verify the correct operation of the mains power supply section. Power should be applied via SK100, and the unit turned on with S100. A multimeter is then used to measure the four d.c. supply rails: +5V, $+7\frac{1}{2}$V, +15V, and −15V. Should any of these be more than 5% in error, a check should be made on the regulator i.c. or Zener diode associated with that supply, paying particular attention to the device code number. For no output on a particular rail, the transformer input to the appropriate rectifier, the bridge rectifier itself, and the regulator should be inspected, with particular attention being paid to the orientation of the components. When the various outputs of the power supply p.c.b. are satisfactory, the power connections to the audio processor p.c.b., the backplane p.c.b., and SK101/102 should be checked with a meter before any filter/monitor p.c.b.s are installed or auxiliary units connected.

VR1 and VR2 on all filter/monitor boards should be set to their mid-value positions. The monitor channel p.c.b. should now be inserted into its socket on the backplane, S50 set to 'Left', and VR50 set to minimum sensitivity. A 500mV (r.m.s.) 1kHz sine wave signal should be connected to the left input on SK52 and VR50 increased to give a full-scale indication on the monitor channel l.e.d.s. The full-scale indication should be achieved with the sensitivity control set near to the fully anti-clockwise position, otherwise the connections to VR50 should be changed to give minimum resistance in the 'Off' position. Selection of 'Right' should produce no display, while selection of 'Mono' should illuminate 80% of the scale (i.e. 6dB down), with approximately +3·8V on pin 5 of IC2 on the monitor board. The input signal should then be transferred to pin 3 of IC50 and a check made that full-scale indication is achieved with 'Left' selected. The tests above should then be repeated using the 'Right' input channel; the loudspeaker input is tested on pin 3 of IC51.

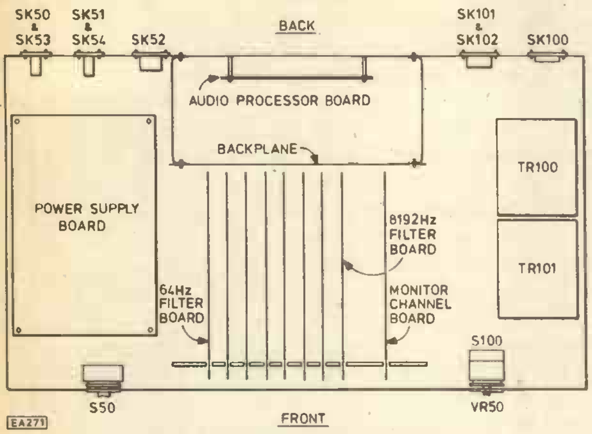


Fig. 18. Detailed overall assembly

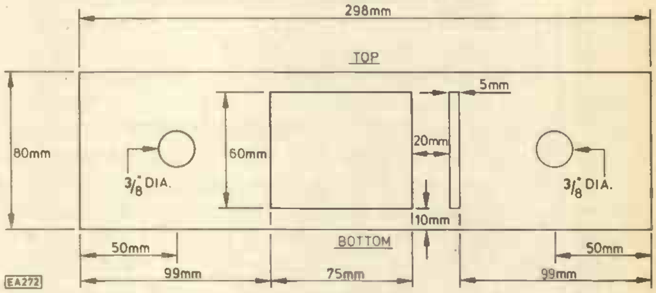


Fig. 19. Front panel detail

**Fig. 16 (right). Printed circuit board of backplane**

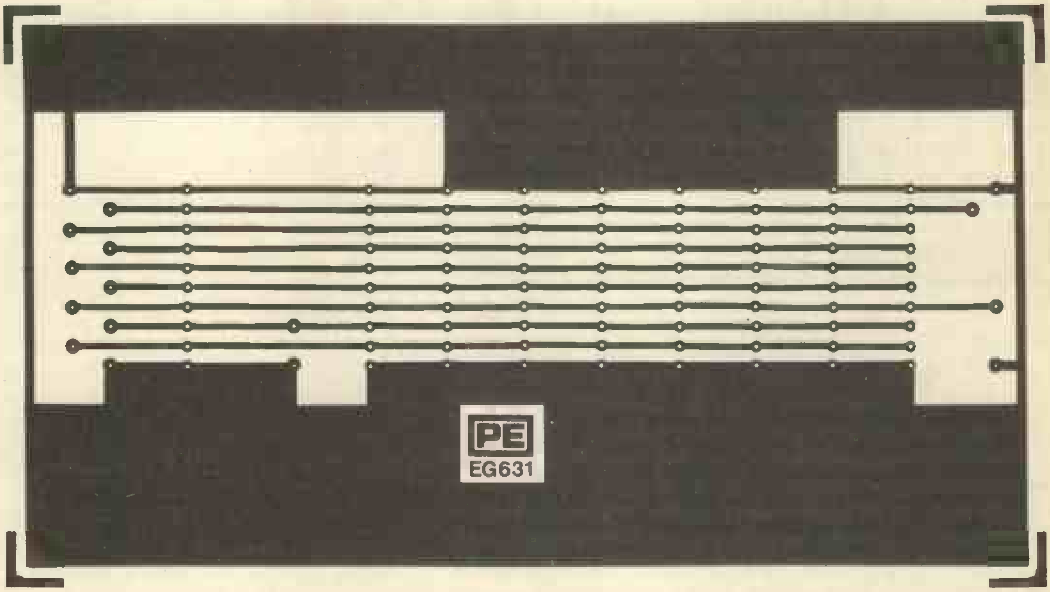
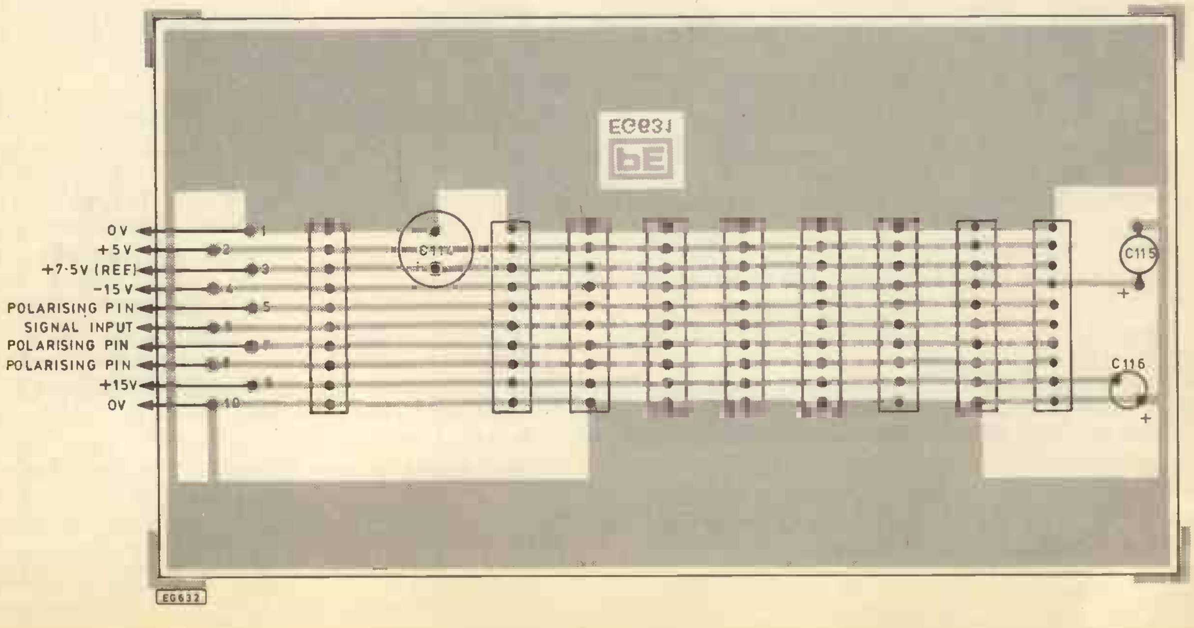



**Fig. 17 (below). Component layout**



The final test on the audio processor section is to check that, with VR50 set to maximum sensitivity, a full-scale indication is obtained with an input signal to approximately 5mV (r.m.s.) at the tape monitor input. This confirms that the variable gain stage, IC51d, is operating with the expected gain ratio (100:1).

A 500mV (r.m.s.) signal at 1kHz should now be applied to the left channel tape monitor input and 'Left' selected on SW50. The eight filter channel p.c.b.s are now inserted in their appropriate positions, starting with the 64Hz board. As each filter is added, the display shown in Figure 21 should build up. When complete, this display actually represents the shape of the response characteristic of the 1kHz filter (see Figure 7), with the expected roll-off rate of 6dB per octave. Failure of any channel should be investigated using the extender board and with the signal generator adjusted to the filter's nominal centre frequency. Under these conditions an output of approximately $+7\frac{1}{2}$ volts is expected at pin 12 of IC1, and also at pin 5 of IC2. Otherwise, the voltage at these points will depend on the frequency separation between signal generator and filter centre, e.g. at 1kHz, the 512Hz filter output will be approximately +3·8V.

When the eight filters are installed and working correctly, the gain of each may be set if necessary. This is done by applying a constant amplitude sine wave input at the centre frequency of each filter in turn, and then adjusting the appropriate VR1 to give a voltage at pin 5 of IC2 of the channel under test which is the same (and less than $+7\frac{1}{2}$ volts) for all boards. The monitor channel is best set at 1kHz, and the analyser is ready for use when the adjustments are complete.

The analyser input sensitivities at the minimum setting of VR50 are approximately 500mV (r.m.s.) for tape monitor and 10V (r.m.s.) for the loudspeakers (equivalent to $12\frac{1}{2}$ watts into 8Ω). At maximum setting, these sensitivities are increased by a factor of approximately 100. The loudspeaker input sensitivity may be altered by changing the value of R51 and R60; these may even be fitted as switchable values or replaced by preset resistors. To obtain the sensitivities quoted for 4Ω speakers, the values should be reduced by approximately 2 times, while for 15Ω, an increase of 2 times is required. The equivalent power levels may seem rather low by comparison to the specification of many amplifiers, but in practice the drive signal may require a higher-than-expected setting. This is because the average signal level of typical programme material over the integration period of the filters is generally significantly lower than the instantaneous peak levels.

The analyser will handle inputs up to 10 volts r.m.s. at the tape monitor inputs without harm, and it presents an impedance of 47kΩ. With the component values shown, the inputs on the loudspeaker sockets may rise to 100 volts r.m.s. without harm, and the isolation between input and ground exceeds 30kΩ. The display is not affected by over-driving the input stages, but over-dissipation of the filter/display boards at maximum indication in bar mode should be avoided if the l.e.d. current has been programmed higher than 12mA/l.e.d. (i.e. if R6 has been reduced much below 1kΩ). Simultaneous full-scale indication on all channels in bar mode may cause the analyser to become warm if sustained for long periods, but no damage should result.

The setting of the display time constant (by means of VR2) is a matter of personal choice. Minimum setting of VR2 will produce a 'fast' display which will follow input peaks. This, however, tends to produce a visually 'noisy' display which can be tiring to the eye over long periods. A 'slower' display, on the other hand, can induce a feeling of vague frustration in the user. The optimum setting is best found by experiment, but a mid-way setting of VR2 will produce a generally acceptable result.

In addition to the uses of the analyser for equalising loudspeaker systems, using a microphone and preamplifier, as described in the first section of this article, many other applications will be found. The use of test material such as test records/tapes with the analyser connected in the loudspeaker outputs allows interesting comparisons to be made between equipment components. VHF radio material will be found to have a noticeably more restricted frequency range than, say disc, and many interesting spectral characteristics of source material will become apparent. For example, in a conversation between male and female speakers, it is quite possible to distinguish the sex of the speaker by the overall spectral shape of the voice alone; the male voice has a similar spectral shape, but generally lower in frequency, as expected. Despite the pre-existing bias of many observers to the possible 'gimmick' nature of the analyser as a component in an audio system, its use as a constant output monitor quickly gains acceptance due to the psychologically acceptable 'feel' of the display; unlikely, but true!

## EXTENDING THE ANALYSER

The graphic analyser described is complete in itself, but it may also be used as the basis for a design to suit any particular application not catered for by the basic design. The possible extensions and modifications fall into three main areas: changes to the audio processor section; changes to the filter and display section; simple additions to the overall unit.

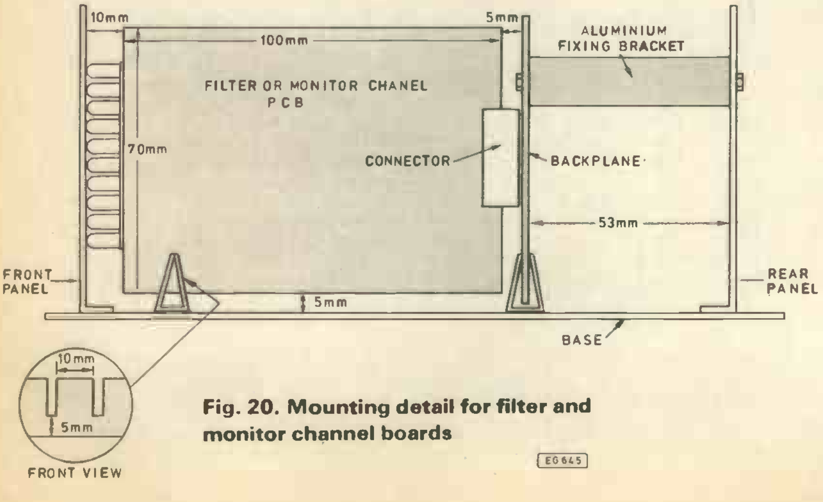



**Fig. 20. Mounting detail for filter and monitor channel boards**

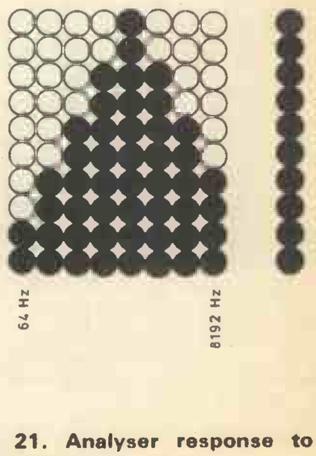



**Fig. 21. Analyser response to a 1kHz sine wave**

Possible changes to the audio processor section are limited only by the range of applications and the imagination/ingenuity of the user. A simple change might be the addition of multi-channel signal handling capabilities, with variable preset gain on each channel. Other modifications could include the derivation of a (left-right) difference signal, the inclusion of automatic sensitivity control, and the production of an absolute signal level indication. Many other changes will occur to constructors in the light of their own particular applications.

The addition of three further filter channels to the filter and display section has already been discussed, and the relevant filter component values are given in Table 1. The use of half-octave filters (i.e. spaced at $\sqrt{2}f_0$ multiples instead of $2f_0$) is simply achieved by modification of the filter Q by changing $R_2$ and $R_3$, and the reduction of the overall gain by the same factor as the change in Q (change $R_4$). The new Q is 2·915 and $R_3/R_2$ is 1·657, compared to 1·5 and 1·333, respectively, in the basic design. The extension of the display range from 30dB to 60dB is readily achieved, as shown in Fig. 22, by the addition of an operational amplifier and a second LM3915. In this circuit the reference to both i.c.s is held at +7·5 volts and the signal input to the lower i.c. is amplified by 30dB. The use of 1% resistors allows the gain to be set within ±0·2dB, but it should be noted that an op-amp offset voltage of 5mV will move the first l.e.d. threshold by as much as 4dB, and an offset trim may be required in some cases. Extension to a 90dB display range is possible, but presents a number of practical difficulties. These mainly arise from the fact that the threshold of the lowest l.e.d. will be set around 0·5mV, i.e. 500µV! Several offset nulls are required and careful attention to wiring design is essential.

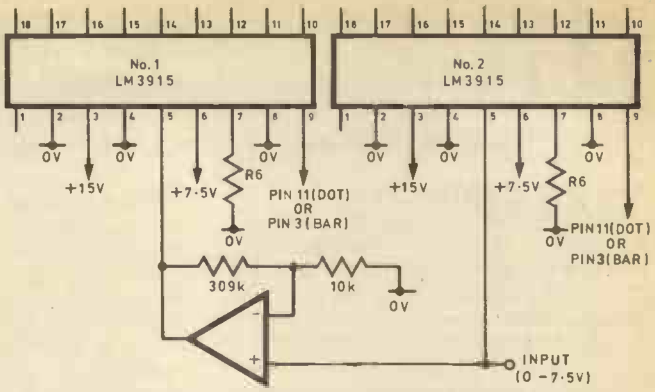



**Fig. 22. Circuit for a 60dB display using two LM3915s. All pins shown with no connection are l.e.d. drive outputs**

Add-on units for the analyser are a simple way of extending the range of facilities without change to the basic design.

**Next Month;** a microphone preamplifier for matching a wide range of microphones to the low level input to the analyser, and a noise source.

# New Generation of SOFTYs

**Whilst being primarily an EPROM programmer, one could say that SOFTY is to the microprocessor software engineer what the oscilloscope is to the straight-forward electronics engineer, certainly when there are limited funds.**

Anyone who has tried to investigate the working (or non-working) of a microcomputer system using conventional equipment such as a scope, will appreciate the purpose behind Softy's existence. However, the basic characteristics of this unique engineering tool will not be repeated here since these were covered in the Softy review of *PE January 1980* by Dr. A. A. Berk. Suffice it to say that Softy, apart from being a stand-alone control type microcomputer in its own right (based on SC/MP µP), is primarily intended to aid microcomputer firmware developement by allowing memory analysis and manipulation on any system, irrespective of the processor used.

Now there is Softy 2, and the question is: How does this new generation machine differ from its forefather?

### SINGLE SUPPLY EPROMS!

Immediately apparent in the photograph is that Softy 2 is housed in a ABS plastic case; this comprising two halves which clip together, and being of the same ilk as that used on the Sinclair ZX80. The power supply is also enclosed in a plastic "battery eliminator" type case with integral three-pin mains plug. The case incorporates an antistatic tray, using conductive foam for EPROM storage, and the zero insertion force (ZIF) socket has a "personality Switch" to accommodate the pin-out requirements of the various EPROM devices. Notably, Softy 2 may be used to program single supply rail EPROMs too, such as the 2716, 2516, 2732 and 2532.

### EXTRA MEMORY

Memory size has been doubled to now give a 2K static RAM buffer (working RAM), 2K monitor ROM, and PIA with scratchpad RAM (INS 8154).

The ROMULATOR facility, which is an in-circuit ROM emulator for dynamic program development, has been improved with buffering on address and data lines, and a ROMULATOR ribbon cable with terminating 24-pin d.i.l. plug is to be supplied as standard.

In addition to the original Transwift software based cassette interface, there are serial and parallel I/O routines for interfacing to another computer, a printer (RS232 and Centronics etc.,) tape reader and punch etc.

### NEW COMMANDS

Among the new or improved commands added to Softy's repertoire are INSERT and DELETE. The former looks ahead for the first occurance of three unused bytes (FF FF FF) and shifts the preceding code rightwards to allow space further back in memory to insert another instruction. The latter, DELETE, is more or less the reverse of this. The first three unoccupied bytes are found and the code shifted left to remove the instruction under the cursor. Both these commands will shift as much of the 2K as is necessary but will not work if there is no free space. This kind of flexibility means that you do not need to be a computer to program one. In all, there are seven extra keys on the Softy 2 keyboard.

Softy 2 is available direct from Dataman Designs of Lombard House, Dorchester, Dorset, and costs £169 plus VAT ready built and tested. No kits are available. It is also available from Watford Electronics and other general suppliers.

Softy 2 has not changed its role and all the original features remain. Essentially an intelligent memory module designed to reveal as much of its contents as possible on a standard TV screen, it has its own UHF modulator.

The editing capabilities benefit from a double cursor system which is intended to take the pain out of offset calculations for relative jumps, there are numerous useful functions like a match-byte which will seek out the occurrence of any byte of code throughout the memory, and highlight it on Softy's unique multi-intensity display.

# MICRO PROMPT

**The hardware and software exchange point for PE computer projects**

## A BLANK EXPRESSION

*Sir—Like R. J. Newman (Microprompt, May '81) I was troubled with the blank character apparently inserted by the STR$ function at the front of strings derived from numeric values.*

*Adrian Waters, founder of the UK101 user group (now Computer User Aids) then explained to me that the blank was already there, before the application of the STR$ function if the value is positive, its place otherwise taken by the negative sign. He also pointed out that this was a feature of BASIC which was probably present in a number of versions, apart from the UK101. The statement X$ = "8" accepts "8" as a literal, not a numeric value, so there is no leading blank in this case.*

*To demonstrate the presence of the leading blank in positive numeric values, give your UK101 the following instructions: PRINT "8" : PRINT 8 : PRINT −8 , when you will note that the first statement yields an 8 in the first print position, the second an 8 in the second print position, thus indicating the presence of the leading blank and in the third case the negative sign takes the place of the blank.*

*The following BASIC subroutine removes the blank character. If the application cannot possibly yield a string with other than a leading blank, the first line may be omitted.*

```
5000  IF LEFT $ (X$, 1) <>" " THEN
RETURN
5010  X$ = RIGHT $ (X$, LEN(X$) − 1) :
RETURN
```

*On the subject of the UK101 User Group I must say that Adrian Waters has been most helpful in helping me to sort out little problems such as the above. My one disappointment was the apparent lack of response to his idea that we should form local groups within the User Group. Since local contact can be useful on occasions, especially when one is a fair distance from London, I would be interested to hear from other UK101 and OSI Superboard users in the Edinburgh and Lothian area—whether or not they are members of a national group—if they are interested in forming a local association.*

*An S.A.E. would be appreciated to facilitate replies. Hopefully such local groups can be run to complement rather than compete with the national groups.*

*David J. Giles,*
*Edinburgh.*

It should be emphasised that material presented in Prompt has not necessarily been proven by us. Neither can compatibility with all *generations* of the computer equipment to which it relates be guaranteed.

## SOFT BAUD RATE

*Sir—I wonder if any of your readers would be interested in the following cassette Baud rate modification of the Compukit UK101. All the previous Baud rate modifications have been to allow teleprinters etc., to run from the ACIA. This modification allows true software control of the cassette interface Baud rate selectable between 300/600 and is working perfectly in my system.*

*The modification isn't as difficult as one might at first think to install, as the p.c.b. has a track taking IC14 pin 5 up to IC68 pin 13 anyway, a spare inverter/buffer is available on IC62 and thus only a small amount of wiring is necessary.*

*After reset pin 5 of IC14 is at a Ø and K57 then, when reaching 1100 is loaded with 0110 and thus only divides by 6, this causes the ACIA to run at 600 Baud, the diode and 4k7 resistor allow C11 to charge faster and remove any problems when loading data at the 600 Baud rate.*

*To select 300 Baud simply POKE 61440, 81 which causes IC57 to be loaded with 0000 after reaching the count of 1100 thus dividing by 12, as pin 2 of IC62 is now at a Ø the 4k7 resistor has no effect on the charging time of C11 due to the diode series with it.*

*Remember after reset and entry into machine code F0004 must be set to 51H for 300 Baud machine code load. In BASIC POKE 61440, 17 selects 600 Baud.*

*The following machine code routine modifies the beginning of the subroutine to move the display up one line and enables the user to have the top one or more lines static, as a heading, whilst the data beneath scrolls.*

*Suggested start address:*

| | | |
|---|---|---|
| 0230 | A2D4 | LDX |
| 0232 | A0000 | LDY |
| 0234 | 84E3 | STY |
| 0236 | A080 | LDY |
| 0238 | 4C66 FB | JMP |

80 leaves top 2 lines unscrolled
*40 would leave only one line*
*C0 would leave 3 lines etc.*

*Now when printing lists, say,*

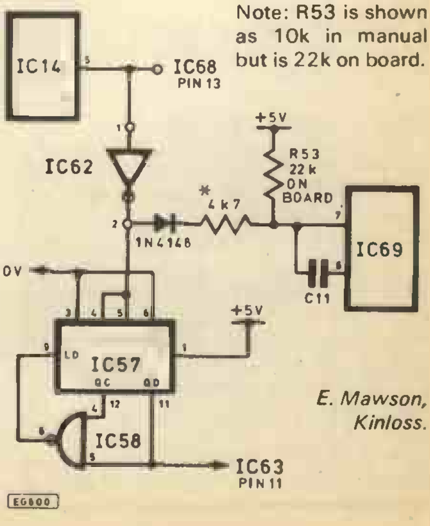
**IF PEEK 520 = >15 THEN POKE 11,48:POKE 12,2:X = USR(X)**

*and screen will scroll up leaving top lines unmoved.*

*NB. All above addresses are with new monitor.*

* If difficulties are experienced in receiving data from tape try varying the resistor value.

Note: R53 is shown as 10k in manual but is 22k on board.




*E. Mawson,*
*Kinloss.*

## NEW MONITOR SAVE/HEX DUMP

*Sir—In the UK101 Manual a very useful cassette save/hex memory dump routine is described. This works with the OLD monitor, but is not compatible with the NEW one.*

*Since a number of Compukit owners have upgraded their systems with the new monitor—and new kits are delivered with it, there seems to be a definite demand for a routine with the new monitor. The following program will do just that.*

*Like before, the starting address of the code to be saved should be placed in $00F7 (LOW) and $00F8 (HIGH). The end address goes into $00F9 (LOW) and $00FA (HIGH). However, the program starts at $0228 instead of $0222 previously. The reason for this is that the new monitor occupies addresses $0222–$0224 for NMI—and $0225–$0227 for IRQ—vectors. See opposite page.*

*At the same time, I should like to express appreciation of the very useful Memory and Address Decoding Maps submitted by Mr. David McDonnell in the March issue of P.E. However, a slight correction should be made to his Hardware Memory Map, in accordance with the previous description of new monitor usuage. His line:*

*"$0222 to $02FA: UNUSED—USING NEW MONITOR EPROM"*

*should instead read:*

*"$0228 to $02FA: UNUSED—USING NEW MONITOR EPROM"*

*I have found the Compukit UK101 to be a system of great potential for a reasonable price, but have experienced a very particular and unexpected difficulty; that of obtaining a detailed monitor listing, for the old as well as the new version. I think a responsible attitude on behalf of the producer amounts to considering such documentation as being an integral and necessary part of the combined hardware/software product sold, and that such monitor listings should be available at a reasonable price for those who feel they need them to take full advantage of the computer's potential. Do you not agree?*

*Mr. Gisle K. Dyvik,*
*Norway.*

## DISASSEMBLED LISTING

```
0228  A90D     LDA  #$0D
022A  208202   JSR  $0282
022D  207AFF   JSR  $FF7A
0230  A92E     LDA  #$2E
0232  207B02   JSR  $027B
0235  A5F8     LDA  $F8
0237  206902   JSR  $0269
023A  A5F7     LDA  $F7
023C  206902   JSR  $0269
023F  A92F     LDA  #$2F
0241  207B02   JSR  $027B
0244  A200     LDX  #$00
0246  A1F7     LDA  ($F7, X)
0248  206902   JSR  $0269

024B  A90D     LDA  #$0D
024D  20B1FC   JSR  $FCB1
0250  A920     LDA  #$20
0252  208202   JSR  $0282
0255  E6F7     INC  $F7
0257  D002     BNE  $025B
0259  E6F8     INC  $F8
025B  38       SEC
025C  A5F9     LDA  $F9
025E  E5F7     SBC  $F7
0260  A5FA     LDA  $FA
0262  E5F8     SBC  $F8
0264  10DE     BPL  $0244
0266  4C30FE   JMP  $FE30

0269  85FC     STA  $FC
026B  20ACFE   JSR  $FEAC
026E  AD64D1   LDA  $D164
0271  207B02   JSR  $027B
0274  AD65D1   LDA  $D165
0277  207B02   JSR  $027B
027A  60       RTS
027B  20B1FC   JSR  $FCB1
027E  208202   JSR  $0282
0281  60       RTS
0282  8D0202   STA  $0202
0285  48       PHA
0286  8A       TXA
0287  48       PHA
0288  98       TYA
0289  48       PHA
028A  AD0202   LDA  $0202
028D  F033     BEQ  $02C2
028F  AC0602   LDY  $0206
0292  F008     BEQ  $029C
0294  A240     LDX  #$40
0296  CA       DEX
0297  D0FD     BNE  $0296
0299  88       DEY
029A  D0F8     BNE  $0294
029C  C90A     CMP  #$0A
029E  F02B     BEQ  $02CB
02A0  C90D     CMP  #$0D
02A2  D006     BNE  $02AA
02A4  202A03   JSR  $032A
02A7  4CC202   JMP  $02C2
02AA  8D0102   STA  $0201
02AD  201703   JSR  $0317
02B0  EE0002   INC  $0200
02B3  A92F     LDA  #$2F
02B5  EA       NOP
02B6  18       CLC
02B7  69CD     ADC  #$CD
02B9  EA       NOP
02BA  CD0002   CMP  $0200
02BD  3009     BMI  $02C8
02BF  203303   JSR  $0333

02C2  68       PLA
02C3  A8       TAY
02C4  68       PLA
02C5  AA       TAX
02C6  68       PLA
02C7  60       RTS
02C8  202D03   JSR  $032D
02CB  201703   JSR  $0317
02CE  A9CD     LDA  #$CD
02D0  EA       NOP
02D1  29E0     AND  #$E0
02D3  8D0202   STA  $0202
02D6  A207     LDX  #$07
02D8  BD4803   LDA  $0348, X
02DB  9D0702   STA  $0207, X
02DE  CA       DEX
02DF  10F7     BPL  $02D8
02E1  BE5003   LDX  $0350, Y
02E4  A920     LDA  #$20
02E6  A02F     LDY  #$2F
02E8  EA       NOP
02E9  C020     CPY  #$20
02EB  3001     BMI  $02EE
02ED  0A       ASL  A
02EE  8D0802   STA  $0208
02F1  A000     LDY  #$00
02F3  200702   JSR  $0207
02F6  D0FB     BNE  $02F3

02F8  EE0902   INC  $0209
02FB  EE0C02   INC  $020C
02FE  EC0902   CPX  $0209
0301  D0F0     BNE  $02F3
0303  200702   JSR  $0207
0306  CC0202   CPY  $0202
0309  D0F8     BNE  $0303
030B  A920     LDA  #$20
030D  200A02   JSR  $020A
0310  CE0802   DEC  $0208
0313  D0F8     BNE  $030D
0315  F0A8     BEQ  $02BF
0317  AE0002   LDX  $0200
031A  AD0102   LDA  $0201

031D  A000     LDY  #$00
031F  EA       NOP
0320  D004     BNE  $0326
0322  9D00D3   STA  $D300, X
0325  60       RTS
0326  9D00D7   STA  $D700, X
0329  60       RTS
032A  201703   JSR  $0317
032D  A9CD     LDA  #$CD
032F  EA       NOP
0330  8D0002   STA  $0200
0333  AE0002   LDX  $0200
0336  BD00D3   LDA  $D300, X
0339  A000     LDY  #$00

033B  EA       NOP
033C  F003     BEQ  $0341
033E  BD00D7   LDA  $D700, X
0341  8D0102   STA  $0201
0344  A99A     LDA  #$9A
0346  D0D5     BNE  $031D
0348  B900D0   LDA  $D000, Y
034B  9900D0   STA  $D000, Y
034E  C8       INY
034F  60       RTS
0350  D3       ???
```

## HEX DUMP OF HEX DUMP

| | 8 | 9 | A | B | C | D | E | F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0228 | A9 | 0D | 20 | 82 | 02 | 20 | 7A | FF | A9 | 2E | 20 | 7B | 02 | A5 | F8 | 20 |
| 0238 | 69 | 02 | A5 | F7 | 20 | 69 | 02 | A9 | 2F | 20 | 7B | 02 | A2 | 00 | A1 | F7 |
| 0248 | 20 | 69 | 02 | A9 | 0D | 20 | B1 | FC | A9 | 20 | 20 | 82 | 02 | E6 | F7 | D0 |
| 0258 | 02 | E6 | F8 | 38 | A5 | F9 | E5 | F7 | A5 | FA | E5 | F8 | 10 | DE | 4C | 30 |
| 0268 | FE | 85 | FC | 20 | AC | FE | AD | 64 | D1 | 20 | 7B | 02 | AD | 65 | D1 | 20 |
| 0278 | 7B | 02 | 60 | 20 | B1 | FC | 20 | 82 | 02 | 60 | 8D | 02 | 02 | 48 | 8A | 48 |
| 0288 | 98 | 48 | AD | 02 | 02 | F0 | 33 | AC | 06 | 02 | F0 | 08 | A2 | 40 | CA | D0 |
| 0298 | FD | 88 | D0 | F8 | C9 | 0A | F0 | 2B | C9 | 0D | D0 | 06 | 20 | 2A | 03 | 4C |
| 02A8 | C2 | 02 | 8D | 01 | 02 | 20 | 17 | 03 | EE | 00 | 02 | A9 | 2F | EA | 18 | 69 |
| 02B8 | CD | EA | CD | 00 | 02 | 30 | 09 | 20 | 33 | 03 | 68 | A8 | 68 | AA | 68 | 60 |
| 02C8 | 20 | 2D | 03 | 20 | 17 | 03 | A9 | CD | EA | 29 | E0 | 8D | 02 | 02 | A2 | 07 |
| 02D8 | BD | 48 | 03 | 9D | 07 | 02 | CA | 10 | F7 | BE | 50 | 03 | A9 | 20 | A0 | 2F |
| 02E8 | EA | C0 | 20 | 30 | 01 | 0A | 8D | 08 | 02 | A0 | 00 | 20 | 07 | 02 | D0 | FB |
| 02F8 | EE | 09 | 02 | EE | 0C | 02 | EC | 09 | 02 | D0 | F0 | 20 | 07 | 02 | CC | 02 |
| 0308 | 02 | D0 | F8 | A9 | 20 | 20 | 0A | 02 | CE | 08 | 02 | D0 | F8 | F0 | A8 | AE |
| 0318 | 00 | 02 | AD | 01 | 02 | A0 | 00 | EA | D0 | 04 | 9D | 00 | D3 | 60 | 9D | 00 |
| 0328 | D7 | 60 | 20 | 17 | 03 | A9 | CD | EA | 8D | 00 | 02 | AE | 00 | 02 | BD | 00 |
| 0338 | D3 | A0 | 00 | EA | F0 | 03 | BD | 00 | D7 | 8D | 01 | 02 | A9 | 9A | D0 | D5 |
| 0348 | B9 | 00 | D0 | 99 | 00 | D0 | C8 | 60 | D3 | | | | | | | |

*(After entering manually first time, the program can save itself to cassette tape, directly)*

# SAVE/HEX DUMP PROGRAM

## GRAPHICS MANIPULATION

*Sir—Although the Compukit has a quite extensive graphics set, it is difficult to use them to their full potential. This is because a) there is no graphic documentation supplied with the machine and b) the graphics are not directly accessible from the keyboard. The program, Graphics-Aid, described below, overcomes both these problems and is a very useful tool for producing good graphic displays.*

*In use, the graphics section of the character set is displayed as the top half of the screen. The bottom half is clear and is used as the display area. The required graphic is selected by moving the top cursor over it. The bottom cursor is moved into position, and then by pressing the space bar the graphic character is deposited in that position. The bottom cursor is moved using the keys U, D, L and R (Up, Down, Left and Right) and the top using SHIFTED U, D, L and R.*

*RUB-OUT deletes the character under the bottom cursor (for correcting).*

SHIFT ' 'restarts program (used as a clear screen function.

*RETURN causes both cursors to flash revealing characters under them. Mode exited by pressing SHIFT.*

*SHIFT ';' (ie '+') this causes the machine to scan the display area with a visible cursor and when it encounters a character, its value along with its position relative to the original cursor is displayed: press any key to continue on to the next character. This function is very useful since many small displays (eg cars, spaceships etc) are poked into position relative to one pointer, so by setting the cursor to the centre of the display and using this function, it is possible to produce a working system quickly and easily.*

```
10 REM GRAPHICS AID: BY ADL
20 FOR I=128TO242
30 IF(I+10)/23=INT((I+10)/23)
THENPRINT:A=(A+1) AND1
40 IFA=1THENPRINTCHR$(I)"
";:GOTO60
50 PRINT" "CHR$(I);
60 NEXT:PRINT
70 FORI=0TO22:PRINT"
";:POKE54220+POS(8),I:NEXT
80 FORI=1TO10:PRINT:NEXT
100 C1=54221:C2=53261:POKE11,0:
POKE12,253:S=32
102 GOTO350
110 POKEC1,154:POKEC2-1,18:
POKEC2+1,22
120 X=USR(X):
A$=CHR$(PEEK(531))
130 IFA$="n"THENRUN
140 D=0:IFPEEK(57100)
<254THEN230
150 IFA$="U"THEND=-64
160 IFA$="D"THEND=64
170 IFA$="L"THEND=-1
180 IFA$="R"THEND=1
190 IFA$=" "THENS=PEEK(C2):
GOTO120
192 IFPEEK(531)=13THEN350
195 IFPEEK(531)=28THENS=32:
GOTO120
200 IFD=0THEN120
210 X=C1+D:IFX>54269ORX
<53645THEN120
220 POKEC1,S:S=PEEK(X):C1=X:
GOTO110
230 IFA$="e"THEND=-65
240 IFA$="T"THEND=65
250 IFA$=" "THEND=-2
260 IFA$="b"THEND=2
265 IFA$="+"THEN300
270 IFD=0THEN120
280 X=C2+D:IFX<53261ORX>53626
THEN120
290 POKEC2-1,32:POKEC2+1,32:
C2=X:GOTO110
300 POKEC1,S:D=32:FORI=
53645TO54269:POKEI-1,D:D=
PEEK(I):POKEI,154
310 IFD=32THEN340
320 PRINTD,I-C1;:POKE54221+
POS(8),32:X=USR(X)
330 PRINTCHR$(13)TAB(20)
CHR$(13);
340 NEXT:POKEI-1,32:
POKE54221,32:GOTO110
350 POKEC2-1,32:POKEC2+1,32:
POKEC1,S
360 FORI=1TO500:NEXT
370 POKEC2-1,18:POKEC2+1,22:
POKEC1,154
380 FORI=1TO500:NEXT
390 IFPEEK(57100)=254THEN350
400 GOTO120
```

**Note: Lines 40 to 70 there are two spaces between the quotes. Lines 50 & 190 there is one space between the quotes.**

*A. D. Love,*
*Swansea.*

## INDEXED SOFTWARE

*Sir—Here is an easy way of loading only one program from several filed on one cassette, which works on the UK101 and presumably the Superboard. When SAVEing start each program with:*

**1 A=X**
**9 A=O: poke 515,0**
*X is the sequential number of the program.*

*At the end of the program, while the tape is still running, type RUN (Return). Repeat this routine for each program.*

*When LOADing first type in these two program lines:*

**5 IF A=Y THEN NEW**
**6 END**
*Where Y is the number of the wanted program minus one.*

*Then LOAD the tape in the usual way. Each program will LOAD and then RUN. Until the program before the required one is reached, line 5 will do nothing and line 6 will stop the current program so that LOADing can continue.*

*When the penultimate program RUNs, line 5 promptly erases it, any surviving line of previous programs, and itself. The wanted program then LOADs and RUNs. Line 9 puts A=O in case A is a variable in the program and POKE 515,0 returns the computer to normal operation from LOAD. If you do not want any particular program actually to run, make line 9 STOP.*

*If the wanted program is the first on the cassette there is no need to enter lines 5 and 6. Just LOAD in the usual way. If there are to be only two programs on the cassette, do not bother with A=X, A=O and lines 5 and 6. To LOAD the second program, simply type 5 NEW before LOADing.*

*A. H. Whitfield*
*Maidenhead*

## SIMPLE DECODE

*Sir—There is a very simple way of address decoding for the UK101 which can be used to control up to 8 external devices, and which seems to have escaped attention.*

*IC17 pin 11 is selected (active low) when the address is A15......A0 = 1111 XX01 XXXX XXXX (X = don't care). To make use of this, a wire can be taken from this pin to one of the unused pins of the 40-pin expansion socket (pin 29 for instance, the earth connection having been cut). On the external decoding board, this is connected to pin 5 of a 74LS138 3-to-8 line decoder, pins 1,2,3,4 and 6 being respectively connected to A7, A10, A11, 0V and +5V.*

*Y0 (pin 15) is then selected when the address is F100 to F17F (61696 to 61823), Y1 (pin 14) for F180 to F1FF (61824 to 61951) etc.*

*W. Gough,*
*Cardiff.*

## A SMART PROBLEM

*Sir—I have built a UK101 and a Smart 2 8K expansion board from kits. The UK101 works well; it has the new monitor ROM and 8K on board.*

*On powering up the expansion board in the manner suggested in its instructions, a fault became evident after inserting ic's WNM and V. The UK101 would reset from its random screen pattern to show "select M, C or W", etc. but the cursor would not flash and several symbols (CHR 27) were present on the screen. These were the same at every switch on.*

*I have examined the board for soldering faults, both visually and with a meter. There are none that I can find. I have swapped all of the ic's around where possible. The fault is still present when the 8T28's on the UK101 are removed, these chips working OK when substituted elsewhere. If the expansion board is left plugged into J1 on the UK101, but not powered up, the computer works normally with its own 8K.*

*I presume the fault is on the expansion board, but I am not sure. Can anyone give me any advice on what to check? Or even, where to take it to have it checked?*

*I am not an electronics man, but I do have access to a 'scope and various meters, etc. Any help would be greatly appreciated.*

*Roger Cannon,*
*Basingstoke.*

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| Ref. | Amps 30V | Amps 15V | Price | P&P |
|---|---|---|---|---|
| 112 | .5 | 1 | 2.90 | 1.00 |
| 79 | 1 | 2 | 3.93 | 1.00 |
| 3 | 2 | 4 | 6.35 | 1.20 |
| 20 | 3 | 6 | 7.39 | 1.44 |
| 21 | 4 | 8 | 8.79 | 1.60 |
| 51 | 5 | 10 | 10.86 | 1.60 |
| 117 | 6 | 12 | 12.29 | 1.72 |
| 88 | 8 | 16 | 16.45 | 1.96 |
| 89 | 10 | 20 | 18.98 | 1.84 |
| 90 | 12 | 24 | 21.09 | O.A. |
| 91 | 15 | 30 | 24.18 | O.A. |
| 92 | 20 | 40 | 32.40 | O.A. |

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|---|---|---|---|---|
| 102 | .5 | 1 | 3.75 | 1.20 |
| 103 | 1 | 2 | 4.57 | 1.20 |
| 104 | 2 | 4 | 7.88 | 1.44 |
| 105 | 3 | 6 | 9.42 | 1.60 |
| 106 | 4 | 8 | 12.82 | 1.72 |
| 107 | 6 | 12 | 16.37 | 1.84 |
| 118 | 8 | 16 | 22.29 | 2.20 |
| 119 | 10 | 20 | 27.48 | O.A. |
| 109 | 12 | 24 | 32.88 | O.A. |

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| Ref | VA | Price | P & P |
|---|---|---|---|
| *07 | 20 | 4.64 | 1.20 |
| 149 | 60 | 7.37 | 1.20 |
| 150 | 100 | 8.38 | 1.44 |
| 151 | 200 | 12.28 | 1.72 |
| 152 | 250 | 14.61 | 2.04 |
| 154 | 500 | 22.52 | 2.20 |
| 155 | 750 | 32.03 | O.A. |
| 156 | 1000 | 40.92 | O.A. |
| 157 | 1500 | 56.52 | O.A. |
| 158 | 2000 | 67.99 | O.A. |
| 159 | 3000 | 95.33 | O.A. |

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|---|---|---|---|---|
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| 126 | 1 | 2 | 6.50 | 1.20 |
| 127 | 2 | 4 | 8.36 | 1.60 |
| 125 | 3 | 6 | 12.10 | 1.72 |
| 123 | 4 | 8 | 13.77 | 1.96 |
| 40 | 5 | 10 | 17.42 | 1.84 |
| 120 | 6 | 12 | 19.87 | 2.04 |
| 121 | 8 | 16 | 27.92 | O.A. |
| 122 | 10 | 20 | 32.51 | O.A. |
| 189 | 12 | 24 | 37.47 | O.A. |

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Pri 220-240 volts

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|---|---|---|---|---|
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| 70 | 6 | 3 | 6.99 | 1.20 |
| 108 | 8 | 4 | 8.16 | 1.44 |
| 72 | 10 | 5 | 8.93 | 1.60 |
| 116 | 12 | 6 | 9.89 | 1.60 |
| 17 | 16 | 8 | 11.79 | 1.72 |
| 115 | 20 | 10 | 15.87 | 1.84 |
| 187 | 30 | 15 | 19.72 | 2.04 |
| 226 | 60 | 30 | 40.41 | O.A. |

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| Ref | mA | Volts | £ | P&P |
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| 13 | 100 | 9-0-9 | 2.35 | 0.50 |
| 235 | 330, 330 | 0-9, 0-9 | 2.19 | 0.60 |
| 207 | 500, 500 | 0-8-9, 0-8-9 | 3.05 | 0.95 |
| 208 | 1A, 1A | 0-8-9, 0-8-9 | 3.88 | 1.20 |
| 236 | 200, 200 | 0-15, 0-15 | 2.19 | 0.60 |
| 214 | 300, 300 | 0-20, 0-20 | 3.08 | 1.00 |
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| 203 | 500, 500 | 0-15-27 | 4.39 | 1.20 |
| 204 | 1A, 1A | 0-15-27 | 6.84 | 1.20 |
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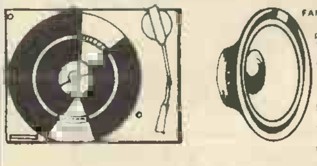

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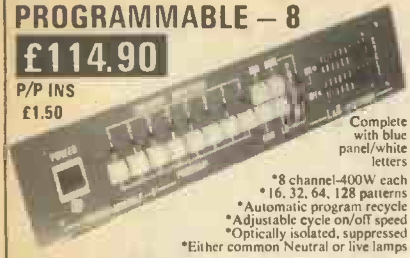

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